SPRINGER
REFERENCE

Jan W. Gooch

# Encyclopedic Dictionary of Polymers

Springer

# Encyclopedic Dictionary of Polymers

Jan W. Gooch (Ed.)

# Encyclopedic Dictionary of Polymers

With 710 Figures and 38 Tables

Springer

**Dr. Jan W. Gooch**
2020 Howell Mill Road
C227
Atlanta, GA 30318
USA

ISBN 13: 978-0-387-31021-3
The electronic version of the whole set will be available under ISBN-13: 978-0-387-30160-0.
The print and electronic bundle of the whole set will be available under ISBN-13: 978-0-387-33502-5.

springer.com

Printed on acid-free paper SPIN: 11494034 2109 — 5 4 3 2 1 0

The editor would like to express his gratitude to
all individuals who made available their time
and resources in order to contribute to this book:
F. Joseph Schork; Lisa Deter-Hoskin,
Roger D. Hester, Paula T. Hammond and
by James W. Larsen.

# Preface

The editor offers scientists, engineers, academia, and others interested in adhesives, coatings, elastomers, inks, plastics, and textiles a valuable communication tool within this book. In addition, the more recent innovations and biocompatible polymers and adhesives products have necessitated inclusion into any lexicon that addresses polymeric materials. Communication among scientific and engineering personnel has always been of critical importance, and as in any technical field, the terms and descriptions of materials and processes lag the availability of a manual or handbook that would benefit individuals working and studying in scientific and engineering disciplines. There is often a challenge when conveying an idea from one individual to another due to its complexity, and sometimes even the pronunciation of a word is different not only in different countries, but also in industries. Colloquialisms and trivial terms that find their way into technical language for materials and products tend to create a communications fog, thus unacceptable in today's global markets and technical communities.

The editor wishes to make a distinction between this book and traditional dictionaries, which provide a word and definition. The present book provides for each term a complete expression, chemical structures and mathematic expression where applicable, phonetic pronunciation, etymology, translations into German, French, and Spanish, and related figures if appropriate. This is a complete book of terminology never before attempted or published.

The information for each chemical entry is given as it is relevant to polymeric materials. Individual chemical species (e.g., ethanol) were taken from the *CRC Handbook of Chemistry and Physics* (2004), the Merck Index and other reference materials. The reader may refer to these references for additional physical properties and written chemical formulae. Extensive use was made of ChemDraw®, CambridgeSoft Corporation for naming and drawing chemical structures (conversion of structure to name and vice versa), which are included with each chemical entry where possible. Special attention was given to the IUPAC name that is often given with the common name for the convenience of the reader.

The editor assembled notes over a combined career in the chemical industries and academic institutions regarding technical communication among numerous colleagues and helpful acquaintances concerning expressions and associated anomalies. Presently, multiple methods of nomenclature are employed to describe identical chemical compounds by common and IUPAC names (e.g., acetone and 2-propanone) because the old systems (19th century European and trivial) methods of nomenclature exists with the modern International Union of Pure and Applied Chemistry, and the conflicts between them are not likely to relent in the near future including the weights and measures systems because some nations are reluctant to convert from English to metric and, and more recently, the International Systems of Units (SI). Conversion tables for converting other systems to the SI units are included in this book for this purpose. In addition, there are always differences in verbal pronunciation, but the reasons are not acceptable to prevent cogent communication between people sharing common interests.

In consideration of the many challenges confronting the reader, who must economize time investment, the structure of this book is optimized with regard the convenience of the reader as follows:

- Comprehensive table of contents
- Abbreviations and symbols
- Mathematics signs
- English, Greek, Latin, and Russian alphabets
- Pronunciation/phonetic symbols
- Main body of terms with entry term in English, French, German, and Italian
- Conversion factors
- Microbiology nomenclature and terminology
- References

The editor acknowledges the utilization of many international sources of information including journals, books, dictionaries, communications, and conversations with people experienced in materials, polymer science and engineering. A comprehensive reference section contains all of the sources of information used in this publication. Pronunciation, etymological, cross-reference, and related information is presented in the style of the 11th edn of the Merriam-Webster Dictionary, where known, for each term. The spelling for each term is presented in German, French, and Spanish where translation is possible. Each term in this book includes the following useful information:

- Spelling (in **bold** face) of each term and alternative spellings where more than one derivation is commonly used.
- Phonetic spelling \-\ using internationally published phonetic symbols, and this is the first book that includes phonetic pronunciation information missing in technical dictionaries that allows the reader to pronounce the term.
- Parts of speech in English following each phonetic spelling, e.g. *n.*, *adj.*
- Cross-references.
- Also called *example* in italics.
- Etymological information [-] for old and new terms that provides the reader the national origins of terms including root words, prefixes and suffixes; historical information is critical to the appreciation of a term and its true meaning.
- French, German, Italian, and Spanish spellings of the term {-}.
- A comprehensive explanation of the term.
- Mathematical expressions where applicable.
- Figures and tables where applicable.
- A comprehensive reference section is included for further research.

References are included for individual entries where a publication(s) is directly attributable to a definition or description. Not all of the references listed in the Reference section are directly attributable to entries, but they were reviewed for information and listed for the reader's information. Published dictionaries and glossaries of materials were very helpful for collecting information in the many diverse and smaller technologies of the huge field of polymers.

The editor is grateful that so much work has been done by other people interested in polymers.

The editor has attempted to utilize all relevant methods to convey the meaning of terms to the reader, because a term often requires more information than a standard entry in a textbook dictionary, so this book is dedicated to a complete expression. Terminology and correct pronunciation of technical terms is continuously evolving in scientific and industrial fields and too often undocumented or published, and therefore, not shared with others sometimes leading to misunderstandings. Engineering and scientific terms describe a material, procedure, test, theory or process, and communication between technical people must involve similar jargon or much will be lost in the translation as often has been the editor's experience. The editor has made an attempt to provide the reader who has an interested in the industries that have evolved from adhesives, coatings, inks, elastomers, plastics and textiles with the proper terminology to communicate with other parties whether or not directly involved in the industries. This publication is a single volume in the form of a desk-handbook that is hoped will be an invaluable tool for communicating in the spoken and written media.

Physics, electronic, and magnetic terms because they are related to materials and processes (e.g., *ampere*).

Biomolecular materials and processes have in the recent decade overlapped with polymer science and engineering. Advancements in polymeric materials research for biomolecular and medical applications are rapidly becoming commercialized, examples include biocompatible adhesives for sutureless tissue bonding, liquid dressings for wounds and many other materials used for *in vitro* and *in vivo* medical applications. To keep pace with these advancements, the editor has included useful terms in the main body that are commonly used in the material sciences for these new industries.

A microbiology section has been included to assist the reader in becoming familiar with the proper nomenclature of bacteria, fungi, mildew, and yeasts – organisms that affect materials and processes because they are ubiquitous in our environment. Corrosion of materials by micro-organisms is commonplace, and identification of a specific organism is critical to prevent its occurrence. Engineers and material scientists will appreciate the extensive sections on different types of micro-organisms together with a section dedicated to microbiology terminology that is useful for communicating in the jargon of biologists instead of referring to all organisms as "bugs."

New materials and processes, and therefore new terms, are constantly evolving with research, development and global commercialization. The editor will periodically update this publication for the convenience of the reader.

Statistics, numerical analysis other data processing, and experimental design terms are not addressed as individual terms, because they are not materials related, and the mathematical sciences possess an extensive, separate and distinct terminology while this book is primarily devoted to materials.

# Table of Contents

# Abbreviations and Symbols

| Abbreviations | Symbols |
|---|---|
| $An$ | Absorption (formerly extinction) (=log $t_i^{-1}$) |
| $A$ | Area |
| $A$ | Surface |
| $A$ | Helmholtz energy ($A = U - TS$) |
| $A$ | Pre-exponential constant [in $k = A \exp(-E^{\ddagger}/RT)$] |
| $A_2$ | Second virial coefficient |
| $a$ | Exponent in the property/molecular weight relationship ($E^{\ddagger} = KM^{a}$); always with an index, e.g., $a_n$, $a_s$, etc. |
| $a$ | Linear absorption coefficient, $a = l^{-1}$ |
| Absolute | abs |
| Acre | Spell out |
| Acre-foot | acre-ft |
| Air horsepower | air hp |
| Alternating-current (as adjective) | a-c |
| $A^{m}$ | molar Helmholtz energy |
| American Society for Testing and Materials | ASTM |
| Amount of a substance (mole) | n |
| Ampere | A or amp |
| Ampere-hour | amp-h |
| Amplitude, an elliptic function | am. |
| Angle | β |
| Angle, especially angle of rotation in optical activity | $\propto$ |
| Angstrom unit | Å |
| Antilogarithm | antilog |
| $a_0$ | Constant in the Moffit-Yang equation |
| Area | $A$ |
| Atactic | at |
| atomic weight | at. Wt. |
| Association | Assn. |
| Atmosphere | atm |
| Average | avg |
| Avogadro number | $N_L$ |
| Avoirdupois | avdp |
| Azimuth | az or α |
| Barometer | bar |
| Barrel | bbl |
| Baumé | Bé |
| $b_0$ | Constant in the Mofit-Yang equation |
| Board fee (feet board measure) | fbm |
| Boiler pressure | Spell out |
| Boiling point | bp |
| Boltzmann constant | k |
| Brake horsepower | bhp |
| Brake horsepower-hour | bhp-h |
| Brinell hardness number | Bhn |
| British Standards Institute | BSI |
| British thermal unit[1] | Btu or B |
| Bushel | bu |
| $C$ | Heat capacity |
| $c$ | Specific heat capacity (formerly; specific heat); $c_p$ = specific isobaric heat capacity, $c_v$ = specific isochore heat capacity |
| $c$ | "Weight" concentration (=weight of solute divided by volume of solvent); IUPAC suggests the symbol $\rho$ for this quantity, which could lead to confusion with the same IUPAC symbol for density |

| | |
|---|---|
| $\hat{c}$ | Speed of light in a vacuum |
| $\hat{c}$ | Speed of sound |
| Calorie | cal |
| Candle | c |
| Candle-hour | c-h |
| Candlepower | cp |
| Ceiling temperature of polymerization, °C | $T_c$ |
| Cent | c or ¢ |
| Center to center | c to c |
| Centigram | cg |
| Centiliter | cl |
| Centimeter or centimeter | cm |
| Centimeter–gram–second (system) | cgs |
| Centipoise | cP |
| Centistokes | cSt |
| Characteristic temperature | |
| Chemical | chem. |
| Chemical potential | µ |
| Chemical shift | δ |
| Chemically pure | cp |
| Circa, about, approximate | ca. |
| Circular | cir |
| Circular mils | cir mils |
| *cis*-tactic | ct |
| $C^m$ | molar heat capacity |
| Coefficient | coef |
| Cologarithm | colog |
| Compare | cf. |
| Concentrate | conc |
| Conductivity | cond, $\lambda$ |
| Constant | const |
| Continental horsepower | cont hp |
| Cord | cd |
| Cosecant | csc |
| Cosine | cos |
| Cosine of the amplitude, an elliptic function | cn |
| Cost, insurance, and freight | cif |
| Cotangent | cot |
| Coulomb | Spell out |
| Counter electromotive force | cemf |

| | |
|---|---|
| $C_{tr}$ | Transfer constant ($C_{tr} = k_{tr}/k_p$) |
| Cubic | cu |
| Cubic centimeter (liquid, meaning milliliter. ml) | cu, cm, $cm^3$ |
| Cubic centimeter | $cm^3$cubic expansion coefficient $\propto$ |
| Cubic foot | cu ft |
| Cubic feet per minute | cfm |
| Cubic feet per second | cfs |
| Cubic inch | cu in. |
| Cubic meter | cu m or $m^3$ |
| Cubic micron | cu µ or cu mu or $\mu^3$ |
| Cubic millimeter | cu mm or $mm^3$ |
| Cubic yard | cu yd |
| Current density | Spell out |
| Cycles per second | Spell out or c |
| Cylinder | cyl |
| D | Diffusion coefficient |
| $D_{rot}$ | Rotational diffusion coefficient |
| Day | Spell out |
| Decibel | db |
| Decigram | dg |
| Decomposition, °C | $T_{dc}$ |
| Degree | deg or ° |
| Degree Celsius | °C |
| Degree centigrade | C |
| Degree Fahrenheit | F or ° |
| Degree Kelvin | K or none |
| Degree of crystallinity | $\propto$ |
| Degree of polymerization | X |
| Degree Réaumur | R |
| Delta amplitude, an elliptic function | dn |
| Depolymerization temperature | $T_{dp}$ |
| Density | ρ |
| Diameter | diam |
| Dictionary of Architecture and construction | DAC |
| Diffusion coefficient | D |
| Dipole moment | p |
| Direct-current (as adjective) | d-c |
| Dollar | $ |

| | |
|---|---|
| Dozen | doz |
| Dram | dr |
| Dynamic viscosity | ŋ |
| $E$ | Energy ($E_k$ = kinetic energy, $E_p$ = potential energy, $E^{\ddagger}$ = energy of activation) |
| $E$ | Electronegativity |
| $E$ | Modulus of elasticity, Young's modulus ($E = \sigma_{ii}/\epsilon_{ii}$) |
| $E$ | General property |
| $\mathbf{E}$ | Electrical field strength |
| $e$ | Elementary charge |
| $e$ | Parameter in the $Q$-$e$ co-polymerization theory |
| $e$ | Cohesive energy density (always with an index) |
| Edition | edn. |
| Editor, edited | ed |
| Efficiency | eff |
| Electric | elec |
| Electric polarizability of a molecule | ∝ |
| Electrical current strength | I |
| Electrical potential | V |
| Electrical resistance | R or X |
| Electromotive force | emf |
| Electronegativity | E |
| Elevation | el |
| Energy | E |
| Enthalph | H |
| Entropy | S |
| Equation | eq |
| Equivalent weight | equiv wt |
| Et alii (and others) | et al. |
| Et cetera | etc. |
| Excluded volume | u |
| excluded volume cluster integral | β |
| Exempli gratia (for example) | e.g. |
| Expansion coefficient | ∝ |

| | |
|---|---|
| External | ext |
| $F$ | Force |
| $f$ | Fraction (exclusing molar fraction, mass fraction, volume fraction) |
| $f$ | Molecular coefficient of friction (e.g., $f_s$, $f_D$, $f_{\mathrm{rot}}$) |
| $f$ | Functionality |
| Farad | Spell out or f |
| Federal | Fed. |
| Feet board measure (board feet) | fbm |
| Feet per minute | fpm |
| Feet per second | fps |
| Flash point | flp |
| Fluid | fl |
| Foot | ft |
| Foot-candle | ft-c |
| Foot-Lambert | ft-L |
| Foot-pound | ft-lb |
| Foot-pound-second (system) | fps |
| Foot-second (see cubic feet per second) | |
| Fraction | ∫ |
| Franc | fr |
| Free aboard ship | Spell out |
| Free alongside ship | Spell out |
| Free on board | fob |
| Freezing point | fp |
| Frequency | Spell out |
| Fusion point | fnp |
| $G$ | Gibbs energy (formerly free energy or free enthalpy) ($G = H - TS$) |
| $G$ | Shear modulus ($G = \sigma_{ij}/$*angle of shear)* |
| $G$ | Statistical weight fraction ($G_l = g_l/\Sigma_l\, g_i$) |
| $g$ | Gravitational acceleration |
| $g$ | Statistical weight |
| $g$ | *Gauche* conformation |

| | |
|---|---|
| $g$ | Parameter for the dimensions of branched macromolecules |
| $G^{m}$ | Molar Gibbs energy |
| Gallon | gal |
| Gallons per minute | gpm |
| Gallons per second | gps |
| Aauche conformation | g |
| Gibbs energy | G |
| Grain | Spell out |
| Gram | g |
| Gram-calorie | g-cal |
| Greatest common divisor | gcd |
| $H$ | Enthalpy |
| $H^{m}$ | Molar enthalpy |
| $h$ | Height |
| $h$ | Plank constant |
| Haversine | hav |
| Heat | Q |
| Heat capacity | C |
| Hectare | ha |
| Henry | H |
| High pressure (adjective) | h-p |
| Hogshead | hhd |
| Horsepower | hp |
| Horsepower-hour | hp-h |
| Hour | h or hr |
| Hundred | C |
| Hundredweight (112 lb) | cwt |
| Hydrogen ion concentration, negative logarithm of | pH |
| Hyperbolic cosine | cosh |
| Hyperbolic sine | sinh |
| Hyperbolic tangent | tanh |
| $I$ | Electrical current strength |
| $I$ | Radiation intensity of a system |
| $i$ | Radiation intensity of a molecule |
| Ibidem (in the same place) | ibid. |
| Id est (that is) | i.e. |

| | |
|---|---|
| Inch | in. |
| Inch-pound | in-lb |
| Inches per second | ips |
| Indicated horsepower | ihp |
| Indicated horsepower-hour | ihp-h |
| Infrared | IR |
| Inside diameter | ID |
| Intermediate-pressure (adjective) | i-p |
| Internal | int |
| International Union of Pure and Applied Chemistry | IUPAC |
| Isotactic | it |
| $J$ | Flow (of mass, volume, energy, etc.), always with a corresponding Index |
| Joule | J |
| $K$ | General constant |
| $K$ | Equilibrium constant |
| $K$ | Compression modulus ($p = -K\,\Delta V/V_0$) |
| $k$ | Boltzmann constant |
| $k$ | Rate constant for chemical reactions (always with an index) |
| Kelvin | K (Not $^{o}$K) |
| Kilocalorie | kcal |
| Kilocycles per second | kc |
| Kilogram | kg |
| Kilogram-calorie | kg-al |
| Kilogram-meter | kg-m |
| Kilograms per cubic meter | kg per cu m or kg/m$^{3}$ |
| Kilograms per second | kgps |
| Kiloliter | kl |
| Kilometer or kilometer | km |
| Kilometer per second | kmps |
| Kilovolt | kV |
| Kilovolt-ampere | kVA |
| Kilowatt | kW |

| | |
|---|---|
| Kilowatthour | kWh |
| Knoop hardeness number | KHN |
| *L* | Chain end-to-end distance |
| *L* | Phenomenological coefficient |
| *l* | Length |
| Lambert | L |
| Latitude | lat or $\phi$ |
| Least common multiple | lcm |
| Length | l |
| Linear expansion coefficient | Y |
| Linear foot | lin ft |
| Liquid | liq |
| Lira | Spell out |
| Liter | l |
| Logarithm (common) | log |
| Logarithm (natural) | log. or ln |
| Kibgutyde | kibg. or $\lambda$ |
| Loss angle | δ |
| Low-pressure (as adjuective) | l-p |
| Lumen | 1* |
| Lumen-hour | 1-h* |
| Luments per watt | lpW |
| *M* | "Molecular weight" (IUPAC molar mass) |
| *m* | Mass |
| Mass | spell out or m |
| Mass fraction | w |
| Mathematics (ical) | math |
| Maximum | max |
| Mean effective pressure | mep |
| Mean horizontal candlepower | mhcp |
| Meacycle | mHz |
| Megohm | MΩ |
| Melting point, -temperature | mp, $T_m$ |
| Meter | m |
| Meter-kilogram | m-kg |
| Metre | m |
| Mho | spell out |
| Microampere | µA or mu A |
| Microfarad | µf |

| | |
|---|---|
| Microinch | µin. |
| Micrometer (formerly micron) | µm |
| Micromicrofarad | µµf |
| Micromicron | µµ |
| Micron | µ |
| Microvolt | µV |
| Microwatt | µW or mu W |
| Mile | Spell out |
| Miles per hour | mph |
| Miles per hour per second | mphps |
| Milli | m |
| Milliampere | mA |
| Milliequivalent | meq |
| Milligram | mg |
| Millihenry | mH |
| Millilambert | mL |
| Milliliter or milliliter | ml |
| Millimeter | mm |
| Millimeter or mercury (pressure) | mmHg |
| Millimicron | mµ or m mu |
| Million | Spell out |
| Million gallons per day | mgd |
| Millivolt | mV |
| Minimum | min |
| Minute | min |
| Minute (angular measure) | ′ |
| Minute (time) (in astronomical tables) | m |
| Mile | Spell out |
| Modal | m |
| Modulus of elasticity | E |
| Molar | M |
| Molar enthalpy | $H^m$ |
| Molar Gibbs energy | $G_m$ |
| Molar heat capacity | $H_m$ |
| Mole | mol |
| Mole fraction | x |
| Molecular weight | Mol wt or M |
| Month | Spell out |
| *N* | Number of elementary particles (e.g., molecules, groups, atoms, electrons) |

| | |
|---|---|
| $N_L$ | Avogadro number (Loschmidt's number) |
| $n$ | Amount of a substance (mole) |
| $n$ | Refractive index |
| Nanometer (formerly millimicron) | nm |
| National Association of Corrosion Engineers | NACE |
| National Electrical Code | NEC |
| Newton | N |
| Normal | N |
| Number of elementary particles | N |
| Occupational Safety and Health Administration | OSHA |
| Ohm | Ω |
| Ohm-centimeter | ohm-cm |
| Oil absorption | O.A. |
| Ounce | oz |
| Once-foot | oz-ft |
| Ounce-inch | oz-in. |
| Outside diameter | OD |
| Osomotic pressure | Π |
| $P$ | Permeability of membranes |
| $p$ | Probability |
| $p$ | Dipole moment |
| $\mathbf{p}_i$ | Induced dipolar moment |
| $p$ | pressure |
| $p$ | Extent of reaction |
| Paint Testing Manual | PTM |
| Parameter | Q |
| Partition function (system) | Q |
| Parts per billion | ppb |
| Parts per million | ppm |
| Pascal | Pa |
| Peck | pk |
| Penny (pency–new British) | p. |
| Pennyweight | dwt |

| | |
|---|---|
| Per | Diagonal line in expressions with unit symbols or (see Fundamental Rules) |
| Percent | % |
| Permeability of membranes | P |
| Peso | Spell out |
| Pint | pt. |
| Planck's constant ($E = h\nu$) (6.62517 $\pm$ 0.00023 $\times 10^{-27}$ erg s | h |
| Polymolecularity index | Q |
| Potential | Spell out |
| Potential difference | Spell out |
| pound | lb |
| Pound-foot | lb-ft |
| Pound-inch | lb-in. |
| Pound sterling | £ |
| Pounds-force per square inch | psi |
| Pounds per brake horsepower-hour | lb per bhp-hr |
| Pounds per cubic foot | lb per cut ft |
| Pounds per square foot | psf |
| Pounds per square inch | psi |
| Pounds per square inch absolute | psia |
| Power factor | Spell out or pf |
| Pressure | p |
| Probability | p |
| $Q$ | Quantity of electricity, charge |
| $Q$ | Heat |
| $Q$ | Partition function (system) |
| $Q$ | Parameter in the $Q$–$e$ co-polymerization equation |
| $Q$, $Q$ | Polydispersity, polymolecularity index ($Q = \overline{M}_w/\overline{M}_n$) |
| $q$ | Partition function (particles) |

| | |
|---|---|
| Quantity of electricity, charge | Q |
| Quart | qt |
| Quod vide (which see) | q.v. |
| $R$ | Molar gas constant |
| $R$ | Electrical resistance |
| $R_G$ | Radius of gyration |
| $R_n$ | Run number |
| $R_\vartheta$ | Rayleigh ratio |
| $r$ | Radius |
| $r_0$ | Initial molar ratio of reactive groups in polycondensations |
| Radian | Spell out |
| Radius | r |
| Radius of gyration | $R_G$ |
| Rate constant | k |
| Rayleigh ratio | $R_\vartheta$ |
| Rayleigh scattering | |
| Reactive kilovolt-ampere | kVA |
| Reactive volt-ampere | VA |
| Reference(s) | ref |
| Refractive index | n |
| Relaxation time | τ |
| Resistivity | ρ |
| Revolutions per minute | rpm |
| Revolutions per second | rps |
| Rod | Spell out |
| Root mean square | rms |
| $S$ | Entropy |
| $S^m$ | Molar entropy |
| $S$ | Solubility coefficient |
| $s$ | Sedimentation coefficient |
| $s$ | Selectivity coefficient in osmotic measurements) |
| Saybolt Universal seconds | SUS |
| Secant | sec |
| Second | s or sec |
| Second (angular measure) | ″ |

| | |
|---|---|
| Second-foot (see cubic feet per second) | |
| Second (time) (in astronomical tables) | s |
| Second virial coefficient | $A_2$ |
| Shaft horsepower | shp |
| Shilling | s |
| Sine | sin |
| Sine of the amplitude, an elliptic function | sn |
| Society | Soc. |
| Soluble | sol |
| Solubility coefficient | S |
| Solubility parameter | δ |
| Solution | soln |
| Specific gravity | sp gr |
| Specific heat | sp ht |
| Specific heat capacity (formerly: specific heat) | c |
| Specific optical rotation | $[\propto]$ |
| Specific volume | sp vol |
| Spherical candle power | scp |
| Square | sq |
| Square centimeter | sq cm or $cm^2$ |
| Square foot | sq ft |
| Square inch | sq in. |
| Square kilometer | sq km or $km^2$ |
| Square meter | sq m or $m^2$ |
| Square micron | sq μ or $\mu^2$ |
| Square root of mean square | rms |
| Standard | std |
| Standard | Stnd. |
| Standard deviation | σ |
| Staudinger index | [η] |
| Stere | s |
| Syndiotactic | st |
| $T$ | Temperature |
| $t$ | Time |
| $t$ | *trans* conformation |
| Tangent | tan |
| Temperature | T or temp |
| Tensile strength | ts |
| Threodiisotactic | tit |

| | |
|---|---|
| Thousand | M |
| Thousand foot-pounds | kip-ft |
| Thousand pound | kip |
| Ton | Spell out |
| Ton-mile | Spell out |
| Trans conformation | t |
| Trans-tactic | tt |
| $U$ | Voltage |
| $U$ | Internal energy |
| $U^m$ | Molar internal energy |
| $u$ | Excluded volume |
| Ultraviolet | UV |
| United States | US |
| $V$ | Volume |
| $V$ | Electrical potential |
| $v$ | Rate, rate of reaction |
| $v$ | Specific volume always with an index) |
| Vapor pressure | vp |
| Versed sine | vers |
| Versus | vs |
| Volt | v or V |
| Volt-ampere | VA |
| Volt-coulomb | Spell out |
| Voltage | U |
| Volume | V or vol. |
| Volume (of a publication) | Vol |
| $W$ | Weight |
| $W$ | Work |
| $w$ | Mass function |
| Watt | w or W |
| Watthour | Wh |
| Watts per candle | wpc |
| Week | Spell out |
| Weight | W or w |
| Weight concentration* | c |
| Work | *y* yield |
| $X$ | Degree of polymerization |
| $X$ | Electrical resistance |
| $x$ | Mole fractio *y* yield |
| Yard | yd |
| Year | yr |
| Young's | E |
| $Z$ | Collision number |
| $Z$ | *z* fraction |
| $z$ | Ionic charge |

| | |
|---|---|
| $z$ | Coordination number |
| $z$ | Dissymmetry (light scattering) |
| $z$ | Parameter in excluded volume theory |
| $\alpha$ | Angle, especially angle of rotation in optical activity |
| $\alpha$ | Cubic expansion coefficient [$\alpha = V^{-1}(\partial V/\partial T)_p$] |
| $\alpha$ | Expansion coefficient (as reduced length, e.g., $\alpha_L$ in the chain end-to-end distance or $\alpha_R$ for the radius of gyration) |
| $\alpha$ | Degree of crystallinity (always with an index) |
| $\alpha$ | Electric polarizability of a molecule |
| $[\alpha]$ | "Specific" optical rotation |
| $\beta$ | angle |
| $\beta$ | Coefficient of pressure |
| $\beta$ | Excluded volume cluster integral |
| $\Gamma$ | Preferential solvation |
| $\gamma$ | Angle |
| $\gamma$ | Surface tension |
| $\gamma$ | Linear expansion coefficient |
| $\delta$ | Loss angle |
| $\delta$ | Solubility parameter |
| $\delta$ | Chemical shift |
| $\epsilon$ | Linear expansion ($\epsilon = \Delta l/l_0$) |
| $\epsilon$ | Expectation |
| $\epsilon_r$ | Relative permittivity (dielectric number) |
| $\eta$ | Dynamic viscosity |
| $[\eta]$ | Staudinger index (called $J_0$ in DIN 1342) |
| | Characteristic temperature, especially theta temperature |

| | |
|---|---|
| θ | Angle, especially angle of rotation |
| ϑ | Angle, especially valence angle |
| k | Isothermal compressibility [$k = V^{-1}\ (\partial V/\partial p)_T$] |
| k | Enthalpic interaction parameter in Solution theory |
| $\lambda$ | Wavelength |
| $\lambda$ | Heat conductivity |
| $\lambda$ | Degree of coupling |
| μ | Chemical potential |
| μ | Moment |
| μ | Permanent dipole moment |
| ν | Moment, with respect to a reference value |
| ν | Frequency |
| ν | Kinetic chain length |
| φ | Shielding ratio in the theory of Random coils |
| Ξ | Partition function |
| Π | Osmotic pressure |
| ρ | Density |
| σ | Mechanical stress ($\sigma_{ii}$ = normal stress, $\sigma_{ij}$ = shear stress) |
| σ | Standard deviation |
| σ | Hindrance parameter |
| τ | Relaxation time |
| $\tau_i$ | Internal transmittance (transmission factor) (represents the ratio of transmitted to absorbed light) |
| $\phi$ | Volume fraction |
| $\varphi(r)$ | Potential between two segments separated by a distance $r$ |
| Φ | Constant in the viscosity-molecular-weight relationship |
| [Φ] | "Molar" optical rotation |
| ξ | Interaction parameter in solution theory |
| $\psi$ | Entropic interaction parameter in solution theory |
| $\omega$ | Angular frequency, angular velocity |
| Ω | angle |
| Ω | Probability |
| Ω | Skewness of a distribution |

*Weight of solute divided by volume of solvent; IUPAC suggests the symbol ρ for this quantity, which could lead to confusion with the same IUPAC symbol for density.

**Notations**

The abbreviations for chemicals and polymer were taken from the "Manual of Symbols and Terminology for Physicochemical Quantities and Units," Pure Appl Chem 21*1) (1970), but some were added because of generally accepted use.

The ISO (International Standardization Organization) has suggested that all extensive quantities should be described by capital letters and all intensive quantities by lower-case letters. IUPAC does not follow this recommendation, however, uses lower-case letters for specific quantities.

The following symbols are used above or after a letter.

## Symbols above letters

—: Signifies an average, e.g., $\overline{M}$ is the average molecular weight; more complicated averages are often indicated by ⟨⟩, e.g., $\langle R_G^2 \rangle$ is another way of writing $\overline{(R_G^2)}_z$

~: Stands for a partial quantity, e.g., $\tilde{v}_A$ is the partial specific volume of the compound A; $V_A$ is the volume of A, whereas $\tilde{V}_A^m$ xxx is the partial molar volume of A.

## Superscripts

°: Pure substance or standard state

∞: Infinite dilution or infinitely high molecular weight

$m$: Molar quantity (in cases where subscript letters are impractical)

($q$): The $q$ order of a moment (always in parentheses)

‡: Activated complex

*Subscripts*

| | |
|---|---|
| Initial state | |
| 1 | Solvent |
| 2 | Solute |
| 3 | Additional components (e.g., precipitant, salt, etc.) |
| am | Amorphous |
| $B$ | Brittleness |
| bd | Bond |
| cr | Crystalline |
| crit | Critical |
| cryst | Crystallization |
| e | Equilibrium |
| E | End group |
| G | Glassy state |
| $i$ | Run number |
| $i$ | Initiation |
| i | Isotactic diads |
| ii | Isotactic triads |
| Is | Heterotactic triads |
| $j$ | Run number |
| $k$ | Run number |
| m | Molar |
| M | Melting process |
| mon | Monomer |
| $n$ | Number average |
| $p$ | Polymerization, especially propagation |
| pol | polymer |
| $r$ | General for average |
| s | Syndiotactic diads |
| ss | Syndiotactic triads |
| st | start reaction |
| $t$ | Termination |
| tr | transfer |
| $u$ | Monomeric unit |
| w | Weight average |
| $z$ | $z$ average |

*Prefixes*

| | |
|---|---|
| at | atactic |
| ct | *cis*-tactic |
| eit | erythrodiisotactic |
| it | isotactic |
| st | syndiotactic |
| tit | threodiisotactic |
| tt | *trans*-tactic |

Square brackets around a letter signify molar concentrations. (IUPAC prescribes the symbol $c$ for molar concentrations, but to date this has consistently been used for the mass/volume unit.)

Angles are always given by °.

Apart from some exceptions, the meter is not used as a unit of length; the units cm and mm derived from it are used. Use of the meter in macromolecular science leads to very impractical units.

## Elemental symbols and atomic weights

Source: International Union of Pure and Applied Chemistry (IUPAC) 2001. Values from the 2001 table Pure Appl. Chem. 75: 1107–1122 (2003). The values of zinc, krypton, molybdenum and dysprosium have been modified. The *approved name* for element 110 is included, see Pure Appl. Chem. 75: 1613-1615 (2003). The *proposed name* for element 111 is also included.

A number in parentheses indicates the uncertainty in the last digit of the atomic weight.

1. Geological specimens are known in which the element has an isotopic composition outside the limits for normal material. The difference between the atomic weight of the element in such specimens and that given in the table may exceed the stated uncertainty.
2. Range in isotopic composition of normal terrestrial material prevents a more precise value being given; the tabulated value should be applicable to any normal material.
3. Modified isotopic compositions may be found in commercially available material because it has been subject to an undisclosed or inadvertent isotopic fractionation. Substantial deviations in atomic weight of the element from that given in the Table can occur.
4. Commercially available Li materials have atomic weights that range between 6.939 and 6.996; if a more accurate value is required, it must be

## List of elements in name order

| At. No. | Symbol | Name | Atomic wt. | Notes |
|---|---|---|---|---|
| 89 | Ac | Actinium | [227] | 5 |
| 13 | Al | Aluminium | 26.981538(2) | |
| 95 | Am | Americium | [243] | 5 |
| 51 | Sb | Antimony | 121.760(1) | 1 |
| 18 | Ar | Argon | 39.948(1) | 1, 2 |
| 33 | As | Arsenic | 74.92160(2) | |
| 85 | At | Astatine | [210] | 5 |
| 56 | Ba | Barium | 137.327(7) | |
| 97 | Bk | Berkelium | [247] | 5 |
| 4 | Be | Beryllium | 9.012182(3) | |
| 83 | Bi | Bismuth | 208.98038(2) | |
| 107 | Bh | Bohrium | [264] | 5, 6 |
| 5 | B | Boron | 10.811(7) | 1, 2, 3 |
| 35 | Br | Bromine | 79.904(1) | |
| 48 | Cd | Cadmium | 112.411(8) | 1 |
| 55 | Cs | Caesium | 132.90545(2) | |
| 20 | Ca | Calcium | 40.078(4) | 1 |
| 98 | Cf | Californium | [251] | 5 |
| 6 | C | Carbon | 12.0107(8) | 1, 2 |
| 58 | Ce | Cerium | 140.116(1) | 1 |
| 17 | Cl | Chlorine | 35.453(2) | 3 |
| 24 | Cr | Chromium | 51.9961(6) | |
| 27 | Co | Cobalt | 58.933200(9) | |
| 29 | Cu | Copper | 63.546(3) | 2 |
| 96 | Cm | Curium | [247] | 5 |
| 110 | Ds | Darmstadtium | [281] | 5, 6 |
| 105 | Db | Dubnium | [262] | 5, 6 |
| 66 | Dy | Dysprosium | 162.500(1) | 1 |
| 99 | Es | Einsteinium | [252] | 5 |
| 68 | Er | Erbium | 167.259(3) | 1 |
| 63 | Eu | Europium | 151.964(1) | 1 |
| 100 | Fm | Fermium | [257] | 5 |
| 9 | F | Fluorine | 18.9984032(5) | |
| 87 | Fr | Francium | [223] | 5 |
| 64 | Gd | Gadolinium | 157.25(3) | 1 |
| 31 | Ga | Gallium | 69.723(1) | |
| 32 | Ge | Germanium | 72.64(1) | |
| 79 | Au | Gold | 196.96655(2) | |
| 72 | Hf | Hafnium | 178.49(2) | |
| 108 | Hs | Hassium | [277] | 5, 6 |
| 2 | He | Helium | 4.002602(2) | 1, 2 |
| 67 | Ho | Holmium | 164.93032(2) | |
| 1 | H | Hydrogen | 1.00794(7) | 1, 2, 3 |
| 49 | In | Indium | 114.818(3) | |
| 53 | I | Iodine | 126.90447(3) | |
| 77 | Ir | Iridium | 192.217(3) | |
| 26 | Fe | Iron | 55.845(2) | |

| | | | | |
|---|---|---|---|---|
| 36 | Kr | Krypton | 83.798(2) | 1, 3 |
| 57 | La | Lanthanum | 138.9055(2) | 1 |
| 103 | Lr | Lawrencium | [262] | 5 |
| 82 | Pb | Lead | 207.2(1) | 1, 2 |
| 3 | Li | Lithium | [6.941(2)] | 1, 2, 3, 4 |
| 71 | Lu | Lutetium | 174.967(1) | 1 |
| 12 | Mg | Magnesium | 24.3050(6) | |
| 25 | Mn | Manganese | 54.938049(9) | |
| 109 | Mt | Meitnerium | [268] | 5, 6 |
| 101 | Md | Mendelevium | [258] | 5 |
| 80 | Hg | Mercury | 200.59(2) | |
| 42 | Mo | Molybdenum | 95.94(2) | 1 |
| 60 | Nd | Neodymium | 144.24(3) | 1 |
| 10 | Ne | Neon | 20.1797(6) | 1, 3 |
| 93 | Np | Neptunium | [237] | 5 |
| 28 | Ni | Nickel | 58.6934(2) | |
| 41 | Nb | Niobium | 92.90638(2) | |
| 7 | N | Nitrogen | 14.0067(2) | 1, 2 |
| 102 | No | Nobelium | [259] | 5 |
| 76 | Os | Osmium | 190.23(3) | 1 |
| 8 | O | Oxygen | 15.9994(3) | 1, 2 |
| 46 | Pd | Palladium | 106.42(1) | 1 |
| 15 | P | Phosphorus | 30.973761(2) | |
| 78 | Pt | Platinum | 195.078(2) | |
| 94 | Pu | Plutonium | [244] | 5 |
| 84 | Po | Polonium | [209] | 5 |
| 19 | K | Potassium | 39.0983(1) | 1 |
| 59 | Pr | Praseodymium | 140.90765(2) | |
| 61 | Pm | Promethium | [145] | 5 |
| 91 | Pa | Protactinium | 231.03588(2) | 5 |
| 88 | Ra | Radium | [226] | 5 |
| 86 | Rn | Radon | [222] | 5 |
| 75 | Re | Rhenium | 186.207(1) | |
| 45 | Rh | Rhodium | 102.90550(2) | |
| 111 | Rg | Roentgenium | [272] | 5, 6 |
| 37 | Rb | Rubidium | 85.4678(3) | 1 |
| 44 | Ru | Ruthenium | 101.07(2) | 1 |
| 104 | Rf | Rutherfordium | [261] | 5, 6 |
| 62 | Sm | Samarium | 150.36(3) | 1 |
| 21 | Sc | Scandium | 44.955910(8) | |
| 106 | Sg | Seaborgium | [266] | 5, 6 |
| 34 | Se | Selenium | 78.96(3) | |
| 14 | Si | Silicon | 28.0855(3) | 2 |
| 47 | Ag | Silver | 107.8682(2) | 1 |
| 11 | Na | Sodium | 22.989770(2) | |
| 38 | Sr | Strontium | 87.62(1) | 1, 2 |
| 16 | S | Sulfur | 32.065(5) | 1, 2 |
| 73 | Ta | Tantalum | 180.9479(1) | |
| 43 | Tc | Technetium | [98] | 5 |
| 52 | Te | Tellurium | 127.60(3) | 1 |

| | | | | |
|---|---|---|---|---|
| 65 | Tb | Terbium | 158.92534(2) | |
| 81 | Tl | Thallium | 204.3833(2) | |
| 90 | Th | Thorium | 232.0381(1) | 1, 5 |
| 69 | Tm | Thulium | 168.93421(2) | |
| 50 | Sn | Tin | 118.710(7) | 1 |
| 22 | Ti | Titanium | 47.867(1) | |
| 74 | W | Tungsten | 183.84(1) | |
| 112 | Uub | Ununbium | [285] | 5, 6 |
| 116 | Uuh | Ununhexium | | see Note above |
| 118 | Uuo | Ununoctium | | see Note above |
| 114 | Uuq | Ununquadium | [289] | 5, 6 |
| 92 | U | Uranium | 238.02891(3) | 1, 3, 5 |
| 23 | V | Vanadium | 50.9415(1) | |
| 54 | Xe | Xenon | 131.293(6) | 1, 3 |
| 70 | Yb | Ytterbium | 173.04(3) | 1 |
| 39 | Y | Yttrium | 88.90585(2) | |
| 30 | Zn | Zinc | 65.409(4) | |
| 40 | Zr | Zirconium | 91.224(2) | 1 |

determined for the specific material [range quoted for 1995 Tables 6.94 and 6.99].

5. Element has no stable nuclides. The value enclosed in brackets, e.g. [209], indicates the mass number of the longest-lived isotope of the element. However, three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.
6. The names and symbols for elements 112–118 are under review. The temporary system recommended by J Chatt (1979) Pure Appl. Chem. 51: 381–384 is used above. The names of elements 101–109 were agreed in 1997 [see Pure Appl. Chem. 69: 2471–2473 (1997)] and for element 110 in 2003 [see Pure Appl. Chem. 75: 1613–1615 (2003)]. The proposed name for element 111 is also included.

1. Geological specimens are known in which the element has an isotopic composition outside the limits for normal material. The difference between the atomic weight of the element in such specimens and that given in the table may exceed the stated uncertainty.
2. Range in isotopic composition of normal terrestrial material prevents a more precise value being given; the tabulated value should be applicable to any normal material.
3. Modified isotopic compositions may be found in commercially available material because it has been subject to an undisclosed or inadvertent isotopic fractionation. Substantial deviations in atomic weight of the element from that given in the table can occur.
4. Commercially available Li materials have atomic weights that range between 6.939 and 6.996; if a more accurate value is required, it must be determined for the specific material [range quoted for 1995 Tables 6.94 and 6.99].
5. Element has no stable nuclides. The value enclosed in brackets, e.g. [209], indicates the mass number of the longest-lived isotope of the element. However, three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and atomic weights are tabulated.
6. The names and symbols for elements 112–118 are under review. The temporary system recommended by J Chatt (1979) Pure Appl. Chem. 51: 381–384, is used above. The names of elements 101–109 were agreed in 1997 [see Pure Appl. Chem. 69: 2471–2473 (1997)] and for element 110 in 2003 [see Pure Appl. Chem. 75: 1613–1615 (2003)]. The proposed name for element 111 is also included.

# Pronunciation symbols

| | |
|---|---|
| ə | Banana, collide, abut |
| ˈə, ˌə | Humdrum, abut |
| ᵊ | Immediately preceding \l\, \n\, \m\, \ŋ \, as in batt**le**, mitt**en**, eat**en**, and sometimes op**en** \ˈō-pᵊm\, lock **and** key \-ᵊ ŋ-\; immediately following \l\, \m\, \r\, as often in French table, pris**me**, tit**re** |
| ər | furth**er**, m**er**g**er**, b**ir**d |
| ˈə-,ˈə- | As in two different pronunciations of |
| r | h**urr**y \ˈ hər-ē, \ˈ hə-rē\ |
| a | m**a**t, m**a**p, m**a**d, g**a**g, sn**a**p, p**a**tch |
| ā | d**a**y, f**a**de, d**a**te, **a**orta, dr**a**pe, c**a**pe |
| ä | b**o**ther, c**o**t, and, with most American speakers, f**a**ther, c**a**rt |
| á | f**a**ther as pronounced by speakers who do not rhyme it with *bother*; French p**a**tte |
| aú | n**ow**, l**ou**d, **ou**t |
| b | ba**b**y, ri**b** |
| ch | **ch**in, nature \ˈnā-chər\ |
| d | **d**i**d**, a**dd**er |
| e | b**e**t, b**e**d, p**e**ck |
| ˈē,ˌē | b**ea**t, nosebl**ee**d, **e**venly, **ea**sy |
| ē | eas**y**, meal**y** |
| f | **f**i**f**ty, cu**ff** |
| g | **g**o, bi**g**, **g**ift |
| h | **h**at, a**h**ead |
| hw | **wh**ale as pronounced by those who do not have the same pronunciation for both *whale* and *wail* |
| i | t**i**p, ban**i**sh, act**i**ve |
| ī | s**i**te, s**i**de, b**uy**, tr**i**pe |
| j | **j**ob, **g**em, e**dge**, **j**oin, **j**u**dge** |
| k | **k**in, coo**k**, a**che** |
| k̲ | German i**ch**, Bu**ch**; one pronunciation of lo**ch** |
| l | **l**ily, poo**l** |
| m | **m**ur**m**ur, di**m**, ny**m**ph |
| n | **n**o, ow**n** |
| ⁿ | Indicates that a preceding vowel or diphthong is pronounced with the nasal passages open, as in French *un bon vin blanc* \œⁿ-bōⁿvaⁿ-bläⁿ\ |
| ŋ | sing \ˈ siŋ \, singer \ˈ siŋ-ər\, finger \ˈfiŋ-gər\, ink \ˈIŋk\ |
| ō | b**o**ne, kn**ow**, b**eau** |
| ó | s**aw**, **a**ll, gn**aw**, c**augh**t |
| œ | French c**oeu**f, German H**ö**lle |
| œ̲ | French **feu**, German H**öh**le |
| ói | c**oi**n, destr**oy** |
| p | **p**e**pp**er, li**p** |
| r | **r**ed, ca**r**, **r**a**r**ity |
| s | **s**our**ce**, le**ss** |
| sh | as in **sh**y, mi**ss**ion, ma**ch**ine, spe**ci**al (actually, this is a single sound, not two); with a hyphen between, two sounds as in *grasshopper* \ˈgras-ˌhä-pər\ |
| t | tie, attack, late, later, latter |
| th | as in thin, ether (actually, this is a single sound, not two); with a hyphen between, two sounds as in knighthood \ˈnīt-ˌh----d\ |
| t̲h̲ | **th**en, ei**th**er, **th**is (actually, this is a single sound, not two) |
| ü | r**u**le, y**ou**th, **u**nion \ˈyün-yən\, few \ˈfyü\ |
| ú | pull, wood, book, curable \ˈky ú r-ə-bəl\, fury \ˈfy----r-ē\ |
| ue | German f**ü**llen, h**ü**bsch |
| u̲e̲ | French r**ue**, German f**üh**len |
| v | **v**i**v**id, gi**ve** |
| w | **w**e, a**w**ay |
| y | **y**ard, **y**oung, cue \ˈkyü\, mute \ˈmyüt\, union \ˈyün-yən\ |
| ʸ | indicates that during the articulation of the sound represented by the preceding character the front of the tongue has substantially the position it has for the articulation of the first sound of yard, as in French *digne* \dēnʸ\ |
| Z | **z**one, rai**se** |
| zh | as in vi**s**ion, azure \ˈa-zhər\ (actually this is a single sound, not two). |
| \ | reversed virgule used in pairs to mark the beginning and end of a transcription: \ˈpen\ |

| | |
|---|---|
| ˈ | mark preceding a syllable with primary (strongest) stress: \ˈpen-mən-ˌship\ |
| ˌ | mark preceding a syllable with secondary (medium) stress: \ˈpen-mən-ˌship\ |
| - | mark of syllable division |
| ( ) | indicate that what is symbolized between is present in some utterances but not in others: *factory* \ˈfak-t(ə-)rē |
| ÷ | indicates that many regard as unacceptable the pronunciation variant immediately following: *cupola* \ˈkyü-pə-lə, ÷-ˌlō\ |

## Explanatory notes and abbreviations

| | |
|---|---|
| (date) | date that word was first recorded as having been used |
| [. . .] | etymology and origin(s) of word |
| {. . .} | usage and/or languages, including French, German, Italian and Spanish |
| *adj* | adjective |
| *adv* | adverb |
| *B.C.* | before Christ |
| Brit. | Britain, British |
| C | centigrade, Celsius |
| c | century |
| E | English |
| Eng. | England |
| F | French, Fahrenheit |
| Fr. | France |
| fr. | from |
| G | German |
| Gr. | Germany |
| L | Latin |
| ME | middle English |
| *n* | noun |
| *neut.* | neuter |
| NL | new Latin |
| OE | old English |
| OL | old Latin |
| pl | plural |
| prp. | present participle |
| R | Russian |
| sing. | singular |
| S | Spanish |
| U.K. | United Kingdom |
| *v* | verb |

Source: By permission: from Merriam-Webster's Collegiate © Dictionary, 11th edn. © 2004 by Merriam-Webster Inc. (www.Merriam-Webster.com).

## Languages

French, German and Spanish translations are enclosed in {--} and preceded by F, G, I and S, respectively; and gender is designated by f-feminine, m-masculine, n-neuter. For example: Polymer--{F polymere m} represents the french translation "polymere" of the English word polymer and it is in the masculine case. These translations were obtained from multi-language dictionaries including: Glenz W (ed) (2001) A glossary of plastics terminology in 5 languages, 5th edn. Hanser–Gardner Publications Inc., Cincinnati (with permission).

# A

**a** \ā\ *n.* (1) SI abbreviation for prefix Atto-, (2) Symbol for acceleration.

**"a" or "α"** *n.* Redness–greenness coordinate in certain transformed color spaces, generally used as the Δ*a*, or difference in "*a*" between a specimen and a standard reference color. If "*a*" or Δ*a* is plus, then there is more redness than greenness; if "*a*" or Δ*a* is minus, then there is more greenness than redness. It is normally used with b or *β* as part of the chromaticity or chromaticity difference. McDonald and Roderick (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Billmeyer FW and Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

*See uniform chromaticity coordinates.*

**"a"** Kubelka–Munk equation *n.* Mathematical constant characteristic of a color at complete hiding; dependent on the optical constants *K* and *S*: $a = \tfrac{1}{2}(1/R\infty + R\infty) = 1 + K/S$. McDonald and Roderick (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**au** *n.* Abbreviation for atomic unit.

**A** *n.* Abbreviation for Ampere.

**Å** \ˈaŋ-strəm\ [Anders J. *Angstrom*] (1892) {*d* Angströmeinheit *f*, *f* unité f Angtröm, *s* unidad *f* Angström} *n.* A unit of length equal to 1 × $10^{-12}$m. Abbreviation for deprecated Angstrom unit. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Roton, FL.

*See Angstrom unit.*

**A-Acid** \ā-ˈa-səd\ [F. or L.; F. *acide*] (1626) *n.* $NH_2C_6H_4COOH$. Trade abbreviation for anthranilic acid, an intermediate used in the manufacture of the pigment, Lake Red D.

**AATCC** *n.* Abbreviation for the American Association of Textile Chemists and Colorists.

**AB** (=absolute). A prefix attached to the names of practical electrical units to indicate the corresponding unit in the old cgs system (emu), e.g., abampere and abvolt.

**A-B-A model polymers** *n.* Two phase block copolymers, predictable molecular weights, narrow molecular weight distribution, convenient end-capping, thermoplastic, anionically polymerized, i.e., Kraton-G$^R$ and Hytrel$^R$. The B block is usually styrene that forms hard and amorphous domains.

**A-B-A** *n.* **Thermoplastic elastomers.** Three-block thermoplastic polymer elastomer, high-strength rubber, no vulcanization, completely soluble, two glass and two glass transition temperatures, i.e., styrene and butadiene.

**Abbe' number** \a-ˈbā, ˈa-ˌbā-\ [F, fr. LL *abbat-*, *abass*] (1530) *n.* The refractive index varies with the wavelength of incident light, and the abbe' number *v* is given as a measure of this dispersion; and the capacity to separate the colors of white light increases as *v* decreases.

**Abbe' refractometer** \-ˌrē-ˌfrak-ˈtä-mə-tər\ *n.* Common form of refractometer used for determining the refractive index of oils and other liquids, or of grease-like products, which are capable of liquefaction at moderate temperatures. Good accuracy is attainable in the range of 1.3–1.7, readings being given to the fourth decimal place. The prisms, which constitute the most important part of the instrument, and hence the liquid held between their faces, are capable of being maintained accurately at the temperature of the determination.

With the use of special liquids to form an optical seal to the prisms and a special technique of viewing, it is also used for determining the refractive index of solids such as plastics cast in sheets with polished surfaces and edges The refractometer measures the real part of the refractive index and thus helps to answer three different types of questions. First, and most simply, it is useful in the empirical identification of pure substances, it can act as a criterion of purity, and it serves in the quantitative analysis of solutions. These characterizations are made possible by the precision and accuracy of refractometers. Second, the evaluation of dipole moments of substances via measures of dielectric constant at a single temperature requires the knowledge of their refractive indexes. Third, refractive index measured as a function of wavelength, in concert with measurement of molar absorptivity characterize the optical properties of a given molecule. These measures in turn provide information on the electronic structures of molecules. As an example, refractometry can be useful in the determination of chain length and isomerism in organic molecules. The development of modern NMR and mass spectrometers has largely displaced the use of refractometry in such studies, giving less ambiguous answers regarding molecular structures, but at a great increase in instrumental complexity and cost. The modern Abbe refractometer invented at the Carl Zeiss Works was exclusively manufactured by Zeiss until the early 20th century. The explosive growth of laboratory work after World War I led a number of other companies to begin its manufacture as well, including Adam Hilgar and Stanley in Great Britain, and Spencer Lens Co., Bausch & Lomb, Gaertner, and Valentine in the USA Ernst Abbe constructed the first "Abbe" refractometer in 1869. Five years later, in 1874, he published a comprehensive booklet, and in it he discussed the theory of refractometer.

**Abbozzo** *adj.* Underpainting of an oil painting, either in monochrome or color. *Sometimes called bozzo or deadcoloring.*

**Abcoulomb** *n.* The abcouloumb, the emu of charge, is defined as the charge, which passes through a given surface in one second if a steady current of one abampere flows across the surface. Its dimensions are, therefore, $\mathrm{cm}^{0.5}\,\mathrm{g}^{0.5}$ which differ from the dimensions of the statcoulomb by a factor, which has the dimensions of speed. This relationship is connected with the fact that the ratio $2K_e/K_m$ must have the value of the square of the speed of light in any consistent system of units. It follows further that 1 abcouloumb $= 2.99793 \times 10^{10}$ statcoulomb, the speed of light in vacuo\being $(2.99793 \pm 0.000003) \times 10^{10}$ cm/s. Weast RC Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Roton, FL.

**Abegg's rule** \ˈä-ˌbegz-\ [Abegg, Richard Wilhelm Heinrich; Danish chemist, major work on chemical valence] (1869–1910) *n.* A Chemistry: For a given chemical element (as sulfur) the sum of the absolute value of its negative valence of maximum value (as −2 for sulfur in $H_2S$) and its positive value (as +6 in $H_2SO_4$) is often equal to 8. For use in regard to a helical periodic system. This tendency is exhibited especially by the elements of the fourth–seventh groups and is known as Abegg's rule. General chemistry. Brookes/Cole, New York, 2003.

**Aberration** \ˌa-bə-ˈrā-shən\ [L. *aberrare*] (1594) *n.* In optical systems, the failure of light rays from one object point to converge to a single focal point.

*See chromatic aberration and spherical aberration.*

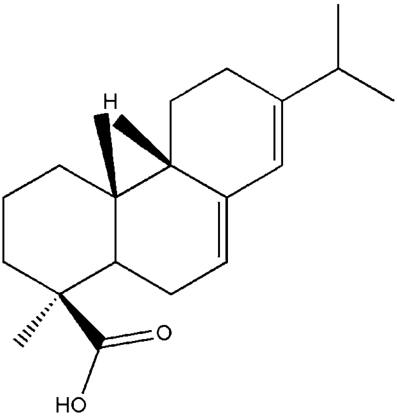
**ABFA** n. *See azobisformamide.*

**Abherent** \ab-ˈhir-ənt\ (adhesive) *n.* A coating or film applied to one surface to prevent or reduce its adhesion to another surface brought into intimate contact with it. Abherents applied to plastic films are often called *anti-blocking agents.* Those applied to molds, calendar rolls, etc., are sometimes called *release agents* or parting agents. Skeist I (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Abhesive** \-əb-ˈhē-siv, -ziv\ (1670) *n.* Material that resists adhesion; applied to surfaces to prevent sticking, heat-sealing, etc. Skeist I (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Abietic acid** \a-bē-ə-tek, a-səd\ *n.* $C_{19}H_{30}COOH$. A monocarboxylic acid derived from rosin. Plasticizers derived from it include hydroabietyl alcohol, hydrogenated methyl abietate, and methyl abietate.

**Abietic acid, commercial grade** *n.* $C_{20}H_{30}O_2$. Product consisting chiefly of rosin acids in substantially pure form, separated from rosin or tall oil commercially for specific purposes and in which abietic acid and its isomers are the principal components. Syn: Sylvic acid.



**Abietates** *n.* Esters or salts of abietic acid, a principal constituent of ordinary rosin from which the products of commerce are derived, no attempt being made to separate abietic acid from the other acids which rosin is likely to contain. Metallic abietates, as such, are rarely encountered under this name but generally as resonates. Esters of rosin, however, are commonly described as abietates and not as resonates. For example, methyl abietate (Trademark – Abalyn), a mixture of the methyl esters of the rosin acids. $C_{19}H_{29}COOCH_3$. The article of commerce is colorless to yellow, almost odorless, thick liquid. $D_{20}^{20}$ 1.040 bp 360–365°F with decompn. $^{n}D^{20}$ 1.530. Flash pt 180–218°C. Insoluble in water, miscible with usual organic solvents, also with aliphatic hydrocarbons. Dissolves ester gums, rosin, many synthetic resins as well as ethyl cellulose, rubber, etc., bp 360–365°F with decomposition; use as a solvent for ester gums, rosin, many synthetic resins, ethyl cellulose, rubber, etc.; in the manufacture of varnish resins; as ingredient in adhesives. Esters of rosin are described as abietates and include the methyl, ethyl, and benzyl derivatives, usually used as plasticizers. The ester abietates, which have enjoyed some popularity, are the methyl, ethyl, and benzyl derivatives. They are soft, resinous materials and are used chiefly as plasticizers. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland OR. Wypych G (2003) Plasticizer's data base. Noyes Publication, New York. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, 2001. Merck index, 13th edn. Merck and Company Inc., Whitehouse Station, NJ, 2001.

**Ablation** \a-ˈblā-shən\ (15c) *n.* Derived from the Latin *ablatio*, meaning "a carrying away", this term has been used by astrophysicists to describe the erosion and disintegration of meteors entering the atmosphere, and more recently by space scientists and engineers for the layer-by-layer decomposition of a plastic surface when heated quickly to a very high temperature. Usually, the decomposition is highly endothermic and the absorption of energy at the surface slows penetration of high temperature to the interior. In other words, it is the ability of a material such as a polymer to form a protective thermal layer when carbonized by extreme heat. {G ablative, F ablative, S ablative, I ablative}. Kidder RC (1994). Handbook of fire retardant coatings and fire testing services. CRC Press, Boca Raton, FL. Rosato DV (1992) Rosato's plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York.

**Ablative coatings** *n.* Thick, mastic-like materials which absorb heat; they are designed to char and sacrifice themselves while protecting the metal substrate underneath. This type of coating is similar with Intumescent coatings that produce foam on exposure to high heat to protect the substrate, but do not char as ablative coatings. These coatings are used for missiles and re-entry rockets. Kidder RC (1994) Handbook of fire retardant coatings and fire testing services. CRC Press, Boca Raton, FL. Nelson G (1990) Fire and polymers: hazards identification and prevention. Oxford University Press, Oxford.

*See also Ablative plastic.*

**Ablative plastic** *n.* Material which absorbs heat while part of it is being consumed by heat through a decomposition process (pyrolysis) which takes place near the surface exposed to the heat. Nelson G (1990) Fire and polymers: hazards identification and prevention. Oxford University Press, Oxford. Pittance JC (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**ABL bottle** *n.* A filament-wound test vessel about 46 cm in diameter and 61 cm long, subjected to rising internal hydrostatic pressure to determine the quality and strength of the composition from which it was made.

**Abnormal crimp** \(ˌ)ab-ˈnór-məl, əb- ˈkrimp\ *n.* A relative term for crimp that is either too low or too high in frequency and/or amplitude or that has been put into the fiber with improper angular characteristics.

**ABR** *n.* Copolymers from acrylic esters and butadiene.

**Abraded yarn** \ə-ˈbrādəd\ *n.* A filament yarn in which filaments have been cut or broken to create hairiness (fibrillation) to simulate the surface character of spun yarns. Abraded yarns are usually plied or twisted with other yarns before use. Kadolph SJ and Langford AL (2001) Textiles. Pearson Education, New York.

**Abraser** *n.* An instrument used for measuring resistance to abrasion using a sample on a turntable rotating under a pair of weighted abrading wheels that produce abrasion through side-slip. Koleske JV (ed) (1995). Paint and coating testing manual. American Society for Testing and Materials.

**Abrasiometer** *n.* One of the many devices used to test abrasion of a coating by using an air blast to drive an abrasive against the test film, or by rotating a film submerged in an abrasive, or by simply dropping a stream of abrasive onto the film. Koleske JV (ed) (1995). Paint and coating testing manual. American Society for Testing and Materials, www.gardco.com

**Abrasion** \ə-ˈbrā-zhən\ [ML *atrasion-, abrasion,* fr. L *abradere*] (1656) *n.* The wearing away of a surface in service by action such as rubbing, scraping, or erosion. {G Abrieb m, F abrasion f, S abrasión f, I abrasione f}.

**Abrasion coefficient** \-ˌkō-ə-ˈfi-shənt\ *n.* Method for reporting the result of an abrasion test using the falling sand abrasion tester, in which it is assumed that the abrasion resistance is proportional to the film thickness.

$$\text{Abrasion Coefficient} = \frac{W_1 - W_2}{T},$$

where $W_1$ is the grams of abrasive and holder before tests, $W_2$ the grams of abrasive and holder after test, and $T$ is the thickness of coating in mils (0.001 in.) (0.025 mm). Koleske JV (ed) (1995). Paint and coating testing manual. American Society for Testing and Materials. Gardner–Sward handbook, MNL 17, 14th edn. ASTM, Conshohocken, PA.

**Abrasion cycle** *n.* The number of abrading motions or cycles to which a test specimen is subjected in a test of abrasion resistance. Paint and coating testing manual (Gardner–Sward handbook). MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Abrasion resistance** *n.* (1) This test method (*see www.astm.org*) covers the determination of the resistance or organic coatings produced by an air blast of abrasive material on coatings applied a plane rigid substrate such as a glass or metal. (2) The ability of a coating to resist being worn away and to maintain its original appearance and structure as when subjected to rubbing, scraping, or erosion such as measured by the Taber Abraser The resistance to shearing of material from a surface, i.e., rubber has abrasion resistance from sand. The ability of a fiber or fabric to sustain wearing of its surface. (3) The ability of a material to withstand mechanical actions such as subbing, scraping, grinding, sanding, or erosion that tends progressively to remove material from its surface Gardner–Sward handbook. MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

*See abrasion.*

**Abrasion test** *n.* Tests designed to determine the ability to withstand the effects of rubbing and scuffing.

**Abrasive** (1853) *n.* Any material which, by a process of grinding down, tends to make a surface smooth or rough.

**Abrasive finishing** *n.* (1) A method of removing flash, gate marks, and rough edges from plastics articles by means of grit-containing belts or wheels. The process is usually employed on large rigid or semirigid products with intricate surfaces that cannot be treated by tumbling or other more efficient methods of finishing. (2) To finish, dress, or decorate a surface using a material such as polishing grit.

**Abrasive forming** *n.* Formation of a part or shape using abrasives to chip away unwanted materials.

**Abrasiveness** \ə-ˈbrā-siv, zivˈnes\ (1875) *n.* The property of a substance that causes it to wear or scratch other surfaces with which it is in contact. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Abrasive wheels** *n.* An abrasion material in the shape of a disk which is often turned on a power tool, i.e., abrasive polishing of granite.

**Abraum** A red ocher used to stain mahogany.

**Abridged spectrophotometer** \ə-ˈbrij ˌspek-trō-fə-ˈtä-mə-tər\ *n.* An instrument which measures spectral transmittance or reflectance at a limited number of wavelengths, usually employing filters rather than a monochromator. Skoog DA, Holler FJ, Nieman TA (1997) Principles of instrumental analysis, Brooks/Coles, New York. Willard HH, Merritt LL, and Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Company, New York.

*See filter spectrophotometer.*

**ABS** \ˌā-(ˌ)bē-ˈes\ [*a*crylonitrile-*b*utadiene-*s*ytrene] (1966) *n.* Copolymer of acrylonitrile-butadiene-styrene segments. Abbreviation for acrylonitrile-butadiene-styrene. *See ABS resin.*

**Absolute** \ˈab-sə ˌlüt\ [ME *absolut*, fr. L *absolutus*, fr. pp of *absolvere* to set free, absolve] (14c) *adj.* Adjective used to describe measurements in terms of fundamentally defined units. Merriam-Webster's collegiate dictionary, 10th edn. Merriam-Webster Inc., Springfield, MA, 2000.

**Absolute alcohol** *n.* Ethyl alcohol that has been refined by azeotropic distillation to 99.9% purity (200 proof). Other commercial ethanols contain about 5% water and may contain denaturants that make the alcohol undrinkable. Pure anhydrous ethyl alcohol (ethanol). The term is used to distinguish it from the several varieties of alcohol which are available, and which contain varying amounts of water and/or other impurities.

**Absolute humidity** (1867) *n.* The actual weight of water vapor contained in a unit weight of air.

*See humidity, absolute.*

**Absolute pressure** *See pressure.*

**Absolute reflectance** *n.* Reflectance measured relative to the perfect diffuser.

**Absolute temperature** *n.* Temperature measured from the absolute zero, at which all molecular motions cease; 0.0 K (Kelvin) = −273.15°C. Whitten KW, Davis RE, Davis E, Peck LM., and Stanley GG (2003) General chemistry. Brookes/Cole, New York.

*See Kelvin temperature scale.*

**Absolute units** *n.* A system of units based on the smallest possible number of independent units. Specifically, one unit of force, work, energy and power not derived from or dependent on gravitation.

**Absolute viscosity** *n.* (1) Tangential force on unit area of either of two parallel planes at unit distance apart, when the space between the planes in filled with fluid (in question) and one of the planes moves with unit velocity in its own plane relative to the other. (2) Force required to move in opposite directions at a velocity of 1 m/s, two parallel plans of liquid, 1 m$^2$ in area and separated from each other by a distance of 1 m. The absolute viscosity is designated by the Greek letter $\eta$. Goodwin J. W., Goodwin J., and Hughes R. W. (2000) Rheology for chemists. Royal Society of Chemistry, Cambridge.

*See poise, viscosity.*

**Absolute zero** (1848) *n.* The temperature at which all particles in a substance are in their lowest energy states: 0 K or –273.15°C, the temperature at which all chemical activity ceases. It is equal to –273.15°C or –459.67°F. Absolute 0 K has never been achieved and does not exist in nature or perhaps not anywhere in the known universe. Serway RA, Faugh J S, Bennett CV (2005) College physics. Thomas, New York. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Abson** *n.* ABS. Manufactured by Goodrich, USA.

**Absorbance** \əb-ˈsór-bən(t)s, -ˈzór-\ (1947) *n.* Logarithm of the reciprocal of spectral internal transmittance. The ability of a substance to transform radiant energy into a different of energy, usually with a resulting rise in temperature. Mathematically, absorbance is the negative logarithm to the base 10 of transmittance. Willard HH, Dean JA, Merritt LL (1995) Instrumental methods of analysis. Wadsworth, New York.

*See Beer–Bouguer law and light absorbance.*

**Absorbency** (1859) *n.* That property of a porous material, such as paper, which causes it to take up liquids or vapors (e.g., moisture) with which it is in contact. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Absorption** [F & L; F, fr. L] (1741) *n.* (1) The penetration of a substance into the mass of another substance by chemical or physical action. (2) The process by which energy is dissipated within a specimen placed in a field of radiant energy. Since some part of the impinging energy may be transmitted through the specimen and another part be reflected, the energy absorbed will nearly always be less than that impinging. (3) The adhesion of a substance to the surface of a solid or liquid. Pollutants are extracted by adsorption on activated carbon or silica gel {G Absorption f, F absorption f, S absorción f, I assorbimento m}.

*See, for example, water absorption.*

**Absorption coefficient** *n.* Absorption of radiant energy for a unit concentration through a unit path-length for a specified wavelength and angle of incidence and viewing. Skoog DA, Holler FJ, Nieman TA (1997) Principles of instrumental analysis. Brooks/Coles, New York.

*See absorption factor, Beer–Bouguer law, Kubelka–Munk theory, and Mie theory.*

**Absorption factor** *n.* The ratio of the intensity loss by absorption to the total original intensity of radiation. If $I_o$ represents the original intensity, $I_r$, the intensity of reflected radiation, $I_t$, the intensity of the transmitted radiation, then the absorption factor is given by the expression

$$\frac{I_o - (I_r + I_t)}{I_o}.$$

Also called coefficient of absorption. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colouritst, West Yorkshire, England.

**Absorption hygrometer** *n.* Any one of several types of hygrometers containing a hygroscopic substance, the change in length, thickness, or mass of which is a measurable index of the humidity of the atmosphere.

**Absorption, Lambert's law** *n.* If $I_o$ is the original intensity, $I$ the intensity after passing through a thickness $x$ of a material whose absorption coefficient is $k$, $I = I_o c^{-kx}$. The index of absorption $k'$ is given by the relation $k = 4\pi k'n/\lambda'$, where $n$ is the index of refraction and $\lambda$ the wavelength in vacuo. The mass absorption is given by $k/d$ when $d$ is the density. The transmission factor is given by $I/I_o$. Barton AFM (1983) Handbook of solubility parameters and other cohesion parameters. Chemical Rubber Company Press, Boca Raton, FL.

**Absorption, oil** *n.* Oil absorption of a pigment or extender is recorded as the amount of vegetable drying oil required to convert a given mass or volume of the dry powder to a very stiff putty-like paste, which does not break or separate. It is more usually expressed as the pounds of refined linseed oil required for 100 pounds of pigment or g·100 g.

**Absorption spectrophotometry** (spectrophotometry) *n.* An analytical technique utilizing the absorption of electromagnetic radiation by a specimen (or solution) as a property related to the composition and quantity of a given material in the specimen. The radiation is usually is the ultraviolet, the visible, or the near-infrared portions of the electromagnetic spectrum. When the absorbing medium is in the gaseous state, the absorption spectrum consists of dark lines or bands, being the reverse of the mission spectrum of the absorbing gas. The spectrum of the transmitted light shows broad dark regions are that are not resolvable into lines and have no sharp or distinct edges when the absorbing medium is in the solid or liquid state. In quantitative spectrophotometry, the intensity of the radiation passing through a specimen or solution is compared with the intensity of the incident radiation and with radiation passing through a nonabsorbing solvent (*blank*). The percent absorbed by the solution is exponentially related to the solute concentration (Beer's law). Modern spectrophotometers are capable of generating nearly monochromatic radiation, so they can develop plots of percent absorption versus wavelength – *absorption spectra* – for the test compound. Skoog DA, Holler FJ, Nieman TA (1997) Principles of instrumental analysis. Brooks/Coles, New York. Willard HH., Dean JA., Merritt LL (1995) Instrumental methods of analysis. Wadsworth, New York.

*See infrared spectrophotometry.*

**Absorption spectrum** (1879) *n.* The spectrum obtained by the examination of light from a source, itself giving a continuous spectrum, after this light has passed through an absorbing medium in the gaseous state. The absorption spectrum will consist of dark lines or bands, being the reverse of the emission spectrum of the absorbing substance. The spectrum of the transmitted light shows broad dark regions that are not resolvable into lines and have no sharp or distinct edges when the absorbing medium is in the solid or liquid state. Skoog DA, Holler FJ, Nieman TA (1997) Principles of instrumental analysis. Brooks/Coles, New York. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Company, New York.

**Absorption tinting strength** *n. See tinting strength, absorption.*

**Absorptive power or absorptivity** *n.* For any body, the body is measured by the fraction of the radiant energy falling upon the body which is absorbed or transformed into heat. This ratio varies with the character of the surface and the wavelength of the incident energy. It is the ratio of the radiation absorbed by any substance to that absorbed under the same conditions by a black body. Fox AM (2001) Optical properties of solids. Oxford University Press, Oxford. Driggers RC, Edwards T, Co P (1998) Introduction to infrared and electro-optical systems. Artech House Inc., MA, USA.

**ABS polymers** *n.* Generic term for copolymers of polyblends from acrylonitrile, butadiene, and styrene.

**ABS resin** *n.* Any of a family of thermoplastics based on acrylonitrile, butadiene, and styrene combined by a variety of methods involving polymerization, graft copolymerization, physical mixtures, and combinations thereof. Hundreds of standard grades of ABS resins are available, and many special grades, alloyed or otherwise modified to yield unusual properties. The standard grades are rigid, hard and tough, and possess good impact strength. ABS compounds in pellet form can be extruded, blow molded, calendered, and injection molded. ABS powders are used as modifiers for other resins, for example, PVC.

Typical applications for ABS resins are household appliances, automotive parts, business-machines and telephone components, pipe and pipe fittings, packaging and shoe heels. Wickson EJ (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York. Harper CA (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Abut** \ə-ˈbət\ [ME *abutten,* partly fr. OF *aboter* to border on, fr. *a-* (fr. L *ad-*) + *bout* blow, end, fr. *boter* to strike; partly fr. OF *abuter* to come to an end, fr. *a-* + *but* end] (15c) *v.* To adjoin at an end; to be contiguous.

**Abvolt** *n.* The cgs electromagnetic unit of potential difference and electromotive force. It is the potential difference that must exist between two points in order that one erg of work be done when one abcoulomb of charge is moved from one point to the other. One abvolt is $10^{-8}$V. Weast RC Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Roton, FL.

**Acacia gum** \ə-ˈkā-shə ˈgəm\ *n.* Water-soluble gum obtained from trees of the acacia species, as an exudation from incisions in the bark. It is water soluble and is used as an adhesive, thickening agent and for transparent paints. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, Amsterdam.

*Also known as Gum Arabic.*

**Academy board** \ə-ˈka-də-mē ˈbōrd\ *n.* A board which is given a surface in preparation for painting, primarily oil painting. It is made of paper containing chalk and size and has a face of pale gray or white ground, usually of a white lead, oil, and chalk mixture.

**Accelerant** \ik-ˈse-lə-rənt, ak-\ (1916) *n.* A chemical used to speed up chemical or other processes. For example, accelerants are used in dyeing triacetate and polyester fabrics. {G Beschleuniger m, F accélérateur m, S acelerador m, I acceleratore m}. Goldber DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Accelerated aging** *n.* Any set of conditions designed to produce in a short time the results obtained under normal conditions of aging. In accelerated aging test, the usual factors considered are heat, light, or oxygen either separately or combined. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials. Paint and coating testing manual (Gardner–Sward handbook), MNL 17, 14th edn. ASTM, Conshohocken, PA.

**Accelerated life** *See accelerated aging.*

**Accelerated test** *n.* A test procedure in which conditions such as temperature, humidity, and ultraviolet radiation are intensified to reduce the time required to obtain a deteriorating effect similar to one resulting from exposure to normal service conditions for much longer times.

**Accelerated weathering** *n.* Tests designed to simulate, but at the same time to intensify and accelerate, the destructive action of natural outdoor weathering on coatings films. The tests involve exposure to artificially produced components of natural weather, e.g., light, heat, cold, water vapor, rain, etc., which are arranged and repeated in a given cycle. There is no universally accepted test, and different investigators use different cycles. Paint and coating testing manual (Gardner–Sward handbook), MNL 17, 14th edn., ASTM, Conshohocken, PA, 1995.

*See artificial weathering.*

**Accelerated weathering machine** *n.* Device intended to accelerate the deterioration of coatings by exposing them to controlled sources of radiant energy, heat, water, or other factors that may be introduced. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

*See weatherometer and accelerated weathering.*

**Acceleration** \ik-ˌse-lə-ˈrā-shən, (ˌ)ak-\ (1531) *n.* The time rate of change of velocity in either speed or direction. cgs unit – cm/s. Dimensions $[LT^{-2}]$.

*See angular acceleration.*

**Acceleration due to gravity** *n.* The acceleration of a body freely falling in a vacuum. The International Committee on Weights and Measures has adopted as a standard or accepted value, $980.665\,\mathrm{cm/s^2}$ or $32.174\,\mathrm{ft/s^2}$. Hartland S (ed) (2004) Surface and interfacial tension. CRC Press, Boca Raton, FL.

**Acceleration due to gravity at any latitude and elevation** *n.* If $\phi$ is the latitude and $H$ the elevation in centimeters the acceleration in cgs units is, $g = 980.616 - 2.5928 \cos 2\phi + 0.0069 \cos^2 2\phi - 3.086 \times 10^{-6}\ H$ (Helmert's equation).

**Accelerator** (1611) *n.* (1) Any substance used in small proportion which increases the speed of a chemical reaction. In the paint industry, the term usually indicates materials that hasten the curing or cross-linking of a resin system. In the polyester resin field, it covers more specifically an additive which accelerates the action of the catalyst. (2) An organic or inorganic chemical which hastens the vulcanization of rubber, natural or synthetic, causing it to take place in a shorter time or at a lower temperature. Accelerators, particularly organic, are not mere catalysts of vulcanization, however, because they produce different and generally beneficial states of cure and different degrees of stability or resistance to chemical attack in the vulcanization. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

*See catalyst and cross-linking agent.*

**Accommodation** *n.* The adjustment of the eye to obtain maximum sharpness of the retinal imge for *n* object at which an observer is viewing. One of the important changes involves the shape of the eye lens.

**Accra** \ə-ˈkrä\ *n.* Natural copal resin of African origin. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, 2001.

**Accroides** *n.* Resinous accumulation which occurs on the leaf and stem of the *Xanthorrhoea* species. It is native to Australia and Tasmania. It appears on the market in red and yellow forms, both of which are soluble in industrial alcohol, and are used in spirit varnishes. The resin is also described as "Black Boy Gum", "Botany Bay Resin," "grass tree gum," "gum acaroid," "acaroid resin," "red gum," and "yacca" or "yacka" gum. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany.

Timber Press, Portland, OR. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, Amsterdam. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

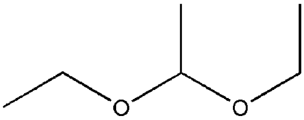
**Accumulator** \ə-ˈkyü-m(y)ə-ˌlā-tər\ (1748) *n.* Series of rolls which festoon strip metal on a continuous line both at the beginning and at the end. This allows the beginning or the end of the line to stop while the rest of the line is in operation. The accumulator actually accumulates a considerable length of strip, and gives a portion of its strip to whichever end is stopped.

**Accumulator** *n.* (1) In blow molding and injection molding, an auxiliary ram extruder providing fast parison delivery or fast mold filling. The accumulator cylinder is filled with plasticated melt from the main extruder between parison deliveries shots, and stores this melt until the plunger is called upon to deliver the next parison or shot. (2) A pressurized gas reservoir that stores energy in hydraulic systems. {G Akkumulator m, F accumulateur m, S acumulador m, I accumulatore m}. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

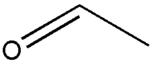
**Acenaphthene** *n.* $C_{10}H_6(CH_2)_2$. Solid with an mp of 95°C, obtained from coal tar. It is a dyestuff intermediate.

**Aceta** *n.* Cellulose acetate, manufactured by Bayer, Germany.

**Acetal** \ˈa-sə-ˌtal\ *n* [G *Azetal*, fr. *azet-*, *acet-* + *Al*kohol] (1853). $CH_3CH(OC_2H_5)_2$. (1) A colorless, flammable liquid used in cosmetics and as a solvent. (2) Any of a class of compounds formed from aldehydes combined with alcohol. (3) A group of materials including polyoxymethylene (Delrin$^{R}$).



**Acetaldehyde** \ˌa-sə-ˈtal-də-hīd\ [ISV] (1877) (ethanal, ethyl aldehyde, acetic aldehyde) *n.* $CH_3CHO$. Low boiling liquid (21°C). A colorless, flammable liquid made by the hydration of acetylene, the oxidation or dehydrogenation of ethyl alcohol, or the oxidation of saturated hydrocarbons or ethylene (*See image*).



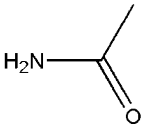
**Acetaldehyde resin** *n.* Product of auto-condensation of acetaldehyde.

**Acetal formation, mechanism of** *n.* The formation of the (–CHO–) repeat unit which after initiation (i.e., Lewis acids) forms –CHO+ and propagates to the polymer $(–CHO–)_n$.

**Acetal resin** (polyformaldehyde, polyoxymethylene, and polycarboxane) *n.* A thermoplastic produced by the addition polymerization of a aldehyde through the carbonyl function, yielding unbranched polyoxymethylene $(–O–CH_2–)n$ chains of great length. Examples are DuPont's "Delrin" and Hoechst–Celanese's "Celcon" (acetal copolymer based on trioxane). The acetal resins are among the strongest and stiffest of all thermoplastics, and are characterized by good fatigue life, resilience, low moisture sensitivity high resistance to solvents and chemicals, and good electrical properties. They may be processed by conventional injection molding and extrusion techniques, and fabricated by welding methods used for other thermoplastics. Their main area of application is industrial and mechanical products, e.g., gears, rollers, and many automotive parts. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Acetal resins** *n.* High molecular weight, stable, linear polymers of formaldehyde; structurally, an oxygen atom joins the repeating units in an ether rather than ester-type link. These also include butyrals. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Acetamide** \ə-ˈse-tə-ˌmīd, ˌa-sə-ˈta-ˌmīd\ [ISV] (1873) *n.* $CH_3CONH_2$. Amide of acetic acid with a melting point of 81°C and boiling point of 222°C. Generally used as a plasticizer for cellulose esters (*See image*).



**Acetate** \ˈa-sə-ˌtāt\ (1827) *n.* (1) Generic name for fibers from cellulose-$2\frac{1}{2}$-acetate. (2) A salt or ester of acetic acid. (3) A generic name for cellulose acetate plastics, particularly for their fibers. Where at least 92% of the hydroxyl groups have been acetylated, the term *triacetate* may be used as the generic name of the fiber. (4) A compound containing the acetate group, $CH_3COO–$ (e.g., polyvinyl acetate).

**Acetate chromes** *n.* Lead chromate pigments prepared from lead acetate or basic lead acetate. Available as the lemon, primrose, medium, and orange shades. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Acetate dope** *n.* Term applied to cellulose acetate lacquers used for coating aircraft fabrics.

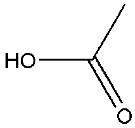
**Acetate fiber** *n.* A manufactured fiber in which the fiber-forming substance is cellulose acetate (FTC definition). Acetate is manufactured by treating purified cellulose refined from cotton linters and/or wood pulp with acetic anhydride in the presence of a catalyst. The resultant product, cellulose acetate flake, is precipitated, purified, dried, and dissolved in acetone to prepare the spinning solution. After filtration, the highly viscous solution is extruded through spinnerets into a column of warm air in which the acetone is evaporated, leaving solid continuous filaments of cellulose acetate. The evaporated acetone is recovered using a solvent recovery system to prepare additional spinning solution. The cellulose acetate fibers are intermingled and wound onto a bobbin or shippable métier cheese package, ready for use without further chemical processing. In the manufacture of staple fiber, the filaments from numerous spinnerets are combined into tow form, crimped, cut to the required length, and packaged in bales. Acetate fibers are environmentally friendly. Characteristics: Acetate fabrics are breathable, luxurious in appearance, fast-drying, wrinkle and shrinkage resistant, crisp, or soft in hand depending upon the end use. End uses: The end uses of acetate include women's and men's sportswear, evening wear, lingerie, dresses, blouses, robes, coats, other apparel, linings, draperies, bedspreads, upholstery, ribbons, formed fabrics, and filtration products. Complete textile glossary, Celanese Corporation, Three Park Avenue, New York, NY. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books. New York.

**Acetate green** *n.* Range of Brunswick or chrome greens derived from mixtures of acetate chrome and Prussian blue. These can be made wet or dry by mixing. The type made by wet mixing is preferred to paint making, as these greens have less tendency to partial separation in the film, a phenomenon known as "floating."

**Acetate Rayon**$^R$ *n.* Cellulose acetate made from preswelling cellulose pulp with acetic acid followed by esterification with sulfuric acid–acetic anhydride mixture, the diacetate dissolved in acetone, the triacetate in methylene chloride and dry spun into fibers. Kadolph SJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Acetates** *n.* (1) Metallic salts derived from acetic acid by interaction of the metallic oxide, hydroxide, carbonate with the acid, or by the esters derived by interaction of alcohols with acetic acid. Typical metallic salts are lead, cobalt, and manganese acetates. Common esters are ethyl, propyl, isopropyl, butyl, and amyl acetates. Acetate salts have the formula $CH_3COOMe$, where Me is a monovalent metal. Divalent metals like lead, etc., obviously combine with two acid radicals. The formula given above for the acetate salts apply also to esters, except that the Me becomes an alkyl radical. (2) It is also used colloquially for cellulose acetate plastics. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York. Vincenti R (ed) (1994) Elsevier's textile dictionary, 2003. Elsevier Science and Technology Books, Amsterdam.

**Acetic acid** \ə-ˈsē-tik, ˈa-səd\ (F *acétique* fr. L *acetum* vinegar] (1808) *n.* $CH_3COOH$ (ethanoic acid, methanecarboxylic acid, and vinegar acid) $CH_3COOH$. A colorless liquid with the familiar taste and odor of vinegar, it is the chief constituent in dilute form. Acetic acid was originally derived by souring wine and beer, but is synthesized today by oxidation of acetaldehyde in the presence of a catalyst. Among the uses of acetic acid in the plastics industry is the manufacture of cellulosics plastics such as cellulose acetate (CA), CA butyrate and CA propionate, vinyl acetate, and acetate esters for plasticizing thermoplastics. It is a monobasic acid. Its mp is 16°C and bp, 118°C. In the paint industry, its chief applications are in the manufacture of metallic acetates used for the production of driers, and in the manufacture of acetate esters employed as solvents or plasticizers.(*See image*)

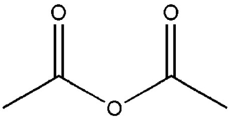


Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York

**Acetic aldehyde** *See acetaldehyde.*

**Acetic anhydride** (1976) *n.* $(CH_3CO)_2O$. The pungent liquid may be thought of as the condensation product of two molecules of acetic acid by removal of one molecule of water, though in fact it is made by reaction of acetic acid with ketene, $CH_2=C=O$. It is a strong acetylating agent, used for many of the same purposes as its parent acid. It is an important reagent, which has wide application in the manufacture of many raw materials and intermediates for the paint trade, and also in analysis. It is used for the acetylation of hydroxyl groups as in the manufacture of acetyl ricinoleates, and in the manufacture of cellulose acetate. It has a bp of 137°C. Morrison RT, Boyd

RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Paint/coatings dictionary, Blue Bell, PA: Federation of Societies for Coatings Technology, 1978.



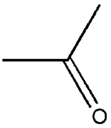
**Acetic ester and acetic ether** *n. See ethyl acetate.*

**Acetic ether** *See ethyl acetate.*

**Acetocopal** *n.* Product obtained when Congo Copal is reacted with acetic anhydride.

**Acetone** \ˈa-sə-ˌtōn\ [Gr *Azeton*, fr. L *acetum*] (1839) (dimethyl ketone, 2-propanone) *n.* $CH_3COCH_3$. The simplest and most important member of the ketone family of solvents. All the cellulosics plastics and polyvinyl chloride, polyvinyl acetate, polymethyl methacrylate, epoxies, and some thermosetting resins are soluble in acetone. It is also an intermediate in the production of bisphenol. It is a typical low-boiling ketone. It is a liquid which flashes at ordinary room temperature, has a bp of 57.5°C, fp of –15°C; and a Sp gr of 0.788 at 25°C. Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products – Chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York: Weast RC Handbook of chemistry and physics. The Chemical Rubber Co., Boca Roton, FL.

*Also known by its chemical names dimethyl ketone or propanone.*



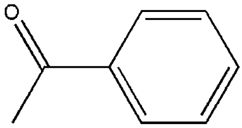
**Acetone extraction** *n.* In molded phenolic products, the amount of acetone-soluble material that can be extracted from the material is an indication of the degree of cure.

**Acetone resin** *n.* A synthetic resin produced by the reaction of acetone with materials such as phenol or formaldehyde.

**Acetonyl acetone** *n.* $CH_3COCH_2CH_2COCH_3$. Solvent containing two keto groups in each molecule. It has a boiling range of 188–193°C; a Sp gr of 0.973/15°C; a refractive index of 1.449; flp of 85°C (185°F); and vapor pressure of less than 2 mmHg at 30°C.

**Acetophenone** *n.* $CH_3COC_6H_5$. A solvent with a bp of 202°C; mp of 20°C; Sp gr of 1.023/25°C; flp of 83°C (180°F); and refractive index of 1.536.

*Also known as phenyl methyl ketone or acetyl benzene* (*See image*).



**Acetyl** \ə-ˈsē-tᵊl, ˈa-sə-; ˈa-sə-ˌtēl\ (1864) *n.* Monovalent radical $CH_3CO–$.

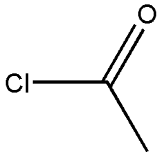
**Acetylated congo** *See acetocopal.*

**Acetylated damar** *n.* Product obtained when dammar is reacted with acetic anhydride.

**Acetylation** (1900) *vt.* Reaction wherein the hydrogen atom of a hydroxyl group is replaced by an acetyl radical ($CH_3CO$). It can really be regarded as an ester formation, except that it is a specific ester, the acetate, which is formed. When the acetyl value of castor or other oils containing free hydroxyl groups, or of the reaction mixture of monoglycerides, or alkyds, is determined, acetic anhydride is commonly used as the acetylating agent. This reacts with any free hydroxyl groups, whether they occur in the fatty acid chains of the vegetable oil or in unreacted polyhydric alcohols. This can also be written as a reaction with acetylene groups. Acetylene is an alkyne or $HC\equiv CH$. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Acetyl benzene** \-ˈben-ˌzēn, ben-ˈ\.
*See acetophenone.*

**Acetyl chloride** *n.* $CH_3OCl$. Acetic acid in which the –OH group has been replaced by –Cl; a very active acetylating agent (*See image*).



**Acetyl coenzyme A** (1952) *n.* A compound $C_{25}H_{38}N_7O_{17}P_3S$ formed as an intermediate in metabolism and active as a coenzyme in biological acetylations.

**Acetyl cyclohexane sulfonyl peroxide** *n.* A polymerization initiator, often used in conjunction with a dicarbonate such as di-sec-butyl peroxydicarbonate in vinyl chloride polymerization. The initiators have largely replaced enzoÿl and lauroÿl peroxides, the principal initiators in the early years of PVC production.
*See acetyl cyclohexane sulfonyl peroxide.*

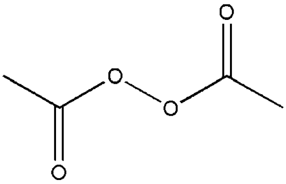
**Acetylene** \ə-ˈse-tᵊl-ən, -tᵊl-ˌēn\ (1864) *n.* (ethyne) $HC\equiv CH$. A colorless (but not ordorless) gas obtained by reacting water with calcium carbide, $CAC_2$, or by cracking petroleum hydrocarbons. In the plastics industry, it is an important intermediate in the production of vinyl chloride, neoprene, acrylonitrile, and trichloroethylene.
*See also polyacetylene.*

**Acetylene black** *n.* Particularly pure form of carbon black pigment, made by the controlled combustion of acetylene in air under pressure. It is graphitic in nature and has high electrical conductivity. Donnet J-B, Wang M-J (1993) Carbon black. Marcel Dekker, New York.
*See also carbon black.*

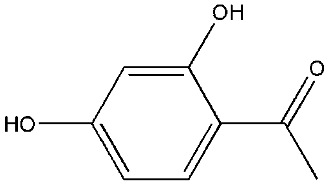
**Acetylene polymers** *See polyacetylene.*

**Acetyl number (value)** *n.* Number of milligrams of potassium hydroxide required to neutralize the acetic acid set free from 1 g of an acetylated compound when the latter is subjected to hydrolysis.

**Acetyl peroxide** (diacetyl peroxide) *n.* $(CH_3CO)_2O_2$. A polymerization catalyst (*See image*).

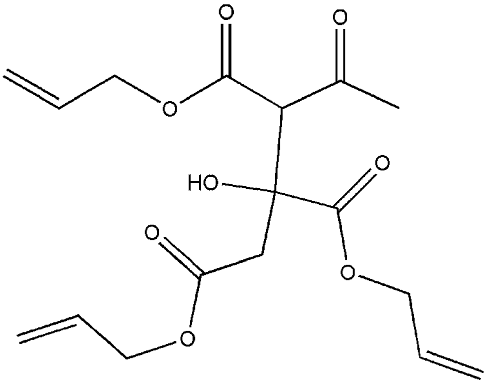


**4-Acetyl resorcinol** (2,4-dihydroxyacetophenone) *n.* $C_6H_3(OH)_2CO–CH_3$. A light stabilizer for plastics.

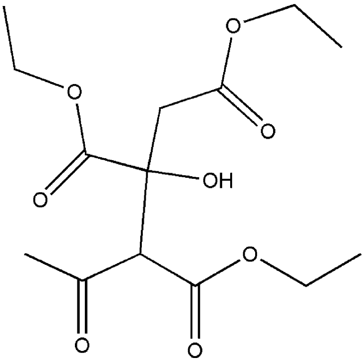


**Acetyl ricinoleates** *n.* Plasticizers, such as butyl and ethyl acetyl ricinoleates. They can be regarded as esters of acetylated ricinoleic acid. The hydroxy group in the ricinoleic chain has been acetylated or esterified, and the carboxylic group has also undergone esterification, but with an alcohol. Wypych G (2003) Plasticizer's data base. Noyes Publication, New York.

**Acetyl triallyl citrate** *n.* $CH_3COOC_3H_4(COOCH_2CH{=}CH_2)_3$. A cross-linking agent for polyesters and a polymerizable monomer. Easily polymerized with peroxide catalysts, it forms a clean, hard thermosetting resin.



**Acetyl triethyl citrate** *n.* $CH_3COOC_3H_4(COOC_2H_5)_3$. A plasticizer produced by esterifying and acetylating citric acid, used in cellulose nitrate, cellulose acetate, and certain vinyls, e.g., polyvinyl acetate. It has been FDA-approved for food-contact use. Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York.

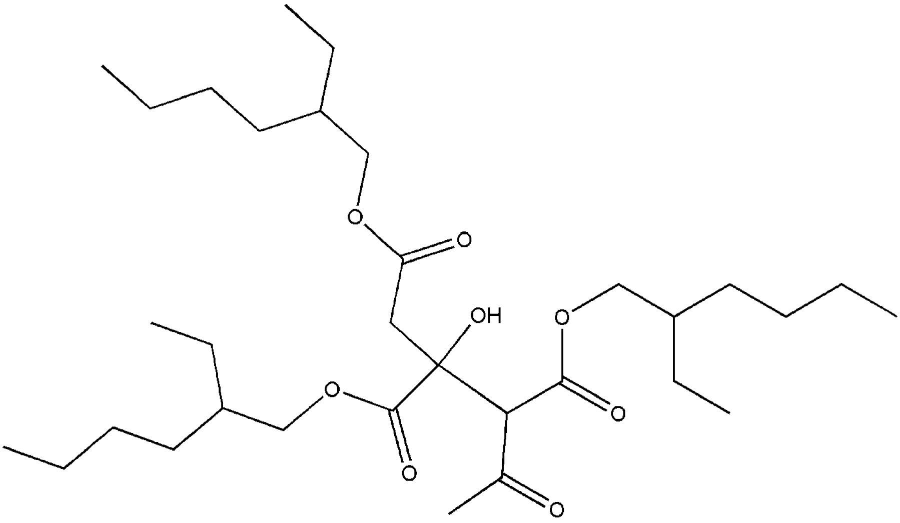


**Acetyl tri-2-ethylhexyl citrate** *n.* $CH_3COOC_3H_4(COOC_8H_{17})_3$. A plasticizer for vinyls, with limited compatibility for cellulose nitrate and ethyl cellulose.

**Acetyl value** *n.* The number of milligrams of potassium hydroxide (KOH) necessary to neutralize the acetic acid liberated by hydrolysis of 1 g of an acetylated compound. It can also be written as a measure of the degree of esterification or combination of acetyl radicals with cellulose in acetate or triacetate products.

**Achromatic** \ˌa-krə-ˈma-tik, (ˌ)ā-\ (1766) *adj.* Having no distinguishable hue; neutral. *See gray scale.*

**Achromatic** *n* **Objective.** An objective corrected spherically for one wavelength

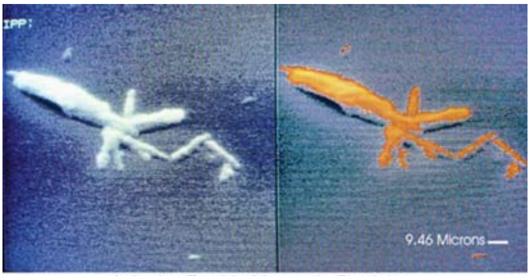


(usually green light) and chromatically for two wavelengths.

**ACI** *n.* Abbreviation for American Concrete Institute.

**Acicular** \əˈsi-kyə-lər\ [L *acicula*] (1794) *adj.* Having a needle-like shape. It is a term applied chiefly to describe the shape of igment particles, which are long and slender. To be acicular, the length of the particle must be at least three times the width.

**Acicular pigments** *n.* Pigments whose particles are needle-shaped. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.



Acicular Ferritic Magnetic Particles

**Acid** \ˈa-səd\ [F *acide*, L *acidus* fr. *acēre*] (1626) *n.* (1) Inorganic compound characterized by an ionizable hydrogen atom. With organic acids, however, the definition must be extended to emphasize the ionizable hydrogen atom in question is directly attached, through an oxygen atom, to a carbon atom, which is also attached to another distinct oxygen atom. Thus, for example, acetic acid has the formula $CH_3COOH$, and it will be seen from this how the hydrogen atom is located. The inorganic acids, sometimes referred to as mineral acids, are written $HCl$, $HNO_3$, $H_3PO_4$, etc. All these hydrogen atoms, whether organic or inorganic, are capable of being substituted by a monovalent metallic radical, or by monovalent alkyl or aryl groupings. (2) Is a proton donor (Brønsted–Lowry). (3) Is an electron-pair acceptor (Lewis). (4) Increases the concentration of dissolved cations related to the solvent (solvent system) Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Acid acceptor** *n.* A compound that acts as a stabilizer by chemically combining with acid that may be initially present in minute quantities in a plastic, or that may be formed during the decomposition in the resin. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See also stabilizer.*

**Acid catalysts** *n.* Acids which may be either organic or inorganic, or salts from these acids which exhibit acidic characteristics. They are used to promote or accelerate chemical reactions, and find special applications in the manufacture and subsequent hardening of synthetic resins. Acid catalysts have been employed in the manufacture of polymerized drying oils, coumarone, urea, phenol- and melamine-formaldehyde resins, and in the cold-setting of compositions containing the last three named resins. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See catalyst and urea formaldehyde resins.*

**Acid curing (hardening)** *n.* A process of curing or hardening resins through the use of acid catalysts. These are frequently employed with urea and melamine-formaldehyde resins. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Acid-Dyeable variants** *n.* Polymers modified chemically to make them receptive to acid dyes. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

**Acid dyes** *n.* Term given to dyestuffs that possess acidic groupings, e.g., carboxy, sulfonic acid or both. They form salts with heavy metals like barium and calcium, and this reaction is used in lake formation. It is usually an azo, triarylmethane, or anthraquinone dye with acid substituents such as nitro, carboxy, or sulfonic acid. Acid dyes include such dyes as eosine, erioglaucine, fluorescein, naphthol yellow, ponceau, quinoline, tartrazine, etc. They precipitate with calcium, barium, or titanium glycerol chlorides or other metallic salts, to give suitable insoluble pigment dyestuffs, or they may be precipitated on bases to form lakes. Kadolph SJ, Langford AL (2001) Textiles. Pearson Education, New York. Wells K, Beal S, Woodburn C, Durant J, Brandimane J (1997) Fabric dyeing. Interweave Press Incorporated. Loveland, Colorado. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

*See dyes.*

**Acid fading** n. *See gas fading.*

**Acid groups** *n.* Functional groups having the properties of acids. In cellulose and its derivatives, these are usually carboxyl groups.

**Acidic** \ ə-ˈsi-dik, a-\ (1880) *adj.* A term describing a material having a pH of less than 7.0 in water. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Acidic solution** *n.* An aqueous solution in which the concentration of hydrogen (hydronium) ions exceeds that of hydroxide ions. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Acidity** \ə-ˈsi-də-tē, a-\ (1620) *n.* (1) Measure of the free acid present. (2) In oils, acidity denotes the presence of acid-type constituents whose concentrations are usually defined in terms of the neutralization number, called acid number. {G Säuregrad m, F taux d'acidité, taux m, S grado de acidez, grado m, I acidità f}. Dainth J (2004) Dictionary of chemistry. Oxford University Press, Oxford, UK. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Acid number or value** *n* The number of milligrams of KOH required to neutralize the free acids in one gram of an oil, resin, varnish, or other substance; generally reported on the non-volatile.

*See acid value.*

**Acidolysis** *n.* A chemical reaction analogous to hydrolysis in which an acid plays a role similar to that of water.

*See also ester interchange.*

**Acid recovery** *n.* A reclamation process in chemical processing in which acid is extracted from a raw material, by-product, or waste product. In the manufacture of cellulose acetate, acetic acid is a major by-product. Acid recovery consists of combining all wash water containing appreciable acetic acid and concentrating it to obtain glacial acetic acid.

**Acid refined linseed oil** *n.* Linseed oil that has been treated with acid, usually sulfuric, to remove mucilaginous matter.

**Acid resistance** *n.* The ability of materials to withstand attack by acids, specifically strong mineral acids. The type of acid should be stated (i.e., organic or inorganic). Most plastics have excellent acid resistance. Tests for resistance of plastics to some acids are included in ASTM 543.

**Acid salt** *n.* A salt, the anion of which can serve as an acid by losing an $H^+$ (donating a proton). Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Acid sludge** *n.* Residue which separates from mineral and related oils when they are refined with sulfuric acid.

**Acid value** *n.* The measure of the free-acid content of a substance. It is expressed as the number of milligrams of potassium hydroxide (KOH) neutralized by the free acid present in 1g of the substance. This value, also called acid number, is sometimes used in connection with the end-group method of determining molecular weights of polyesters. It is also used in evaluating plasticizers, in which acid values should be as low as possible. Deligny P, Oldring PKT, Tuck N (2001) Resins for surface coatings, alkyds and polyester, vol 22. John Wiley and Sons, New York. Patton TC (1961) Alkyd resin technology. John Wiley and Sons Inc., New York. Martens CR (1961) Alkyd resins. Reinhold Publishing Co., New York. Wypych G (2003) Plasticizer's data base. Noyes Publication, New York.

*See acid number.*

**Aclar** *n.* Fluorinated polycarbonate film. Manufactured by Allied Chemical, USA.

**ACM** *n.* Copolymers from acrylic ester and 2-chlorovinyl ether.

**Acoustical board** \ə-ˈkü-stik or -sti-kəl-\ *n.* A low-density, sound-absorbing structural insulating board having a factory-applied finish and a fissured, felted-fiber, slotted or perforated surface pattern provided to reduce sound reflection. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Acoustical material** *n.* Any material considered in terms of its acoustical properties. Commonly and especially, a material designed to absorb sound.

**Acoustical paint** *See anti-noise paint.*

**Acoustical plaster** *n.* A special low-density, sound-absorptive plaster, applied in the form of a finish-coat, to provide a continuous finished surface. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Acoustical tile** *n.* An acoustical material in board form, usually having unit dimensions of 24 in. × 24 in. (approx. 61 cm × 61 cm) or less. Usually used on ceilings but also may be applied to sidewalls. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Acoustic coating** *n.* Coating which absorbs or deadens sound. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

*See anti-noise paints.*

**Acoustic emission testing** *n.* A non-destructive test for determining material or structural integrity by detecting and recording location, amplitude, and frequency of sound emissions as test loads are applied.

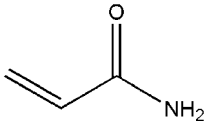
**Acrilan** \ˈa-krə-ˌlan, -lən\ *n.* Poly(acrylonitrile). Manufactured by Chemstrand Corp., Monsanto, USA. Tortora PG (2000) Fairchild's dictionary of textiles, 7th edn. Fairchild Publications, New York.

**Acrolein** \ə-ˈkrō-lē-ən\ [ISV *acr-* (fr. L *acr-*, *acer*) + L *olēre*] (1857) (propenal, acrylic or allyl aldehyde) *n.* CH$_2$=CHCHO. A liquid derived from the oxidation of allyl alcohol or propylene, used as an intermediate in the production of polyester resins and polyurethanes. It is an unsaturated liquid aldehyde with a bp of 52°C. It possesses a very pungent odor, and has strong lachrymatory properties.

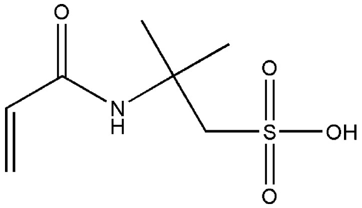
**Acrolein polymers and resins** *n.* Homopolymers or copolymers of acrolein.

**Acronal** Dispersions based on uni- and copolymers of acrylic esters. Manufactured by BASF, Germany.

**Acrylamide** \ˌa-kr ᵊl- ˈa-ˌmīd\ [*acrylic* + *amide*] (1946) *n.* $CH_2{=}CHCONH_2$. A crystalline solid produced by hydrolysis of acrylonitrile; the monomer of polyacrylamide and a useful comonomer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.



**2-Acrylamido-2-methylpropanesulfonic acid (AMPS)** *n.* A solid aliphatic sulfonic-acid monomer produced by Lubrizol Corp. Its homopolymers are water-soluble and hydrolytically stable. It can be incorporated into other polymers by crosslinking.



**Acrylan rubber** *n.* Butyl acrylate/5–10% acrylonitrile copolymer. Manufactured by Monomer Corp., USA.

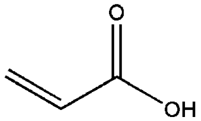
**Acrylate** \ˈa-krə-ˌlāt\ (1873) *n.* Ester formed from acrylic acid. The term also applies to the metallic salts of this acid. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Acrylate elastomers** *n.* Elastomeric formed from acrylate and elastomeric monomers such as butadiene. Harper CA (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Acrylate resin** *See acrylic resin.*

**Acrylic** \ ə-ˈkri-lik\ [ISV *acro*kein + *-yl* + $^{1}$*-ic*] (1855) *adj.* (1) The generic class of polymers and monomers (appox. 1942) derived from acrylic acid including polymethyl methacrylate. (2) Generic name for fibers from at least 85% poly(acrylonitrile). {D Acrylglas n, F verre acrylique, verre m, S vidrio crílico, vidrio m, I vetro acrilico, vetro m}. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Morrison RT, Boyd, RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Acrylic acid** (ca. 1855) (propenoic acid, vinylformic acid) *n.* $CH_2{=}CHCOOH$. A colorless, unsaturated acid, that polymerizes readily. The homopolymer is used as a thickener and textile-sizing agent and, cross-linked, as a cation-exchange resin. Acrylic-acid esters are widely used as monomers for acrylic resins. Mol wt., 72.06; mp, 14°C; bp, 141.0°C; Sp gr, 1.422.



Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Acrylic aldehyde** *See acrolein.*

**Acrylic coating polymers** *n.* Acrylic resins or polymers such as polymethyl methacrylate used for formulating coating.

**Acrylic ester** (acryl ester) *n.* An ester of acrylic or methacrylic acid or of structural derivatives thereof. Polymers derived from these monomers range from soft, elastic, film-forming materials to hard plastics. They are readily polymerized as homopolymers or copolymers with many other monomers, contributing improved resistance to heat, light, and weathering. Some members of the acrylic-ester family (e.g., butylenes dimethacrylate and trimethylolpropane trimethacrylate) function as reactive plasticizers in PVC and elastomers. They serve as plasticizers during processing, then polymerize while curing to impart hardness to the finished article. Odian

GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.
*See also acrylic resin.*

**Acrylic esters** *n.* Elastomeric polymers formed from acrylate and elastomeric monomers such as butadiene. Harper CA (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Acrylic fiber** (1951) *n.* A manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of acrylonitrile units [$-CH_2-CH(CN)-$] (FTC definition). Acrylic fibers are produced by two basic methods of spinning (extrusion), dry and wet. In the dry spinning method, material to be spun is dissolved is a solvent. After extrusion through the spinneret, the solvent is evaporated, producing continuous filaments, which later may be cut into staple, if desired. In wet spinning, the spinning solution is extruded into a liquid coagulating bath to form filaments, which are drawn, dried, and processed. Uses of acrylic fibers include floor coverings, blankets, and apparel uses such as suitings, pile fabrics, coats, collars, linings, dresses, and shirts. Vincenti R (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York. Kadolph SJ, Langford AL (2001) Textiles. Pearson Education, New York. Complete textile glossary. Celanese Corporation, Three Park Avenue, NY. Tortora PG, Merkel RS (2000) Fairchild's dictionary of textiles, 7th edn. Fairchild Publications, New York.

**Acrylic foam** *n.* A cellular polymer used for lining drapes and made by mixing an emulsified acrylic resin with compressed air in the ration of one part emulsion to four or five parts air, spreading the foam on a substrate, then drying in an oven. The emulsion may contain fillers and pigments to provide opacity, and a foaming aid such as ammonium stearate. When the coated fabric must have abrasion resistance for washing and cleaning, the acrylic foam can be crushed between rollers to partly collapse the cell structure. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Acrylic latex** *n.* Aqueous dispersion, thermoplastic or thermosetting, of polymers or copolymers of acrylic acid, methacrylic acid, esters of these acids, or acrylonitrile.

**Acrylic plastics** *n.* Thermoplastic or thermosetting plastics of polymers including copolymers of acrylic acid, methacrylic acid, esters of these acids or acrylonitrile.

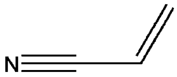
**Acrylic resin** (1936) *n.* A polymer composed of acrylic or methacrylic esters, sometimes modified with non-acrylic monomers such as the ABS group. The acrylates may be methyl, ethyl, butyl, or 2-ethylhexyl. Usual methacrylates are the methyl, ethyl, butyl, lauryl, and stearyl. The resins may be in the form of molding powders or casting syrups, and are noted for their exceptional clarity and optical properties. Acrylics are widely used in lighting fixtures because they are slow-burning or even, with additives, self-extinguishing, and do not produce harmful smoke or gases in the presence of flame. Deligny P, Oldring PKT, Tuck N (2001) Resins for surface coatings, alkyds, and polyester, vol 22. John Wiley and Sons, New York. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Acrylic rubber** (AR) *n.* A synthetic rubber made at least partly from acrylonitrile, or from ethyl acrylate copolymerized with many of the monomers or block polymers of the synthetic-rubber family. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Acrylide maroon** *n.* This group includes the azo pigments based on acrylides of beta hydroxy naphthoic acid (e.g., toluidine maroon); they are characterized by their excellent soap, acid, and alkali resistance and good bake resistance. Poor bleed resistance in aromatic and alcohol solvents, poor light fastness in other than masstone shades (including metallics), low hiding power and high cost discourage their use except where chemical resistance requirements demand; to this extent they may be considered as specialty pigments. Herbst W, Hunger K (2004) Industrial organic pigments. John Wiley and Sons Inc., New York.

**Acrylonitrile** \ˌa-krə-lō-ˈnī-trəl, -ˌtrēl\ (1893) (propenenitrile, vinyl cyanide) *n.* (1) A monomer with the structure $CH_2{=}CH{-}CN$. It is most useful in copolymers. Its copolymer with butadiene is nitrile rubber, and several copolymers with styrene exist that are tougher than polystyrene. It is also used as a synthetic fiber and as a chemical intermediate. (2) A raw material for the manufacture of synthetic resins and rubbers. It is a liquid at room temperatures, with a bp of 77°C and flp of 0°C. Kadolph SJ, Langford AL (2001) Textiles. Pearson Education, New York. Odian G (2004) Principles of polymerization. Joihn Wiley and Sons, New York.

*Also known as vinyl cyanide.*



**Acrylonitrile–butadiene copolymer (NBR)** *n.* Any of a family of copolymers ranging from about 18 to 50% acrylonitrile, and sometimes including small amounts of a third monomer. The family includes the German materials perbunan and buna-N, and the nitrile rubbers. The outstanding property of this nitrile-rubber family is excellent resistance to oils, fats, and hydrocarbons such as motor fuels, making them useful for motor gaskets, abrasion linings, conveyor belts, and hoses for oils and fuels. Odain G (2004) Principles of polymerization. Joihn Wiley and Sons New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers Inc., New York. James F (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Acrylonitrile-butadiene-styrene (ABS)** *n.* Acrylonitrile and styrene liquids and butadiene gas polymerized together in a variety of ratios to produce the family of ABS resins.

**Acrylonitrile-butadiene-styrene copolymers** *n.* Terpolymer of three monomers, forming ABS.

**Acrylonitrile-butadiene-styrene resin** *n. See ABS resin and nitrile barrier resin.*

**Acrylonitrile-chlorinated PE-styrene** *n.* A terpolymer of three monomers by the same names.

**Acrylonitrile-styrene copolymer** *n.* Any of a group of copolymers that have the transparency of polystyrene, but with improved resistance to solvents and stress cracking.

**ACS** *n.* Abbreviation for the American Chemical Society, headquartered at 1155 16th St, NW, Washington, DC 20036. The Society's polymer chemistry division holds national meetings and publishes several journals.

**Actinic degradation** *n. See ultraviolet degradation.*

**Actinic resistance** *n. See ultraviolet resistance.*

**Actinide series** *n.* Elements of atomic numbers 89–103 analogous to the lanthanide series of the so-called rare earths.

**Actinoid** *n.* A member of the series of 14 elements following actinium in the periodic table. It is also called actinide.

**Action** \ˈak-shən\ *n.* Action is measured by the product of work by time. Cgs units of action are the erg-second and the joule-second. Dimensions $(ML^2T^{-1})$. Plank's quantum or constant of action is $6.62006876 \times 10^{-34}$ J.s. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw Hill Science/Engineering/Math, New York.

**Action stretch** *n.* A term applied to fabrics and garments that give and recover in both the lengthwise and the widthwise directions. Action stretch is ideal for tight-fitting garments such as ski pants. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Activate** \ˈak-tə-ˌvāt\ (1626) *v.* To put into a state of increased chemical activity.

**Activated** *adj.* Materials, specially treated to confer absorptive, adsorptive, or catalytic properties on them. Such substances include activated alumina, activated earths, and activated carbon.

**Activated carbon** (1921) *n.* (1) Any form of carbon characterized by high adsorptive capacity of gases, vapors, and colloidal solids. (2) A highly adsorbent powdered or granular carbon made usually by carbonization and chemical activation and used chiefly for purifying by adsorption. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.
*Also known as activated charcoal.*

**Activated complex** *n.* A short-lived combination formed by collision of reactant particles in an elementary process; also called transition state.

**Activation** (1626) *n.* The process of making more active: to make (as moleclules) reactive or more reactive; inducing radioactivity in a specimen by bombardment with neutron or other types of radiation; rendering a thermoplastic surface more receptive to printing inks, paints, and adhesives by chemical treatment such as carbon and alumina; corona discharge or flame treatment; energetic elevation of a molecule to a state in which it becomes ready to react with another molecule. {G Aktivierung f, F activation f, S activación f, I attivazione f}. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA, 2004. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Activation energy** (1940) $(E, E_A)$ *n.* The energy required to facilitate reaction between two molecules or, in the context of the Eyring theory of low, the energy required to cause a molecule of liquid or chain segment of a polymer to "jump" from its present position to a nearby hold (i.e., an empty volume of molecular or chain-segment size) in the liquid. Activation energies are usually expressed per mole of substance (SI: J/mol) and are evaluated by fitting reaction-rate or flow data at several temperatures to an equation of the Arrhenius form, $k = Ae^{-Ea/RT}$. Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York.
*See Arrhenius equation.*

**Activator** (1626) *n.* (1) An agent added to the accelerator in natural or synthetic resins to enhance the action of the accelerator in the vulcanizing process. (2) A chemical additive used to initiate the chemical reaction in a specific mixture.

*See accelerator and catalyst.*

**Activator, initiator** *n.* It is usually necessary to add an activator (e.g., $FeSO_4 \cdot 7H_2$) to attain reasonable rates of polymerization when redox initiators (lauroÿl peroxide and fructose) are used at zero degree temperature or below.

**Active mass** *n.* The active mass of a substance is the number of gram molecular weights per liter in solution, or in gaseous form. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc. New York.

**Active metal** *n.* Metal in a condition of high chemical activity that is more susceptible to corrosion.

**Active site** *n.* A location on the surface of a heterogeneous catalyst or an enzyme at which reactant molecules can combine and react with low required activation energy. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Activity** \ak-ˈti-və-tē\ (1530) *n.* A quantity which measures the parent or effective concentration (or, for a gas, partial pressure) of a species and which takes into account interparticle interactions which produce non-ideal behavior. At low concentrations (or pressures) activity is essentially equal to concentration (or pressure).

**Activity coefficient** *n.* A factor which, when multiplied by the molecular concentration yields the active mass. The activity coefficient is evaluated by thermodynamic calculations, usually from data on the emf of certain cells, or the lowering of the freezing point of certain solutions. It is a correction factor, which makes the thermodynamic calculations correct. Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York.

**Acute bisectrix ($Bx_a$)** The bisector of the acute optic axial angle for biaxial crystals. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**ACV** *n.* Abbreviation for Adams chromatic value.

**Acyclic** \(ˌ)ā-ˈsī-klik, -ˈsi-\ (1878) *n.* Open chain, not ring formation.

**Acyl, acyl groups** *n.* When the OH group is removed from a fatty acid molecule, the monovalent residue is described as an acyl radical. Examples of acyl radicals are $CH_3CO$–acetyl; $C_2H_5CO$=propionyl; and $C_3H_7CO$–butyrl. Radicals derived from carboxylic acids by removal of the hydroxyl group. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Acylation** *vt* (1907). Formation or introduction of an acyl radical in or into an organic compound. An acyl group (RCO–) becomes attached to the aromatic ring, thus forming a ketone; the process is called acylation; includes Friedel-Craft acylation. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Adams chromatic value color difference equation** *n.* One of the transformations of CIE color space into another space which is perceived as visually more uniform. It is used to describe the difference between two similar colors: it is based on the Munsell value function.

$$Y_c/100 = 1.2219V_Y - 0.23111V_Y^2 + 0.23951V_Y^3 - 0.021009V_Y^4 + 0.000840V_Y^5.$$

For determining the $V_x$, substitute $X_c/0.9804$ for $Y_c$, for determining $V_z$, substitute $Z_c/1.1810$ for $Y_c$ in the above equation. The transformed space is then calculated according to the following equations:

$$a = V_X - V_Y,$$
$$b = 0.4\ (V_Z - V_Y) \text{ or } 0.4\ (V_Y - V_Z),$$
$$L = 0.23\ V_Y.$$

The total color difference, $\Delta E$, is calculated as follows

$$\Delta E = \sqrt{(0.23\Delta V_Y + [\Delta(V_x - V_Y)]^2 + [0.4\Delta(V_z - V_Y)]^2}.$$

Note that if $b$ is calculated as 0.4 ($V_z - V_Y$), a plus number indicates blueness; if the $b$ is calculated as 0.4 ($V_Y - V_z$), a plus number indicates yellowness. The equation is generally used with a normalizing constant placed outside the brackets. If the components $L$, $a$, and $b$ are used individually they are also multiplied by the normalizing constant, $f$. The normalizing constant or factor, $f$, is used to convert the numbers obtained to the same magnitude as those obtained with the NBD equation. The factor used is generally 40, although it may vary between 40 and 50 and must therefore be specified. Unless specified otherwise, the value 40 is assumed to have been used. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Adaptation** \ˌa-ˌdap-ˈtā-shən, –dəp-\ (1610) *n.* Changes in the sensitivity of the eye resulting from changes in the viewing light sources, thus enabling the eye to meet the needs of vision in a very wide range of conditions.

**Adapter** *n* (1801) (die adapter). In an extrusion setup, the portion of the die assembly that attaches the die to the extruder and provides, inside a flow channel for the molten plastic between the extruder and the die.

**Adapter plate** *n.* In injection molding, the plate holding the mold to the press frame or platen.

**Adapter ring** An annular retaining part of extrusion and injection apparatus.

**ADC** *See allyl diglycol carbonate.*

**Addition polymer** *n.* Polymer made by addition polymerization (IUPAC).

**Addition polymerization** *n.* A reaction in which unsaturated monomer molecules join together to provide a polymer in which the molecular formula of the repeating unit is identical with that of the monomer. The molecular weight (i.e., $M_w$, $M_n$) of the polymer so formed is thus the total of the molecular weights of all of the combined monomer units. Example: $n\mathrm{CH_2} = \mathrm{CH_2} \rightarrow (-\mathrm{CH_2CH_2})_n$, with molecular weight $= n \times 28.03$, and where $n = 100$, then 2803 g/mol of polymer. Polymers formed from monomers without the lose of a small molecule unlike condensation polymerization, the composition of polymer is the same as the monomer, e.g., polyethylene. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience, Publishers Inc., New York.

**Additive** \ˈa-də-tiv*j* (1699) *adj.* A supplementary material combined with a base material to provide special properties. For example, pigments are used as dope additives to give color in mass dyeing. Examples are slip additives, pigments, stabilizers, and flame retardants. Also sometimes called Modifier {G Additiv n, F additif m, S aditivo m, I additivo m}. Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York.

**Additive color mixture** *n.* Color which results when the same area of the retina of the eye is illuminated by lights of different spectral distribution, such as by two or more colored lights. Pigments such as paints obey substractive color mixtures whereas light (sources of illumination) obeys additive color mixture may result from addition of lights from two or more sources, by visual averaging of s colored dots (dot matrix) as on colored television screens or paper, or by additive color mixture rules. For example, yellow paint mixed with blue paint yeidls green paint, and yellow light mixed with blue light yields white light. McDonald Roderick (1997) Colour physics for industry, 2nd edn. Society of Deyes and Colourists, West Yorkshire, England. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Additive reaction** *n.* Chemical reaction in which two components join together to form a single reaction product. In a pure additive reaction, neither of the reactants undergoes molecular fission or splitting, but attaches itself to the other reactant intact. In other additive reactions, one of the reactants may split into two separate parts, each of which attaches itself to the appropriate places of the other intact reactant. There is still, however, a single reaction product. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Adduct** ə-ˈdəkt, a-\ [L *adductus*, pp of *adducere*] (ca. 1839) *vt.* (1) The cyclic product of an addition reaction between one unsaturated compound, such as a diene and another. (2) A crystalline mixture, not a true compound, in which molecules of one of the components are contained within the crystal-lattice framework of the other component. Such complexes are stable at room temperature but the entrapped component can escape when the mixture is melted or dissolved. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Adduct curing agent** *See cross-linking agent.*

**Adeps lanae, anhydrous** *n.* Pharmaceutical name for lanolin or purified wood grease.

**Adhere** \ad-ˈhir, əd\ [MF *adhérer*, L *adhaerēre* fr. *ad-* + *haerēre*] (1536) *v.* To cause two surfaces to be held together by adhesion.

**Adherend** *n.* A body which is held to another body by an adhesive.

*See also substrate.*

**Adherend preparation** n. *See surface preparation.*

**Adherometer** An instrument that measures the force required to strip a coating from a metal surface. Paint/Coatings Dictionary. Federation of Societies for Coatings Technology, Philadelphia, 1978.

**Adhesion** \əd-ˈhē-zhən, əd-\ [F or L; F *adhésion*, fr. L *adhaesion-*, *adhaesio*, fr. *adhaerēre*] (1624) *n.* The state in which two surfaces are held together by interfacial forces, which may consist of valence forces or interlocking action, or both. One method for testing the strength of adhesive bonds. Skeist I (ed) (1990) Handbook of adhesives. Reinhold Publishing Co., New York.

*See also adhesion, mechanical, and adhesion, specific* {G Adhäsion f, F adhésion f, S adhesión f, I adesione f}.

**Adhesion, mechanical** *n.* Adhesion between surfaces in which the adhesive holds the parts together by interlocking action such as "contact cement."

*See adhesion, specific.*

**Adhesion promoter** *n.* A chemical coating that is applied to a substrate before it is coated with a plastic, to improve the adhesion of the plastic to the substrate. Adhesion promoters include materials such as silanes and silicones with hydrolysable groups on one end of their molecules that react with moisture to yield silanol groups, which in turn react with or adsorb to inorganic surfaces to enable strong bonds to be made. At the other ends of the molecules are reactive, but nonhydrolyzable groups that are compatible with resins or elastomers in adhesive formulations. Adhesion promoters are added to the adhesive as water or ethanol solutions. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Adhesion, specific** *n.* Adhesion between surfaces that are held together by valence forces of the same type as those that give rise to cohesion.

*See adhesion, mechanical.*

**Adhesive** (1670). *n, adj, adv. n.* Adhesives are used in to bond two or more surfaces. *Adj.* An adhesive material binds two or more surfaces. *Adv.* Two or surfaces or bonded adhesively. The above usages of the different forms of the term were derived from The following information was derived from. Adhesives used in all of these applications can be classified into five types. A monomeric cement contains a monomer of at least one of the polymers to be joined and is catalyzed so that a bond is produced by polymerization. A solvent cement is a product that dissolves the plastics being joined, forming strong intermolecular bonds, then evaporates. *Bonded adhesives* are solvent solutions of resins, sometimes containing plasticizers that dry at room temperature. *Elastomeric adhesives* contain natural or synthetic rubbers either dissolved in solvents or suspended in water or other liquid, and are dried at room or elevated temperatures. *Reactive adhesives* are those containing partly polymerized resins, e.g., epoxies, polyesters, or phenolics that cure with the aid of catalytic hardeners to form a bond (usually thermoset). Further, various descriptive adjectives are applied to the term, adhesive, to indicate certain characteristics as follows: *Physical form*—liquid adhesive, tape adhesive; *Chemical type*—silicate adhesive, resin adhesive; *Material bonded*—paper adhesive, metal-plastic adhesive, can-label adhesive; and *Conditions of use*—hot-setting adhesive. In addition, contact-adhesives, moisture cure adhesives (cyanoacrylate and silicone) are among the many types of specialty adhesives in the ever-growing number of products from the developing adhesives industry. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Adhesive activated yarns** *n.* Yarns treated by the fiber manufacturer to promote better adhesion to another material such as rubber and/or allowing easier processing.

**Adhesive assembly** *n.* An adhesive that can be used for bonding parts, such as in the manufacture of a boat, airplane, furniture, etc. *Note*—The term, "assembly adhesive," is commonly used in the wood industry to distinguish such adhesives (formerly called “joint glues”). It is applied to adhesives used in fabricating finished structures or goods, or subassemblies thereof, as differentiated from adhesives used in the production of sheet materials for sale as such, for example, plywood, or laminates.

**Adhesive cellular** *See adhesive, foamed.*

**Adhesive, cold-setting** *n.* An adhesive that sets at temperatures below 20°C (68°F). *See also adhesive, hot-setting; adhesive, inter-mediate temperature setting; and adhesive, room temperature setting.*

**Adhesive, contact** *n.* An adhesive that is apparently dry to the touch and which will adhere to itself instantaneously upon contact; also called contact bond adhesive or dry bond adhesive.

**Adhesive dispersion** *n.* A two-phase system in which one phase is suspended in a liquid.

**Adhesive, edge jointing** *n.* Adhesive used to bond strips of veneer together by their edges in the formation of larger sheets.

**Adhesive film** *n.* A thin film of dry resin, usually a thermoset, used as an interleaf in the production of laminates such as plywood. Heat and pressure applied in the laminating process cause the film to bond the layers together.

**Adhesive, foamed** *n.* An adhesive, the apparent density of which has been decreased substantially by the presence of numerous gaseous cells dispersed throughout its mass.

**Adhesive, heat activated** *n.* A dry adhesive film that is rendered tacky or fluid by application of heat or heat and pressure to the assembly.

**Adhesive, hot melt** *n.* An adhesive that is applied in a molten state and forms a bond on cooling to a solid state.

**Adhesive, hot-setting** *n.* An adhesive that requires a temperature at or above 100°C (212°F) to set the adhesive.

**Adhesive, intermediate temperature** *n.* An adhesive that sets in the temperature range 31–99°C (87–211°F).

**Adhesive migration** *n.* In non-wovens, the movement of adhesive together with its carrier solvent in a fabric during drying, giving it a non-uniform distribution within the web, usually increasing to the outer layers.

**Adhesive, multiple layer** *n.* A film adhesive, usually supported, with a different adhesive composition on each side; designed to bond dissimilar materials such as the core to face bond of a sandwich composite.

**Adhesive, pressure-sensitive** *n.* A viscoelastic material that in solvent-free form remains permanently tacky. The material will adhere instantaneously to most solid surfaces and can be removalable (e.g., adhesive labels for garments).

**Adhesive, room temperature** *n.* An adhesive that sets in the temperature ranges of 20–30°C.

**Adhesives** *n.* In textiles, materials which cause fibers, yarns, or fabrics to stick together or to other materials.

**Adhesive, separate application** *n.* A term used to describe an adhesive consisting of two parts, one part being applied to one adherend and the other part to the other adherend and the two brought together to form a joint.

**Adhesive, solvent** *n.* An adhesive having a volatile organic liquid as a vehicle. *Note*—This term excludes water-based adhesives.

**Adhesive, solvent activated** *n.* A dry adhesive film that is rendered tacky just prior to use by application of a solvent.

**Adhesive tape test** *See tape test.*

**Adhesive, warm-setting** *n.* A term that is sometimes used as a Syn: intermediate temperature setting adhesive. *See adhesive, intermediate temperature setting.*

**Adiabatic** \ˌa-dē-ə-ˈba-tik, ˌā-ˌdī-ə-\ [Gk *adiabatos* impassable, fr. *a-* + *diabatos* passable, fr. *diabainein* to go across, fr. *dia-* + *bainein* to go] (1890) *adj.* Denoting a process or system in heat is not added or removed, but while work may be delivered to or by the system. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA, 2004. Ready RG (1996) Thermodynamics. Pleum Publishing Company, New York.

**Adiabatic change** *n.* A change which takes place with no gain or loss of heat. Ready RG (1996) Thermodynamics. Pleum Publishing Company, New York.

**Adiabatic extrusion** *See autothermal extrusion.*

**Adipate plasticizer** *n.* For plasticizers derived from adipic acid.

*See*

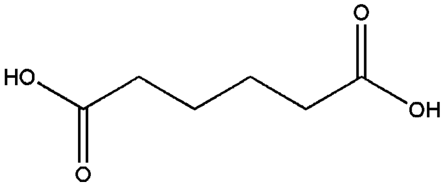
Benzyloctyl–diisobutyl–
Bis(2,2,4-trimethyl-1,3-
pentanediol)
Monoisobutyrate–
Dibutoxyethoxy ethyl–
Dibuto-xyethyl–
Dibutyl–
Dicapryl–
Diethoxyethyl–
Dienthyl–
Di(2-ethylhexyl)–

Di-n-hexyl–
Diisodecyl–
Diisooctyl–
Dimethoxyethyl–
Di(methyl-cylo-
Hexyl) –
Dinonyl–
Ditetrahydro-
Furfuryl–
n-octyl-n-decyl–

All of the above are polypropylene adipates. Wypych G (2002) Plasticizer's data base. Noyes Publication, New York. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Adipates** *n.* Esters of adipic acid.

**Adipic acid** [ISV] (1877). (hexanedioic acid, 1.4-butanedicarboxylic acid) *n.* A dicarboxylic acid used in the production of polyamides, alkyd resins, and urethane foams. Esters of adipic acid are used as plasticizers and lubricants. It is used in the polymerization reaction to form nylon 66 polymers and in the manufacture of polyurethane foams acid value, 767, molecular weight, 146.1; mp, 151°C; and bp, 216°C/15 mmHg.



**Adiponitrile carbonate** (ADNC) *n. See* 5,5'-*tetramethylene di-*(1,3,4-*dioxazol–2–one*).

**Adiprene** *n.* Polyurethane elastomer. Manufactured by DuPont, USA.

**ADNC** Abbreviation for adiponitrile carbonate.

**Adobe brick** *n.* Large, roughly molded, sun dried clay brick of varying sizes.

**Adronal** *See cyclohexyl acetate.*

**Adsorbed water** *n.* Water which is held on the surface of a material by secondary bonding forces (e.g., hydrogen bonding), and its physical properties are substantially different from those of absorbed water or chemically combined water at the same temperature and pressure. This type of water is often called a hygroscopic film. Complete textile glossary. Celanese Acetate LLC, Three Park Avenue, New York, 2000. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Adsorbent** \- bənt\ *n* (1917). Substance offering a suitable active surface, upon which other substances may be adsorbed.

**Adsorption** \ad-ˈsórp shən, -ˈzórp\ [*ad* + ab*sorption*] (1882) *n.* (1) The concentration of molecules of a particular kind at the interface between two phases such as the pigment and vehicle in printing inks.

Adsorption can effectively remove a component such as the drier from an ink vehicle. (2) The attraction of gases, liquids, or solids to surface areas of textile fibers, yarns, fabrics, or any material. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (1993) Printing ink manual, 5th edn. Blueprint, New York. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Adulteration** \ə-ˌdəl-tə-ˈrā-shən\ (1506) *n.* Presence of inferior materials, which reduce the quality of the standard.

**Advanced composite** *n.* Polymer, resin, or other matrix-material system in which reinforcement is accomplished via high-strength, high-modulus materials in continuous filament form or is discontinuous form such as staple fibers, filberts, and in-situ dispersions. Harper CA (2002) Handbook of plastics, elastomers, and composites, 4th edn. McGraw-Hill, New York.

**Advanced fiber** *n.* Any reinforcing fibers characterized by either very high strength, modulus or high operating temperature, beyond those of more familiar fibers such as glass, nylon, and polyester. Examples are aramid, fibers of some metals, carbon, boron, silicon carbide and silicon nitride, and whiskers of metals and inorganics. Chung DD (1994) Carbon fiber composites. Elsevier Science and Technology Books, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Advanced resin** *n.* Any of a new multiclass of thermoplastics of carious chemical natures, distinguished from the established and more common plastic materials by higher strength, modulus, or serviceability at 200+ °C. These materials also command premium prices and some require special processing. Examples are polyimides, polyetheretherketone, liquid-crystal polymers, polytetrafluoroethylene, and polybenzimidazole. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York.

**Advancing colors** *n.* Colors that give the illusion of being closer to the eye than their complementary colors when both are adjacent and in the same plane; colors ranging from yellow-green to scarlet are examples.

**Aeration cell** *n.* Electrolytic cell in which the driving force to cause corrosion results from a difference in the amount of oxygen in solution at one point as compared to another. Corrosion is accelerated where the oxygen concentration is least or most.

**Aerobic** \ˌa(-ə)r-ˈō-bik, ˌe(-ə)r-\ (1884) *adj.* Term referring to processes that can occur only in the presence of oxygen.

**Aerogel** *n.* A porous, foam-like network with very small "cells," whose substance may be silica, a polymer or a carbonized polymer. Densities can range from half of solid values to as low as $3\,\mathrm{mg/cm^3}$.

**Aerograph** *n.* A spray gun for coatings, using air.

**Aerosol** \ˈar-ə-ˌsäl, ˈer-, -ˌsól\ (1923) *n.* A suspension of liquid or solid particles in a gas (e.g., smoke, fog mist). In the packaging industry, the term means a self-contained sprayable product in which the propellant force is supplied by a compressed or liquidified gas (e.g., isopentane) for an "aerosol spray paint."

**Aerosol coating** *n.* A conveniently packaged spray coating in a sealed can. Pressure is supplied by compressed liquefied gas.

**Aerugo** *See verdigris.*

**Aesthetics** \es-ˈthe-tik, is-, *British usually ēs*-\ [Gr *ästhetisch*, NL *aestheticus*, Gk *aisthētikos* of sense of perception, fr. *aisthanesthai* to perceive] (1798) *adj.* In textiles, properties perceived by touch and sight, such as the hand, color, luster, drape, and texture of fabrics or garments.

**Affine deformation** *n.* A deformation in which each element in the volume distorts in the same way as does the volume as a whole.

**Affinity** \ə-ˈfi-nə -tē\ [ME *affinite*, MF *afinité*, L *affinitas*, fr. bordering on, related by marriage, fr. *ad* + *finis* end, border] (14c) *n.* With respect to an adhesive, affinity is attraction or polar similarity between the adhesive and an adherend.

**African ochre** *See pigment yellow* (42/77492).

**After-bake** *n.* A technique used with phenolic and amino resins to increase the output of a molding press by ejecting moldings before they are fully cured, subsequently completing the cure by baking them. After baking may also be done with fully cured parts to improve their electrical properties and heat resistance.

**Afterburner** \ˈbər-nər\ (1947) *n.* An air pollution abatement device that removes undesirable organic gases through incineration.

**Aftercure** *n.* A continuation of the process of curing or vulcanization after the cure has been carried to the desired degree and the source of heat removed, generally resulting in over-cure and a product less resistant to aging than properly cured products.

**After-flame** *n.* In an ignition test, persistence of flame after removal of the ignition source.

**After-flame time** *n.* The duration of after-flame.

**Afterglow** \ˈaf-tər ˌglō\ (1871) *n.* The flameless, glowing combustion of certain solid materials that occurs after the removal of an external source of ignition or after the cessation of combustion of the material.

**After-tack** *n.* Film defect in which the coated surface, having once reached a tack-free stage, subsequently develops a sticky condition. The effect may be due to syneresis (i.e., expulsion of liquid from a gel). Also applies to printing inks.

**Aftertreatment** *n.* Any treatment done after fabric production. In dyeing, it refers to treating dyed material in ways to improve properties; in nonwovens, it refers to finishing processes carried out after a web has been formed and bonded. Examples are embossing, creping, softening, printing, and dyeing.

**Ag** Chemical symbol for the element silver. Tortora PG (ed) (1889) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Agar (or agar-agar)** \ˈa-gər\ [Malay *agar-agar*] (1889) *n.* Gelling hydrocolloid from sea algae plants which are polymers of galactose.

**Ager** A steam chamber used for ageing printed or padded material.

**Age resistance** Resistance to deterioration with time.

**Agglomerate** \ə-ˈglä-mə-ˌrāt\ [L *agglomerates*, pp of *agglomerare* to heap up, join fr. *ad-* + *glomer-*, *glomus* ball] (1684) *vt.* (1) Cluster of individual; particles. (2) Cluster of dry pigment particles held together by surface forces. The spaces between the particles are filled with air; may also be present in liquid paints of the pigment has not been properly dispersed.

*See aggregate.*

**Agglomeration** (1774) *n.* Condition in which particles become united into clusters of individual particles. May be loosely used to refer to undispersed material.

**Aggregate** \ˈa-gri-gət\ [ME *aggregate*, fr. L *aggregatus*, pp of *aggregare* to add to, fr.

*ad-* + *greg-*, *grex* flock] (15c) *adj.* (1) A group of dry pigment particles held together by their surface forces; the spaces between the particles are filled with air. (2) An inert granular material, such natural sand, manufactured sand, gravel, crushed gravel, crushed stone, vermiculite, perlite, and air-cooled blast furnace slag, which when bound together into a conglomerate mass by a matrix, forms concrete or mortar. (3) In the reinforced-plastics industry, a mixture of a hard, fragmented material with an epoxy binder, used as a flooring or surfacing medium, or in epoxy tooling {*aggregation* G Aggregatzustand m, F état d'aggrégation, état m, S estado de agregación, estado m, I stato di aggregazione, stato m}.

*See agglomerate.*

**Aggressive tack** *See tack, dry.*

**Aging** (ageing) *n.* (1) The deterioration of textile or other materials caused by gradual oxidation during storage and/or exposure to light. (2) The oxidation stage of alkali-cellulose in the manufacture of viscose rayon from bleached wood pulp. (3) Originally, a process in which printed fabric was exposed to a hot, moist atmosphere. Presently, the term is applied to the treatment of printed fabric in moist steam in the absence of air. Aging is also used for the development of certain colors in dyeing, e.g., aniline black. (4) The process, or the results of, exposure of plastics to natural or artificial environmental conditions for a prolonged period of time. Storage of paints, varnishes, etc., under defined conditions of temperature, relative humidity, etc. in suitable containers, or of dry films of these materials, for the purpose of subsequent tests. Complete textile glossary. Celanese Acetate LLC, Three Park Avenue, New York, 2000. Glenz W (ed) (2001) A glossary of plastics terminology in five languages, 5th edn. Hanser–Gardner Publications Inc., Cinicinnati.

*See also artificial aging and artificial weathering. See also maturing* {G Alterung f, F vieillissement m, S envejecimiento m, I invecchiamento m}.

**Aging, rubbers** *n.* The process of oxidation and other degradations of rubber or elastomeric materials.

**Aging time** n. *See time, joint conditioning.*

**Agitate** \ˈa-jə-ˌtāt\ [L *agitatus*, pp of *agitare*, frequentative of *agere* to drive] (15c) *v.* To stir or to mix, as in the case of a dyebath or solution.

**Agitation** *n.* Process of mixing or stirring to achieve homogeneity, but not necessarily dispersion.

**Agitator** *n.* Mechanical device used for mixing or stirring.

**AI** *n.* Abbreviation of amide-imide (polymer). *See polyamide-imide resin.*

**AIA** *n.* Abbreviation for American institute of architects.

**AICE** Abbreviation for American institute of chemical engineers.

**AIMA** *n.* Abbreviation for acoustical and insulating materials association.

**Air assist thermoforming** *n.* Method of thermoforming in which air is employed to perform the sheet immediately prior to the final pull down onto the mold, using vacuum.

**Air-assist vacuum forming** *n.* A modification of the process of sheet thermoforming in which partial performing of the sheet is effected by air flow or air pressure before vacuum pull-down.

**Air bag** *n.* An automatically inflating bag in front of riders in an automobile to protect them from pitching forward in an accident. End use for manufactured textile fibers.

**Air blowing** *n.* Process employed for the production of low temperature blown oils or of high temperature isomerized oils. A large stream of air, sent through vegetable oils under suitable conditions, produces chemical changes in them. These changes are recognized by solubility characteristics, increased viscosity, and improved drying and polymerizing properties; but the changes which occur with a particular oil are governed by its chemical composition. Shahidi F, Bailey AE (eds) (2000) Bailey's industrial oil and fat products. John Wiley and Sons, New York. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, 2001.

*See blown bitumen, blown castor oil, blown oil, and blown stand oil.*

**Air brush** *n.* Very small spray gun, not much larger than a fountain pen, designed as an artist's tool.

**Air brushing** *n.* Blowing color on a fabric or paper with a mechanized pneumatic brush.

**Air bubble** *n.* Dry bubble in coating film caused by entrapped air.

**Air-bubble viscometer** *n.* An instrument used to measure the viscosities of oils, varnishes and resin solutions by matching the rate of rise of an air bubble in the sample liquid with the rate of rise in one of a series of standard liquids, whose viscosities are known. The Gardner–Holt bubble viscometer is such an instrument (Paul N. Gardner, Company Inc., 316 N. E. Fifth Street, Pompano Beach, Fl, www.gardco.com).

**Air cap** *n.* Perforated housing for atomizing air at head of spray gun.

**Air columns** Frequency of vibration in (*see organ pipes*).

**Air conditioning** *n.* (1) A chemical process for sealing short, fuzzy fibers into a yarn. Fabrics made from air-conditioned yarns are porous. Because they allow more air circulation, these fabrics are also cooler. (2) Control of temperature and/or humidity in work or living space.

**Air contamination** *n.* Foreign substances introduced into the air which make the air impure.

**Air cure** *n.* Vulcanization which takes place at room temperature with the use of ultrafast or fast-acting accelerator.

**Air drying** *See drying.*

**Air ducts** *n.* Pipes that carry warn air or cold air to rooms and back to furnace or air conditioning system.

**Air entangled yarns** *See compacted yarns.*

**Air entraining agents** *n.* Natural wood resins, fats, inorganic materials, sulfonated compounds, and oils for air entrapment in concrete.

**Air entrapment** *n.* Inclusion of air bubbles in coating film or in other solids such as concrete.

*See microvoids.*

**Air flotation** *n.* Process used to separate light from heavy pigment particles by a strong current of air. The air stream is so arranged that the pigment particles are carried vertically from the grinding mill. By this means only the finest particles are carried away, the larger and heavier ones falling back to be re-ground.

**Air forming** *n.* A process in which air is used to separate and move fibers to fashion a web such as the Kroyer® process for short fibers, usually of wood pulp; or the Rando-Webber® process for staple-length fibers.

**Air gap** *n.* (1) In extrusion of film, sheet or a coating, the distance from the die opening to the nip formed by the pressure roll and the chill roll. (2) In the radio-frequency heating of plastics and corona treatment of films, the space between the electrode and the surface of the material.

**Air jet** A type of sandblasting gun in which the abrasive is conveyed to the gun by partial vacuum.

**Air jet spinning** *n.* A spinning system in which yarn is made by wrapping fibers around a core stream of fibers with compressed air. In this process, the fibers are drafted to appropriate sliver size, then fed to the air jet chambers where they are twisted, first in one direction, then in the reverse direction in a second chamber. They are stabilized after each twisting operation.

**Air jet texturing** *See texturing.*

**Air-knife coating** *n.* A coating technique especially suitable for thin coatings such as adhesives, wherein a high-pressure jet of air is forced through orifices in a knife to meter and control the thickness of the coating.

*See also spread coating.*

**Air-laid nonwovens** *n.* Fabrics made by an air-forming process. The fibers are distributed by air currents to give a random orientation within the web and a fabric with isotropic properties.

**Airless blast deflashing** *n.* The process of removing flash from molded parts by bombarding them with tiny nonabrading pellets that break off flash by impact.

*See also blast finishing.*

**Airless spray** *n.* A system of applying paint under high pressure in which the paint is broken up into droplets when it enters to lower-pressure region outside of the gun tip. Very little air is used as compared to conventional air spray.

**Airless spraying** *n.* Process of atomization of paint by forcing it through an orifice at high pressure. This effect is often aided by the vaporization of the solvents, especially if the paint has been previously heated. The term is not generally applied to those electrostatic spraying processes, which do not use air for atomization.

*See also hydraulic spraying.*

**Air-lock** *n.* Surface depression on a molded part, caused by trapped air between the mold surface and the plastic material.

**Air loss** *n.* Loss in mass by a plastic or coating on exposure to air at room temperature.

**Air permeability** *n.* The porosity or the ease with which air passes through material. Air permeability determines such factors as the wind resistance of sailcloth, the air resistance of parachute cloth, and the efficacy of various types of air filters. It also influences the warmth or coolness of a fabric.

**Airplane fabric** *n.* A plain, tightly woven, water-repellent fabric traditionally made of mercerized cotton. During World War I, the fabric was treated with a cellulose acetate dope and used to cover the wings, tail, and fuselage of airplanes. Today, similar fabrics made from nylon or polyester/cotton blends are used in rainwear and sportswear.

**Air pollutants, hazardous** *n.* Materials discharged into the atmosphere that have a proven relationship to increase human death rates.

**Air pollution** The presence of contaminants in the air in concentrations that interfere directly or indirectly with man's health, safety, or comfort.

**Air quality control regions** *n.* Geographical units of the country, as required by USA. Law, reflecting common air pollution problems, for purposes of reaching national standards.

**Air-quality regulations** *n.* Federal, state and/or local regulations constructed for the purpose of protecting air quality, e.g., low volatile organic compounds regulations.

**Air quality standards** *n.* The prescribed level of pollutants in air that cannot be exceeded during a specified time in a specified geographical area.

**Air ring** *n* (air-cooling ring). In the process of blowing tubular film, a circular manifold with one or more annular openings concentric with and just above the die lip that blows a uniform stream of air on or along the plastic tube. The air may be refrigerated.

**Air sampling** *n.* Determining quantities and types of atmospheric contaminants by measuring and evaluating a representative sample of air. The most numerous environmental hazards are chemical, and can be conveniently divided into (a) the particulates and (b) the gases or vapors. Particulates are mixtures or dispersions of solid or liquid particles in air and included dust, smoke, mist, and similar materials.

**Air separation** *See air flotation.*

**Air shot** (air purge) *n.* In injection molding, a shot made with the nozzle withdrawn from the mold, so that the expelled melt may fall freely and be caught for measurement of cup temperature or for weighing.

**Airslip forming** (airslip vacuum forming) *n.* A variation of snap-back forming in which a male mold is enclosed in a box so that, as the mold advances toward the softened sheet, air is trapped between mold and sheet. The ballooning sheet is thus kept from touching the mold during most of the latter's advance. At the end of the stroke, vacuum is applied, destroying the air cushion, and the sheet is sucked against the plug. *See also sheet thermoforming.*

**Air-supported roof** *n.* A fabric-based roofing system that is supported and held in place by air pressure.

**Air vent** *n.* A passageway, typically a fine groove or scratch, between a mold cavity and the outside edge of the mold face, that allows air to escape as melt is injected into the cavity.
*See burn mark.*

**Al** Chemical symbol for the element aluminum.

**Alabaster** \ˈa-lə-ˌbas-tər\ [ME *alabaster,* fr. MF, fr. L *alabaster* vase of alabaster, fr. Gk *alabastros*] (14c) *n.* Fine-grained, translucent variety of very pure gypsum, generally white or delicately shaded.

**Alathon** Ethylene/vinyl acetate copolymer. Manufactured by DuPont, USA.

**Albatross** \ˈal-bə-ˌtrós, -ˌträs\ [prob. alter. of obs. *alcatrace* frigate bird, fr. Sp or Pg *alcatraz* pelican, fr. Arabic *al-ghattās,* a kind of sea eagle] (1672) *n.* A soft, lightweight wool or wool blend fabric in a plain weave with a napped, fleecy surface that resembles in texture, the breast of the albatross. It is usually light-colored and is used in negligees, infants' wear, etc.

**Albedo** \al-ˈbē-(ˌ)dō\ [fr. L *albus*] (ca. 1859) *n.* The fraction of incident light or other electromagnetic radiation that is reflected by a surface.

**Albertol, alberlat** *n.* Modified phenolic resins. Manufactured by Chem. Werke Albert, Germany.

**Albino bitumen** *n.* Pale bitumen of petroleum origin, similar in general physical characteristics to the black types, but distinguished by its deep golden brown color.

**Albite** \ˈal-ˌbīt\ [Sw *albit,* fr. L *albus*] (ca. 1843) *n.* $NaAlSi_3O_8$. A widely distributed white feldspar. One of the common rock-forming plagioclase groups.

**Albumin** \al-ˈbyü-mən; ˈal-ˌbyü-, -byə-\ [ISV *albumen* + *-in*] (1869) *n.* Water-soluble protein derived from egg whites or animal blood, used in used in coatings and adhesives.

**Alburnum** Softer part of the wood between the inner part and the heart wood. Syn: sapwood.

**Alchemy** \ˈal-kə-mē\ [ME *alkamie*, *alquemie*, fr. MF or ML; MF *alquemie*, fr. ML *alchymia*, fr. Arabic *al-kīmiy ā'*, fr. *al* the + *kīmiyā'* alchemy, from LGk *chēmeia*] (14c) *n.* The chemical period from about 300 BC to AD 1500 during which a central goal was the transmutation of base metals into gold.

**Alcohol** \ˈal-kə-ˌhól\ [Fr. L, fr. ML, powdered antimony, fr. OSp, from Arabic *al-kuÖul* the powdered antimony, from *kuÖl* kohl] (1672) *n.* (1) A generic term for organic compounds having the general structure ROH. In aliphatic alcohols, R has the formula $C_nH_{2n+1}$, as in methyl alcohol, $CH_3OH$, or *n*-butanol, $C_4H_9OH$. In more complex alcohols R may be other alkyl, acyclic or alkaryl groups. Alcohols are classified according to the number of –OH groups they contain–monohydric, dihydric, trihydric, or polyhydric. Dihydric alcohols are called glycols; trihydric alcohols are also known as *glycerols*; and the term polyol is used for any polyhydric alcohol. Alcohols have many important applications in the plastics industry. They are used directly as solvent applications in the plastics industry. They are used directly as solvent and diluents. Many esters of alcohols with organic acids are plasticizers. As intermediates, alcohols are used in the production of resins such as acrylics, alkyds, aminos, polyurethanes, and epoxies. (2) Specifically, ethanol, $C_2H_5OH$. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Alcohol, denatured** *n.* Ethyl alcohol that has been adulterated with a toxic material such as acetaldehyde or benzene so as to render it unfit for human consumption but still useful as an industrial solvent or, occasionally, as a reactant.

**Alcohol resistance** *n.* Ability of a dried or cured coating to withstand the damaging effects of (ethyl) alcohol.

**Alcohols** *n.* A family of organic solvents containing the grouping C–OH, used in flexographic and gravure inks. The most common members of this group are: methyl (wood) alcohol, ethyl (grain) alcohol, Propyl and isopropyl alcohol.

**Alcoholysis** *n.* By analogy to *hydrolysis*, any chemical reaction in which an alcohol acts in a way similar to that of water. Its general chemical reaction involves an ester exchange. The cleavage of a C–C bond by the addition of an alcohol.
*See also ester interchange.*

**Alcove** \ˈal-ˌkōv\ [F *acôve*, fr. Sp *alcoba*, fr. Arabic *al-qubbah* the arch] (1676) *n.* A small recessed space, opening directly into a larger room.

**Aldehyde** \ˈal-də-ˌhīd\ [Gr *Aldehyde*, fr. NL *al. dehyde.*, abb. *alcohol dehydrogenatum* dehydrogenated alcohol] (ca. 1846) *n.* (1) A generic term for organic compounds containing a double-bonded oxygen and hydrogen bonded to the same terminal carbon atom of the molecule, i.e., the –CHO group. Thus they may be represented by the general formula RCHO. The simplest one is formaldehyde, HCHO, in which R is hydrogen. For all other, R represents a hydrocarbon radical. (2) Any of a class of highly reactive organic chemical compounds obtained by oxidation of primary alcohols, characterized by the common group –CHO and used in the manufacture of resins, dyes, and organic acids.

**Aldehyde resin** *n.* Synthetic resin made by treating various aldehydes with condensation agents. Phenol, urea, aniline, and melamine react readily with aldehydes, such as formaldehyde, which are also called *Aldehyde Resins* {G Aldehydharz n, F résine aldéhyde, résine f, S resina aldehídica, resina f I resina aldeidica, resina f}.

**Aleurites** *n.* Botanical name for a species of shrub or tree which provides vegetable oils used in varnish manufacture. The various *aleurites* include *A. fordii, A. montana, A. cordate, A. trisperma,* and *A. moluccana.* The first three yield tung oils, the fourth, bagillumbang oil, and the last, candlenut oil.

**Aleuritic acid** *n.* $C_{15}H_{28}(OH)_3COOH$, DL-erythro-9,10,6-trihydroxy-hexadecanoic acid. Acid obtained from the major constituent of the hard lac portion of shellac. It is present as an interester acid, of monocarboxylic type, which on hydrolysis with caustic soda yields a mixture of two sodium salts, sodium aleuritate and sodium lacollate.

**Alfin catalyst** *n.* A catalyst obtained from alkali alcoholates derived from a secondary alcohol, used for polymerizing olefins.

**Alfin polymerization** *n.* The "Alfin" catalyst (Hans-Georg Elias (1977) Macromolecules, Plenum Press, New York), consists of a suspension in an inert solvent like pentane of a mixture of an alklenylsodium compound (such as allyl sodium), an alkoxide of a secondary alcohol (such as isoproxide), and an alkali halide (such as sodium chloride); the catalyst is highly specific for the polymerization of dienes into the 1,4 forms.

**Alfrey-price equation** *n.* This copolymer equation enables you to predict the composition of the polymer as a function of the current ratio of monomers and the relative reactivities for monomers reacting with themselves or with the comonomer.

*Also called the copolymerization equation*:

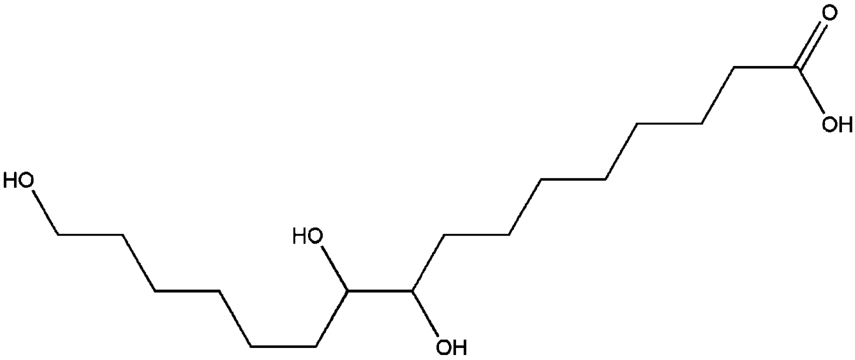
$$\frac{d[M_1]}{d[M_2]} = \frac{[M_1]}{[M_2]} \cdot \frac{r_1[M_1] + [M_2]}{[M_1] + r_2[M_2]}.$$

The ratio of rate constant, $r$, for homo-addition, $k_{11}$ or $k_{22}$, over cross-addition, $k_{12}$ or $k_{21}$, has been termed the reactivity ratio, $r_1$ or $r_2$, for the monomer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Algae** \ˈal-jē\ [L, seaweed] (1551) *n.* Unicellular or polycellular plants (*thallophytae*), a class of cryptograms, which live in fresh or saltwater and are distinguished from fungi by the presence of chlorophyll and response to photosynthesis (e.g., seaweeds, kelps). Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York. *See anti-fouling composition.*

**Algicide** (**algaecide**) \ˈal-jə-ˌsīd\ (1904) *n.* Chemical agent used to destroy algae.

**Algin** \ˈal-jən\ (1883) *n.* Any of various colloidal substances (as an alginate or alginic acid) derived from marine brown algae and used esp. as emulsifiers or thickeners. Soluble salts (sodium, ammonium, and



potassium) of a polyuronic acid (mannuronic acid), a polymer obtained from brown sea plants.

**Alginate** \ˈal-jə-ˌnāt\ (ca. 1909) *n.* Any derivative of alginic acid; alginates are used as emulsifying agents, as thickeners, and in films.

**Alginate fiber** *n.* Fiber formed from a metallic salt (normally calcium) of alginic acid, which is a natural polymer occurring in seaweed. Alginate fiber is soluble in water.

**Alginates** *See algin.*

**Alginic acid** *n.* Polysaccharide composed of beta D mannuronic acid residues found in certain seaweeds.

**Algoflon** Poly(tetrafluoroethylene). Manufactured by Montedison, Italy.

**Aliphatic** \ˌa-lə-ˈfat-ik\ [ISV, fr. Gk *aleiphat-*, aleiphar oil, fr. *aleiphein* to smear, perhaps akin to Gk *lipos* fat] (1889) *adj.* Designating a large class of organic compounds (and their radicals) having open-chain structures and consisting of the paraffin, olefin, and acetylene hydrocarbons and their derivatives. Examples are butane, isopropyl alcohol, many fats and oils, adipic acid, amyl acetate, ethylamines. The name also applies to petroleum products, which are straight-chain hydrocarbon derived from a paraffin-base crude oil {G aliphatisch, F aliphatique, S alifático, I alifatico}.

**Aliphatic amino group** *n.* $-NH_2$ radical when attached to a chain.

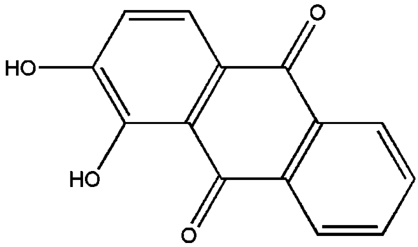
**Aliphatic compounds** *n.* A class of organic compounds which are composed of open chains of carbon atoms. These include paraffins, olefins, etc.

**Aliphatic isocyanates** *n.* Open chained structures containing the isocyanate group, $-N{=}C{=}O$. Aliphatic isocyanates are used extensively in paints and coatings, providing excellent UV stability, chemical resistance and hardness with flexibility to a variety of coatings and elastomers.

**Aliphatic solvent** *n.* Hydrocarbon solvents comprised primarily of paraffinic and cycloparaffinic (naphthenic) hydrocarbon compounds. Aromatic hydrocarbon content may range from less than 1% to about 35%.

**Aliphatic solvents** *n.* Organic liquids having an open chain hydrocarbon structure and *KB* values below 40. They are relatively poor solvents for printing ink resins. Examples are VM&P naphtha, textile spirits and mineral oils (*cf. aromatic solvents*).

**Alizarin** \ə-ˈli-zə-rən\ [prob. fr. F *alizarine*] (ca. 1835) *n.* 1,2-dihydroxyanthraquinone, the raw material in making many pigments. It is obtained from madder roots, or made synthetically, and is also used in the manufacture of lake pigments (*See image*).



**Alizarin madder lake** *See alizarin red.*

**Alizarin red** *n.* Pigment Red 83 (58000). Light maroon pigment produced by treating alizarin with calcium and aluminum salts in the presence of alumina. It is identical with madder lake. Syn: alizarin madder lake, alizarin red B, and dihydroxy anthraquinone lake.

**Alkali** \ˈal-kə-ˌlī\ [ME, fr. ML, from Arabic *al-qili*] (14c) *n.* Any of the hydroxides and carbonates of the alkali metals (lithium, sodium, and potassium), and the radical ammonium. The term is also used more generally for any strong base in aqueous solution capable of forming salts.

*See base.*

**Alkali blue** *n.* Complex organic blue toner prepared by the phenylation of para rosaniline or fuchsine.

**Alkali cellulose** *n.* Also called regenerated cellulose, pure cellulose obtained from wood pulp, etc., reacted with strong alkali solutions at low temperatures, and is a further step in the reaction of mercerization; as a fiber is called rayon, viscose.

*See regenerated cellulose.*

**Alkali metal** (ca. 1885) *n.* A member of group AI in the periodic table.

**Alkaline** \ˈal-kə-lən, -ˌlīn\ (1677) *adj.* A term used to describe a material having a pH greater than 7.0 in water.

**Alkaline catalysts** *n.* Hydroxides of sodium, potassium, lithium, and ammonium, or salts derived from these metallic radicals, which exhibit alkaline characteristics. Gaseous ammonia can also be used, as well as a number of basic organic compounds. The most important reactions in which alkaline catalysts are involved are in the condensation of phenols with formaldehyde, the condensation of urea with formaldehyde, and in the isomerization of drying oils.

**Alkaline-earth metal** *n* (1903). Any of the bivalent strongly basic metals of group II of the periodic table comprising beryllium, magnesium, calcium, strontium, barium, and radium.

*Known also as alkaline earth.*

**Alkali refined linseed oil** *n.* Raw linseed oil treated with alkali to reduce the free acidity by formation of eater-soluble salts, which are subsequently removed by washing.

**Alkali resistance** *n.* (1) The ability of a plastic material to withstand the action of an alkali. ASTM D 543 lists several alkalis as reagents for testing the chemical resistance of plastics. (2) The degree to which a coating resists reaction with alkaline materials such as lime, cement, plaster, soap, etc.

**Alkali-resistant paint** *See alkali resistance.*

**Alkali-resistant red** (12315,12355) *n.* Azo pigments based on acrylides of beta hydroxy naphthoic acid and sometimes called naphthol reds; the distinction between them and the acrylide maroons is strictly tinctorial. For the most part, they have identical properties except the reds are somewhat easier grinding but poorer in bake resistance than the maroons. These reds find some application in latex paints, particularly for application over alkaline substrates; they are not sufficiently lightfast for exterior exposure.

**Alkali-soluble resins** *n.* These are generally lower molecular weight (than conventional lattices) polymers containing about 5–15% carboxyl groups which require amine and/or cosolvent to solubilizer them. These systems are generally dispersions of micelles rather than true solutions. Abbreviation for ASR.

**Alkane** \ˈal-ˌkān\ [*alk*yl+*-ane*] (1899) *n.* The generic term for any saturated, aliphatic hydrocarbon, i.e., a compound consisting of carbon and hydrogen only and containing no double or triple bonds. Linear alkanes are representable as $C_nH_{2n+2}$ while cyclic alkanes have the general formula $C_nH_2n$. Examples are propane, $C_3H_8$, and cyclohexane, $C_6H_{12}$.

**Alkane-imide resin** *n.* A thermoplastic introduced by Raychem Corp under the trade name Polyimidal. The polymer retains high strength up to 200°C and melts at 302°C. It has good electrical properties, low water absorption, and high solvent resistance.

**Alkathene** Poly(ethylene) (high pressure) manufactured by ICI, Great Britain.

Synonyms: Ethylene polymer, Ambythene, Etherin, Hizex, Grez, Biocolene C, Epolene C and E.

**Alkene** \ˈal-ˌkēn\ [ISV *alkyl*+*ene*] (1899) *n.* An unsaturated hydrocarbon with the general formula $C_nH_{2n}$. Contains a C=C double bond. Same as olefin. Morrison RT, Boyd RN (1992) Organic Chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Alkyd** \ˈal-kəd\ [blend of *alkyl* and *acid*] (1929) *n.* Originally, alcohol and acid nouns formed the term "alkyd". Synthetic resins formed by the condensation of polyhydric alcohols with polybasic acids, including anhydrides. They may be regarded as complex esters. The most common polyhydric alcohol used is glycerol, and the most common polybasic acid is phthalic anhydride. Modified alkyds are those in which the polybasic acid is substituted in part by a monobasic acid, of which the vegetable oil fatty acids are typical. {G Alkydharz n, F résine alkyde, résine f, S resina alquídica, resina f, I resina alchidica, resina f}. Wicks ZW, Jones FN, Pappas SP (1999) Organic Coating. Wiley-Interscience, New York. Gooch JW (2002) Emulsification and Polymerization of Alkyd Resins. Kluwer Academic/Plenum Publishers, New York. Patton TC (1962) Alkyd resin technology. John Wiley and Sons Inc., New York.

**Alkydal** *n.* Trade name for a polyester resin, manufactured by Bayer, Germany.

**Alkyd molding compound** *n.* A compound based on an alkyd resin containing fillers, pigments, lubricants, and other additives. Alkyd molding compounds are chemically similar to polyesters, but the term alkyd is usually applied to those polyester formulations that use lesser quantities of monomers of the high-viscosity or dry types, resulting in free-flowing granular and nodular types. The compounds are used for applications requiring good electrical properties and long-term dimensional stability such as automotive distributor caps, rotors, and coil caps. Alkyds can be compression molded at low pressure, they cure rapidly, and they present no venting problems because no volatiles are liberated during cure.

**Alkyd resin** *n.* A polyester resin resulting from the condensation of a polyfunctional alcohol and acid, typically glycerine and phthalic anhydride. Today the term is mostly used for (1) resins modified with drying oils and used as vehicles for varnishes and paints; and (2) for cross-linking resins in alkyd molding compounds. The word *alkyd* is an acronym, from al- for alcohol, and –cid (changed to kyd) for acid. {G Alkydharz n, F résine alkyde, résine f, S resina alquídica, resina f, I resina alchidica, resina f}.
*See glyptal.*

**Alkyl** \ˈal-kəl\ (1882) *adj.* A general term for a monovalent aliphatic hydrocarbon radical, which may be represented as having been derived from an alkane by dropping one hydrogen from the formula, $C_nH_{2n+2}$. Examples of alkyl groups are $C_2H_5$– (ethyl) and $(CH_3)_2CH_2CH$– (isobutyl).

**Alkyl aluminum compound** *n.* Any of a family of organo-aluminum compounds widely used as catalysts in the Ziegler-process polymerization of olefins. Members include trialkyl compounds such as triethyl-, tripropyl-, and triisobutyl aluminums; alkyl aluminum hydrides such as diisobutyl aluminum hydride and diethyl aluminum hydride; and alkyl aluminum halides such as diethyl aluminum chloride.

**Alkylaryl phosphate** (octylphenyl phosphate) *n.* $(C_8H_{17}O)(C_6H_5O)PO$. A phosphate diester, a plasticizer for cellulose acetate butyrate, ethyl cellulose, polystyrene, and vinyl resins.

**Alkylaryl phthalate** *n.* Any of a family of diesters of phthalic acid containing two alkoxy groups, one aliphatic and one aromatic, used as plasticizers for cellulosic plastics, polymethyl methacrylate, polystyrene, and vinyl resins.

**Alkylation** \ˌal-kə-ˈlā-shən\ (1900) *n* The introduction of an alkyl radical into an organic molecule.

**Alkyl group** *n.* Monovalent aliphatic radicals derived from aliphatic hydrocarbons by removal of a hydrogen.

**Alkyl phenolic resin** *n.* Phenol–formaldehyde resin in which the phenol used has an alkyl group in the para position. In resins used in coatings, the most common are the tertiary butyl and tertiary amyl phenols.

**Alkylthio cadmium** *n.* A stabilizer for PVC.

**Alkyne** \ˈal-ˌkīn\ [*alkyl*+*-yne*, alter. of *–ine*] (ca. 1909) *n.* $C_nH_{2n-2}$. A hydrocarbon containing at least one pair of carbon atoms linked by a triple bond (–C=C–). The simplest alkyne is acetylene, HC=CH. *adj.* Signifying the presence in a compound of the triple bond.

**Alligatoring** \ˈa-lə-ˌgā -tər iŋ, ēŋ\ [S *el lagarto* the lizard, fr. *el* the (fr. L *ille* that + *lagarto* lizard, fr. (assumed) VL *lacartus*, fr. L *lacertus*, *lacerta*] (1579) *n.* A form of paint failure in which cracks form on the surface layer only. It is caused by the application of thick films where the underlying surface remains relatively soft. The effect is often caused during weather aging.

**Allobar** *n.* A form of an element differing in isotopic composition from the naturally occurring form.

**Allomerism** *n.* A similarity of crystalline form with a difference in chemical composition.

*See polyallomer.*

**Alloprene** *n.* Chlorinated rubber. Manufactured by ICI, Great Britain.

**Allotonic** Additive, which changes the surface tension of water.

**Allotropes** \ˈa-lə-ˌtrōp\ [ISV] (ca. 1889) *n.* Different forms of an uncombined element.

**Allotropy** \ə-ˈlä-trə-pē\ (1850) *n.* (1) The existence of a substance in two or more solid, liquid or gaseous forms due to differences in the arrangement of atoms of molecules. Examples are amorphous, graphite, and diamond forms of carbon; $NO_2$ and $N_2O_4$. (2) Property which an element or compound possesses, of existing in different forms which in themselves have different characteristics. These various forms are described as allotropic modifications. Carbon, for example, is found in an amorphous form as carbon black, and in the crystalline form as graphite, and as a diamond.

*See monotropic and enantiotropic.*

**All-over pattern** *n.* The typical effect produced by a wallcovering. A pattern in which the units of design are evenly distributed over a surface, without undue emphasis.

**Allowable stress** *n.* In engineering design, the maximum stress to which a structure or structural element may be subjected under the expected operating conditions. The allowable stress is normally less, by a sizeable factor of safety than the stress of the same type that would cause the member to fail under the same conditions.

**Alloy** \ˈa-ˌlói *also* ə-ˈlói\ [F *aloi*, fr. OF *alei*, fr. *aleir* to combine, fr. L *alligare* to bind] (1604) *n.* A blend of a polymer or copolymer with other polymers or elastomers. An important example is a blend of styrene-acrylonitrile copolymer with butadiene-acrylonitrile rubber. The term *polyblend* is sometimes used for such mixtures. Some writers restrict the term allow to mixtures of polymers that form a single phase, reserving the term *blend* for nonhomogeneous mixture. The sale of plastics blends and alloys worldwide was 1.3 billion pounds (0.95 Tg) in 1987 and was predicted to have increased by more than 50% by 1992.

**Allyd aldehyde** *See acrolein.*

**Allyl** \ˈal-əl\ [ISV, fr. L *allium* garlic] (1854) *adj.* The group $CH_2=CH$–, e.g., allyl alcohol ($CH_2=CH$–$CH_2OH$). The unsaturated radical, $CH_2=CHCH_2$–, which upon liberation forms biallyl (1,5-hexadiene), a pungent, volatile liquid.

**Allyl alcohol** (propenyl alcohol, AA, 2-propene-1-ol) *n.* $CH_2=CH_CCH_2$–OH. A colorless liquid with a characteristic pungent odor synthesized by hydrolysis of allyl chloride (from propylene) with dilute caustic, or by the dehydration of propylene glycol. It is a basic material for all allyl resins, and its esters are used as plasticizers (*See image*).

**Allyl chloride** (3-chloropropene, α-chloropropylene, AC) *n.* $CH_2=CH$–$CH_2Cl$. Used in the preparation of allyl alcohol and various thermosetting resins.

**Allyl cyanide** (3-butenoic acid nitrile, allyl carbylamine, vinylacetonitrile) *n.* $CH_2=CHCH_2CN$. Used as a crosslinking agent.

**Allyl diglycol carbonate** (ADC) *n.* A colorless, water-clear monomer that can be polymerized and cast into a variety of transparent, optical-grade products. It can be copolymerized with other unsaturated monomers such as vinyl acetate, maleic anhydride, and methyl methacrylate to produce polymers with a wide spectrum of properties.

**Allyl diglycol carbonate resin** *n.* A thermosetting-resin group with outstanding optical clarity, good mechanical properties, and the highest scratch resistance of all transparent plastics. The resins are made by polymerizing the monomer of the same name with catalysts such as benzoÿl peroxide or, preferable, diisopropyl peroxy dicarbonate.

**Allyl esters** *n.* Esters of allyl alcohol, used in the production of plasticizers and resins.

**Allyl resins** *n.* Resins formed by the addition polymerization of compounds containing the group $CH_2=CHCH_2$, such as esters of allyl alcohol with dibasic acids. They are commercially available as monomers, as partly polymerized prepolymers, and as molding compounds. The dominant compound in the family is diallyl phthalate (DAP). Others are diallyl isophthalate (DAIP), diallyl maleate (DAM), and diallyl chlorendate (DAC). The monomers and partial polymers may be cured with peroxide catalysts to thermosetting resins that are stable at high temperatures and have good solvent and chemical resistance. The molding compounds may be reinforced with glass fibers or other reinforcements, and are easily molded by compression- and transfer-molding methods. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc.

**Allyl starch** *n.* Soft, gummy mass prepared by the reaction of starch with allyl chloride in the presence of strong alkali.

**Almaciga** *n.* Native Philippine name for manila copal.

**Almond oil** *n.* Vegetable non-drying oil, with an iodine value of about 99, and sp gr of 0.918/15°C.

**Alpaca** \al-ˈpa-kə\ [Sp, fr. Aymara *allpaqa*] (1811) *n.* (1) Long, fine hair from Alpaca sheep. (2) A fabric from alpaca fibers or blends (originally a cotton cloth with alpaca filling) that is used for dresses, coats, suits, and sweaters. It is also used as a pile lining for jackets and coats (the term has been incorrectly used to describe a rayon fabric).

**Alpaca stitch** *n.* A 1 × 1 purl-links stitch that is knit so that the courses run vertically instead of horizontally as the fabric comes off the knitting machine. A garment made with an alpaca stitch is not always 100% alpaca; it can be made of other natural or manufactured fibers.

**Alpha-** \ˈal-fə\ [ME, fr. L, fr. Gk, of Semitic origin; akin to Hebrew *āleph* aleph] (13c) *n.* A prefix, usually ignored in alphabetizing compound names, and usually abbreviated by the Greek letter $\alpha$, signifying that the substitution is on the carbon atom immediately adjacent to the main functional group of the compound. An example is $\alpha$-aminobutanol, $CH_3–CH_2CH(NH_2)CH_2OH$. Similarly, substituents on the second and third carbon atoms distant from the main functional group are designated $\beta$ and $\gamma$, respectively.

**Alpha cellulose** *n.* One of three forms of cellulose. Alpha cellulose has the highest degree of polymerization and is the chief constituent of paper pulp and chemical dissolving-grade pulp. It is a colorless filler obtained by treating wood pulp with alkali, used in light-colored thermosetting resins such as urea formaldehyde and melamine formaldehyde. The material is sometimes treated with resinous agents to coat the individual particles and reduce water absorption of the finished articles.

*Also see beta cellulose and gamma cellulose.*

**Alpha-hydroxypropionic acid** *See lactic acid.*

**Alpha-methylstyrene** *n.* $C_6H_5C(CH_3)=CH_2$. A colorless liquid, which can be polymerized by acids to resinous products and will copolymerize with other monomeric vinyl compounds. It has a bp of 165°C; Sp gr of 0.914 at 20°/4°.

**Alpha olefins** *n.* Olefins having 5–20 carbon atoms.

*See olefin.*

**Alpha paper** *n.* Paper made from purified wood cellulose, often beautifully preprinted when used as surfacing sheets of decorative laminates.

**Alpha particle** (1903) (alpha ray) *n.* A charged particle, essentially a helium nucleus, emitted during the radioactive decay of certain elements. Alpha particles have little penetrating power, typically dissipating their energy in passing through a few centimeters of air, but they can do harm if released within the human body. In simple form it is a radioactive emission consisting of two protons and two neutrons as in a ${}^4_2He$ nucleus.

**Alpha-pinene** *See pinene.*

**Alpha-protein** *n.* Protein obtained from Soya beans which is chiefly glycinin. The process of extraction of the protein from the beans involves dissolution of the protein and separation from cellulose, removal of carbohydrates, and hydrolysis of the protein to reduce its chemical complexity. Its uses are similar to those of casein, with which it has much in common, being employed in water paints, emulsions, and adhesives of all types.

**Alsimag®** *n.* Registered trademark of American Lava Corporation for ceramic materials. These materials are used in guides and discs on textile processing machines and fiber manufacturing equipment.

**Alternating copolymer** *n.* A polymer in which two different mer units alternate along the chain in a regular pattern of –A–B–A–B.–

*See also graft and block polymer.*

**Alternating current (AC)** *n.* Current in which the charge-flow periodically reverses, as opposed to direct current, and whose average value is zero. Alternating current usually implies a sinusoidal variation of current and voltage. This behavior is represented mathematically in various ways:

$$I = I_0 \cos(2\pi ft + \phi),$$

$$I = I_0 \angle \phi,$$

$$I = I_\mathrm{I} \mathrm{e}^{jwt},$$

where $f$ is the frequency; $w = 2\pi f$, the pulsatance, or radian frequency; $\phi$ the phase angle; $I_\mathrm{o}$ the amplitude; and $I_\mathrm{l}$ the complex amplitude. In the complex rotation, it is understood that the actual current is the real part of $I$. For circuits involving also a capacitance $C$ in farads and $L$ in henrys, the impedance becomes,

$$\sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}.$$

*Also known as AC*

**Alternating polymers** *n.* Copolymers composed of monomers in uniform alternating succession along the chain, which require highly specific copolymerization reactivity ratios.

**Alternating strain amplitude** *n.* Related through the complex modulus to the alternating stress amplitude.

**Alternating stress** *n.* A stress mode typical of fatigue tests in which the specimen is subjected to stress that varies sinusoidally between tension and compression, the two maximum stresses being equal in magnitude. In some tests, the stress cycles between zero and a tensile maximum, or other unsymmetrical limits. The term applies also to other modes of loading, such as bending and torsion.

**Alternating-stress amplitude** *n.* A test parameter of a dynamic fatigue test, others being frequency and environment. It is one half the algebraic difference between the highest and lowest stress in one full cycle.

**Alternating twist** *n.* A texturing procedure in which *S* and *Z* twist are alternately inserted in the yarn by means of a special heating arrangement.

**Altitudes with the barometer** *n.* If $b_1$ and $b_2$ denote the corrected barometer readings at two stations, $t$ the mean of the temperatures, $t_1$ and $t_2$ of the air at the two stations, $e_1$ and $e_2$ the tension of water vapor at the two stations, $h$ the mean height above sea level, $\Phi$ the latitude; then the difference in elevation in centimeters is $h = 1{,}843{,}000$ $(\log b_\mathrm{i} - \log b_2)$ $(1 + 0.00367t)$ $(1+ 0.0026 \cos 2\phi + 0.00002h + 3/8k)$, where

$$k = 1/2(e_1/b_1 + c_2/b_2).$$

An approximate formula, sufficient for differences not over 1000 m is

$$H = 1{,}600{,}000\left(\frac{b_1 - b_2}{b_1 + b_2}\right)(1 + 0.004t).$$

**Alumina** \ə-ˈlü-mə-nə\ [NL, fr. L *alumin-*. *alumen* alum] (1801) (corundum) *n.* The oxide of aluminum, $Al_2O_3$, very refractory and next to diamond and boron nitride in hardness, obtained by the calcinations of bauxite. Alumina powder is used as a fire-retardant filler in plastics and, over the past two decades, alumina fibers have enjoyed increasing use as reinforcements for plastics, metals, and even ceramics. Its density is 3.965 g/cm$^3$.

**Alumina-blanc fixe** *n.* Composite color base used in the manufacture of certain types of lakes. It is made by first reacting aluminum sulfate with soda ash, and then adding barium chloride solution to form barium sulfate from the sodium sulfate derived from the first reaction.

**Alumina fiber** *n.* A class of reinforcing fibers available as whiskers or continuous filaments, with quite different properties. Whiskers are almost pure $Al_2O_3$ (corundum) and are grown by passing a stream of moist hydrogen over aluminum powder heated to 1300–1500°C. Their strength ranges from 4 to 24 GPa, modulus ranges from 400 to 1000 GPa, and they cost about US$15/g. Continuous filaments are lower in crystallinity and/or alumina content (densities range from 2.7 to 3.7 $g/cm^3$), tensile strengths range from 1.3 to 2.1 GPa, and moduli from 105 to 380 GPa, depending on the manufacturer.

**Alumina hydrate** *n.* A white inorganic pigment used as an extender in inks and noted for its transparency.

*See aluminum oxide, hydrated.*

**Alumina trihydrate** (aluminum hydroxide, aluminum hydrate, and hydrated aluminum oxide) *n.* $Al_2O_3{\cdot}3H_2O$ for $Al(OH)_3$. A white crystalline powder, alumina trihydrate accounts for about half of all flame retardants used in plastics. When heated above about 220°C, it releases water endothermically.

**Aluminum (in UK, aluminium)** \ə-ˈlü-mən-nəm\ [NL, fr. *alumina*] (1812) *n.*

*See aluminum powder and aluminum paste.*

**Aluminum alkyl** (aluminum trialkyl) *n.*

*See alkyl aluminum compound.*

**Aluminum arsenite** *n.* Admixture with alumina used as a base for lakes, its function being to improve the brilliance of the color.

*See aluminum phosphate.*

**Aluminum chelate** *n.* Chemically modified aluminum secondary butoxide, used as a curing agent for epoxy, phenolic, and alkyd resins.

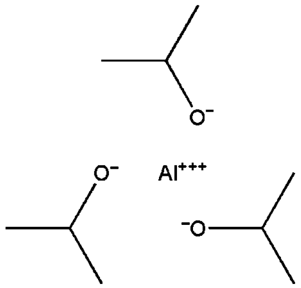
**Aluminum dihydroxy stearate** *n.* $Al(OH)[OOC(CH_2)_{10}CHOH(CH_2)_5{-}CH_3]_2$. A white material used as a plastics lubricant.

**Aluminum distearate** $Al(OH)[OOC(CH_2)_{16}CH_3]_2$. A white powder used as a lubricant for plastics.

**Aluminum hydrate** *See aluminum oxide, hydrated.*

**Aluminum ink** *See silver ink.*

**Aluminum isopropylate** (aluminum isopropoxide). $Al[OCH(CH_3)_2]_3$. A white solid, crosslinking agent (*See image*).



**Aluminum mixing varnish** *n.* Any of the vehicles for aluminum paste or powder which have the property of causing the metallic flakes of the pigment to "leaf" or float, and that retains this property for an indefinite period of time. They are characterized by low acid number, usually less than 15; but in some specifications, the acid number is required to be less than seven. Ready mixed aluminum vehicles are those that are: made without lead drier, used in factory prepared paints, and capable of retention of excellent leafing properties for very long periods of time. Ready-to-mix aluminum vehicles are mixed with aluminum paste or powder, and used within a few hours at the job site. Vehicles for non-leafing aluminum paints are rarely referred to as aluminum mixing varnishes.

**Aluminum monostearate** *n.* $Al(OH)_2[OOC(CH_2)_{16}CH_3]$. A white or yellowish-white powder, a stabilizer.

**Aluminum naphthenate** *n.* Pale brown, jelly-like product, containing approximately 4.0% of aluminum, although the precise metal content varies with the type of naphthenic acid used in its manufacture.

**Aluminum oleate** *n.* $Al[OOC(CH_2)_7CH{=}CH(CH_2)_7CH_3]_3$. A plastics lubricant.

**Aluminum oxide** *See aluminum oxide, hydrated.*

**Aluminum oxide abrasive** *n.* Produced in electric furnaces by purifying bauxite of a crystalline form and adding various amounts of titanium to impart extra toughness. The grain is a tough, durable abrasive characterized by the long life of its cutting edges. It is stable chemically and will not react with hydrochloric or nitric acids or with metals other than the alkaline metals.

*See emery.*

**Aluminum oxide cloth** *n.* Extremely hard, sharp, and enduring coated abrasive cloth particularly suited for finishing metals, capable of the hardest service.

**Aluminum oxide, hydrated** *n.* $Al(OH)_3$. Crystalline powder, balls, or granules. Used as a pigment or a base for organic lakes and as an extender for inks. Density, 2.4 g/cm$^3$ (19.8–20.2 lb/gal); O.A., 41–53 lb/100 lb. Particle size, 0.38–8.5 µm. Syn: alumina hydroxide, alumina trihydrate, alumina hydrate, hydrated alumina, gibb-site and transparent white.

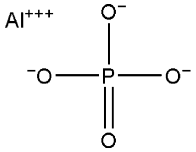
**Aluminum oxide paper** *n.* Extremely hard, sharp and enduring coated abrasive paper, particularly suited for hardwoods, lacquer and metals.

**Aluminum paint** *n.* A coating consisting of a mixture of metallic aluminum pigment in powder or paste form, dispersed in a suitable vehicle.

**Aluminum palmitate** *n.* $Al_2(OH)_2[OOC(CH_2)_{14}CH_3]$. A plastics lubricant.

**Aluminum paste** *n.* Metallic aluminum flake pigment in paste form, consisting of aluminum, solvent, and various additives. The metallic aluminum pigment can be in the form of very small, coated leaves or amorphous powder, known under the respective designations of "leafing" and "non-leafing". *See leafing.*

**Aluminum phosphate** *n.* Admixture with alumina used as a base for lakes, its function being to improve the brilliance of the color. (*See image*).



*See aluminum arsenite*

**Aluminum pigment** *See aluminum powder.*

**Aluminum potassium silicate** *n.* $3Al_2O_3 \cdot K_2O \cdot SiO_2 \cdot 2H_2O$. Pigment White 20 (77019). Generically known as mica, a complex hydrous aluminum silicate, based on several mineralogically related groups. The most common is Muscovite. Mica crystals have well-developed basic cleavage that permit slitting into thin flaky pigment particles. Widely used in paints, rubber and sealants. Density, 2.82 g/cm$^3$ (23.5 lb/gal); O.A., 56.74. Particle size 5–20 µm. Hardness (moh), 2.5. Syn: mica, ground muscovite, graphitic mica, and sericite.

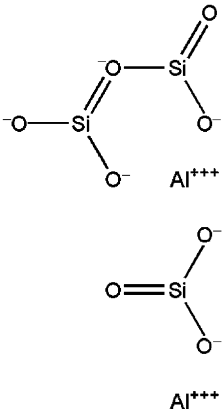
**Aluminum powder** *n.* Minimum metal used as a pigment. Available in leafing or non-leafing forms. Density, 2.73 g/cm$^3$ (22.5 lb/gal).

**Aluminum primer** *n.* (1) Primer specifically formulated for aluminum metal. (2) Primer containing a proportion of aluminum pigment, but distinguished from aluminum paints in which the aluminum is designed to float to the top of the film giving metallic brilliance, a feature undesirable in a primer.

Aluminum primers are used on resinous timber or timber, which has been treated with oil-soluble wood preservatives.

**Aluminum resinate** *n.* Brown soft mass, insoluble in water; used for water proofing and as a drier in varnish.

**Aluminum silicate** *n.* Any of a large group of minerals with various proportions of $Al_2O_3$ and $SiO_2$, occurring naturally in clays. They are used as pigments and fillers in plastics.



**Aluminum silicate (clay)** *n.* $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$. Pigment white 19 (77005) white inert pigment of little color and opacity, obtained from certain natural deposits of china clay, kaolin, feldspar, and similar materials. Hydrated aluminum silicate, fine grain crystallized clay. Laminar structure with repeating alumina–silica configurations. Density, 2.58 g/cm$^3$ (21.5 lb/gal); O.A., 32.1–55 lb/100 gal. Particle size, 05.3.5 µm. Syn: Kaolin, hydrated aluminum silicate, china clay, pipe clay, and white bole.

**Aluminum soaps** *n.* Aluminum compounds of fatty acids and naphthenic acid, etc. These materials are soluble generally in paint vehicles and thinners, and are employed as thickening, flatting, and water proofing agents.

**Aluminum stearate** *n.* Complex salt or soap of aluminum and stearic acid. It is a white powder, which forms colloidal solutions or gels with drying oils and certain solvents. It is used as a flatting agent, anti-setting agent for pigments, and to help prevent penetration.

**Amalgam** \ə-ˈmal-gəm\ [ME *amalgame*, fr. MF, fr. ML *amalgama*] (15c) *n.* Solutions of certain metals in mercury, which is of considerable value in the preparation of unsupported films of surface coatings. If, for example, a coated tinned-iron sheet or tinfoil is rubbed with or immersed in mercury, an amalgam is formed between the tin coating and the mercury, The initially hard tin surface is replaced by a soft, semi-liquid coating of tin-amalgam, from which it is a relatively easy matter to detach dried coatings for further examination. The tin surface is said to be amalgamated.

**Amber** \ˈam-bər\ [ME *ambre*, fr. MF, fr. ML *ambra* fr. Arabic *anbar* ambergris] (14c) *n.* A natural fossil resin formed during the Oligocene age by exudation from a species of pine now extinct. Its empirical formula is $C_{10}H_{16}O$, it softens at about 150°C, can be fabricated and polished. It is a fossil resin found chiefly in the blue earth of East Prussia. It is primary an exudation of *Pinus* succinifera. It has been used in jewelry, cigarette holders, and pipe mouthpieces.

**Amberlite** Synthetic ion-exchange resins. Manufactured by Roehm & Haas, USA.

**Ambient** \ˈam-bē-ənt\ [L *ambient-*, *ambiens*, pp of *ambire* to go around, fr. *ambi-* + *ire* to go] (1596) *adj.* Completely surrounding; indicative of the surrounding environmental conditions such as temperature, pressure, atmosphere, etc. When no values are given, the temperature is presumed to be room temperature (18–23°C) and the atmosphere to be air at standard pressure (101.3 kPa).

**Ambient air quality** *n.* Average atmospheric purity, as distinguished from discharge measurement taken at the source of pollution. The general amount of pollution present in a broad area.

**Ambient conditions** *n.* A term used to denote the temperature, pressure, etc. of the surrounding air.

*See atmospheric conditions.*

**Ambient cure** *See self-curing.*

**Ambient temperature** *n.* (1) The temperature of the medium immersing an object. (2) The prevailing room temperature.

**American gallon** *See gallon, USA.*

**American national standards institute** *n.* (ANSI) address: 1430 Broadway, New York, NY 10018. Clearinghouse and national coordinator for voluntary standards of engineering, equipment, industrial processing, and safety. Formerly known as American Standards Association (ASA). In the plastics field, ANSI works closely with the society of the plastics industry (SPI) and the society of automotive engineers (SAE) to develop and publish standards for plastics materials, processing equipment, operations, and operating safety.

**American process zinc oxide** *n.* Zinc oxide pigment made directly from zinc ores. Sometimes called "direct" process.

*See zinc oxide.*

**American society for testing and materials** *n.* ASTM. A non-profit corporation formed for the development of standards on characteristics and performance of materials, products, systems, and services, and the promotion of related knowledge. In ASTM terminology, standards include test methods, definitions, recommended practices, classifications, and specifications.

**American turpentine** *n.* Light-colored, volatile, essential oil obtained from resinous exudates or resinous wood associated with living or dead coniferous trees, particularly of the genus, *Pinus*, or more commonly pines.

*See turpentine.*

**American vermillion** *n.* A pigment usually consisting of a lead molybdate or as a basic lead chromate (as chrome red).

**Ameripol** *n.* Poly(isoprene). Manufactured by Firestone, USA.

**Ameripol SM** *n.* *Cis*-1,4-poly(isoprene). Manufactured by Firestone, USA.

**Amide** \ˈa-ˌmīd, -məd\ [ISV, from New Latin *ammonia*] (ca. 1847) *n.* A compound containing the $-CONH_2$ group, formed by the reaction of an organic acid or an ester with ammonia. Except for formamide, all amides are crystalline solids at room temperature. Examples are acetamide, $CH_3CONH_2$, and urea, $H_2NCONH_2$.

**Amide-imide resin** *See amino resin.*

**Amides** \ˈa-ˌmīd, -məd\ [ISV, fr. L *ammonia*] (ca. 1847) *n.* Carboxylic acids in which the hydroxyl group of the acid is replaced by an amino or amido group ($NH_2$). Thus, acetamide ($CH_3CONH_2$) is obtained by substituting the hydroxyl (OH) of acetic acid with the $NH_2$ group. They may also be regarded as derivates of ammonia ($NH_3$), in which one of the hydrogen atoms is replaced by an acyl group.

**Amido** \ə-ˈmē-(ˌ)dō, ˈa-mə-ˌdō\ [ISV *amide*+-*o*-] (1877) *adj.* Terms "amido" and "amino" apply to the same grouping, $NH_2$. The former term is usually applied to the $NH_2$ group when it occurs in an acid amide.

**Amine** \ə-ˈmēn, ˈa-ˌmēn\ [ISR, fr. NL *ammonia*] (1863) *n.* Organic bases derived from the parent compound, ammonia ($NH_3$). The hydrogens of the ammonia may be substituted by alkyl groups, in which case the series of aliphatic bases is produced. Similarly, aromatic bases are formed when the hydrogens are substituted with aryl groups. Primary, secondary, tertiary and quaternary amines are formed as one, two, three, or four of the hydrogen atoms are substituted. Substitution of a fourth hydrogen atom is possible because it is considered available in the hypothetical compound, ammonium hydroxide ($NH_4OH$). A compound derived (in concept) from ammonia by substitution of one or more hydrogen atoms by a hydrocarbon radical. Amines in which one, two or all three of the ammonia hydrogens have been substituted are termed primary, secondary, and tertiary amines.

**Amine end group** *n.* The terminating ($–NH_2$) group of a nylon polymer chain. Amine end groups provide dye sites for polyamides.

**Amine equivalent** *n. See amine value.*

**Amine equivalent weight** *n.* Molecular weight of amine divided by the number of active hydrogens in the molecule.

**Amine-furfural resin** *See aniline-furfural resin.*

**Amine nitrogen content** *n.* Refer to federal test method 141a for test procedure.

**Amine resin** *n.* Synthetic resin derived from the reaction of urea, thiourea, melamine or allied compounds with aldehydes, particularly formaldehyde.

*See amino resin.*

**Amines** *n.* Organic bases derived from the parent compound, ammonia ($NH_3$) the hydrogens of the ammonia may be substituted by alkyl groups, in which case the series of aliphatic bases is produced. Similarly, aromatic bases are formed when the hydrogens are substituted with aryl groups. Primary, secondary, tertiary, and quaternary amines are formed as one, two, three or four of the hydrogen atoms are substituted. Substitution of a fourth hydrogen atom is possible because it is considered available in the hypothetical compound, ammonium hydroxide ($NH_4OH$).

**Amine value** *n.* The number of milligrams of potassium hydroxide equivalent to the fatty amine basicity in 1g of sample. Syn: amine equivalent.

**Amino-** \ə-ˈmē-(ˌ)nō\ [ISV *amine*+-*o*-] (1904) *adj.* A prefix signifying the presence in a compound or resin of an $–NH_2$ or $=NH$ group.

**Amino acid** *n.* An organic acid containing an amino group attached to the carbon atom adjacent to the $–COOH$ group, obtained by the hydrolysis of a protein or by synthesis. Examples are glycine, $CH_2(NH_2)–COOH$ (e.g., glycine $+NH_3–CH_2–COO^+$) and cysteine, $HSCH_2CH(NH_2)COOH$.

**Amino acids** (1898) *n.* Amino group and a carboxyl group, $H_2NCHRCOOH$, e.g., glycine $+NH_3–CH_2–COO^+$.

**Amino coatings** *n.* Made from amino resins which include resins from reacting urea, thiourea, melamine or allied compounds, usually with formaldehyde.

**2-Amino-2-methyl-1-propanol** *See amp.*

**Amino plastics** Plastics based on resins made by the condensation of amines, such as urea and melamine, with aldehydes.

*See amino resin.*

**Aminoplasts** *n.* Thermosetting resins made by the polycondensation of formaldehyde with a nitrogen compound and a higher aliphatic alcohol. The two general types are *urea-formaldehyde* and *triazine-formaldehyde.* Melamine is the triazine most often used. *See also amino resin.* {G Aminoplaste mpl, F aminoplastes mpl, S aminoplásticos mpl, I amminoplasti mpl}

**γ-Aminopropyltriethoxy silane** *n.* $NH_2(CH_2)_3Si(OC_2H_5)_3$. A silane coupling agent used in reinforced epoxy, phenolic, melamine and many thermoplastic resins.

**Amino resin** (polyalkene amide, aminoplast) *n.* A generic term for a group of nitrogen-rich polymers containing amino nitrogen or its derivatives. The starting amino-bearing material is usually reacted with formaldehyde to form a reactive monomer that is condensation-polymerized to a thermosetting resin. Included amino compounds are urea, melamine, copolymers of both with formaldehyde, and, of limited use, thiourea, aniline, dicyandiamide, toluenesulfonamide, benzoguanidine, ethylene urea, and acrylamide. Not included, because properties warrant separate classification, are polyamides of the nylon type, polyurethanes, polyacrylamide, and acrylamide copolymers. The most important members of the amino-resin family are melamine-formaldehyde and urea-formaldehyde resins. The basic resins are clear, water-white syrups or white powdered materials that can be dispersed in water to form colorless syrups. They cure to high temperatures with appropriate catalysts. Molding powders are made by adding fillers to the uncured syrups, forming a consistency suitable for compression and transfer molding. Amino resins are usually cured by baking and are blended with other resins (e.g., alkyds or epoxies). Amino resins are also cured by chemical means at normal air temperature, e.g., wood finishes.

**AMMA** *n.* Abbreviation for copolymers of acrylonitrile and methyl methacrylate. In Europe, written A/MMA.

**Ammeter** \ˈa-ˌmē-tər\ [*am*pere + -*meter*] (1882) *n.* Instrument for measuring the strength (amperage) of electric currents.

**Ammine** \ˈa-ˌmēn, a-ˈmēn\ [ISV *ammonia* + $^{2}$-*ine*] (1897) *n.* The name given to ammonia, NH$_3$, when it serves as a ligand.

**Ammonia cure** *n.* A modification of a hot air pressure cure for rubber, often used for curing, in which ammonia gas is used to accelerate vulcanization and to prevent the deteriorating effect of air.

**Ammonium caseinate** *n.* Casein solubilized by ammonium hydroxide generally employing a hot water presoak.

**Ammonium soaps** *n.* Soaps formed by reaction of ammonia with the higher molecular weight fatty acids, such as ammonium oleate, linoleate, stearate, etc., used as wetting or emulsifying agents.

**Amoora oil** *n.* Semidrying vegetable oil with an iodine value of 135 and Sp gr of 0.939/15°C.

**Amorphous** \ə-ˈmór-fəs\ [Gk *amorphous*, fr. *a-* + *morphē* form] (ca. 1731) *adj.* Devoid of crystallinity or stratification. Most plastics are amorphous at processing temperatures, many retaining this state under all normal conditions. Lacking crystallinity.

**Amorphous domain** (and crystalline domains) *n.* Amorphous or noncrystalline portions of a solid polymer; conversely, crystalline a domains are nonamorphous. A single crystalline polymer chain can possess amorphous regions (domains), e.g., polyethylene.

**Amorphous nylons** *n.* When unsymmetrical monomers are use to synthesize polyamides (Nylons), the normal ability of the chains to crystallize can be disrupted and amorphous (often transparent) polymers are formed.

**Amorphous silica** *n.* SiO$_2$. A naturally occurring or synthetically produced pigment, characterized by the absence of pronounced crystalline structure, and which has no sharp peaks in its X-ray diffraction pattern. It may contain water of hydration or be an anhydrous type. It is used as an extender pigment, fatting agent, and as a desiccant in metal flake and metal powder coatings.

**Amorphous solid** *n.* A substance with the external appearance and characteristics of a solid, but with the irregular structure typical of a liquid; a highly supercooled liquid; a glass.

**AMP** *n.* Abbreviation for 2-amino-2-methyl-1-propanol. Used as a pigment dispersant or as a pH modifier.

**Ampere** \ˈam-ˌpir, -per\ [André-Marie *Ampère*] (1881) *n.* (A) The primary electrical unit of the SI system, upon which all other electrical units are based. The ampere itself is defined as that current, which, if maintained in two long, parallel, fine wires located 1 m apart in a vacuum, will produce between these conductors a force of $2 \times 10^{-7}$ N/m of length. Practically, an ampere is the current that flows between two points connected with an electric resistance of one ohm when their potential difference is 1 V.

**Ampere's rule** *n.* A positive charge moving horizontally is deflected by a force to the right if it is moving in a region where the magnetic field is vertically upward. This may be generalized to currents in wires by recalling that a current in a certain direction is equivalent to the motion of positive charges in that direction. The force felt by a negative charge is opposite to that felt by a positive charge.

**Amphibole** \ˈam(p)-fə-ˌbōl\ [F, fr. LL *amphibolus*, fr. Gr *amphibolos*] (ca. 1823) *n.* A group of asbestos minerals.

**Amphoprotism** *n.* The ability of a species either to gain or to lose a proton.

**Amphoteric** \ˌam(p)-fə-ˈter-ik\ [ISV, fr. Gk *amphoteros* each of two, fr. *amphō* both] (ca. 1849) *adj.* Designating an element or a compound that can behave either as an acid or a base, i.e., as an electron donor or an electron acceptor. Polymerization emulsifiers having both anionic and cationic groups are called amphoteric emulsifiers.

**Amphoterism** *n.* The ability of a substance to react either as an acid or as a base.

**Amplitude** \ˈam-plə-ˌtüd, -ˌtyüd\ (1542) *n.* The maximum value of the displacement in an oscillatory motion.

**amu** *n.* The atomic mass unit (amu), a unit of mass equal to 1/12 the mass of the carbon atom of mass number 12. On the atomic mass scale $^{12}\text{C} \equiv 12$.

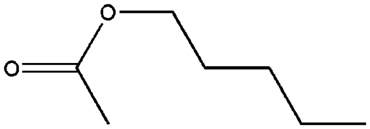
$$\begin{aligned} 1\,\text{amu} &= 931.4812(52)\,\text{MeV} \\ &= 1.660531(11) \times 10^{-27}\,\text{kg (SI units)} \\ &= 1.660531(11) \times 10^{-24}\,\text{g (cgs units)}. \end{aligned}$$

The numbers in parentheses are the standard deviation uncertainties in the last digits of the quoted value, computed on the basis of internal consistency.

**Amyl** \ˈa-məl\ [L *am*ylum + E *–yl*] (1850) *n.* The radical $C_5H_{11}$–, also known as *pentyl*. The amyl radical occurs in six isomeric forms, and the term amyl usually refers to any mixture of the isomers.

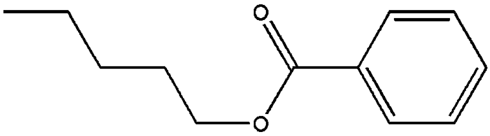
**Amylaceous** *adj.* Pertaining to, or of the nature of, starch; starchy.

**Amyl acetate** (ca. 1881) (banana oil, pear oil, and amylacetic ester) *n.* $CH_3COOC_5H_{11}$. A commercial solvent for several resins, including the cellulosics, vinyls, acrylics, polystyrene, and uncured alkyds and phenolics. It has a strong, fruity odor (hence its nicknames), and its main constituent is isoamyl acetate, but other isomers such as normal- and secondary-amyl acetates are present in amounts determined by the grade and origin. It is a medium boiling solvent. The commercial product has a boiling range of 120–145°C, a Sp gr of approximately 0.876, and a flp of 31°C (87°F). Syn: banana oil (*See image*).

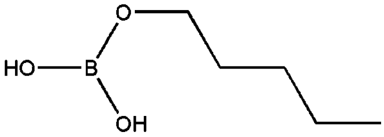


**Amyl alcohol** (1863) *n.* $C_5H_{11}OH$. Commercial alcohol having a boiling range of 128–132°C; Sp gr of 0.816/15°C; a flp of 43°C (110°F); and a vapor pressure of 10 mmHg at 20°C. It has some application in the manufacture of cellulose lacquers as a high boiling diluent (*See image*).

**Amyl benzoate** *n.* $C_6H_5COOC_5H_{11}$. High boiling solvent-plasticizer, with a bp of 261°C, and Sp gr of 0.994 (*See image*).



**Amyl borate** *n.* $(C_5H_{11})_3BO_3$. High boiling solvent-plasticizer. The commercial liquid has a boiling range of 250–260°C (*See image*).



**Amyl citrate** *See citrates.*

**Amyl ether** *n.* $(C_5H_{11})_2O$. Amyl ether, or diamyl ether as it is correctly called, is a useful high boiling solvent of the ether series, with a boiling range of 170–190°C.

**Amyl formate** *n.* $HCOOC_5H_{11}$. A solvent for resins and cellulose derivatives. It is a medium boiling solvent with a bp of 13°C, and flp of 27°C.

**Amyl lactate** $CH_3CH(OH)COOC_5H_{11}$. Water white to pale yellow colored liquid used as an ester solvent. It plasticizes in lacquers and has a bp of 210°C.

**Amyl nitrate** (ca. 1881) *n.* $C_5H_{11}NO_2$. A pale yellow, pungent flammable liquid ester, of commercial amyl alcohol and nitrous acid.

**Amyl oleate** Solvent and plasticizer for cellulosic and vinyl resins.

**Amyl propionate** *n.* $CH_3CH_2COOC_5H_{11}$. Very strong solvent, similar in properties and uses to amyl acetate, but possessing a higher boiling range, 140–170°C. Its flp is about 41°C.

**Amyl salicylate** *See isoamyl salicylate.*

**Amyl stearate** *n.* $C_{17}H_{35}COOC_5H_{11}$. Pale yellow colored substance used as a high boiling plasticizer. It has a mp of 30°C and a bp of 360°C.

**Amyl tartrate** *n.* Plasticizer with strong solvent power and a bp of about 400°C.

**Amyrin** *n.* $C_{30}H_{50}O$ for both $\alpha$ and $\beta$ modifications. Amyrins, isolated in $\alpha$ and $\beta$ forms, are constituents of elemi resin. They are believed to be alcoholic in character.

**Anacardic acid** *n.* $C_{22}H_{32}O_3$. Ortho pentadecadienylsalicylic acid. Principal constituent of cashew nutshell liquid.

**Anacardol** *n.* $C_{21}H_{32}O$. Monohydroxy phenol, which closely resembles the anacardic acid from which it is readily obtained by decarboxylation when heated. The substituent side chain is the same for both compounds.

**Anadonis green** *See chromic oxide green.*

**Anaerobic** \ˌa-nə-ˈrō-bik; ˌan-ˌa(-ə), -ˌe(-ə)-\ (ca. 1881) *adj.* Free of oxygen and/or air. Used in connection with bacteria, developing without air. Important for anaerobic corrosion (tanks and ship bottoms).

**Anaerobic adhesive** *n.* An adhesive that cures only in the absence of air after being confined between assembled parts. An example is dimethacrylate adhesive, used for bonding assembly parts, locking screws and bolts, retaining gears and other shaft-mounted parts, and sealing threads and flanges.

**Analyzer** \ˈa-nᵊl-ˌīz\ [Prob. irreg. fr. analysis] (1587) *vt.* A second polarizing element inserted above a preparation. When its vibration direction is at right angles to the vibration direction of the polarizer, the field becomes black if no anisotropic specimen is on the stage.

**Anamorphosis** *n.* Distorted painting, which appears normal when viewed from the side. A form of "trick" painting fashionable in the 16th and 17th centuries.

**Anatase** \ˈa-nə-ˌtās, -ˌtāz\ [F, fr. Gk *anatasis* extension, fr. *anateinein* to extend, fr. *ana-* + *teinein* to stretch] (ca. 1828) (octahedrite) *n.* A crystalline ore of titanium dioxide.

*See titanium dioxide, anatase.*

**Anchorage** \ˈaŋ-k(ə-)rij\ (15c) *n.* Part of an insert that is molded inside of a plastic part and held fast by shrinkage of the plastic onto the insert's knurled surfaces. (1) Property or profile of metal or wood substrate to enhance the adhesion of a coating. (2) Adhesion of rubber to fiber, fabric, metal or other material to which the rubber compound is applied by calendering, welding, cement spreading, or other means.

**Andrade creep** *n.* A type of creep behavior in which the compliance of the sample is proportional to the cube root of the time under stress. A variety of polymers exhibit this behavior.

**Anelasticity** \ˌa-nᵊl-as-ˈti-sə-tē\ (1947) *n.* The dependence of elastic strain on both stress and time, resulting in a lag of strain behind stress. In materials subjected to cyclic stress, the anelastic effect causes damping.

**Angel's hair** *n.* Fibrous strands of material pulled away from thermoplastic films, particularly polypropylene, in heat-sealing and cutting operations that employ hot knives or wires. The angel's hair accumulates on the cutting mechanism, eventually affecting performance and requiring removal.

**Angle** \ˈaŋ-gəl\ [ME, fr. MF, fr. L *angulus*] (14c) *n.* The ratio between the arc and the radius of the arc. Units of angle, the radian, the angle subtended by an arc equal to the radius; the degree 1/360 part of the total angle about a point. Dimensions, –a numeric.

**Angle head** (offset head, and crosshead). An extruder head so designed that the principal direction of the extrudate makes an angle with the (extended) axis of the screw. *See also crosshead.*

**Angle of contact** *n.* Associated with the phenomenon of wetting. When a drop of liquid contacts a solid surface it can remain exactly spherical, in which case no wetting occurs; or it can spread out to a perfectly flat film, and in that latter case complete wetting occurs. The angle of contact is the angle between the tangent to the periphery of the drop at the point of contact with the solid, and the surface of the solid. When the drop spreads to a perfectly flat film, the angle of contact is zero. When it remains exactly spherical, the area of contact is a point only, and the angle of contact is 180°.

**Angle of incidence** *n.* Angle between the axis of an impinging light beam and the perpendicular to the object surface.

**Angle of reflection** *n.* Angle between the axis of a reflected light beam and the perpendicular to the object surface.

**Angle of repose** (angle of rest) *n.* The maximum angle that a conical pile of particles makes with the horizontal surface on which it rests. No ASTM test is listed for this important property of plastic powders and pellets. The smaller the angle of repose, the more easily does the material flow through hoppers and constrictions.

**Angle of viewing** Angle between the axis of a detected light beam and the perpendicular to the object surface.

**Angle-ply laminate** *n.* A laminate in which equal numbers of plies are oriented at equal plus and minus angles from the plies in the length direction, making the laminate orthotropic. The most commonly chosen angles are +60°, giving nearly equal strengths in all directions in the plane of the laminate.

*See also cross laminate.*

**Angle press** *n.* A hydraulic molding press equipped with horizontal and vertical rams, used in the production of complex moldings containing deep undercuts or side cavities.

**Angocopalolic acid** *n.* $C_{23}H_{36}O_3$. A constituent acid of Angola copal. It is an unsaturated monobasic acid and has a melting point of 85°C.

**Angocopaloresenes** *n.* Identified as both $\alpha$ and $\beta$ forms, these are constituents of Angola copal. The former has a mp of about 64°C and the latter about 222°C; $\alpha$ angocopaloresene corresponds with $C_{30}H_{54}O_6$, and $\beta$ angocopaloresene with $C_{25}H_{38}O_4$.

**Angola copal** *n.* Fossil copal of African origin.

**Angora** \aŋ-ˈgōr-ə\ (1852) *n.* (1) The hair of the Angora goat. The long, fine fibers are so smooth and soft that they must be combined with other fibers in weaving. (2) The hair of the Angora rabbit. The fine, lightweight hair is warm, and it is often blended with wool to decrease price and to obtain novelty effects in weaving. By law, the fiber must be described as Angora rabbit hair.

**Angstrom unit (Å)** \ˈaŋ-strəm\ [Anders J. *Angstrom*] (1892) {*G* Angströmeinheit *f*, *F* unité f Angtröm, *S* unidad *f* Angström} *n.* A unit of length equal to 1 × $10^{-10}$m. A unit of linear measure named after A. J. Ångström, used especially in expressing the length of light waves, equal to one ten-thousandth of a micron, or one-hundred-millionth of a centimeter ($1 \times 10^{-8}$cm). It has been replaced by the nanometer (nm). 1 Å = 0.1 nm.

**Angular acceleration** *n.* The time rate of change of angular velocity either in angular speed or in direction of the axis of rotation (precession). cgs unit, one radian per second . Dimensions, $[T^{-2}]$. If the initial angular velocity is $\omega_t$, the angular acceleration,

$$\alpha = \frac{\omega_t - \omega_o}{t}.$$

The angular velocity after time *t*,

$$\omega_t = \omega_o + a_t.$$

The angle swept out in time *t*,

$$\theta = \omega_o t + \frac{1}{2}\alpha t^2.$$

The angular velocity after movement through the arc $\theta$,

$$\omega = \sqrt{w_o^2 + 2\alpha\,\theta}.$$

In the above equations, for angular displacement in radians, angular velocity will be in radians per second and angular acceleration in radians per squared seconds.

**Angular aperture** *n.* The angular aperture of an objective is the largest angular extent of wave surface, which it can transmit.

**Angular aperture** *n.* **AA** The largest angle between the image forming rays collected or transmitted by a lens system, e.g., objective or condenser of a microscope.

**Angular harmonic motion or harmonic motion of rotation** *n.* Periodic, oscillatory angular motion in which the restoring torque is proportional to the angular displacement. Torsional vibration.

**Angular momentum or moment of momentum** Quantity of angular motion measured by the product of the angular velocity and the moment of inertia. cgs unit, unnamed, its nature is expressed by gcm$^2$/s. Dimensions, $[ML^2T^{-1}]$. The angular momentum of a mass whose moment of inertia is $I$, rotating with angular velocity $\omega$, is $I\omega$.

**Angular velocity** *n.* Time rate of angular motion about an axis. Cgs unit, one radian per second. Dimensions, $[T^{-1}]$. If the angle described in time $t$ is $\theta$, the angular velocity,

$$\omega = \frac{\theta}{t},$$

where $\theta$ in radians and $t$ in seconds gives $\omega$ in radians per second.

**Angular welding** *See friction welding.*

**Anhedral** *adj.* Anhedral crystals are those whose growth has been impeded by adjacent crystals growing simultaneously, so that the development of plane faces is inhibited. Also crystals eroded, partly dissolved, or mechanically deformed to the point where nearly all traces of crystal faces have been removed. All anhedral crystals are irregularly shaped and do not have plane faces, cf., euhedral.

**Anhydride** \(ˌ)an-ˈhī-ˌdrīd\ (1863) *n.* (1) A compound from which water has been extracted. (2) An oxide of a metal (basic anhydride) or of a nonmetal (acidic anhydride) that forms a base or an acid, respectively, when united with water. (3) An organic compound made (conceptually) by the union of two acid molecules with the elimination of a molecule of water. In practice, organic anhydrides are usually produced by other reactions.

**Anhydrite** \-ˌdrīt\ [Gr *Anhydrit*, fr. Gk *anydros*] (ca. 1823) *n.* The mineralogical name for native anhydrous calcium sulfate which is often associated in nature with calcium sulfate dehydrate or gypsum. It occurs occasionally as an impurity in gypsum and plaster of Paris.

*See calcium sulfate, anhydrous.*

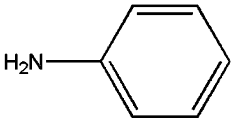
**Anhydrous** \-drəs\ [Gk *anydrods*, fr. *a-* + *hydōr* water] (1819) *adj.* Perfectly dry; containing no water. It is generally accepted to mean free from water of any kind, whether as such in the free-state, or as water of crystallization or other tightly held water.

**Anidex fiber** *n.* A manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 50% by weight of one or more esters of a monohydric alcohol and acrylic acid, $(CH_2{=}CH{-}COOH)$ (FTC definition).

**Anilides** *n.* Acyl derivatives from aniline. Possibly the commonest anilide in the paint trade is acetanilide, $C_6H_5NHCOCH_3$.

**Aniline** \ˈa-nᵊl-ən\ [Gr *anilin*, fr. *Anil* indigo, fr. FP, fr. Arabic *an-nīl* the indigo plant. fr. Sanskrit fr. *nīlī* indigo, fr. feminine of *nīla* dark blue] (1850) (phenylamine, aminobenzene) *n.* $C_6H_5NH_2$. A colorless, oily liquid made by the reduction of nitrobenzene with iron chips and an acid catalyst. It is used in the production of aniline-formaldehyde resins and certain catalysts and antioxidants.

*See dyes* (*See image*).



**Aniline cloud point** *See aniline point.*

**Aniline dye** *n.* Large class of synthetic dyes made from intermediates based upon or made from aniline.

**Aniline-formaldehyde resin** *n.* An aminoplastic that is made by condensing formaldehyde and aniline in an acid solution. The resins are thermoplastic and are used in making molded and laminated insulating materials with high dielectric strength and good chemical resistance.

*See also amino resin.*

**Aniline-furfural resin** *n.* Furfural yields resinous compounds not only with aniline but with aromatic amines generally. Rosin modified resins have also been produced. Amine-furfural resins are dark in color. Bleaching occurs on exposed to light. They possess the unique property of compatibility with cellulose acetate.

**Aniline ink** *n.* A fast-drying ink used for printing on cellophane, polyethylene, etc. Aniline inks were first made from solutions of coal-tar dyes in organic solvents, hence the name. Modern inks generally employ pigments rather than dyes.

*See flexographic ink.*

**Aniline number** *See aniline point.*

**Aniline pigments** *n.* Made from distillation products of coal tar, a by-product of coke and coal gas manufacture.

*Also known as coal-tar colors.*

**Aniline point** *n.* The minimum temperature at which a hydrocarbon solvent is completely soluble in an equal volume of freshly distilled aniline. Below this point, the mixture is cloudy and separates into two layers. It is used as a measure of solvent power of hydrocarbon solvents. Refer to ASTM D 1012. Syn: aniline cloud point and aniline number.

**Aniline printing** *See flexography.*

**Anilox* roller** Mechanically engraved intaglio from roller used in flexo presses to transfer a controlled film of ink from the contacting rubber-covered fountain roller to the rubber plate (or rubber-covered roller) which prints the web *Registered Trade Name, Inmont Corp.

**Animal black** (animal char, animal charcoal, boneblack) *n.* A form of charcoal derived from animal bones, used as a pigment. Three types are known: drop black; bone black; and ivory black. Drop black and bone black are produce by the calcinations of bones, but ivory black in its original cake form is virtually extinct.

*See also carbon black, bone black, drop black, and ivory black.*

**Animal fats** *n.* Include such products as lard, bone fat, tallow and butter fat. They are semisolid at ordinary air temperature, and consist chiefly of the glycerides of oleic and stearic acids.

**Animal fibers** *n.* Fibers of animal origin such as wool, alpaca, camel hair, and silk.

**Animal oils** *n.* Normally restricted to the animal foot oils and lard oil, and quite distinct from the fish oils. Neatsfoot oil is typical of the foot oils. The animal oils are characterized by the almost complete absence of acids more unsaturated than oleic acid, and by the presence of cholesterol. The presence of this latter compound enables them to be distinguished from the nondrying vegetable oils.

**Animal waxes** *n.* Obtained from a great variety of sources and have little in common, except absence of glycerides.

**Animi** *n.* Fossil copal, sometimes described as "goose-skin" animi because of the characteristic markings on its surface. It originated in Zanzibar and hence its alternative name, Zanzibar copal.

*Also known as gum animi and mombassa gum.*

**Anion** \ˈa-ˌnī-ən\ [Gk, neut. of *aniōn*, prp. of *anienai* to go up, fr. *ana-*+ *ienai* to go] (1834) *n.* An atom, molecule or radical that has gained an electron to become negatively charged. Anions in a liquid subjected to electric potential collect at the positive pole or anode.

**Anion exchange resin** *n.* Certain synthetic resins with the property of absorbing anions from aqueous salt solutions.
*See ion-exchange resin.*

**Anionic** \ˌa-(ˌ)nī-ä-nik\ (ca. 1920) *adj.* Pertaining to a negatively (−) charged atom, radical, or molecule, or to any compound or mixture having negatively charged groups.

**Anionic-cationic polymerization** *n.* A method of preparing multi-block copolymers using a combination of anionic and cationic) (ion coupling) methods.

**Anionic polymerization** *n.* Polymerization using an anionic initiator (−charge), e.g., n-butyl lithium initiator to form polyisoprene. {G anionische Polymerisation f, F polymérisation anionique, polymérisation f, S polimerización aniónica, polimerización f, I polimerizzazione anionica, polimerizzazione f}.
*See ionic polymerization.*

**Anionic surfactant** *n.* Surfactants, which give negatively charged ions in an aqueous solution.

**Anisole** *n.* $C_6H_5OCH_3$. Mixed aromatic–aliphatic ether. It has good solvent properties and a bp of 154°C.

**Anisotropic** \ˌa-ˌnī-sə-ˈträ-pik\ (1879) *adj.* (1) A transparent particle having different refractive indices depending on the vibration direction of light. (2) Said of materials whose properties, e.g., strength, refractive index, thermal conductivity, are unequal in different directions. Oriented thermoplastics and unidirectionally fiber-reinforced resins are typically anisotropic. Not isotropic.
*See isotropic.*

**Anisotropy** *n.* The quality of being anisotropic; having directionally dependent properties. Exhibiting different optical properties when tested along axes in different directions. {G Anisotropie f, F anisotropie f, S.anisotropía f, I anisotropia f}.
*See isotropic*

**ANLAB color difference equation** *n.* Abbreviation used primarily in Britain for Adams-Nickerson L, a, b Color difference equation. The normalizing factor is generally 40 and b is calculated as $0.4(V_Z – V_Y)$.
*See Adams chromatic value color difference equation.*

**ANM** *n.* Copolymers from acrylic ester and acrylonitrile.

**Annealing** \ə-ˈnē(ə)l\ [ME *anelen* to set on fire, fr. OE *onîlan*, fr. *On*+ *îlan* to set on fire, burn, fr. *āl* fire; akin to OE *îled* fire, ON *eldr*] (1664) *v.* The process of relieving stresses in molded plastics, metal, or glass by heating to a predetermined temperature, maintaining this temperature for a set period of time, and slowly cooling the articles. Sometimes the articles are placed in jigs to prevent distortion as internal stresses are relieved during annealing.

**Annual growth ring** Growth layer of a tree put on in a single growth year. This includes springwood and summerwood.

**Annular stop** *n.* The opaque ring-shaped stop with a central opening placed usually in the objective back focal plane to give annular stop dispersion staining.

**Anode** \ˈa-ˌnōd\ [Gk *anodos* way up, fr. *ana-*+*hodos* way] (1834) *n.* (1) The positive terminal of an electrical source to which electrons and negatively charged ions travel, negative for an electrolytic cell and positive for a galvanic cell. (2) The electrode at which corrosion (oxidation) occurs, electron collection electrode.

**Anprolene** *See ethylene oxide.*

**ANS** *n.* Abbreviation for Adams–Nickerson–Stultz color difference equation.

**ANSI** *n.* Abbreviation for American National Standards Institute, which is the US. member of ISO.

**Anthophyllite** \ˌan(t)-thə-ˈfi-ˌlīt, (ˌ)an-ˈthä-fə-\ [Gr for *Anthophyllit*, fr. NL *anthophyllum*, fr. Gk *anthos*+*phyllon* leaf] (ca. 1828) *n.* A type of Asbestos, the major source which is in Finland. Anthophyllite is a natural magnesium iron silicate, formerly used as a filler in polypropylene to provide heat stability.

**Anthracene** \ˈan(t)-thrə-ˌsēn\ (1862) *n.* $C_6H_4{:}(CH)_2C_6H_4$. Yellow, crystalline solid obtained from the distillation of coal tar.

**Anthracene oil** *n.* Fraction obtained from the distillation of coal tar, with a boiling range in the region of 270°C, and containing a substantial proportion of anthracene and similar hydrocarbons.

**Anthranilic acid** \ˌan(t)-thrə-ˈni-lik-\ [ISV *anthr*acene+*anil*ine] (1881) *n.*
*See A-acid.*

**Anthraquinone dyes** \ˌan(t)-thrə-kwi-ˈnōn, -ˈkwi-ˌnōn\ [prob. fr. Fr, fr. *anthracene*+*quinone*] (1869) *n.* Dyes that have anthraquinone as their base and the carbonyl group (>C=O) as the chromophore. Anthraquinone-based dyes are found in most of the synthetic dye classes.
*See dyes.*

**Antibacterial finish** *n.* A treatment of a textile material to make it resistant to, or to retard growth of, bacteria.

**Antibiotic** \ˌan-ti-bī-ˈä-tik, -ˌtī-; ˌan-ti-bē-\ (1894) *adj. A* substance derived from a living organism capable of killing or incapacitating another organism.

**Antiblocking agent** (antiblock). An additive that is incorporated into resins and compounds to prevent surfaces of products (mainly films) from sticking to each other or to other surfaces. The term is not generally used for coatings, dusts, or sprays applied to surfaces for the same purpose, or as slip agents, after products have been formed. Antiblocking agents usually are finely divided, solid, infusible materials, such as silica, but be minerals or waxes. They function by forming minute, protruding asperities that maintain separating air spaces that interfere with adhesion.

**Antibonding orbital** *n.* The molecular orbital in which electrons have higher energies than in the unbonded atoms; an orbital characterized by a region of low electron probability density between the bonded atoms, producing a destabilizing effect on the molecule.

**Antichlor** *n.* A chemical, such as sodium thiosulfate, used to remove excess chlorine after bleaching.

**Anticondensation paint** *n.* Coating designed to minimize the effects of condensation of moisture under intermittently dry and humid conditions. Such a material normally has a matt textured finish and frequently contains heat-insulating material as a filler.

**Anticorrosion paint or composition** *n.* Coating used for preventing the corrosion of metals and, more particularly, specially formulated to prevent the rusting of iron, steel, and other metals.

**Antifelting agents** *n.* Products that prevent or minimize matting and compaction of textile materials.

**Antifloating agent** *n.* Additive used to prevent floating.

**Antiflooding agent** *n.* Additive used to prevent flooding.

**Antifoaming agent** *n.* An additive that reduces the surface tension of a solution or emulsion, thus inhibiting or modifying the formation of bubbles and foam. Commonly used are insoluble oils, dimethyl polysiloxanes and other silicones, certain alcohols, stearates, and glycols. In many polymerizations, these agents prevent foaming altogether. They are also used to delay foaming when producing cellular plastics. Irene Ash, Michael Ash (1993) Handbook of Industrial Surfactants, Ashgate Publishing, UK.

**Antifogging agent** *n.* An additive that prevents or reduces the condensation of fine droplets of water on a shiny surface. Such additives function as mild wetting agents that exude to the surface and lower the surface tension of water, thereby causing it to spread into a continuous film. Antifogging agents are much used in PVC wrapping films for meats and other moist foods. Examples are alkylphenol ethoxylates, complex polyol monoesters, polyoxyethylene esters of oleic acid, polyoxyethylene sorbitan esters of oleic acid, and sorbitan esters of fatty acids. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York.

**Antifouling composition** *n.* Paint-like composition used to prevent the growth of barnacles and other organisms on ships' bottoms. It usually contains substances, which are poisonous to such organisms in the early stages of growth. Such compositions are applied over protective paints, e.g., over anticorrosion paints in the case of steel ships.

**Antigelling agent** *n.* An additive that prevents a solution from forming a gel.

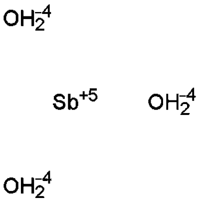
**Antilivering agent** *n.* Additive used to prevent the livering of a coating. *See livering.*

**Antimicrobial agent** *See biocide.*

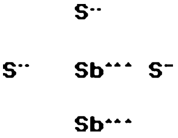
**Antimony orange** $Sb_2S_3$ Like antimony vermillion, which it resembles closely, it is a sulfide pigment, and can be prepared by precipitation from as aqueous antimony salt solution with hydrogen sulfide. Kirk-Othmer (1996) Encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Antimony oxide** *n.* $Sb_2O_3$. Pigment White 11 (77052). Antimony and oxygen combine to form trioxide, tetraoxide, and pentoxide. The most common antimony trioxide pigment is used as a flame retardant in paints, plastics and textiles. It contains, in addition, traces of the tetroxide ($Sb_2O_4$), and of the oxides of lead, arsenic, and iron. Density, 5.3–5.7 g/cm$^3$ (44.0–47.5 lb/gal); O.A., 11–14; particle size, 1 µm. Syn: antimony trioxide, antimony white, antimony sesquioxide, and flower of antimony. Kirk-Othmer (1996) Encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Antimony trioxide** (antimony white, flowers of antimony, and antimony oxide) *n.* $Sb_2O_3$. A very fine white powder made by vaporizing antimony metal in an oxidizing atmosphere, then cooling and collecting the oxide dust. Available in several ranges of particle size, it is used as a flame retardant and pigment in plastics, usually in synergistic combination with an organo-halogen compound. PVC is the biggest consumer. Kirk-Othmer (1996) Encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.



**Antimony vermillion** *n.* $Sb_2S_3$. Pigment varying on color from pale orange to deep crimson, with good opacity and tinting strength. It is prepared either by adding a solution of sodium thiosulfate to a solution of tartar emetic and tartaric acid, or to a solution of another suitable antimony salt. The pigment is not resistant to acids, alkalis, or heat, but, if properly made, is lightfast. It is sometimes referred to as Crimson Antimony. Kirk-Othmer (1996) Encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.



**Antimony white** n. *See antimony oxide.*

**Antimony yellow** *n.* $Pb_3(SbO_4)$. Essentially, lead antimonite, which may be considered to be chemically combined lead and antimony oxides. It varies in color from sulfur yellow to orange-yellow, depending upon the proportion of the two materials. Kirk-Othmer (1996) Encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York.

**Antinode** \ˈan-ti-ˌnōd, ˈan-ˌtī-\ [ISV] (1882) *n.* A region or location of maximum disturbance in a standing wave. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw Hill Science/Engineering/Math, New York.

**Anti-noise paint** *n.* Coating used for its sound deadening effect, on vibrating and naturally noisy machinery. It relies for its effectiveness on its very rough surface, produced by the incorporation of cork and similar granular, or fibrous materials. *Also called Acoustical Paint.*

**Antioxidant** \ˌan-tē-ˈäk-sə-dənt, ˌan-ˌtī-\ (1926) *n.* A substance that slows down the oxidation of oils, fats, etc., and thus helps to check deterioration: antioxidants are added commercially to foods, soaps, etc. Although the term technically applies to molecules reacting with oxygen, it is often applied to molecules that protect from any free radical molecule with unpaired electrons. Chemistry encyclopedia, www.ChemistryAbout.com. A substance incorporated in a material to inhibit oxidation at normal or elevated temperatures. Antioxidants are used mainly with natural and synthetic rubbers, petroleum-based resins, and other such polymers that oxidize readily due to structural unsaturation. However, some thermoplastics, namely polypropylene, ABS, rubber-modified polystyrene, acrylic and vinyl resins, also require protection by antioxidants for some uses. There are two main classes: (1) Those inhibit oxidation by reacting with chain-propagating radicals, such as hindered phenols that intercept free radicals. These are called primary antioxidants or free-radical scavengers. (2) Those decompose peroxide into non-radical and stable products; examples are phosphates and various sulfur compounds, e.g., esters of thiodipropionic acid. These are referred to as secondary antioxidants, or peroxide decomposers. {G Ozonschutzmittel n, F anti-ozone m, S antiozonante m, I antiozonante m}. Merriam-Webster's collegiate dictionary, 10th edn. Springfield, MA, 2000. Glenz W (ed) (2001) A glossary of plastics terminology in five languages, 5th edn. Hanser–Gardner Publications Inc., Cinicinnati. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Antioxidants** *n.* Agents, which deter or retard autooxidation degration such as phenol and arylamines, agents react with the intermediate peroxy radicals. These agents retard the action of oxygen in drying oils and other substances subject to oxidation. {G Antioxidans n, F antioxydant m, S antioxidante m, I antiossidante m}. Glenz W (ed) (2001) A glossary of plastics terminology in five languages, 5th edn. Hanser–Gardner Publications Inc., Cinicinnati. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Antiozonant** \-ˈō-(ˌ)zō-nənt\ (1954) *n.* Substance that retards or prevents the action of ozone on elastomers when exposed under tension, either statically or dynamically, to air containing ozone.

**Antiozonants** Same antioxidants.

**Anti-parallel spins** Two spins, which are in opposite directions.

**Antique finish** *n.* Usually applied to nearly painted furniture or objects for the purpose of giving the appearance of mellowness of age.

**Antiquing** \(ˌ)an-ˈtēk\ (1923) *n.* (1) Treating or finishing of wood to make it look old. (2) Imparting a special coloring effect by the application of a base coat followed by a transparent or semitransparent colored glaze, which is either applied by brush, then partially wiped away or applied by wiping with a cloth.

**Anti-sag agent** *n.* Additive used to control sagging of a coating.
*See thickening agent.*

**Antiseptic** \ˌan-tə-ˈsep-tik\ [*anti-* + Gk *sēptikos*] (1751) *adj.* An agent used to destroy or restrain the growth of microorganisms.

**Anti-septic wash** *See fungicidal wash.*

**Anti-settling agent** *n.* Substance incorporated into pigmented paint to retard settling and to maintain uniform consistency during storage or, in dipping paints, during painting operations. These additives normally function by altering the rheological properties of the paint. Syn: suspending agent.

**Anti-shatter composition** *n.* Composition designed to prevent the fragmentation of glass and glass-like materials. The main use of these compositions is in the manufacture of spliterproof glass. They are applied as an adhesive, resilient sandwich between relatively thin sheets of glass. A violet blow may cause cracking of the glass, but the anti-shatter composition is designed to retain the various pieces in position. Properties include good permanent adhesion to the glass, a natural resilience such that it will absorb violet shocks without itself distintegrating, a permanent freedom from color, and absolute transparency.

**Anti-silking agent** *n.* Additive used to prevent silking, which is a special case of floating, resulting in the formation of parallel hairlike striations of differing colors, running through the length of the painted surface.

**Anti-skinning agent** *n.* Any material added to a coating or printing ink to prevent or retard the processes of oxidation or polymerization which results in the formation of an insoluble skin on the surface of the coating or printing ink in a container.

**Anti-slip paint** *n.* Used for application to decks and other surfaces where the conditions conductive to slipping are present. It prevents slipping by providing a tough, rough surface. The roughness is usually achieved by the addition of sand or cork dust. *Also called non-skid paint.*

**Antisoiling properties** The properties of textile materials whereby they resist deposition of dirt and stains.

**Antistaining properties** The ability of a textile to resist the deposition of oil- or water-borne stains.

**Anti-stat** \-ˈstat *or* an-ti-stat-ic, -ˌsta-tik\ (1952) *adj.*

*See antistatic agent.*

**Antistatic agent** (antistat) *n.* A chemical (or other material) that imparts slight electrical conductivity to plastics compounds (or other polymeric formulation), preventing the accumulation of electrostatic charges on finished articles. The agent may be incorporated in the materials before molding (most preferable) or applied to their surfaces afterward. Antistatsic agents function either by being inherently conductive or by absorbing moisture from the air. Examples are long-chain aliphatic amines and amides, phosphate esters, quaternary ammonium salts, polyethylene glycols, polyethylene-glycol esters, and ethoxylated long-chain amines. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York, 1986-, 1990-, 1992-, 1993-editions.

**Antistatic properties** The ability of a textile material to disperse an electrostatic charge and to prevent the build up of static electricity.

**Antitracking varnish** *n.* When two points of high electrical potential difference are suitably located in contact with the surface of an organic insulating medium, the surface of the insulator may be degraded to carbon under the imposed electrical stresses, and a carbon track formed between the two points. Phenol-formaldehyde laminated boards are sometimes given a special coating of varnish at their exposed surfaces to prevent such carbonization. Varnishes used for such purposes are described as anti-tracking varnishes. American Society for Testing and Materials, www.astm.org, 100 Barr Harbor Drive, West Conshohocken, PA.

**Antiwrinkling agent** *n.* Material added to surface coating compositions to prevent the formation of wrinkles in films during drying.

**Ant oil** *See furfural.*

**Antwerp blue** *n.* Essentially, zinc ferrocyanide with a pale greenish-blue color. It is characterized by good opacity and almost complete absence of floating tendency.

**AOCS** Abbreviation for American Oil Chemists Society.

**Apertured non-woven fabric** *n.* A non-woven fabric having many small through-holes made by laying the fabric on a perforated plate or screen and applying fluid pressure.

**APHA color scale** *n.* Abbreviation for American Public Health Asscoation color scale developed for visually evaluating slight yellowness of solutions. It is based on dilutions of a platinum–cobalt standard solution of 500 APHA. This single-number color scale was originally developed by Hazen, and may also be referred to as the Hazen color scale.

**API** *n.* Abbreviation for American Petroleum Institute.

**API gravity** *n.* Measure of specific gravity of petroleum and petroleum products, defined by the following equation:

$$\text{API gravity, degrees} = \frac{141.5}{\text{specific gravity } 60/60^{\circ}\text{F}} - 131.5.$$

**Apochromat** \ˌa-pə-krō-ˈmat\ [ISV] (1887) *adj.* A term applied to photographic and microscope objectives indicating the highest degree of color correction.

**Apochromatic objective** *n.* An objective corrected for spherical aberration at two wavelengths and for chromatic aberration at three wavelengths.

**Apparent density** The mass per unit volume of material including voids inherent in the material as tested, such as pellets, powders, foams, chopped film or fiber scrap. Usually expressed as lbs/cubic foot or g/cm$^3$. The term bulk density is synonymous for particulate materials. ASTM tests are D 1895 for pellets and powders, except PTFE powders, for which D 1457 applies; D 1622 for rigid foams.

*See also density and bulk factor.*

**Apparent viscosity** *n.* At any point in a fluid undergoing laminar shear, the nominal shear stress divided by apparent shear rate. In simple fluids, viscosity is a state property, depending only on composition, temperature, and pressure. In polymer melts and solutions, it is, nearly always, also dependent on the shear rate (or stress), hence the term *apparent viscosity.* The term is also applied to the quotient of the shear rate at the wall, which reduces to $\pi R^4 \cdot \Delta P/(8QL)$, where $R$ and $L$ are the radius and length of the tube, $\Delta P$ is the pressure drop through the tube, and $Q$ is the volumetric flow rate. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Staudinger H, Heuer W (1930) A relationship between the viscosity and the molecular weight of polystyrene (German). Ber 63B:222-234.

**Appearance** \ə-ˈpir-ən(t)s\ (14c) *n.* Manifestations of the nature of objects and materials through visual attributes such as size, shape, color, texture, glossiness, transparency, opacity, etc.

**Appliance finish** *n.* Generally, thermoset coatings, which are characterized by their hardness, mar resistance, and good chemical resistance.

**Application** \ˌa-plə-ˈkā-shən\ [ME *applicacioun*, fr. L *application*-, application inclination, fr. *applicare*] (15c) *n.* Process by which surface coating compositions are transferred to a variety of surfaces, such as: brushing; spraying (cold and hot); dipping (simple immersion); dipping (assisted by application of vacuum and/or pressure); roller coating; flushing; and spreading.

**Applicator** \ˈa-plə-ˌkā-tər\ (1659) *n.* Device to deposit a film of a specified thickness, such as doctor blade, wire wound rod, drawdown bar, etc.

**Applicator roll** *n.* Roll in a roller coater, which applies the paint to a continuous strip.

**Appliqué** \ˌa-plə-ˈkā\ [Fr, pp of *appliquer* to put on, fr. L *applicare*] (1801) *n.* Pattern or picture, formed by laying various materials usually on a fabric ground. Especially suitable for dressmaking and needlework. A design or ornament applied to another surface. In wallpaper, cut-outs applied to a plain, textured, or figured background.

**Appurtenance** \ə-ˈpərt-nən(t)s, -ˈpər-tᵊn-ən(t)s\ (14c) *n.* Any built-in, nonstructural portion of a building, such as doors, windows, ventilators, electrical equipment, partitions, etc.

**Apricot kernel mixed fatty acids** *n.* These have a mp of 12–14°C; an acid value of 194; and an iodine value of 103.

**Apricot kernel oil** *n.* Non-drying oil with iodine value of 96.

**Apron** \ˈā-prən, -pərn\ {*often attributive*} [ME, alteration (resulting fr. false division of *a* napron) of *napron*, fr. MF *naperon*, dim. of *nape* cloth, mod. of L *mappa* napkin] (15c) *n.* A paved area, such as the juncture of a driveway with the street or with a garage entrance. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Apron mark** *See decating mark.*

**Aprotic solvent** \(ˌ)ā-ˈprō-tik\ [$^2$*a-* + *pro*ton + $^1$*-ic*] (1931) *adj.* An organic solvent that neither donates protons to or accepts them from a substance dissolved in it. Benzene, $C_6H_6$, is such a solvent. Wypych G (2001) Handbook of solvents. Chemtec Publishing, New York.

**Aprotic substance** *n.* A substance that can act neither as an acid nor as a base. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Aptitude, color** *See color aptitude.*

**A. Pullulans** *See color aptitude.*

**Aqua regia** *n.* A powerful oxidizing and complexing solvent mixture composed of about three parts concentrated HCl to one part concentrated $HNO_3$.

**Aquarelle** \ˌa-kwə-ˈrel, ˌä-\ [F, fr. obs. I *acquarella* (now *acquerello*), fr. *acqua* water, fr. L *aqua*] (1869). (1) *n.* Drawing or print which has been colored with transparent water color washes. (2) Color that is made workable when mixed with water.

**Aquatint** \ˈa-kwə-ˌtint, ˈä-\ [I *acqua tinta* dyed water] (1782) *n.* Method of engraving which, like etching, involves the use of a mordant acid for biting a metal plate, but differing in that aquatint is used to render tonal instead of linear effects.

**Aqueous** \ˈa-kwē-əs, ˈa-\ [ML *acqueus*, fr. L *aqua*] (1646) *adj.* Water-containing or water-based.

**Aqueous acrylic** *See latex.*

**Aqueous phase of emulsion** The aqueous phase of an aqueous emulsion is water mixed with surfactant sometimes initiator and catalyst.

**Aqueous thermoplastic emulsions** *n.* Water based acrylic emulsions with noncrosslinked latex particles.

**Aquo complex** *n.* A complex in which water molecules serve as ligands.

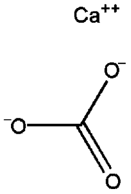
**AR** *n.* Abbreviation for acrylic rubber.

**Arabic** (14c) n. *See acacia gum or gum Arabic.*

**Arachis oil** \ˈar-ə-kəs-\ [NL *arachis*, genus that includes the peanut, fr. Gk *arakis*, dim. of *arakos*, a legume] (ca. 1889) *n.* *See peanut oil.*

**Arachne machine** *n.* (1) A machine for producing loop-bonded nonwovens. The fabric is formed by knitting a series of warp yarns through a fiber web processed on a card. *Also see bonding.* (2) Stitch bonding.

**Aragonite** \ə-ˈra-gə-ˌnīt, ˈar-ə-g -\ [Gr *Aragonit*, fr. *Aragon*, Spain] (1803) *n.* *See calcium carbonate* (*See image*).



**Aralac** Albumin fiber. Manufactured by National Dairy Products, USA.

**Araldite** *n.* Epoxide resins. Manufactured by CBA, Switzerland.

**Aramid** \ˈar-ə-məd, -ˌmid\ [*aro*matic poly*amide*] (1972) *n.* Acronym for *aro*matic poly*amide*, currently available in fiber foam only, having at least 85% of the amide groups bonded to two aromatic rings. DuPont's Kevlar® is poly(*p*-phenylene terephthalamide). Aramid fibers exhibit low flammability, high strength, and high modulus. Fabrics made from aramid fibers maintain their integrity at high temperatures. Such fabrics are used extensively in hot-air filters. Aramids are also found in protective clothing, ropes and cables, and tire cord.

**Aramid fiber** *n.* Any of a family of high-strength, high-modulus fibers made from aramid resin. DuPont's Kevlar® −49 and −29 are the best known. K-49's ultimate strength is 3.4 GPa (500 kpsi), modulus is 131 GPa (19 Mpsi), ultimate elongation is 2.4%. K-29 has about equal strength, but half the modulus and twice the elongation. Density of either is 1.44 g/cm$^3$. Strength/density is higher for either of these fibers than for any others except some whiskers.

**Archimedes principle** \ˌär-kə-ˈmē-dēz-\ *n.* A body wholly or partly immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced. A body of volume $V$ (cm$^3$) immersed in a fluid of density $\rho$ (g/cm$^3$) is buoyed up by a force in dynes

$$F = \rho g V,$$

where $g$ is the acceleration due to gravity. A floating body displaces its own weight of liquid. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Architectural coatings** *n.* Coatings intended for on-site application to interior or exterior surfaces of residential, commercial, institutional, or industrial – as opposed to industrial coatings. They are protective and decorative finishes applied at ambient temperatures. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Architecture** \ˈär-kə-ˌtək-chər\ (1555) *n.* The art and science of designing and building structures, or large groups of structures, in keeping with aesthetic and functional criteria, and structures built in accordance with such principles.

**Arcing** \ˈär-kiŋ\ (1893) *v.* Swinging spray gun away from the perpendicular.

**Arco microknife** Instrument designed for testing scratch hardness and adhesion of coatings. A diamond point is weighted until it can penetrate a film to the metal substrate in two retracing steps. The weight necessary to achieve this cutting force for films of standard thickness is a measure of hardness.

**Arc resistance** *n.* The ability of a plastic material to maintain low conductivity along the path of exposure to a high-voltage electrical arc, usually stated in terms of the time required to render the material electrically conductive. Failure of the specimen may be caused by heating to incandescence, burning, tracking, or carbonization of the surface. Dissado LA, Fothergill CJ (eds) (1992) Electrical degradation and breakdown of polymers. Institution of Electrical Engineering (IEE), London. Emerson JA, Torkelson JM (eds) (1991) Optical and electrical properties of polymers: materials research society symposium proceedings, vol 24. Materials Research Society, Warrendale, PA. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Arc tracking** *See tracking.*

**Ardil** *n.* Fiber from peanut protein. Manufactured by ICI, Great Britain.

**Area, unit of** The square centimeter. The area of a square whose sides are 1 cm in length. Other units of area are similarly derived. Dimensions, [$l^2$].

**Argillaceous** \ˌär-jə-ˈlā-shəs\ (ca. 1731) *adj.* Composed primarily of clay or shale; clayey.

**Argyle** also ar-gyll \ˈär-ˌgī(ə)l, är-ˈ\ [*Argyle*, *Argyll*, branch of the Scottish clan of

Campbell, fr. whose tartan the design was adapted] (1899) *n.* A pattern consisting of diamond shapes of different colors knit in a fabric.

**Arithmetic mean** (arithmetic average, mean $\overline{x}$) *n.* (1) In statistics, the average of a set of measurements found by summing the measurements and dividing the sum by the number of measurements (number-average molecular weight is an arithmetic average). (2) The conceptual mean, $\mu$, of the population from which a set of measurements was drawn, rarely known exactly. The sample mean, $\overline{x}$, is the most efficient estimator of the population mean, $\mu$.

**Arnaudon's green** *See chromium oxide green.*

**Arnite** Poly(ethylene terephthalate) (as plastic). Manufactured by AKU, The Netherlands.

**Aromatic compounds** *n.* A class of organic compounds containing a resonant, unsaturated ring of carbon atoms. Included are benzene, naphthalene, anthracene, andtheir derivatives. The term *aromatic* stems from the fact that many of these compounds have an agreeable odor. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Aromatic content** Percent aromatic hydrocarbons present in a solvent mixture or in a compound.

**Aromatic electrophilic-substitution** *n.* Typical reactions of the benzene ring since the ring is electron rich (a base) and reactants are electron poor; typical reactions include nitration, halaogenation, and sulonation. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Aromatic hydrocarbon** *n.* A compound of carbon and hydrogen whose molecular structure contains one or more rings of six carbon atoms, with at least one of the rings containing alternating, resonant single and double bonds. Benzene, which is the simplest of the aromatic hydrocarbons, has the molecular formula $C_6H_6$. The family includes many solvents for plastics.

**Aromatic petroleum residues** *n. See diolefin resins.*

**Aromatic polyamide** *n. See aramid.*

**Aromatic polyester** *n.* A polyester that has aromatic rings in its chain, e.g., polyethylene terephthalate.

**Aromatics** (15c) *n.* Compounds containing at least one benzene ring. Benzene, toluol, Xylol or aromatic solvents.

**Aromatic solvents** *n.* Organic liquids having a cyclic or ring hydrocarbon structure and KB values over 40. They are good solvents for printing ink resins. Examples are toluol and xylol (cf. *Aliphatic solvents*). Use of aromatic solvents is severely restricted by Rule 66. Aromatic solvents containing less than 80% aromatic compounds are frequently designated as partial aromatic solvents.

**Aromatization** \ə-ˌrō-mə-tə-ˈzə-shən\ (15c) *vt.* Process of converting saturated or aliphatic hydrocarbons to aromatic hydrocarbons.

**Arrhenius equation** \ə-ˈrē-nē-əs, -ˈrā-\ *n.* (1) A classical equation describing how rates of chemical reactions increase with rising absolute temperature:

$$r = Ae^{-E/RT},$$

in which $r$ is the reaction rate (in appropriate units), $A$ the collision factor (in the same units as $r$), e the 2.71828…, $E$ is the activation energy of the reaction (J/mol), $R$ the universal molar-energy constant (8.3144 J/(mol K), and $T$ is the absolute temperature (K). (2) An almost identical form, differing only in that the sign of the exponent is positive (viscosities *decrease* with rising temperature), has been used with good results to represent the temperature dependence of liquid viscosities, including those of polymer solutions and melts.

It, too, is often referred to as an Arrhenius equation. This form has also been successful in modeling the temperature dependence of creep failure and property retention during heat aging. For viscosity work, the logarithmic form of this equation is more convenient.

$$\ln(\mu/\mu_o) = E(T - T_o)/RTT_o.$$

here $E$, $R$, and $T$ have the same meanings as above; $\mu_o$ represents the viscosity at a reference temperature, $T_o$, which is usually chosen to be within the temperature range over which the viscosities have been measured. Atkins PW, Atkins P, De Paula J (2001) Physical chemistry. W. H. Freeman Co., New York. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Miller ML (1966) Structure of polymers. The Reinhold Publishing Co., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Arrhenius plot** *n.* A plot of the logarithm of the specific rate constant for a reaction against the reciprocal of the absolute temperature; useful for determining the activation energy of the reaction. Atkins PW, Atkins P, De Paula J (2001) Physical chemistry. W. H. Freeman Co., New York.

**Arrhenius theory of electrolytic dissociation** *n.* This theory states that the molecule of an electrolyte can give rise to two or more electrically charged atoms or ions. Atkins PW, Atkins P, De Paula J (2001) Physical chemistry. W. H. Freeman Co., New York.

**Arsenic orange** \ˈärs-nik ˈär-inj\ *n. See realgar.*

**Artificial aging** \ˌär-tə-ˈfi-shᵊl\ *n.* The accelerated testing of plastics to determine their changes in properties such as dimensional stability, water resistance, resistance to chemicals and solvents, light stability, and fatigue resistance.

**Artificial daylight** *n.* Term loosely applied to light sources, frequently equipped with filters, which are claimed to reproduce the color and spectral distribution of daylight. A more specific definition of the light source is to be preferred.

*See correlated color temperature, color rendering index, and spectral power distribution curve.*

**Artificial stone** *n.* Special concretes and tiles, artificially colored to simulate natural stone, obtained by mixing stone dust aggregate and chips with Portland cement.

**Artificial turf** *n.* A manufactured carpet having the appearance of grass. It is used to replace grass in sports arenas, yards, etc. *Also see recreational surfaces.*

**Artificial ultramarine** *n.* Synthetic ultramarine blue.

*See ultramarine blue.*

**Artificial weathering** *n.* A process of simulating weathering conditions such sunlight and rain using accelerated methods (e.g., Salt Fog Spray ASTM B 117). Artificial weathering is a method of utilizing exposure to cyclic laboratory conditions involving changes in temperature, relative humidity, and radiant energy, with or without direct water spray, in an attempt to produce changes in the material similar to those observed after long-term continuous outdoor exposure. American Society for Testing and Materials, www.astm.org, 100 Barr Harbor Drive, West Conshohocken, PA. American Society for Testing and Materials, www.astm.org, 100 Barr Harbor Drive, West Conshohocken, PA.

**Artists' colors** *n.* Various paint media used by artists, such as oil paints, watercolors, gouache, tempera, encaustic, fresco, silicate esters, and latex.

**Art linen** *n.* A plain-weave, softly finished fabric used either bleached or unbleached as a base fabric for needlework.

**Aryl** \ˈar-əl\ [ISV *ar*omatic + -*yl*] (1906) *adj.* Pertaining to monovalent aromatic groups, e.g., $C_6H_5$, phenyl.

**ASA** *See American national standards institute.*

**Asbestine** *See magnesium silicate, nonfibrous.*

**Asbestos** \as-ˈbes-təs, az-\ [ME *albestron* mineral supposed to be inextinguishable when set on fire, prob. fr. MF, fr. ML *asbeston*, alter. of L asbestos, fr. Gk, unslaked lime, fr. *asbestos* inextinguishable, fr. *a-* + *sbennynai* to quench] (1607) *n.* The commercial term for a family of fibrous mineral silicates comprising some 30 known varieties, of which six were, for many years, commercially important. They are of two general types, *serpentine* and *amphibole.* The serpentine type contains chrysotile that was most widely used as a reinforcement in thermosetting resins and laminates and, in finer form, as a filler in polyethylene, polypropylene nylons, and vinyls. Abestos used in flooring sheet and tiles. The amphiboles provided good chemical resistance and lower water absorption, but the outstanding properties provided all asbestos types were resistance to heat, fire retardance, and resistance to chemicals and for reinforcing plastics, and some brake linings for vehicles may still contain it. Extreme precautions must be taken in handling asbestos and asbestos-filled materials. The OSHA limit for such workers is 2 fibers/m$^3$ of air, averaged over an 8-h shift. The use of asbestos products has declined in the United States due to health hazards associated with it. Hibbard MJ (2001) Mineralogy. McGraw-Hill Companies Inc., New York. James F (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Asbestos-cement** *n.* A dense, rigid, board containing a high proportion of asbestos fibers bonded with Portland cement; resistant to fire, flame, and weathering; has low resistance to heat flow. Used as a building material in sheet form and corrugated sheeting. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Asbestos-cement board** *n.* A dense, rigid, board containing a high proportion of asbestos fibers bonded with Portland cement; resistant to fire, flame, and weathering; has low resistance to heat flow. Used as a building material in sheet form and corrugated sheeting. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Asbestos plaster** *n.* A fireproof insulating material generally composed of asbestos with Bentonite as the binder. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Asbestos sheeting** *n.* A dense, rigid, board containing a high proportion of asbestos fibers bonded with Portland cement; resistant to fire, flame, and weathering; has low resistance to heat flow. Used as a building material in sheet form and corrugated sheeting. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Asbestos wallboard** *n.* A dense, rigid, board containing a high proportion of asbestos fibers bonded with Portland cement; resistant to fire, flame, and weathering; has low resistance to heat flow. Used as a building material in sheet form and corrugated sheeting.

**Ascaridole** (1,4-peroxide-*p*-menthene-2). $C_{10}H_{16}O_2$. A naturally occurring peroxide with uses as a polymerization initiator.

**Aseptic packaging** *n.* A package that has been sterilized with gas, heat or radiation after it was sealed.

**Ash** \ˈash\ [ME *asshe*, fr. OE *æsc*; akin to OHGr *ask* ash, L *ornus* mountain ash] (before 12c) *n.* The mineral residue left after burning or decomposition of a sample of a substance.

**Ash content** The solid residue remaining after a substance has been incinerated or heated to a temperature sufficient to drive off all volatile or combustible substances.

**Ashing** *n.* A finishing process used to produce a satin-like finish on plastic articles, or to remove cold spots or teardrops from irregular surfaces, which cannot be reached by wet sanding. The part is applied to a loose muslin disk loaded with wet ground pumice, rotating at a lineal speed of about 20 m/s.

**ASM international** (American Society of Materials) *n.* A material science and engineering society headquartered in Materials Park, OH, www.asminternational.org.

**Aspartic acid** \ə-ˈspär-tik-\ [ISV, irreg. fr. L *asparagus*] (1863) *n* $COOHCH_2CH(NH_2)COOH$. Amino acid constituent of proteins of both animal and vegetable origin. In particular it is present in casein. It is a dibasic acid.

**Aspect ratio** (1907) *n.* (1) The ratio of length to diameter of a fiber or yarn bundle. (2) In tire production, the ratio of the height of the tire to its width. (3) In a rectangular structure, the ratio of the longer dimension to the shorter. Complete textile glossary. Celanese Acetate LLC, Three Park Avenue, New York, 2000.

**Asphalt** \ˈas-ˌfólt *also* ˈash-, *esp British* -ˌfalt\ [ME *aspalt*, fr. LL *asphaltus*, fr. Gk *asphaltos*] (14c) (bitumen) *n.* (1) A dark brown or black, bituminous, viscous material which gradually liquefies when heated. The predominating constituents are bitumens, all of which occur in the solid or semisolid form in nature or are obtained by refining petroleum, or which are combinations of the bitumens mentioned with each other or with petroleum or derivatives thereof. (2) A similar material obtained artificially in refining petroleum; used in built-up roofing systems as a water-proofing agent. (3) A mixture of such substances with an aggregate for use in paving. Usmani AM (1997) Asphalt science and technology. Marcel Dekker, New York.

**Asphalt cut back** *n.* Asphalt plus thinner; asphalt solution; asphalt coating formed by dissolving asphalt. Usmani AM (1997) Asphalt science and technology. Marcel Dekker, New York.

**Asphalt emulsion** *n.* A suspension or emulsion of ordinary asphalt in water. Such emulsions have attained wide use because, unlike straight asphalt, they do not have to be heated to be applied. The suspended asphalt is spread on in the usual way; and after the water has evaporated, the asphalt hardens into a continuous mass. Uses: highways; cement water-proofing; roofing compounds; and the like.

*Also called emulsified Asphalt.*

**Asphaltenes** *n.* Highly condensed hydrocarbon compounds present in bitumens and asphaltums. Little is known of their chemical structure, but they are usually characterized by their insolubility in low boiling aliphatic hydrocarbons. Their physical condition is solid or semisolid. Usmani

AM (1997) Asphalt science and technology. Marcel Dekker, New York.

**Asphaltic bitumens** *n.* May be either naturally occurring materials or otherwise obtained from the distillation of asphaltic base petroleum; they are readily soluble in aliphatic and aromatic hydrocarbons and have good film-forming properties. Usmani AM (1997) Asphalt science and technology. Marcel Dekker, New York.

**Asphaltic pyrobitumens** *n.* Include elaterite, impsonite, and wurtzlite. They are characterized by their hydrocarbon nature, infusibility, and insolubility in carbon disulfide. Oxygen-containing compounds are present only in small amounts. Usmani AM (1997) Asphalt science and technology. Marcel Dekker, New York.

**Asphalt paint** *n.* A liquid asphaltic product sometimes containing small amounts of other materials such as lampblack, aluminum flakes, and mineral pigments. Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products – chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York.

**Asphalt paper** *n.* A paper sheet material that has been coated, saturated, or laminated with asphalt to increase its toughness and its resistance to water. Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products – chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York.

**Asphalt seal coat** *n.* A bituminous coating, with or without aggregate, applied to the surface of a pavement to waterproof and preserve the surface and to improve the texture of a previously applied bituminous surface. Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products – chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York.

**Asphalt tile sealer** *n.* Resin or plastic-type finish usually containing a water or alcohol carrier. Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products – chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York.

**Asphaltum (or asphalt)** \as-ˈfól-təm, *esp British* -ˈfal-\ [ME *asphalt*, fr. LL *aspaltus*, fr. Gk *asphaltos*] (14c) *n.* US paint industry's term for asphalt. In Britain, the term is reserved for natural asphalt. Usmani AM (1997) Asphalt science and technology. Marcel Dekker, New York.

**Asplit** *n.* Phenoplast. Manufactured by Hoechst, Germany.

**ASR** *See alkali-soluble resins.*

**Assembly** \ə-ˈsem-blē\ [MD *assemblee*, fr. MF, fr. OF, fr. *assembler*] (14c) *n.* A group of materials or parts, including adhesive, which has been placed together for bonding or which has been bonded together.

**Assembly adhesive** *See adhesive, assembly.*

**Assembly glue** *See adhesive, assembly.*

**Assembly of plastics** *n.* Plastic parts may be joined to others by many methods. Self-tapping screws are made with special thread designs to suit specific resins. Threaded inserts to receive mounting screws may be molded in or installed by press-fitting or by means of self-tapping external threads. Press-fitting may be employed to join plastics to similar or dissimilar materials. Snap-fit joints are made by molding or machining an undercut in one part, and providing a lip to engage this undercut in the mating component.

**Assembly time** *n.* Elapsed time after the adhesive is spread and until the pressure becomes effective.

*See time, assembly.*

**Associative thickener** A thickener which obtains its efficiency presumably by association between thickener molecules or thickener and latex particles rather than through high molecular weight or chain stiffness of the thickener molecules themselves.

*See also thickener.*

**A-stage** *n.* An early stage in the preparation of certain thermosetting resins in which the material is still fusible and soluble in certain liquids. Sometimes referred to as a *resol.*

*See also B-stage and C-stage.*

**A-stage thermosetting resins** *n.* The first stage of novalac (phenolic) formation before crosslinking or curing.

**Astigmatism** \ə-ˈstig-mə-ˌti-zəm\ (1849) *n.* An error of spherical lenses peculiar to the formation of images by oblique pencils. The image of a point when astigmatism is present will consist of two focal lines at right angles to each other and separated by a measurable distance along the axis of the pencil. The error is not eliminated by reduction of aperture as is spherical aberration.

**ASTM** American society for testing materials. ASTM headquarters is located at 1916 Race St., Philadelphia, PA, may be the largest non-governmental, standards-writing body in the world, with 33,000 members. All information, standards, etc., for adhesives, coatings, inks, plastics and sealants are available on the official ASTM web site, www.astm.org.

**Astrakhan cloth** \ˈas-trə-kən, -ˌkan\ *adj.* A thick knit or woven fabric with loops or curls on the face. The base yarns are usually cotton or wool and the loops are made with fibers such as mohair, wool, and certain manufactured fibers. The face simulated the pelt of the astrakhan lamb. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Asymmetric** \ˌa-sə-ˈme-tri-kəl\ [Gk *asymmetria* lack of proportion, fr. *asymmetros* ill-proportioned, fr. *a-* + *symmetrical*] (1690) *adj.* Of such a form that no point, line or plane exists about which opposite portions are congruent. The opposite of *symmetrical.* Merriam-Webster's Collegiate Dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Asymmetry** *n.* In chemistry, a molecular arrangement in which a particular carbon atom is joined to four different groups.

**Atactic** \(ˌ)ā-ˈtak-tik\ [ISV $^{2}$*a-* + *-tactic*] (1957) *adj.* Pertaining to a polymer in which the pendant side groups, as $-\mathrm{CH}_3$ in polypropylene, are randomly located around the main chain. It can also be defined as the term for polymer tacticity to indicate unsymmetrical and alternating substituent groups along a polymer chain {G ataktisch, F atactique, S atáctico, I atattico}.

**Atactic block** *n.* A block of chain units in a polymer of copolymer that has a random distribution of equal numbers of the possible configurational base units. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Atactic configuration** *See atactic.*

**Atactic polymer** *n.* A polymer with molecules in which substituent groups or atoms are arranged at random around the backbone chain of atoms. The opposite of a *stereospecific polymer* and *isotactic polymer.*

*Also see isotactic polymer, syndiotactic polymer, and tactic polymer.*

**ATE** *n.* Abbreviation for Aluminum triethyl (triethyl-aluminum), a polymerization catalyst for olefins.

**Atecticity** *n.* The degree of random location that the side chains exhibit off the backbone chain of a polymer. Rosato DV (ed) (1992) Rosato's plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York.

**Athermal transformation** *n.* A reaction that proceeds without thermal (not dependent on heat, enthalpy $\Delta H = 0$) activation as contrasted to isothermal transformation, which occurs at constant temperature. An *athermal* mixture of liquids or polymer in a solvent involves no enthalpy ($\Delta H = 0$) change in an ideal solution; and the Gibbs free energy ($-\Delta G$) is always negative for the solution (polymer dissolved in solvent) to occur while the entropy ($\Delta S$) increases. Barton AFM (1983) Handbook of solubility parameters and other cohesion parameters. CRC Press, Boca Raton.

**Atlac** *n.* Polyester resin, manufactured by Atlas, USA.

**Atmosphere (standard atmosphere)** A unit of pressure; $1\,\text{atm} = 1.013 \times 10^5$ pascals $(\text{Pa}) = 760\,\text{mmHg}$.

**Atmospheric conditions** *n.* In general, the relative humidity, barometric pressure, and temperature existing at a given time.

**Atmospheric fading** *See gas fading.*

**Atom** \ˈa-təm\ [ME, fr. L *atomus*, fr. Gk *atomos*, fr. *atomos* indivisible, fr. *a-* + *temnein* to cut] (15c) *n.* The smallest particle of an element, which can enter into a chemical *combination.* All chemical compounds are formed of atoms, the difference between compounds being attributable to the nature, number, and arrangement of their constituent atoms. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Atomic absorption** *n.* An analytic method of measuring qualitatively/ quantitatively elements that is based on absorption of specific wave-lengths of radiation.

**Atomic emission spectroscopy** *n.* Same as atomic absorption, except radiation is emitted and measured as being indicative of specific atomic spectral characteristics. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

**Atomic energy** *n.* (1) The constitutive internal energy of the atom, which was absorbed when it was formed. (2) Energy derived from the mass converted into energy in nuclear transformations.

**Atomic mass unit** (1942) *n.* (1) The mass of a neutral atom of a nuclide. It is usually expressed in terms of the physical scale of atomic masses, that is, in atomic mass units (amu). (2) A unit of mass; one atomic mass unit (amu) is defined as $\frac{1}{12}$ the mass of one $^{12}_{6}\text{C}$ atom. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Roton, FL. *See amu.*

**Atomic number** (1821) *n.* The number ($Z$) of protons within the atomic nucleus. The electrical charge of these protons determines the number and arrangement of the outer electrons of the atom and thereby the chemical and physical properties of the element.

**Atomic structure** *n.* According to the currently accepted view, the atom consists of a central part, called nucleus, and a number of *electrons* (called orbital or planetary electrons) circling about the latter, like planets about the sun.

The nucleus is of a high specific weight; it contains most of the mass of the entire atom (its mass is considered equal to the atomic mass) and is composed of positively charged particles, called *protons* (the number of which always equals the atomic number, and particles of 0 charge, called neutrons. The diameter of the nucleus is between $10^{-13}$ and $10^{-12}$cm, and the relatively vast distance in which the orbital electrons circle about it is illustrated by the fact that this nuclear diameter is only $10^{-4}$ to $10^{-5}$ of the entire atomic diameter. While the nucleus carries an integral number of positive charges (an integral number of protons) each of $1{\cdot}6 \times 10^{-19}$ C, each electron carries one negative charge of $1{\cdot}6 \times 10^{-19}$C, and the number of orbital electrons is equal to the number of protons in the nucleus (i.e., to the atomic number, *Z*), so that the atom as a whole has a net charge of 0. The electrons are arranged in successive shells around the nucleus; the maximum number of electrons in each shell is determined by natural laws, and the extra nuclear electronic structure of the atom is characteristic of the element. The electrons in the inner shells are tightly bound to the nucleus; this inner structure can be altered by high-energy particles, γ-rays or radium, or X-rays. The electrons in the outer shells are responsible for the chemical properties of the element. Russell JB (1980) General chemistry. McGraw-Hill, New York. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Atomic theory** (ca. 1847) *n.* All elementary forms of matter are composed of very small unit quantities called atoms. The atoms of a given element all have the same size and weight. The atoms of different elements have different sizes and weights. Atoms of the same or different elements unite with each other to form very small unit quantities of compound substances.

**Atomic unit** *n.* A mass equal to 1/12 the mass of an atom of carbon-12. The unit is deprecated by the SI system.

**Atomic weight** (1820) (atomic mass) *n.* The mass of an elemental isotope relative to that of the C-12 isotope of carbon, whose mass has been set at exactly 12.0000 atomic units (daltons). For most elements, the tabulated atomic weight is the average, weighted by natural mass abundance, over all the element's isotopes, so is never an integer. The actual mass-fraction of a gram-of one a u is the reciprocal of Avogadro's number. $1/(6.02283 \times 10^{23})$.

**Attapulgite** *n.* $(Mg, Al)_5Si_8O_{20}(OH)_2{\cdot}8H_2O$. A clay mineral, with the ideal formula, in which there is considerable replacement of magnesium by aluminum. Electron micrographs show single laths or needles and bundles of laths or needles oriented in random fashion, which structure is generally believed to account for the high degree of porosity and absorptivity characteristic of this mineral. The name is derived from the place name, Attapulgus, GA. *See hydrated magnesium aluminum silicate.*

**Attenuation** \ə-ˈten-yə-ˌwāt\ [L *attenuatus*, pp of *atfenuare* to make thin, fr. *ad-* + *tenuis* ] (15c) *n.* (1) The process for making slim and slender, for example, the formation of fibers from molten glass. (2) The gradual diminution of intensity or amplitude of a damped vibration with distance or time. Merriam-Webster's collegiate dictionary, 10th edn. Springfield, MA, 2000. Giambattista A, Richardson R, Richardson

RC, Richardson B (2003) College physics. McGraw Hill Science/Engineering/Math, New York.

**Atto-** \ˈa-(ˌ)tō\ [ISV, fr. D or N *atten* eighteen, fr. ON *āttjān*; akin to OE *eahtatīene* eighteen]. The SI prefix meaning × $10^{-18}$.

**Attrition mills** *n.* Machines for reducing materials into smaller particles by grinding down by friction. Equipment used in shredding pulp prior to acetylation in the manufacture of acetate and triacetate fibers, equipment used in shredding pulp prior to acetylation.

**AU** *n.* Abbreviation for polyurethane elastomers with polyester segments.
*See Angstrom unit.*

**Aufbau procedure** *n.* The procedure of starting at the lowest of a set of energy levels and gradually adding electrons to progressively higher levels; "building-up" procedure.

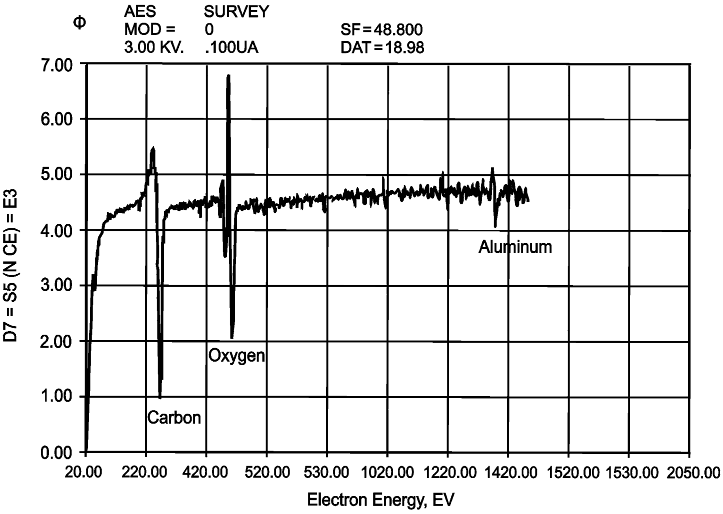
**Auger electron spectroscopy (AES)** This technique is most powerful for providing analysis of the first few atom layers (10 Å or less) on the surface of the sample (AES explores the electronic energy levels in atoms. The term Auger-process has come to denote any electron de-excitation in which de-excitation energy is transferred to a second electron, the "Auger electron." An AES spectrum of alumina is shown. Thompson M, Baker MD, Tyson JF, Christie A (1985) Auger electron spectroscopy. John Wiley and Sons Inc., New York.

**Aureobasidium Pullulans** *n.* A common ubiquitous, omnivorous, and highly polymorphic species of fungus which is often the primary organism in defacement of paint films (black yeast). *A. Pullulans* is heterocaryotic since cells of most strains contain one–eight nuclei. It is now thought that *Pullularia Pullulans* and *A. Pullulans* are one and the same organism. Kirk PM, Cannon PF (2001) Fungi, 9th edn. CABI Publishing, Wallingford.

**Aureolin** *n.* Potassium cobaltinitrite yellow pigment. Syn: Cobalt yellow.

**Austrian cinnabar** *See chrome orange.*

**Autoacceleration** *n.* In some vinyl polmerizations, as the reaction approaches completion and the viscosity of the reaction medium rises, there is a rising rate of increase of molecular weight of the chains



Auger Electron Spectroscopy Spectrum of Alumina, $Al_2O_3$.

that have not yet been terminated. This rising increase is called autoacceleration, or the *Trommsdorff effect*, or gel *effect*. In similar terms, the acceleration of a reaction, such polymerization, which continues to increase without external stimulus, i.e., gel effect and Trommsdorff effect.

**Autoadhesion** (tackiness) *n.* The ability of two continguous surfaces of the same material, when pressed together, to form a strong bond that prevents their separation at the place of contact.

**Autocatalytic degradation** *n.* A type of breakdown in which the initially generated products accelerate the rate at which later degradation proceeds.

**Autoclave** \ˈó-tō-ˌklāv\ [F, fr. *aut-* + L *clavis* key] (1876) *n.* A strong pressure vessel with a quick-opening door and means for heating and applying pressure to its contents. Autoclaves are widely used for bonding and curing reinforced-plastic laminates such as polyesters, epoxies, and phenolics. They are closed vessels for conducting a chemical reaction, sterilization or other operation under pressure and heat.

**Autoclaveable** *adj.* Capable of being sterilized in steam at two to three times standard atmospheric pressure with no change in properties.

**Autoclave molding** *See bag molding.*

**Autodissociation** (self-dissociation) *n.* The production of cations and anions by dissociation of solvent molecules without interaction with other species. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Auto-flex die** *n.* Trade name for a type of sheet-extrusion die with a flexible lip in which each lip-adjusting bolt, which can either push against the lip or pull it, is paired with a nearby cartridge heater. When a signal from the beta-ray gauge that is constantly traversing the width of the sheet indicates that the sheet is too thick or too thin at a given point, the heater voltage at the relevant bolt is raised or lowered, expanding or contracting the bolt and decreasing or increasing the lip opening at that point. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Autogenous** \ó-ˈtä-jə-nəs\ [Gk *autogenēs*, fr. *aut-* + *genēs* born, produced] (1846) *n.* A system processing independent of external influences, equivalent to autothermal extrusion. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.

**Autohesion** Term which refers to the ability of two continguous surfaces of the same material to form a strong bond which prevents their separation at the place of contact. Also known as *Self-adhesion*. Skeist I (ed) (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Autoignition temperature** *n.* The temperature at which a combustible material will ignite and burn spontaneously under specified conditions. Troitzsch J (2004) Plastics flammability handbook: principle, regulations, testing and approval. Hanser–Gardner Publications, New York. Babrauskas V (2003) Ignition handbook. Fie Science Publishers, New York. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997. Nelson G (1990) Fire and polymers: hazards identification and prevention. Oxford University Press, UK.

**Automatic control** *n.* In processing, control achieved by instruments that **Automatic mold.** A mold for compression, transfer, or injection molding that is equipped to perform all operations of the molding cycle, including ejection of the molded parts, in a completely automatic manner without human assistance.

**Automatic press** *n.* Hydraulic press for compression molding or an injection machine which operates continuously, being controlled mechanically, electrically, hydraulically, or by a combination of any of these methods.

**Automatic profile control** *n.* In film and sheet extrusion, a system for controlling the uniformity of thickness across the sheet. The main components are a traversing thickness sensor such as a beta-ray gauge, a computer and program that uses the sensor's signals to direct a mechanism that rotates the die-lip-adjusting bolts.

**Automatic unscrewing mold** *n.* A mold for making threaded products – bottle caps are typical – that incorporates a mechanism for unscrewing the product from the mold core (or vice versa) as the mold opens, thereby releasing the product. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Autoxidation or autooxidation** \ó-ˌtäk-sə-ˈdā-shən\ (1883) *n.* Oxidation by direct combination with molecular oxygen (as in air) at ordinary temperatures as described in. The reaction of diatomic oxygen ($O_2$) with π-bonds to form intermediate peroxides, etc. and permanent chemical bonds that are responsible for drying or curing of oils in alkyd resins (e.g., the drying of linseed oil). A reaction in which one substance acts simultaneously as an oxidizing agent and a reducing agent; also called *disproportionation.* The area of interest to materials scientists is the polymerization of oils, oil based resins such as vegetable oil based alkyd resins and inks. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Muizebelt WJ, Donkerbroek MWF, Nielsen JB, Hussem, Biedmond MEF (1998) Oxidative crosslinking of alkyd resins studied with mass spectroscopy and NMR using model compounds. J Coatings Tech 70 (876)83-92.

**Autoxidation inhibitors** *n.* Chemical agents, which inhibit the autoxidation (or oxidative polymerization) reactions, i.e., phenol and arylamines. Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Autoxidative polymerization** *n.* The reaction of oxygen with fatty acids, oils or other reactive materials to form higher molecular weight polymers (e.g., autoxidative polymerization of vegetable oils and emulsified vegetable oils). Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York.

**Autoxidation of polymers** *n.* The reaction of oxygen with polymers to form peroxides, etc., which can result in crosslinking and/or degradation. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Autothermal extrusion** (adiabatic or autogenous extrusion) *n.* In screw extruders, a steady state of operation in which the increase in enthalpy of the plastic from feed throat to die entry is equal to the net energy furnished by the drive to the screw. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Auxochrome** *See chromophore.*

**Average degree of polymerization** *n.* $\overline{DP}$ Average degree of polymerization is equal to or twice for a chain growth polymerization, disproportionation or combination. Coleman MM, Strauss S (1998) Fundamentals of polymer science: an introductory text. CRC Press, Boca Raton, FL.

**Average molecular weight (viscosity method)** *n.* The molecular weight of polymeric materials determined by the viscosity of the polymer in solution at a specific temperature. This gives an average molecular weight of the molecular chains in the polymer independent of specific chain length. Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York. Billmeyer FW Jr (1984) Textbook of polymer science, 3rd edn. Wiley-Interscience, New York.Staudinger H, Heuer WA (1930) Relationship between the viscosity and the molecular weight of polystyrene (German). Ber 63B:222-234.

*See number-average, viscosity-average, and weight-average molecular weight.*

**Average stiffness** The ratio of change in stress to change in strain between two points on a stress–strain diagram, particularly the points of zero stress and breaking stress. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

*Also see modulus.*

**Average toughness** *See toughness.*

**Avogadro's law** \ˌa-və-ˈgä-(ˌ)drō, ˌä-\ (1811) *np.* Equal volumes of different gases at the same pressure and temperature contain the same number of molecules.

**Avogadro's number** \ˌa-və-ˈgä-(ˌ)drōz-\ [Count Amedeo *Avogadro*] (1924) *np.* The number of atoms in exactly 12 g of $^{12}_{6}$C; $6.02 \times 10^{23}$. The number of units in 1 mol of units. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Avogadro's principle** (or theory) *np.* The numbers of molecules present in equal volumes of gases at the same temperature and pressure are equal.

**Avrami equation** \ˈäv-rä-mē\ [M. Avrami, European, published 1939–1941] *n.* The time dependence of the overall crystallization of a polymer is described by the Avrami equation, where specific volume is related to crystalline and amorphous regions within the same polymer, then

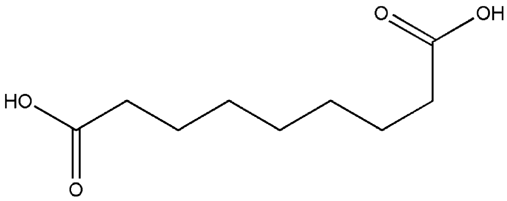
$$(v_t - v_\mathrm{f})/(v_\mathrm{o} - v_\mathrm{f}) = \exp(-Kt^n),$$

where $v_\mathrm{o}$ and $v_\mathrm{f}$ are initial and limiting values of the specific volume, and $v_\mathrm{t}$ is the specific volume of at a time *t*, and *K* is a kinetic constant. This equation describes the rate of polymer crystallization at a temperature. The crystallinity is expressed as the volume fraction ($\phi$) of the crystalline material. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Avrami M Kinetics of phase change I: general theory. J Chem Phys 7:1103; Kinetics of phase change II: transformation-time relations for random distribution of nuclei. 8:212; Kinetics of phase change III: granulation, phase change and microstructures. 9:177. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York.

**Axial yarn** *n.* A system of axis, crystallographic. One of several imaginary lines assumed in describing the positions of the planes by which a crystal is bounded, the positions of the atoms in the structure of the crystal and the directions associated with vectorial and tensorial physical properties. Longitudinal yarns in a triaxial braid that are inserted between bias yarns. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Axminster carpet** *n.* A machine-woven carpet in which successive weft-wise rows of pile are inserted during weaving according to a predetermined arrangement of colors. There are four main types of Axminster looms: Spool, Gripper, Gripper-Spool, and Chenille. Complete Textile Glossary. Celanese Corporation, Three Park Avenue, New York, NY.

**Azelaic acid** (nonanedioic acid, 1,7-heptanedicarboxylic acid) *n.* $HOOC(CH_2)_7COOH$. A yellowish-white crystalline powder, derived from a fatty acid such as oleic acid by oxidation with ozone. It is an intermediate used in the production of plasticizers, polyamides and alkyd resins. Acid value, 595.5; mol wt, 188.2; mp, 106°C; bp, 237°C/15 mmHg. For plasticizers derived from azelaic acid. Merck Index (2001) 13th edn. Merck and Company Inc., Whitehouse Station, NJ.



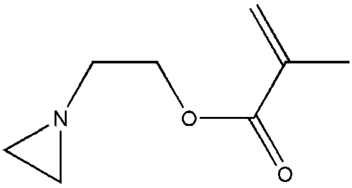
*See dicyclohexyl-, di(2-ethylbutyl)-, di(2-ethylhexyl)-, di(2-ethylhexyl)-4-thio-, di-n-hexyl-, diisobutyl-, and diisooctyl azelates.*

**Azeotrope** \ˈā-zē-ə-ˌtrōp\ [*a-* + *zeo-* (fr. Gk *zein* to boil) + *-trope*] (1938) *n.* A liquid mixture that is characterized by a constant minimum or maximum boiling point which is lower or higher than any of the components, and that distills without change in composition. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Azeotropic copolymer** *n.* A copolymer in which the relative numbers of the different mer units are the same as in the mixture of monomers from which the copolymer was obtained. During a copolymerization reaction, the copolymer has the same composition as the monomer feed mixture, and a polymeric product of constant composition is formed throughout the copolymerization reaction. Kricheldorf HR, Swift G, Nuyken O, Huang SJ (2004) Handbook of polymer synthesis. CRC Press, Boca Raton, FL. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Azimuthal quantum number** l \ˌa-zə-ˈmə-thəl-\ *n.* A quantum number hich specifies a subshell for an electron in an atom.

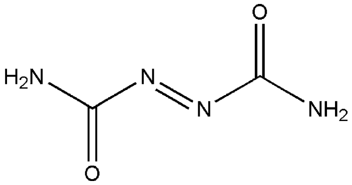
**2(1-Aziridinyl)ethyl methacrylate** *n.* A vinyl monomer that combines a reactive vinyl group with an aziridinyl functional group. It can be polymerized alone or with other vinyl monomers to yield polymers with pendant aziridinyl groups that promote adhesion of coatings to the polymer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.



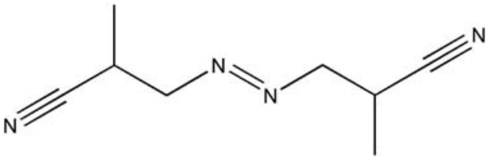
**Azlon fiber** *n.* A manufactured fiber in which the fiber-forming substance consists of any regenerated naturally occurring proteins

(FTC definition). Azlon is not currently produced in the United States.

**Azobisformamide** (ABFA, azodicarbonamide) *n.* $H_2NCON{=}NCONH_2$. An aliphatic azo compound widely used as a chemical blowing agent in PVC, polystyrene, polyolefins, many other plastics, and in natural and synthetic rubbers. It is nontoxic, odorless, nonstaining, and, unlike other organic blowing agents, it is self-extinguishing and does not support combustion. Since ABFA in the pure state decomposes at temperatures above 216°C, when used with heat-sensitive plastics such as PVC, an activator that lowers its decomposition temperature is added to the compound. Such activators are compounds of cadmium, zinc, and lead, which also act as heat stabilizers, either directly or synergistically with other stabilizers. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley *(See image).*



**Azobis(isobutyronitrile)** *n.* A blowing agent developed in Germany for use in rubber and PVC. It is non-staining and yields white PVC foam of fine uniform cell structure. However, its decomposition product, tetramethyl succinonitrile, is toxic and must be eliminated from the expanded product. For this reason the material is not used commercially in the USA as a blowing agent. It is used as a polymerization initiator. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.



**Azo-compound initiators** *n.* Azo compounds (R–N=N–R) which decompose to form free radicals ($R+N_2+R$), which are capable of initiating polymerization.

**Azodicarbonamide** *See azobisformamide.*

**Azo dye** *n.* Any of an important family of dyes containing the –N=N– group, produced from amino compounds by the processes of diazotization and coupling. By varying the composition it is possible to produce acidic, basic, triazo, and tetrazo types, depending on the number of −N=N− groups in the molecule. Herbst W, Hunger K (2004) Industrial organic pigments. John Wiley and Sons Inc., New York.

**Azo group** *n.* The structural grouping, −N=N−.

**Azo pigment** n. *See benzidine yellows.*

**Azure blue** n. *See cobalt blue.*

**Azurite** \ˈa-zhə-ˌrīt\ [F, fr. azur] (ca. 1868) *n.* Natural blue pigment derived from the mineral, azurite, a basic copper carbonate. The mineral occurs in various parts of the world in secondary copper ore deposits where it is frequently associated with malachite, a green basic carbonate of copper. Perkins D (2001) Mineralogy. Prentice-Hall, New York. Kirk–Othmer (1996) Encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York. Lewis PA (ed) (1985–1990) Pigment handbook, 2nd edn, vols 1–4. Wiley-Interscience, New York.

*Also known as mountain blue.*

# B

**b** \ˈbē\ *n.* SI abbreviation for barn.

**"b" or "*β*"** *n.* Yellowness–blueness coordinate in color spaces, $\Delta b$, the difference in "b", between a specimen and a standard reference color, normally used with "a" or "α" as part of the chromaticity difference. If "b" is plus, there is more yellowness than blueness; if "b" is minus, there is more blueness than yellowness. The exception is Adams chromatic value. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See also uniform chromaticity scale diagram and color difference equations.*

**"b", Kubelka–Munk** *n.* Mathematical constant characteristic of a color at complete opacity; dependent on the optical constants $K$ and $S$. $b = [2(K/S) + (K/S)^2]^{1/2}$. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See "a", Kubelka–Munk equation.*

**B** (1) Chemical symbol for the element boron. (2) Symbol for magnetic induction.

**Ba** *n.* Chemical symbol for the element barium.

**Babo's law** The addition of a non-volatile solid to a liquid in which it is soluble lowers the vapor pressure of the solvent in proportion to the amount of substance dissolved. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Back coating** *n.* The application of latex or adhesive to the back of a carpet to anchor the tufts, usually followed immediately by addition of a secondary backing material such as woven jute or non-woven polypropylene. Complete textile glossary. Celanese Acetate LLC, New York, 2000.

**Back draft** (back taper, counterdraft) *n.* A slight undercut or tapered area in a mold tending to prevent removal of the molded part. Complete textile glossary. Celanese acetate LLC, New York, 2000.

*See also undercut.*

**Backed cloth** *n.* A material with an extra warp or filling added for weight and warmth. Satin-weave and twill-weave constructions are frequently used in the design of backed cloth because they are relatively resistant to the passage of air. Complete textile glossary. Celanese acetate LLC, New York, 2000.

**Back filling** *n.* A solution composed of varying amounts of cornstarch, China clay, talc, and tallow that is applied to the back side of low-grade, low-cost cloth to change its hand, improve its appearance, and increase its weight. Complete textile glossary. Celanese acetate LLC, New York, 2000.

**Back focal plane** *n.* A "plane" normal to the axis of a lens in which all back focal points lie. Moller KD (2003) Optics. Springer-Verlag, New York. Freir GD (1965) University physics. Appleton-Century-Crofts, New York.

**Backing** *n.* (1) A general term for any system of yarn, which interlaces on the back of a textile material. (2) A knit or woven fabric or plastic foam bonded to a face fabric. (3) A knot or woven fabric bonded to a vinyl or other plastic sheet material. (4) *See carpet backing.* Kadolph SJJ, Langford AL (2000) Textiles. Pearson Education, New York. Complete textile glossary. Celanese Acetate LLC, New York, 2000.

**Backing away from fountain** *n.* A condition in which an ink lacking in flow will not keep in contact with the fountain roller so that the latter can transfer ink to the ductor roller. Eventually the prints become uneven, streaky, and weak. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Backing coat** *n.* In coil coating, the finish on the back side of continuous strip. Tracton AA (2005) Coatings technology handbook. Taylor and Francis Inc., New York.

**Backing plate** *n.* In injection molding, a plate used as a support for the cavity blocks, guide pins, bushing, etc. Sometimes called support plate.

**Back paint** *See back priming.*

**Back pressure** *n.* In extrusion, the head pressure. In screw-injection molding, the head pressure just before the valve opens to make the shot.

**Back-pressure relief port** *n.* A side channel in the head of an extruder, usually leading to a rupture disk through which the melt can escape if the pressure exceeds a safe limit.

**Back priming** *n.* The process of applying a coating to the back surface of construction materials prior to installation, usually for protection against the weather.

**Back putty** *See bed putty.*

**Back sizing** *See filler.*

**Backstitch** (1611) *n. See purl.*

**Back taper** *See back draft.*

**Back warp** *n.* The warp which, along with the back filling, actually forms the second face (back) of double, triple, or quadruple fabrics.

**Back winding** *n.* (1) Rewinding yarn or fiber from one type of package to another. (2) Winding yarn as it is deknit.

**Bacteria** \bak-ˈtir-ē-ə\ [plural of *bacterium*] (1884) *n.* Any of the numerous microscopic, spherical, rod-shaped, or spiral organisms of the class, *Schizomycetes.* Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

**Bacterial corrosion** *n.* A corrosion, which results from substances (e.g., ammonia or sulfuric acid) produced by the activity of certain bacteria. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX.

**Bactericidal** \bak-ˌtir-ə-ˈsī-dᵊl\ (1878) *adj.* Capable of causing the death of bacteria. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

**Bactericidal fiber** *n.* Fiber used for medical applications, socks, shoe liners, etc., in which bactericides are introduced directly into the fiber matrix as opposed to fiber simply having a bactericidal finish applied.

**Bactericidal paint** *n.* Coating, which discourages the multiplication of bacteria.

**Bactericide** (1878) *n.* An agent capable of destroying bacteria. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

*See also biocide.*

**Bacteriostat** \-ˈtir-ē-ō-ˌstat\ (1920) *n.* An agent that, when incorporated in a plastics compound, will prevent the growth of bacteria on surfaces of articles made from the compound. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

**Bacteriostatic** (1920) *n.* Inhibiting the growth of bacteria, but not bactericidal.

**Bacteriostats** (1920) *n.* Chemicals which inhibit the growth of bacteria cells, i.e., bacteriocidal chemicals.

**Baddeleyite** *See zirconium oxide.*

**Baekeland, Dr.** (1907) *n.* Inventor of the oldest family of phenolformaldehyde polymers. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Baffle** \ˈba-fəl\ [prob. alter. of ME (Sc) *bawchillen* to denounce, discredit publicly] (ca. 1590) *vt.* A plug or other device inserted in a flow channel to restrict the flow or change its direction. A metal piece so placed in a rollercoater pan to direct the stream or flow of paint to the pick-up roller. Also used to direct air currents in an oven. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Bagasse** \be-ˈgas\ [Fr] (ca. 1826) (megass) *n.* A tough fiber derived from sugar cane, remaining after the sugar juice has been extracted. It is used as reinforcement in some laminates and molding powders. Vincenti, R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Bagging** \ˈba-giŋ\ (1732) *n.* (1) A fabric woven in cylindrical or tubular form on an ordinary cam loom and used for grain bags, etc. (2) Fabric bulging caused by extension at the knees, elbows, etc., of a garment lacking dimensional stability.

**Baggy cloth** *n.* A fabric that does not lie flat, caused by sections of tight or loose yarns in either the warp or the filling.

**Baggy selvage** *See slack selvage.*

**Bagillumbang oil** *n.* Drying oil obtained from the species *Aleurites trisperma*, which grows in the Philippines.

**Bag molding** *n.* A method of forming and curing reinforced plastic laminates employing a flexible bag or mattress to apply pressure uniformly over one surface of the laminate. A perform comprising a fibrous sheet impregnated with an A- or B-state resin is placed over or in a rigid mold forming one surface of the article. The bag is applied to the upper surface, then pressure is applied by vacuum, in an autoclave, in a press, or by inflating the bag. Heat may be applied by steam in the autoclave, or through the rigid half of the mod. When an autoclave is used, the process is sometimes called autoclave molding.

**Bail** \ˈbā(ə)l\ [ME *beil*, *baile*, prob. of Scand origin; akin to Swedish *bygel* bow, hoop; akin to OE *būgan* to bend] (15c) *n.* Semicircular handle of a kettle, pail, or can.

**Bailing machine** *n.* Mechanical device designed to automatically attach bails to containers.

**Bake hardness** Increased hardness on heating due to elimination of retained solvent in thermoplastic coatings and thermal cross-linking in thermosetting coatings.

**Bakelite** \ˈbā-kə-ˌlīt, -ˌklīt\ n. (1) A trade name derived from the name of Leo H. Baekeland, a pioneering Belgian chemist who developed phenolic resins in the early 1900s. They are the oldest family of phenolformaldehyde polymers. The trade name was long used by the Bakelite Corporation, later absorbed by Union Carbide, who still uses the name for some of its resins. (2) Phenol-formaldehyde resins, manufactured by Bakelite Inc., USA.

**Bake system** *n.* Set of prime, intermediate, and/or top coats which require baking to effect a cured or dried film, and which together have been determined to yield the desired properties for a particular purpose.

**Baking** *n.* Process of drying or curing a coating by the application of heat in excess of 65°C (150°F). When below this temperature, the process is referred to as Forced Drying. Syn: stoving.

**Baking finish** *n.* Paint or varnish that requires baking at temperatures above 65°C (150°F), for the development of desired properties.

**Baking schedule** *n.* Set of related baking temperatures and baking times, which will yield a cured or dried film from a coating materials such as a powder coating for maximum performance. The baking schedule is specific for each material because powder coatings are made from different materials and require different periods of flow time (fusion) and compete cure time (reaction) or program of time comprising temperature held at specific periods of time and minimum and maximum temperatures. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Baking temperature** *n.* Temperature above 65°C (150°F) at a specified time in a baking schedule, which has been determined to produce a cured or dried film having optimum desired properties for the coating.

**Baking time** *n.* Time at a specified temperature, above 65°C (150°F), in a baking schedule, which has been determined to produce a cured or dried film having optimum desired properties for the coating.

**Baking vehicle (varnish)** *n.* Vehicle specifically formulated for coatings, which are intended to be baked in order to affect a cured or dried film.

**Balanced cloth** *n.* A term describing a woven fabric with the same size yarn and the same number of threads per inch in both the warp and the filling direction.

**Balanced design** *n.* In reinforced plastics, a winding pattern so designed that the stresses in all filaments are equal. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Balanced gating** *n.* In multicavity injection molds, the objective is to fill all of the cavities simultaneously, to fill to the same final pressure, and then to have their gates freeze at the same time. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Balanced laminate** *n.* A composite structure in which fiber layers laid at angles to the main axis occur in pairs, at equal ± angles, that may or may not be adjacent. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Balanced reaction** *n.* A reaction in which a state of equilibrium has been reached, and it can be made to proceed in one direction or another by adjusting the conditions. Conditions, which affect the direction of a reaction, are the concentrations of the reactants involved and the temperature and the pressure. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Balanced runners** *n.* In a multicavity injection mold, the runners are balanced when the injected melt reaches all the cavity gates at the same instant after the start of injection. In practice, with identical cavities whose shape, size, number, and layout permit, all runner branches are given equal cross sections and corresponding branch lengths are made equal. Uniform metal temperature throughout is assumed.

**Balanced solvents** *n.* Combination of solvents designed to give a specified performance. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

**Balanced twists** *n.* In a plied yarn or cord, an arrangement of twist, which will not cause the yarn or cord to twist on itself of kink when held in an open loop.

**Balata** \bə-ˈlä-tə\ [Sp, fr. Carib] (1860) *n.* (1) Dried juice of a West Indian tree (*Mimusops globosa*). It has rubbery characteristics and is sometimes used as a substitute of gutta-percha. It resembles both this and ordinary rubber in that it consists of isoprene molecules ($C_5H_8$), but polymerized in its own particular way. Impure form of trans-polyisoprene. (2) *Trans*-1,4-poly(isoprene). Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

**Balata, natural** *n.* A material identical in properties and composition to Gutta–Percha, obtained from trees in South America.

**Balata, synthetic** *n.* A stereospecific rubber, the trans isomer of polyisoprene, made by catalyzed addition polymerization of isoprene.

**Bald spot** Area or patch, usually in a wrinkle finish film, which has failed to wrinkle or give the desired optical effect.

**Bale** [ME, fr. MF, of Gr origin; akin to OHGr *balla* ball] (14c) *n.* Quantity of compressible articles or materials assembled into a shaped unit and bound with cord or metal ties.

**Bale-and-ring test** (ring-and-ball test) *n.* A method of determining the softening temperature of resins (*See www.astm.org*). A specimen is cast or molded in a metal ring of 16-mm inside diameter and 6.4-mm depth. This ring is placed upon a metal plate in a liquid bath heating at a controlled range, and a steel ball 9.5 mm in diameter weighting 3.5 g is placed in the center of the specimen. The softening point is considered to be the temperature of the liquid when the ball penetrates the specimen and touches the lower plate.

**Baling machine** *n.* Device used to form and fasten compressible materials into a shaped unit (bale).

**Ball** \ˈból\ [ME *bal*; akin to OE *bealluc* testis, OHGr *balla* ball, OE *bl* āwan to blow] (13c). When rubbing down paint, varnish films, or the like, with abrasive paper, the material removed by the abrasive action may be either in the form of a dry powder, or, if it has a tendency to softness or stickiness, will collect as relatively large lumps or balls. A film, which exhibits this latter phenomenon is said to ball. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Ball and pebble mills** *n.* A rotating mill for reducing size of materials (e.g., pigments and fillers) or pulverize them using hard metal or ceramic balls. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Ball and ring method** *n.* System of testing the melting and softening temperatures of asphalt, waxes, resins, and paraffin. A ring 15.875 mm in diameter is filled with the substance to be tested, and a steel ball 9.5 mm in diameter is placed upon the substance in the ring. The end point is the temperature at which the substance softens sufficiently to allow the ball to fall through the ring to the bottom of the beaker. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, West Conshohocken, PA, 2001. Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York.

*See also softening point.*

**Ball charge** *n.* Volume of porcelain or steel balls loaded in a ball mill. It is generally one-third the total volume of the ball mill.

**Ball mill** (pebble mill) *n.* A cylindrical or conical shell rotating horizontally about its axis, partly filled with a grinding medium such as natural flint pebbles, ceramic pellets, or hard metal balls. The material to be ground is added to just fill, or slightly more than fill, the voids between the balls.

Water may or may not be added. The shell is rotated at a speed that causes the balls to cascade, thus reducing the particle sizes by repeated impacts. The operation may be batchwise or continuous. In the plastics industry, the term ball mill is reserved by some persons for mills containing metallic grinding media, and the term pebble mill for non-metallic media. For paint, steel balls are frequently used. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York. Weismantal GF (1981) Paint handbook. McGraw-Hill Corp. Inc., New York.

**Ball milling** *n.* A method of grinding and mixing material, with or without liquid, in a rotating cylinder or conical mill partially filled with grinding media such as balls or pebbles. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Balloon** \bə-ˈlün\. The curved paths of running yarns about the take-up package during spinning, down-twisting, plying, or winding, or while they are being withdrawn over-end from packages under appropriate yarn-winding conditions. Humphries M (2000) Fabric glossary. Prentice-Hall, Upper-Saddle River, NJ. Vincenti R (1994) Elsevier's textile dictionary. Elsevier science and technology books, New York.

**Balloon fabric** *n.* A plain-weave cloth having the same breaking strength in each direction. This fabric is made from fine (60–100s) combed yarn woven to constructions of 92 × 108–116 × 128. Vulcanized balloon fabric is used for air cells in planes and barrage balloons. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Ballotini** *n.* Glass beads used in reflective paints. *See beaded* paint and traffic paint. Paint/coatings dictionary. Compiled by definitions Committee of the Federation of Societies for Coatings Technology, 1978.

**Ball punch impact test** *n.* Measure of the resistance of a coating to impact or shock. A ball punch is used for this test. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Ball rebound test** *n.* A method for measuring the resilience of polymeric materials by dropping a steel ball on a specimen from a fixed height and observing the height of rebound. The difference between the two heights is proportional to the energy absorbed. By conducting tests over a range of temperature, results can indicate temperature of first- and second-order transitions, and effects of additives and plasticizers. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. Harper CA (ed) (2002) Handbook of plastics. Elastomers and composites, 4th edn. McGraw-Hill, New York.

*See relevant test methods from American Society for Testing and Materials, www.astm.org, West Conshohocken, PA.*

**Ball-up** *n.* A term used in adhesive circles to describe the tendency of an adhesive to stick to itself.

**Ball viscometer** *See falling-ball viscometer.*

**Ball wrap** *n.* Parallel threads in the form of a twistless rope wound into a large ball. When wound mechanically with quick traverse a ball warp may be made in the form of a large cylindrical package.

**Balmer series** (of spectral lines) *n.* The wavelengths of a series of lines in the spectrum of hydrogen are given in angstroms by the equation

$$\lambda = 3646\frac{N^2}{N^2 - 4},$$

where $N$ is an integer having values greater than 2. Weast RC (ed) (1971) Handbook of chemistry and physics, 59th edn, 1978–1979. The Chemical Rubber Co., Boca Raton, FL.

**Balsa** \ˈból-sə\ [Sp] (ca 1600) *n.* Wood from the tree *Ochroma lagopus*, Ecuador. Its density is only 0.12–0.2 g/cm$^3$, yet it has good strength, especially end-grain compressive strength, so it has found application as an interlayer in reinforced-plastics. Sandwich structures. Hoadley RB (2000) Understanding wood. The Taunton Press, Newtown, CT.

**Balsam** \ˈból-səm\ [L *balsamum*, fr. Gk *balsamon*, prob. of Semitic origin; akin to Hebrew *bāshām* balsam] (before 12c) *n.* Oleoresinous exudations from plants, which are characterized by softness or a semi liquid consistency. They consist of mixtures of resin, essential oils, and other compounds. Typical balsams are Canada, gurjun, Peru, tolu, and storax balsams. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

*See oleoresin.*

**Baluster** \ˈba-lə-stər\ [Fr *balustre*, fr. It *balaustro*, fr. *balaustra* wild pomegranatye flower, fr. L *balaustium*, fr. Gk *balaustion;* fr. its shape] (1602) *n.* (1) One of a number of short vertical members, often circular in section, used to support a stair handrail or a coping. (2) A post in a balustrade.

*Also called banister.*

**Balustrade** \ˈba-lə-strār\ [Fr, fr. It *balaustrata*, fr. *balaustro*] (1644) *n.* An entire railing system (as along the edge of a balcony) including a top rail and its balusters, and sometimes a bottom rail.

**Banana liquid** A solution of nitrocellulose in amyl acetate or similar solvent.

**Banana oil** *See amyl acetate.*

**Banbury** *n.* Compounding apparatus composed of a pair of contra rotating blades, which masticate the materials to form a homogeneous blend. An internal type heavy duty mixer.

*See internal mixer.*

**Banbury mixer** *n.* An intensive mixer originally used for rubber, and for many years used for mixing plastics such as cellulosics, vinyls, polyethylene, and others. It consists of two counter rotating, spiral-shaped blades encased in segments of cylindrical housing, the housing halves joined along internal ridges between the blades. Blades and housing may be cored for circulating heating or cooling liquids. A recent adaptation of the design, with connections to feed and discharge screws, permits continuous operation. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York, 1986-, 1990-, 1992-, 1993-edition.

**Band heater** *See heater band.*

**Banding, heavy tow** *n.* Non-uniform distribution of filaments across lowband width.

**Bandle** *n.* A coarse homespun linen made on narrow hand looms in Ireland.

**Band spectrum** *n.* Lines produced by molecular vibrations, which are so close together that they appear to be continuous.

**Band wire** *n.* A wire attached between dispensing and collecting vessels in order to equalize the electrical potential between them to dissipate electrostatic charge.

**Banister** \ˈba-nəs-tər\ [alter. of *bahuster*] (1667) *n. See baluster.*

**Bank** (1) In calendering and roll-milling, a cylindrical accumulation of working material in the nip of the rolls at the feed point. (2) Another name for a yarn creel.

**Bank, rubber mill** *n.* A relatively small amount of unvulcanized rubber compound rolling in the space between two mill rolls, while the major portion of the compound is bonded around the first roll. A pencil bank is a small, smooth rolling amount of compound between a calender roll and fabric surface being surface or friction coated. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Bar** [Gr fr. Gk *baros*] (1910) *n.* A deprecated unit of pressure, long used in meteorological work as approximately one atmosphere, and actually equal to 0.987 standard atmosphere, i.e., 100 kPa.

**Barathea** \ˌbar-ə-ˈthē-ə\ [fr. *Barathea*] (1862) *n.* (1) A silk, rayon, or manufactured fiber necktie fabric with a broken rib weave and a characteristic pebbly appearance. (2) A fine, dress fabric with a silk warp and worsted filling, woven in a broken filling rib, which completely covers the warp. (3) A smooth-faced worsted uniform cloth with an indistinct twilled basket weave of fine two-ply yarns.

**Barbender plastograph** (PlastiCorder®) *n.* An instrument that continuously measures the torque exerted in shearing a polymer or compound specimen over a wider range of shear rates and temperatures, including those conditions anticipated in actual processing. The instrument records torque, time and temperature with a computer generated graphical representation referred to as a *plastigram*, from which one can infer processability. It shows the effect of additives and fillers, measures and records lubricity, plasticity, scorch, cure, shear and heat stability, and polymer consistency. The modern instrument is equipped with interchangeable heads for bench-scale studies of mixing and extrusion, and with computer control and data acquisition. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Barcol hardness** *n.* The resistance of a material to penetration by a sharp steel point under a known load with an instrument called the Barcol Impressor. Direct readings are obtained on a scale from 0 to 100. The instrument has often been used as a way of judging the degree of cure of thermosetting resins and harder materials. The ASTM test, www.astm.org, is referred to as "Indentation Hardness of Rigid Plastics".
*See indentation hardness.*

**Barefoot resin** *See neat resin.*

**Bare glass** *n.* Glass (yarns, rovings, and fabrics) from which the sizing or finish has been removed: also, such glass before the application of sizing or finish.

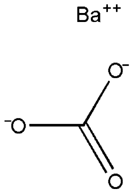
**Barex** Copolymer from acrylonitrile and methyl methacrylate (3:1). Manufactured by Vistron, USA.

**Bargeboard** \ˈbärj-ˌbōrd, -ˌbórd\ (1833) *n.* An often ornamented and sloping board along a gable, covering the ends of roof timbers. Syn: vergeboard and gableboard. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

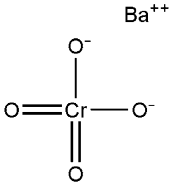
**Barite** \ˈbar-ˌīt, ˌber-\ [Gr *barytēs* weight, fr. *barys*] (1868) *n. See barium sulfate.*

**Barium** \ˈbar-ē-əm, ˈber-\ [NL, fr. *bar*-] (1808) *n.* A silver-white malleable toxic bivalent metallic element of the alkaline-earth group that occurs only in combination. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Barium carbonate** *n.* $BaCO_3$. A white compound, insoluble in water, occurring as a mineral or made by direct precipitation. It has a Sp gr of 4.275 and a mp of 1360°C. It is used in ceramics, fillers, and extenders. Syn: witherite (*See image*). Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.



**Barium chromate** *See barium yellow.* Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.



**Barium chrome** *See barium yellow.*

**Barium-extended titanium dioxide** *n.* Analogous to calcium-extended titanium dioxide, prepared by coprecipitating the $BaSO_4$ with $TiO_2$ or alternately made by a physical blending. In either case, the product contains 30% $TiO_2$ and 75% $BaSO_4$. It is no longer commercially available. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.

**Barium ferrite** *See ferrite.*

**Barium fillers** *n.* Barium sulfate or other compound of barium, which serves as a filler for plastics compounding. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.

**Barium hydroxide monohydrate** (barium monohydrate) $Ba(OH)_2–H_2O)$ *n.* A white powder used in the production of phenol-formaldehyde resins and barium soaps.

**Barium lithol red** *See lithol red.*

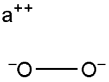
**Barium lithol toner** *n.* Barium salt of 2-amino-1-naphthalene sulfonic acid coupled to 2-naphthol.

**Barium metaborate modified** *n.* $BaB_2O_4 \cdot H_2O$. White crystalline pigment prepared by precipitation from aqueous solution; Sp gr of 3.3, density of 27.5 lb/gal refractive index of 1.55–1.60, O.A. of 30 lb/100 lb, and pH of 9.8–10.3. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.

**Barium naphthenate** *n.* Metallic naphthenate used as a wetting agent for certain pigments, a hardener for some alkyds, and a thickener for oils.

**Barium oleate** *n.* Barium salt of oleic acid. Used for the prevention of chalking, the maintenance of color of titanium paints, and the dispersion of pigments in media during grinding.

**Barium peroxide** *n.* $BaO_2$ or $BaO_2 \cdot 8H_2O$. An oxidizing catalyst used in some polymerization reactions (*See image*).



**Barium plaster** *n.* A special mill-mixed gypsum plaster containing barium salts; used to plaster walls of X-ray rooms.

**Barium ricinoleate** *n.* $Ba(OOCC_7H_4CH{=}CHCH_2CHOHC_5H_{10}CH_3)_2$. A heat stabilizer imparting good clarity, used most often in vinyl plastisols and organosols.

**Barium stearate** *n.* $Ba(C_{18}H_{35}O_2)_2$. White crystalline solid; insoluble in water or alcohol; mp of 160°C, and Sp gr of 1.145. Used as a light and heat stabilizer in plastics. As a heat stabilizer, it is used particularly when sulfur staining is to be avoided. Also used as a lubricant where high temperatures are to be encountered.

**Barium sulfate** (1903) *n.* (1) $BaSO_4$. Natural pigment white 22 (77120). Mineral consisting essentially of barium sulfate. It may contain, in addition, small amounts of sulfates of calcium and strontium, common chalk, calcium fluoride, silica, and iron oxide. Used in paints as a filler or extender. Density, 4.5 g/cm$^3$ (37.5 lb/gal); O.A., 9; particle size 2–30 µm. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.

**Barium sulfates** (barites, blanc fixe, heavy spar, permanent white, and terra ponderosa) $BaSO_4$. *n.* A white powder obtained from the mineral barite or synthesized chemically. One of the synthetic varieties, *blanc fixe*, is made by mixing aqueous solutions containing sulfate and barium ions. As a filler in plastics and rubbers, barium sulfate imparts opacity to X-rays but only a low order of optical opacity. Thus, it is useful as a filler when it is desired to increase specific gravity without adversely affecting the tinctorial power of pigments. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.

**Barium white** *n. See barium sulfate, synthetic and natural.*

**Barium yellow** *n.* Pigment known also as barium chromate, barium chrome, or lemon yellow. It is essentially barium chromate made by adding a solution of sodium dichromate to barium chloride solution. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York.

**Barking** *n.* The removal of bark from wood prior to pulping.

**Bar mold** A mold in which the cavities are arranged in rows on separate bars that may be individually removed to facilitate stripping.

**Barn (b)** *n.* A miniscule area unit commensurate with the cross sections of atomic nuclei. One barn = $10^{-28}$ m$^2$. Nuclear cross sections range from about 0.01 to 1.5 b.

**Barnacle** \ˈbär-ni-kəl\ [ME *barnakille*, alter. of *bernake*, *bernekke*] (15c) *n.* Any of certain crustaceans of the group *cirripedia*, as the goose barnacles, the stalked species which cling to ship bottoms and floating timber, and the rock barnacles, the species which attach themselves to marine rocks.

**Barre** \ˈbär\ [Fr, fr. ML *barra*] (1936) *n.* A defect characterized by bars or streaks, fillingwise in woven fabrics or coursewise in weft-knit fabrics, caused by uneven tension in knitting, defective yarn, improper needle action, or other similar factors.

**Barrel** [ME *barel*, fr. MF *baril*] (14c) *n.* (1) The tubular main cylinder of an extruder, within which the screw rotates. (2) A container, agitated by rotation or vibration, used for tumbling moldings to remove flash and sharp edges. Also used for mixing of dry solids, e.g., pigments with resin pellets. (3) Standard unit of liquid volume in the petroleum industry. It is equal to 42 USA gallons, approximately 35 Imperial gallons; approximately 160 l.

**Barrel finishing** *See tumbling.*

**Barrelling** *See tumbling.*

**Barrel mixing** *See tumbling.*

**Barrel polish** *See tumbling.*

**Barrier coat** *n.* Coating used to isolate a paint system from the surface to which it is applied in order to prevent chemical or physical interaction between them, e.g., to prevent the paint solvent attacking the underlying paint or to prevent bleeding from underlying paint or material. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

*See tie coat and primer.*

**Barrier layer** *n.* In multiplayer films, coextruded sheet, and blow-molded containers, a layer of polymer having very low permeability to the gases and/or vapors of interest for the application of the film, sheet, or container.

**Barrier plastics** *n.* Thermoplastics with low permeability to gases and/or vapors. Most important commercially are nitrile barrier resins. Several others, however, are based on various copolymers, some of which are more permeable than nitrile resins but are easier to process. A major application is bottles for carbonated beverages.

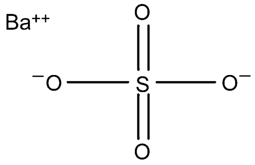
**Barrier screw** *See solids-draining screw.*

**Barrier sheet** *n.* An inner layer of a laminate, placed between the core and an outer layer.

**Bar stock** *n.* Standard lengths of plastics extrusion having simple cross-sectional shapes such as circular (rod stock), square, hexagonal, and rectangular of low aspect ratio, used in fabricating plastics parts by machining, welding, fastening, and adhesive bonding.

**Barye** *n.* cgs pressure unit = 1 dyne/cm$^2$.

**Barytes** \ˈbar-ˌīt, ˈber-\ *See also blanc fixe.* Natural barium sulphate used as an ink pigment and a white extender. It is considerably more abrasive and gritty than precipitated barium sulphate (*See image*).



**Base** *n.* (1) The opposite of acid. Any molecule or ionic substance that can combine with a proton to produce a different substance (salts, soaps). (2) Reinforcing material (glass fiber, paper, cotton, asbestos, etc.) which is impregnated with resin in the forming of laminates and is used as an insulating support for an electrical printed pattern. (3) Metallic salt upon which coloring matter is precipitated to form the insoluble pigments called lakes. (4) A paste or liquid, which is to be thinned or tined. (5) In ink manufacture, a dispersion containing usually only one coloring matter, pigment or dye, properly dispersed in a vehicle. This is subsequently used for mixing to produce the desired end product. (6) *See baseboard.* (7) *See substrate and ground.* Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Baseboard** (1853) *n.* (1) Board along the base of a wall usually finished with moldings. (2) A molding that conceals the joint between an interior wall and floor. Syn: for base, skirting board, base plate, mop board, scrub board, kick board, and washboard.

**Basebox** *n.* (1) In the metal-coating trade, a unit of area equal to 0.4861 m$^2$. (2) In can coating, the standard unit equal to 31,360 in.$^2$ (20.23 m$^2$).

**Base coat** *n.* (1) All plaster applied before the finish coat; may be a single coat or a scratch coat and a brown coat. (2) The first coat applied to a surface, as paint; a prime coat. (3) An initial coat applied to a wood surface before staining or otherwise finishing it.

**Base fabric** *n.* In coated fabrics, the underlying substrate.

**Base plate** *See baseboard.*

**Base unit** *n.* The smallest possible repeating unit of a polymer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Basic** *n.* Of an alkaline nature. Capable of uniting with an acid to form a salt.

**Basic carbonate of lead** *See carbonate white lead.*

**Basic dye** *n.* Having a slightly basic property due to the presence of aniline or a similar group. Industrial dye: chemistry, properties and applications. John Wiley and Sons, New York, 2003.

**Basic fuchsin magenta** *See fuchsin.*

**Basic lead acetate** *n.* Compound derived from lead oxide (litharge) by treatment with insufficient acetic acid for complete neutralization. It is used in the manufacture of acetate chromes. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Basic lead carbonate** *n.* $2PbCO_3 \cdot Pb(OH)_2$. A very effective heat stabilizer, used where toxicity is of no concern as in electrical-insulating compounds. Its use is limited because of its tendency to form blisters during processing and to cause spew when exposed to weather, also by rising concern about lead in the environment. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

*See carbonate white lead.*

**Basic lead chromate** *n.* $PbCrO_4 \cdot PbO$. Normal lead chromates are represented by the formula $PbCrO_4$, but if these are treated with alkalis, the color can be changed from the original bright yellow to an orange color, and basic chromates are produced. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Basic lead nitrate** *n.* $Pb(NO_3)_2$. Compound prepared in a similar manner to basic lead acetate, but nitric acid is used in place of acetic acid to produce nitrate chromes. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Basic lead silico chromate** *n.* Calcined basic lead chromate – basic lead silicate complex on a silica core, used as a corrosion-inhibiting pigment. Sp gr of 4.1; particle size of 7 μm; O.A. of 10–18 g/100 g; $CrO_3$ – 5.4 wt.%; $SiO_2$ – 47.6 wt.%; PbO – 47.0 wt.% (Gooch 1993).

**Basic lead silicate** *n.* $3PbO \cdot 2SiO_2 \cdot H_2O$. Pigment White 16 (77625). Pigment consisting of an adherent surface layer of basic lead silicate "cemented" to silica. Compositions and constants vary depending on commercial grade. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Basic lead sulfate** *n.* $PbSO_4$, Pigment White 2 (77633). Pigment containing normal lead sulfate ($PbSO_4$) in "combination" with a proportion of basic lead, which is taken to be an oxide (PbO). It is a white pigment, which is used in considerable amounts in weather-resisting undercoats and finishes, usually in conjunction with carbonate white lead and/or zinc oxide. Its O.A. is 12–18 g/100 g and its Sp gr is 6.4.

Syn: sublimed white lead. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Basic pigment** *n.* Any pigment which is capable of reacting with fatty acids to form soaps.

**Basic solution** *n.* An aqueous solution in, which the concentration of hydroxide ions exceeds that of hydrogen (hydronium) ions.

**Basis weight** *n.* The weight in pounds of a ream (500 sheets) of paper cut to a given standard size for that grade: 25 × 38 for book papers, 20 × 26 for cover papers, 22½ × 28½ or 22½ × 35 for bristols, 25½ × 30½ for index. For example, 500 sheets 25 × 38 of 80-lb coated will weigh 80 lb. (2) The weight of a unit area of fabric.

Examples are ounces per square yard and grams per square centimeter.

**Basic zinc chromate** *n.* $ZnCrO_4 \cdot 4Zn(OH)_2$. Yellow pigment used primarily for its corrosion-inhibiting properties. Syn: zinc tetroxy chromate.

**Basket stitch (weave)** *n.* In this knit construction, purl and plain loops are combined with a preponderance of purl loops in the pattern courses to give a basket-weave effect.

**Bas-relief (basso-rilieva)** *n.* Sculpture in low relief.

**Basswood oil** *n.* Semidrying oil. Sp gr of 0.938/15°C; iodine value of 111.0.

**Bast fiber** *n.* Any of a group of fibers taken from the inner barks of plants that run the length of the stem, is surrounded by enveloping tissue, and is cemented together by pectic gums. Included in the group are jute, flax, hemp, and ramie, some of which are used to reinforce plastics.

**Batavia dammar or damar** \bə-ˈtā-vē-ə ˈda-mər\ (1698) *n.* Gum or resin exported from Batavia (now called Jakarta), Indonesia. Batavia dammar has two subgrades: Padang or Sumatra.

**Batch** \ˈbach\ [ME *bache*; akin to OE *bacan* to bake] (15c) *n.* In Industry, a unit or quantity of production used in one complete operation. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004).

**Batch adjustment record** *n.* A record of materials added to a paint batch to adjust viscosity, color, and such.

**Batch polymerization** *n.* The polymerization in a single and static, non-continuous volume of monomers. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Batch process** *n.* Any process in which the charge is added intermittently in definite portions, or batches, the operations of he process and the removal of products being completed on each portion before the addition of the next; as opposed to continuous process.

**Batch reactors** *n.* A reaction vessel for batch reactions as opposed to continuous reactors. Smith JM (1981) Chemical engineering kinetics. McGraw-Hill Co., New York.

**Batch record** *n.* A record of all materials and proportions used to produce a batch of paint.

**Bathrobe blanketing** *n.* A double-faced fabric woven with a tightly twisted spun warp and two sets of soft spun filling yarns. The fabric is thick and warm and its filling yarns are frequently napped to produce a soft surface. Today's blankets are made of spun polyester, acrylic, or polyester/cotton blends. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Batik** \bə-ˈtēk, ˈba-tik\ [Japanese *batik*] (1880) *n. See dyes.*

**Batiste** \bə-ˈtēst, ba-\ [F] (1697) *n.* (1) A sheer, woven, mercerized fabric of combed cotton or polyester/cotton resembling nainsook, only finer, with a lengthwise streak. (2) A rayon fabric decorated with dobby woven striped and jacquard florals. (3) A smooth, fine, woven fabric, lighter that challis and very similar to nun's veiling. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Batt** \ˈbat\ (1871) *n.* Insulation in the form of a blanket, rather than loose filling.

**Batten** \ˈba-tən\ [alter. of ME *batent*, *bataunt* finished board, fr. MF *batant*, fr. pre part of *battre*] (1658) *n.* Small thin strips covering joints between wider boards on exterior building surfaces. Harris CM (2005) Dictionary of architecture and construction, McGraw-Hill Co., New York.

**Battery** \ˈba-t(ə-)-rē\ [MF *batterie*, fr. OF, fr. *battre* to beat, fr. L *battuere*] (1531) *n.* (1) A set of galvanic cells connected in series. (2) In common usage, a single commercial galvanic cell. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Batting** \ˈba-tiŋ\ (1773) *n.* A soft, bulky assembly of fibers, usually carded. Battings are sold in sheets or rolls and used for warm interlinings, comforter stuffings, and other thermal or resiliency applications.

**Batu** *n.* East Indian semifossil resin, resembling the dammars. Soluble in aromatic or mixed aromatic–aliphatic hydrocarbons. Dissolves readily in warm vegetable oil. It is almost neutral. Acid value averages bout 30.

**Baudouin test** \bō-ˈdwaⁿ-\. Specific test for sesame oil, which gives a strong carmine coloration when a dilute alcoholic solution of furfural is added to a mixture of the oil and hydrochloric acid, and the whole violently shaken.

**Baumé** (Bé) \bō-ˈmā\ (1877) *adj.* A floating hydrometer method of measuring density of a liquid. The scale for floating hydrometer methods used to measure the specific gravity of a liquid (suspension, etc.). The depth of immersion is a linear function of the inverse of the density, www.photonics.com/dictionary. The Baume' scale is linear in inverse density. A dual transformation of specific gravity ($S$) for liquids devised by the French chemist Antoine Baumé for the graduation of hydrometers for the purpose of measuring percent salt (brine) in water; and, like Twaddell and API, becoming obsolete because they are empirical and have no scientific basis. Letting $S$ equal the ratio of the density of the subject liquid at 15.6°C to that of water at the same temperature, the Baumé transformations are:
For liquids more dense than water, Bé $= 145\,[1-(1/S)]$, and for liquids less dense than water, Bé $= (140/S)-130$.
The hydrometer is used for determining the specific gravities of liquids, engraved, not directly in units of specific gravity, but in a scale consisting of Baumé degrees. These Baumé degrees, often written (Bé), can be converted to true specific gravities by reference to conversion tables.
(*See www.monashscientific.com and Baume'*).

**Bauxite** \ˈbók-ˌsīt, ˈbäk-\ [F *bauxite*, from Les *Baux*] (1861) *n.* $Al_2O_3.2H_2O$. Aluminum mineral, consisting chiefly of a hydrated aluminum oxide. The color of native bauxite may be white, brownish red, or gray. Used as the source of many aluminum compounds. Crude powdered bauxite has been used to some extent as filler for paints.

**Bay** *n.* Space between columns or supports of a building. A bay window is placed between such supports and usually projects outward. If curved or semicircular, it is called a bow window.

**Bayardere** *n.* A very broad term for stripes that run crosswise in a knit or woven fabric.

**BBP** *See butyl benzyl phthalate.*

**BCF yarns** *n.* Bulked continuous filament yarns for carpet trade, usually nylon, polypropylene, or polyester.

**Be** *n.* Chemical symbol for the element beryllium.

**Bead** \ˈbēd\ [ME *bede* prayer, prayer bead, fr. OE *bed*, *gebed* prayer, akin to OE *biddan* to entreat, pray] (before 12c) *n.* (1) Heavy accumulation of a coating, which occurs at the lower edge of a panel or other vertical surface as the result of excessive flowing. (2) Solidified droplet of an oil–resin mix, withdrawn from a varnish or resin mix, for testing purposes. Instructions frequently include a statement that the oil–resin mix shall be heated until a hard or tough bead is obtained. (3) Glass spheres.

*See ballotini.*

**Bead and butt** *n.* Framed work in which the panel is flush with the framing and has a bead run on two edges in the direction of the grain; the ends are left plain.

*Also known as bead, butt, and bead butt work.*

**Bead, butt and square** *n.* Similar to bead and butt, but having the panels flush on the beaded face only, and showing square reveals on the other.

**Beaded paint** *n.* Traffic or marking paint with reflecting beads (ballotini) applied after striping or manufactured with beads and applied.

**Beaded velvet** *n.* Velvet with a cut-out pattern or a velvet pile effect, made on a Jacquard loom. This fabric is used primarily for evening wear.

**Beader** *n.* A device for rolling beads on the edges of thermoplastic sheets or cylinders.

**Bead polymer** *n.* A polymer in the form of nearly spherical particles about 1 mm in diameter.

**Bead polymerization** *n.* A type of olymerization identical to suspension polymerization, except that the monomer is dispersed as relatively large droplets in water or other suitable inert diluents by vigorous agitation.

**Bead polymerization, suspension** *n.* Through agitating or stirring with the aid of a dispersion agent, water insoluble monomers can be dispersed in water as fine droplets, oil soluble free radical initiators start polymerization in the droplets, the droplets grow and convert into beads or pearls.

**Beads, reflective** *See beaded paint and ballotini.*

**Beam** \ˈbēm\ [ME *beem*, fr. OE *bēam* tree, beam; akin to OHGr *boum* tree] (before 12c) *n.* (1) Timber or girder supporting a floor, roof, or ceiling, usually supported at each end by a pier, wall, post, or girder. A structural member whose prime function is to carry transverse loads, as a joist, girder, rafter, or purlin. (2) A cylinder of wood or metal, usually with a circular flange on each end, on which warp yarns are wound for slashing, weaving, and warp knitting.

**Beam ceiling** *n.* (1) A ceiling, usually of wood, made in imitation of exposed floor beams with the flooring showing between. (2) The underside of a floor, showing the actual beams, and finished to form a ceiling.

**Beam dyeing machine** *n.* A machine for dyeing warp yarns or fabrics that have been wound onto a special beam, the barrel of which is evenly perforated with holes. The dye liquor is forced through the yarn or fabric from inside to outside and vice versa. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Industrial dye: chemistry, properties and applications, John Wiley and Sons, New York, 2003.

**Beaming** The operation of winding warp yarns onto a beam usually in preparation for slashing, weaving, or warp knitting. *Also called warping.*

**Beamroll** *See beam.*

**Bearding** *n.* Fuzz on loop pile carpets usually resulting from poor anchorage or fiber snagging.

**Bearing strength** *n.* The ability of plastics sheets to sustain edgewise loads that are applied by pins, rods, or rivets used to assemble the sheets to other articles.

**Beat frequencies** *n.* The beat of two different frequencies of signals on a non-linear circuit when they combine or beat together. It has a frequency equal to the difference of the two applied frequencies.

**Beater** *n.* (1) The machine which does most of the opening and cleaning work on a fiber picker and opener. Revolving at high speed, it beats against the fringe of fiber as the latter is fed into the machine. (2) A machine used in the paper industry for opening pulp and combining additives.

**Beating-up** *n.* The last operation of the loom in weaving, in which the last pick inserted in the fabric is "beat" into position against the preceding picks.

**Beat(s)** *n.* Two vibrations of slightly different frequencies $f_1$ and $f_2$ when added together, produce in a detector sensitive to both these frequencies, a regularly varying response which rises and falls at the "beat" frequency $f_b = f_1 - f_2$. It is important to note that a resonator, which is sharply tuned to $f_b$ alone will not resound at all in the presence of these two beating frequencies.

*See combination frequencies.*

**Beaumontage** *n.* A resin, beeswax, and shellac mixture used for filling small holes or cracks in wood or metal. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, West Conshohocken, PA, 2001.

**Beaver cloth** *n.* Made of high-quality wool, this heavy but soft fabric has a deep nap. Beaver cloth is frequently used in overcoats.

**Becchi–Millian test** *n.* Sensitive test for cottonseed oil. If cottonseed fatty acids are dissolved in 90% ethyl alcohol and a little dilute silver nitrate solution added, they separate, colored brownish or black, as the alcohol is boiled away on heating. It is claimed that as little as 1% of cottonseed oil is detected in a mixture by this test.

**Beck** *n.* A vessel for dyeing fabric in rope form, consisting primarily of a tank and a reel to advance the fabric.

**Becke line** *n.* The bright halo near the boundary of a transparent particle that moves with respect to that boundary as the microscope is focused through best focus.

**Becke test** *n.* The method for determining refractive index of a transparent particle by noting the direction in which the Becke line moves. The halo (Becke lines) will always move to the higher refractive index medium as the focus is raised. The halo crosses the boundary into the lower refractive index medium when the microscope is focused down. The particle must be illuminated with a narrow cone of axial light obtained by closing the aperture diaphragm of the condenser to a small aperture. Nesse WD (2003) Introduction to optical mineralogy. Oxford University Press, New York.

**Beckacite** *n.* Phenoplast, manufactured by Reichhold, USA.

**Becquerel** (Bq) \be-ˈkrel, ˌbe-kə-ˈrel\. The SI unit for rate of disintegration of a radioactive element, equal to 1 dis/s.

**Bedford cord** *n.* A rib-weave fabric with raised lengthwise cords produced by using stuffing threads in the warp. Since the fabric is strong and wears well, it is used for upholstery, suits, riding habits, and work clothes. Tortora PG, Merkel RS (2000) Fairchild's dictionary of, 7th edn. Fairchild Publications, New York.

**Bed putty** *n.* The glazier's putty under glass, on, which the glass is bedded. Syn: black putty.

*See also face putty.*

**Beechnut oil** *n.* A non-drying oil. Its iodine value averages 110, and its Sp gr, 0.992/15°C.

**Beer–Bouguer law (Beer–Lambert law)** *n.* Combined laws expression absorption of radiant energy of a single wavelength as a function of concentration and optical path length of absorbing material:

$$-\log T_i/cl = K,$$

where $T_i$ is the internal transmittance, $c$ the concentration, $l$ the path length, and $K$ is the unit absorption coefficient. The value $-\log T_i$ is sometimes called the optical density, OD, or simply the density, $d$; it is sometimes called the absorption, the absorbency, or the extinction. The unit absorption coefficient, $K$, is sometimes designated $A$, $a$, $\alpha$, $E$, or $\varepsilon$. The units of concentration and path length must be specified. *See absorption coefficient.* Note – In Europe, it is called the law of Lambert–Beer. DeLevie R (1996) Principles of quanitative analysis. McGraw-Hill Higher Education, New York. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

**Beer's law** *np.* If two solutions of the same colored compound are made in the same solvent, one of which is, say, twice the concentration of the other, the absorption due to a given thickness of the first solution should be equal to that of twice the thickness of the second. Mathematically this may be expressed as $l_1c_1 = l_2c_2$ when the intensity of light passing through the two solutions is a constant and if the intensity and wavelength of light intensity and wavelength of light incident upon each solution are the same. DeLevie R (1996) Principles of quantitative analysis. McGraw-Hill Higher Education, New York. Willard, Merritt and Dean, 1974.

**Beeswax** \ˈbēz-ˌwaks\ (1676) *n.* Mixture of crude cerotic acid and myricin separated from honey. It is a soft natural wax, with a mp of 63°C, an acid value usually below 20, a saponification value of 90–95, and a very low iodine value of 6–13.

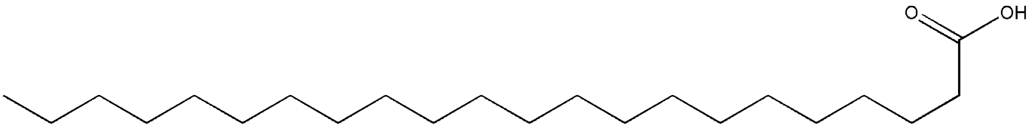
**Beetling** \ˈbē-təl-iŋ\ (ca. 1919) *adj.* A process in which round-thread linen or cotton fabric is pounded to give a flat effect. Beetled linen damask has an increased luster and a leather-like texture. Beetling is also used to give a thread-like or linen-like appearance to cotton.

**Behenic acid** $C_{22}H_{44}O_2$. Long chain, aliphatic acid. It has an mp of 81°C, a bp of 306°C/60 mmHg and an acid value of 164.8 (*See image*).

**Belly benzoin** \-ˈben-zə-wən\ *n.* Benzoin obtained as an exudation from the tree in the later years of its life. Belly benzoin is usually regarded as an inferior grade, obtained during the nine years following the tenth year of the tree's life.

*See also benzoin.*

**Benard (vortex) cell** *n.* Hexagon-shaped cell that is produced by the vortex action of solvent evaporation in thin films. During drying, all solvent paints and many varnishes exhibit Benard cell formation, i.e., roughly hexagonal cells, generally with a well-marked center. The whole cell is in movement with currents streaming up the center and flowing down the walls.



These current, because they affect pigments differently, lead to segregation and deposition of different components in different parts of the film. This phenomenon manifests itself in color and surface irregularities of the film. Weldon DG (2001) Failure analysis of paints and coatings. John Wiley and Sons, New York.

**Bending length** *n.* A measure of fabric stiffness based on how the fabric bends in one plane under the force of gravity. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Bending modulus** *n.* Maximum stress per unit area that a specimen can withstand without breaking when bent. For fibers, the stress per unit of linear fiber weight required to produce a specified deflection of a fiber.

**Bending moment** *n.* The resultant moment about the neutral axis of a beam or column, at any point along its span, of the system of forces that produce bending.

**Bending rigidity** *See flexural rigidity.*

**Bending strength** *See flexural strength.*

**Bend test** *See flexibility test.*

**Benedict's test** *n.* Special test designed to detect the pressure of reducing sugars, and it may also be applied to the products of hydrolysis of certain gums, starch, etc. Benedict's reagent consists of a solution of sodium citrate and sodium carbonate in water, to which a small quantity of copper sulfate is subsequently added. An orange precipitate is obtained when a few ml of the reagent is added to the solution of the suspected compound, if a reducing sugar is present. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Bengaline** \ˈbeŋ-gə-ˌlēn\ [F, from *Bengal*] *n.* A fabric similar to faille, only heavier, with a fine weave and widthwise cords. Originally, bengalines were made of a silk, wool, or rayon warp with a worsted or cotton filling and used for dresses, coats, trimmings, and draperies. Modern bengalines are made with filament acetate or polyester warps. Also, some bengalines have fine spun warps with 2- and 3-ply heavier spun yarns for filling cord effects. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Bengucopalic acid** *n.* $C_{19}H_{30}O_2$. Monobasic acid which has been isolated from Benguela copal. It constitutes about 44% of the copal. The acid is said to resemble the congocopalic acid of Congo copal.

**Bengucopalolic** *n.* $C_{21}H_{32}O_3$. Major constituent acid of Benguela copal, being present to the extent of about 25% of the whole. It has a mp of 115°C.

**Bengucopalresene** *n.* Constituent of Benguela copal. Present in two forms, the $\alpha$ and $\beta$ varieties. The former is present to the extent of about 5% and the latter to the extent of 15%.

**Benguela copal** *n.* Fairly hard natural copal obtained from West Africa. Sometimes known as Lisbon copal and, like other similar copals from this part of West Africa, gives satisfactory oleoresinous varnishes after running.

**Beni** \ˈbā-nē\ [Japanese]. A delicate pink or red pigment of vegetable origin.

**Beni-ye** [Japanese]. A print in which beni is the chief color used. Generally employed to describe all those two-color prints which immediately preceded the invention of polychrome printing.

**Benne oil** \ˈbe-nē\ [of African origin; akin to Malinke *bène* sesame] (1769) *n.*
*See sesame oil.*

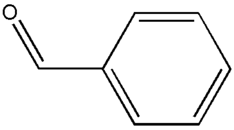
**Ben oil** *n.* Non-drying vegetable oil. The physical properties recorded vary widely from different samples; for example, iodine values have been reported from 72 to 112.

**Bentonite** \ˈben-tᵊn-ˌīt\ (1898) *n.* Very fine-grained clay (a mixture and not a definite mineral type) derived from volcanic ash and consisting largely of montmorillonite mineral. Two classes of Bentonite are recognized: (1) sodium bentonite, which is a swelling type in water and (2) calcium bentonite or subbentonite, which exhibits little swelling in water.

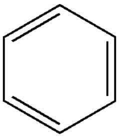
*See aluminum silicate. Also known as wilkinite.*

**Bentonite clay** *See bentonite.*

**Benzaldehyde** \ben-ˈzal-də-ˌhīd\ [ISV] (1866) (benzoic aldehyde, oil of bitter almonds, benzoÿl hydride, benzene carbonal) *n.* $C_6H_5CHO$. A solvent, particularly for polyester and cellulosic plastics (*See image*).



**Benzene** \ˈben-ˌzēn, ben-ˈ\ [ISV *benz-* + *-ene*] (ca. 1872) (benzol, phene) *n.* $C_6H_6$. The compound and building block of all aromatic organic chemistry. It took almost a century of investigation after its discovery by Faraday in 1823 to establish the structure of this extraordinarily stable ring: its system of resonant, alternating single and double bonds. Benzene is a solvent and intermediate in the production of phenolics, epoxies, styrene, and nylon. Hydrogenation of benzene yields cyclohexane, a solvent and raw material for preparing adipic acid, from which nylon is derived. As a solvent, benzene will dissolve ethyl cellulose, polyvinyl acetate, polymethyl methacrylate, polystyrene, coumarone-indene resins, and certain alkyds. Benzene is toxic and has been declared to be a carcinogen, so it requires very careful handling. Pure benzene has a bp of 80°C and a mp of 5.5°C. Its flp is below normal air temperature and its vapor pressure is about 118 mmHg at 30°C. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York. Merck index, 13th edn. Merck and Company Inc., Whitehouse Station, NJ, 2001.



**Benzene ring** (phenyl ring) *n.* The six carbon atoms, diagramed as a hexagon, joined by alternating single and double bonds, each carbon with an attached hydrogen in the case of benzene itself, or with one or more hydrogens replaced by other atoms or radicals. The alternating double bonds, in either of two possible arrangements, may or may not be shown, depending on the expected audience's knowledge of organic chemistry. The Greek letter, $\varphi$, is also used as a symbol for *phenyl.* Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Benzenesulfonylbutylamide** *n.* $C_6H_5SO_2NHC_4H_9$. A plasticizer for cellulosics and polyvinyl acetate.

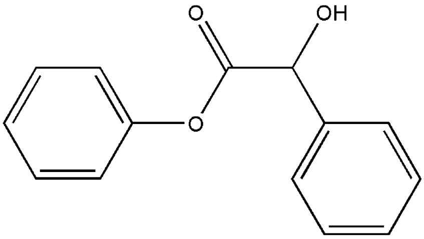
**Benzenesulfonylhydrazide** [4,4′-oxybis (benzenesulfonylhydrazide), OBSH] *n.* A blowing agent, a white crystalline solid that melts and begins to decompose near 105°C. It produces a white unicellular foam when incorporated in PVC plastisol but has a strong residual odor that does not evolve when it is used in rubbers. It is also used in epoxy and phenolic foams and serves as a cross-linking agent in rubber compositions and a rubber/resin blends.

**Benzenoid** \ˈben-ˌzēn, ben-ˈ\ [ISV *benz-* + *-ene*] (ca. 1872) *n.* Benzenoid compound is one, which has a structural resemblance to benzene.

**Benzidine orange** *n.* Metal-free diazo pigments based on dichlorobenzidine. They are highly transparent, bright in color, and low in cost due to their high tinctorial strength, but tend to bleed and fade upon exposure to light.

**Benzidine yellow** *n.* Benzidine or diarylide yellows are disazo pigment dyestuffs. They are approximately twice as strong, much more bleed and heat resistant and markedly inferior in lightfastness versus Hansa yellows.

**Benzillic acid** *n.* $(C_6H_5)_2C(OH)COOH$. It has a mol wt of 228.17 and a mp of 150°C. Known also as diphenyl glycolic acid (*See image*).



**Benzine** \ˈben-ˌzēn, ben-ˈ\ [Ger *Benzin*, fr. *benz-*] (1835) (deprecated) *n.* (1) This term is outdated and misleading, should not be used. (2) European term for gasoline.

*See ligroin.*

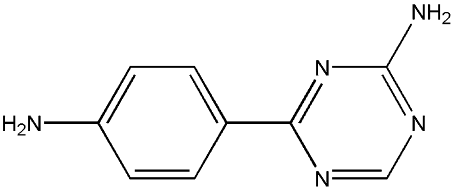
**Benzoate fiber** \ˈben-zə-ˌwāt\. Fiber with a silk-like hand made from a condensation polymer of *p*-(bhydroxyethoxy) benzoic acid.

**Benzofuran** \ˌben-zō-ˈfyur-ˌan, -fyu-ˈran\ (1946) *n.* A compound $C_8H_60$ found in coal tar and polymerized with indene to form thermoplastic resins used especially in adhesives and printing inks.

*See coumarone.*

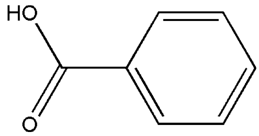
**Benzofuran resin** *See coumarone-indene resin.*

**Benzoguanamine** *n.* (2,4′-diamino-6-phenyl-1,3,5-triazine) $C_6H_5N_3(NH_2)_2$. A crystalline compound that reacts with formaldehyde to give thermosetting resins with resistance to heat and alkalies, and gloss generally superior to hose of melamine-formaldehyde resins. Benzoguanamine resins are used for protective coatings, paper additives and finishes, laminating agents, textile finishes, and adhesives.



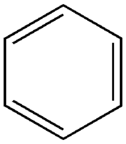
**Benzoguanamine resins** *n.* Resins based on benzoguanamine.

**Benzoic acid** \ben-ˈzō-ik-\ [ISV] (1791) (carboxybenzene, benzene carboxylic acid, phenylformic acid) *n.* $C_6H_5COOH$. A white, crystalline compound occurring naturally in benzoin gum and some berries, also synthesized from phthalic acid or toluene. It is used in making plasticizers such as 2-ethylhexyl-*p*-oxybenzoate, diethyleneglycol dibenzoate, dipropyleneglycol dibenzoate, ethyleneglycol dibenzoate, triethyleneglycol dibenzoate, polyethyleneglycol-(200)- and -(600)-dibenzoate, and benzophenone. It has a mp of 121°C, a bp of 249°C, and an acid value of 460. It is a useful peptizing agent for metallic soaps, either in their solid form or in hydrocarbon solutions. It is sometimes effective in reducing seeding, especially in spirit enamel containing small amounts of basic pigments.



**Benzoic ether** \ben-ˈzō-ik-\ [ISV, fr. *benzoin*] (1791) *n. See ethyl benzoate.*

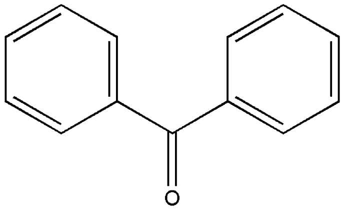
**Benzol** \ˈben-ˌzól, -ˌzōl\ [Gr, fr. *benz-* + *-ol*] (1838) *n.* Commercial solvent derived from the distillation of coal. It is a crude mixture of hydrocarbons, consisting chiefly of benzene, although it may contain in addition some toluene, xylene, carbon disulfide, thiophene, pyridine, acetonitrile, and paraffinic hydrocarbons. A 90%, or 90°, benzol is one from which 90% by volume can be distilled below 100°C.
Also can be spelled as benzole.



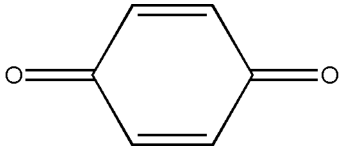
**Benzoline** *n.* (1) Gum benzoin, as it is more commonly known, is a spirit-soluble resin, which appears on the market as Siam, Palembang, Padang, Sumatra, and Penang benzoins. It has a very pleasant "vanilla" smell, and it is used partly on account of this, and partly as a plasticizing resin in spirit varnishes. Benzoin is obtained as an exudation from a tree as a result of deliberate incision. (2) (deprecated) Another name for petroleum benzine.
*See also belly benzoin.*

**Benzoperoxide** *See benzoyl peroxide.*

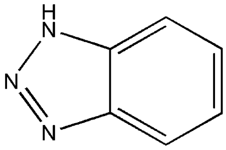
**Benzophenone** \ˌben-zō-fi-ˈnōn, -ˈfē-ˌnōn\ [ISV *benz-* + *phen-* + *-one*] (1885) *n.* (1) (diphenylketone) An involati le solvent and chemical intermediate. (2) Any of a family of UV stabilizers based on substituted 2-hydroxybenzophenone ("B"). Typical members are 4-methoxy-B, 4-octyloxy-B, 4-dodecyloxy-B, 2,2′-dihydroxy-4-methoxybenzophenone, and 2,2′-dihydroxy-4,4′-dimethoxybenzophenone. They function both as direct UV absorbers and, in the case of polyolefins, also as energy-transfer agents and radical scavengers. It is an aromatic ketone having excellent general compatibility. It is a solid at ordinary temperature, has a mp of 48°C, and a bp of 305°C. It is insoluble in water.
*Known also as diphenyl ketone.*



***p*-Benzoquinone** \-kwi-ˈnōn\ (1,4-benzoquinone, chinone). A yellow crystalline compound used, along with many of its derivatives, as an inhibitor in unsaturated polyester resins to prevent premature gelation during storage.



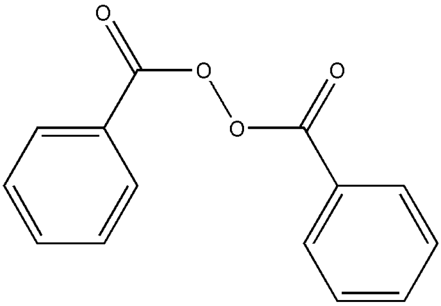
**Benzotriazole** *n.* (1) $C_6H_5N_3$. A double ring compound, parent to many derivatives. (2) Any of a family of UV stabilizers, derivatives of 2-(2′-hydroxyphenyl) benzotriazole, that function primarily as UV absorbers. Typical examples are 2-(2′-hydroxy-5′-methylphenyl)benzotriazole and the corresponding 5′-*t*-octylphenyl analog. The benzotriazoles offer intense and broad UV absorption with a fairly sharp wavelength cutoff close to the visible region. The higher alkyl derivatives are less volatile and therefore more suitable for processing at higher temperatures.



**Benzoyl** \ˈben-zə-ˌwil, -ˌzóil\ [Gr, from *Benzoësäure* benzoic acid + Gk *hylē* matter] (ca. 1855) *n.* $C_6H_5CO$–monovalent aryl radical.

**Benzoyl peroxide** (1924) (dibenzoÿl peroxide, DBP) *n.* A catalyst employed in the polymerization of polystyrene, styrene, vinyl, and acrylic resins. It is also a curing agent for polyester and silicone resins, usually used together with an accelerator such as dimethylaniline. It can be dispersed in diluents or plasticizers to diminish the explosion hazard associated with the dry product. Its natural state is colorless crystals of mp of 103°C. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

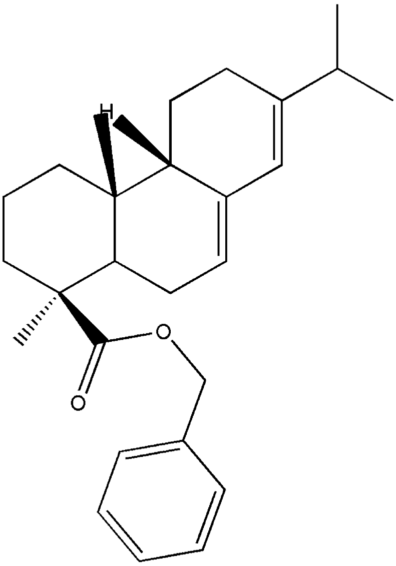
*Known also as benzoperoxide.*



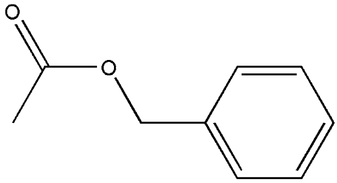
**Benzyl** \ˈben-ˌzēl, -zəl\ [ISV *benz-* + *-yl*] (1869) (α-tolyl) *n.* The radical $C_6H_5CH_2$–, which exists only in combination.

**Benzyl abietate** *n.* Very high boiling plasticizer derived from rosin. It is compatible with many other varnish and lacquer constituents. As a rosin derivative, it is susceptible to atmospheric oxidation and yellowing. (*See image*).

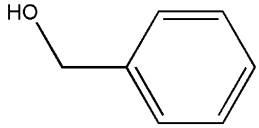
*Sometimes known as benzyl resinate*



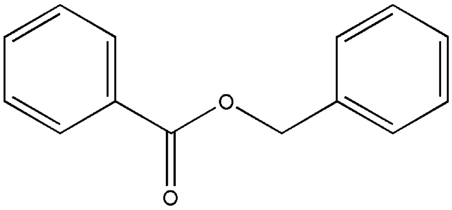
**Benzyl acetate** (phenylmethyl acetate) *n.* A colorless liquid with a pleasant aroma, a solvent for cellulosic resins.



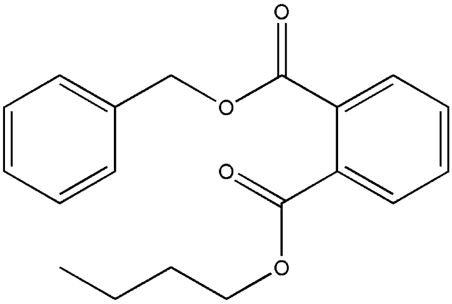
**Benzyl alcohol** (α-hydroxytoluene, phenylcarbinol) *n.* Has excellent solvent properties for a wide range of varnish and lacquer constituents. It has some application as a high boiling solvent, more particularly in baking finishes. It has a bp of 205°C, a flp of 300°C, and a vp of less than 1 mmHg at ordinary temperature.



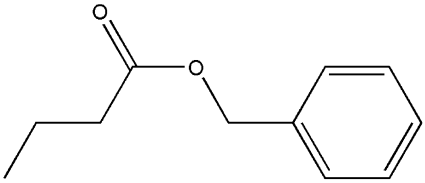
**Benzyl benzoate** *n.* A water-white liquid used as a plasticizer that freezes at room temperature. It has a mp of 19°C, and a bp of 323°C.



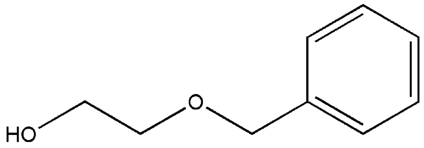
**Benzyl butyl phthalate** *n.* High melting solid, with a bp of 208–288°C/20 mmHg (*See image*).



**Benzyl butyrate** *n.* A liquid with a heavy, fruity odor, a plasticizer.

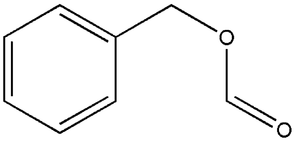


**Benzyl cellosolve** *n.* High boiling solvent with a bp of 256°C and Sp gr of 1.070/20°C.

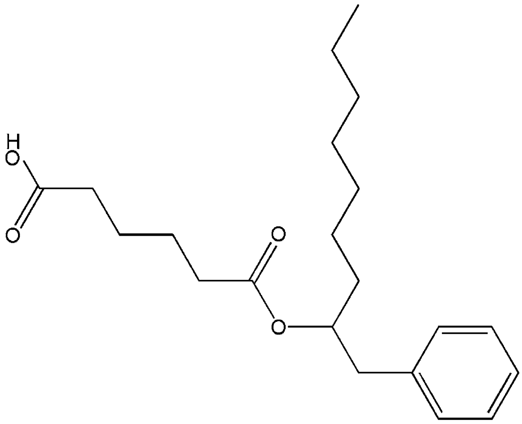


**Benzyl cellulose** *n.* A benzyl ether of cellulose, it is a cellulosic plastic used in lacquers. It also may be formulated for making films and compounds for molding and extrusion.

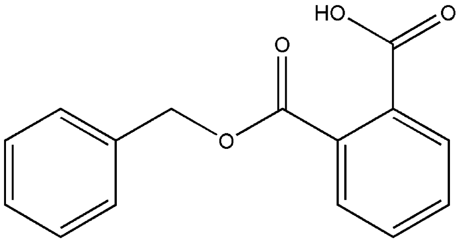
**Benzyl formate** *n.* A solvent for cellulosic resins.



**Benzyloctyl adipate (BOA)** *n.* A plasticizer for polystyrene, vinyl, and cellulosic resins.

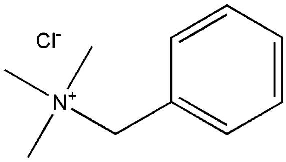


**Benzyl phthalate** *n.* A solid plasticizer: mp of 42°C, and bp of 277°C/15 mmHg.
*Also known as dibenzyl phthalate.*



**Benzyl resinate** *See benzyl abietate.*

**Benzyltrimethylammonium chloride** *n.* A quaternary ammonium salt, a solvent for cellulosics, and a catalyst for phenolic resins.



**Ber** *n.* One of the host trees to which the lac insect affixes itself.

**Berlin blacks** *n.* Low-cost form of air-drying blacks based on solutions of bitumens to which black pigments or fillers are added. They possess excellent opacity, but reduced gloss. Some Berlin blacks are semimatt.

**Berlin blue** *n.* A term used for any of the variety of iron-based blue pigments; Prussian blue.

*See iron blue.*

**Berlin red** A pigment consisting essentially of red iron oxide.

**Bernoulli's theorem** \bər-ˈnü-lēz-\ [Daniel *Bernoulli* † 1782 Swiss physicist]. At any point in a tube through which a liquid is flowing the sum of the pressure energy, potential energy, and kinetic energy is constant. If $p$ is pressure; $h$, height above the reference plane; $d$, density of the liquid, and $v$, velocity of flow,

$$p + hdg + \frac{1}{2}\mathrm{d}v^2 = \text{a constant.}$$

Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Bertholet principle of maximum work** *n.* Of all possible chemical processes, which can proceed without the aid of external energy, that process which always takes place is accompanied by the greatest evolution of heat. This law holds good for low temperatures only and does not account for endothermic reactions. Russell JB (1980) General chemistry. McGraw-Hill, New York.

**Bertrand lens** *n.* An auxiliary, low-power lens which may be inserted in the bodytube of the microscope between the eyepiece and the objective for observing the back focal plane of the objective; useful for conoscopic observations in crystal optics and for checking microscope illumination quality.

**Beryllium** \bə-ˈri-lē-əm\ [NL, from Gk *bēryllion*] (ca. 1847) *n.* A steel-gray light strong brittle toxic bivalent metallic element used chiefly ads a hardening agent in alloys.

**Beryllium copper** *n.* Copper containing about 2.7% beryllium and 0.5% cobalt, used for blow molds and insertable injection-mold cavities. The small percentages of Be and Co greatly increase the strength and hardness of the copper whole preserving its high thermal conductivity and corrosion resistance. Beryllium copper is easily pressure cast and hobbed into mold cavities.

**BESA** Abbreviation for British engineering standards association.

**BET** Abbreviation for Brunauer, Emmett, and Teller, applied to an equation and method for determining the surface area of an absorbent, such as carbon.

**Beta** *adj.* A prefix, usually abbreviated as the Greek letter *β* and usually ignored in alphabetizing compound names, signifying that the so-labeled substitution is on the second carbon atom away from the main functional group of the molecule.

*See alpha.*

**Beta cellulose** *n.* One of the three forms of cellulose. It has a lower degree of polymerization than the alpha form. With gamma cellulose it is known as hemicellulose.

*Also see alpha cellulose and gamma cellulose.*

**Beta gage (beta-ray gage)** *n.* Gage consisting of two facing elements, a $\beta$-ray-emitting source, and a $\beta$-ray detector. When a sheet material (e.g., plastic) is passed between the elements, some of the $\beta$-rays are absorbed, according to the area density or the thickness of the sheet. Signals from the detecting element can be used to control equipment that automatically regulates the thickness. The most usual sources are krypton 85 and strontium 90. Also used for particular applications are cesium 137, promethium 147, and ruthenium 106.

*See also thickness gauging.*

**Beta-minus ($\beta^-$) particle** *n.* A radioactive emission consisting of a high-energy electron, $^{0}_{-1}e$.

*Also known, simply, as a beta particle.*

**Beta particle** (1904) *n.* A subatomic particle created at the instant of emission from a decaying radioactive atomic nucleus, having a mass (at rest) of $9.1095 \times 10^{-28}$ g. A negatively charged beta particle is identical to an ordinary electron, and a positively charged one is identical to a positron. A stream of beta particles is called a *beta ray.* Such rays are use in equipment for measuring and controlling the thickness of plastics films, sheets, and other extrudates. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Beta (b)-particle (beta ray)** *n* (1902). One of the particles, which can be emitted by a radioactive atomic nucleus. It has a mass about $\frac{1}{1837}$ that of the proton. The negatively charged beta particle is identical with the ordinary electron, while the positively charged type (positron) differs from the electron in having equal but opposite electrical properties. The emission of an electron entails the change of a neutron into a proton inside the nucleus. The emission of a positron is similarly associated with the change of a proton into a neutron. Beta particles have no independent existence inside the nucleus, but are created at the instant of emissions.

*See neutrino.*

**Beta-pinene** *See pinene.*

**Beta-plus ($\beta^+$) particle** *n.* A radioactive emission (*particle*) consisting of a positron $^{0}_{1}e$.

**Beta-ray gauge** (beta gauge) *n.* A device for measuring the thickness of plastics films, sheets, or extruded shapes, consisting of a source of beta rays and a detecting element. When material is passed between the source and the detector, some of the rays are absorbed, the percent absorbed being a measure of the thickness of the material. Signals from the detecting element can be used to control equipment that automatically regulates the thickness. The most usual sources are krypton 85 and strontium 90. Also used for particular applications are cesium 137, promethium 147, and ruthenium 106.

*See also thickness gauging.*

**Betatron** \ˈbā-tər-ˌträn\ [ISV] (1941) *n.* An accelerator that uses an electrostatic field to impart high velocities to electrons. Energies of 5–6 MeV will produce X-rays equivalent in energy to gamma radiation of 12–20 g of radium.

**Beton** *n.* A kind of concrete; a mixture of lime, sand, and gravel.

**Bevatron** A six or more billion electron voltaccelerator of protons and other atomic particles. Energies of 5–6 MeV will produce X-rays equivalent in energy to gamma radiation of 12–20 g of radium. Makes use of a Cockcroft–Walton transformer cascade accelerator and a linear (q.v.) as well as an electromagnetic field in the build-up.

**Bevel siding** *See clapboard.*

**BHT** *n.* Abbreviation for butylated hydroxytoluene.

*See di-tert-butyl-p-cresol.*

**Bias fabric** *n.* A two-dimensional fabric that when oriented in the XY plane contains fibers that are aligned in a different direction, i.e., 45° to the *x*-axis fibers.

**Bias filling** *n.* A fabric defect in which the filling yarn does not run at a right angle to the warp. The principal cause is improper processing on the tenter frame.
*Also see bow.*

**Bias ply** *n.* A layer of reinforcing fiber, cloth, or sheet oriented at an angle, less than 90° and typically 45°, to the fiber direction in the main reinforcing layers.

**Biaxial braid** *n.* Braided structure with two yarn systems one running in one direction and the other in the opposite direction.

**Biaxial crystals** *n.* Anisotropic crystals in the orthorhombic, monoclinic and triclinic systems. They have three principal refractive indices, $\alpha$, $\beta$, and $\gamma$.

**Biaxial laminate** *See bidirectional laminate.*

**Biaxially oriented film** *n.* Polymeric film (i.e., polyethylene) which as been strained or stretched in one direction which produces optical and physical birefringence or most importantly, high strength one the axial or long direction.

**Biaxial orientation** *n.* (1) The process of stretching hot plastic film or other article in two perpendicular directions, resulting in molecular alignment. (2) The state of the material that has been subjected to such stretching.
*See also orientation and tentering.*

**Biaxial winding** *n.* A method of filament winding in which the helical bands are laid in sequence, side-by-side, with no crossover of fibers.

**Bibasic lead phthalate** *n.* A heat and light stabilizer for vinyl insulation, opaque film and sheeting, and foam.

**Bicarbureted hydrogen** *See ethylene.*

**Bicomponent fibers** *See composite fibers.*

**Bicomponent yarns** *n.* Spun or filament yarns of two generic fibers or two variants of the same generic fiber.

**Biconstituent fiber** *n.* A fiber extruded from a homogeneous mixture of two different polymers. Such fibers combine the characteristics of the two polymers into a single fiber.

**Bicyclic** *n.* Consisting of two rings.

**Biddiblack** *n.* A particular type of mineral black, mined near Bideford, Devonshire, England.
*See mineral black.*

**Bidirectional** *n.* In two directions. (1) The term may be applied to illumination angles in three-dimensional space. Thus, the incident angle may be 45° relative to the material surface, but this designation does not describe the portion of the circumferential 45° angle possible. The term "bidirectional illumination" generally implies two incident beams separated circumferentially by 180°. (2) The term may also be applied to goniophotometric measurements, to the illumination and to the viewing angle. In either case, the angular distance is expressed as the degrees (or radians) from the perpendicular (normal) to the surface as 0°. Thus, the grazing angle approaches 90°.

**Bidirectional fabric** *n.* A fabric having reinforcing fibers in two directions, i.e., in the warp (machine) direction and filling (cross-machine) direction.

**Bidirectional laminate** *n.* A fiber-reinforced material in which the fibers are laid in two different directions, typically in the length and width directions. In particular such a laminate in which equal volumes of reinforcing fibers are laid in the two directions.

**Bidirectional reflectance distribution function (BRDF)** *n.* The ratio of radiance per unit irradiance, used for describing the geometrical reflectance properties of the surface.

*See bidirectional.*

**Bierbaum scratch hardness** *See scratch hardness.*

**Biff** *See monkey.*

**Bikerman boundary-layer theory** *n.* The theory that adhesive bonding occurs through the formation of an adsorbed, strong boundary layer on the surface of the adhered.

**Bilateral fibers** *n.* Two generic fibers or variants of the same generic fiber extruded in a side-by-side relationship.

**Billow forming** *n.* A variant of thermoforming, in which the hot plastic sheet is clamped in a frame and expanded upward with mild air pressure against a male plug or female die as the plug or die descends into the frame. The process is suitable for thin-walled containers with high draw ratios.

**Bimetallic cylinder** *n.* In most modern extruders and injection machines, the barrel is lined, by centrifugal casting from the melt, with any of several white irons containing chromium and boron carbides and having hardnesses near Rockwell C65. Aster finish-grinding and polishing, the liner, about 1 mm thick, provides excellent resistance to wear or corrosion or both, depending on the formation. The best known trade name is XALOY®.

**Bimetal plate** *n.* In lithography, a plate in which the image area is copper or brass, and the non-image area is aluminum, stainless steel, or chromium.

**Bimolecular process** *n.* An elementary process in which the activated complex is formed as a result of the collision of two particles.

**Bin activator** *n.* A device that promotes the steady flow of granular or powdered plastics from storage bins or hoppers. Among the many types of equipment are vibrators or mallets acting upon the outside of the container, prodding devices or air jets acting directly on the material, inverted-cone baffles with vibrating means located at the bottom of the hopper, and other "live bottom" devices such as scrapers, rolls, and chains.

**Bin cure** *n.* Rubber term for partial or complete vulcanization of a mixed compound while stored in a bin or pile waiting for molding or further processing.

*Also called pile burning or premature vulcanization.*

**Bin dischargers** *n.* Restores flowability to materials, which are prone to packing during storage in bins, silos, or surge hoppers, and promotes free flow of materials, which tend to bridge or hang up.

**Binder** *n.* (1) Non-volatile portion of the liquid vehicle of a coating. It binds or cements the pigment particles together and the paint film as a whole to the material to which is it applied. (2) Component of an adhesive composition, which is primarily responsible for the adhesive forces, which hold two bodies together. (3) Resin or cementing constituent of a plastic compound which holds the other components together. The agent applied to glass mat or performs to bond the fibers prior to laminating or molding. (4) The components in an ink film which holds the pigment to the printed surface. Wicks ZN, Jones F, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

*See also vehicle.*

**Binder content** *n.* The weight of adhesive used to bond the fibers of a web together. Binder content is usually expressed as percent of fabric weight.

**Binder demand** *n.* That amount of binder needed to completely wet a pigment by displacing the air voids. This is determined primarily by: the particle size, shape, chemical composition, and density of the pigment; and the particle size, degree of polymerization and wetting properties of the binder. (Whereas the binder demand refers to a particular pigment-vehicle system, oil absorption is a numerical value assigned to a pigment based on a specific test method.)

**Binder fibers** *n.* Fibers that can act as an adhesive in a web because their softening point is relatively low compared with that of the other fibers in the material.

**Binder ratio** *See pigment/binder ratio.*

**Binding varnish** *n.* A term used by printers or lithographers to describe a viscous varnish in the ink that is used to toughen the dried film.

**Bingham body** *n.* Material displaying plastic flow.

**Bingham liquid** *n.* Liquid exhibiting plastic flow.

*See plastic flow.*

**Bingham plastic** *n.* A model for flow behavior in which no flow occurs until the shear stress exceeds a critical level called the yield value or yield stress above which shear rate is proportional to the stress (after the yield stress has been surpassed). When a Bingham plastic flows through a circular tube, there is a critical radius $r_c$ at which the shear stress, $\Delta P r_c/(2L)$, equals the yield stress. All actual flow occurs between that radius and the wall radius, $R$, while from the center to $r_c$ there is a solid plug carried along by the stream. Parfitt CD, Sing KSW (1976) Characterization of powder surfaces. Academic Press, London. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York.

**Binodal** *n.* Having or relating to two modes; especially, having or occurring with two statistical modes.

**Biochemical oxygen demand (BOD)** *n.* A standard test for estimating the degree of contamination of water supplies. It is expressed as the quantity of dissolved oxygen (in mg/l) required during stabilization of the decomposable organic matter by aerobic biochemical action.

**Biocide** \ˈbī-ə-ˌsīd\ (1947) *n.* An agent incorporated in or applied to the surfaces of plastics to destroy bacteria, fungi, marine organisms, etc. Some plastics, e.g., acetals, acrylics, epoxies, phenoxies, ABS, nylons, polycarbonate, polyesters, fluorocarbons, and polystyrene, are normally resistant to attack by bacteria or fungi. Others, e.g., alkyds, phenolics, low-density polyethylene, urethanes, and flexible vinyls can under some circumstances be affected by growth of these organisms on their surfaces. Even though the resins themselves might be resistant, additives such as plasticizers, stabilizers, fillers, and lubricants can serve as food for fungi and bacteria. Examples of biocides are organotins, brominated salicylanilides, mercaptans, quaternary ammonium compounds, and compounds of mercury, copper, and arsenic.

**Biocompatibility** \-kəm-ˌpa-tə-ˈbi-lə-tē\ (1971) *n.* Materials, which are compatible with living blood and tissue, which is important for artificial blood vessels, hearts, etc.

**Biodegradable** \-di-ˈgrā-də-bəl\ (1961) *adj.* The process of rapid decomposition as a result of the action of micro-organisms.

**Biodegradable surfactant** *n.* Surfactant which may be decomposed by biological action.

**Biodegradation** *n.* The gradual breakdown of plastics and matter by living organisms such as bacteria, fungi, and yeasts. Most of the commonly used plastics are essentially not biodegradable, exhibiting limited susceptibility to assimilation by microorganisms. An exception is polycaprolactam. However, the growing emphasis on environmental aspects of discarded plastics has stimulated research in ways of attaining biodegradability after a predetermined time period. One method is to add a UV-light sensitizer that causes photodegradation after a period of exposure to light, followed by breakup after prolonged exposure to the elements, after which bacteria will finish the job. A third method is the deliberate incorporation of weal links in the polymer chain, temporarily protected by a degradable stabilizer. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

*See also photodegradation.*

**Biologically active polymers** *n.* Polymers capable of specifically and reversibly binding to analytes, including molecules and cells. The biologically active polymers are also capable of releasing substances upon electrical stimulation.

**Biomedical polymers** *See biocompatibility.*

**Biopolymer** \ˌbī-ō-ˈpä-lə-mər\ (1961) *n.* (1) A copolymer in which there is irregularity with regard to the placement (relative locations within the polymer chain, in a linear copolymer) of two or three or more chemically different types of units. These units may be mers, in a product of addition polymerization, or residues of the condensing small molecules in a polycondensate. (2) A polymer produced by living organisms, such as cellulose, natural rubber, silk, rosin, and leather.

**Biot number** *n.* A dimensionless group, *ht*/*k*, important in convective heating and cooling of sheets. *h* is the heat-transfer coefficient at the sheet's surface, *t* the sheet thickness of half-thickness, and *k* is the thermal conductivity of the sheet material.

**Biphenol** *n.* **A** (4,4′-isopropylidenediphenol). An intermediate used in the production of epoxy, polycarbonate, and phenolic resins. The name was coined after the condensation reaction by which it may be formed – two (bis) molecules of phenol with one of acetone (A).

**Biphenyl** \(ˌ)bī-ˈfe-nᵊl, -ˈfē-\ [ISV] (1923) *n.* (diphenyl, phenyl benzene) $(C_6H_5)_2$. A stable, high-boiling (256°C) liquid long used as a heat-transfer medium.

**Bipolymer** *n.* A polymer derived from two species of monomer (IUPAC). The more commonly used Syn: *copolymer.*

**Bird applicator** *n.* Device used for the laboratory application of coating of a prescribed thickness to test panels. It is a machined steel bar with a fixed clearance having a beveled undercut to guide the coating material.

*See applicator.*

**Bird's-eye** *n.* (1) Small localized areas in wood with the fibers indented and otherwise contorted to form few to many small circular or elliptical figures remotely resembling birds' eyes on the tangential surface. Common in sugar maple and used for decorative purposes; rare in other hardwood species. (2) A generic term describing a cloth woven on a dobby loom, with a geometric pattern having a center dot resembling a bird's eye. Originally birds eye was made of cotton and used as a diaper cloth because of its absorbent qualities, but now the weave is made from a variety of fibers or fiber blends for many different end uses. (3) A speckled effect on the back of a knit fabric resulting from the use of different colors on the face design. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

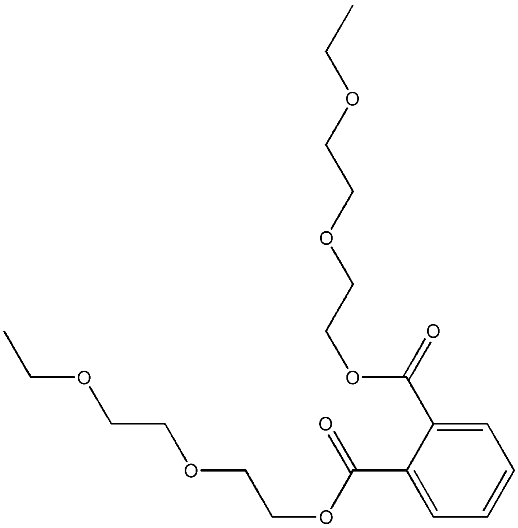
**Birefringence** \ˌbī-ri-ˈfrin-jən(t)s\ [ISV] (1898) *n.* (1) (double refraction) The difference between any two refractive indices in a single material. When the refractive indices measured along three mutually perpendicular axes are identical, the material is said to be optically isotropic. Orientation of a polymer by drawing may alter the refractive index in the direction of draw so that it is no longer equal to that in the perpendicular directions, in which event the material is said to display birefringence. Crystalline polymers, normally birefringent, may become optically isotropic at their melting points. Studies of birefringence provide useful information regarding the shapes of molecules, degrees of orientation and crystal habits. (2) Property of anisotropic materials, those which possess different refractive indices according to the direction of vibration of light passing through a crystal; usually observed with the aid of a polarizing microscope. The degree of birefringence is expressed numerically as the difference between the highest and lowest indices of refraction, even though there may be more than two different indices of refraction. Fox AM (2001) Optical properties of solids. Oxford University Press, UK.

**Bisacki** *n.* Grade of *See lac.*

**Bis(4-*t*-butylcyclohexyl)peroxy dicarbonate** *n.* A catalyst of the organic-peroxide family, used in reinforced plastics and vinyl polymerization. Unlike other percarbonates, it does not require refrigeration for storage or handling.

**Biscuit** *See preform.*

**Bis(ethoxyethoxyethyl) phthalate** \ˈbis-e-ˈthäk-sē-e-ˈthäk-sē-ˈe-thəl-ˈtha-ˌlāt\ *n.* $C_6H_4(COOC_2H_4\ OC_2H_4OC_2H_5)$. A good primary plasticizer for polyvinyl acetate, nitrocellulose, cellulose acetate, and many other polymers (*See image*).

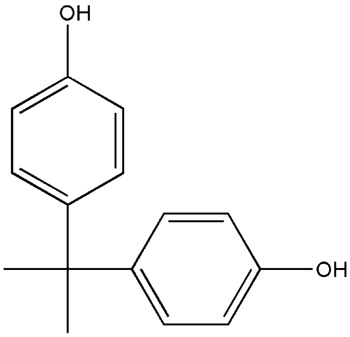


**Bis(*β*-hydroxyethyl-*γ*-aminopropyltriethoxy silane** *n.* A silane coupling agent used in reinforced epoxy resins, also in many reinforced thermoplastics such as PVC, polycarbonates, nylon, polypropylene, and polysulfones.

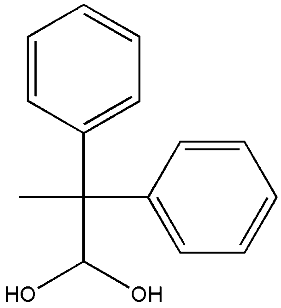
**Bismaleimide resins** *n.* Bismaleimide resins are low molecular substances (dry powders) containing imide structures already in the monomer form.

**Bismarck brown** *n.* Brown-colored dyestuff, which chemically is triaminoazobenzene. It dissolves in alcohol and water, to yield reddish-brown solutions. It has some application in the manufacture of mahogany stains.

**Bisphenol A** \ˈbis-ˈfē-ˌnōl, -ˌnól. fi-ˈ\ *n.* $OH–Ar–(CH_3)_2$ –Ar–OH, a diol which reacts with epichlorohydrin to form bisphenol epoxy resins. (4,4′-isopropylidenediphenol) An intermediate used in the production of epoxy, polycarbonate, and phenolic resins. The name was coined after the condensation reaction by which it may be formed – two (bis) molecules of phenol with one of acetone (A) (*See image*).



**Bisphenol A and F** *n.* Dihydroxydiphenyldimethylmethane, mol wt 224.1. Insoluble in water. Used in the manufacture of phenolic and epoxy resins. Condensation product formed by reaction of two (bis) molecules of phenol with acetone. This polyhydric phenol is a standard resin intermediate, along with epichlorohydrin, in the production of epoxy resins (*See image*).



**Bisphenol epoxy resins** *n.* Resins based on bisphenol A.

**BISRA** *n.* Abbreviation for British iron and steel research association.

**Bistre** \\ˈbis-tər\\ [Fr *bistre*] (ca. 1751) *n.* Brown water color pigment, which is derived from the tarry soot of burned, resinous wood and beechwood. It is similar to asphaltum, in color and composition. The color varies from saffron yellow to brown-black, depending upon the source and treatment of the raw material.

**Bis(tri-*n*-butyltin) oxide** *n.* A liquid derived by the hydrolysis of tributyltin chloride, used to control the growth of most fungi, bacteria and marine organisms on plastics used in boat construction and in urethane foams.

**Bis(tri-*n*-butyltin) sulfosalicylate** *n.* An antimicrobial agent used in flexible PVC film and urethanes.

**Bis(2,2,4-trimethyl-1,3-pentanediol) monoisobutyrate adipate** *n.* A plasticizer for cellulosic resins and polystyrene.

**Bite** *n.* (1) The ability of an adhesive to penetrate surfaces and thereby produce an adhesive bond. (2) Syn: nip.

**Bi-*tert*-butyl-*p*-cresol** *n* (DBPC, butylated hydroxytoluene, and BHT) $[C(CH_3)_3]_2C_6CH_3H_2OH$. A white crystalline solid used as an antioxidant in polyethylene, vinyl monomers, and many other substances.

**Bitter-almond oil, synthetic** *See benzaldehyde.*

**Bittiness** *n.* Presence of material that hinders the appearance of a smooth and uniform coating film.

**Bitty** *n.* Said of coatings containing bits of skin or foreign matter of any type which project above the coating film and hinder the formation of a smooth and uniform film. Syn: peppery.

*See also nibs.*

**Bitumen** \\bə-ˈtyu-mən, bī-, -ˈtu-, *esp British also* ˈbit-yə-\\ [ME *bithumen* mineral pitch, fr. L *bitumen-*, bitumen] (15c) *n* Hydrocarbon material of natural or pyrogenous origin, or combinations of both, frequently accompanied by their non-metallic derivatives, which may be gaseous, liquid, semisolid, or solid and which is completely soluble in carbon disulfide.

*See asphalt, brown bitumen, elaterite, gilsonite, and rafaelite.*

**Bitumens** *n.* A naturally occurring, almost black materials that are also obtained in mineral-oil refining, it consists of a high molecular weight hydrocarbons dispersed in oil-like material.

**Bituminous cement** *n.* A black substance available in solid, semisolid, or liquid states at normal temperatures; composed of mixed indeterminate hydrocarbons; appreciably soluble only in carbon disulfide or other volatile liquid hydrocarbon; especially used in sealing built-up roofing and between joints and in cracks of concrete pavements.

**Bituminous coating** *n.* An asphalt or tar compound used to provide a protective finish for a surface.

**Bituminous emulsion** *n.* A suspension of minute globules of bituminous material in water or of minute globules of water in a liquid bituminous material; used as a protective coating against weather, especially where appearance is not important.

**Bituminous paints** *n.* (1) Originally, the class of paints consisting essentially of natural bitumens dissolved in organic solvents: they may or may not contain softening agents, pigments, and inorganic fillers. They are usually black or dark in color. Within recent years the term "bituminous" has, by common usage, come to include bitumen-like products such as petroleum asphalt. (2) A low-cost paint containing asphalt or coal tar, a thinner, and drying oils; used to waterproof concrete and to protect piping where bleeding of the asphalt is not a problem. Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York.

**Bituminous varnish** *See varnish.*

**Biuret** *n* (allophanamide, carbamylurea) $NH_2CONHCONH_2{\cdot}H_2O$. A white crystalline material derived from urea by heat or by reaction with an isocyanate. It is used primarily in analytical chemistry, but the biuret group is formed during some polymerization reactions, such as primary bonding in urethane elastomers. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Bivinyl** *See butadiene.*

**Black** *n.* Ideally, the complete absorption of incident light; the absence of any reflection. In the practical sense, any color which is close to this ideal in a relative viewing situation, i.e., a color very low saturation and of low luminance.

**Blackboard paint** *n.* Rapid drying flat paint capable of permitting writing on it by chalk; usually black or green in color.

**Black body** *n.* The theory that atoms can exist for a duration solely in certain states, characterized by definite electronic orbits, i.e., by definite energy levels of their extranuclear electrons, and in these stationary states they do not emit radiation; the jump of an electron from an orbit to another of a smaller radius is accompanied by monochromatic radiation. A black body has an emissivity ($e_B$) of 1, indicating that a black body absorbs then emits all radiation at a wavelength. A black body is the opposite property of a perfect reflector of radiation at a wavelength that absorbs no radiation. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Black boy gum** *See accroides.*

**Black chalk** A bluish black clay containing carbon.

**Black dammar** *See black east India.*

**Black east India** *n.* Dark colored resin collected in the East Indies. It resembles the dammars in several respects, notably in solubility and free acid content. Its alternative name is "black dammar".

**Black iron oxide** *n.* FeO·$Fe_2O_3$ or $Fe_3O_4$. Pigment black 11 (77499). Two black oxides of iron are used, namely, the natural mineral, magnetite, and the artificially produced oxide. Both types are magnetic. Neither possesses outstanding opacity. Magnetite consists of about 95% $Fe_3O_4$. Artificial back oxide consists of a mixture of ferric oxide ($Fe_2O_3$) and ferrous oxide (FeO). Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Black Japan** *n.* Black varnish-like material in which the higher grades of asphalt or other resinous compositions are employed, blended with suitable drying oils to produce hard, glossy black coatings which become insoluble in mineral spirits. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Black** *n.* Another name for graphite.

**Black light** *n* (deprecated). Popular term for ultraviolet radiation without any visible radiation. It is an incorrect term because *light* is defined as *visible* radiation and ultraviolet radiation is not detected by the visual mechanism of the eye. Syn: ultraviolet radiation.

**Black magnetic oxide** *See black iron oxide.*

**Black Orlon** *n.* Orlon® (black), acrylic fiber.

**Black out paint** Opaque paint, usually black or dark in color, used during war time, on windows, skylights, etc., to prevent the passage of light to the outside of a building.

**Black varnish** *n.* Any varnish in which the resin component is substituted completely, or in part, by a petroleum bitumen, or natural asphaltum.

**Blanc fixe** \ˈblaŋk-ˈfiks\ [F] (1866) *n* A synthetic form of barium sulfate prepared by reacting aqueous solutions containing barium ions with others containing sulfate ions and precipitating the reaction product. It is used as a special-purpose filler to impart X-ray opacity and high specific gravity. Precipitated barium sulfate is used as a semi-transparent extender in printing inks.

**Blanch** \ˈblanch\ [ME *blaunchen*, fr. MF *blanchir*, fr. OF *blanche*, feminine of *blanc*] (15c) *v.* (1) To make white. (2) As distinct from blush or bloom, a pale milky cast on a coating film.

**Blank** *n.* (1) A piece punched or die-cut from a sheet and intended for further forming into its final shape. (2) In chemical analysis, a dummy sample or solution of the same matrix as the sample to be analyzed but containing none of the analyte sought.

**Blanket** *n.* An unquilted bedding fabric designed primarily to provide thermal insulation.

**Blanket mark** *See corrugation mark.*

**Blanking** (die cutting). The cutting of flat sheet stock to shape by striking it sharply with a punch while it is supported on a mating die. Punch presses are often used for the operation. An alternate method is to make the cut with a thin, sharp-edged, shaped steel blade called a steel-rule die. *See also die cutting.*

**Blanking die** *n.* A metal die used in the blanking process.

**Blast cleaning** *n.* Cleaning and roughening of a surface (particularly steel) by the use of natural or artificial grit or fine metal shot (usually steel), which is projected against a surface by compressed air. *Also known as power cleaning.*

**Blast finishing** *n.* The removal of flash from molded objects (and/or dulling their surfaces) by impinging media such as steel balls, crushed apricot pits, walnut shells or plastic pellets upon them with sufficient force to fracture the flash. When the material being deflashed is not sufficiently brittle at room temperature, the articles are first chilled to a temperature below their brittleness temperature. Typical blast-finishing machines consist of wheels rotating at high speeds, fed at their centers with the media, which are thrown out at high velocities against the objects.

**Bleach** *n.* (1) Refers to the method of measuring the tinctorial strength of an ink or toner, usually accomplished by mixing a small portion of the ink (or toner) with a large amount of white base and evaluating the tinctorial strength of the ink versus a control standard. (2) A whitening agent such as an aqueous solution of sodium hypochlorite commonly used for oxidizing or whitening clothes.

**Bleached oil** *n.* Oil, which has been refined by the acid, alkali, or mechanical process and in which the refining includes a treatment at about 88°C (190°F) with an adsorbent such as fuller's earth or activated charcoal, after which the oil is filtered.

**Bleached shellac** *n.* Substantially colorless product obtained by bleaching natural orange gum lac with chlorine or chlorine-containing agents, such as sodium or calcium hypochlorites.

*Also known as bone dry bleached shellac.*

**Bleaching** *n.* (1) Loss of color of a paint or varnish. This may be due to internal chemical or physical action in the paint itself, to influences from the surface on which it is applied or to weathering or contamination from the atmosphere. (2) Intentional lightening of the color of a material such as wood, vegetable oils, varnishes, etc. (3) Any of several processes to remove the natural and artificial impurities in fabrics to obtain clear whites for finished fabric or in preparation for dyeing and finishing.

*See also fading and whitening in the grain.*

**Bleaching clay** *n.* Clay that possesses decolorizing characteristics for use in refining of mineral, petroleum, vegetable, and animal oils from the spinneret hole involved.

**Bleb** \\ˈbleb\\ (1607) *n.* A blister or bubble on the face of a spinning jet, interrupting the extrusion of the filament.

**Bleb rate** *n.* The frequency of bleb formation in an extrusion operation.

**Bleed** (1) *n.* An escape passage at the parting line of a mold, similar to an air vent but deeper, serving to allow material to escape or bleed out. (2) The spreading or running of a pigment color by the action of a solvent.

*See bleeding.*

**Bleed characteristics** *See bleeding.*

**Bleeding** *n.* (1) The diffusion of colorants through a coating from a previously painted substrate due to the action of the vehicle or solvent or both. The action is dependent on the pigments; vehicles, and solvents of the systems. (2) Diffusion of a soluble colored substance from, into and through a coating from beneath, thus producing an undesirable staining or discoloration. Materials, which give rise to this effect are tannins or dyes in some types of wood; wood preservatives; bituminous coatings; pigment dyestuffs; and stains. (3) Diffusion of coloring matter from the substrate; also, the discoloration arising from such diffusion. In the case of printing ink, the spreading or running of a pigment color by the action of a solvent such as water or alcohol. (4) Migration to the rubber surface of an oil, wax, or plasticizer as a film or in drops, sometimes called sweating. Also a term applied to organic pigment colors if they migrate into an adjacent stock of a different color, or when they are removable at the surface by water or other solvents. (5) The spreading or migration of an ink component into an unwanted area. The terms *migration*, *crocking*, *blooming*, and *bronzing* are sometimes used loosely to describe the same phenomenon. (6) Loss of color by a fabric or yarn when immersed in water, a solvent, or a similar liquid medium, as a result of improper dyeing or the use of dyes of poor quality. Fabrics that bleed can cause staining of white or light shade fabrics in contact with them while wet. Martens CR (1968) Technology of paints, varnishes and lacquers. Reinhold Publishing Co., New York. Paint testing manual: physical and chemical examination of paints, varnishes, lacquers, and colors – stp 500. American Society for Testing and Materials, West Conshohocken, PA, 1973. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978.

**Bleeding pigment** *n.* A pigment in a coating which is partially soluble in the solvent or vehicle portion of subsequent coats applied to it.

**Bleedout** In filament winding, the excess liquid resin that migrates to the surface of a winding.

**Blemish** *n.* Any surface imperfection of a coating or substrate.

**Blend** *n.* (1) A mixture, such as a mixture of solvents or a mixture of inks. (2) A yarn obtained when two or more staple fibers are combined in a textile process for producing spun yarns (e.g., at opening, carding, or drawing). (3) A fabric that contains a blended yarn (of the same fiber content) in the warp and filling.
*See alloy.*

**Blender** *n.* A round, softish brush of badger hair or similar material with a blunt tip, used for blending colors and removing brush marks left by coarser brushes. (2) A small laboratory mixer used to dispense pigment in a vehicle.
*Also called softener.*

**Blenders** *n.* Mixing of liquid/liquid and/or solids components by mixing in a vessel using paddles or other low shear rate means of mixing.

**Blending** *n.* (1) Any process in which two or more components or ingredients are physically intermingled without significant change of the physical states of the components. (2) The bringing together of two or more polymers, using whatever means may be needed, such that the final scale of segregation is microscopic or finer. (3) The combining of staple fibers of different physical characteristics to assure a uniform distribution of these fibers throughout the yarn.

**Blending resin** (extender resin) *n.* With respect to vinyl plastisols and organosols, a blending resin is one of larger particle size and lower cost than the dispersion resins normally used, a partial replacement for the primary resin. Blending resins are sometimes sued to achieve a better balance of properties other than cost.

**Blinding** *n.* Loss of luster of fibers after wet processing.

**Blinding of lithographic plates** *n.* Loss of ink-receptivity in the plates' image areas.

**Blister** *n.* (1) An imperfection on the surface of a plastic article caused by a pocket of air or gas beneath the surface. Note – A blister may be caused by insufficient adhesive; inadequate curing time, temperature or pressure; or trapped air, water, or solvent vapor. (2) A thermoformed canopy or pocket roughly hemispherical, for example an aircraft cockpit cover or a shape used in blister packaging.

**Blister house** *n.* House-like structure used as an accelerated test for blister resistance of coatings. Under controlled conditions, it attempts to simulate or accelerate blistering, which occurs on buildings.

**Blistering** *n.* Formation of dome-shaped projections in paints or varnish films resulting from local loss of adhesion and lifting of the film from the underlying surface.

**Blistering of paints, determination of degree of** *n.* Test method to evaluate the degree of blistering that may develop when paint systems are subjected to conditions which will cause blistering, using photographic reference standards.

**Blistering resistance** *n.* The ability of a coating to resist the formation of dome-shaped, liquid- or gas-filled projections in its film resulting from local loss of adhesion and lifting of the film from the underlying surface or coating.
*See blistering.*

**Blister packaging** *n.* The enclosing of articles in thermoformed, transparent "blisters" shaped to more or less fit the contours of the articles. The preformed blisters, usually slightly oversized to provide ample room, are made of thermoplastics such as vinyl, polystyrene, or cellulosic plastics. They are placed inverted in fixtures and loaded with the articles, and then cards coated with an adhesive are applied and sealed to the flanges between and around the blisters by means of heat and pressure.

**Block** *n.* A portion of a polymer molecule comprising many mer units that has at least one constitutional or configurational feature not present in the adjacent portions.

**Block coat** *See tie coat, transition primer, and barrier coat.*

**Block copolymers** *n.* (1) A copolymer with chains composed of shorter homopolymeric chains that are linked together. These "blocks" can alternate regularly or randomly. Such copolymers usually have some higher properties than either of the homopolymers or their physical blends. They have distinct blocks of polymer segments such as,

AAAABBBBAAAABBBAAA

sequencing of A and B monomers. When blocks are of different monomer species, the term *block copolymer* is used. (2) An essentially linear copolymer in which there are repeated segments of different chemical structure. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Block cutter** *n.* A craftsman who, by hand, hammers into a roller the brass strips and felt from which the wallpaper will be printed.

**Blocked curing agent** *n.* A curing agent or hardener rendered unreactive, which can be reactivated as desired by physical or chemical means.

**Block filler** *n.* A pigmented coating of heavy consistency used to fill void spaces in concrete or cinder blocks, prior to the application of the top coat, in order to produce a smooth surface.

**Block flooring** *n.* End grain blocks glued down in decorative patterns.

**Blocking** *n.* (1) The undesirable sticking together of two painted surfaces when pressed together under normal conditions or under specified conditions of temperature, pressure, and relative humidity. (2) Undesired adhesion between touching layers of a material, such as occurs under moderate pressure and sometimes pressure and heat, during storage of fabrication. Such agents are called antiblocking agents.

**Blocking point** *n.* Lowest temperature at which two coated surfaces in mutual contact will tick together sufficiently to injure the surfaces permanently and/or prevent easy separation. Thus, blocking point is a major quality criterion for evaluating coating-grade petroleum waxes.

**Blocking test** *n.* Procedure for determining the tendency of painted surfaces to stick together (block) when stacked or placed in contact with each other under a weighted load. *See block resistance.*

**Block press** *n.* (1) A press used to agglomerate laminate squares under heat. The squares, which have been cut from laminated sheet, are crossed to combat the anisotropy that normally occurs during laminating. (2) A press used to mold very large blocks of polystyrene foam.

**Block printing** *n.* A process of printing with blocks on which the unit or design stands out in relief. Pear wood is traditionally used, and a different block is needed for each color. *Also called hard-blocking. See printing.*

**Block resistance** *n.* The resistance to blocking.

**Blood compatibility** *See biocompatibility.*

**Blood red** *n.* A pigment consisting essentially of red iron oxide.

**Bloom** \ˈblüm\ [ME *blome*, fr. ON *blōm*; akin to OE *blōwan* to blossom] (13c) *n.* A haziness which develops on high gloss surfaces resulting in scattering of the surface reflectance. One mechanism is by exudation of a component such as a plasticizer out of the paint film. (2) Undesirable deposit, which sometimes forms on a glossy coating, resulting in whitening or loss of gloss. (3) Similar to bleeding in that it is migration of liquids or solids to the surface of a rubber compound to cause a change of appearance in color or cloudiness at the surface. Waxes used in excess of their solubility point in rubber come to the surface as a wax bloom, as does sulfur that remains as an excess over the amount actually chemically combined with the rubber. (4) Undesirable exudation of pentachlorophenol on the surface of wood that has been treated with a preservative solution. (5) In the plastics industry, bloom is a visible exudation on the surface of a plastic, generally caused by lubricant, plasticizer, etc. (6) The fluorescence of mineral oil; the blue or purple cast apparent when the oil is spread in a thin film. (7) The appearance of brightness of a dyed fabric when the fabric is viewed across the top while held at eye level. Syn: FOG. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978. *See blush. See also oil and debloomed.*

**Blooming** *See opening.*

**Bloom oil** *n.* One of the liquid decomposition products obtained from the destructive distillation of rosin. It can be regarded as a rosin oil, and has a bp of about 270°C.

**Blotch** *See finishing spot.*

**Blotching** *See mottle.*

**Blotch printing** *See printing.*

**Blowing** *n.* Porosity or sponginess occurring during cure, either deliberately through use of a gas releasing material to form sponge or expanded rubber, or inadvertently due to entrapped moisture to cause undesirable porosity. The practice of injecting a gas into a hot and flowing resin to create a part or film.

**Blowing** *n* (of Plaster). Appearance on the surface of the plaster of conical hollows (pops or blows). They are due to the presence of particles of reactive material, which expand, after the plaster has set, with sufficient force to push out the plaster in front of the particles. They may occur in undercoats or finishing coats of plaster, or both.

**Blowing agent** (foaming agent) *n.* A substance that, alone or in combination with other substances, is capable of producing a cellular structure in a plastic or rubber mass. Thus, the term includes compressed gases that expand when pressure is released, soluble solids that leave pores when leached out, liquids that develop cells when they vaporize, and chemical agents that decompose or react under the influence of heat to form a gas. Liquid foaming agents include certain aliphatic and halogenated hydrocarbons, low-boiling alcohols, ethers, ketones, and aromatic hydrocarbons. The chemical blowing agents range from simple salts such as ammonium or sodium bicarbonate to complex nitrogen-releasing agents, of which azobisformamide (ABFA) is an important example.

**Blown bitumen** *n.* Generally regarded as the blown products of petroleum bitumens, which have been previously obtained as residues from the distillation of crude petroleum. The petroleum bitumens are subjected to high temperature blowing with air, which has profound effects on the properties of the material. Melting point is raised considerably, and the product becomes rubbery. For bitumens of the same melting point, the blown product has a higher penetration figure.

*See bitumen and air blowing.*

**Blown castor oil** *n.* Product of very high viscosity and reddish-brown color, obtained by blowing raw castor oil. One of its chief applications is as a plasticizer or softener for cellulosic compositions.

**Blown film** *See film blowing.*

**Blown oils** *n.* Vegetable or fish oil, which has been partially oxidized by blowing with a current of air while at an elevated temperature. The characteristics of the oil such as its increased viscosity and degree of oxidation can be controlled by time, temperature, and amount of air.

**Blow-up ratio** *n* (BUR). (1) In blow molding, the ratio of the largest diameter of a cavity into which a parison is to be blown to the outside diameter of the parison. (2) In blown-film extrusion, the ratio of the film diameter, before collapsing or gusseting, to the mean diameter of the die opening.

**Blue asbestos** (crocidolite) *n.* An iron-rich form of asbestos, fibers of which were long used in reinforced plastics when good chemical resistance was essential.

**Blue basic lead sulfate (blue lead)** *n.* A variant of white basic lead sulfate containing 78% monobasic lead sulfate. It is not actually a blue pigment, but has a dark gray or slate color.

*See basic lead sulfate.*

**Blueing** Neutralizing the yellow cast of certain white pigments or paints by adding a trace of blue, thereby increasing apparent whiteness.

*See blue toner.*

**Blue stone** *See copper sulfate.*

**Blue toner** *n.* Pigment or dye used in small quantities to neutralize the yellow cast of certain white pigments or coatings, increasing apparent whiteness; also used to make black coatings more jet black.

**Blue verditer** *n.* Basic copper carbonate. Syn: azurite.

**Blue vitriol** *See copper sulfate.*

**Bluing** *n.* A mold blemish in the form of a blue oxide film on the polished surface of a mold, caused by overheating.

**Bluing off** *v.* A term used by mold makers for the process of checking the accuracy of two mating surfaces by applying a thin coating of Prussian blue to one surface, pressing the coated surface against the other surface, and observing the areas of intimate contact where the blue color has transferred.

**Blushing** *n.* (1) Film defect, which appears as a milky opalescence as the film dries; can be a temporary or permanent condition. It is generally caused by rapid evaporation, moisture, or incompatibility. Syn: fog. (2) Milky opalescence which sometimes develops as a film of lacquer dries, and is due to the deposition of moisture from the air and/or precipitation of one or more of the solid constituents of the lacquer; usually confined to lacquers which dry solely by evaporation of solvent. Also applies to printing inks. (3) A white or grayish cast on high gloss paint; results from the precipitation of binder solids owing to incompatibility with water, oil, or solvent. *See also bloom.*

**BMC** *n.* Abbreviation for bulk molding compound.

**BOA** *See benzyl octyl adipate.*

**Board** *n.* (1) A heavy weight, thick sheet of paper or other fibrous substance, usually of a thickness greater than 6 mil (0.006 in.). (2) Lumber less than 2 in. (6 cm) thick and between 4 (10 cm) and 12 in. (30 cm) in width; a board less than 4 in. (10 cm) wide may be classified as a strip.

**Board and batten** *n.* A type of wall cladding for wood-frame houses: closely spaced, applied boards or sheets of plywood, the joints of which are covered by narrow wood strips.

**Board and brace** *n.* A type of carpentry work consisting of boards which are grooved along both edges and have thinner boards fitted between them.

**Board foot** A unit of cubic content, used in measuring lumber; equal in volume to a piece 1 $ft^2$ and 1 in. thick, or 2360 $cm^3$.

**Boardy** A term used to describe a fabric with a very stiff hand.

**Bob-and-C** \ˈbä-bən\ [origin unknown] (1530) *n.* A cylindrical or slightly tapered barrel, with or without flanges, for holding slubbings, rovings, or yarns.

**BOBTEX® ICS yarn system** *n.* A process for producing a simulated spun yarn by embedding individual fibers in a thermoplastic or adhesive coating on a filament yarn.

**Bodanyl** *n.* Poly(caprolactam). Manufactured by Feldmühle, Rorschach, Switzerland.

**Bodied linseed oil** *See bodied oil.*

**Bodied oil** *n.* In the strictest sense of the term, this is a drying oil which has been heat polymerized. The term is also used more broadly to describe drying oils which have viscosities greater than those of the oils in their natural condition, irrespective of how the increased viscosity is attained, e.g., blown oil or stand oil.

**Body** *n.* (1) A term used loosely in the paint and adhesives industries to denote overall consistency, i.e., a combination of viscosity, density, pastiness, tackiness, etc. (2) An aspect of fabric quality, akin to drape and hand. (3) A general term referring to viscosity, consistency, and flow of a vehicle or ink. (4) Used also to describe the increase in viscosity by polymerization of drying oils at high temperatures. (5) A practical term widely used to give a qualitative picture of consistency. For Newtonian liquids, both is the same as viscosity.

**Body gum (#8 varnish)** In printing inks, linseed oil that has been heat polymerized to a heavy, gummy state. It is commonly used as a bodying agent.

**Body putty** *n.* A paste-like mixture of plant resin, often a polyester, and a filler such as talc, used to smooth and repair metal surfaces such as auto bodies.

**Bodying** *n.* Increase in the apparent viscosity of a paint, varnish, resin, or lacquer, which occurs either deliberately during manufacture of adventitiously during storage.

**Bodying agent** *n.* A material added to an ink to increase its viscosity.
*See thickener.*

**Boea** *n.* One of the classes of Manila copal.

**Boiled oil** *n.* Linseed oil, and sometimes soya oil, which has been treated in any of the following ways: (a) Heated for a short time to slightly increase viscosity and shorten drying time; (b) Heated with compounds of lead and/or cobalt and/or manganese forming fatty acid salts of the metal(s), thus shortening the drying time; (c) By adding soluble driers with or without heating. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Boilers** Group name for nitrocellulose and lacquer solvents.

**Boil-in-bag** A type of food packaging foil, plastic, or laminate intend to be dropped into boiling water in order to cook the contents.

**Boiling point** Temperature at which the vapor pressure of a liquid is just slightly greater than the total pressure of the surroundings. The liquid as a consequence is rapidly converted from the liquid state into a vapor.

**Boiling-point elevation** *n.* A colligative property: the increase in boiling point of a solvent brought about by the presence of a solute. For each mole-weight of solute in solvent there is a boiling point elevation and the change in bp is represented by

$$\Delta T_{\mathrm{bp}} = K_{\mathrm{bp}} m,$$

where $K = 0.51$ for water, and $m$ is the molality or mole-weight solute/1000 g of solvent. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Blow molding** The process of forming hollow articles by expanding a hot plastic element against the internal surfaces of a mold is blow molding. In its most common form, the process comprises extruding a tube (*parison*) downward between the opened halves of a metal mold, closing the mold to pinch off and seal the parison at top and bottom, injecting air through a needle inserted through the parison wall, cooling the mass by contact with a chilled mold, opening the mold and removing the formed article. Improvements on this process have increased the number of products and their properties. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Boiling range** Range between initial and final boiling temperatures of a solvent. Many solvents have no specific boiling point but distill over a definite range of temperature; e.g. VM&P Naphtha 250–300°F.

**Bole** *n.* Name frequently given in the arts to clay, either white or colored.

**Bolster** \ˈbōl-stər\ [ME, fr. OE; akin to OE *belg* bag] (before 12c) *n.* A spacer or filler in a mold.

**Bolt** *n.* A roll or piece of fabric of varying length.

**Boltzmann constant** *n.* The number that relates the average energy of a molecule to its absolute temperature, $1.380658 \times 10^{-23}\ \mathrm{J K^{-1}}$, $1.3807 \times 10^{-16}\ \mathrm{erg K^{-1}}$. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Boltzmann superposition principle** *n.* Strain is presumed to be a linear function of stress, so the total effect of applying several stresses is the sum of the effects of applying each one separately. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Bolus alba** \ˈbō-ləs ˌal-bə\. *See kaolin.*

**BON** *n.* Acronym for betaoxy-naphthoic acid, which can be coupled with a variety of amine compounds to form a soluble azo dye, which is then precipitated by any of several metals to form "Bon" reds or maroons.

**Bon-arylamide red** *n.* Any of any group of metal-free monazo pigments based on substituted 2-hydroxy-3-naphthoic acid.

**Bond** *n.* (1) *Chemical* – Force of attraction between atoms in a molecule. (2) *Adhesive* – Adhesion between to materials, such as between an adhesive and a given surface. (3) *Coatings* – Adhesion between a coating and a substrate to which it has been applied.

*See also adhere.*

**Bond axis** *n.* A line passing through the nuclei of two bonded atoms.

**Bond coat** *n.* Coating used to improve the adherence of succeeding coats.

**Bond distance** *n.* The distance between nuclei of two bonded atoms.

*Also known as bond length.*

**BON pigment** *n.* (1) Any of several brilliant reds and maroons widely used in plastics and rubbers, resistant to bleeding, migration, and crocking. The initials Bon stand for $\beta$-oxynaphthoic acid, the base raw material. (2) A related azo pigment made by coupling $\beta$-hydroxynaphthoic acid to an amine and forming the barium, calcium, strontium, or manganese salt thereof. The colors range from yellowish red to deep maroon.

**Bond strength (adhesive)** *n.* (1) Adhesive bond between joined substrates, the force required to break the bond divided by the bond area (Pa) (tensile-shear strength. The term adherence is frequently used in place of bond strength adhesion and bond). (2) Of fiber-reinforced laminates, the strength of the bond between fiber and matrix. (3) The degree of attraction between adjacent atoms within a molecule, usually expressed in J/mol. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

*See peel adhesion.*

**Bonded adhesive** *See adhesive.*

**Bonded fabric** *n.* (1) A wed of fibers held together by an adhesive medium that does not form a continuous film. (2) *See nonwoven fabric.*

**Bonding** *n.* (1) A process for adhesive laminating two or more fabrics or fabric and a layer of plastic foam. There are two methods: the flame method used for bonding foam and the adhesive method used for bonding face and backing fabrics. (2) One of several processes of binding fibers into thin sheets, webs, or battings by means of adhesives, plastics, or cohesion (self-bonding). Several types of bonding or bonding processes are listed below. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Point bonding** *n.* The process of binding thermoplastic fibers into a onwoven fabric by applying heat and pressure so that a discrete pattern of fiber bonds is formed. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Print bonding** *n.* A process of binding fibers into a non-woven fabric by applying an adhesive in a discrete pattern. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Saturation bonding** *n.* A process of binding fibers into a non-woven fabric by soaking the web with an adhesive. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Spray bonding** *n.* A process of binding fibers into a non-woven fabric involving the spray application of a fabric binder.

**Stitch bonding** *n.* A bonding technique for non-wovens in which the fibers are connected by stitches sewn or knitted through the web. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

*Also known as quilting.*

**Bonding action** *n. See bond strength.*

**Bonding equipment** *n.* Equipment used for welding polymer parts such as ultrasonic welding; also cementing equipment.

**Bonding orbital** *n.* A molecular orbital in which electrons have lower energies than they would in the unbonded atoms; an orbital characterized by a region of high electron probability density between the bonded atoms, leading to a stabilizing effect on the molecule. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Bonding pair** *n.* A pair of electrons shared between two atoms and constituting a covalent bond model). Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Bonding resin** *n.* Any resin used for bonding aggregates together, e.g., holt melt epoxy, such as foundry sands, grinding wheels, abrasive papers, asbestos brake linings, and concrete masses. Plywood adhesives are sometimes called bonding resins. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Bonding with binder fibers** *n.* Specially engineered low-melting point fibers are blended with other fibers in a web, so that a uniformly bonded structure can be generated at low temperature by fusion of the binder fiber with adjacent fibers. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Bonds, chemical** *n.* The electronic linkages between atoms such as –C–H, which can be covalent, ionic and others. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Bone black** *n.* Made by charring animal bones in closed retorts. Bone black is blue-black in color and is fairly smooth in texture. It contains carbon, calcium phosphate, and calcium carbonate. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Bone brown** *n.* Pigment related to bone black. Both are obtained from bones by calcinations, but with bone brown the temperature of calcinations is much lower and less carbonization occurs. The pigment is not widely used.

**Bone dry bleached shellac** *n.* A bleached, light-colored orange gum shellac.

*See bleached shellac.*

**Bone glue** *n.* Impure gelatin prepared from bones. Skeist I (ed) (1990) Handbook

of adhesives. Van Nostrand Reinhold, New York.
*See gelatin and glue.*

**Bone oil** *n.* Fatty oil obtained by the dry distillation of bones.

**Bone white** *n.* Pigment made by acclimating animal bones. Composed chiefly of tricalcium phosphate. Calcium carbonate and minor constituents make up the rest. Bone white is a grayish white and slightly gritty powder. Syn: bone ash. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Bookbinders' varnish** *n.* Rapid drying varnish based on shellac, sandarac or gum mastic, or mixtures of these resins. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Booster ram** *n.* A hydraulic ram used as an auxiliary to main ram of a molding press.

**BOP** Abbreviation for butyl octyl phthalate.
*See butyl ethylhexyl phthalate.*

**BOPP** Abbreviation for biaxially oriented polypropylene.

**Boralloy** *n.* Boronitride, manufactured by Union Carbide, USA.

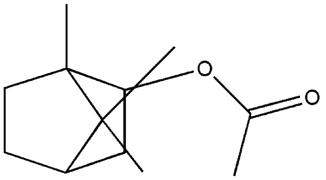
**Borax** \ˈbōr-ˌaks, ˈbór-, -əks\ [ME *boras*, fr. MF, fr. ML *borac-*, *borax*, fr. Arabic *būraq*, fr. Persian *būrah*] (14c) *n.* $Na_2B_4O_7 \cdot 10H_2O$. Natural hydrated sodium borate, found in salt lakes and alkali soils. Also, the commercial name for sodium borate. It is used in some fire-retardant paints, and to dissolve casein in distemper.

**Border** *n.* A narrow strip around an edge. A border wallcovering is used for trimming, or as a frieze, generally just under the ceiling. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.
*See soffit.*

**Boric-acid ester** *n.* One of a family of flame retardants for plastics, etc. and plasticizers. Examples are the trimethyl, tri-*n*-butyl, tricyclohexyl, and tri-*p*-cresyl borates. Kidder RC (1994) Handbook of fire retardant coatings and fire testing services. CRC Press, Boca Raton, FL.

**Borneol** \ˈbór-nē-ˌól, -ˌōl\ [ISV, fr. *Borneo*] (1876) *n.* $C_{10}H_{18}O$. Constituent of pine oil. A terpenic alcohol. It is a solid at ordinary temperature, with a mp of 203°C (397.4°F), bp of 212°C (413.6°F), Sp gr of 1.011. It is sometimes described as bornyl alcohol or borneo camphor. Solubility characteristics are good, and it has some application as a plasticizer.

**Bornyl acetate** *n.* A solvent and plasticizer for nitrocellulose.



**Boron-epoxy composite** *n.* A composite in which boron fibers are embedded in an epoxy matrix. Modulus is about 200 GPa, tensile strength about 1.6 GPa, rising with fiber content. The combination of high specific modulus and high specific strength has made these composites attractive for aerospace vehicles in spite of their high cost. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Boron fiber** *n.* An advanced reinforcing fiber produced by passing 10-µm, resistively heated tungsten wire through an atmosphere of boron trichloride and hydrogen. Hydrogen reduces the $BC1_3$ and the boron deposits on the wire to make a filament from 120 to 140 µm in diameter. Density is low, 2.4–2.6g/cm$^3$. Boron fiber is extremely strong and stiff with strength near 3.1GPa (450kpsi) and modulus near 400 GPa (58Mpsi). The very high cost of these fibers (ca. $1/g) has limited their use. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Boron hydride** *See diborane.*

**Boron resins** *n.* Esters derived from boric acids and polyhydric alcohols. Characterized by solubility in water.

**Boron trifluoride etherate** *n.* A metal halide $BF_3{\cdot}O(C_2H_5)_2$ which serves as a cationic initiator for the polymerization of monomers.

**Boss** *n.* (1) A protuberance provided on an article to add strength, facilitate alignment during assembly, or for attaching the article to another part. (2) That part of a drafting roll of largest diameter where the fibers are gripped. It may be an integral part of the roll, as in steel rolls, or it may have a covering of leather, cork, etc. In the former case, the boss is fluted.

**Boston round** *n.* A family of variously sized, blown bottles either glass or plastic, of circular-cylindrical shape with a short curved shoulder and length-to-diameter ratio in the body of about 1.7:1.

**Boston stone, the** *n.* Originally a paint mill imported around 1700 by a painter, Thomas Child. Later used as a landmark or central point from which distances from Boston were measured. It is the earliest known implement of the paint industry in America. The round stone was rolled back and forth in the trough of a larger flat stone underneath, in which oil and pigment were dispersed. The Boston Stone is the official insignia of the Federation of Societies for Coatings Technology. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Botany bay resin** *See accroides.*

**Bottom** *n.* (1) Ship's bottom. (2) Hard deposit in paint cans.

**Bottom-drying** *n.* Drying of a film from the bottom towards the top of the film, e.g., lead naphthenate is used as a bottom drier.

**Bottoms** *See tailings.*

**Bouclé** \bu-ˈklā\ [F *bouclé*] (1895) *n.* (1) A fabric woven or knit with bouclé yarns. (2) An uneven yarn of three piles one of which forms loops at intervals.

**Bouclé yarn** *n.* A novelty yarn with loops which give fabrics a rough appearance. Some bouclé yarns have cotton cores with other fibers wound around them. Bouclé yarns may be made from wool, cotton, silk, linen, manufactured fibers, or combinations of fibers. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Bouguer's (Lambert's) law** *n.* Describes the proportionality between the absorption of radiant energy by a non-scattering material and its optical path length $-\log T_i/l = K$, where $T_i$ is the internal transmittance, $l$ the path length, and $K$ is the unit absorption coefficient. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw Hill Science/Engineering/Math, New York.

*See Beer–Bougure law.*

**Bounce back** *n.* A spray rebound.

**Boundary surface** *n.* A surface of constant electron probability density, $\psi^2$.

**Bourrelet** A double-knit fabric with raised loops running horizontally across the surface of the cloth giving a rippled or corded effect.

**Bow** *n.* (1) Distortion of a board in which the face is convex or concave longitudinally. (2) The greatest distance, measured parallel to the selvages, between a filling yarn and a straight line drawn between the points at which this yarn meets the selvages. Bow may be expressed directly in inches or as a percentage of the width of the fabric at that point.

**Bow window** *See bay.*

**Boxed heart** *n.* Term used when the pith falls entirely within the four faces anywhere in the length of a piece of wood.

**Boxing** *v.* Combining of two or more separate batches to one uniform batch.

**Box loom** *n.* A loom using two or more shuttles for weaving fabrics with filling yarns that differ in fiber type, color, twist, level, or yarn size. The box motion is automatic, changing from one shuttle to another. Examples of fabrics made on box looms are crepes and ginghams.

**Box mark** *n.* A fine line parallel to the filling caused by shuttle damage to a group of filling yarns.

**Boyer-Beaman rule** *n.* A rule of thumb stating that the ratio of polymer's glass-transition temperature to its melting temperature ($T_g/T_m$), both in Kelvin, usually lies between 0.5 and 0.7. For symmetrical polymers, such as polyethylene, it is close to 0.5; for unsymmetrical ones, such as polystyrene and polyisoprene, it is near 0.7.

**Boyle's law** \bóilz-\ [Robert *Boyle*] (ca. 1860) *np.* The part of the ideal-gas law, due to Robert Boyle, stating that the volume of a gas is inversely proportional to its pressure. This can also be stated as, at a constant temperature the volume of a given quantity of any gas varies inversely as the pressure to which the gas is subjected. For a perfect gas, changing from pressure $p$ and volume $v$ to pressure $p'$ and volume $v'$ without change of temperature, $pv = p'v'$. Atkins PW, De Paula J (2001) Physical chemistry, 7th edn. W. H. Freeman Co., New York.

**Bozzo** *See abbozzo.*

**BPF** *n.* Abbreviation for British plastics federation.

**BR** *n.* Poly(butadiene). Abbreviation for butadiene rubber (British standards institution).

*See polybutadiene.*

**Br** *n.* Chemical symbol for the element bromine.

**Barbender plastograph** *n.* A rheometer for measuring shear-strain with temperature relationships. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Braid** *n.* (1) A narrow textile band, often used as trimming or binding, formed by plaiting several strands of yarn. The fabric is formed by interfacing the yarns diagonally to the production axis of the material. (2) In aerospace textiles, a system of three or more yarns which are interlaced in such a way that no two yarns are twisted around each other.

**Braid angle** *n.* The acute angle measured from the axis of a fabric or rope to a braiding yarn.

**Braided fabric** *n.* A narrow fabric made by crossing a number of strands diagonally so that each strand passed alternatively over or under one or more of the other strands. They are frequently used in shoelaces and suspenders.

**Braiding** *n.* The intertwining of three or more strands to make a cord. The strand form a regular diagonal pattern down the length of the cord.

**Brake lining medium** *n.* A medium for bonding together the chosen filling agent for the brake lining, e.g., asbestos.

**Branched** *n.* Refers to side chains attached to the main chain in molecular structure of polymers, as opposed to linear arrangement.

**Branching** *n.* (1) The growth of a new polymer chain from an active site on an established chain, in a direction different from that of the original chain. Branching occurs as a result of chain-transfer processes or from the polymerization of difunctional monomers, and is an important factor influencing polymer properties. (2) Two-dimensional polymers having relatively short side-chains branching from the main backbone. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Brashness** *n.* Condition of wood characterized by low resistance to shock and by an abrupt failure across the grain without splintering.

**Brayer** *n.* A small hand roller for distributing ink.

**Brazil wax** *n.* A name sometimes applied to a carnauba wax.

**Brazil-wood** *n.* A natural red dye from the wood of *Caesalpinia braziliensis.*

**Break** The break in an oil is the flocculent material or foots which separate on long standing or upon heating.

**Breakdown** *n.* To soften or plasticize rubber by working it on a rubber mill or in an internal mixer. Same as to mill or masticate.

**Breakdown voltage** *n.* The voltage required, under specific conditions, to cause the failure of an insulating varnish or other insulating material.

*See dielectric breakdown voltage and dielectric strength.*

**Breakfree oil** *n.* Oil which has been refined mechanically by heating to about 88°C (190°F), adding an adsorbent such as fuller's earth or activated charcoal, agitating, and filtering.

*Also known as non-break oil.*

**Break factor** *n.* A measure of yarn strength calculated as: (1) the product of breaking strength times indirect yarn number, or (2) the product of breaking strength times the reciprocal of the direct yarn number.

**Breaking** *v.* Separation of an emulsion or latex into two phases.

**Breaking extension** *n.* Elongation necessary to cause rupture of a test specimen; the tensile strain at the moment of rupture. *See elongation.*

**Breaking length** *n.* A measure of the breaking strength of a yarn; the calculated length of a specimen whose weight is equal to its breaking load. The breaking length expressed in kilometers is numerically equal to the breaking tenacity expressed in grams-force per tex. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Breaking ratio** *See break factor.*

**Breaking strength** (Load) *n.* (1) The maximum resultant internal force that resists rupture in a tension test. The expression "breaking strength" is not used for compression tests, bursting tests, or tear resistance tests in textiles. 2. The load (or force) required to break or rupture a specimen in a tensile test made according to a specified standard procedure.

*Also see breaking load and ultimate strength.*

**Breaking tenacity** *n.* The tensile stress at rupture of a specimen (fiber, filament, yarn, cord, or similar structure) expressed as Newton per tex, grams-force per tex, or gram-force per denier. The breaking tenacity is calculated from the breaking load and linear density of the unstrained specimen, or obtained directly from tensile testing machines, which can be suitably adjusted to indicate tenacity instead of breaking load for specimens of known linear density. Breaking tenacity expressed in grams-force per tex is numerically equal to breaking length expressed in kilometers. Shah V

(1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Break spinning** *n.* A direct spinning process for converting manufactured fiber tows to spun yarn that incorporates prestretching and tow breaking with subsequent drafting and spinning in one operation.

**Break-out** *See smash.*

**Break test(oils)** *n.* Break in drying oils is a measure of the materials rendered insoluble in carbon tetrachloride under the conditions of test by a prescribed method.

**Breathable film** *n.* A film that is at least somewhat permeable to gases due to the presence of open cells throughout its mass or to minute perforations. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Brewster's law** *n.* The tangent of the polarizing angle for a substance is equal to the index of refraction. The polarizing angle is that angle of incidence of which the reflected polarized ray is at right angles to the refracted ray. If $n$ is the index of refraction and $\theta$ the polarizing angle, $n = \tan\theta$. Moller KD (2003) Optics. Springer-Verlag, New York.

**Bridging** *n.* (1) In the flow by gravity of powders or pellets in feed hoppers and the throats of extruders and injection molders, the stoppage of flow caused by the formation of an arch across the flow path.

**Bridle** *n.* Series of rolls that keeps the tension on the strip of a continuous line.

**Bright** *n.* The term applied to fibers whose luster has not been reduced by physical or chemical means; the opposite of dull or matte. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Brightener, optical** *n.* fluorescent dye, or pigment, which absorbs UV radiation and re-emits light of a violet or bluish hue. Used to increase the luminance factor and to remove the yellowish of white or off-white materials. Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York.

**Brighteners** *n.* Additives for providing optical brilliance to a plastic part. Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York.

**Brightening agents** (optical brighteners, fluorescent bleaches, and optical whiteners) *n.* Brightening agents are chemicals used primarily in fibers but also to some extent in molded and extruded products, to overcome yellow casts and to enhance clarity or brightness. In contrast to bluing agents, which act by removing yellow light, the optical brighteners absorb ultraviolet rays and convert their energy into visible blue-violet light. Thus, they cannot be used ion compounds containing UV-absorbing agents. Optical brighteners are used in PVC sheet and film, fluorescent lighting fixtures, vinyl flooring, nylon fishing line, polyethylene bottles, etc. A few examples of optical brighteners are coumarins, naphthotriazolyl stilbenes, benzoxazolyl-, benzimidazolyl-, naphthylimide-, and diaminostilbene disulfonates. Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York. *See brightener, optical.*

**Brightfield illumination** *n.* The usual form of microscope illumination with the image of the sample on a bright, evenly lighted field; or in vertical illumination, light reflected through the objective by means of prism or semireflecting plane glass. Loveland RP (1981) Photomicrograsphy. Krieger Publishing Co., New York.

**Brightness** *n.* (1) Brightness is measured by the flux emitted per unit emissive area as projected on a plane normal to the line of sight. The unit of brightness is that of a perfectly diffusing surface giving out 1 lm/cm$^2$ of projected surface and is called the *Lambert*. The millilambert (0.001 L) is a more convenient unit. *Candle per square centimeter* is the brightness of a surface, which has, ion the direction considered, a luminous intensity of 1 c/cm$^2$. (2) (dprecated) The dimension of color that is referred to an achromatic scale, ranging from black to white, also called lightness or luminous reflectance or transmittance. Because of confusion with saturation, the use of this term should be discouraged. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Brightness flop** *n.* Change in lightness with direction of observation.

**Brilliance** *n.* A subjective term referring to: (1) Clarity or freedom from visible suspended matter or opalescence in clear coatings. (2) Cleanness or lack of a muddy or dirty tone in pigmented coatings. (3) The combined effect of lightness and strength, or purity of tone of printing inks. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Brilliant ultramarine** Synthetic ultramarine blue.

*See ultramarine blue.*

**Brine** \ˈbrīn\ [ME, fr. OE *bryne*; akin to MD *brīne* brine] (before 12c) *n.* Concentrated aqueous salt solution. The term can be applied to solutions of any salt, but it is commonly applied to solutions of sodium chloride.

**Brinell hardness** \brə-ˈnel-\ [Johann A. *Brinell* † Swedish engineer] (1915) *n.* The hardness of a material as determined by pressing a hardened steel or carbide ball, 10 mm in diameter, into the specimen under a fixed load. The Brinell number is the load in kilograms divided by the area in mm$^2$ of the spherical impression formed by the ball. For non-ferrous materials, the prescribed load is 500 kg applied for 30 s. The Brinell test is used mostly for ductile metals, for which the Brinell number is related to yield strength in a simple way. Also known as Brinell hardness number. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Bring forward** *n.* In repainting, to repair local defective areas with the appropriate paints so as to bring them into conformity with the surrounding areas before applying the finishing coats.

**Brinkman number** *n.* A dimensionless group relevant for heat transfer in flowing viscous liquids such as polymer melts. It is defined by $N_{\mathrm{Br}} = \mu V^2/k\Delta T$, in which $\mu$ is the viscosity, $V$ the velocity, $k$ the thermal conductivity, and $\Delta T$ is the difference in temperature between the stream and the confining wall. The number represents the ratio of the rates of heat generation and heat conduction. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.

**Bristle** \ˈbri-səl\ ME *bristil*, fr. *brust* bristle, fr. OE *byrst*; akin to OHGr *burst* bristle] (14c) *n.* (1) A generic term for a short, stiff, coarse fiber. It is frequently hog hair. (2) Any grade of nylon monofilament used in toothbrushes, hairbrushes, paintbrushes (*tapered bristle*), etc.

**British gum** *See dextrin.*

**British standards institution** A national organization (corresponding to the American National Standards Institute and the American Society for Testing and Materials), which establishes and publishes standard specifications and codes of practice.

**British thermal unit** (Btu) *n.* Before the introduction of the SI system, the Btu was variously defined as the quantity of heat required to raise the temperature of 1 lb (avoirdupois) of water 1°F, either at or near 39°F (the temperature of maximum density), at 50°F or 60°F, or averaged from 32 to 212°F ("mean Btu"). The Btu is defined as 1055.056 J.

**Brittle** \ˈbri-tᵊl\ [ME *britil*; akin to OE *brēotan* to break. ON *brjōta*] (14c) *adj.* Easily broken when bent rapidly or scratched as with a knife blade or the finger nail; the opposite of tough.

**Brittle fracture** An abrupt breaking of a material in which there is very little or no elongation or distortion of the part before failure. In a tensile test, the stress-strain graph is nearly linear to the breaking point. Grellman W, Seidler S (ed) (2001) Deformation and fracture behavior of polymers. Springer-Verlag, New York.

**Brittleness** *n.* The lack of flexibility and the tendency to crack when deformed or struck.

**Brittleness temperature** The temperature at which a plastic or elastomer breaks in cantilever-bending impact under specific conditions. The brittleness temperature is related to that of the glass transition, for those plastics with $T_g$s below room temperature, such as flexible PVC. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Brittle point** The temperature at which a polymer no longer exhibits viscoelastic properties. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Brittle point, brittle temperature** Lowest temperature at which a material withstands an impact test under standardized conditions.

**Brittle strength** *n.* The strength of a polymer at the brittle point or temperature.

**Broadcast** \ˈbród-\ (1767) *adj.* To apply or sprinkle solid particles on an uncured coating surface.

**Broadcloth** \ -ˌklóth\ (15c) *n.* (1) Originally, a silk shirting fabric so named because it was woven in widths exceeding the usual 29 in. (2) A tightly woven, lustrous cotton or polyester/cotton blend fabric in a plain weave with a crosswise rib. It resembles poplin, but the rib is finer, and broadcloth always has more picks that poplin. The finest qualities are made with combed pima or Egyptian cotton. (3) A smooth, rich-looking, woolen fabric with a napped face and a twill back. Better grades have a glossy, velvety hand. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Broadgoods** A fabrics-industry term for woven materials, including glass fabrics that are over 46 cm in width.

**Broadloom** \-ˌlüm\ (1925) *adj.* A term that refers to carpets woven in widths from 54 in. to 18 ft, as distinguished from narrow loom widths of 27–36 in. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Brocade** \brō-ˈkād\ [S *brocado*, fr. Catalan *brocat*, fr. I *broccato*, fr. *broccare* to spur, brocade, fr. *brocco* small nail, fr. L *broccus* projecting] (1588) *n.* (1) A rich, Jacquard-woven fabric with an all over interwoven design of raised figures or flowers. The pattern is emphasized by contrasting surfaces or colors and often has gold or silver threads running through it. The background may be either a satin or a twill weave. (2) A term describing a cut-pile carpet having a surface texture created by mixing twisted and straight standing pile yarns. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Brocatelle** \ˌbrä-kə-ˈtel\ [Fr, fr. It *broccatello*] (1669) *n.* A fabric similar to brocade with a satin or twill figure in high relief on a plain or satin background. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Broken color** *n.* General multicolored effect brought about by the automatic merging of wet paints of various colors or by manipulation, which produce apparently accidental effects. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Broken-color work** *See antiquing.*

**Broken end** *n.* A broken, untied warp thread in a fabric. There are numerous causes, such as slubs, knots, improper shuttle alignment, shuttle hitting the warp shed, excessive warp tension, faulty sizing, and rough reeds, heddles, dropwires, and shuttles.

**Broken pick** *n.* A broken filling thread in a fabric. Usual caused include too much shuttle tension, weak yarn, or filling coming into contact with a sharp surface.

**Broken selvage** *See cut selvage.*

**Broken white** *n.* Off-white in which the initial pure whiteness of the principal pigment has been very slightly "broken" or modified in a yellow or brown direction.

**Bronze** \ˈbränz\ {*often attributive*} [F, fr. I *bronzo*] (1739) *n.* An appearance characteristic of some printed films in which the apparent color of the print depends upon the angles of viewing and illumination. Leach RH, Pierce RJ, Hickman, EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Bronze blue** *n.* One of the names applied to the complex ferric ferrocyanide or iron blues. Leach RH, Pierce RJ, Hickman, EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Bronze gold powders** *n.* Metallic powders made from alloys of copper. They range in color from bonze gold to green yellow. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers, Krieger Publishing Co., New York.

**Bronze paint** *n.* Paint incorporating bronze gold powder in a bronzing liquid. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers, Krieger Publishing Co., New York.

**Bronze paste** *n.* Paste consisting of fine metallic flakes in a volatile medium. The metal may be aluminum, copper, or alloys of copper. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers, Krieger Publishing Co., New York.

**Bronze pigment** *n.* Simulated bronze- or gold-colored pigments made by staining aluminum flakes with brown or yellow colorants. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers, Krieger Publishing Co., New York.

**Bronzing** *v.* (1) A subjective, descriptive, appearance term applied to the metal-like reflectance, which sometimes appears at the surface of non-metallic colored materials. It is perceived at the specular angle, by observing the image of a white light source, for example, and is characterized by a distinct hue of different dominant wavelength than the hue of the paint film itself. The origin of the selective specular reflectance observed is generally considered to be reflectance from very small particle size pigments partially separated from surrounding vehicle at or near the surface. (2) Characteristic metallic luster shown by certain highly colored pigments in full strength, e.g., certain iron and phthalocyanine blues. May also occur with bleeding type pigments in making finishes. (3) Application of imitation gold or other metals either in powder form or in leaves. (4) Printing with a sticky size and dusting same with finely powdered metal particles or flakes to give the appearance of metallic printing. *Also known as bronze dusting.* Leach RH, Pierce RJ, Hickman, EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Brookfield viscometer** *n.* The Brookfield “Synchrolectric” viscometer is the most widely used instrument for measuring the viscosities of plastisols and other liquids, both Newtonian and non-Newtonian.

About a dozen models are available to accommodate subranges of viscosity in the overall range from 0.01 to 1000 Pas. It is portable and can be hand held. A synchronous motor provides four or eight spindle speeds by shifting gears. Near the tip- of the spindle, and concentric with it, is a horizontal disk whose drag torque in the liquid is detected by a torsion spring; a pointer indicates viscosity. By taking readings at different rotational speeds, one can estimate the pseudoplasticity of the liquid. For accurate work, the spindle guard should be removed and the diameter of the vessel containing the liquid should be at least five times that of the disk. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK. Pierce PE (1969) Rheology of coatings. J Paint Tech 41(533):383-395

**Brookite** \ˈbru-ˌkīt\ [*Henry J. Brooke* † 1859 English mineralogist] (1825) *n.* Rutile form of titanium dioxide characterized by its orthorhombic form. Its color varies from black to reddish brown. It is not used directly as a pigment.

**Brown coat** *n.* The coat of roughly finished plaster beneath the finish coat; in three-coat work, the second coat of plaster, applied over a scratch coat and covered by the finish coat; in two-coat work, the base-coat plaster applied over lath or masonry; may contain a greater proportion of aggregate than the scratch coat.

*Also known as floating coat.*

**Browne heat test** Heat polymerization test designed to determine the purity of tung and similar oils. The result is reported as the number of minutes required to cause gelation at the specific temperature (282°C). Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, West Conshohocken, PA, 2001.

**Brown hard varnish** *n.* Spirit varnish prepared from shellac dissolved in industrial alcohol. Cheaper grades may consist of shellac–rosin mixtures, spirit manila, spirit manila–rosin mixtures, or alcohol soluble rosin-modified phenolic resin.

**Brownian motion** \ˈbraú-nē-ən-\ [Robert *Brown* † 1858 Scottish botanist] (ca. 1889) *n.* Refers to the continual movement of extremely small particles suspended in a fluid. The accepted explanation is that movement of the particles is due to bombardment by molecules of the fluid. The average length of path $L$ followed by a particle in any given direction at a given time $t$ is directly proportional to the square root of the absolute temperature $T$ and the time $t$; it is also inversely proportional to the square root of the viscosity $\eta$ of the medium and to the diameter $d$ of the particle (Avogadro's number $N$ and the gas constant $R$ enter in as constants):

$$L = \frac{2R}{N}\sqrt{\frac{Tt}{\eta d 3\pi}}.$$

Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Brownian movement** *n.* A continuous agitation of particles in a colloidal solution caused by unbalanced impacts with molecules of the surrounding medium. The motion may be observed with a microscope when a strong beam of light is caused to traverse the solution across the line of sight. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Brown rot** (1894) *n. See dry rot.*

**Brunswick black** \ˈbrənz-(ˌ)wik-\. Solution consisting of gilsonite, petroleum pitch, or similar material in spirit or aromatic hydrocarbons.

**Brush** \ˈbrəsh\ [ME *brusshe*, fr. MF *broisse*, fr. OF *broce*] (14c) *n.* A tool composed of bristles set into a handle; most often used to apply coatings. Bristles may be synthetic or natural. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Brushability** *n.* The ability or ease with which a coating can be brushed.

**Brush (or roller) cleaner** *n.* A combination of chemicals in which a brush or rollers may be soaked in order to permit cleaning with soap and water. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Brush graining** *n.* An imitation effect of wood grain; produced by drawing a clean dry brush through a dark liquid stain, applied over a dry, light base coat.

**Brushing consistency** *n.* Rheological conditions at which a coating can be properly applied to a substrate with a brush. Brushing is used on sweaters, scarves, knit underwear, wool broadcloths, etc.

**Brush mark** *n.* A small ridge or valley produced in a paint film by the combining action of the bristles of a brush.

**Brushout** The application of paint on a small surface for testing.

**BS** *n.* Abbreviation for British standard code of practice.

**BSI** *n.* Abbreviation for British standards institution.

**Btu (BTU)** *See British thermal unit.*

**Bubble** \ˈbə-bəl\ {*often attributive*} [ME *bobel*] (14c) *n.* (1) In blown-film extrusion, the expanding tube moving from the die to the collapsing rolls at the top of the tower. (2) A void within a molding or an extrusion.

**Bubble coating** *n.* Coating wherein the light scattering characteristics are derived partially or wholly from small bubbles or microvoids in a transparent binder. The air-filled or vapor-saturated voids having diameters in the range of the wavelength of light, are trapped in a water soluble medium such as soya protein. This type of coating has a low specific weight and high lightness.
*See microvoids.*

**Bubble forming** *n.* A variant of sheet thermoforming, in which the plastic sheet is clamped in a frame suspended above a mold, heated, expanded into a blister shape with air pressure, then molded to its final shape by means of a descending plug applied to the blister and forcing it downward into the mold. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Bubbler** *n.* A device inserted into a mold force, cavity, or core that delivers.

**Bubble tube viscometer** *n.* One of the bubble viscometers which is used by comparing the speed of a rising air bubble in a liquid of unknown viscosity with that of a liquid of known viscosity, both liquids being in corked glass tubes of identical size, and at the same temperature. Syn: air bubble viscometer. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Paint and coating testing manual (Gardner-Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Bubbling** *n.* Film defect, temporary or permanent, in which bubbles of air or solvent vapor, or both, are present in the applied film.

**Bucket spinning** *See pot spinning.*

**Buckling** (14c) *v.* (1) A crimping of the fibers in a composite material that may occur in glass-reinforced thermosets due to shrinkage of the resin during cure. (2) The principal mode of failure of axially loaded, slender structural members such as columns and panels.

**Buckram** \ˈbə-krəm\ [ME *buckeram*, fr. OF *boquerant*, from OP *bocaran*] (15c) *n.* A scrim fabric with a stiff finish, often used as interlining.

**Buffer** \ˈbə-fər\ {*often attributive*} [*buff*, v., to react like a soft body when struck] (1835) *n.* A solution which contains moderate or high concentrations of a Brønsted–Lowery conjugate acid–base pair; a solution whose pH does not change greatly in response to added acids or bases.

**Buffer coat** *n.* A finishing material applied over an old coating to protect it from solvent action of the new finish.

**Buffing** *n.* A surface-finishing method used with plastics and other materials in which the object is rubbed with cloths or cloth wheels that may contain fine, mild abrasives of waxes or both.

*Also see tumbling.*

**Buffing compounds** *n.* Polishing grit for developing a smooth surface.

**Buhr mill** *n.* Stone mill in which a viscous pigment-medium paste is dispersed between the flat surfaces of two large stones, one of which rotates.

**Buhrstone** \ˈbər-ˌstōn\ (1690) *n.* Type of porous flint, formed in France, used for millstones.

**Build** *n.* Real or apparent thickness, fullness, or depth of a dried film.

**Building** *n.* A more or less enclosed and permanent structure for housing, commerce, industry, etc., distinguished from mobile structures and those not intended for occupancy.

**Building Block** *n* (1846). A rectangular masonry unit, other than a brick, made of brunt clay, cement, concrete, glass, gypsum, or any other material suitable for use in building construction. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Building board** *n.* Any sheet of building material, often faced with paper or vinyl; suitable for use as a finished surface on walls, ceilings, etc. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Building coats** *n.* Coats used to build up a surface or surfaces before rubbing.

**Building code** *n.* A collection of rules and regulations adopted by authorities having appropriate jurisdiction to control the design and construction of buildings, alteration, repair, quality of materials, use and occupancy, and related factors of buildings within their jurisdiction; contains minimum architectural, structural, and mechanical standards for sanitation, public health, welfare, safety, and the provision of light and air.

**Building paper** *n.* A heavy, relatively cheap, durable paper, such as asphalt paper, used in building construction, especially in frame construction, to improve thermal insulation and weather protection and to act as a vapor barrier. Special types are: sheathing paper, used betweens sheathing and siding; floor lining paper, used between rough and finish floors. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Buildup** *n.* A term applied to substantivity of dye for a textile material. It refers to the ability of a dye to produce deep shades.

**Built-up roofing** *n.* A continuous roof covering made up of laminations or plies of saturated or coated roofing felts, alternated with layers of asphalt or coal tar pitch and surfaced with a layer of gravel or slag in a heavy coat of asphalt or coal tar pitch or finished with a cap sheet; generally used on flat or low-pitched roofs. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Bulk density** *n.* The density of a particulate material (granules, powder, flakes, chopped fiber, etc.) expressed as the ratio of weight to total volume, voids included.

**Bulk development** *n.* Any of various relaxation treatments to produce maximum bulk in textured or latent crimp yarns or in fabrics made there from. The essential conditions are heat, lubrication, movement, and the absence of tension. Bulk development may be accomplished during wet processing or may be a separate operation such as hot-air tumbling, steam-injection tumbling, or dry cleaning.

**Bulk factor** *n.* The ratio of the volume of a given mass of plastic particles to the volume of the same mass of material after molding or forming. The bulk factor is also equal to the ratio of the density after molding or forming to the apparent density (bulk density) of the material as received.

**Bulking** *n.* In the process of formulating coatings, the step wherein ingredient weights are converted to their volume equivalents.

**Bulking value** *n.* Reciprocal of apparent density. Solid volume of a unit weight of material, usually expressed as gallons per pound or l/kg. For practical purposes this is 0.120 divided by the specific gravity (ASTM). Syn: specific volume.

*Also called specific volume.*

**Bulk material** *n.* A material or product in large quantity such as a drum or sack.

**Bulk modulus** *n.* The modulus of volume elasticity, i.e., the resistance of a solid or liquid to change in volume with change in pressure, at constant temperature. The thermodynamic definition is:

$$B = -v(\partial P/\partial v)_T = -(\partial P/\partial \ln v)_T,$$

in which $v$ is the specific volume, $P$ the pressure, and $T$ is the specific temperature. This may be approximated over an interval of pressure as $0.5\cdot(v_2+v_1)\cdot(P_2-P_1)/(v_1-v_2)$. With plastics, $B$ gradually diminishes as temperature rises and increase with rising pressure. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Bulk molding compound (BMC)** *n.* *See premix.*

**Bulk polymerization** *n.* The polymerization of a monomer (mass polymerization) in the absence of any medium other than a catalyst or accelerator. The monomer is usually a liquid, but the term also applies to the polymerization of glass and solids in the absence of solvents or any other dispersing medium. Polystyrene, polymethyl methacrylate, low-density polyethylene, and styrene-acrylonitrile copolymers are examples of polymers most frequently produced by bulk polymerization. Acrylic monomers may be simultaneously polymerized and formed into products by conducting the polymerization in molds such as those for rods and sheets. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Bulk specific gravity** *n.* The specific gravity of a porous solid when the volume of the solid used in the calculation includes both the permeable and impermeable voids. Compare specific gravity and bulk density.

**Bulk yarn** *n.* Yarn of glass (or other) fiber in bulk form, as opposed to roving, mat, or woven forms.

**Bumping** *n.* Sudden, explosive boiling following the superheating of a liquid.

**Buna** \ˈbyü-nə, ˈbü-\ *n.* Copolymer from butadiene and acrylonitrile, manufactured by Hüls, Germany.

*See acrylonitrile-butadiene copolymer.*

**Buna rubber** *n.* A brand of synthetic rubber made by polymerizing or copolymerizing butadiene with another material, as acrylonitrile, styrene, or sodium.

**Buna-S or SS** (GR-S) *n.* A synthetic elastomer produced by the copolymerization of butadiene and styrene. Manufactured by Hüls, Germany.

*Also known as styrene-butadiene rubber.*

**Bunghold oil** *See boiled oil.*

**Bunghole** \ˈbəŋ-ˌhōl\ (1571) *n.* Orifice, usually in a steel drum, a barrel, or a keg, which is stopped by a "bung" or large stopper.

**Bunting** \ˈbən-tiŋ\ [perhaps fr. E dialect bunt (to sift)] (1711) *n.* A soft, flimsy, loose-textured, plain weave cloth most frequently used in flags. Bunting was originally made from cotton or worsted yarns, but today's flags are made primarily from nylon or acrylic fibers.

**BUR** *n.* Abbreviation for blow-up ratio.

**Burgundy pitch** *See pitch, burgundy.*

**Burl** \ˈbər(-ə)l\ [ME *burle*, fr. (ass.) MF *bourle* tuft of wool, fr. (ass.) VL *burrula*. dimin. of LL *burra* shaggy cloth] (15c) *n.* Swirl or twist in the grain of wood that usually occurs near a know, but does not contain a knot.

**Burlap** \ˈbər-ˌlap\ [origin unknown] (ca. 1696) *n.* A coarse, heavy, plain weave fabric constructed from singles yarn of jute. Used for bags, upholstery lining, in curtains and draperies.

*See jute.*

**Burling** *v.* (1) The process of removing loose threads and knots from fabrics with a type of tweezers called a burling iron. (2) The process of correcting loose tufts and replacing missing tufts following carpet construction.

**Burn mark** *n.* Any visual sign of burning or charring at a particular spot on a part. In injection molding with poorly vented molds, burn marks can be caused by severe compression-heating of the air trapped in the mold cavity and consequent ignition of the molten plastic in contact with the hot air pocket (dieseling).

**Burned** *v.* Showing evidence of excessive heating during processing or use of a plastic, as evidenced by blistering, discoloration, charring, or distortion.

**Burned finish** *n.* Wood finish in which the hard portion of the grain stands out in relief, the effect being produced by using a blowtorch and a stiff-bristled brush.

*Also known as fiery finish.*

**Burning-in** *v.* Process of repairing scratches and other damaged places in a finish, by melting compounds (stick shellac) into the defect with a heated tool.

**Burning off** *v.* Removal of paint by a process in which the paint is softened by heat, e.g., from a flame, and then scraped off while still soft.

**Burning rates** *n.* (1) The oxidation in air of a polymer with time. (2) The speed at which a fabric burns. It can be expressed as the amount of fabric affected per unit time, in terms of distance or area traveled by the flame, afterglow, or char.

*See flammability, oxygen-index flammability test, self-extinguishing.*

**Burnishing** [ME, fr. MF *bruniss*-, stem of *brunir*, literally, to make brown, fr. *brun*] (14c) *adj, n.* Shiny or lustrous spots on a paint surface caused by rubbing or polishing.

**Burnish resistance** *n.* Resistance of a coating to an increase in gloss or sheen due to polishing or rubbing.

**Burn-out printing** *See printing.*

**Burnt lime** *See calcium oxide.*

**Burnt sienna** *See iron oxide, natural.*

**Burnt umber** *n.* Naturally occurring ferric oxide containing manganese dioxide and varying amounts of silica and alumina. Characteristic color is a rich, dark brown. Ferric oxide range, 45–65%; manganese dioxide range, 3–20%. Produced by calcining raw umber.

*See umber.*

**Burr** A device that assists in loop formation on circular-knitting machines equipped with spring needles.

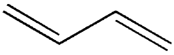
**Bursting strength** *n.* Of rigid plastic tubing, the internal liquid pressure required to cause rupture of a test specimen. Tubes with internal diameters between 3.2 and 152 mm (1/8–6 in.) may be tested and diameter and wall thickness must be reported. The term has much the same meaning for filament-wound pressure vessels. (2) The force required to rupture a fabric by distending it with a force applied at right angles to the plane of the fabric under specified condition. Bursting strength is a measure widely used for knit fabrics, non-woven fabrics, and felts where the constructions do not lend themselves to tensile tests. The two basic types of bursting tests are the inflated diaphragm method and the ball-bust method. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Bush kauri copal** *n.* Special grade of the Kauri copal, which has fossilized on trees at the point of exudation and above ground level.

**Butacite** Poly(vinyl butyral). Manufactured by DuPont, USA.

**Butcher's linen** *n.* A plain weave, stiff fabric with thick and thin yarns in both the warp and the filling. The fabric was originally made of linen but is now duplicated in 100% polyester or a variety of blends such as polyester/rayon or polyester/cotton.

**Butadiene** \ˌbyü-tə-ˈdī-ˌēn, -ˌdī-ˈ\ [ISV *butane* + *di*- + -*ene*] (1900) *N.* Buta-1,3-diene, 1,3-butadiene, erythrene, vinylethylene, bivinyl, divinyl. $CH_2{=}CHCH{=}CH_2$. A gas, insoluble in water but soluble in alcohol and ether, obtained from cracking of petroleum, from coal-tar benzene, or from acetylene. It is widely used in the formation of copolymers with styrene, acrylonitrile, vinyl chloride and other monomers, imparting flexibility to the products made from them. Its homopolymer is a synthetic rubber. As noted it is a synthetic chemical compound, used principally in the manufacture of synthetic rubber, nylon, and latex paints (*See image*).



**Butadiene-acrylonitrile copolymer (NBR)** *See acrylonitrile-butadiene copolymer.*

**Butadiene rubber (BR)** *See polybutadiene.*

**Butadiene styrene latex** A synthetic latex similar to synthetic rubber; used for latex paints.

*Also known as styrene butadiene.*

**Butadiene-styrene thermoplastics** *See styrene-butadiene thermoplastic.*

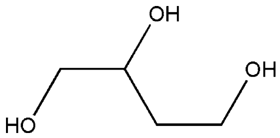
**Butaldehyde** \ˈbət ˈal-də-ˌhīd\. *See butyraldehyde.*

**Butanal** *See butyraldehyde.*

**1,4-Butanedicarboxylic acid** *See adipic acid.*

**1,3- or 1,4-Butanediol** *See 1,3- or 1,4-butylene glycol.*

**1,2,4-butanetriol** *n.* A nearly colorless liquid, an intermediate for alkyd resins, and a plasticizer for cellulosics.



**Butanoic acid** *See butyric acid.*

**1-Butanol** \ˈbyü-tᵊn-ˌól\. *See n-butyl alcohol.*

**Butene** \ˈbyü-ˌtēn\ [ISV *butyl* + *-ene*] (1885) *n.* Any of the monounsaturated $C_4$ hydrocarbons listed below:

| IUPAC name | Alternative names |
|---|---|
| 1-butene | α-butylene |
| *cis*-2-butene | *cis*-*β*-butylene |
| *trans*-2-butene | *trans*-*β*-butylene |
| Methylpropene | Isobutylene, isobutene |

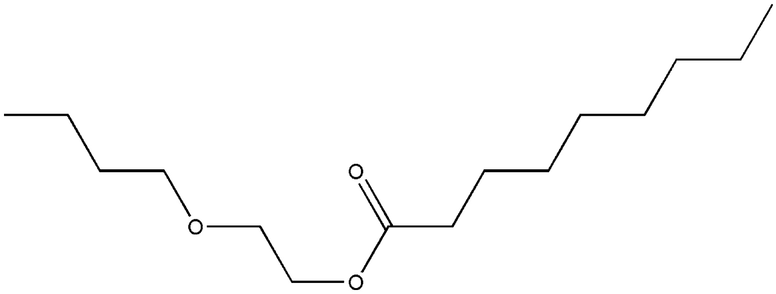
The term butanes refers to the first three compounds above as a group. The butylenes are used as monomers for rubbery homopolymers and copolymers with styrene, acrylics other olefins, and vinyls. They are also used in adhesives for many plastics, and in making plasticizers. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**2-Butene-1,4-diol** *n.* A nearly colorless, odorless liquid, an intermediate for alkyd resins, plasticizers, nylon, and a cross-linking agent for resins.

**Buton** *n.* Cross-linkable plastic produced at high polymerization temperatures from butadiene and styrene. Manufactured by Esso, Great Britain.

**2-Butoxyethanol** *See ethylene glycol monobutyl ether.*

**2-Butoxyethyl pelargonic acid** *n.* ($C_9H_{18}O_2$). A plasticizer for polystyrene, vinyl chloride polymers and copolymers, and cellulosics.



**Butoxyethyl stearate** *n.* Octadecanoic acid 2-butoxy ethylester. A high-boiling plasticizer for nitrocellulose, polystyrene, ethyl cellulose, and polyvinyl acetate.

**Butt** *n.* To met without overlapping.

**Butt fusion** *n.* A method of joining pipe, sheet or other forms of a thermoplastic resin wherein the ends of the two pieces to be joined are heated into the lower end of the polymer's melting range, then rapidly pressed together and allowed to cool, forming a homogeneous bond. ASTM D 2657 describes a recommended practice for butt-joining polyolefin pipe by heat fusion.

**Butt joint** (1823) *n.* A joint made by fastening and/or bonding two surfaces that are perpendicular to the main surfaces of the parts being joined.

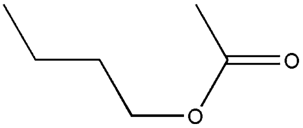
**Button lac** Lac refined in the form of buttons, which are usually about 3 in. (7.5 cm) in diameter and 1/4 in. (6 mm) in thickness.

**Butt veneer** *n.* Veneer having a strong curly figure, caused by roots coming into the trunk at all angles.

**Butyl** \ˈbyü-tᵊl\ [ISV *but*yric + *-yl*] (1869) *n.* (1) The radical $C_4H_9$-, occurring only in combination. (2) Abbreviation used by British standards institution for butyl rubber.

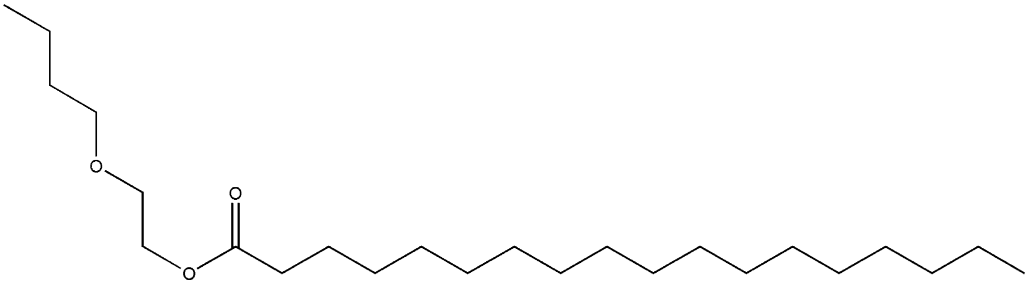
**Butyl acetate** *n.* $CH_3COOC_4H_9$. A pleasantly aromatic solvent of moderate strength for ethyl cellulose, cellulose nitrate, vinyls, polymethyl methacrylate, polystyrene, coumarone-indene resins, and certain alkyds and phenolics.

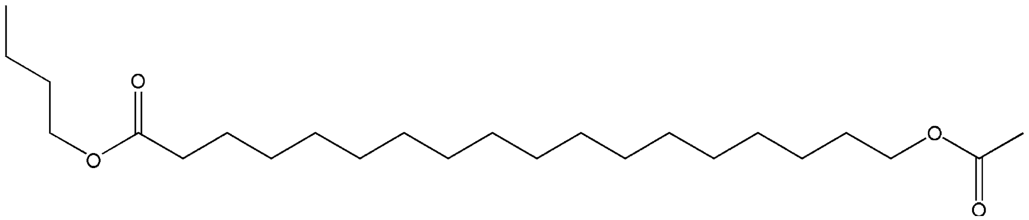
*See n-butyl acetate.*



***n*-Butyl acetate** *n.* $CH_3COOC_4H_9$. Limpid, colorless liquid with fruity odor. Prepared by heating and distillation, after contact of *n*-butyl alcohol with acetic acid in the presence of a catalyst such as sulfuric acid. Solvent used in production of lacquers, natural gums and synthetic resins.

**Butyl acetoxystearate** *n.* $C_{24}H_{46}O_4$. A plasticizer similar to butyl acetyl ricinoleate,

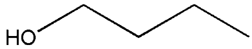




but with the double bond saturated. It is compatible with cellulosic and vinyl resins.

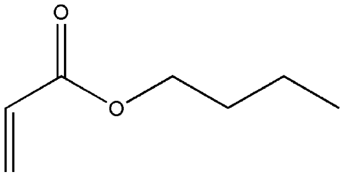
**Butyl acetyl ricinoleate** *n.* $C_{24}H_{44}O_4$. A yellow, oily liquid derived from castor oil, butyl alcohol, and acetic anhydride, used as a plasticizer, compatible with cellulosics and vinyls.

**Butyl alcohol** (ca. 1871) *n.* $C_4H_9OH$. Any of four flammable alcohols used in organic synthesis and as solvents.
*See n-butyl alcohol.*



***n*-Butyl alcohol** *n.* Colorless liquid, with vinous, irritating odor which causes coughing. Solvent used for resins, coatings, shellac, and butylated melamine resins. Syn: 1-butanol and propyl carbinol.

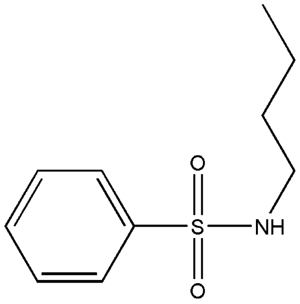
***n*-Butyl acrylate** *n.* $CH_2{=}CHCOOC_4H_9$. Colorless liquid. A monomer used in the manufacture of synthetic resins and as a solvent for cellulose esters. Sp gr, 0.898; bp, 145°C.



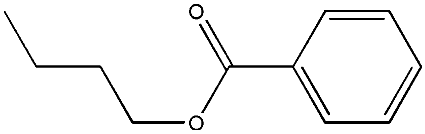
**Butylated hydroxytoluene** (di-*tert*-*p*-cresol, BHT) *n.* A white, crystalline solid, the most widely used antioxidant for plastics such as ABS and LDPE. It has been approved by the FDA for use in foods and food-packaging materials.

**Butylated resin** *n.* A resin containing the butyl radical, $C_4H_9$–.

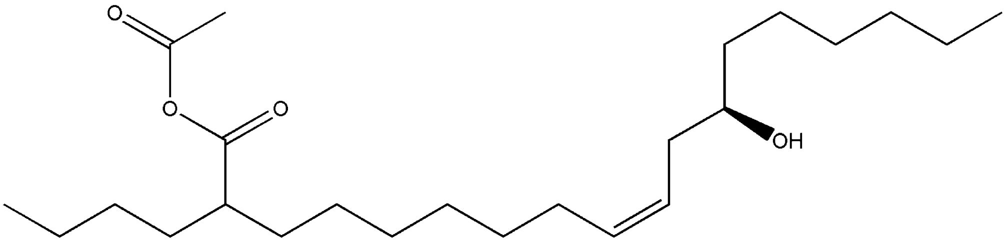
**Butyl benzenesulfonamide** *n.* (*N*-*n*-butyl benzenesulfonamide) $C_6H_5SO_2–NHC_4H_9$. A plasticizer for some synthetic resins and an intermediate for resin manufacturer (*See image*).



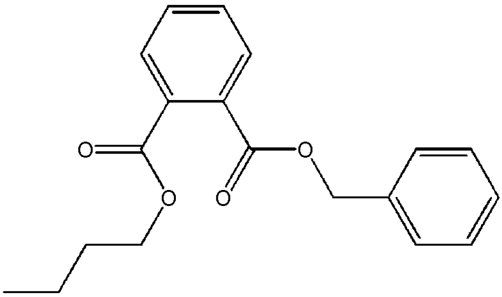
**Butyl benzoate** *n.* (*n*-butyl benzoate). A plasticizer and solvent for cellulosics.



**Butyl benzyl phthalate (BBP)** *n.* $(C_4H_9OOC)C_6H_4(COOCH_2C_6H_5)$. A clear, oily liquid used as a plasticizer for cellulosic and vinyl resins. It imparts good stain resistance, low



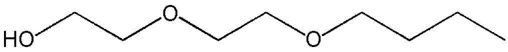
volatility at calendaring and extruding temperatures, low oil extraction and good heat and light stability.



**Butyl benzyl sebacate** *n.* $C_4H_9OOC(CH_2)_8COOCH_2C_6H_5$. An ester-type plasticizer with a light straw color. It combines the desirable properties of dibenzyl sebacate and dibutyl sebacate.

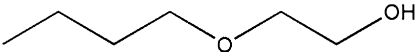
**Butyl borate** *See tributyl borate.*

**Butyl carbitol** *n.* Diethylene glycol monobutyl ether, butyldiglycol, 2-[2-(1-butoxy) ethoxy] ethanol. Practically odorless oil, solvent, and water miscibile liquid used as a coalescent in latex paints; bp, 230.4°C; mp, −68.1°C; Sp gr, 0.9536.

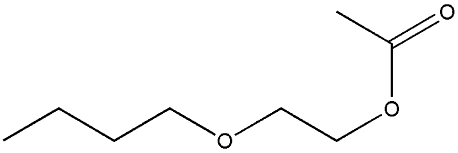


**Butyl carbitol acetate** *n.* $CH_3COO(CH_2CH_2O)_2C_4H_9$. Diethylene glycol monobutyl ether acetate.

**Butyl cellosolve** Ethylene glycol monobutyl ether, 2-butoxyethanol. Liquid soluble in 20 parts water; soluble in most organic solvents. It is used as a coalescent in latex paints; bp, 171–172°C; Sp gr, 0.901.

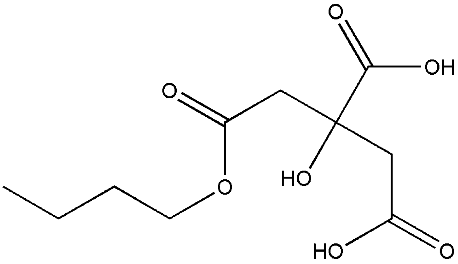


**Butyl cellosolve acetate** *n.* Ethylene glycol monobutyl ether acetate.

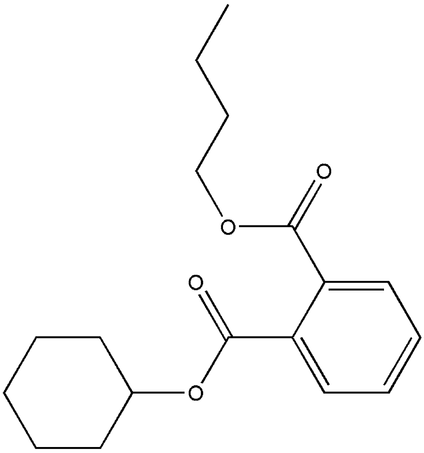


**Butyl citrate** *n.* Colorless or pale yellow, stable, odorless, non-volatile liquid. Plasticizer, anti-foam agent, solvent for cellulose nitrate.

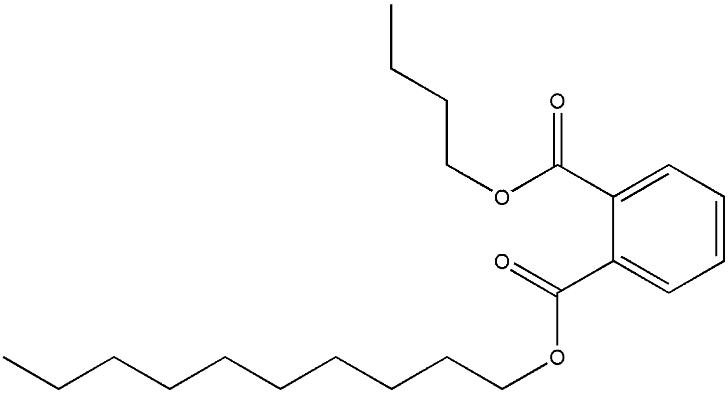
*Also known as tributyl citrate. See citrates* (*See image*).



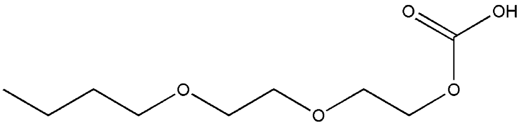
**Butyl cyclohexyl phthalate** *n.* A plasticizer for PVC, other vinyls, cellulosics, and polystyrene.



**Butyl decyl phthalate** *n.* $C_{22}H_{34}O_4$. A plasticizer for polystyrene, PVC, and vinyl chloride-acetate copolymers (*See image*).

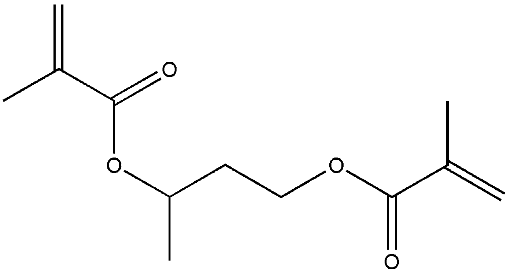


**Butyl diglycol carbonate** *n.* [diethyleneglycol bis(*n*-butylcarbonate)]. A colorless liquid of low volatility, used as a plasticizer with many resins (*See image).*

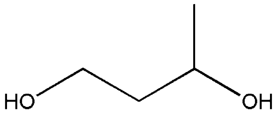


**Butylene** *See butene.*

**1,3-Butylene dimethacrylate** A polymerizable monomer used in PVC and rubber systems to obtain rigid or semi rigid products from materials that are normally flexible. The monomer acts as a plasicizer at room temperature and cross-links at processing temperatures (*See image*).



**1,3-Butylene glycol** *n.* (1,3-butanediol) $CH_3CHOHCH_2CH_2OH$. A colorless liquid made by catalytic hydrogenation of aldol (3-hydroxy-*n*-butyradehyde). Its most important use is as an intermediate in the manufacture of polyester plasticizers (*See image*).

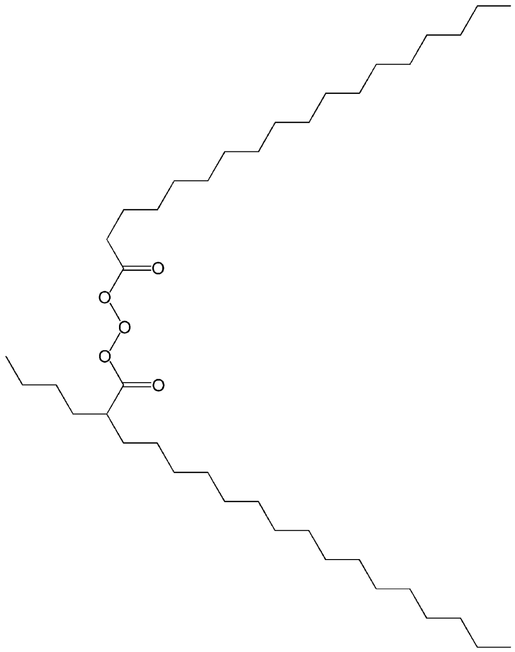


**1,4-Butylene glycol** *n.* (1,4-butanediol, tetramethylene glycol). A stable, hygroscopic, colorless liquid used in the production of polyesters by reaction with dibasic acids, and in the production of polyurethanes by reaction with diisocyanates (*See image*).

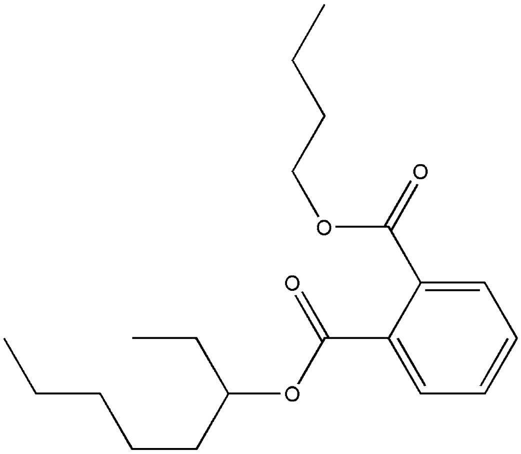
**1,3-Butylene glycol adipate polyester** *n* (Santicizer® 334F). A polymeric plasticizer for PVC.

**Butyl epoxy stearate** *n.* $C_{40}H_{78}O_5$. A plasticizer for PVC, imparting low-temperature flexibility (*See image*).

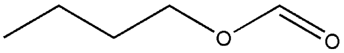
**Butyl ethylhexyl phthalate** *n.* (butyl octyl phthalate, BOP). A mixed ester of butanol and 2-ethylhexanol, widely used as a primary plasticizer for PVC compounds and plastisols, in which it performs like dioctyl



phthalate in most respects. It is also compatible with vinyl chloride-acetate copolymers, cellulose nitrate, ethyl cellulose, polystyrene, chlorinated rubber, and at lower concentrations, with polymethyl methacrylate (*See image*).



**Butyl formate** *n.* A solvent for several resins, including cellulose acetate (*See image*).



**Butyl isodecyl phthalate** *n.* (decyl butyl phthalate) $(C_4H_9OOC)C_6H_4$–$(COO C_{10}H_{21})$. A plasticizer for PVC and polystyrene.

**Butyl isohexyl phthalate** *n.* $(C_4H_9OOC) C_6H_4(COOC_6H_{13})$. A plasticizer for cellulosics, acrylic resins, polystyrene, PVC, and other vinyl resins.

**Butyl lactate** *n.* $CH_3CHOHCOOC_4H_9$. Slow evaporating liquid, which is miscible with most of the organic solvents. It is a solvent for nitrocellulose, ethyl cellulose, oils, dyes, natural gums, and synthetic resins.

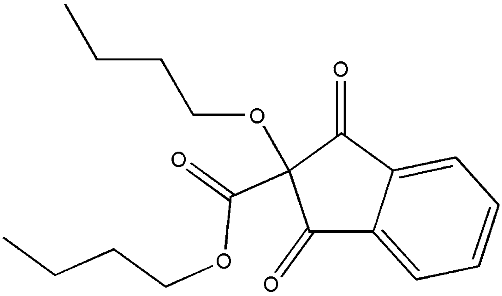
**Butyl octadecanoate** *See butyl stearate.*

**Butyl octyl phthalate** *See butyl ethlyhexyl phthalate.*

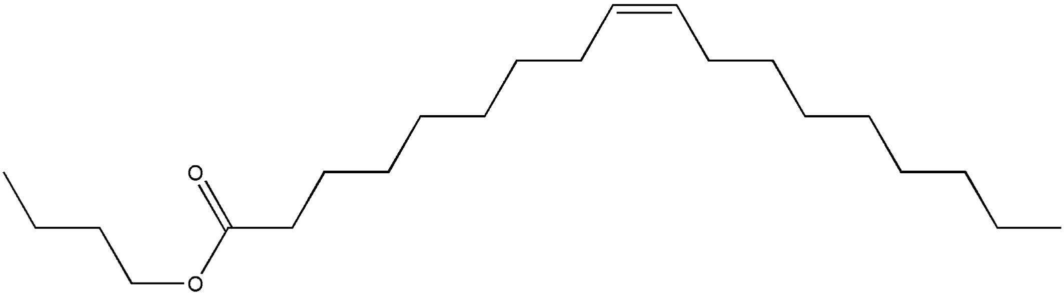
**Butyl oleate** *n.* $CH_3(CH_2)_7CH{=}CH (CH_2)_7COOC_4H_9$. A solvent, plasticizer and lubricant, used mainly with neoprene and other synthetic rubbers, chlorinated rubber, and ethyl cellulose; also a mold lubricant (*See image*).

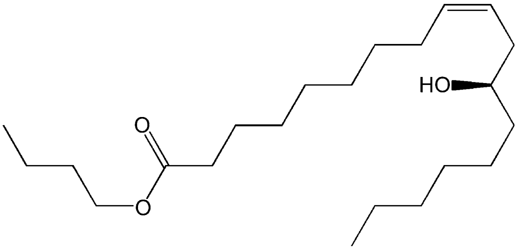
**Butyl phthalate** *See phthalate esters.*

**Butyl phthalyl butyl glycollate** *n.* A plasticizer with good light stability, used mainly with PVC and polystyrene, but compatible with most other thermoplastics. It has been approved by the FDA for contact with foods (*See image*).



**Butyl ricinoleate** *n.* Yellow to colorless oleaginous liquid derived from castor oil fatty acid (ricinoleic acid) and butyl alcohol. Used as a plasticizer or lubricant (*See image*).



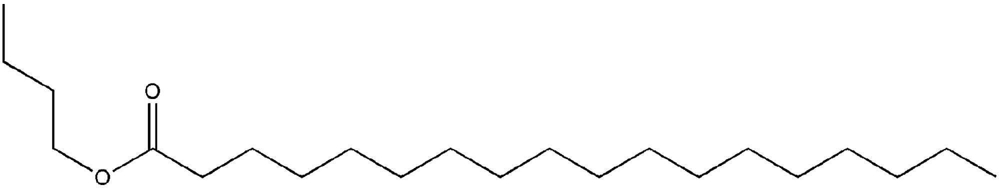


**Butyl rubber** *n* (1940). A synthetic elastomer produced by copolymerizing isobutylene with a small amount (ca 2%) of isoprene or butadiene. It has good resistance to hear, oxygen and ozone, and low gas permeability. Thus, it is widely used in inner tubes and to line tubeless tires. Butyl rubber is a vinyl polymer, and is very similar to polyethylene and polypropylene in structure, except that every other carbon is substituted with two methyl groups. It is made from the monomer isobutylene, by cationic vinyl polymerization. It can also go by the name of polyisobutylene. (1) Generic name for vulcanizable elastic copolymers of isobutylene and small amounts of diolefins. (2) Mixture of isobutylene, 98% and butadiene or isoprene, 2%. (3) Poly(isobutylene) with 2% isoprene. Manufactured by Bayer, Germany.

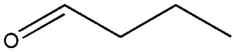
**Butyl stearate** (butyl octadecaonoate) *n.* $C_{17}H_{35}COOC_4H_9$. A mold lubricant and plasticizer, compatible with natural and synthetic rubbers, chlorinated rubber, and ethyl cellulose. It can be used in vinyls in very low concentrations as a non-toxic, secondary plasticizer and lubricant. In the production of polystyrene, butyl stearate is added to the emulsion polymerization to impart good flow properties to the resin (*See image*).

**Butyl (tetra) titanate** *n.* $Ti(OC_4H_9)_4$. Used for adhesion promoter, catalyst, and in heat-resistant paints.

**Butyraldehyde** \ˌbyü-tə-ˈral-də-ˌhīd\ [ISV] (ca. 1885) (butaldehyde, *n*-butanal, *n*-butyl aldehyde, butyric aldehyde) *n.* An aldehyde sometimes used in place of formaldehyde in the production of resins. Butyraldehyde reacts with polyvinyl alcohol to form polyvinyl butyral. It is used in the



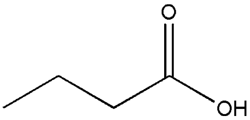
manufacture of rubber and synthetic resins. Sp gr, 0.817; bp, 75.7°C. Syn: butaldehyde, butyl aldehyde, and butyric aldehyde (*See image*).



**Butyrate** \ˈbyü-tə-ˌrāt\ (1873) *n.* (1) A salt or ester of butyric acid. (2) The industry nickname for cellulose acetate butyrate (CAB).

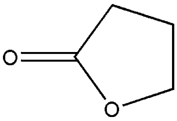
**Butyrates** *n.* Name applied to esters of butyric acid, such as cellulose butyrate, ethyl butyrate, etc.

**Butyric acid** (*n*-butyric acid, butanoic acid, ethylacetic acid, and propylformic acid). *n* $CH_3(CH_2)_2COOH$. A water soluble liquid with a strong butter-rancid odor, used in the production of cellulose acetate butyrate. Derivatives of butyric acid are used in the production of plasticizers for cellulosic plastics (*See image*).



**Butyric alcohol** *See n-butyl alcohol.*

**γ-Butyrolactone** (butyrolactone) *n.* A hygroscopic, colorless liquid obtained by the dehydrogenation of 1,4-butanediol with the structure: It is a solvent for cellulosics, epoxy resins, and vinyl copolymers (*See image*).



# C

**c** *n.* \ˈsē\. (1) Abbreviation for SI prefix, centi-. (2) Abbreviation for Cubic.

**C** *n.* (1) Chemical symbol for the element carbon. (2) Abbreviation for Celsius or centigrade. (3) Symbol for electrical capacitance.

**Ca** *adj.* Circa; about, approximate.

**Ca** *n.* Chemical symbol for the element calcium.

**CA** *See cellulose acetate.*

**C or Δc** *n.* Abbreviations for chromaticity or chromaticity difference, receptivity.
*See color difference equations.*

**C 23** *n.* Ethylene/propylene copolymer. Manufactured by Montecatini, Italy.

**CAB** *n.* Cellulose acetobutyrate.

**Cabinet** *n.* A basic part of the manufactured-fiber spinning machine, where, in dry spinning, the filaments become solidified by solvent evaporation and, in melt spinning, the filaments are solidified by cooling.

**Cabinet finish** *n.* A varnished or polished hardwood interior finish as distinguished from a painted softwood finish.

**Cabled yarn** *n.* A yarn formed by twisting together two or more plied yarns.

**Cable stitch** *n.* A knit effect produced by crossing a group of stitches over a neighboring stitch group.

**Cable twist** *n.* A construction of thread, yarn, cord, or rope in which each successive twist is in the direction opposite the preceding twists; i.e., and S/Z/S or Z/S/Z construction.

**Cable varnishes and lacquers** *n.* Employed for impregnating the cloth or similar covering of cables. Normally, oil varnishes are used.

**Cacahuananche oil** *n.* This oil is obtained from the nuts of the tree, *Licania arborea.* So far as the usual laboratory tests are concerned, this oil and Brazilian oiticica oil are much alike. The raw oil becomes lard-like on aging but may be permanently liquefied by heat. The raw and lightly heat-treated oil wrinkles as it dries, similarly to oiticica and tung oils.

**CAD/CAM** *n.* Acronym for computer-aided design and computer-aided manufacturing.

**Cadmium** \ˈkad-mē-əm\ [NL, fr. L *cadmia* zinc oxide, fr. Gk *kadmei*a, fr. feminine of *kadmeios* Theban, from *Kadmos*] (1822) *n.* A bluish white malleable ductile toxic bivalent metallic element used in protective platings and in bearing metals.

**Cadmium ethylhexanoate** *n.* A metallic soap used as a stabilizer for vinyls, especially to avoid plate-out in calendaring compounds.

**Cadmium green** *n.* Pigment green 18. Composed of 93–94% hydrated chromium, oxide, the balance being cadmium yellow.

**Cadmium lithopone** *n.* Pigment red 108 (77202). Range of yellow, orange, and red colors consisting of either cadmium sulfide or cadmium red reduced on barium sulfate. They are usually produced by co-precipitation followed by calcinations.
*See cadmium red.*

**Cadmium/mercury lithopones** *n.* Orange, red, and maroon pigments consisting of calcined co-precipitations of cadmium sulfide and mercury sulfide, with barium sulfate.

**Cadmium/mercury sulfides** *n.* CdSHgS. Pigment orange 23 (77201). A series of cadmium/mercury sulfides of mixed crystal composition. Colors vary according to CdS/HgS ratio from deep orange to maroon. Known for high heat stability, solvent insolubility, good chemical resistance, and excellent light fastness. CdS/HgS ratio, 89.1/10.9. Density 4.8–5.2 g/$cm^3$ (40–43 lb/gal); O.A., 33.2; particle size, 0.1–1.0 μm. Syn: Mercadium® orange, mercury cadmium, cadmium red/orange, and mercury/cadmium sulfide.

**Cadmium orange** *n.* Mixture or co-precipitate of cadmium sulfide and cadmium selenide used as a pigment.
*See cadmium sulfide.*

**Cadmium plating** *n.* Electrodeposition of cadmium on iron wire, steels articles, etc., to make them relatively rust-proof. This surface treatment makes the substrate more suitable for subsequent painting.

**Cadmium pigment** *n.* Any inorganic pigment based on cadmium sulfide or cadmium sulfoselenide, used widely in PVC, polystyrene, and polyolefins. Included are cadmium-maroon, -orange, -red, and-yellow. The cadmium pigments have good resistance to heat (up to 500°C) and to alkalis, and do not bleed. Light stability is good in solid colors, but may be poor when used for tints with white pigments. Resistance to acids is poor.

**Cadmium red** *n.* Pigment red 108 (77202). Pigments of calcined co-precipitations of compounds of cadmium, sulfur, and selenium; a brilliant red pigment, opaque, with good staining power, fast to light, unaffected by exposure to sulfur fumes; considerable resistance to heat. Density, 4.9 g/cm$^3$ (41 lb/gal); O.A., 20 lb/100 lb.

**Cadmium ricinoleate** *n.* $[CH_3(CH_2)_5\text{-}CHOHCH_2CH{=}CH(CH_2)_7COO]_2\text{–}Cd$. A white powder derived from castor oil, used as a heat stabilizer for vinyl chloride polymers and copolymers.

**Cadmium selenide** *See cadmium red and cadmium orange.*

**Cadmium stearate** *n.* $(C_{17}H_{35}COO)_2Cd$. A heat- and light-stabilizer, used when good clarity in transparent compositions is desired.

**Cadmium sulfide** (ca. 1893) $(Cd/Zn)S$ or $CdS$ Pigment yellow 37 (77199) *n.* Class of yellow, orange, and red pigments that include pure cadmium sulfides and blends of cadmium sulfides with ZnS and CdSe and used with $BaSO_4$ to form lithopone type pigments. They show excellent heat and good alkali resistance especially for baking finishes. Density, 4–64.7 g/cm$^3$ (38–39 lb/gal); O.A., 18–22 lb/100 lb. Syn: cadmium yellow and cadmium orange.

**Cadmium yellow** *See cadmium sulfide.*

**Cage effect** *n.* Free radicals that exist very close together in a solvent or monomer molecule called a “cage”.

**Caisson** \ˈkā-ˌsän, -sən, British also kə-ˈsün\ [Fr, fr. MF, fr. OP, fr. *caissa* chest, fr. L *capsa*] (ca. 1702) *n.* Recessed compartment in a vault or ceiling; recessed panel in a ceiling or soffit.

**Cajeputene** *See dipentine.*

**Cake, press** *n.* The thick cake of wet pigment that is withdrawn from the filter press.

**Caking** *n.* (1) Settling of pigment particles of a paint into a compact mass which is not easily redispersed by stirring. (2) In printing inks, caking is the collecting of pigment upon plates, rollers or blankets caused primarily by the inability of the vehicle to hold the pigment in suspension.
*See piling.*

**Calcareous** \kal-ˈkar-ē-əs, -ˈker-\ [L *calcarius* of lime, from *calc-*, *calx*] (1677) *adj.* Any material containing calcium or calcium compounds.

**Calcicoater** \ˈkal-sik ˈkotər\ *n.* (1) Vegetable oil product that has been reacted with lime to form a heavy gel-like soap, which has almost infinite tolerance for mineral spirits; used in flat wall paints, primers, and sealers. (2) Pigmented flat paints using such heavy gel-like soap vehicles.

**Calcimine** \ˈkal-sə-ˌmīn\ [alter. of *kalsomine*] (ca. 1859) *n.* Also spelled “kalsomine”. Essentially, chalk and glue ready to mix with water. Used as a decoration for interior surfaces. It will not withstand washing. In Britain, it is referred to as powdered distemper.

**Calcination** \ˌkal-sə-ˈnā-shən\ *n.* (1) Process of heating or roasting a material to a high temperature, but below its fusing point, to cause it to lose moisture or other volatile material or to be oxidized or reduced. Originally, a heat process for the production of lime (CaO) from limestone. (2) The process of subjecting a sorptive mineral to prolonged heating at fairly high temperature, resulting in the removal of water, and an increase in the hardness, physical stability, and absorbent properties of the material.

**Calcined clay** *n.* China clay (kaolin) that has been heated until the combined water is removed and the plastic character of the clay is destroyed. This produces an air–solid interface within the particle, which increases hiding in he resulting coating. *See clay.*

**Calcite** \ˈkal-ˌsīt\ (1849) *n.* Naturally occurring form of calcium carbonate. It is an essential material of limestone, marble, and chalk.

**Calcium acetate** (vinegar salts, gray acetate, lime acetate, and brown acetate) *n.* $(CH_3COO)_2Ca{\cdot}H_2O$. A stabilizer.

**Calcium carbide** (ca. 1888) *n.* Usually a dark gray crystalline compound $CaC_2$ used for the generation of acetylene and for making calcium cyanamide.

**Calcium carbonate** (1873) (aragonite, calcite, chalk, limestone, lithographic stone, marble marl, travertine, and whiting) *n.* $CaCO_3$. Grades of calcium carbonate suitable as fillers for plastics are obtained from naturally occurring deposits as well as by chemical precipitation. The natural types are prepared by dry grinding, yielding particles usually over 20 µm, used in stiff products such as floor tiles; or by wet grinding, yielding particles under 16 µm, used in flexible products. The chemically precipitated types range from 0.05 to 11 µm in size, and are most often used in plastisols and highly flexible products. Both the wet-ground and precipitated types are available with coating such as resins, fatty acids, and calcium stearate. These coated grades have low oil absorption, of particular value in compounding plastisols. The calcium stearate coatings provide improved electrical properties, heat stability and lubricity during processing, which is beneficial in extrusion compounds.

**Calcium carbonate fillers** *n.* Fine powder of calcium carbonate (white) to fill spaces in a polymer or coating.

**Calcium carbonate, natural** *n.* $CaCO_3CaMg(CO_3)_2$. Pigment white 18 (77220). White extender pigment derived from natural chalk, limestone, or dolomite, consisting of calcium carbonate with up to about 44% magnesium carbonate. Density, 2.71 g/cm$^3$ (22.6 lb/gal); O.A., 6–15; particle size, 1.5–12 µm. Syn: calcite, limestone, whiting, marble flour, Paris white, chalk, ground oyster shells, iceland spar, and spanish white.

**Calcium carbonate, synthetic** *n.* $CaCO_3$. Pigment white 18 (77220). Calcium carbonate manufactured by a precipitation process in order to obtain a finer or more uniform particle size range. Four commercial processes are known. Density, 2.65 g/cm$^3$ (22.07 lb/gal); O.A., 28–58; particle size, 0.6–30 µm. Syn: precipitated calcium carbonate.

**Calcium chloride** (1885) *n.* $CaCl_2$. Salt used in the manufacture of some lakes and toners from acid dyestuffs, fireproof paints, sizing compounds, wood preservatives, snow melter, and anti-freeze.

**Calcium glycerophosphate (calcium glycerinophosphate)** *n.* $CaC_3H_7O_2{-}PO_4$. A white, crystalline powder, odorless and nearly tasteless, used as a stabilizer for plastics.

**Calcium hydroxide** (ca. 1889) *n.* $Ca(OH)_2$. A white crystalline strong alkali that is used in mortar and plaster.

*Also known as slaked lime.*

**Calcium hypochlorite** (ca. 1889) *n.* $CaCl_2O_2$. A white power used as a bleaching agent and disinfectant.

**Calcium linoleate** *n.* White amorphous powder soluble in alcohol and ether; insoluble in water. Used for waterproofing compounds, emulsifying agents, and as a stabilizer for oleoresinous paints.

**Calcium lithol red** *See lithol red.*

**Calcium metasilicate** *See calcium silicate, natural.*

**Calcium naphthenate** *n.* Calcium salt of naphthenic acids. Used as an auxiliary drier, dispersing and stabilizing aid.

**Calcium octoate** *n.* Calcium salt of 2-ethyl hexoic acid. Used as auxiliary drier, dispersing, and stabilizing aid.

**Calcium oxide** (ca. 1885) (calx, lime, quicklime, and burnt lime) *n.* CaO. A white powder with affinity for water, with which it combines to form calcium hydroxide. It has been used to remove traces of water in vinyl plastisols.

*Also known as quicklime.*

**Calcium phosphate** (1869) (calcium orthophosphate, tricalcium phosphate, tricalcic phosphate, and tertiary calcium phosphate) *n.* $Ca_3(PO_4)_2$. A stabilizer.

**Calcium phosphate, dibasic** (calcium biphosphate, acid calcium phosphate, and primary calcium phosphate) *n.* $CaH_4(PO_4)_2 \cdot H_2O$. A stabilizer.

**Calcium phosphate, monobasic** (dicalcium orthophosphate, bicalcic phosphate, and secondary calcium phosphate) $CaHPO_4$ or $CaHPO_4 \cdot H_2O$. A stabilizer.

**Calcium resinate** *n.* Calcium salt of rosin used as auxiliary drier and dispersing and stabilizing aid. Commonly known as Limed Rosin, which is really rosin, the acidity of which has been substantially neutralized.

**Calcium ricinoleate** *n.* $[CH_3(CH_2)_5CHOH\text{-}CH_2CH{=}CH(CH_2)_7COO]_2$. A white powder derived from castor oil, used as a non-toxic stabilizer for PVC.

**Calcium silicate** (1888) (wollastonite) *n.* $CaSiO_3$. A naturally occurring mineral found in metamorphic rocks, used as a reinforcing filler in low-density polyethylene, polyester, and other thermosetting molding compounds. It imparts smooth molded surfaces and low water absorption.

**Calcium silicate, natural** *n.* $CaSiO_3$. It has white color and acicular particles. It is characterized by high flatting action, combined with low oil absorption, and is used as an extender in paints, ceramics and plastics. Density, 2.9 g/cm$^3$ (24.2 lb/gal); O.A., 25–30; particle size, 7 µm (fine particle grade); hardness (moh), 4.5. Syn: wollastonite and calcium metasilicate.

**Calcium silicate, synthetic** *n.* $CaSiO_3 \cdot nH_2O$. Extender pigment with some dry hiding opacity. Density, 2.26 g/cm$^3$ (18.8 lb/gal); O.A., 280; particle size, 10–12 µm.

**Calcium stearate** *n.* $(C_{17}H_{35}COO)_2$. (1) A non-toxic stabilizer and lubricant. It is not often used alone because of its early color development, but is used in combination with zinc and magnesium derivatives and epoxides in manufacturing other non-toxic stabilizers. (2) Calcium salt of stearic acid. A metallic soap used in paints as wetting aid for pigments, flatting agents, and additive for improving sanding sealers.

**Calcium sulfate** (ca. 1885) (anhydrite) *n.* $CaSO_4{\cdot}2H_2O$. (1) A filler and white pigment. Notwithstanding its slight solubility in water, it is used to some extent in distempers and water paints, it forms the base of certain lakes and other pigments. The hydrated forms are known as *gypsum*, *terra alba*, and Plaster of Paris.

**Calcium sulfate, anhydrous** *n.* $CaSO_4$. Manufactured by calcining natural gypsum ($CaSO_4{\cdot}2H_2O$) or as byproducts from other precipitation processes. Notwithstanding its slight water solubility, it is used in distempers and water paints. It also forms the base of certain lakes and other pigments. Plaster of Paris is partially calcined gypsum. Density, 2.96 g/cm$^3$ (24.7 lb/gal); O.A., 20; particle size, 1.8–2.2 µm. Syn: anhydrite, dead burned calcium sulfate, and dehydrated gypsum.

**Calcium sulfate hemihydrate** *n.* CaSO4·½$H_2O$. *See gypsum (calcined) and plaster of Paris.*

**Calcium tallate** *n.* Calcium salt of tall oil acids used as an auxiliary drier and dispersing and stabilizing aid.

**Calcium thiocyanate** (calcium sulfocyanate, calcium rhodanate) *n.* $Ca{-}(SCN)_2{\cdot}3H_2O$. In water solution, a solubilizer for acrylic and cellulosic resins.

**Calcium–zinc stabilizer** *n.* Any of a family of stabilizers based on compounds and mixtures of compounds of calcium and zinc. Their effectiveness is limited, but they are among the few that have been approved by the FDA for materials to be contacted by foods.

**Calendar** *n.* (1) To produce or process sheets of material by pressing between a series of revolving heated rolls. (2) The machine performing the process of calendering.

**Calender coating** *n.* A roller coating on a film or other material. The process of applying plastics to substrates such as paper or fabric by passing both the substrate and a plastic film through calender rolls. *See coating.*

**Calendered cloth** *n.* Basis of varnished cloths for electrical insulation. The process of calendering cloths involves the passing of moist cloth between heavy rollers, resulting in a smooth or glazed appearance.

**Calendered film and sheet** *n.* Rolled film and sheet.

**Calendered papers** Wallpapers with hard coatings.

**Calendering** *n.* The process of forming thermoplastics sheeting and films by passing the material through a series of rigid, heated rolls and rolling to press out voids. Four rolls are typical. The gap between the last pair of heated rolls determines the thickness of the sheet. Subsequent chilled rolls cool the sheet. The plastic compound is usually premixed and plasticated on separate equipment, then fed continuously into the nip of the first pair of calender rolls.

**Calendering rolls** *n.* (1) The main cylinders on a calender. (2) Smooth or fluted rolls used on carious fiber-processing machines such as pickers and cards to compress the lap or sliver as it passes between them.

**Calender with rubber** *n.* A machine for impregnating fabric.

**Calibrate** \ˈka-lə-ˌbrāt\ (ca. 1864) *vt.* (1). To determine the exact relationship between the indicated or recorded readings of a measuring instrument or method and the true values of the quantities measured, over the instrument's range. (2) (mainly European usage). To bring the dimensions of an extruded tube or pipe within their specified ranges.

**Calibration** *n.* (1) The process of ascertaining the errors of a measuring technique or instrument by comparing its readings with the corresponding values of known standards or the readings of a more accurate technique or instrument. Calibration standards for the whole gamut of measurements are available from the USA National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards, Gaithersbury, MD. "They can also furnish standard materials, some of them polymeric. *See NIST special publication 260*, "Standard Reference Materials Catalog". NIST also calibrates instruments on request. *See special publication 250*, "NIST Calibration Services Users' Guide". Both publications are available from the USA Government Printing Office in Washington DC. (2) *See calibrate* (2).

**Calico** \ˈka-li-ˌkō\ [Calicut, India] (1578) *n.* A plain, closely woven, inexpensive cloth, usually cotton or a cotton/manufactured fiber blend, characteristically having figured patterns on a white or contrasting background. Calico is typically used for aprons, dresses, and quilts.

**Caliper** \ˈka-lə-pər\ [alteration of *caliber*] (1588) *n.* (1) The thickness of film or sheet, typically stated in thousandths of an inch (mils). (2) Any of several types of precise instruments used to measure thickness, as micrometer caliper.

**Calk** \ˈkók, ˈkó-kər\ [prob. alter. of *calkin*, fr. ME *kakun*, fr. MD or ONF *calcain* heel, fr. L *calcaneum*, fr. *calc-*, *calx* heel] (1587) *n, vt. See caulk.*

**Calking** *See caulking compound.*

**Calorie** \ˈka-lə-rē, ˈkal-rē\ [F *calorie*, fr. L *calor* heat, fr. *calēre*] (1866) (small calorie) *n.* A deprecated, small unit of heat energy: the amount of heat required to raise the temperature of 1 g of water, at or near 4°C, 1°C. The ASTM "Standard for Metric Practice" (E 380) lists five slightly different calories, all nearly equal to 4.185 J. In future, most of these will fade away, leaving only the "calorie (International Table)", equal to 4.186800 J. The term calorie is also used loosely, especially in the nutrition field, to mean 1000 calories, the kilocalorie, or "large calorie".

**Calorimeter** *n.* An instrument for measuring the heat liberated (or absorbed) during chemical reactions or physical changes of state.

**Calorimetry** *n.* The process of measuring quantities of absorbed or evolved heat, often used to determine specific heat.

**Calutron** \ˈkal-yə-ˌträn\ [California University cyclotron] (1954) *n.* An apparatus operating on the principle of the mass spectrograph and used for separating $U^{235}$ from $U^{238}$.

**Calvary twill** *n.* A pronounced, raised cord on a 63° twill weave characterizes this rugged cloth usually made from wool or wool blend yarns.

**Cam** *n.* A rotating or sliding piece or projection used to impart timed or periodic motion to other parts of a machine. It is used chiefly as a controlling or timing element in machines rather than as part of a power transmission mechanism. Cams are particularly important in both knitting and weaving machinery. Acronym for computer-aided manufacturing.

**Camber** \ˈkam-bər\ [F *cambrer*, fr. MF *camber*, fr. L *camur*] (1627) *v.* Strip under tension, as on a coating line that has a tendency to deviate from the horizontal or to slope to one side.

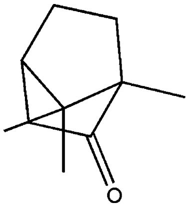
**Cambogia** *See gamboge.*

**Cambric** \ˈkām-brik\ [obs. Flemish *Kameryk*] (1530) *n.* A soft, white, closely woven, cotton or cotton blend fabric that has been calendered on the right side to give it a slight gloss. Cambric is used extensively for handkerchiefs.

**Camel hair** *n.* A term inaccurately applied to a fine haired brush, the hair of which is obtained from squirrels native to Russia and Siberia.

**Camphol** *See oxanilide.*

**Camphor** \ˈkam(p)-fər\ [ME *caumfre*, fr. AF, fr. ML *camphora*, fr. Arabic *kāfūr*, fr. Malay *kapur*] (*d*-2-camphanone, 2-keto-1,7,7-trimethylnorcamphane) *n.* $C_{10}$–$H_{16}O$. A bridged-ring, naturally occurring ketone with a mp of 175°C and a bp of 204°C with the structural formula: It is a colorless, aromatic, crystalline material originally derived from camphor oil but now mostly synthesized from pinene. It is used as a plasticizer for celluloid, cellulose nitrate, and lacquers. In 1870, the Hyatt brothers were awarded a USA patent for a horn-like compound of camphor and cellulose nitrate, which they called celluloid. The event marked the start of the USA plastics industry.



**Camphoric acid** *n.* $C_8H_{14}(COOH)_2$. A dibasic-acid plasticizer for cellulose nitrate, derived from Camphor by oxidizing the =C=O and adjacent =CH2 groups and opening the right-side ring.

**Can** *n.* (1) A cylindrical container, about 3 feet high and 10–12 in. in diameter, that is used to collect sliver delivered by a card, drawing frame, etc. (2) *See drying cylinders.*

**CAN** *n.* Abbreviation for cellulose acetate nitrate.

**Canada balsam** *n.* Oleoresin, which exudes naturally from *Pinus balsamea*, the Canadian balsam pine. It is essentially a resin dissolved in an essential oil. When freshly exuded it is a viscous liquid, but it hardens on exposure. Its chief use is for cementing lenses and other glass objects, because its refractive index, 1.53, is near that for glass. It is also used in the manufacture of fine lacquers.

**Canada turpentine** *See Canada balsam.*

**Candela** \kan-ˈdē-lə, -ˈde-, -ˈdā-; ˈkan-də-lə\ [L, candle] (1949) (cd) *n.* One of the six basic units of the SI system, the unit of luminous intensity, defined as the luminous intensity normal to the surface of 1/60 of a square centimeter of a black body at the temperature of freezing platinum (1772°C) under a pressure of 101.325 kPa. In older literature, the same abbreviation has been used for both candlepower and candle, which have different values.

**Candelilla wax** *n.* Natural wax obtained from the stems of a plant, which grows in Mexico and Texas. It varies in color from pale yellow-to-yellow or greenish-brown. It is one of the harder waxes, although not so hard as carnauba wax. Used in varnishes, electric insulation compositions, waterproofing and insect proofing, and paint removers.

**Candle (new unit)** *n.* 1/60 of the intensity of 1 $cm^2$ of a blackbody radiator at the temperature of solidification of platinum (2042 K).

**Candle (unit of luminous intensity)** *n.* Candle power is a measure of intensity of a source of light as compared with a standard candle.

*See foot-candle.*

**Candlenut oil** *n.* Oil derived from the nuts of the candlenut tree (*Aleurites moluccana*) of tropical Asia and Polynesia.

**Candlewick fabric** *n.* An unbleached muslin base fabric used to produce a chenille-like fabric by applying candlewick (heavy-plied yarn) loops and cutting the loops to give a fuzzy effect.

**Cangle filter** *n.* A small filter interposed between the spinning pump and spinning jet to effect final filtration of the spinning solution prior to extrusion.

**Cangle water temperature** *n.* The temperature of the water surrounding the candle filter or within the heating jacket during fiber extrusion.

**Cannon–Fenske viscometer** *n.* Capillary viscometer (calibrated) used for measuring relative flow time for liquids, useful for determining relative, specific and inherent viscosities of polymer solutions and extrapolation of intrinsic viscosities. It is convenient to clean and calibrate, but lacks correction due to different volume levels leading to weight due to gravity in the viscometer (*See image*).

**Canopy ceiling** *n.* A decoration composed of a ceiling paper, or a sidewall paper such as a strip, in which the strips are cut in triangles and hung so that the apex will terminate in the center of the ceiling to produce a striking domed effect.

**Can stability** *See shelf life and storage stability.*

**Cantilever-beam stiffness** *n.* A method of determining stiffness of plastics by measuring the force and angle of bend of a cantilever beam made of the specimen material. The ASTM test is *D*747.

*See also flexural modulus.*

**Canton flannel** *n.* A heavy cotton or cotton blend material with a twilled face and a napped back. The fabric's strength, warmth, and absorbance make it ideal for interlinings and sleeping garments.

**Canvas** \ˈkan-vəs\ [ME *canevas*, fr. ONF. fr. (assumed VL *cannabaceus*, fr. L *cannabis*] (13c) *n, v, vt.* A coarse cloth made from cotton, hemp, or flax. It may be used for artist's canvas or a picture painted on canvas. *See duck.*

**Canvas board** *n.* A paper board with primed canvas fastened to one face.

**Caoutchouc** \ˈkaú-ˌchúk, -ˌchúk, -ˌchű\ [F, fr. obs. Sp *cauchuc* (now *caucho*), fr. Quechua *kawchu*] (1775) *n.* An early name for pure natural (raw) rubbers, still in use in the French literature.

**CAP** *See cellulose acetate propionate.*

**Capacitance** \kə-ˈpa-sə-tən(t)s\ [capacity] (1893) (C, electric capacity) *n.* The property of a system of two conducting surfaces (plates or foils, typically) separated by a non-conductor (*dielectric*) that permits storage of electric charge in proportion to the voltage difference between the conductors. The SI unit is the farad (F). A capacitor storing one coulomb of charge at a potential difference of 1°V has a capacitance of 1°F. Plastics are much used as capacitor dielectrics. Capacitance is measured by the charge, which must be communicated to a body to raise its potential one unit. Electrostatic unit capacitance is that which requires one electrostatic unit of charge to raise the potential one electrostatic unit. The farad = 0 × 1011 electrostatic units. A capacitance of one farad requires one coulomb of electricity to raise its potential 1°V. Dimensions $[\varepsilon \mathrm{L}]$, $[\mu^{-1}\mathrm{L}^{-1}\mathrm{T}^{2}]$. A conductor charged with a quantity $Q$ to a potential $V$ has a capacitance,

$$C = \frac{Q}{V}.$$

Capacitance of a spherical conductor of radius, $r$, is $C = Kr$. Capacitance of two concentric spheres of radii $r$ and $r'$ is

$$C = K\frac{rr'}{r - r'}.$$

Capacitance of a parallel plate condenser, the area of whose plates is $A$ and the distance between them $d$,

$$C = \frac{KA}{4\pi d}.$$

Capacitances will be given in electrostatic units if the dimensions of condensers are substituted in cm. $K$ is the dielectric constant of the medium.

**Capillarity** \ˌka-pə-ˈlar-ə-tē\ (1830) *n.* Force of attraction between like and dissimilar substances. It is exhibited, for example, by the rise of a liquid up a capillary tube, or by the wetting of solids by liquids.

**Capillary action** *n.* A phenomenon associated with surface tension and contact angle. Examples are the rise of liquids in capillary tubes and the action of blotting paper and wicks.

**Capillary constant** *n. Also known as specific cohesion,*

$$a^2 = \frac{2T}{(d_1 - d_2)q} = hr,$$

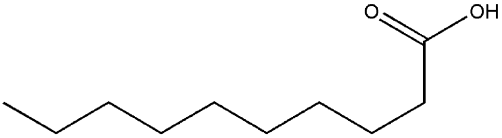
where $T$ is the surface tension, $d_1$ and $d_2$, the densities of the two fluids, $g$ the acceleration due to gravity, $h$ is the height of the rise in a capillary tube of radius $r$.
*See surface tension.*

**Capillary viscometers** Seed for concentrated solutions or polymer melts and described just above, the other, described here, used

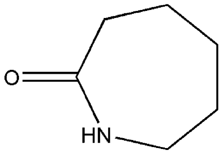
for measuring dilute-solution viscosities. The most widely used of the latter types employ a glass capillary tube and means for timing the flow of a measured volume of the solution (e.g., polymer in solvent) through the tube under the force of gravity. This time is then compared with the time taken for the same volume of pure solvent, or of another liquid of known viscosity, to flow through the same capillary. Relevant tests are from ASTM (www.astm.org).

*See also dilute-solution viscosity and viscometer.*

**Capric acid** \ˈka-prik-\ (decanoic acid, decylic acid, decoic acid) *n.* $CH_3(CH_2)_8COOH$. A plasticizer and an intermediate for resins (*See image*).

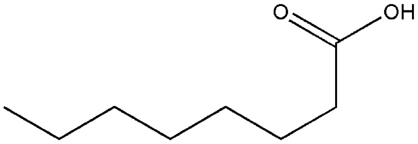


**Caprolactam** \ˌka-prō-ˈlak-ˌtam\ [*capro*ic acid + *lac*tone + *am*ide] (1944) (ε-caprolactam, hexanoic acid-ε-amino lactam) *n.* (1) A cyclic amid having the structure shown below. When the ring is opened, caprolactam is polymerizable to a nylon resin known as nylon 6 or *polycaprolactam.* It is also used as a cross-linking agent for polyurethanes, and as a plasticizer. In the late 1960s it was found that caprolactam could be rotationally cast by heating the solid monomer to its melting point (ca 71°C) and introducing the molten monomer into a mold along with a catalyst, then heating and rotating the mold in the usual manner. The liquid gradually thickens and gels against the mold in the manner of a plastisol, and conversion to nylon 6 is accomplished in a few minutes. (2) A white, hygroscopic, crystalline solid or leaflets (*See image*).

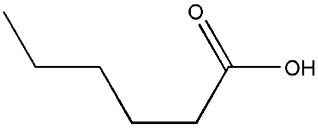


**Cap spinning** *n.* A system of spinning employing a stationary, highly polished metal cap just large enough to fit over the take-up bobbin, which revolves at a high rate of speed. The cap controls the build and imparts sufficient tension to the yarn for winding. The yarn is twisted and wound onto packages simultaneously.

**Caprylic acid** \kə-ˈpri-lik\ [ISV *capryl*] (1845) (octanoic acid, octoic acid, octylic acid, caprilic acid) *n.* $CH_3(CH_2)_6COOH$. A plasticizer and organic intermediate (*See image*).



**Caproic acid** \kə-ˈprō-ik-\ *n.* $C_6H_{12}O_2$. Hexanoic acid. Natural unsaturated fatty acid found in oils or made synthetically and used in pharmaceuticals and flavors (*See image*).



**Capstan** \ˈkap-stən, -ˌstan\ [ME, prob. fr. MF *cabestant*] (14c) *n.* In the plastics industry, a drum or pulley that controls the speed of a filament, wire, or web between production stages.

**Captive production** *n.* Production of materials or components by a manufacturer for its own use or for later incorporation in its products. Compare custom molder.

**CAR** Carbon fiber.

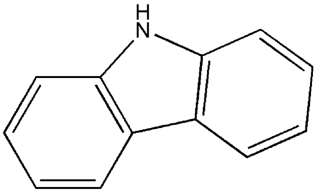
**Carbamide** \ˈkär-bə-ˌmīd, kär-ˈba-məd\ [ISV *carb-* + *amide*] (1865) *n. See urea.*

**Carbamide phosphoric acid** (urea phosphoric acid) *n.* $CO(NH_2)_2{\cdot}H_3PO_4$. A catalyst for acid-setting resins.

**Carbamyl urea** *See biuret.*

**Carbanion** \kär-ˈba-ˌnī-ən, -ˌnī-ˌän\ (1933) *n.* An organic ion carrying a negative charge (−) on a carbon atom.

**Carbazole** \ˈkär-bə-ˌzōl\ [ISV *carb-* + *az-* + *-ole*] (1887) (dibenzopyrrole, diphenylenimine) *n.* Pigment violet 23 (51319). Extracted from coal tar, unsaturated compound. (*See image*)



These pigments are manufactured in a variety of shades from red-shade to blue-shade violets. The latter appear more popular for toning (reddening) phthalocyanine blues. These pigments have excellent fastness properties even at high degrees of dilution but exhibit poorer color retention in metallized (aluminum flake) finishes than in light $TiO_2$ pastels. The are produced in both toner and lake (alumina hydrate) forms. They are used in the manufacture of poly(*N*-vinylcarbazole).

**Carbenes** *n.* Constituents of bituminous type products, which are insoluble in the chlorinated hydrocarbons, carbon tetrachloride and chloroform, but soluble in carbon disulfide.

**Carbenium ions** *n.* Stable carbenium ions, e.g., triphenyl-methyl and tropylium salts, and their merit is that can initiate the polymerization of certain olefins by direct addition.

**Carbinol** \ˈkär-bə-ˌnól, -ˌnōl\ [ISV, fr. obs. Gr *Karbin* methyl, fr. Gr *karb-*] (ca. 1885) *n.* (1) $–CH_2OH$. Monovalent primary alcohol radical. It may be part of an aliphatic or an aromatic alcohol. For example, ethyl alcohol ($C_2H_5OH$) can be described as methyl carbinol, or benzyl alcohol ($C_6H_5CH_2OH$) as phenyl carbinol. (2) It is sometimes used as a Syn: methanol.

**Carbitol** [2,(2-ethoxyethoxy)ethanol, ethyl cellosolve] $C_2H_5OCH_2–CH_2OCH_2CH_2OH$ and also written as $C_2H_5O(CH_2)_2O(CH_2)_2OH$. This is a trade name of an active, water-soluble solvent, the monoethyl ether of diethylene glycol. Properties: bp, 195°C; sp gr, 0.990/20°C; flp, 96°C (205°F); vp, les than 0.1 mmHg/20°C. If the ethyl ($C_2H_5$) group is substituted by methyl ($CH_3$), butyl ($C_4H_9$) groups, etc., the corresponding methyl and butyl carbitols are obtained.

**Carbodiimide polymers** *n.* Self-addition of isocyanates with the aid of organic phosphine and arsine oxides as catalysts form yields of polymers referred to as *carbodiimides*; example, $n$RN=C=NR.

**Carbohydrate** \-ˌdrāt, -drət\ (ca. 1869) *n.* An aldehyde or ketone which is a polyol, or a polymer of these.

**Carbohydrates** *n.* Compounds containing carbon and the elements of water, and thus their only elements are carbon, hydrogen, and oxygen. They are all variations of the same basic formula: $C_m(H_2O)_n$. The carbohydrates include the mono-, di-, tri, tetra-, and poly-saccharides, as well as the conjugated saccharides.

**Carbolic acid** \kär-ˈbä-lik\ [ISV *carb-* + L *oleum* oil] (ca. 1859) *n.* A Syn: phenol.

**Carbon** \ˈkär-bən\ [F *carbone*, fr. L *carbon-*, *carbo* ember, charcoal] (1789) *n.* (1) A non-metallic tetravalent element, atomic no. 6, atomic wt. 12.011; the major bioelement. It has two natural isotopes, $^{12}C$ and $^{13}C$ (the former, set at 12.00000, being the standard for all molecular weights), and two artificial, radioactive isotopes of interest, $^{11}C$ and $^{14}C$. The element occurs in three pure forms (diamond, graphite, and in the fullerines), in amorphous form (in charcoal, coke, and soot), and in the atmosphere as $CO_2$. Its compounds are found in all living tissues, and the study of its vast number of compounds constitutes most of organic chemistry. (2) A non-metallic chiefly tetravalent element found native (as in the diamond and graphite) or as a constituent of coal, petroleum, and asphalt, of limestone and other carbonates, atomic number 6, atomic weight 12.011 (longest living isotope). Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York.

**Carbon 14 (radiocarbon)** *n.* Radioactive carbon of mass number 14, naturally occurring bur usually made by irradiating calcium nitrate. It has been used as a $\beta$-ray source in gages for measuring the thickness of plastics films. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York.

**Carbon black** (ca. 1889) *n.* Pigment black 7 (77266) finely divided carbon formed by any one of the following processes: (1) incomplete combustion of natural gas in burners under moving channel irons (channel carbon black). (2) Incomplete combustion of natural gas and petroleum in large, closed furnaces (furnace carbon black) (3) decomposition of gasses in large converters filled with hot refractory brick checker work. These carbon blacks vary in particle size and some of them may be surface treated. A generic term for the family of colloidal carbons. More specifically, carbon black is made by the partial combustion and/or thermal cracking of natural gas, oil. Or another hydrocarbon. Acetylene black is the carbon black derived from burning acetylene. Animal black is derived from bones of animals. Channel blacks are made by impinging gas flames against steel plates or channel irons (hence the name), from which the deposit is scraped at internals. Furnace black is the term sometimes applied to carbon blacks made in a refractory-lined furnace. *Lamp black*, the properties of which are markedly different from other carbon blacks, is made by burning heavy oils or other carbonaceous materials in closed systems equipped with settling chambers for collecting the soot. *Thermal black* is produced by passing natural gas through a heated brick checker work where it thermally cracks to form a relatively coarse carbon black. Carbon blacks are widely used as fillers and pigments in PVC, phenolics, polyolefins, and several other resins, also imparting resistance to ultraviolet rays. In polyethylene, carbon black acts as a cross-linking agent, in rubbers, as a reinforcement. Donnet J-B, Wang M-J (1993) Carbon black. Marcel Dekker, New York. Pierson HO (1994) Handbook of carbon, graphite, diamond and fullenes. Noyes Data Corporation/Noyes Corporation, New York.

**Carbon blacks and graphite** *n.* Carbon black is the amorphous form and graphite is the crystalline form of carbon. Pierson HO (1994) Handbook of carbon, graphite, diamond and fullenes. Noyes Data Corporation/Noyes Corporation, New York. Kirk–Othmer encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York, 1996. Pierson HO (1994) Handbook of carbon, graphite, diamond and fullenes. Noyes Data Corporation/Noyes Corporation, New York.

**Carbon dating** (1951) *n.* Carbon dating is a variety of radioactive dating which is applicable only to matter that was one living and presumed to be in equilibrium with the atmosphere, taking carbon dioxide from the air for photosynthesis. Cosmic ray protons bombard nuclei n the upper atmosphere, producing neutrons that in turn bombard nitrogen, the radioactive isotope carbon-14 ($^{14}C$). The $^{14}C$ isotope combines with oxygen to form carbon dioxide and is incorporated into the cycle of living things. The $^{14}C$ isotope forms as at a rate that is constant, so that by measuring the radioactive emissions from once-living matter and comparing its activity with the equilibrium level of living things, a measurement of the time elapsed can be made (i.e., the activity of a sample can be directly compared to the equilibrium activity of living matter and the age calculated). The half-life of $^{14}C$ is about 5730 years by the emission of an electron of energy 0.016 MeV. This changes the number of the nucleus to seven, producing a nucleus of $^{14}N$. The low activity limit of the $^{14}C$ limits age determinations to the order of 50,000 years by counting techniques, and extended to perhaps 1,000,000 years by accelerator techniques. Fossil fuels have no $^{14}C$ content, and atmospheric testing of nuclear weapons in the 1950s and 1960s increased the $^{14}C$ content of the atmosphere. Lowe JJ (1997) Radiocarbon dating. John Wiley and Sons, New York. Higham T, Ramsey B, Owen C (2004) Radiocarbon and archaeology. Oxford University School of Archaeology, UK. Levin HL (2005) The earth through time. John Wiley and Sons, New York.

**Carbon dioxide** (1873) *n.* $CO_2$. A gas commonly found in the atmosphere. In a solid state (below freezing temperature) it is called dry ice. Levin HL (2005) The earth through time. John Wiley and Sons, New York.

*Also known as carbonic acid gas.*

**Carbon disulfide** (1869) *n.* $CS_2$. A colorless flammable poisonous liquid used as a solvent for rubber and as an insect fumigant. *Also called carbon bisulfide.*

**Carbon fiber** (1960) *n.* (1) A high-tensile fiber or whisker made by heating rayon or polyacrylonitrile fibers or petroleum residues to appropriate temperatures. Fibers may be 7–8 μm in diameter and are more that 90% carbonized. (2) Any fiber consisting mainly of elemental carbon and increasingly used in reinforced-plastics products. They may be prepared by growing single crystals in a carbon electric arc under high-pressure inert gas; by growth from a vapor state via pyrolysis of a hydrocarbon gas; or by pyrolysis of organic fibers, the most widely used method. Polyacrylonitrile and rayon fibers are most commonly used as starting materials. The terms “carbon fibers” and “graphite fibers” are used somewhat interchangeably. However, PAN-based carbon fibers are 93–95% C by elemental analysis, whereas graphic fibers are usually 99 + % C. The difference is due mainly to the temperature of formation. 1315°C for fibers formed from PAN, while the high-modulus graphite fibers are graphitized at 3450°C. The higher the graphite content, the higher the elastic modulus but the lower the strength. Properties hold to very high temperatures in inert atmospheres (Properties transverse to the fiber length are much lower than along the length). In recent years, carbon fibers have become the leading reinforcement for high-performance composites. The less expensive carbon fibers produced from pitch have broadened the markets for these reinforcements. Strength and modulus range considerably depending on the supplier and grade, from 1.7 to 3.5 GPa (250–500 kpsi) for strength and from 230 to 830 GPa (34–120 Mpsi) for modulus. Chung DD (1994) Carbon fiber compositors. Elsevier Science and Technology Books, New York. Pierson HO (1994) Handbook of carbon, graphite, diamond and fullness. Noyes Data Corporation/Noyes Corporation, New York.

**Carbon 14** (1936) *n.* A heavy radioactive isotope of carbon of mass number 14 used in tracer studies and in dating archaeological and geological materials. Lowe JJ (1997) Radiocarbon dating. John Wiley and Sons, New York.

**Carbon monoxide** (1873) *n.* A colorless odorless very toxic gas CO that burns to carbon dioxide with a blue flame and is formed as a product of the incomplete combustion of carbon.

**Carbon steel** (1903) *n.* A strong hard steel that derives its physical properties from the presence of carbon.

**Carbon tetrachloride** (1866) (tetrachloromethane) *n.* $CCl_4$. A clear, dense pungent-smelling liquid similar to that of chloroform, a powerful solvent for many resins and miscible with most other organic solvents, and a starting compound in the synthesis of nylon 7. It has a sp gr of 1.629 and is non-flammable. Solvent action on oils and similar products and soft resins is good. It is frequently used to reduce fire hazards. Very toxic (no flash or fire point). Its use as a solvent has now been severely curtailed because of its high toxicity and known carcinogenicity. Syn: tetrachloromethane, perchloromethane.

**Carbon 13** (1939) *n.* An isotope of carbon of mass number 13 that constitutes about 1/70 of natural carbon and is used as a tracer in spectroscopy utilizing nuclear magnetic resonance. Breitmaier E, Voelter W (1986) Carbon-13 NMR spectroscopy. John Wiley and Sons, New York.

**Carbon 12** (1946) *n.* An isotope of carbon of mass number 12 that is the most abundant carbon isotope and is used as a standard for measurements of atomic weight. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Carbonaceous** \ˌkär-bə-ˈnā-shəs\ (1791) *adj.* Matter containing carbon.
*See organic* (1).

**Carbon-arc lamp** *n.* A type of fading lamp, which utilizes an arc between two carbon electrodes as the source of radiation.

**Carbonate white lead** *n.* $Pb_3O8C_2H_2$. Pigment white 1 (77597). Basic carbonate of lead, the composition of which approximates to the formula $Pb(OH)_2{\cdot}2PbCO_3$. It is the normal white lead of industry and is often given the above description to differentiate it from white lead sulfate, which is also used as a pigment. It is marketed in several grades designated according to the method of manufacture, e.g., stack, chamber, electrolytic or precipitated. The latter is further subdivided into high, medium, and low stain varieties. Syn: basic carbonate of lead, basic lead carbonate, cremnitz white, kremnitz white, and white lead. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Carbon–carbon composite** *n.* A combination of carbon or graphite fibers in a carbon or graphite matrix, produced by impregnating a carbon- or graphite-fiber cloth or mat structure with a carbonizable binder such as pitch.

**Carbon-fiber-reinforced plastics (CRP)** *n.* Plastics, either thermosetting or thermoplastic – most commonly epoxies or high-performance resins – that contain carbon or graphite fibers. Chung DD (1994) Carbon fiber compositers. Elsevier Science and Technology Books, New York.

**Carbonific** *n.* Chemical compound which, upon decomposition, produces a mass of carbon which frequently occupies a volume much greater than the original unburned materials. Carbonifics function to produce the insulating, relatively incombustible properties of intumescent coatings.

**Carbonium** \kär-ˈbō-nē-əm-\ [*carb-* + *-onium*] (1942) *n.* A positively charged organic ion such as $H_3C$, having one less electron than a corresponding free radical and behaving chemically as if the positive charge were localized on the carbon atom.

**Carbonium ions** *n.* Positively charged organic molecules in which every atom has an octet of electrons which makes it more stable, e.g., $RCH{=}O^+R$.

**Carbonium-ion polymerization** *n.* Cationic $–C^+$ initiated polymerization reaction.

**Carbonization** *n.* Process of degrading organic matter to elemental carbon. The term is used chiefly in describing the decomposition of varnish films and the like, when subjected to elevated temperatures. Carbonization of films on stoving is always associated with pronounced darkening.

**Carbonizing** *n.* A chemical process for eliminating cellulosic material from wool or other animal fibers. The material is reacted with sulfuric acid or hydrogen chloride gas followed by heating. When the material is dry, the carbonized cellulose material is dust-like and can be removed.

**Carbonyl** (carbonyl group) \ˈkär-bə-ˌnil, -ˌnēl \ (1869) *n.* An organic functional group $–C{=}O$, found only in combination, as in aldehydes, ketones and organic acids.

**Carbonyl addition–elimination** *n.* The single most important type of reaction mechanism which has been applied to the preparation of step-growth polymers is the "addition–elimination reaction" of the carbonyl double bond of carboxylic acids and carboxylic acid derivatives; included in this general type of reaction are esterification amidation and anhydride formation from carboxylic acids, esters, amides, anhydrides and acid halides.

**Carbonyl addition–substitution** *n.* Step-growth polymerization schemes based on carbonyl addition-substitution reactions are almost entirely concerned with reaction of aldehydes; step-growth polymers prepared by this type of reaction include polyacetals, phenolformaldehyde polymers, ureaformaldehyde polymers, and melamineformaldehyde polymers.

**Carbonyl group** *n.* The bivalent radical, $–C{=}O$, especially in aldehydes or ketones.

**Carbonyl value** *n.* Keto group $–C{=}O$, is sometimes referred to as the carbonyl radical. Thus the amount of keto groups in a compound is its carbonyl value.

**Carborane** (dicarbadodecaborane) *n.* $C_2B_{10}H_{12}$. An icosahedral cage compound containing mostly boron, with two active hydrogens on the carbon atoms, and available in several isomers. It is polymerizable, but only the silicone copolymers have been manufactured.

**Carborundum** *See silicon carbide.*

**Carbowax** *n.* Poly(ethylene glycol), manufactured by Union Carbide, USA (now Dow Chemical).

**Carboxy nitroso rubber (CNR)** *n.* A fluorocarbon elastomer, synthesized as a terpolymer from tetrafluoroethylene trifluoronitrosomethane, and nitro-soperfluorobutyric acid. CNR has unique resistance to strong oxidizers and is nonflammable in pure oxygen, hence has found applications in the aerospace field. The gum can be processed on standard rubber-mixing equipment for molding, or dissolved for application by spraying, dipping or brushing.

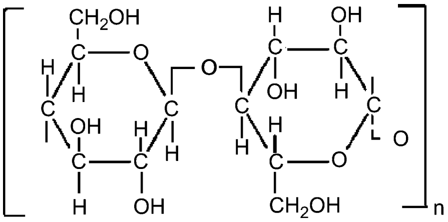
**Carboxyl end group** *n.* The chain-terminating (–COOH) group found in polyamide and polyester polymers.

**Carboxyl group** *n.* The radical –COOH, characteristic of most organic acids.

**Carboxylate ion** *n.* The anion of a carboxylic acid.

**Carboxylic** *n.* Term for the –COOH group, the radical occurring in organic acids.

**Carboxylic acid** *n.* Organic acid which possesses one or more carboxyl groups (*See image*). The simplest member of the series is formic acid and has the general formula H·COOH.



**Carboxymethyl cellulose (CMC)** \kär-ˌbäk-sē-ˌme-thəl, -ˈsel-yə-ˌlōs, -ˌlōz\ (1947) *n.* The common name for a cellulose ether of glycolic acid. It is an acid ether derivative of cellulose formed by the reaction of alkali cellulose with chloroacetic acid. It is usually marketed as a water-soluble sodium salt, more properly called sodium carboxymethyl cellulose. The sodium salt of this compound is commonly used as a stabilizer or an emulsifier. In the early literature, it is sometimes called cellulose glycolate or cellulose glycolic acid.

**Carburizing** *n.* A process for case-hardening steels in which the objects to be hardened are heated with carbonates and charcoal in the absence of air for bout 24 h at 840–950°C, then quenched in oil. The depth of hardening is about 1.7 mm and the surface hardness is from 50 to 55 on the Rockwell C scale.

**Carcinogen** \kär-ˈsi-nə-jən, ˈkär-sᵊn-ə-ˌjen\ (1853) *n.* Any material that has been tested and found to cause cancer in laboratory animals or that, through statistical studies, is correlated with the incidence of cancers in humans. An example from the plastics industry is vinyl chloride monomer, which is believed to have caused human liver cancer. PVC polymer, on the other hand, in non-carcinogenic. A list of known carcinogens is available from OSHA (USA Office of Health and Safety Administration). Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Card choking** *See cylinder loading.*

**Card clothing** *n.* The material used to cover the working surfaces of the card, i.e., cylinder and rolls or flats. The clothing consists of either wire teeth set in a foundation fabric or rubber, or narrow serrated metal flutes which are spirally arranged around the roll. The metallic wire has the appearance of band-saw blade.

**Card conversion efficiency** *n.* The efficiency of the carding process, expressed as a percentage obtained from ratio of sliver output to staple input.

**Carded yarn** *n.* A cotton yarn that has been carded but not combed. Carded yarns contain a wider range of fiber lengths and, as a result, are not as uniform or as strong as combed yarns. They are considerably cheaper and are used in medium and course counts.

**Cardigan** \ˈkär-di-gən\ [James Thomas Brudenell, 7th Earl of *Cardigan* † 1868 English soldier] (1868) *n.* (1) A modification of the rib-knitting stitch to allow tucking on one (half cardigan) or both (full cardigan) sets of needles. (2) A sweater that buttons down the front. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA.

**Carding** *n.* A process in the manufacture of spun yarns whereby the staple is opened, cleaned, aligned, and formed into a continuous, untwisted strand called a sliver.

**Cardol** *n.* One of the original constituents of cashew nutshell liquid, occurring to the extent of about 10%. It is a dihydroxy phenol, containing a side chain with two double bonds.

**Care label** *n.* The label that gives directions for cleaning, ironing, and otherwise maintaining a fabric of fiber product.

**Carene** *n.* Terpene hydrocarbon, which is a constituent of certain turpentines. Carene has been reported in German, Indian, Russian, and Finnish turpentines.

**Cariflex** *n.* Block copolymer of styrene/butadiene/styrene. Manufactured by Shell, The Netherlands.

**Carlona** *n.* Poly(ethylene), manufactured by Shell, The Netherlands.

**Carlona pt** *n.* Poly(propylene), manufactured by Shell, The Netherlands.

**Carmine** \ˈkär-mən, -ˌmīn\ [F *carmine*, fr. ML *carminium*, irreg. fr. Arabic *qirmiz* kermes + L *minium* cinnabar] (1712) *n.* Aluminum lake of a pigment from cochineal.

**Carmine lake** *n.* Natural Red 4 (75470). Barium lake of the dyestuff produced by coupling 7-amino-1-naphthalenesulfonic acid with R-sale (2-naphthol-3 : 6-disulfonic acid).

**Carmine vermillion** *See mercuric sulfide.*

**Carnauba Wax** \kär-ˈnó-bə, ˌkär-nə-ˈü-bə\ (1854) *n.* Extremely hard wax obtained from the leaves of a Brazilian tree. It appears on the market in several grades, such as bleached, yellow, fatty gray, and chalky gray. The wax has the following approximate constants: mp, 84°C, Sp gr, 0.998; acid value, 2; saponification value, 80; iodine value, 13. It is a constituent of wax polishes, and has some application in matt, overprinting, and baking varnishes. Its solubility is of a very low order in most varnish solvents and other constituents. Syn: Brazil wax.

**Carnaubic acid** *n.* $C_{23}H_{47}COOH$. One of the constituent acids for carnauba wax; monocarboxylic acid. Mp, 72°C.

**Carnaubyl alcohol** *n.* $C_{24}H_{49}OH$. Alcoholic constituent of carnauba wax. Mp, 69°C.

**Carnot cycle** *n.* A sequence of operations forming the working cycle of an ideal heat engine of maximum thermal efficiency. It consists of isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression to the initial state.

**Carotene (carotin)** \ˈkar-ə-ˌtēn\ [ISV, fr. LL *carota* carrot] (1861) *n.* $C_{40}H_{56}$. Hydrocarbon found in linseed and other vegetable oils where it is believed to act as an anti-oxidant.

**Carpet backing** *n.* A primary backing through which the carpet tufts are inserted is always required for tufted carpets. The backing is usually made of woven jute or non-woven manufactured fiber fabrics. A secondary backing, again made of jute or manufactured fibers, is normally added at the latex back-coating stage. Carpet backings are an important end use for nonwoven fabrics.

**Carpet underlay** *n.* A separate fabric, which is used to provide cushioning for carpet. Carpet underlays are made of hair and jute, sponge rubber, bonded urethane, or foamed urethane.

**Carpets** *n.* Heavy functional and ornamental floor coverings consisting of pile yarns or fibers and a backing system. They may be tufted or woven.

*Also see tufted carpet.*

**Carrageen** \ˈkar-ə-ˌgēn\ [*Carragheen*, near Waterford, Irland] (1829) (sometimes spelled “Carrageenan” or “Carrageenin”) *n.* Hydrocolloid obtained from a group of sea plants related to *Chondrus crispas*, colloquially called Irish moss or moss. It is a complex carbohydrate made up of galactose, dextrose, and levecose residue. Useful for mucilaginous and gelatizing qualities.

*Also known as Irish moss, Irish gum, pearl moss, pig wrack, and rock salt moss.*

**Carrier** *n.* (1) A product added to a dye bath to promote the dyeing of hydrophobic manufactured fibers and characterized by affinity for, and ability to swell, the fiber. (2) A moving holder for a package of yarn used on a braiding machine. (3) A term sometimes used to describe the tube or bobbin on which yarn is wound. Tortora PG (ed) (1997) Fairchild’s dictionary of textiles. Fairchild Books, New York.

**Carrierless dyeing variants** *n.* Polymers that have been modified to increase their dyeability. Fibers and fabrics made from these polymers can be dyed at the boil without the use of carriers.

**Carter lead** *n.* White lead manufactured in the USA. by what is known as the Carter process. This is somewhat similar to the chamber process except that the metallic lead is used in a finely divided state instead of sheets. The process is therefore quicker, but the resulting product is very similar to chamber white lead.

**Cartoon** *n.* (1) Preliminary sketch or detailed drawing for a painting, mural, etc., either to scale or actual size. The design is transferred from the paper to the working surface. (2) Term also used to describe a comic drawing or an animated film based on a succession of comic, grotesque drawings.

**Cartridge heater** *n.* A rod-shaped electrical heating element, consisting of a metal outer shell, sealed within which is a Nichrome-wire coil embedded in a thermally stable, electrically insulating powder, such as magnesium oxide. Cartridge heaters come in a wide range of physical sizes and wattages and are used in heating and controlling the temperatures of dies and molds, injection nozzles, hot stampers, etc.

**Carvone** *n.* Ketone derived from the terpene dipentine.

**Cascade coating** *n.* A process for applying epoxy and other thermosets to objects such as electrical resistors and capacitors, in which finely powdered resin is poured over the preheated object. The article is usually rotated as the powder is applied.

**Cascade control** (piggy-back control) *n.* In automatic control, a system in which the output of one unit is the input of the next, the goal being to obtain closer control of an important, final variable by controlling more sensitive, linked variables. A cascade system may be of the open-loop or closed-loop type.

**Case hardening** *n.* Any of several processes by which the working surfaces of steel tools and molds are hardened after being machined in their softer, original states. It can also be described as the surface hardening without thorough drying of the film.

*See carburizing, flame hardening, and nitriding.*

**Casein** *n.* (1) A protein usually obtained from milk. Used to make sizing, adhesive solutions, and coatings. Used as a binder in aqueous dispersions of pigments. (2) The protein substance occurring in milk and cheese. It can be obtained by treating skim milk with a dilute acid, but the type used mainly for plastics (rennet casein or paracasein) is made by treating warm skim milk with a rennet extract. Skeist I (ed) (1977) Handbook of adhesives. Reinhold Publishing Co., New York. Dainth J (2004) Dictionary of chemistry. Oxford University Press, New York.

*See also casein plastic.*

**Casein finish** *See casein paint and distemper.*

**Casein paint** *n.* Coatings in which casein replaces the ordinary drying oils, or is used as an emulsifying agent in emulsion paints. Both types may be thinned with water.

**Casein plastic** *n.* A family of thermosetting plastics derived from Casein, used widely in the early years of the plastics industry but less important now. Casein plastics have poor water resistance and dimensional stability, which limits their applications.

**Caseinates** *n.* Metallic salts derived from casein.

**Casement** A window sash that opens on hinges at the vertical edge.

*See casement window.*

**Casement cloth** *n.* A general term applied to lightweight, sheer fabrics used for curtains and for screening purposes and as a backing for heavy drapery fabrics of the decorative type. This type of fabric is sometimes made in small fancy weaves for dresswear.

**Casement window** *n.* Window hinged at the side to swing in or out.

**Cashew net shell oil** *n.* Natural oil from the shells of the nuts of the species *Anacardium occidentale*, containing a high proportion of cardol – a substituted phenol. By reaction of this oil with formaldehyde, a resin is produced which gives films with good chemical resistance.

**Cashew nut shell liquid resin** *n.* Resin derived from the liquid obtained from the shells of the nuts of the species, *Anacardium occidentale*, which grows chiefly in India and South America. The naturally occurring liquid is a mixture of a dihydroxy phenol cardol and anacardic acid. This acid readily decarboxylates on heating to yield a monohydroxy phenol with an unsaturated side chain, anacardol.

**Cashmere** *n.* The extremely soft hair of the Cashmere goat. Cashmere is often blended with sheep's wool in fabrics.

**Casing** *n.* A term coined by Bell Telephone Laboratories, an acronym for the process of Cross-linking by Activated Species of inert gases developed to impart printability and adhesive receptivity to polymers such as PTFE and polyethylene. In this process, articles are exposed to a flow activated inert gases in a glow-discharge tube, forming a shell of highly cross-linked molecules having high surface energy on the article surfaces.

**Casing knife** *n.* In paper handing, a knife used to trim wallpaper around casings, at moldings, baseboards, etc.

**Cassel brown** *See Vandyke brown.*

**Cassel earth** *See Vandyke brown.*

**Cassel yellow** *n.* $PbCl_2 \cdot 7PbO$. Lead oxychloride pigment.

**Casson equation** *n.* Rheology expression used to relate share rate, viscosity, and at infinite shear rate for dispesrsions (pigment coatings, etc.). Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York.

**Cassone painting** *n.* Pictures used to decorate the sides of an Italian marriage chest (cassone). The most common subjects were scriptural, chivalrous, mythological, and heraldic.

**Cast** *n.* (1) A tinge; a subjective term used in combination with a directional indicator to describe a slight deviation from the norm in color or appearance. The term is most often applied to color, and refers to a small difference in hue. For example, four pure hues are generally recognized psychologically, red, green, blue, and yellow. Each is unique and contains no quality of the others. If a blue hue seems to contain some element of green that blue is said to have a green "cast". (2) The term may also be applied to appearance aspects other than color. For example, a material which is normally expected to be transparent (non-scattering) but which is slightly cloudy (due to a small amount of light scattering) is said to have a "milky cast" or a "cloudy cast". McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Skeist I (ed) (1977) Handbook of adhesives. Reinhold Publishing Co., New York.
*See casting.*

**Cast coating** *See coating.*

**Cast embossing** *n.* A process of casting films against an embossed temporary carrier. Vinyl plastisols, organosols, solutions, or lattices are used as film formers, which may be backed up with layers of foam or fabric. The temporary carrier is often paper, embossed with the desired pattern and treated so as to be easily stripped from the fused film or laminate.

**Cast film** *n.* Film produced by pouring or spreading a solution, hot melt, or dispersion of plastic material onto a temporary carrier – typically a polished metal roll, hardening the material by suitable means, and stripping the solidified film from the surface. Cellulosic, polystyrene, and vinyl films are often produced in this manner.

**Cast film extruders** *n.* Equipment used for preparing thin polymer films by use of one or two free-rolling casting and polishing rollers.

**Cast film extrusion** *See chill roll extrusion.*

**Castanha de cotia kernel oil** *n.* A drying oil from a tree indigenous to Brazil. It is believed to contain a substantial proportion of eleostearic acid, or acid of similar type. Its rate of polymerization is much slower than that of tung oil. Its iodine value is 154.

**Cast-coated paper** *n.* A paper or board, the coating of which is allowed to harden or set while in contact with a finished casting surface. Cast-coated papers have a high gloss.

**Caster oil (dehydrated)** *n.* Castor oil from which some chemically combined water has been removed to improve its drying properties.

**Cast-in heater** *n.* A type of heater used on cylindrical surfaces, such as extruded barrels, in which a rod-type heating element is bent to a semi-cylindrical shape and cast within an aluminum channel shape whose inner surface has the cylinder's radius. Pairs of such cast-in elements are then strapped tightly to the barrel with Monel bands and high-strength bolts, leaving the heater terminals exposed for electrical connections. Copper tubing may also be cast into the same elements, permitting circulation of water or, better, an non-volatile heat-transfer liquid, for barrel cooling.

**Cast-in lining** *See bimetallic cylinder.*

**Casting** *n.* Manufacturing process dating back to at least 4000 BC. for inexpensively producing large or complex parts. The process of forming solid or hollow articles from fluid plastic mixtures or resins by pouring or injecting the fluid into a mold or against a substrate with little or no pressure, followed by solidification and removal of the formed object. The finished product of a casting operation.

*See also cast embossing, centrifugal-, film-, slush-, solid-, rotational-, and solvent casting; embedding, encapsulation, potting, and drawdown* (2, *n*).

**Casting plaster** *See gypsum and calcined.*

**Casting resin** *n.* Resin which can be cast and hardened in a mold to form a shaped article.

**Casting syrup (casting resin)** *n.* Liquid monomers or partially polymerized polymers, usually containing catalysts or curing agents, capable of polymerizing to the solid state after they have been cast in molds. The materials most generally used as the acrylics, styrenes, polyesters, epoxies, silicones, and nylons.

*Also called potting syrups when used for encapsulating articles such as electrical components or assemblies.*

**Castor oil (ricinus oil)** *n.* A pale-yellowish oil derived from the seeds of the castor bean, *Ricinus communis*, and consisting essentially or ricinolein. Its principal characteristics are light color, relatively high specific gravity and viscosity, and its solubility is alcohol. It differs from other oils in that its composition is mostly hydroxy fatty acids. It is essentially a non-drying oil, but it may be converted to a drying oil by "chemical dehydration" by which a hydroxy group and an adjacent hydrogen atom are removed as water to form a drying oil fatty acid ester with two double bonds, one of them being conjugated. This dehydration yields what commonly is known as dehydrated castor oil. In its original undehydrated form, castor oil is well known for its use in resins and as a plasticizer for cellulose ester lacquers. It is an important starting material for plasticizers, certain nylons, and alkyd resins; and an ingredient in certain urethane forms. Merck Index, 13th edn. Merck and Company Inc., Whitehouse Station, NJ, 2001. Paint: pigment, drying oils, polymers, resins, naval stores, Cellulosics Esters, and ink vehicles, vol 3. American Society for Testing and Material, Philadelphia, PA, 2001.

**CAT** *n.* (1) Abbreviation for the ISCC color-matching amplitude test. This test was devised by the subcommittee for Problem 10 of the Inter-Society Color Council as a measure of discrimination ability for small differences in saturation. It is not a test for defective color vision. Results depend on experience as well as on inborn ability. It is sold by the Federation of Societies for Coatings Technology, Philadelphia, PA, USA. (2) Abbreviation for catalyst.

**Cat eyes** *n.* Undissolved globules of rubber in a cement generally made from only rubber and solvent. Expression also used for PVC sheet and paint films. etc.

*Also called fish eyes. See pinhole.*

**Catalyst** \ˈka-tᵊl-əst\ (1902) *n.* A substance that causes or accelerates a chemical reaction when added to the reactants in a minor amount, and that is not consumed in the reaction. A negative catalyst (inhibitor, retarder) decreases the rate of reaction or prevents it altogether.

*See also hardener, inhibitor, acid catalysts, accelerator, curing agent, and initiator.*

**Catalysts and promoters** *n.* Substances whose presence increases the rate of a chemical reaction. They are added in a small quantity as compared to the amounts of primary reactants, and do not become a component part of the chain; they are referred to as an initiator. In some cases the catalyst functions by being consumed and regenerated; in other cases the catalyst seems not to enter the reaction and functions by virtue of surface characteristics of some kind. They are added to doped solvents to produce polymerization at room temperature or a temperature blow the softening point of the thermoplastic. A negative catalyst (inhibitor, retarder) slows down a chemical reaction.

**Catalytic agent** *n.* A substance, which by its mere presence alters the velocity of a reaction, and may be recovered unaltered in nature or amount at the end of the reaction.

**Catalytic curing** *n.* Mechanism by which a coating is cross-linked by the action of a catalyst as opposed to oxidation, etc. Examples of such systems are two-part (pot) and epoxies and polyurethanes.

**Cataphoresis** \ˌka-tə-fə-ˈrē-səs\ [NL] (1889) *n. See electrophoresis.*

**Catch-up** In lithography, the printing of non-image areas of a plate and is overcome generally by increasing the amount of fountain solution applied to it. It may occur as a run is started before the dampening adjustment is correctly set.

**Caterpillar (caterpillar puller)** *n.* A device used downstream of the extruder in extrusion of pipe and profiles, consisting of two driven and counter-rotating belts, having an elongated oval shape about 0.8 m long, with pads attached to the outsides of the belts. One of the belts is elevatable to adjust the clearance between them so as to firmly grip the extrudate being pulled away from the cooling tank, yet not so strongly as to deform it. Belt speed is adjustable over a wide range to accommodate different rates of extrusion.

**Cathode** \ˈka-ˌthōd\ [Gr *kathodos* way down, fr. *kata-* + *hodos* way] (1834) *n.* (1) In an electrolytic cell through which current is being forced by an external emf, the cathode is the negative electrode, giving up electrons to cations in the electrolyte. In a cell or battery *delivering current*, the cathode is the positive terminal. Also used in connection with cathodic protection. (2) In an electro-chemical cell, the electrode at which reduction occurs. (3) In a vacuum tube the cathode is the electrode from which electrons are emitted. The negatively charged electrode in a gas-discharge tube.

*See anode.*

**Cathode ray** (1880) *n.* The stream of electrons emanating from the cathode in a discharge tube.

**Cathode ray tube** (1905) *n.* A vacuum tube in which a beam of electrons is projected on a fluorescent screen to produce a luminous spot at a point on the screen determined by the effect of the electron beam of a variable magnetic field within the tube.

**Cathode sputtering** *See vacuum metallizing.*

**Cathodic corrosion** *n.* Corrosion due to the development of alkalinity by a reaction at a cathode – sometimes experienced with aluminum and lead. Alkalinity from this source may also affect paints vulnerable to alkali attack.

*See cell and electrolytic.*

**Cathodic polarization** *n.* Portion of the reduction in the initial potential of a corrosion cell that occurs at the cathode.

**Cathodic protection** *n.* Reduction or elimination of corrosion of a metal achieved by making current flow to it from a solution by connecting it to the negative pole of some source of current. The source of the protective current may be a sacrificial metal, such as zinc, magnesium, or aluminum. The current may also be derived from a rectifier, generator, or battery applied through an appropriate anode which may be consumed by the applied current, as in the case of steel, or remain substantially unaffected by the current, as in the case of graphite or platinum. Uhlig HH (2000) Corrosion and corrosion control. John Wiley and Sons Inc., New York.

**Cation** \ˈkat-ˌī-ən\ [Gk *kation*, neut., prp. of *katienai* to go down cap, fr. *kata*-cata- + *ienai* to go] (1834) *n.* An atom, molecule or radical, usually in aqueous solution, that has lost an electron and has become positively charged. It can also be described as a positively charged atom or radical, which moves to the negative electrode or cathode during electrolysis. Metallic ions, such as iron and copper, etc., are cations.

**Cationic** \ˈkat-(ˌ)ī-ˈä-nik\ (ca. 1920) *adj.* Pertaining to any positively charged atom, radical, or molecule; or to any compound or mixture containing positively charged groups.

**Cation-exchange resin** *See ion-exchange resin.*

**Cationic detergent** *n.* A detergent that produces positively charged colloidal ions in solution.

**Cationic dyeable variants** *n.* Polymers modified chemically to make them receptive to cationic dyes.

**Cationic dyes** *See dyes, basic dyes.*

**Cationic polymerization** *n.* Process in which the active end of the growing polymer molecule is a positive ion. If the ion is a carbonium ion, it is referred to as carbonium ion polymerization. a polymerization reaction with a positive or cationic initiator, i.e., a cationic initiator.

*See ionic polymerization.*

**Cationic surfactant** *n.* Surfactant which gives a positively charged ion in aqueous solution.

**Cauchy's dispersion formula** *n*,

$$n = A + \frac{B}{\lambda^2} + \frac{C}{\lambda_4} + \cdots$$

An empirical expression giving an approximate relation between the refractive index $n$ of a medium and the wavelength $\lambda$ of the light; $A$, $B$, and $C$ being constants for a given medium.

**Caul** *n.* A sheet of metal, wood, or other material used in laminating to apply and equalize pressure.

*See platen.*

**Caulk (calk)** *n.* To fill voids with plaster or semiplastic materials; to fill crevices in the adherend surface with adhesive materials; to provide a seal against moisture or solvent intrusion.

**Caulking** *See caulking compound.*

**Caulking cartridge** *n.* An expendable container made of plastic, fiberboard or metal, filled with caulking compound, for use in a caulking gun. A common type is 2 in. (5 cm) in diameter, approximately 8 in. (20 cm) long, and fitted with a plastic nozzle.

**Caulking compound** *n.* A soft, plastic, putty-like material, consisting of pigment and vehicle, used for sealing joints in buildings and other structures where normal structural movement may occur, or for preventing leakage. Caulking compound retains its plasticity for an extended period after application. It is usually available in two consistencies: "gun grade", for use with a caulking gun, and "knife grade", for application with a putty knife; extruded preformed shapes are also available.

**Caulking gun** *n.* A device for applying caulking compound by extrusion. In a hand gun, the required pressure is supplied mechanically by hand; in a pressure gun, the pressure required usually is greater and is supplied pneumatically.

**Cause-and-effect diagram (fishbone diagram)** *n.* A graphical way of analyzing a process, based on ideas and experiences of workers and engineers concerning the materials, machines, and methods of the process, in order to identify possible causes of product defects.

**Caustic** *n.* A strong chemical base.

**Caustic potash (KOH)** *n.* Archaic name for potassium hydroxide. A strong base.

**Caustic soda (NaOH)** *n.* Archaic name for sodium hydroxide. A strong base.

**Cave painting** *n.* The art produced in the form of paintings on the walls of caves from the beginning of the Old Stone Age to the end of the New Stone Age, around 3000 BC. The entire period covers a span of some 200,000 years. The Paleolithic cave paints at Altamira (Spain) and those at Lascaux (France) are believed to date between 40,000 and 10,000 BC.

*See prehistoric art.*

**Cavity** \ˈka-və-tē\ [MF *cavité*, fr. LL *cavitas*, fr. L *cavus*] (1541) *n.* A depression, or sometimes the set of matching or associated depressions, in a plastics molds that forms the outer surfaces of the cast or molded article(s). The cavity may surround a CORE, the portion of the mold that forms the inner surfaces of a hollow article.

**Cavity side (British)** *n.* The side of an injection mold that is adjacent to the nozzle.

**Cavity-retainer plate** *n.* A plate in a mold that holds the cavities and forces. Such plates are at the mold parting line and usually contain the guide pins and bushings.

*Also called force-retainer plate.*

**Cavity-side part (USA)** *n.* The stationary part of an injection mold.

**Cavity-transfer mixer** *n.* A two-piece device installed at the end of an extruder screw to accomplish both distributive and dispersive mixing. The *stator* is a barrel extension into whose inside surface is machined an array of many hemispherical cavities. The *rotor* is a screw extension whose exterior is similarly contoured. The lands of rotor and stator have the usual close clearance of screw and barrel. As the melt steam passes through, it is smeared between the lands and is repeatedly cut into small globs and recombined, passing from rotor to stator, stator to rotor, until it emerges.

**CBA** *n.* In the plastics-foam industry, abbreviation for chemical blowing agent.

**cd** *n.* SI abbreviation for Candela.

**Cd** *n.* Chemical symbol for the element cadmium.

**CDP** *n.* Abbreviation for cresyl diphenyl phosphate.

**Cedar** *n.* A durable softwood generally noted for decay resistance; includes Western red cedar, incense cedar, and eastern red cedar.

**Cedar nut oil** *n.* *Pinus cembra*, from the seeds of which this oil is derived, grows prolifically in several parts of the world. The main constituent acids are linoleic, linolenic, and oleic acids, and the oil possesses useful drying properties. Iodine values up to 160 have been reported.

**Ceiling** *n.* The overhead surface of a room, usually a covering or decorative treatment used to conceal the floor above or the roof.

**Ceiling temperature** *n.* The temperature above which polymerization will not occur, symbolized $T_c$.

**Celanese acetate** *See acetate fiber.*

**Celcon** *n.* Poly(formaldehyde) (from trioxane with some ethylene oxide). Manufactured by Celanese, USA.

**Celestial blue pigment** *n.* Iron blue precipitated on barytes. Usually only a few percent of blue is used.

**Celestite** *n.* Mineral, which is chiefly strontium sulfate. When ground, it has some application as a filler, being used as an alternative to barytes. The ground mineral is also known as *strontium white.*

**Cell** *n.* (1) A small etched depression in a gravure cylinder that carries the ink. (2) In the cellular-plastics industry, a single void produced by a blowing agent, by mechanically entrained gas, or by the evaporation of a volatile constituent. When the void is completely surrounded by polymer, the cell is said to e *closed.* A *completely open* cell has no wall membranes but is part of a three-dimensional network of connected fibers or rods.

**Cell collapse** *n.* A defeat in foamed plastics characterized by slumping and cratered surfaces, with the internal cells resembling a stack of leaflets when viewed in cross section under a microscope. The condition is caused by tearing of the cell walls, weakened by plasticization or other mechanism.

**Cell, electroylic** *n.* Source of electrical current that is responsible for corrosion, consisting of an anode and a cathode immersed in an electrolyte and electrically bonded together. The anode and cathode may be separate metals or dissimilar areas on the same metal. They will develop a difference in potential that causes current to flow and corrosion at the anode when the electrodes are in electrical contact with each other.

**Cellidor** *n.* Thermoplast based on Cellit. Manufactured by Bayer, Germany.

**Cellit** Cellulose acetate or acetobutyrate. Manufactured by Bayer, Germany.

**Celloidin (celluidine, photoxylin)** *n.* A form of cellulose nitrate made by precipitation from an ether-alcohol solution of collodion cotton.

*See cellulose nitrate and collodion.*

**Cellon** *n.* Cellulose acetate. Manufactured by Dynamit Nobel, Germany.

**Cellophane** *n.* (1) Regenerated cellulose film, chemically similar to rayon, made by mixing cellulose xanthate with dilute sodium hydroxide solution to form a viscose, then extruding the viscose into an acid bath for regeneration. Cellophane is coated on one or both sides to render it moisture proof and capable of being sealed with heat or solvent (The term *rayon* is used when the regenerated material is in fibrous form). Cellophane is widely used for packaging, most often with coatings of other polymers to overcome its tendency to absorb moisture and to improve the film's heat-sealability. Trade name for viscose film. (2) Hydrate cellulose from pump. Manufactured by Kalle, Germany.

**Cellosolve** *n.* $C_2H_5OCH_2CH_2OH$. Proprietary name for the monoethyl ether of ethylene glycol, ethoxyethanol. It is also the generic name for a comprehensive series of ethers or similar type such as methyl cellosolve, butyl cellosolve, etc. A relatively slow drying flexographic ink solvent frequently used as a retarder. Cellosolve is water miscible. Properties: bp, 135°C; Sp gr, 0.931/20°C; flp, 42°C (107°F); vp, 4 mmHg/20°C.

*See ethylene glycol monoethyl ether.*

**Cellosolve® acetate** *n.* $CH_3COOCH_2CH_2OCH_2CH_3$. Medium high boiling solvent (ethylene glycol monoethyl ether acetate). Properties: bp, 156°C (313°F); Sp gr, 0.975/20°C; flp, about 53°C (128°F); and vp, 1.5 mmHg/20°C.

**Cellular mortar** *See syntactic foam.*

**Cellular plastic (expanded plastic, foamed plastic)** *n.* A plastic with numerous cells of gas distributed throughout its mass. The terms *cellular*-, *expanded*-, and *foamed plastic* are used synonymously. A cellular plastic may be produced by (1) incorporating a blowing agent that decomposes to liberate a gas; (2) mechanically whipping in a gas or vaporizable liquid; (3) by adding a water-soluble salt or a solvent-extractable agent to the mix prior to forming, then leaching out the agent after forming to leave voids; or (4) other techniques described under epoxy foam, phenolic foam, polystyrene foam, syntactic foam, urethane foam. Cellular plastics range in density from some slightly less than that of the parent resin to less than 0.01 g/cm$^3$. The cells may be open or closed, depending on the process and density.

*See also structural foam.*

**Cellular striation** *n.* In a cellular plastic, a layer of cells differing in size or nature from the majority of cells in the same mass.

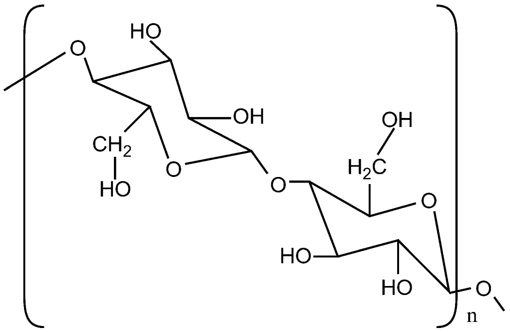
**Cellular vinyls** *n.* Vinyls containing occulted gas in bubbles or cells. Cellular vinyls are used to form polymers with very low densities, down to below 0.1 g cm$^{-3}$, due to the high gas volume fraction, and hence can have exceptionally low thermal conductivities.

**Cellulase** *n.* Enzyme that attacks and breaks down cellulosic substrates such as wood, cellulosic thickeners in paint, etc.

**Celluloid** *n.* (1) An old trade name, now generic, for cellulose nitrate compounded with camphor and ethanol. The ethanol is removed after processing by heating, leaving behind the camphor, which toughens the compound. Originally the trade name and now the common name of a synthetic plastic made by mixing pyroxylin, or cellulose nitrate, with pigments and fillers in a solution of camphor in alcohol. (2) Cellulose nitrate, plasticized with camphor. Manufactured by Dynamit Nobel, Germany.

**Celsius** *See temperature, celsius.*

**Cellulose** \ˈsel-yə-ˌlōs\ [F, fr. *Cellule* living cell. Fr. NL *cellula*] (1848) *n.* $(C_6H_{10}O_5)_n$. (1) A polysaccharide $(C_6H_{10}O_5)_x$ of glucose units that constitutes he chief part of the cell walls of plants, occurs naturally in such fibrous products as cotton and kapok, and is the raw material of many manufactured good as paper and rayon. (2) A natural carbohydrate polymer of high molecular weight, having the structure shown below. Cellulose is a constituent of most higher plants (*spermatophyta*). Cotton is the purest natural form, containing about 90%; it occurs to a small extent in the animal kingdom. Chemically, cellulose is 1–4 glucan of high degree of polymerization. It is desirable to apply "cellulose" to this material only and to designate the predominantly cellulosic residue obtained by subjecting woody tissues to various pumping processes as "cellulosic residues", "cellulosic pumps", or the like. Cotton linters and wood pulp are the major sources of cellulose for cellulosic plastics (*See image*).



**Cellulose acetate** (1895) (CA) *n.* An acetic-acid ester of cellulose, forming a tough, transparent thermoplastic material when compounded with plasticizers. It is obtained by the action, under rigidly controlled conditions, of acetic acid and acetic anhydride on purified cellulose, usually obtained from cotton linters. All three available hydroxyl groups in each glucose unit of the cellulose can be acetylated, but in the material normally used for plastics it is usual to acetylate fully, then to lower the acetyl value by partial hydrolysis, leaving, on average, 2.4 acetate groups per $C_6$ unit. Cellulose acetate compounds are used when toughness, permanence, flame resistance, and transparency are required at moderate cost. However, they absorb up to 2.5% of atmospheric moisture, making them unsuitable for long-term outdoor exposure. (2) A clear thermoplastic material, usually in film form, made from cellulose and acetic acid. (3) Cellulose triacetate is derived from a reaction of acetic anhydride, acetic acid and little sulfuric acid; partial hydrolysis removes some of the acetate groups and degrades the chain to 200–300 repeat units and yields cellulose acetate (roughly a diacetate) which is the commercial product.

**Cellulose acetate butyrate (CAB)** *n.* A mixed ester produced by treating fibrous cellulose with butyric and acetic acids and anhydrides in the presence of sulfuric acid. CAB is generally supplied in the form of pellets prepared by mixing the molten ester with a plasticizer, then extruding and palletizing. It is one of the toughest of the cellulosic plastics, and has good transparency, colorability, weatherability, electrical properties and resistance to inorganic chemicals. It can be processed by extrusion, injection molding, blow molding, rotational molding, and thermoforming. Applications include pipe, tool handles, instrument housing, lighting, packaging film, and marine hardware.

**Cellulose acetate propionate (CAP, cellulose propionate)** *n.* A thermoplastic formed by treating fibrous cellulose with propionic and acetic acids and anhydrides in the presence of sulfuric acid. CAP is easily extruded and injection molded, forming tough, flexible products with shock resistance close to that of ethyl cellulose. In properties and applications it resembles the acetate butyrate rather than the straight acetate.

**Cellulose acetobutyrate** *See cellulose acetate butyrate.*

**Cellulose esters** *n.* Any derivative of cellulose in which the free hydroxyl groups attached to the cellulose chain have been replaced wholly or in part by acidic groups, e.g., nitrate, acetate, propionate, butyrate, or stearate groups. Esterification is effected by the use of a mixture of an acid with its anhydride in the presence of a catalyst such as sulfuric acid. Mixed esters of cellulose, e.g., cellulose acetate butyrate, are prepared by using mixed acids and mixed anhydrides.

**Cellulose ethers** *n.* A cellulose derivative based on the etherification products of cellulose, such as ethyl cellulose, methyl cellulose, and sodium carboxymethyl cellulose. *See cellulose thickeners.*

**Cellulose ethers** *n.* Derivatives of cellulose in which one or more of the hydroxyl hydrogens have been replaced by alkyl groups.

**Cellulose fiber** *n.* The fibrous material remaining after non-fibrous components of wood have been removed by the pulping and bleaching operations. Used in making paper, etc.

**Cellulose glycolate** *See carboxymethyl cellulose.*

**Cellulose gum** *See carboxymethyl cellulose.*

**Cellulose lacquer** *See lacquer.*

**Cellulose nitrate** (1880) (CN, nitrocellulose, NC, pyroxylin) *n.* Cellulose nitrate, dating back to the work of French chemist

Braconnet in 1833, is the oldest of the synthetic plastics. It is made by treating fibrous cellulose with a mixture of nitric and sulfuric acids, and was first used in the form of a lacquer (*See collodion*). In 1870, John Wesley Hyatt and his brother patented the use of plasticized cellulose nitrate as a solid, moldable material, the first commercial thermoplastic (celluloid). Camphor was the first (and is still the best) plasticizer for CN, although many camphor substitutes have been developed. Alcohol is normally used as a volatile solvent to assist in plasticization, after which it is removed. Molded products of CN are extremely tough, but highly flammable and subject to discoloration in sunlight. CN is amendable to many decorative variations. Its principal uses today are in knife handles, table-tennis balls, and eyeglass frames. A mixture of nitric and sulfuric acids converts cellulose into cellulose nitrate; pyroxylin is a less nitrated material and it has been useful for photographic film, collodion, and celluloid plastics.

**Cellulose plastics** *n.* Plastics based on derivatives of cellulose, such as esters (cellulose acetate) and ethers (ethyl cellulose).

**Cellulose propionate** *n.* Ester of cellulose and propionic acid.

*See cellulose acetate propionate.*

**Cellulose thickeners** *n.* Aqueous thickeners based on cellulose compounds such as carboxymethyl cellulose, hydroxyethyl cellulose, and methyl cellulose.

**Cellulose triacetate** *n.* A member of the cellulosic plastics family made by reacting purified cellulose with acetic anhydride in the presence of a catalyst in such a manner that at least 92% of the hydroxyl groups are replaced by acetyl groups. Because of its high softening point this material cannot be molded or extruded. Its major use is for casting films or spinning fibers from solutions, such as in a mixture of methylene chloride and methanol.

**Cellulosic fiber** *n.* A fiber composed of, or derived from, cellulose. Examples are cotton (cellulose), rayon (regenerated cellulose), acetate (cellulose acetate), and triacetate (cellulose triacetate).

**Cellulosic plastic (cellulosic resin)** *n.* Any of a family of thermoplastics made by substituting various chemical groups fore the hydroxy groups in the cellulose molecules of cotton and purified wood pulp.

*See the following: cellulose acetate, cellulose acetate butyrate, cellulose acetate propionate, cellulose esters, cellulose nitrate, cellulose triacetate, ethyl cellulose, hydroxyethyl cellulose, and regenerated cellulose.*

**Cellulosics, resins** *n.* Resins and polymers derived from cellulose $[C_6H_{10}O_5]_n$.

**Celsius** \ˈsel-sē-əs\ *adj.* One hundredth of the thermometer scale, divided into 100 degrees, in which 0°C is the freezing point of water, and 100°C is the boiling point at 1.013 bar. The preferred name according to the International System of Units (SI) is degree of Celsius (°C).

**Cement** *n.* A material or a mixture of materials (without aggregate) which, when in a plastic state, possesses adhesive and cohesive properties and hardens in place. Frequently, the term is used incorrectly for concrete, e.g., a “cement” block for concrete block (*n*) *See adhesive.* (*v*) *See bond.*

**Cement-asbestos board** *n.* A dense, rigid, non-combustible board containing a high proportion of asbestos fibers, which are bonded with Portland cement; highly resistant to weathering.

*Also called asbestos-cement board.*

**Cement coating** *See cement paint.*

**Cement colorants** *n.* Term used to describe colors with sufficient tinctorial strength and alkali resistance to be suitable for coloring Portland cement or concrete. The natural earth colors, synthetic iron oxide colors, chromium oxide, ultramarine, and some of the organic pigments are used for this purpose.

**Cementing** *n.* Joining plastics to themselves of dissimilar materials by means of solvents (dopes, or chemical cements. *Dope adhesives See solvent cementing*), comprise a solvent solution of a plastic similar to the plastic to be joined. *Chemical cements*, the only type suitable for thermosetting plastics, are based on monomers or semi-polymers or semi-polymers that polymerize in the joint to form a strong bond.

*See adhesive.*

**Cementitious** *n.* Having cementing properties.

**Cement paint** *n.* Paint supplied in dry powder form, based essentially on Portland cement, to which pigments are sometimes added for decorative purposes. This dry powder paint is mixed with water immediately before use.

**Cement plaster** *n.* (1) Plaster with Portland cement as the binder; sand and lime are added on job. Used for exterior work or in wet or high humidity areas. (2) In some regions, Gypsum Plaster.

**Cement, Portland** *See Portland cement.*

**Cement, rubber** *n.* An adhesive that is a dispersion or solution of raw or compounded rubber, or both, in a suitable liquid.

**Cenobrium** *See mercuric sulfide.*

**Cenospheres** *n.* Hollow microspheres in fly ash formed during combustion of coal in electric-power plants. They have had some use as a lower-cost substitute for glass microspheres in syntactic foams.

**Centered cell** *n.* A unit cell, which has entities (atoms, molecules, and ions) at locations in addition to the ell corners. A non-primitive cell.

**Center-gated mold** *n.* In injection molding, a mold in which each cavity is fed through an orifice at the center of the cavity. This type of gating is employed for items such as cups and bowls.

**Centering mark** *See clip mark.*

**Center loop** *See kink.*

**Center of interest** *n.* In a room, the principal focal point, architecturally speaking, such as, for example, a fireplace. In a wallcovering design, the dominant motif, usually hung at eye level in the central area of a room to establish a starting point for handing the rest of the wallcovering.

**Centi-(c)** the SI-approved prefix signifying multiplication by $10^{-2}$.

**Centigrade** *See celsius.*

**Centimeter** \ˈsen-tə-ˌmē-tər\ (Brit. *centimetre*) *n.* A measure of length equal to a hundredth part of a meter (Brit. *metre*), or 0.3937 in.; abbreviated cm; an inch equals 2.54 cm.

**Centipoise** \-ˌpȯiz\ (cP) *n.* A deprecated, but still widely used viscosity unit, 0.01 poise. Water at 20°C has a viscosity of 1.002 cP. The SI equivalent is: 1 cP = 0.001 Pa s. Liquids of low viscosity are usually given in centipoise units.

**Centistoke (cs)** *n.* (1) A deprecated, but still used unit of kinematic viscosity, 0.01 Stoke, the approximate kinematic viscosity of water at 20°C. The SI equivalent is: 1 cs $= 10^{-6}$ m$^2$/s. (2) One one-hundredth of a stoke, which is the unit of kinematic viscosity:

$$\nu = \frac{\eta}{\rho},$$

where $\eta$ is the viscosity $\rho$ is the density. Sine SI units 1 cSt = 1 mm$^2$/s.

**Central stop** *n.* The opaque stop usually placed in the objective back focal plane to give central stop dispersion staining.

**Centrifugal casting** *n.* A method of forming plastic in which the dry or liquid plastic is placed in a rotatable container. It is heated to a molten condition by the transfer of hear through the walls of the container, and rotated such that the centrifugal force induced will force the molten plastic to conform to the configuration of the interior surface of the container.

**Centrifugal clarifier** *n.* Apparatus somewhat similar to a cream separator, used for clarifying clear and colored solutions by throwing out solid particles by means of centrifugal force. Clarifiers of this type are operated at high speed. The bulky and apparently undissolved particles are thrown aside into a collector.

**Centrifugal coasting** *n.* The process of forming tubes or other hollow cylindrical objects by introducing a measured amount of fluid resin dispersion into a rotatable container or mold, rotating the mold about the cylinder's axis at a speed high enough to force the fluid against all parts of the mold by centrifugal force, maintaining such rotation while solidifying the plastic by applicable means such as heating, then cooling if necessary, and removing the formed part. The fluid resin may be a dispersion such as a plastisol, or an A-stage thermoset with or without reinforcing strands.; This process should not be confused with rotational casting, which involves rotation at low speeds about one or more axes of rotation and gravity flow. Centrifugal casting is also used with metals, in particular, to manufacture bimetallic cylinders.

*See also centrifugal molding.*

**Centrifugal impact mixer** *n.* A device used for continuously mixing free-flowing dry blends, comprising a conical hopper in which are rotated at high speeds a rotor disk and a peripheral impactor. The material is fed to the center of the rotor, which throws it against the impactor blades, which in turn throws the material against fixed impactors at the extremities of the cone. From there, the material flows downward to a discharge orifice. Compare: high-intensity mixer.

**Centrifugal molding** *n.* A process similar to centrifugal casting except that the materials employed are dry, sinterable powders such as polyethylene. The powders are fused by heating the mold then solidified by cooling it.

**Centrifugal pot** *See pot spinning.*

**Centrifugation** *n.* A method for determining the distribution of molecular weights by spinning a solution of the specimen at a speed such that the molecules are not removed from the solvent but are held at a point where the centrifugal force tending to remove them is balanced by the dispersive forces caused by the thermal agitation.

**Centrifuge** *n.* Machine which exploits centrifugal force as a means of removing solid or semisolid particles from liquids.

**Centripetal force** *n.* The force required to keep a moving mass in a circular path. Centrifugal force is the name given to the reaction against centripetal force.

**Cera alba** *n.* Bleached or white beeswax.

**Cera flava** *n.* Yellow or unbleached beeswax.

**Ceramic** \sə-ˈra-mik, *esp Brit.* kə-\ [Gr *keramikos*, fr. *keramos* potter's clay, pottery] (1850) *adj.* Technology of producing fired clay and porcelain articles, their glazes, pigments, and modifiers.

**Ceramic fiber** *n.* A term embracing all reinforcing fibers made of refractory oxides such as $Al_2O_3$, BeO, MgO, $MgO{\cdot}Al_2O_3$, $ThO_2$, and $ZrO_2$. Although glasses are also ceramic materials, glass fibers are not generally included. Ceramic fibers are produced by chemical vapor deposition, melt drawing, spinning, and extrusion. Their main advantages are high strength and modulus, and resistance to high temperatures.

**Ceramic fiber reinforcements** *n.* Nonmetallic inorganic fibrous materials, available in a wide spectrum of forms, both continuous and discontinuous.

**Ceramics** *n.* A general term applied to the art or technique of producing products by a ceramic process.

**Ceraplast** *n.* Any reinforced thermoplastic, particularly polyethylene, containing ceramic or mineral particles that have been dispersed in the polymer melt to their ultimate size (no agglomerates) and completely enveloped in resin. Bonding of the envelope to the filler particles and the matrix polymer is aided by the addition of a small percentage of reactive monomer or resin precursor. It is believed that, in the extremely thin transition envelope, there is a smooth gradient of modulus from that of the particulate material to that of the polymer. The mechanical properties of ceraplasts are superior to those in which the same fillers have been conventionally incorporated.

**Ceresine** *n.* Non-crystalline wax made by refining ozokerite. Mp, 60–71°C (140–160°F).

**Cerium naphthenate** *n.* Rare earth drier for air drying and baking finishes; sometimes used to replace lead naphthenate.

**Cermet** \ˈsər-ˌmet] [*cer*amic + *met*al] (1948) *n.* (1) Composite materials consisting of two components, one being either an oxide, carbide, boride or similar inorganic compound and the other a metallic binder. (2) Any refractory composition made by bonding grains of ceramics, metal carbides, nitrides, etc, with a metal. Co-deposition of cermets with nickel in the electroless-nickel process provides excellent wear resistance and chemical resistance to molds, dies, extruder screws and other tooling components used in the plastics industry.

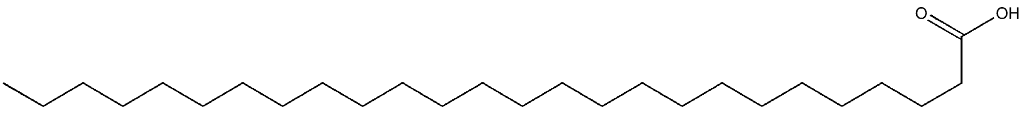
**Cerotic acid** *n.* A common name for either heptacosanoic acid or hexacosanoic acid. The former has the formula: $C_{26}H_{53}$ COOH, and a mp of 82°C; the latter, the formula: $C_{25}H_{51}COOH$, and a mp of 88°C. Cerotic acid is a constituent of natural waxes, in which it occurs as the cerotate esters. Neocerotic acid, formula, $C_{24}H_{49}$ COOH, mp of 77.8°C, is known as a constituent acid of beeswax (*See image*).

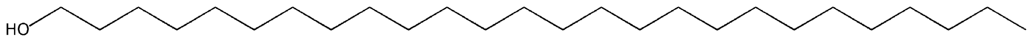
**Cerulean blue** \sə-ˈrü-lē-ən\ *n.* Very complex pigment consisting essentially of a combination of cobalt and tin oxides. It is bluish-green in color and very stable.

**Cerussite** \sə-ˈrə-ˌsīt\ [Gr *Zerussit*, fr L *cerussa*] (1850) *n.* $PbCO_3$. Natural lead carbonate, found in the upper zone of lead deposits. Colorless, white, and gray. Sp gr of 6.55. Effervesces in nitric acid.

**Ceryl alcohol** *n.* $C_{26}H_{53}OH$. Alcohol obtained from Chinese wax (*See image*).

**Cetoleic acid** *n.* $CH_3(CH_2)_9CH{=}CH(CH_2)_9$ COOH. One of the constituent fatty acids of many fish oils, It has a single double bond.





**Cetraria** *See Iceland moss.*

**CF** *n.* Cresol/formaldehyde resin.

**CFK** Man-made fiber-reinforced plastics.

**CFRP** *See carbon-fiber-reinforced plastics.*

**C glass** *n.* A type of glass fiber not quite as strong and stiff as e glass but having better chemical resistance. Its major constituents are $SiO_2$ 65%, CaO 13%, $Na_2O$ 8%, $B_2O_3$ 5%, $Al_2O_3$ 3%, and MgO 2%. Fiber density is 2.49 g/cm$^3$, tensile modulus is 71 GPa, and tensile strength is 3.2 GPa.

**CGPM** *n.* Abbreviation for Conférence Générate Des Poids Et Mesures, the international group that developed the system of weights and measures intended for worldwide use. The name Systéme International des Unités and the abbreviation SI were adopted by the 11th CGPM in 1960. For information on SI units *See SI* (2) *and the Appendix.*

**cgs System** Centimeter-gram-second system. Now replaced by SI units.

**cgs-EM system of units** System for measuring physical quantities in which the basic units are the centimeter, gram and second, and the numerical value of the magnetic constant, m, is unity. It is being replaced by the SI units.

**Chafe mark** *See abrasion mark.*

**Chafed end** *n.* A warp end that has been abraded during processing. It generally appears as a dull yarn often containing broken filaments.

**Chaffer fabric** *n.* A fabric, coated with unvulcanized rubber, that is wrapped around the bead section of the tire before vulcanization of the complete tire. The purpose of the chafer fabric is to maintain an abrasion-resistant later of rubber in contact with the wheel on which the tire is mounted.

**Chai oil** *n.* Mexican oil obtained from *Salvia hispanica.* It has excellent drying properties. A prominent characteristic of the oil is its high surface tension, which causes it to "crawl", cooking at 260°C (500°F) for a short time destroys this property. Its main constituent acids may make up more than 90% of the total acids. Properties: Sp gr, 0.9338/15°C; refractive index, 1.4855; iodine value, 196.3; saponification value 192.2.

**Chain binders** *n.* Yarns running in the warp direction on the back of a woven carpet, which hold construction yarns together.

**Chain branching** *n.* In a chain reaction, a step, which produces more chain carriers than it consumes.

**Chain dyeing** *See dyeing.*

**Chain expansion factor** *n.* The ratio of the length of a polymer chain in any given solvent to the length of the polymer chain in a theta solvent.

**Chain extension** *n.* Linear polymers (such as urethanes) of relatively low molecular weight may be extended by reaction of isocyanate endgroups with diamines to form interchain urea linkages, which, in turn add to other unreacted isocyanate endgroups to form biuret branching sites; reaction if isocyanate endgroups with diols to form new urethane linkages and extend the polymer chain, then, under more vigorous reaction conditions, by causing some still unreacted isocyanate endgroups to react with internal urethane linkages to form allophanate branching sites and cross-links; and by reaction of isocyanate endgroups with water to form urea linkages between linear chains, again followed by biuret cross-linking reactions.

**Chain flexibility** *n.* The ability of polymer molecules to assume a variety of configurations, arising from freedom of segments to rotate around C–C bonds. Polar side groups generally hinder rotation, making chains stiffer, while alkyl side chains tend to increase flexibility. Higher melting point materials are often characterized by relatively low chain flexibility (higher chains stiffness).

**Chain, folded** *n.* Chain folded is the conformation of a flexible polymer molecule when present in a crystal. The molecule exists and reenters the same crystal, frequently generating folds.

**Chain isomerism** *n.* Isomerism involving differences in skeletal chains of atoms in molecules.

**Chain kinetics** *n.* The study of rates and mechanisms of chemical reactions and of the factors on which they depend.

**Chain length** *n.* The number of monomeric or structural units in a linear polymer, or the main chain in a branched polymer. This can also be written as the total length of chain molecule, measured from atom to atom along the chain. Kinetic chain length *v.* gives the average number of monomer molecules that can be added to a free radical before the free radical is destroyed by a termination reaction. *Note*—This term should not be used for the direct distance between the ends of the molecule.

*See also degree of polymerization.*

**Chain polymerization** *n.* Polymerization processes are of two basic types: stepwise (or step reaction) and chain reaction. The kinetics of the two types of reaction are entirely different; the properties of the polymers they produce differ with respect to molecular weight distribution and usually, although not inevitably, differ in kind. The vast majority of chain reaction polymerize-tions are those generally known as addition polymerizations involving the conversion of vinyl-type monomers.

**Chain reaction** *n.* In general, any self-sustaining process, whether molecular or nuclear, the products of which are instrumental in, and directly contribute to the propagation of the process. Specifically, a *fission chain* reaction, where the energy liberated for particles produced (fission products) by the fusion of an atom cause the fusion of other atomic nuclei, which in turn propagate the fission reaction in the same manner. In other words, a reaction type characterized by the formation of products of a later step (chain carriers), which are reactants for an earlier step.

**Chain scission** *n.* A degradation mechanism (300–500°C) involving rupturing of bonds in the backboned of the polymer chain, while non-chain scission is concerned with all other bond-breaking reactions caused by pyrolysis.

**Chain stiffness** *See chain flexibility.*

**Chain transfer** *n.* Refers to the termination of a growing polymer chain and the start of a new one. The process is mediated by a chain transfer agent, which may be the monomer, initiator, solvent, polymer, or some species that has been added deliberately to affect chain transfer.

**Chain-transfer agent** *n.* A substance, used in polymerization that has the ability to stop the growth of a molecular chain by yielding an atom to the active radical at the end of the growing chain, but in turn being converted to another radical that *n* initiate the growth of a new chain. Examples are thiols and carbon tetrachloride. Such agents are useful for preventing the occurrence of too long chains and too high weight-average molecular weights.

**Chair rail** *n.* The topmost molding of a dado, placed on the wall at the height of a chair back as a protection.

**Chalcogen** \ˈkal-kə-jən\ [ISV *chalk-* bronze, ore (fr. Gk *chalkos*) + *-gen*; from the occurrence of oxygen and sulfur in many ores] (ca. 1961) *n.* Any of the elements oxytgen, sulfur, selenium and tellurium. A member of group VIA in the periodic table.

**Chalk** *n.* (1) A soft white mineral consisting essentially of calcium carbonate occurring as the remains of sea shells and minute marine organisms. (2) Soft naturally occurring form of calcium carbonate. The whiter varieties are powdered, washed, and dried. The product is known as whiting; the finer varieties as Paris white. (3) The product of chalking.

*See chalking.*

**Chalkiness** *n.* (1) A dull, whitened appearance sometimes associated with certain extra-dull colors. (2) A fillingwise fabric defect observed as bands varying luster or sheen.

**Chalking** *n.* (1) Formation of a friable powder on the surface of a paint film caused by the disintegration of the binding medium due to disruptive factors during weathering. The chalking of a paint film can be considerably affected by the choice and concentration of the pigment (BSI). It can also be affected by the choice of the binding medium. (2) A condition of a printing ink in which the pigment is not properly bound to the paper and can be easily rubbed off as a powder. (3) Formation of a powdery surface condition due to oxidation of the surface of rubber and release of pigments and fillers at the surface. Not to be confused with bloom, which looks similar.

**Chalking resistance** *n.* The ability of a coating to resist the formation of a friable powder on the surface of its film caused by the disintegration of the binding medium due to degradative weather factors. The chalking of a coating can be considerably affected by the choice and concentration of pigment and binding medium.

*See chalking.*

**Chalk kauri** *n.* Soft, white, powdery form of kauri copal.

**Chalk masking** *n.* The color change due to chalking and not due to a change in the colorant.

**Chalk, precipitated** *n.* Obtained as a by-product in water softening by sodium carbonate. It consists chiefly of calcium carbonate, but is often contaminated by appreciable quantities of calcium sulfate.

**Challis** \ˈsha-lē\ [prob. fr. the name *Challis*] (ca. 1837) *n.* A very soft, lightweight, plain-weave fabric, usually printed with a delicate floral pattern. The name is derived from the Anglo-Indian term “shalee” meaning soft.

**Chamber white lead** *n.* Particular type of white lead pigment, made by hanging strips or straps of lead in chambers, and subjecting them to the corrosive action of moist air, carbon dioxide, and acetic acid vapor. Chamber white lead differs from the stack form, usually being finer and of a better color.

*See carter lead.*

**Chambray** \ˈsham-ˌbrā, -brē\ [irreg. fr. *Cambrai*, France] (1814) *n.* (1) A plain woven-spun fabric, almost square (i.e., 80 × 76), with a colored warp and a white filling. Lightweight chambrays are used for shirts, dresses, and children’s clothes. (2) A similar but heavier fabric of carded yam, used for work clothing.

**Chameleon** \kə-ˌmēl-yən\ [ME *camelion*, fr. MF, fr. L *chamaeleon*, fr. Gk *chamaileōn*, fr. *chamai* on the ground + *leōn* lion]

(14c) *n.* A variable multicolored effect achieved by using warp yarns of one color and two filling yarns of different colors in each shed. It is sometimes used in taffeta, faille, or poplin made from silk or manufactured filament yarns.

**Change-can mixer (pony mixer)** *n.* A type of planetary mixer comprising several paddle blades mounted on a vertical shaft rotating in one direction while the can or contained counter-rotates. The paddle shaft is usually mounted on a hinged structure so that it can be swung out of the can, permitting the can to b removed, emptied, and replaced easily. This type of mixer is employed for relatively small batches (12–480 L) of fluid dispersions and dry materials.

**Change in filling** *See mixed end or filling.*

**Change in length on untwisting** *n.* The increase or decrease in length measured when a specimen is untwisted. The change is expressed as the percentage extension or contraction of the nominal gauge length of the specimen, i.e., specimen length prior to untwisting.

**Channel black** *n.* Form of carbon black made from natural gas by the channel combustion process. The gas is burned with insufficient air in jets, and the flames are allowed to impinge on a cool, channeled metallic surface. The deposited carbon is then scraped from the channel after a certain period of burning. Because of air pollution control requirements, this type of black has been almost completely replaced by Furnace Black in the USA.

**Channel depth (*h* or *H*)** *n.* Of an extruder screw, at any point along its length, the radial distance between the flight-tip surface and the screw-root surface. In a screw section of constant depth, half the difference between the other (major) diameter of the screw and its root diameter.

**Channel-depth ratio** *n.* In an extruder screw, the ratio of the depth in the first turn of the screw at the feed end to the depth in the last turn at the delivery end. If the lead of the screw is constant, the channel–depth ratio is slightly larger than the channel–volume ratio (which follows).

**Channel-volume ratio** *n.* In an extruder screw, the ratio of the volume of the first turn of the screw at the feed end to the volume of the last turn at the delivery end. The term compression ratio is commonly used as a synonym in the extrusion industry.

**Char** (l, *n*) *n.* Animal or vegetable carbon black used as a decolorant in the process industries (2, *v*). To partly burn and blacken, especially the outside surface of a carbonaceous material.

**Charcoal black** *n.* Black pigment obtained from wood charcoal.

**Charge** (*n.*) The amount of material used to load a mold at one time or for one cycle. The amount may be expressed in either mass or volume units. In injection and transfer molding, the charge includes sprues and runners.

**Charge-transfer** *n.* Refers to the termination of a growing polymer chain and the start of a new one.

**Char length** *n.* In flammability testing, the distance from the edge of the sample exposed to the flame to the upper edge of the charred or void area.

**Charles' law (Gay–Lussac's law)** *n.* The temperature part of the ideal-gas law as follows: at constant pressure, the volume of any gas is directly proportional to its absolute temperature (*K*).

**Charpy impact test** *n.* A destructive test (ASTM D 256B) of impact resistance using a centrally notched test specimen 126 mm long and typically 12.7 mm square. The specimen is supported horizontally near its ends and struck on the side opposite the notch by a pendulum, having sufficient kinetic energy to break the specimen with one blow. The result is expressed as the quotient of the energy absorbed from the pendulum divided by the specimen width (J/cm or ft-lb/in).

**Chase (shoe)** *n.* An enclosure of any shape used to (1) Shrink-fit parts of a mold cavity in place. (2) Prevent spreading or distortion in hobbing, (3) Enclose an assembly of two or more parts of a split-cavity block and (4) A rectangular metal frame in which type and plates are locked up for letterpress printing.

**Chaser** *n.* Mill for dispensing pigments in binder to form very stiff pastes or putty. It consists of a circular pan in which one or two massive rollers run about central axes.

**Chatki** *n.* Stone mill for grinding shellac.

**Chatter** *n.* Transverse roll marks on roll coat-painted strip with varying film thicknesses, which are usually due to roll coater vibration or a non-concentric roller.

**CHC** *n.* Chlorohydrin copolymers (from epichlorohydrin and ethylene oxide).

**Checking** *n.* (1) That phenomenon manifested in paint films by slight breaks in the film that do not penetrate to the underlying surface. The break should be called a crack if the underlying surface is visible. Where precision is necessary in evaluating a paint film, checking may be described as visible (as seen with the naked eye) or as microscopic (as observed under a magnification of 10 diameters). (2) Equals crazing.

*See cold-checking and checking resistance.*

**Checking resistance** *n.* The ability of a coating to resist slight breaks in its film that do not penetrate to the underlying surface. The breaks should be called cracks if penetration extends through the underlying surface. Where precision is necessary in evaluating a coating film, checking may be described as visible (as seen with the naked eye) or as microscopic (as observed under minimum magnification of 10 diameters).

*See cracking resistance. See checking.*

**Checks** *n.* (1) Rough surface due to fine cracks from weathering. (2) Roughness formed on calendered sheet when temperature of calender rolls is too low or when the sheet is chilled too suddenly.

**Cheese** *n.* (1) A supply of glass fiber wound into a cylindrical mass. (2) A cylindrical package of yarn wound on a flangeless tube.

**Cheesecloth** *n.* A low-count, plain weave, soft cotton, or cotton blend cloth also known as *gauze.*

**Cheesy** *adj.* Character of a paint or varnish film, which, although dry, is mechanically weak and rather soft.

**Chelate** \ˈkē-ˌlāt *also* ˈchē-\ (1826) *adj.* A compound comprised of metallic ions bound by a chelating agent.

**Chelating agent** *n.* (1) A term derived from the Greek word *chele*, meaning claw. Thus, a chelating agent is a substance whose molecules are capable of seizing and holding metallic ions in a claw like grip. (2) A sequestering or complexing agent that, in aqueous solution, renders a metallic ion inactive through the formation of an inner ring structure with the ion. (3) Organic compound that can remove many of the heavy metal cations from solution by forming soluble chelate compounds. Ethylenediaminetetraacetetic acid (EDTA) is typical. Syn: sequestering agent and chelate.

**Chelation** *n.* Reversible reaction of a metallic ion with a molecule or ion to form a complex molecule which does not have all or most of the characteristics of the original metallic ion. Syn: sequestration.

**Chemical analysis** *n.* Chemical analysis refers to the determination of chemical structure and chemically active species. It involves both direct measurements and use of specific compounds to achieve selective reactions of a component of the substance being analyzed; to produce a readily measurable species; or to determine a reactive end product.

**Chemical change (reaction)** *n.* A change in which one or more substances are transformed into one or more new substances.

**Chemical composition** *n.* Chemical composition is basically organic polymers that are very large molecules composed to chains of carbon atoms generally connected to hydrogen atoms (H), and often also to oxygen (O), nitrogen (N), chlorine (Cl), fluorine (F), and sulfur (S).

**Chemical conversion coating** *n.* A treatment, either chemical or electrochemical, of the metal surface to convert it to another chemical form which provides an insulating barrier of exceedingly low solubility between the metal and its environment, but which is an integral part of the metallic substrate. It provides greater corrosion resistance to the metal and increased adhesion of coatings applied to the metal. Examples are phosphate coatings on steel or zinc and chromate coatings on aluminum.

**Chemical crimping** *n.* A crinkled or puckered effect in fabric obtained by printing sodium hydroxide onto the goods in a planned design. When the material is washed, the part to which the paste has been applied will shrink and cause untreated areas to pucker. The same effect is obtained with a caustic resist print and a sodium hydroxide bath.

**Chemical fiber** *See manufactured fiber.*

**Chemical finishing** *n.* Processes in which additives are applied to change the aesthetic and functional properties of a material. Examples are the application of antioxidants, flame-retardant, wetting agents, and stain and water repellents.

**Chemically foamed plastic** *n.* A cellular plastic in which the cells are formed by thermal decomposition of a blowing agent or by the reaction of gas-liberating constituents. *See also cellular plastic.*

**Chemical polymeric blends** *n.* Mixtures of thermoplastic resins, etc.

**Chemical pretreatment** *See chemical conversion coating.*

**Chemical properties** *n.* Material characteristics that relate to the structure of a material and its formation from the elements.

**Chemical property** *n.* A property of a substance which can be described only by referring to a chemical reaction.

**Chemical reactions** *n.* Reactions between atoms and molecules to produce chemical compounds different from reactants. Chemical reactions may be elementary reactions or stepwise reactions.

**Chemical resistance (reagent resistance)** *n.* The ability of a plastic to maintain structural and esthetic integrity when exposed to acids, alkalis, solvents, and other chemicals. ASTM tests for chemical resistance of plastics include: C 581, chemical resistance of thermosetting resins used in glass–fiber-reinforced structures; D 543, resistance of plastics to chemical reagents; D 1239, resistance of plastic films to extraction by chemicals; D 1712, resistance of plastics to sulfide staining; D 21451, test method for staining of polyvinyl chloride compositions by rubber-compounding ingredients; D 2299, determining relative stain resistance of plastics; D 3615, chemical resistance of thermoset molding compounds used in the manufacture of molded fittings; D 3681, Chemical Resistance of Reinforced-Thermosetting-Resin Pipe in a Deflected Condition; D 3753, Specification for Glass–Fiber-Reinforced Polyester Manholes; and D 4398, Determining the Chemical Resistance of Fiberglass-Reinforced Thermosetting Resins by One-Side Panel Exposure.

**Chemical-resistant paint** *See chemical resistance.*

**Chemicals for electroplating** *n.* Most plastics plated today are finished with a copper/nickel/chrome electroplate, but many other finishes are possible, such as bright brass antique brass, satin nickel, silver, black chrome, and gold. The actual composition of the electroplate is designed for the particular application of the electroplate.

**Chemical shifts** *n.* The variation of the resonance frequency of a nucleus in nuclear magnetic resonance (NMR) spectroscopy in consequence of its magnetic environment. through absorption arising from shielding and deshielding by electrons, value is ppm. The chemical shift of a nucleus, $\delta$, is expressed in ppm by its frequency, $\nu_{\mathrm{cpd}}$, relative to a standard, $\nu_{\mathrm{ref}}$, and defined as $\delta = 10^6(\nu_{\mathrm{cpd}} - \nu_{\mathrm{ref}})/\nu_o$ where $\nu_o$ is the operating frequency of the spectrometer. For $^1$H and $^{13}$C NMR the reference signal is usually that of tetramethylsilane ($SiMe_4$).

**Chemical stability** *n.* Degree of resistance of a material to chemicals, such as acids, bases, solvents, oils, and oxidizing agents, and to chemical reactions, including those catalyzed by light.

**Chemiluminescence** \ˌke-mē-ˌlü-mə-ˈne-sᵊn(t)s, ˌkē-\ [ISV] (1889) *n.* Emission of light during a chemical reaction.

**Chemisorption** \ˈke-mi-ˌsórb, ˈke-, -ˌzórb\ [*chem.*- + -*sorb* (as in adsorb)] (1935) *vt.* Adsorption, particularly when irreversible, by chemical action rather than physical action.

**Chemist** \ˈke–mist\ [NL *chemista*, short for ML *alchimista*] (1562) *n.* (1) *obs.* Alchemist, one trained in chemistry (2) *Brit*: pharmacist. (3) A professional who possesses an earned bachelor's or higher degree with a major in a science from an accredited institution and who develops, applies, or communicates the principles of chemistry and exercises independent judgment and discretion in conceiving, planning, coordinating, or executing chemical projects, or who has experience in so doing. The chemical sciences deal with the composition, structure, and properties of substances and of the transformations they undergo.

**Chemistry** \ˈke-mə-strē\ *n.* The science of the compositions and structures of substances and of the changes, which these undergo. The study of molecules and the reactions they undergo.

**Chenille** \shə-ˈnē(ə)l\ [F, literally, caterpillar, fr. L *canicula*, dim. of *canis* dog; fr. its hairy appearance] (ca. 1739) *n.* (1). A yarn with a fuzzy pile protruding from all sides, cut from a woven chenille weft fabric. Chenille yarns are made from all fibers, and they are used as filling in fabrics and for embroidery, fringes, and tassels. (2) Fabric woven with chenille yarn.

*Also see tufted fabric.*

**Cherry** *n.* An even-textured, moderately high-density wood of the eastern USA, rich red-brown in color; takes a high luster; used for cabinetwork and paneling.

**Cheviot** \ˈshe-vē- ət, *esp British* ˈche-\ (1815) *n.* A rugged tweed made from uneven yarn, this fabric usually has a rather harsh hand.

**Chevron** \ˈshev-rən\ [ME, fr. MF, rafter, fr. (assumed) VL *caprion-*, *caprio* rafter, akin to L caper goat] (14c) *n.* A broad term applied to prints in zigzag stripes or to herringbone weaves.

**Chicle** \ˈchi-kəl, ˈchi-klē\ [AS, fr. Nahautl *tzictli*] (ca. 1889) *n.* Raw material for chewing gum (mixture of *trans*-1,4-poly (isoprene) + triterpenes. A natural product.

**Chiffon** *n.* A plain weave, lightweight, sheer, transparent fabric made from fine, highly twisted yarns. It is usually a square fabric, i.e., having approximately the same number of ends and picks and the same count in both warp and filling.

**Chill-back** *n.* A material capable of reducing the temperature of a batch of varnish or resin, either because of a considerable temperature difference between itself and the hot material, or because it absorbs heat in melting also.

**Chillers** *n.* A self-contained (individual or central) system comprised of a refrigeration unit and a coolant circulation mechanism consisting of a reservoir and a pump.

**Chilling** *n.* (1) In varnish or resin manufacture, the deliberate and rapid reduction of the temperature of the charge in a varnish or resin pot. (2) On a painted or varnished surface, a clouding of the surface or a reduction of luster as a result of the movement and cold air over the drying surface. *Also called quenching.*

**Chill roll** *n.* A metal roll – a shell within a shell with a relatively small clearance between the two – with water or other heat-transfer medium circulating through the so-formed annular space, used to cool an extruded or cast film or sheet prior to winding or cutting. The surface of the roll may be polished or textured to impart a finish to the plastic.

**Chill-roll extrusion** *n.* Film extrusion in which the molten film is drawn over cooled, polished rolls, imparting high gloss to the film. Syn: cast film extrusion.

**Chimb** *See chime.*

**Chime** *n.* The top ring of a coating container into which the friction top is pressed in order to effect an air-tight seal. Syn: chimb and chine.

**Chimney** *n.* An incombustible vertical structure containing one or more flues to provide draft for fireplaces, and to carry off gaseous products of combustion to the outside air from fireplaces, furnaces, or boilers.

**China clay** *n.* $Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$. Pigment white 19 (77005). A complex hydrated aluminum silicate produced by the breakdown of the mineral feldspar. The finest grades are used by the color and paint trades – often under proprietary names – and are utilized as a base for lakes and as an extender and anti-settling agent in paints. *See aluminum silicate. Also known as kaolin.*

**China wood oil** *See tung oil.*

**Chinchilla cloth** *n.* A heavy, twill weave, filling-pile fabric with a napped surface that is rolled into little tufts or nubs. The material is frequently double faced with a knitted or woven, plain or fancy back. Chinchilla cloth is used primarily in coats. The term is also used to refer to a knitted woolen fabric having a napped surface.

**Chine** *See chime.*

**Chinese blue** Term often applied to better grades of Prussian blue.
*See milori blue and iron blue.*

**Chinese ink** *See India ink.*

**Chinese lac** *n.* Resinous exudation of the wild Chinese tree, *Angia sinensis* or *Tssi-chau*, from which it is obtained by making deliberate incisions in the trunk. It is very susceptible to exposure, changing in color gradually, through red to black. The resinous exudation has very good solubility, blending satisfactorily with turpentine and alcohol.

**Chinese red** *See chrome orange.*

**Chinese vegetable tallow** Fatty substances from the kernels of the Chinese vegetable tallow tree, *Stillingia sebifera*. This is the same tree, which yields stillingia oil.

**Chinese vermillion** *See mercuric sulfide.*

**Chinese wax** An insect secretion, collected from certain evergreens, which are indigenous to China. Properties: mp, 81°C; Sp gr, 0.970; saponification value, 92; and a negligible iodine value. Known also as Insect Wax.

**Chinese white** (1) A paint using zinc oxide as the principal pigment. (2) Syn: zinc oxide.

**Chino** A cotton or cotton blend twill used by armies throughout the world for summer-weight uniforms. Chino is frequently dyed khaki.

**Chinoiserie** \shēn-ˈwäz-rē, -ˈwä-zə-; ˌshēn-ˌwäz-ˈrē, -ˌwä-zə-\ [F, fr. *chinois* Chinese, fr. *Chine* China] (1883) *n.* Originally, European designs "in the Chinese taste". Now loosely applied to almost any oriental form of decoration.

**Chinon** Graft copolymer of 70% acrylonitrile on 30% casein. Manufactured by Toyoba, Japan.

**Chintz** \ˈchin(t)s\ [earlier *chints*, plural of *chint*] (1614) *n.* A glazed fabric produced by friction calendering. Unglazed chintz is called cretonne.

**Chip** (1) The form of polymer feedstock used in fiber production. (2) The feedstock for a pulp digestor. (3) A defect in a non-woven fabric.

*Also see flake.*

**Chip board** *n.* Paperboard generally made from reclaimed paper stock and frequently used as a facing for partitions. The board is of moderately low density and should not be confused with particle board.

**Chipping** *n.* (1) Removal of paint, or rust and scale, by mechanical means. (2) Total or partial removal of a dried paint film in flakes by accidental damage or wear during service; in traffic paints, this failure is usually characterized by sharp edges and definite demarcation of the base area. (3) Spreading of white or colored chips or flakes during the application of seamless flooring. This procedure is used to impart a decorative effect to the flooring.

**Chipping rating standards** *n.* A set of photographic standards depicting the size and number of chips in each of several categories, as described in ASTM Method D-3170.

**Chipping resistance** *n.* The ability of a coating or layers of coatings to resist total or partial removal, usually in small pieces, resulting from impact by hard objects or from wear during service.

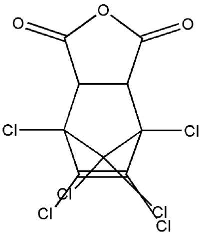
*See chipping.*

**Chips** *n.* (1) Term used to describe the size of resin particles. It represents a form intermediate between bold lumps and dust. (2) Dry combination of binder and pigment which in solvent forms paint, or which can be added to color plastics (e.g., vinyl chips and nitrocellulose chips).

**Chirality** \ˈkī-rəl\ [*chir-* + $^{1}$*-al*] (1894) *adj.* The property of an organic molecule of not being identical with its mirror image; a compound whose molecules are chiral can exist as enantiomers, but non-chiral compounds cannot be enantiomers. All asymmetric molecules are chiral; however, not all chiral molecules are asymmetric since some having axes of rotational symmetry are chiral. Chiral and prochiral atoms are sites or potential sites, respectively, of stereoisomerism.

**Chlorazol dyes** *n.* Range of soluble dyestuffs, which are used in the manufacture of colored inks.

**Chlorendic anhydride** (1,4,5,6,7,7-hexachloro-5-norbornene-2,3-dicar-boxylic anhydride, HET anhydride, a difunctional acid anhydride) *n.* HET anhydride is a white, crystalline powder used as a hardening agent and flame retardant in epoxy, alkyd, and polyester resins (*See image*).



**Chlorinated biphenyl (chlorinated diphenyl)** *n.* Any of a group of plasticizers ranging from liquids to hard solids, used with polyvinylidene chloride and polystyrene. They are also used in conjunction with DOP as coplasticizers for PVC, and in conjunction with polyvinyl acetate, ethyl cellulose and other thermoplastics, as adhesives.

**Chlorinated diphenyls (PCB)** *n.* Range of chlorinated hydrocarbons varying in properties from very liquid plasticizers, through thick syrups to solid resins. They are characterized by excellent compatibility, stability, and absence of free acidity, high toxicity, and non-flammability.

**Chlorinated hydrocarbon** *n.* Any of a wide variety of liquids and solids resulting from the substitution or addition of chlorine in hydrocarbons such as methane, ethylene, and benzene. They are employed as solvents, plasticizers, and monomers for plastics manufacture.

**Chlorinated hydrocarbons** *n.* Powerful solvents, which include such members as chloroform, carbon tetrachloride, ethylene dichloride, methylene chloride, tetrachorethane, trichloroethylene, etc. Generally speaking, they are toxic. Their main applications include non-flammable paint removers, cleaning solutions, and special finishes where presence of residual solvent in the film is a disadvantage. Many are not prohibited in most countries.

**Chlorinated paraffin (chlorocosane)** *n.* Any of a family of yellow to light amber liquids produced by chlorinating a paraffin oil, with uses as secondary plasticizers for vinyls, polystyrene, polymethyl methacrylate, and coumarone-indene resins. Chlorinated paraffins also impart flame resistance to polyolefins, polystyrene, PVC, natural rubber, and unsaturated polyester resins.

**Chlorinated paraffin wax** *n.* Ordinary paraffin wax can be chlorinated, under certain conditions, to yield products which no longer resemble the parent wax, but which have assumed definite resinous characteristics. The amount of chlorine present determines the physical properties of the resultant waxes. These with smaller amounts of chlorine are liquids, whereas those with about 70% chlorine are brittle resins. Their applications are in fire-retarding compositions and as plasticizers.

**Chlorinated para-nitraniline red** *See chlorinated para reds.*

**Chlorinated para reds** *n.* Pigment red 4 (12085). There are two varieties of chlorinated para red: (1) Ortho-chlor-papa nitraniline and (2) Para-chlorotho nitraniline; both are diazotized and coupled to beta naphthol. Both are light yellow shade reds of the toluidine red orange.

**Chlorinated polyether** [poly-3,3-bis-(chloromethyl)oxacyclobutane, Penton®] *n.* A corrosion-resistant thermoplastic obtained by polymerization of chlorinated oxetane monomer, the oxetane being derived from pentaerythritol, to a high molecular weight (250,000–350,000). The polymer is obtained from pentaerythritol by preparing a chlorinated oxetane and polymerizing it to a polyether by means of opening the ring structure. The polymer is linear, crystalline, and extremely resistant to degradation at processing temperatures. It may be injection molded, extruded, or applied as a coating by the fluidized-bed method. The resin is widely used in valves, pumps, flow meters, etc., for chemical plants.

**Chlorinated polyethylene (CPE)** *n.* Any polyethylene modified by simple chemical substitution of chlorine on the linear backbone chain, CPEs range from rubbery amorphous elastomers at 35–40% Cl to hard, semicrystalline materials at 68–75% Cl. They are sometimes included with chlorinated natural and butyl rubbers under the term chlorinated rubbers. Certain CPEs are used as modifiers in PVC compounds to obtain better flexibility and toughness, particularly low-temperature toughness, greater latitude in compounding, and ease of processing.

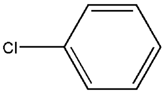
**Chlorinated polyvinyl chloride (CPVC)** *n.* A PVC resin modified by post-chlorination. A series of such resins, known as "Hi-Temp Geon", is available from B F Goodrich Chemical Co. Compared to conventional rigid PVC, CPVC withstands service temperatures 20–30°C higher, is stronger, and has better chemical resistance. CPVC is mildly hygroscopic, so requires predrying before processing. With that proviso, it can be processed by all the methods used for rigid PVC with few modifications.

**Chlorinated polyvinyl chloride resins** *n.* CPVC is a plastic produced by the post-chlorination of PVC.

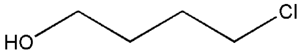
**Chlorinated rubber (rubber chloride)** *n.* (1) Natural rubber in which about two-thirds of the hydrogen atoms have been replaced by chlorine atoms. The resin is formed by the reaction of rubber with chlorine at about 100°C in an inert solvent or as a latex. Unlike rubber, the resulting product is readily soluble and yields solutions of low viscosity. It is sold as white powder, fibers, or as blocks. Commercial products generally contain about 65% chlorine. It has good chemical resistance properties, however, it tends to cobweb when sprayed. Now mostly chlorinated polymers are used, as 1-butene, polyethylene, etc. It has adhesive properties and, because of its good fire resistance, is used in paints. (2) Chlorinated natural rubber. Manufactured by Bayer, Germany.

**Chlorine retention** *n.* A characteristic of several resins and textile finishes whereby they retain some of the chlorine from bleach. On heating of the goods, the chlorine forms hydrochloric acid, causing tendering of the cloth. This is especially true of certain wrinkle resistant finishes for cotton and rayon.

**Chlorobenzene** \ˌklōr-ō-ˈben-ˌzēn, ˌklór-, -ben-ˈ\ [ISV] (ca. 1889) (chlorbenzene, chlorbenzol, chlorobenzol, phenylchloride) *n.* $C_6H_5Cl$. A solvent, and an intermediate in the production of phenol (*See image*).



**Chlorobutanol** (chlorbutanol, 1,1,1-trichloro-2-methyl-2-propanol, acetone chloroform, trichloro-*tert*-butyl alcohol) *n.* $Cl_3CC(CH_3)_2OH$. A plasticizer for esters and ethers of cellulose (*See image*).



**Chlorodiphenyl resin (chlorobiphenyl resin)** *n.* Any resin made from chlorinated biphenyl, rosin or rosin ester, and the higher fatty acids. These resins are used as plasticizers and modifying resins in plastics, and in lacquers and varnishes.

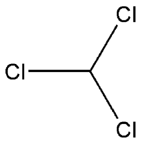
**Chloroethane** *n.* Syn: ethyl chloride.

**Chloroethene (chlorethylene)** Syn: vinyl chloride.

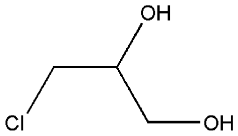
**Chlorofluorocarbon resin** *n.* Any resin made by the polymerization of monomer(s) containing only carbon, chlorine, and fluorine. The principal member is polychlorotrifluoroethylene (pctfe).

**Chlorofluorohydrocarbon resin** *n.* A resin made by polymerization of monomer(s) containing only carbon, chlorine, fluorine, and hydrogen.

**Chloroform** \ˈklōr-ə-ˌfórm, ˈklór-\ [F *chloroforme*, fr. *chlor-* + *formyle* formyl; fr. its having been regarded as a trichloride of this group] (1838) (trichloromethane) *n.* $CHCl_3$. A pungent, toxic, dense liquid, useful as a solvent for epoxy resins and others. (2) Clean, colorless, volatile liquid. Sp gr of 1.485 (20/20°C); bp of 61.2°C; fp of 63.5°C; wt/gal of 12.29 lb (25°C); refractive index of 1.4422 (*See image*).



**Chlorohydrin** \ˌklōr-ə-ˌhī-drən, ˌklór-\ [ISV *chlor-* + *hydr-* + $^{1}$-*in*] (ca. 1890) (α-chlorohydrin, 3-chloropropane-1,2-diol, glyceryl α-chlorohydrin) *n.* $ClCH_2CHOHCH_2OH$. A solvent, mainly for cellulosics (*See image*).



**Chlorohydrin rubber** *See epichlorohydrin rubber.*

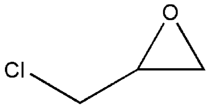
***α*-Chloro-*meta*-nitroacetophenone** *n.* $O_2NC_6H_4COOH_2Cl$. A bacteriostat and fungistat for plastics.

**Chloronaphthalene oil** *n.* Any of several nearly colorless oils derived by chlorinating naphthalene, used as plasticizers and flame retardants.

**Chloroprene** \-ˌprēn\ [*chlor-* + iso*prene*] (1931) *n.* $CH_2Cl–CHCl–CH{=}CH_2$. Polymerization of the monomer to poly(1-chloroprene) to form the synthetic chlorinated elastomer.

**Chloroprene polymer** *See neoprene.*

**Chloropropylene oxide** *n.* Syn: epichlorohydrin (*See image*).



**Chlorostyrenated polyester** *n.* An unsaturated polyester resin made by reacting a fluid polyester with monochlorostyrene in place of styrene (*See polyester, unsaturated*). Monochlorostyrene is less volatile and more reactive than styrene, providing faster cure rates and increased flexural strength and modulus in glass–fiber laminates.

**Chlorosulfonated polyethylene (CSM, CSPR)** *n.* Polyethylene which has been reacted with a mixture of chlorine and sulfur dioxide under ultraviolet light irradiation. Polymer may be vulcanized to form a product with good ozone, heat, oxygen and weathering resistance. It is produced by simultaneous treatment, with sulfur dioxide and chlorine, of dissolved, radicalized polyethylene. A commercial product (Hypalon®, DuPont) contains 22–26% Cl and 1.3–1.7% S.

**Chlorotrifluoroethylene** *n.* $ClFC{=}CF_2$. A colorless gas. The monomer for polychlorotrifluoroethylene. It is obtained by either dehalogenation or dehydrohalogenation of saturated chlorofluorocarbons or chlorohydrocarbons, e.g., by reacting 1,1,2-trichlorotrifluoroethane with zinc. The monomer for the preparation of polychloro-trifluoroethylene by free radical polymerization in aqueous systems.

**Choked coiler** *n.* A condition in carding or drawing in which sliver is either puffy, badly condensed, or very uneven, leading to overloading of the coiler trumpets and causing work stoppage.

**Choked flyers** *n.* A situation in which roving will not pass through the flyer channels because of heavy or cockled conditions caused by such factors as uneven drafting, waste, over-cut fibers, and improper finish.

**Choker bar (restrictor bar)** *n.* A bendable metal bar incorporated in a sheet-extrusion die for controlling flow distribution and lateral sheet thickness, and for reducing stagnation in the melt. The shape of a flow passage between the choker bar and the lower die body is altered by turning bolts connected to the bar.

**Cholesteric** \ˌkō-lə-ˈster-ik, kə-ˈles-tə-rik\ [*cholesteric* relating to cholesterol, fr. F *cholesterique*] (1942) *adj. See liquid–crystal polymer.*

**Chopped strand** *n.* A type of glass–fiber reinforcement consisting of strands of individual glass fibers that have been chopped into lengths from 1 to 12 mm. The individual fibers are bonded together within the strands so that they remain in bundles after being cut.

*See also roving.*

**Chopped-strand mat** *n.* A mat formed from randomly oriented, chopped strands of glass and held together, just strongly enough for handling, by a binder.

**Choppers** *n.* Chopper guns, long cutters, roving cutters cut glass fibers into strands and shorter fibers to be used as reinforcements in plastic.

**CHR** Chlorohydrin elastomer [poly(epichlorohydrin)].

**Christiansen effect** *n.* When finely powdered substances, such as glass or quarts, are immersed in a liquid of the same index of refraction complete transparency can only be obtained for monochromatic light. If white light is employed the transmitted color corresponds to the particular wavelength for which the two substances, solid and liquid have exactly the same index of refraction. Due to differences in dispersion the indices of refraction will match for only a narrow band of the spectrum.

**Chroma** \ˈkrō-mə\ [Gk *chroma*] (ca. 1889) *n.* (1) Color intensity or purity of tone, being the degree of freedom from gray. (2) One of the three terms used in Munsell notations. It correlates approximately with the psychological dimension of saturation.

**Chromatic aberration** *n.* A lens receiving white light from an object will form the blue image closer to the lens than the red image, forming color fringes. This caused by refractive index variation with wavelength (dispersion), always blue greater than red.

**Chromaticity** *n.* The quality of color expressed as a function of wavelength and purity.

**Chromaticity coordinates** *n.* **CIE.** The ratios of each of the three tristimulus values *X*, *Y*, and *Z* in relation to the sum of the three; designated as *x*, *y*, and *z*, respectively. They are sometimes referred to as the trichromatic coefficients. When written without subscripts they are assumed to have been calculated for Illuminant C and the 2° (1931) Standard Observer unless specified otherwise. If they have been obtained for other illuminants or observers, a subscript describing the observer of illuminant should be used. For example, $x_{10}$ and $y_{10}$ are chromaticity coordinates for the 10° observer and Illuminant *C*.

**Chromaticity coordinates** *n.* **General** The two dimensions of any color order system which exclude the lightness dimension and describe the chromaticity. Thus, *x* and *y*, or *a* and *b*, or *u* and *v*, or *YB* and *RG*, may be considered as chromaticity coordinates in various color spaces. Unless otherwise specified, the term chromaticity coordinates is assumed to refer to the CIE coordinates *x*, *y*, and *z* for Illuminant *C* and the 2° (1931) Standard Observer.

*Also known as color coordinates.*

**Chromaticity diagram** *n.* **CIE.** A two-dimensional graph of the chromaticity coordinates, *x* as the abscissa and *y* as the ordinate, which shows the spectrum locus (chromaticity coordinates of monochromatic light, 380–770 nm). It has many useful properties for comparing colors of both luminous and non-luminous materials.

**Chromaticity diagram** *n.* **General.** Plane diagram formed by plotting one of the chromaticity coordinates against the other.

**Chromaticity difference diagrams** *n.* Plane diagram formed by plotting the differences of one of the chromaticity coordinates against the differences of the other chromaticity coordinate, the differences being taken from the neutral point or, for a specific color, from the chromaticity coordinates for the standard of that color.

**Chromaticness** *n.* Combined hue and saturation of a color, with no reference to its lightness. Syn: chromaticity.

**Chromatography** (1937) *n.* In chemistry, analytical technique used for the chemical separation of mixtures and substances. A process in which a gas or liquid solution moves through a calibrated column containing a subdivided solid phase into which some components of the solution are absorbed, smaller molecules more quickly and thoroughly than larger ones. This is followed by pure carrier gas or solvent, the stream being monitored by a differential detector. Larger molecules emerge first, smaller ones later. The detector signal is proportional to the concentration of each species in the effluent. The process is mainly used for analysis of organic mixtures, but also for their separation. The name "chromatography" derives from the work of the Russian botanist N. Tswett, who first used the process to separate chloroplast pigments, obtaining colored bands on filter paper. Some variations of the process are *gas chromatography* (the gas mixture is passed through a porous bed, or through a capillary tube lined with an absorbent liquid or solid phase); paper chromatography (a drop of specimen is placed near one end of a porous paper); ion-exchange chromatography; thin-layer chromatography (the sample is placed on an absorbent cake spread on a smooth glass plate); and, important for plastics, size-exclusion chromatography.

**Chrome green (brunswick green)** *n.* $PbCrO_4xPbSO_4yFeNH_4Fe(CN)_6$. Any of a family of pigments ranging from light yellow-green through dark green, based on physical mixtures of chrome yellow and iron blue (a complex ammonium iron hexacyanoferrate). The amount of iron blue determines the shade, about 2% being used for light yellow-green, and up to 64% being used for dark greens. Variation can be achieved by pigment blends with extenders. Noted for good hiding and tinting strength, poor alkali resistance. Density, 4.1–5.4 g/cm$^3$ (34.2–45.0 lb/gal) O.A., 13–25; particle size, 0.2–1.2 µm. Syn: chromium green, lead chrome green, brunswick green and milori green.

**Chromel and alumel** *n.* Special high-nickel alloys that, when their wires are joined, develop high thermoelectric power, and are therefore useful for temperature measurement. "Type *K*" thermocouples are usually chosen for high-temperature work in oxidizing atmospheres.

**Chrome ochre** *See chromium oxide green.*

**Chrome orange, light and deep** *n.* $PbCrO_4 \cdot PbO$. Pigment orange 21 (77601). Chrome orange is chemically basic lead chromate. The hue ranges from light to deep orange, and the color is related to particle size. A pigment characterized by good opacity, fair lightfastness, and good gloss retention and durability. Disadvantages are poor alkali and acid resistance and poor high temperature stability. Density, 6.6–7.1 g/cm$^3$ (55.1–58.8 lb/gal); O.A., 9–12; particle size, 0.1–1.0 µm. Syn: orange chrome, Austrian cinnabar, Persian red, Chinese red, Derby red, American vermillion, and chrome red.

**Chrome-orange pigment** *n.* Any pigment based on basic lead chromate, $PbO \cdot PbCrO_4$, that is of a deep orange color.

**Chrome oxide green** *n.* A stable pigment based on anhydrous chromium oxide, $Cr_2O_3$. The form based on hydrated chromium oxide is called Guignet's Green. Syn: schnitzer's green.
*See chromium oxide green.*

**Chrome red** *See basic lead chromate, chrome orange, and light and deep.*

**Chrome vermillion** *See molybdate orange.*

**Chrome yellow** *n.* A light resistant opaque yellow pigment composed essentially of lead chromate.

**Chrome yellow, light, and primrose** *n.* $xPbCrO_4 \cdot yPbSO_4$. Pigment yellow 34 (77603). Yellow pigments based on combinations of lead chromate and lead sulfate, The hue and tint strength being controlled by the ratio of chromate to sulfate during precipitation. In the light and lemon hues, the approximate ratio of $x/y$ is 2.5/1 (2.5 $PbCrO_4 \cdot PbSO_4$); in the primrose hues, the $x/y$ ratio is approximately 3.2/1. The pigments are characterized by good opacity, fair lightfastness, good glass retention and durability, and poor resistance to alkali, acid, and high temperature. Density, 5.44–6.09 g/cm$^3$ (17–39 lb/gal); O.A., 17–39; particle size, 0.1–0.8 µm. Syn: lemon chrome, golden chrome, middle chrome, Paris yellow, Leipsic yellow, and cologne yellow.

**Chrome yellow, medium** *n.* PbCrO4. Pigment yellow 34 (77600). Approaches chemically pure lead chromate. Characterized by good opacity, fair to good lightfastness, good gloss retention and durability, poor alkali resistance. Density, 5.58–6.04 g/cm$^3$ (46.6–50.3 lb/gal); O.A., 16–35; particle size, 0.15–1 µm.

**Chrome yellow pigment (primrose chrome and permanent yellow)** *n.* Any pigment based on normal lead chromate, $PbCrO_4$ that is characterized by a medium yellow color. Other shades ranging from light greenish-yellow to medium reddish-yellow are made by co-precipitating lead chromate with other insoluble compounds such as lead sulfate or lead phosphate.

**Chromic acid** (1800) *n.* $H_2CrO_4$. An acid analogous to sulfuric acid but known only in solution and in the form of its salts.

**Chromic chloride (chromium chloride, chromium chloride hexahydrate)** *n.* $CrCl_3$ or $[Cr(4H_2O)Cl_2]Cl\cdot 2H_2O$. A catalyst for polymerizing olefins.

**Chromic hydrate** *See chromium hydroxide.*

**Chromic oxide** *See chromium oxide green.*

**Chromium green** *See chrome green.*

**Chromium hydrate** *See chromium hydroxide.*

**Chromium hydroxide** *n.* $Cr(OH)_3$. Green pigment, manufactured by adding a solution of ammonium hydroxide to the solution of a chromium salt. Syn: chromic hydrate and chromium hydrate.

**Chromium oxide green** *n.* $Cr_2O_3$. Pigment green 17 (77288). Most permanent green pigment, almost pure chromium sesquioxide. May be manufactured by reducing a chromate (e.g., sodium dichromate) with sulfur or carbonaceous materials. Outstanding lightfastness and resistance to acid, alkali and high temperatures often used as a colorant in cementitious products. Density, 5.1–5.4 g/cm$^3$ (42.5–45.0 lb/gal); O.A., 12–24; particle size 2–6 µm. Syn: arnaudon's green, chromium sesquioxide, chrome oxide green, vert emeraude (dull), anadonis green, chrome ochre, green cinnabar, green rouge, leaf green, oil green, dingler's green, and schnitzler's green.

**Chromium oxide, hydrated** *See hydrated chromium oxide.*

**Chromium plating (chrome plating)** *n.* An electrolytic process that deposits a hard, inert, smooth layer of chromium onto working surfaces of other metals for resistance to corrosion and wear. Extruder screws, chill rolls for sheet and film production, calendaring rolls, dies, and molds are commonly chromium plated.

**Chromium sesquioxide** *See chromium oxide green.*

**Chromophore** *n.* (1) A group such as $-NO$, $-NO_2$, or $-N{=}N-$ that, when present in a molecule, enables the molecule to be transformed into a dye upon the introduction of an acid group. (2) Certain groups of atoms such as, $-C{=}Cl$, $-C{=}N-$, $-N{=}N-$, and $-N{=}O$, when present in an organic molecule, can give rise to colored compounds. Groups acting in this way are called chromophores. Although compounds containing chromophores are not necessarily colored. The hue is affected by the presence of other groups known as "auxochromes", such as $-NH_2$, $-OH$, $-NO_2$, $-CH_3$ and halogens $-Cl$, $-Br$, and $-I$.

**Chrysotile** \-ˌtīl\ [Gr *Chrysotil*, fr. *chrys-* + *-til* fiber, fr. Gk *tillein* to pluck] (1850) (serpentine) *n.* $Mg_3Si_2O_5(OH)_4$ for $3MgO\cdot 2SiO_2\cdot 2H_2O$. A hydrated magnesium orthosilicate, the chief constituent of *serpentine* asbestos. Chrysotile-bearing asbestos has been the most used type, once accounting for over 90% of the world production. Its fine and silky fibers, and mats and felts made therefrom, where widely used as fillers and reinforcements for plastics, providing excellent resistance to chemicals and fire. Many of its former uses are now prohibited because of the carcinogenicity of some types of asbestos. *See magnesium silicate and fibrous.*

**Chute-feed system** *n.* Pneumatic fiber transport system used in linking textile processing equipment or operations, especially opening, blending, and carding.

**CI** *n.* Abbreviation for color index.

**Cibanoid** *n.* Urea-formaldehyde resin. Manufactured by CIBA, Switzerland.

**C.I.E** *n.* Abbreviation for commission internationale d'éclair-AGE, the French name for the International Commission on Illumination. In older publications, the abbreviation ICI was used.

**CIE chromaticity coordinates** *See chromaticity coordinates, cie.*

**CIE color difference equation** *n.* May refer to the color difference equation provisionally adopted by the CIE in 1964, one of four then recommended for study. It incorporates a linear transformation into a more nearly uniform color space. The following are the equations used:

$$U^* = 13W^*(u - u_o),$$
$$V^* = 13W^*(v - v_o),$$
$$W^* = 25Y^{1/3} - 17 \quad (1 \leq Y \leq 100),$$
$$u = \frac{4X}{X + 15Y + 3Z} \text{ or } u = \frac{4x}{-2x + 12y + 3},$$
$$v = \frac{6X}{X + 15Y + 3Z} \text{ or } v = \frac{6y}{-2x + 12y + 3},$$

$u_o$ and $v_o$ refer to a nominally achromatic color. For the 1931 Standard Observer and Illuminant *C*, $u_o = 0.2009$ and $v_o = 0.3073$. The total color difference is calculated as

$$\Delta E = [(\Delta U^*)^2 = (\Delta V^*)^2 + (\Delta W^*)^2]^{1/2},$$

$\Delta U^* = U^*$ sample $-U^*$ standard, indicating redder if positive and greener if negative. $\Delta V^* = V^*$ sample – $V^*$ standard, indicating yellower if positive and bluer if negative. This equation is properly titled the 1964 CIE $U^*$, $V^*$, and $W^*$ equation. Sward GG (ed) (1972) Paint testing manual: physical and chemical examination of paints, varnishes and lacquers, and colors, 13th edn. ASTM Special Technical Publication No, 500, American Society for Testing and Materials, Philadelphia, PA. Billmeyer FW, Saltzman M (1996) Principles of color technology. John Wiley and Sons Inc., New York.

**CIE 1976 (*L** *a** *b**) color difference equation** (from J Opt Soc Am 64:896) (1974) (Modified Adams–Nickerson).

$$\Delta E_{\mathrm{CIE}}(L^*, a^*, b^*) = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2},$$

where

$$L^* = 25\left(\frac{100Y}{Y_o}\right)^{1/3} - 16 \quad (1 \leq Y \leq 100),$$
$$a^* = 500\left[\left(\frac{X}{X_o}\right)^{1/3} - \left(\frac{Y}{Y_o}\right)^{1/3}\right],$$
$$b^* = 200\left[\left(\frac{Y}{Y_o}\right)^{1/3} - \left(\frac{Z}{Z_o}\right)^{1/3}\right],$$

*X*, *Y*, and *Z* are the tristimulus values of the sample, $X_o$, $Y_o$, and $Z_o$ define the color of the nominally white object color stimulus (the illuminant). $\Delta L^* = L^*$ for the sample – $L^*$ for the standard; $\Delta a^* = a^*$ for the sample – $a^*$ for the standard; $\Delta b = b^*$ for the sample – $b^*$ for the standard.

**CIE 1976 (*L**, *u**, *v**) color difference equation** *n.* (from J Opt Soc Am 64:(1974).

$$\Delta E_{\mathrm{CIE}}(L^*, u^*, v^*) = [(\Delta L^*)^2 + (\Delta u^*)^2 + (\Delta v^*)^2]^{1/2},$$

where

$$L^* = 25\left(\frac{100Y}{Y_o}\right)^{1/3} - 16 \quad (1 \leq Y \leq 100),$$
$$u^* = 13L^*(u' - u'_o),$$
$$v^* = 13L^*(v' - v'_o),$$

$$u' = \frac{4X}{X + 15Y + 3Z},$$
$$v' = \frac{9Y}{X + 15Y + 3Z},$$
$$u'_o = \frac{4X_o}{X_o + 15Y_o + 3Z_o},$$
$$v'_o = \frac{9Y_o}{X_o + 15Y_o + 3Z_o}.$$

$X$, $Y$, and $Z$ are the tristimulus values of the sample. $X_o$, $Y_o$, and $Z_o$ are the tristimulus values for the illuminant. $\Delta L = L^*$ for the sample – $L^*$ for the standard; $\Delta u^* = u^*$ for the sample – $u^*$ for the standard; $\Delta v^* - v^*$ for the sample – $v^*$ for the standard.

**CIE color notation system** *n.* Colorimetric specification system based on stimulus-response characteristics adopted by the CIE in 1931. The current recommendations for the system may be obtained from the official publication, CIE Publication No. 15 (E-1.3.1) 1971, "Colorimetry Official Recommendation of the International Commission on Illumination", available from National Bureau of Standards and Technology, Washington, DC.

**CIE luminosity curve** *See luminosity curve.*

**CIE standard observer** *n.* The observer data adopted by the Commission Internationale d'Eclairage to represent the response of the average human eye, when light-adapted, to an equal-energy spectrum. Unless otherwise specified, the term applies to the data adopted in 1931 for a 2° field of vision. The data adopted in 1964, sometimes called the 1964 observer, were obtained for a 10°, annular field which excludes the 2° field of the 1931 observer functions.

**CIE tristimulus values** *n. See tristimulus values, cie.*

**CIL flow test** A capillary-rheometer test developed at Canadian Industries Ltd for characterizing the flow of thermoplastics. The reported flow unit is the amount of melt that is forced through a specified orifice per unit time when a suitably chosen force is applied. Similar to melt-flow index.

**Cill** *n.* Brit. term for sill.

**Cim** *n.* Acronym for computer-integrated manufacturing.

**Cimene** *See dipentene.*

**Cinaper** *n.* An obsolete form of cinnabar.

**Cinder block** *n.* A lightweight masonry unit made of cinder concrete; widely used or interior partitions.

*See clinker block.*

**Cinnabar** \ˈsi-nə-ˌbär\ [ME *cynabare*, fr. MF & L; MF *cenobre*, fr. L *cinnabaris*, from Gk *kinnabari*, of non-Indo-European origin; akin to Arabic *zinjafr* cinnabar] (14c) *n.*

*See mercuric sulfide.*

**Cinoper** *n.* An obsolete form of cinnabar.

**Cintz** *n.* Wallpapers resembling the printed cotton materials from India once known as "chints", featuring brightly colored flowers.

**Circuit** *n.* In filament winding, one complete traverse of the fiber-feed mechanism of the winding machine; or a complete traverse of a winding band from one arbitrary point along the winding path to another point on a plane through the starting point and perpendicular to the axis.

**Circular-knit fabric** *n.* A tubular weft-knit fabric made of a circular-knitting machine.

**Circular knitting** *See knitting.*

**Ciré** \sə-ˈrā, sē-\ [F, fr. pp of *cirer* to wax, fr. *cire* wax, fr. L *cera*] (1921) *n.* A brilliant patent leather effect produced by application of wax, heat, and pressure.

***Cis-*** A chemical prefix (Latin: "on this side"), usually ignored in alphabetizing lists, denoting an isomer in which certain atoms or groups are on the same side of a plane. Opposite of *trans-*.

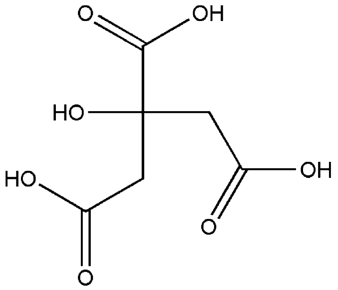
**Cis isomer** *n.* Any isomer in which two identical atoms or groups are adjacent to each other or on the same side of a structure.

**Cissing** *n.* (1) A slight shrinkage of a glossy paint resulting in small cracks through which the undercoat may be seen; a mild form of crawling. British Syn: crawling. (2) A process for preparing a wood surface for graining by wetting with a sponge.
*Also spelled "sissing".*

**Citrate plasticizer** *n.* Any of a family of plasticizers derived from citric acid, $HO_2C\text{-}CH_2C(OH)(CO_2H)CH_2CO_2H$, noted for their low order of toxicity. Included citrates are: triethyl, tri(2-ethylhexyl), tricyclohexyl, tri-*n*-butyl, acetyl triethyl, acetyl tri-*n*-butyl, acetyl tri-*n*-octyl, *n*-decyl, and acetyl tri(2-ethylhexyl).

**Citrates** *n.* Esters derived from citric acid. The tri-ethyl, -butyl, and -amyl citrates form a series of plasticizers.

**Citric acid** *n.* $C_3H_4(OH)(COOH)_3$. Tricarboxylic, monohydroxy acid. One molecule of water is normally included in the formula. It has an mp of 154°C, but decomposes on further heating (*See image*).



**Citronella oil** *n.* Essential oil, known also as oil of lemongrass. It possesses a strong lemon-like smell, and is used to a small extent as a deodorant.

**CL** *n.* Poly(vinyl chloride) fiber.

**CLA** *n.* Abbreviation for center-line average (BS 1134); indication of surface roughness.

**Clamping capacity** *n.* The largest rated projected area of cavities and runners that an injection or transfer press can safely hold closed at full molding pressure.

**Clamping force** *n.* In injection and transfer molding, the force applied to the mold to keep it closed, and opposing the pressure exerted by the injected plastic acting upon the projected area of cavities and runners. Per square centimeter of cavities and runners, at least 3.5 kN of clamping force is required.

**Clamping plate** *n.* A plate, fitted to a mold that secures the mold to the frame of the molding machine.

**Clamping pressure** *n.* In injection and transfer molding with a hydraulically operated mold, the hydraulic-fluid pressure applied to the mold ram to keep the mold closed during the molding cycle. Compare clamping force.

**Clamps** *n.* The parts of a testing machine that are used to hold a specimen while it is subjected to force.
*Also called jaws.*

**Clamshell molding** *n.* A term applied to the modern version of the oldest form of blow molding – preheating two sheets of plastic, placing them between halves of a split mold, closing the mold, drawing the sheets against their respective mold surfaces by means of vacuum, then completing the forming with air pressure between the sheets. The modern process, mechanized and conveyorized, is superior to blow molding from a parison for very large parts and for those in which uniformity of wall thickness is important.

**Clapboard** *n.* A wood siding commonly used as an exterior covering on a building of frame construction; applied horizontally and overlapped, with the grain running lengthwise; usually thicker along the lower edge than along the upper.
*Also known as bevel siding and lap siding.*

**Claret red** *n.* Azo pigment produced by coupling Tobias acid (2-naphthylamine-1-sulfonic acid) with 3-oxynaphthoic acid, followed by conversion to the calcium lake.

**Clarifiers** *n.* Additives that increase the transparency of a plastic material.

**Clarifoil** *n.* Cellulose acetate. Manufactured by British Celanese, Great Britain.

**Clarity** *n.* (1) In general, the optical property of being clear. (2) In acetate manufacture, a measure of the appearance of dope solutions, indicating the quality of the acetylation mixture. (3) In printing, the sharpness or definition of a print pattern.

**Clarity of plastics** *n.* The ability of a transparent material to transmit a clear image of an object when viewed through it, without any aberration.

**Clash–Berg point** *n.* The rising temperature at which the apparent modulus of rigidity of a specimen falls to 931 MPa, the end point of "flexibility" as defined by Clash and Berg in their studies of low-temperature flexibility. In a similar test described in ASTM D 1043, the deciding shear modulus is one-third the C–B value.

**Class I, II, or III liquids** *n.* Groupings of flammable and combustible liquids arbitrarily classified by boiling points and closed cup flash point methods, in order to specify particular procedures and types of electrical equipment to be used when handling them.

**Classical mechanics** *n.* A system of mechanics developed before the inception of quantum ideas; useful for describing the behavior of objects and particles much larger than atoms.

**Clathrate** \ˈkla-ˌthrāt\ [L *clathratus*, furnished with a lattice, fr. *clathrin* (plural) lattice, fr. Gk *kl* ēithron bar, fr. *kleiein* to close] (1906) *adj.* A "cage compound" in which atoms or molecules are trapped in a cage of covalently bonded atoms, but mot directly bonded to them.

**Clay** *n.* Any naturally occurring sediment rich in hydrated silicates of aluminum, predominating in particles of colloidal or near-colloidal size. There are many types of clays and clay-like minerals. Those of particular interest to the plastics industry are varieties refined by nature and man to a state of good color and particle-size distribution, such as kaolin (China clay). They are used as fillers in epoxy and polyester resins, PVC compounds, and urethane foams. Calcined clays are those that have been heated to a high temperature to drive off the chemically bound water, sometimes also surface-treated to improve their chemical inertness and moisture resistance. They are used primarily in vinyl insulation.

*See aluminum silicate, kaolinite, and China clay.*

**Clean** *n.* A complete lack of any visible nonuniformity sometimes referred to as seeds, when viewed in thin films by any macroscopic or microscopic use of visible light.

**Cleaner** *n.* (1) Detergent, alkali, acid or other cleaning material; usually water or steam borne. (2) Solvent for cleaning paint equipment.

**Clear** *n.* A complete lack of any visible nonuniformity when viewed in mass, in bottles or test tubes, by strong transmitted light.

**Clear coating** *n.* Transparent protective and/or decorative film.

**Clearcole, clairecolle** *n.* (1) Glue size in appropriate dilution with the addition of small quantity of whiting. It is used to reduce porosity of ceiling and other surfaces prior to the application of size-bound distemper. (2) A primer consisting of glue, water, and white lead or whiting. (3) A clear coating used in application of gold leaf.

**Clearing** *n.* The treatment of printed fabrics with a chemical solution to improve the appearance of the whites. In many cases the treatment also brightens the printed areas.

*Also see reduction clearing.*

**Clear lacquer** *See clear coating.*

**Clear point** *n.* With regard to vinyl plastisols, clear point is the rising temperature at which an unpigmented plastisol suddenly becomes transparent, signifying that the resin particles have completely dissolved in the warm plasticizer. This test is useful for determining the relative fusion temperatures of different plastisols.

**Cleavage** *n.* (1) Breaking of a laminate due to the separation of the strata. (2) Portion of the material adhering to the side of a container after the major portion has been drained. (3) The property of a crystalline substance of splitting along definite crystal planes.

**Cleveland condensing humidity cabinet (QCT)** *n.* An accelerated weathering apparatus which operates on a condensation type of water exposure at elevated temperature.

**Cleveland open cup** *n.* Device used in determining flash and fire points of petroleum products.

**Cleve's acid** *n.* Old name for α-naphthol-5-sulfonic acid. It was also known as *L acid* and is used in the manufacture of Helio Bordeaux BL.

**Clicker die** *n.* A cutting die for stamping out blanks from plastic sheet.

**Clicker press** *n.* A stamping press used with clicker dies to cut shapes from plastic sheet. Compare die cutting.

**Clicking** *n. See die cutting.*

**Climate cabinet** *n.* Any enclosure used to emulate selected climatic conditions.

**Clinker block** *n.* British term for cinder block.

**Clipmark** *n.* Visible deformation of selvage due to pressure from a tenter clip.

**CLO** *n.* A unit of thermal resistance. The insulation needed to keep an individual producing heat at the rate of 58 W/m$^2$ comfortable of 21°C air temperature with air movement of 0.1 m/s. One clo is roughly equal to the insulation value of typical indoor clothing.

**Clockspring** *n.* Slipping action in coil coating, usually at the center of a coil of the strip during the recoiling operation.

**Cloisonné** \ˌklói-zə-ˈnā, ˌklwä-\ [F, fr. pp of *cloisonner* to partition] (1863) *adj.* A surface decoration in which differently colored enamels or glazes are separated by fillets applied to the design outline. For porcelain enamel, the fillets are wire secured to the metal body; for tile and pottery, the fillets are made of ceramic paste, squeezed through a small-diameter orifice.

**Cloqué fabric** \klō-ˈkā, ˈklō-ˌ\ [F *cloqué*, fr. pp of *cloquer* to become blistered, fr. F dialect (Picard) *cloque* bell, bubble, fr. ML *clocca* bell] (1936) *n.* From the French term for blistered, it refers to any fabric whose surface exhibits an irregularly raised blister effect.

**Closed assembly time** *See time, assembly.*

**Closed-cell foamed plastic** (unicellular foam) *n.* A cellular plastic in, which interconnecting cells are too few to permit the bulk flow of fluids through the mass.

**Closed-cell foams** *n.* Individual cells are non-interconnecting. The ells are basically without access to the surrounding air of fluids; cells are not communicating.

**Closed coat** *n.* In coated abrasives, when the abrasive grains completely cover coat-side surface of the backings. Closed coats are designed for severe service and are used for most applications.

*See also open coat.*

**Closed loop control** *See feedback control.*

**Close drying** *n.* Material is said to be close drying when it does not show much fullness or body on the substrate. Often, the true fullness is not brought out until after rubbing. This is especially true with lacquer finishes.

**Close grain** *n.* Wood having narrow and inconspicuous annual growth rings. The term is sometimes used to designate wood having small and closely spaced pores, but in this sense the term "fine textured" is more often used.

**Cloth** *n.* A generic term embracing all textile fabrics and felts. Cloth may be formed of any textile fiber, wire, or other material, and it includes any pliant fabric woven, knit, felted, needled, sewn, or otherwise formed.

**Cloud chamber** *n.* An apparatus containing moist air or other gas which on sudden expansion condenses moisture to droplets on dust particles or other nuclei. Thus charged particles or ions in the space become nuclei and their numbers and behavior, when properly illuminated, may be studied.

**Cloudiness** *n.* The lack of clarity or transparency in a paint or varnish film.

**Clouding** *n.* Development in a clear varnish or lacquer film or liquid of an opalescence or cloudiness caused by the precipitation of insoluble matter or immiscibility of components.

**Cloud point** *n.* (1) In condensation polymerization, the temperature at which the first turbidity appears, caused by water separation when a reaction mixture is cooled. (2) In petroleum and other oils, the falling temperature at which the oil becomes cloudy, from precipitation, of wax or other solid. (3) Point at which a definite lack of clarity (cloudiness) appears when a liquid is subject to adulteration or when it is mixed with another substance, or the temperature at which a liquid becomes cloudy when it is cooled.

**Cloudy web** *n.* An uneven or irregular web from the doffer of a card.

**Clumps** In non-woven fabrics, an irregularly shaped grouping of fibers caused by insufficient fiber separation.

**Clupanodonic acid** *n.* Acid found in many fish oils. The acid possesses an unusually high iodine value – well in excess of 200. *Also called doscosapentanoic acid.*

**CMC** *n.* Abbreviation for carboxymethyl cellulose or for ceramic-metal composite.

**CN** *n.* Abbreviation for cellulose nitrate.

**CNR** *n.* Carboxynitroso rubber.

**Co** *n.* Chemical symbol for the element cobalt.

**Coacervate** *n.* \kō-ˈa-sər-ˌvāt\ [L *coacervatus*, pp of *coacervare* to heap up, fr. *co-* + *acervus* heap] (1929) *v.* An aggregate of colloidal droplets held together by electrostatic attractive forces.

**Coacervation** *n.* The separation of a polymer solution into two or more liquid phases, one of which is a polymer-rich liquid. The term was introduced to distinguish this phenomenon from the precipitation of a polymer solute in solid form. The process is used in microencapsulation by emulsifying or dispersing the material to be encapsulated with a solution of the polymer. By changing the temperature or concentration of the mixture, or by adding another polymer or solvent, a phase separation may be induced and the polymeric portion forms a thin coating on the external surfaces of the particles. After further treatment to solidify the polymeric wall, the capsules can be isolated in powder form by filtration. It is an intermediate stage between sol and gel formation.

**Coagulant** \kō-ˈa-gyə-lənt\ (1770) *n.* A substance that (1) initiates the formation of relatively large particles in a finely divided suspension or (2) assists in the formation of a gel, thus accelerating settling of the particles or their deposition on a substrate.

**Coagulation** *n.* (1) A physical or chemical action inducing transition from a fluid to a semi-solid or gel-like state, or the bringing together of small, individual particles into clumps. (2) Process whereby a fluid liquid is changed into a thickened, curdled or congealed mass. (3) Irreversible agglomeration of particles originally dispersed in a rubber latex.

**Coagulation bath** *n.* A liquid bath that serves to harden viscous polymer strands into solid fibers after extrusion through a spinneret. Used in wet spinning processes such as in rayon or acrylic fiber manufacture.

**Coagulum** *n.* An agglomerate of particles.

**Coalesced filaments** *n.* Filaments stuck together by design or accident during the extrusion process.

**Coalescence** *n.* The formation of a film of resinous or polymeric material when water evaporates from an emulsion or latex system, permitting contact and fusion of adjacent latex particles. Action of the joining of particles into a film as the volatile evaporates.

**Coalescent (coalescing agent)** *n.* Solvent with a high bp which, when added to a coating, aids in film formation via temporary plasticization (softening) of the vehicle.

**Coal tar** *n.* Coal tar which is also known as *aniline* is an oily, colorless, toxic liquid, which darkens upon exposure to air. It is soluble in water, alcohol, and ether, and forms a number of salts. It can also be described as a dark brown to black cementitious material produced by the destructive distillation of bituminous coal.

**Coal tar colors** *See aniline pigments.*

**Coal tar epoxy** *n.* Modified coal tar floor coating designed to bond to asphalt and concrete surfaces. High strength and resistant to most corrosive reagents.

**Coal tar epoxy coating** *n.* Coating in which binder or vehicle is a combination of coal tar with epoxy resin.

**Coal tar hydrocarbons** *n.* Aromatic hydrocarbons derived from coal tar, including benzene, toluene, xylene, naphtha, etc.

**Coal tar pitch** *n.* Distillation residue from coal tar. It varies considerably from a very soft to a very hard product. Fusion points vary from as low as 27°C (80°F) to as high as 232°C (450°F).

**Coal tar pitch coatings** *n.* Most plastics plated today are finished with a copper/nickel/chrome electroplate, but many other finishes are possible, such as bright brass, antique brass, satin nickel, silver, black chrome, and gold. The actual composition of the electroplate is designed for a particular application of the electroplate.

**Coal-tar resin** *See coumarone-indene resin.*

**Coal tar-urethane coating** *n.* Coating in which binder or vehicle is a combination of coal tar with a polyurethane resin.

**Coarse end** *See coarse thread.*

**Coarse filling** *See coarse thread.*

**Coarse grain** *n.* Wood with wide and conspicuous annual rings having considerable difference between springwood and summerwood. The term is sometimes used to designate wood and large pores, such as oak, ash, chestnut and walnut, but in this sense the term "coarse texture" is more often used.

**Coarse pick** *See coarse thread.*

**Coarse thread** *n.* A yarn larger in diameter than other yarns being used in the fabric.

**Coat** *n.* Paint, varnish or lacquer applied to a surface in a single application (one layer) to form a properly distributed film when dry. A coating system sexually consists of a number of coats separately applied in a predetermined order at suitable intervals to allow for drying or curing. It is possible with certain types of material to build up coating systems of adequate thickness and opacity by a more or less continuous process of application, e.g., wet-on-wet spraying. In this case, no part o the system can be defined as a separate coat in the above sense.

**Coated abrasive** *n.* A flexible-type backing upon which a film of adhesive holds and supports a coating of abrasive grains. The backing may be paper, cloth, vulcanized fiber or a combination of these materials. Various types of resin and hide glues are used as adhesives. The abrasives used are flint, emery, crocus, garnet, aluminum oxide and silicon carbide.

**Coated fabric** *n.* A cloth that has been impregnated and/or coated with a plastic material in the form of a solution, dispersion, hot melt, or powder. The term is sometimes used when a preformed film is applied to the fabric by calendaring, although such products are more properly termed laminates.

**Coated paper** *n.* A paper coated with clay, other white pigments and a suitable binder.

**Coater** Apparatus, which applies paint.

**Coathanger die** *n.* A sheet-, or film-extrusion die whose melt-distribution manifold has the obtuse-isoceles outline of a coathanger. This popular die design is said to yield uniform distribution of material across the full width of the extruded web, thus producing sheet of laterally more uniform thickness. Side-fed blow-molding dies and spiral-type dies for blown film may also be spoken as a coathanger dies.

**Coating** *n.* (1) Generic term for paints, lacquers, enamels, printing inks, etc. (2) A liquid, liquefiable or mastic composition, which is converted to a solid protective, decorative, or functional adherent film after application as a thin layer. (3) A composition, which when applied in thin layers, forms a non-tacky, adherent film that hides, protects, and/or decorates the substrate.

**Coating, dip** *n.* The process in, which a substrate is immersed in a solution (or dispersion) containing the coating material and withdrawn.

**Coating methods** *See:*

*Air-knife coating*
*Calender coating*
*Cascade coating*
*Curtain coating*
*Decorating*
*Dip coating*
*Electrophoretic deposition*
*Electroplating on plastics*
*Electrostatic fluidized-bed coating*
*Electrostatic spray coating*
*Extrusion coating*
*Flame-spray coating*
*Flocking*
*Flow coating*
*Fluidized-bed coating*
*Friction calendaring*
*Gravure-coating*
*Intumescent coating*
*Kiss-roll coating*
*Painting of plastics*
*Plasma-spray coating*
*Printing on plastics*
*Reverse-roll coating*
*Roller coating*
*Silver-spray process*
*sinter coating*
*Solution coating*
*Spray coating*
*Spread coating*
*Strippable coating*
*Transfer coating*
*Urethane coatings*
*Vacuum metalizing*

**Coating powders** *n.* Finely divided, solid plastic materials, which are heat fusible and form relatively smooth, tough, electrical insulating coatings upon application to metal surfaces.
*See powder coating.*

**Coating, spray** *n.* The process in which a substrate is sprayed with the coating material.

**Coating system** *See coat.*

**Cobalt** \ˈkō-ˌbólt\ [Gr *Kobalt*, alter. of *Kobold*, literally, bobbin, fr. MHGr. *kobolt;* fr. its occurrence in silver ore, believed to be due to globins] (1683) *n.* A tough lustrous silver-white magnetic metallic element that is related to and occurs with iron and nickel and is used in alloys.

**Cobalt aluminate** *See cobalt blue.*

**Cobalt blue** (1835) *n.* $CoO{\cdot}Al_2O_3$. Pigment blue 28 (77346). Bright blue pigment, which is a complex product derived from oxides of cobalt and aluminum. It has excellent lightfastness and good chemical and heat resistance and with low opacity. Density, 4.2–4.3 g/cm$^3$ (35.0–35.8 lb/gal); O.A., 27–36; particle size, 0.5–1.0 µm. Syn: cobalt aluminate, king's blue, thenard's blue, azure blue, cobalt ultramarine, dumont's blue, enamel blue, gahn's ultramarine, Hungary blue, leitner's blue, leyden blue, Vienna blue, wentzel's blue, and zaffre.

**Cobalt chloride** (1885) *n.* A chloride of cobalt. The dichloride $CoCl_2$ that is blue when dehydrated, turns red in the presence of moisture, and is used to indicate humidity.

**Cobalt drier** *n.* One of the many organic cobalt salts (cobalt, naphthenate, cobalt octoate, etc.) which are soluble in paints and varnishes and used to speed the drying and hardening of the oil vehicle. They are also used to accelerate oxidation and polymerization of an ink film.

*Also used as an initiator in polyesters.*

**Cobalt green** *n.* Similar to cobalt blue, except that zinc oxide replaces wholly or partly the aluminum oxide in the latter. It does not contribute to good hiding power.

*Also known as Rinmann's green or zinc green.*

**Cobalt naphthenate** *See naphthenic acid.*

**Cobalt 60** (1946) *n.* A heavy radioactive isotope of cobalt of the mass number 60 produced in nuclear reactors and used as a source of gamma rays (as for radiotherapy).

**Cobalt ultramarine** *n.* Red shade cobalt blue. *See cobalt blue.*

**Cobalt yellow** *See aureolin.*

**Cobwebbing** *n.* Production of fine filaments instead of the normal atomized particles when some coatings are sprayed. Although generally considered a defect in ordinary lacquers, use is made of this property to provide textured coating or a protective covering for equipment during storage. A cocoon is formed around the article by the pronounced cobwebbing action.

**Cobwebbing (in gravure)** *n.* A filmy, weblike build-up of dried ink or clear material on the doctor blade, ends of impression roll, or engraving.

**Cobweb coating** *See cobwebbing.*

**Cocatalyst** *n.* Chemicals which themselves are rather weak catalysts, but which greatly increase the activity of a given catalyst; also called promoters.

**Cochineal** \ˈkä-chə-ˌnēl, ˈkō-\ [MF & Sp; MF *cochenille*, fr. OSp *cochinilla* cochineal insect] (1582) *n.* Natural organic dyestuff made from the bodies of the female insect. *Coccus Cacti*, which lives on plants in Central and South America. The coloring principle is known as carminic acid and is generally laked. It is not fast to light.

**Cochin oil** *n.* Refined grade of coconut oil.

**Cockled yarn** *n.* Spun yarn in which some fibers do not lie parallel to the other fibers but instead are curled and kinked, forming a rough and uneven surface on the yarn. The general cause is fiber overcut to the extent that the drafting rolls catch and hold both ends of the fiber at the same time while attempting to draft, resulting in slippage or breakage (*Also see overcut*).

**Cockling** *n.* A crimpiness or pucker in yarn or fabric usually caused by lack of uniform quality in the raw material used, improper tension on yarn in weaving, or weaving together yarns of different numbers.

**Coconut oil** *n.* Expressed from the nut kernels of the coconut palms, the oil is composed of glycerides of lauric acid, capric acid, myristic, palmitic and oleic acids. Its main use is in non-yellow alkyds. Properties: Sp. gr 0.9190/25°C; refractive index, 1.4545/40°C; iodine value, 9; and saponification value, 255.

**Co-cure** *n.* To cure two or more different materials in one step.

**Coefficient of cubical expansion** *See coefficient of expansion.*

**Coefficient of elasticity** *n.* Reciprocal of Young's modulus in a tension test. A rarely seen Syn: modulus of elasticity.

**Coefficient of expansion** *n.* Ratio of increase in length, area, or volume of a substance for a 1°C rise in temperature.

*Also known as Coefficient of Cubical Expansion.*

**Coefficient of friction** *n.* Measure of the resistance to sliding of one surface in contact with another surface.

*See friction.*

**Coefficient of plastic viscosity** *See viscosity, plastic.*

**Coefficient of scatter** *See scatter, coefficient of.*

**Coefficient of thermal conductivity** *See thermal conductivity.*

**Coefficient of thermal expansion** *n.* The fractional change in length (or sometimes in volume, when specified) of a material for a unit change in temperature, as given by the equation:

$$CE = (1/L)\,\mathrm{d}L/\mathrm{d}T = \mathrm{d}\ \ln\ L/\mathrm{d}T \approx \Delta L/\Delta T.$$

*See also volume coefficient of thermal expansion.*

**Coefficient of twist contraction** *n.* The shortening of a yarn, due to twist, per unit length of untwisted yarn, usually expressed in percent.

**Coefficient of viscosity** (1866) *n. See viscosity* (2).

**Coextrusion** The process by which the outputs of two or more extruders are brought smoothly together in a feed block to form a single multiplayer stream that is fed to a die to produce a layered extrudate. The extruder streams may be split within the feed block to form dual layers, usually in a symmetrical arrangement about the center plane of the final sheet. Sheeting containing up to nine layers is commercially produced. Coextrusion is employed in film blowing, sheet and flat-film extrusion, blow molding, and extrusion coating. The advantage of coextrusion is that each ply imparts a desired characteristic property, such as stiffness, heat-sealability, impermeability, or resistance to some environment, all of which properties would be impossible to obtain with any single material. Layers of poorly compatible plastics can be coextruded by including a thin adhesive layer between them.

**Coextrusion blow molding** *n.* A variant of extrusion blow molding in, which the parison contains two or more layers of at least two materials.

*See coextrusion.*

**Cogswell rheometer** *See extensiometer.*

**Cohesion** *n.* Propensity of a single substance to adhere to itself; the internal attraction of molecular particles toward each other; the ability to resist partition from the mass;

internal adhesion; the force holding a single substance together.

**Cohesive energy (density)** *n.* For liquids the heat of vaporization per unit mass, divided by the specific volume, or the same quantity based on molar properties. Cohesive energy density is also equal to the square of the solubility parameter.

$$\mathrm{CED} = \Delta E_v / V_1.$$

For liquids, the heat of vaporization per unit mass, divided by the specific volume, or the same quantity based on molar properties. Cohesive energy density is also equal to the square of the solubility parameter.

**Coil coating** *n.* High-speed process, which applies paint and other coatings to a continuous flat coil of metal. A continuous coil of metal is unwound, cleaned, surface-treated, coated, heat-cured, cooled and rewound in one operation. The coated coil is subsequently unwound and formed into any number of products, such as house siding, Venetian blinds, and automotive and appliance parts.

*Also called strip coating.*

**Coiling** *n.* The depositing of sliver into cylindrical cans in helical loops. This arrangement permits easy removal for further processing.

**Coiling soup** *n.* In coating or spreading operations, a defect caused by the curling or turning motion of a bank of lacquer or other "soup" compound in front of a doctor knife, or similar application device, wherein streaks are formed on the surface of the coated fabric due to uneven application of the soup.

**Coil yarn** *See textured yarns.*

**Coining** *n.* A term borrowed from the metal-stamping industry for a process of forming integral hinges from plastics. In the case of a polypropylene article, the hinge is produced by molding a thin section between the two parts of the article to be hinged. Such a thin section cannot be molded easily in articles of nylon or acetal resin because of the difficulty of filling the half of the mold cavity opposite the gated half through the thin section. In the coining process, the area to be formed into a hinge is molded in a thickness suitable fore the molding process. Subsequently, the article is placed between bars in a press that quickly squeezes the plastic to the desired thickness. The material must be deformed beyond its compressive yield point but short of failure, so that is remains essentially stable with little recovery from the deformation. This rapid cold pressing produces a high degree of orientation that imparts high strength and flexibility to the integral hinge area.

**Coinjection** *n.* A process similar in its results to coextrusion but accomplished by modifications of the injection-molding process. By means of various nozzle and valving arrangement, two or more materials, can be injected either simultaneously or sequentially to form an article with an outer shell of one material with certain desired properties, the shell filled with another material to attain other desired properties such as reduced cost. Coinjection, like coextrusion, basically means that two or more different plastics are formed into a composite or laminated structure.

**Coin marking** *See metal marking.*

**Coking** *n.* In the running of copals, or sweating of asphaltums, and other materials, which naturally contain a proportion of infusible dirt or mineral matter, this extraneous matter is likely to escape the action of the stirrer. As a consequence, any organic matter associated with it is liable to be overheated, and carbonization occurs. This ultimately results in the formation of carbonaceous lumps, and it is then said to have coked.

**Cold** *n.* Dull, flat surface where a bright, lustrous one is desired.

**Cold-bend test** *n.* A test for measuring the flexibility of a plastic material at low temperatures. A specimen in a series is chilled to one of several specified low temperatures, then bent to a predetermined radius until the temperature at which half the specimens tested do not survive the bend has been identified.

**Cold-checking** *n.* Surface defect on lacquer, especially furniture finishes. It appears as a pattern of fine cracks developing on film surface, when the finished article is subjected to alternate hot and cold conditions. *See checking and temperature checking.*

**Cold cracking** *n.* Crazing and cracking of a coating subjected to low temperature or cold/ambient cycling.

**Cold-curing** *n.* Process of curing at normal atmospheric temperature (i.e., air dry).

**Cold cut** *n.* Dissolving a resin or other material in a suitable solvent by mechanical agitation without the application of heat.

**Cold cycle** *n.* Low temperature cycle during many accelerated tests.

**Cold drawing (cold stretching)** *n.* A stretching process performed at a temperature below a thermoplastic's melting range to orient the material and improve the tensile modulus and strength.

**Cold flex** *n.* The lowest temperature at which the test strip can be twisted through a 200° arc without breaking.

**Cold flow** *n.* Continuing distortion, deformation, or dimensional change which take place in materials under continuous load (constant stress) at ambient temperatures. Syn: compression set.
*See creep.*

**Cold forming** *n.* A group of processes by which sheets or billets of thermoplastics are formed into three-dimensional shapes at room temperature by processes used in the metal-working industry such as forging, brake-press bending, deep drawing, rolling, stamping, heading, and coining. The materials used, generally in relatively thick sections, include ABS, polycarbonate, polyolefins, and rigid PVC. When either the material or the forming dies are preheated, the preferred term is solid-phase forming.

**Cold heading** *n.* A process for forming short plastic rods into rivets by uniformly loading the projecting shaft end in compression while holding and containing the shaft trunk. All thermoplastics can be cold-heated but acetal and nylon are particularly suitable.

**Cold molding** *n.* A process similar to compression molding except that no heat is applied during the molding cycle. The formed part is subsequently cured by heating and cooling. A-stage phenolic resins and bituminous plastics are sometimes molded by his process.

**Cold-parison blow molding** *See blow molding.*

**Cold pressing** *n.* (1) Assembly method in which the bonded structures are held in place by pressure without the application of heat or drying air until the adhesive interface has solidified and reached proper shear proportions. (2) An extraction method for oils such as fish oil.

**Cold-process roofing** *n.* A bituminous roofing membrane, which consists of layers of coated felts that have been bonded with cold-applied asphalt roof cement and surfaced with an emulsified or cutback asphalt roof coating.

**Cold-rolled steel** *n.* Low-carbon, cold-reduced sheet steel.

**Cold rubber** *n.* A synthetic rubber made at a relatively low temperature (about 40°F or 4°C) and having greater strength and durability than that made at the usual temperature (about 120°F or 49°C.

**Cold-runner injection molding (runnerless injection molding)** *n.* Whereas in injection molding thermoplastics the runners are sometimes kept hot to reduce scrap (*See hot-runner mold*), with thermosets the runners are kept cooler than the cavities to prevent material from curing within the runner system. In cold-runner injection molding of thermosets the mold is divided into two sections: a heated section containing the cavities, and an insulated manifold section containing the injection sprue and runners. Material is fed from runners to cavities through very short gates or sub-sprues. The insulated manifold is maintained at a temperature high enough to soften the uncured material, generally in the vicinity of 90°C, but well below the curing temperature prevailing in the cavity section.

**Cold-setting** *n.* Resin or lacquer products, which, under the influence of suitable catalysts, are able to form suitable film properties without the application of heat.

**Cold-setting adhesive** *n.* Synthetic resin adhesive capable of hardening at normal room temperature in the presence of a hardener.

*See adhesive, cold-setting.*

**Cold setting inks** *n.* Solid inks, which must be melted and applied on a hot press. They solidify again on contact with unheated paper.

**Cold slug** *n.* The first material to enter an injection mold, so called because in passing through the sprue orifice it is cooled below the effective molding temperature. In some molds, a small well in the mold opposite the sprue catches the cold slug and thereby prevents it from entering the runner system.

**Cold-slug well** *n.* A small circular cavity, directly opposite the sprue opening in an injection mold that traps the cold slug.

**Cold stretch** *n.* Pulling operation, usually on extruded filaments, to improve tensile properties.

**Cold test** *n.* Refers to pour point. A low cold test means that the product has a low temperature pour point.

**Cold water paint** *n.* Paint in which the binder or vehicle portion is composed of soybean or other vegetable protein, glue, resin emulsion, or other similar material dispersed in water.

**Collacral k** *n.* Industrial poly(vinyl pyrrolidone). Manufactured by BASF, Germany.

**Collage** *n.* Literally, pasting. Employed to describe the practice of some 20th-century artists in introducing paper or other non-pigmented materials in painting. Basically, a pasting technique whereby pictorial images or patterns, and pieces of colored, textured material are superimposed on each other.

**Collapse** *n.* (1) Inadvertent densification of cellular material during manufacture resulting from breakdown of cell structure (ASTM D 883). (2) Inward contraction of the walls of a molded container, e.g., while cooling, resulting in permanent indentation.

**Collet** \ˈkä-lət\ [MF, dim. of *col* collar, fr. L *collum* neck] (1528) *n.* Rigid lateral contained for the mold-forming manual; a dam, a restriction box; the drive wheel that pulls glass fibers from the bushing [A forming tube is placed on the collet and a package of strand (forming cake) is wound up on the tube].

**Colligative properties (Polymers)** *n.* Vapor pressure lowering, freezing point depression, boiling point elevation and osmotic pressure, measurements or properties dependent on the number of molecules (i.e., pressure) and not the chemistry of the molecule.

**Colligative property** *n.* A property of a material or solution that depends mainly on the number, rather than the nature, of the molecules, atoms, or ions present. Examples are gas pressure and osmotic pressure of solutions.

**Collimated roving** *n.* Roving with strands that are more nearly parallel than those in standard roving, usually made by parallel winding.

**Collision frequency factors** *n.* The collision frequency factor $p$ (number of collisions ($\sim 10^{11}$/s) is included in the “collision theory” to describe the temperature dependence of the rate constants of elementary reactions:

$$k_{\mathrm{i}} = pZ\,\exp(-E/RT) = A\exp(-E/RT),$$

where $Z$ is steric factor, $E$ is Arrhenius activation energy ($-E/RT$) is the Boltzmann factor, and often $p$ and $Z$ are incorporated into one constant $A$; the second theory is the “transition state theory”.Houston PL (2001) Chemical kinetics and reaction dynamics. McGraw-Hill Co., New York.

**Collodion** \kə-ˈlō-dē-ən\ [mod. of NL *collodium*, fr. Gk *kollōdēs* glutinous, fr. *kola* glue] (1851) *n.* A solution of cellulose nitrate in alcohol and ether used as a coating lacquer or to cast very thin films of cellulose nitrate on water (“microfilm”).

**Collodion cotton** *See cellulose nitrate.*

**Colloid** \ˈkä-ˌlóid\ [ISV *coll-* + *-oid*] (ca. 1852) *n.* A dispersion of one phase in another in which the particles or units of the dispersed phase have at least one dimension which is larger than usual molecular dimensions, but two small to be observed visually. In other words, a phase dispersed to such a degree that the surface forces become an important factor in determining its properties. In general particles of colloidal dimensions are approximately 10 Å to 1 μm in size. Colloidal particles are often best distinguished from ordinary molecules due to the fact that colloidal particles cannot diffuse through membranes, which do allow ordinary molecules and ions to pass freely. Pertaining to colloid.

**Colloidal clay** *See bentonite.*

**Colloidal dispersion** *See colloid.*

**Colloidal particle** *n.* Large molecules or aggregates of smaller molecules in a size range of 1–500 nm ($10^{-9}$ m).

**Colloidal solution** *n.* Any solution containing colloidal particles. Colloidal solutions are sometimes called sols.

**Colloidal state** *n.* Particular state in which any substance may exist under the proper conditions, determined by fineness of particle subdivision. The colloidal state is defined by a more or less well-marked ultramicroscopic zone in the scale of subdivision, the lower extreme of the zone approaching molecular dimensions, and the upper end gradually passing over into molecular aggregates (suspensions) visible under the ordinary microscope. Becher P (1989) Dictionary of colloid and surface science. Marcel Dekker, New York.

**Colloid, colloidal state** *n.* A state of a substance in the form of small particles dispersed in a medium; and colloid size particles that do not precipitate from a media; smoke and fog are colloidal dispersions.

**Colloid, linear** *n.* Any colloid with fibrous particles or macromolecules. The long, asymmetrical particles may be coiled up or, in some instances, they may be branched.

**Colloid, micellar** *n.* Colloid composed of micelles. A micellar colloid is an aggregation of molecules, usually arranged in a definite order, whose dimensions are less than 0.05 µm. Example: a colloidal solution of soap in water.

**Colloid mill** *n.* A device for preparing emulsions and reducing particle size, consisting of a high-speed rotor and a fixed or counter-rotating element in close proximity to the rotor. The liquid is conveyed continuously from a hopper to the space between the shearing elements, and then discharged into a receiver.

*See also homogenizer.*

**Colloid, molecular** *n.* Any colloid in which the colloidal particles are macromolecules.

**Colloid, protective** *See protective colloid.*

**Colloid, reversible** *n.* Colloid substance that can be converted from the gel to the solid form without the expenditure of chemical energy, that is, by simply warming the gel form or redissolving the dried substance in water. It is a colloid which forms a hydrophilic solid, such as gelatin, agar, gum arabi, starch; a protective colloid.

**Colloid, sphere** *n.* Colloid possessing more or less symmetrically shaped, corpuscular, and relatively compact particles.

**Collotype** \\ˈkä-lə-ˌtīp\\ [ISV] (1883) *n.* (1) A printing process utilizing a glass plate with a gelatin surface carrying the image to be reproduced. (2) A print made by this process.

*Also called photogelatin process.*

**Colmonoy** *See hard-facing alloy.*

**Cologne earth, cologne brown** *n.* A pigment, sometimes referred to erroneously as Vandyke brown, made from roasted American clays which contain ochre and bituminous matter.

*See Vandyke brown.*

**Cologne spirits** *See ethyl alcohol.*

**Cologne yellow** *See chrome yellow and light and primrose.*

**Colonial spirit** *n.* Another name for methyl alcohol.

**Colophony, colophonium** *n.* Old name for rosin; used in Europe.

*See rosin.*

**Colorimeter, tristimulus** *See tristimulus colorimeter.*

**Color** *n.* Color is a basic specification for plastic parts; one of its major properties is its ability to be integrally colored, almost without restriction; in viewing a colored object three factors observed: (1) The quality of light illuminating the object; (2) The ability of the object to absorb certain portions of the light and to reflect others; and (3) The sensitivity of the eye to the reflected illumination. Mcdonald R (ed) (1997) Colour physics for industry; colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Color, universal language and dictionary of names. NBS Special Publication 440, Stock No. 003-003-01705-1, Washington DC. Computer colorant formulation. Kuehni, Lexington Books, Farnsborough, England, 1975. Hardy CH (1936) Handbook of colorimetry. MIT Press, Cambridge, MA.

**Color abrasion** *n.* Color changes in localized areas of a garment resulting from differential wear.

**Color amplitude test** *n.* Test designed to examine any of the factors involved in color aptitude. Most widely used is the ISCC Color-matching aptitude text, or CAT, based on differences in chroma.

**Colorant** *n.* Any dye or pigment that can impart color to a plastic. The dyes are natural or synthetic compounds of submicroscopic or molecular size, soluble in most common solvents, yielding transparent colors. Their generally poor heat resistance and tendency to migrate limit their use as additives to a few families that are superior in heat resistance. However, dyes are sometimes used to post-color finished parts such as buttons and fibers. The pigments are organic and inorganic substances with larger particle sizes, rarely below 1 μm, and usually insoluble in the common solvents. Organic pigments produce translucent and nearly transparent colors, resist migration better than dyes, and are somewhat more, heat-resistant. Inorganic pigments are, with few exceptions, opaque and superior to organics in light-fastness, heat resistance and resistance to migration. Colorants are added to plastics by dry-coloring (simply tumbling the colorant with the base or compounded resin power or pellets); by extrusion coloring (extruding a dry-colored mixture and chopping it into pellets to be reprocessed); by masterbatching (*See color concentrate*); or by stirring colorants or dispersions thereof into liquid plastisols or resin systems. *See also*:

- *Bon pigment*
- *Fluorescent pigment*
- *Flushed pigment*
- *Glitter*
- *Inorganic pigment*
- *Liquid colorant*
- *Luminescent pigment*
- *Metallic-flake pigment*
- *Organic pigment*
- *Pearlescent pigment*
- *Perylene pigment*
- *Phosphorescent pigment*
- *Phthalocyanine pigment*
- *Quinacridone pigment*
- *Rhodamine*
- *Ultramarine-blue pigment*

Herbst W, Hunger K (2004) Industrial organic pigments. John Wiley and Sons Inc, New York. Kirk–Othmer encyclopedia of chemical technology: pigments-powders. John Wiley and Sons, New York, 1996. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, PA, 1978.

**Colorant dispenser** *n.* Mechanical device used to disperse precisely measured volume amounts (usually) of colorants for the purpose of tinting or shading coatings bases.

**Colorant match** *n.* Color match made by using the same colorants in the match as were used in the standard.

**Colorant mixture** *n.* Mixture of colorants containing pigments, or dyestuffs, or both. The color of a mixture may be predicted by subtractive colorant mixture theories.

*See subtractive colorant mixture, complex and simple.*

**Colorants** *n.* Colored pigments and dyes.

**Color aptitude** *n.* Ability to work with color, involving inborn factors as well as acquired abilities.

**Color bleeding** *See bleeding.*

**Color blindness (deprecated)** *n.* An incorrect term applied to defective color vision. An extremely small number of persons having complete lack of color response (are achromatopes). Most so-called color-blind persons are anomalous trichromats, seeing all three primaries but having responses, which are weaker than normal to one of the primaries. Persons who lack response to one primary are called dichromats, seeing only two primaries.

**Color burn-out** *n.* An objectionable change in the color of a printing ink which may occur either in bulk or on the printed sheet. In the former case it is associated primarily with tints, and is caused by a chemical reaction between certain components in the ink formulation. In the latter case it is generally caused by heat generated in a pile of printed material during the drying of an oxidizing type of ink.

**Color center** *n.* A kind of point defect in a crystal.

**Color code** *n.* A system of coloring piping and parts of equipment with various pre-coded colors for identification purposes.

**Color compounding** Formulation and preparation of colored materials for incorporation into molding of plastics.

**Color concentrate** *n.* A plastic compound that contains a high percentage of pigment, to be blended in precise amounts with the base resin or compound so that the correct final color will be achieved. The concentrate provides a clean and convenient method of obtaining accurate color shades in extruded and molded products. The term masterbatch is sometime used for color concentrate, as well as for concentrates of other additives.

*See also multifunctional concentrate.*

**Color concentrates** *n.* Concentrated color dyes and pigments.

**Color constancy** *n.* Relative independence of perceived object color to changes in color of the light source.

**Color coordinates** *See chromaticity coordinates, general.*

**Color difference** *n.* Magnitude and character of the difference between two colors under specified conditions.

**Color difference equations** *n.* Equations that transform CIE coordinates into a more uniform matrix such that a specified distance between two colors is more nearly proportional to the magnitude of an observed difference between them regardless of their hue. The total color difference is generally designated as $\Delta E$, the lightness difference as $\Delta L$, the total chromaticity difference as $\Delta C$, the redness–greenness difference as $\Delta a$, $\Delta \alpha$, or $\Delta RG$, and the yellowness–blueness difference as $\Delta b$, $\Delta \beta$, and $\Delta YB$. The directional differences, such as $\Delta L$, $\Delta RG$, and $\Delta YB$ are frequently designated as the components of $\Delta E$. Color difference equations may also be based on Munsell notations, although such equations are seldom used today. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Billmeyer FW, Saltzman M (1996) Principles of color technology. John Wiley and Sons Inc., New York.

**Colored cement** *n.* A cement to which color pigment has been added.

**Colorfast** *n.* Fade-resistant.

**Colorfastness** *n.* Resistance to fading; i.e., the property of a dye to retain its color when the dyed (or printed) textile material is exposed to conditions or agents such as light, perspiration, atmospheric gases, or washing that can remove or destroy the color. A dye may be reasonably fast to one agent and only moderately fast to another. Degree of fastness of color is tested by standard procedures. Textile materials often must meet certain fastness specifications for a particular use.

*See light resistance and lightfastness.*

**Color floating** *See floating.*

**Color gamut** *See gamut, color.*

**Color harmony manual** *n.* Orderly array of colors spaced (approximately) according to the Ostwald color system, and made by the container corporation of America. Several editions were issued, each slightly different. It is no longer available.

*See Ostwald color system.*

**Colorimeter** \ˌkə-lə-ˈri-mə-tər\ [ISV] (ca. 1872) *n.* Instrument used to measure light reflected or transmitted by a specimen. Two general types of colorimeters are commonly used: (1) for measuring concentrations of colored materials for analytical purposes, and (2) for measuring quantities, which can be correlated with a psychophysical description of color. Generally, the second type should properly be referred to as a tristimulus colorimeter.

**Colorimetric** *n.* Adjective used to refer to measurements converted to psychophysical terms describing color or color relationships.

**Colorimetric purity** *See purity, colorimetric.*

**Colorimetry (color-identification testing)** *n.* Light measurements converted to a psychophysical description or notation, which can be correlated with visual evaluations of color and color differences.

**Color index name** *See color index name.*

**Color index number** *See color index number.*

**Coloring aids** *n.* Bisbenzoxazoles, triazinephenylcoumarins, and bis(styrl)-bisphenyls comprise the most widely used structural types of coloring additives. Used in conjunction with dyes and pigments, coloring aids absorb ultraviolet radiation and emit a blue-violet fluorescence, making polymer surfaces appear bright or cleaner.

**Color in oil** *See color index name.*

**Color in varnish** *See colorant.*

**Colorist** (1686) *n.* A person skilled in the art of color matching (colorant formulation) and knowledgeable concerning the behavior of colorants in a particular material; a tinter (in the American usage) or a shader. The word “colorist” is of European origin.

**Coloristically** *n.* A general term, which describes the nature of the comparison of two colorants in terms as used by a colorist. It may imply hue, saturation, or strength of any combination of these, as well as transparency, undertone, etc.

**Coloristic properties** *n.* A general term originating in Europe, which is derived from the characteristics, which a colorist sees and describes.

**Color match** Pair of colors exhibiting no perceptible difference when observed under specified conditions. The quality of an attempted match is described by the closeness of this ideal match.

**Color matching** *See matching, color.*

**Color matching functions** *n.* Relative amounts of three additive primaries required to match each wavelength of light. The term is generally used to refer to the CIE Standard Observer color matching functions designated $\bar{x} + \bar{y} + \bar{z}$.

*See observer, standard.*

**Color measurement** *n.* Color is a manufactured object is normally obtained by applying a colorant (dye or pigment) to al polymer substrate, such as textile, paper or paint medium. The appearance of such surface colors depends on (1) the nature of the prevailing illumination, (2) the interaction of the illuminating radiation with the colored species in the surface layers, and (3) the ability of the radiation that is transmitted, reflected and scattered from the colored surface to induce the sensation of color in the human eye/brain system. Color measurement consists of the physical measurement of light radiated, transmitted, or reflected by a specimen under specified conditions, and mathematically transformed into standardized colorimetric terms, which can be correlated with visual evaluations of colors relative to one another. McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Physical and chemical examination of paints, varnishes and lacquers and colors. Gardner Laboratory Inc., Bethesda, MD, 1946.

**Color migration** *n.* The movement of dyes or pigments through or out of a material.

**Color mixture, additive** *See additive color mixture.*

**Color notion** *n.* Orderly system of numbers, letters, or a combination of both, which serves to describe the relationship of colors in three-dimensional space. Thus, three dimensions must be included; for example, hue, value, and chroma of the Munsell System. Single dimensional notations, such as a yellowness sale, can be used only if the other two dimensions are fixed or described; two-dimensional notations can be used only if the third is fixed or described.

*See color order systems.*

**Color order systems** *n.* Systems used to describe an orderly three-dimensional arrangement of colors. Three bases can be used for ordering colors: (1) an appearance basis, i.e., a psychological basis; in terms of hue, saturation, and lightness – an example is the Munsell System; (2) an orderly additive color mixture basis, i.e., a psychophysical basis – examples are the CIE System and the Ostwald System; and (3) an orderly subtractive color mixture basis – an example is the Plochere Color System, based on an orderly mixture of inks.

**Color pigments** *n.* Color materials for imparting color to concentrates and plastics parts.

**Color proofs** *n.* Prints, in color, either from the engraving or from the mounted plates.

**Color rendering index** *n.* Method for describing the effect that a particular light source has on the color appearance of objects, in comparison with their color appearance under a reference light source. The Illuminating Engineering Society of the USA and CIE Committee 1.3.2 have developed a method which is currently under study. A color rendering index of 100 indicates perfect agreement between the test source and the reference source.

**Color retention** *n.* The property that a material has when it is exposed to the elements and shows no signs of changing color.

**Color space** *n.* Three-dimensional solid enclosing all possible colors. The dimensions may be described in various geometries giving rise to various spacings with the solid.

*See color order, systems and uniform color space.*

**Color specification** *n.* Term used loosely to describe either (1) the notation for a color standard using one of the color order systems, or (2) the allowable tolerance of samples from a standard in terms of color difference units. For (1), the best specification is a sample of the color desired.

**Color stability** *n.* The constancy of the characteristics of color in a plastic compound – hue, intensity, and saturation – in its products over their service lives in their design environments.

*See light resistance.*

**Color standard** *n.* An ink, wet sample, or printed proof to which another similar material is compared.

**Color strength** *n.* In printing ink, the effective concentration of coloring material per volume.

*Also known as tinctorial strength.*

**Color stripper** *n.* A chemical used to remove some or all of the dyestuffs from a fiber, yarn, or fabric so that a dyeing defect can be corrected, a shade lightened, or another color applied.

**Color temperature** *n.* Term used to describe the color of a Planckian (black-body) radiator. The color is expressed in chromaticity coordinates, $x$ and $y$, determined from theoretical spectral power distribution curves, and the temperature is expressed in the absolute (Kelvin) scale. This term is sometimes used incorrectly to describe the color of “white” light sources.

**Color testing instruments** *n.* Colorimeters or color spectrophotometers for measuring wavelength and tristimulus values for characterizing color.

**Color tolerance** *n.* Limit of color difference from a standard, which is acceptable. It is generally expressed in terms of a particular color difference equation, which must be described, and may consist of a total color difference, $\Delta E$, or directional color differences, or both.

*See color difference equations.*

**Color vision, anomalous** *n.* Term “anomalous” is used to imply the defective vision of an anomalous trichromat, an observer who sees three primaries but has weaker than normal response to one. The degree of the anomaly varies from slight to severe.

*See color blindness.*

**Color vision, defective** *n.* General term used to describe abnormal vision. The term is preferred to the common term “color blindness”.

*See color blindness and color vision, anomalous.*

**Color vision, normal** *n.* Vision of observers requiring mixtures of three independent primary colors to color-match all colors, using quantities of the primaries sufficiently close to those required for the average observer. The observer with normal vision is referred to as a normal trichromat.

**Color wash** *n.* Each pigments, with or without whiting, lightly bound in glue size so as to facilitate ready removal since frequent removal is necessary, e.g., tinted lime wash.

**Color** *n.* British spelling of “colour”; used in English-speaking countries of the old British Empire, including Canada, Australia, New Zealand, etc.

**Color index (C.I.)** *n.* A publication of the Society of Dyers and Colourists (Great Britain) and the American Association of Textile Chemists and Colorists, which includes periodic additions and amendments. It provides C.I. generic names for classifying commercial dyes and pigments with respect to usage and C.I. numbers for classifying them with respect to chemical composition. It gives basic chemical and usage information, performance characteristics, and manufacturers of them.

**Color index name** *n.* Consists of the category, hue, and an identifying number. For example, one phthalocyanine green pigment is C.I. Pigment Green 7.

*See preface for details.*

**Color index number** *n.* A five-digit number which describes the chemical constitution. For example, phthalocyanine green, C.I. Pigment Green 7, is C.I. 74260 (all phthalocyanines are, or will be, numbered 74000–74999).

**Colza oil** \ˈkäl-zə, ˈkōl-\ [F, fr. D *koolzaad*, fr. MDu *coolsaet*, fr. *coole* cabbage + *saet* seed] (1712) *n.* Another name for rapeseed oil, usually reserved for refined grades.

**Coma** *n.* An aberration of spherical lenses, occurring in the case of oblique incidence, when the bundle of rays forming the image is unsymmetrical. The image of a point is comet shaped, hence the name.

**Comb** *n.* Thin spring-steel tool used in graining or combing.

**Combed sliver** *n.* A continuous band of untwisted fiber, relatively free of short fibers and trash, produced by combing card sliver.

**Combed yarn** *n.* A yarn produced from combed sliver.

*Also see combing.*

**Combination** *n.* The termination of a polymer chain by combining chains which doubles the molecular weight. Monomers of different chemical structure, which are initiated to polymerize and form copolymers.

*See comonomers.*

**Combination fabric** *n.* A fabric containing: (1) different fibers in the warp and filling (e.g., a cotton warp and a rayon filling), (2) ends of two or more fibers in the warp and/or filling, (3) combination yarns, (4) both filament yarn and spun yarn of the same or different fibers, or (5) filament yarns of two or more generic fiber types. Combination fabrics may be either knit or woven. They should not be confused with blend fabrics. Although blend fabrics also contain more that one fiber, the same intimately blended spun yarn is present in both warp and filling.

**Combination frequencies** *n.* Two vibrations of arbitrary frequencies $f_1$ and $f_2$ when applied simultaneously to a non-linear (distorting) device will excite it to a motion containing not only the original frequencies, but also members of a set of "combination" frequencies given by $f_c = mf_1 + nf_2$, where $m$ and $n$ are integers. A resonator sharply tuned to any one of these frequencies, which may be produced in the non-linear device will resound to it with an amplitude depending on the type of non-linearity. The superheterodyne radio receiver depends on this phenomenon.

**Combination mold** Syn: family mold.

**Combination yarn** *n.* A piled yarn containing two or more yarns that vary in fiber composition, content, and/or twist level; or plied yarn composed of both filament yarn and spun yarn.

**Combined-oxide formula** *n.* $3Na_2O \cdot 2CaO \cdot 3Al_2O_3 \cdot 2CO_2 \cdot 6SiO_2$, $Na_2O \cdot Al_2O_3 \cdot 4SiO_2 \cdot 2H_2O$. A formula, which represents the constituents as "oxides", with the metallic oxides preceding the acid anhydrides, each arranged in the order of increasing valence. Water of composition appears last. Examples: cancrinite and analcite.

**Combined water** *n.* The water chemically held, as water of crystallization, by the calcium sulfate dehydrate or hemihydrate crystal.

**Combined yarn** *See combination yarn.*

**Combing** *n.* (1) Act of partially removing a coat of wet paint with combs to imitate the grain of wood or other pattern. (2) A step subsequent to carding in cotton and worsted system processing which straightens the fibers and extracts neps, foreign matter, and short fibers. Combing produces a stronger, more even, more compact, finer, smoother yarn.

**Combining volumes** *n.* Under comparable conditions of pressure and temperature the volume ratios of gases involved in chemical reactions are simple whole numbers.

**Combining weight** *n.* The combining weight of an element or radical is its atomic weight divided by its valence. Syn: equivalent weight.

**Combining weights, law of** *n.* If the weights of elements which combine with each other be called their "combining weights", then elements always combine either in the ratio of their combining weights or of simple multiples of these weights.

**Combustible liquid** *n.* Any liquid having a flp at or about 37.8°C (100°F). Combustible liquids are divided into two classes: *Class II* and *Class III*. *Class II* liquids – Those with a flp at or above 37.8°C (100°F) and below 60°C (140°F), except a mixture having components with flp of 93.3°C (200°F) or higher, the volume of which make up 99% or more of the total volume of the mixture. *Class III* liquids – Those with flp at or above 60°C (140°F). *Class III* is subdivided into two classes: *Class IIIA* – Those with flp at or above 60°C (140°F) and below 93.3°C (200°F), except a mixture having components with flp of 93.3° (200°F) or higher, the volume of which make up 99% or more of the total volume of the mixture; *Class IIIB* – Those with flp at or above 93.3°C (200°F). When a combustible liquid is heated for use to within 16.7°C (30°F) of its flp, it is handled in accordance with the requirements for the next lower class of liquids. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

*See flammable liquid.*

**Combustion analysis** *n.* Any of several methods for quantitatively determining, by burning, the elemental composition of organic compounds, including plastics. First introduced in the 1830s by J. von Liebig, it was refined to permit accurate analysis of small samples (10–50 mg) by F. Pregel, who led the development of the microbalance. Modern combustion analysis is highly automated, but still relies on the microbalance.

**Comfort** *n.* Performance parameter of apparel referring to wearability. Encompasses such properties as wicking, stretch, hand, etc.

**Comic inks** *See news inks.*

**Commercial allowance** *n.* The commercial moisture regain plus a specific allowance for finish used in calculating the commercial or legal weight of a fiber shipment.

**Commercial blast** *See NACE no. 3.*

**Commercial moisture regain** *n.* An arbitrary value adopted as the moisture regain to be used in calculating the commercial or legal weight of a fiber shipment.

**Commercial weight** *n.* (1) In natural fibers, the dry weight of fibers or yarns plus the commercial moisture regain. (2) In manufactured fibers, the dry weight of staple spun yarns or filament yarns after scouring by prescribed methods, plush the commercial moisture regain.

**Commercial xylene** *See xylene.*

**Commingled yarn** \kə-ˈmiŋ-gəl, kä-\ (ca. 1626) *v.* In aerospace textiles, two or more continuous multifilament yarns, the filaments of which have been intermixed with each other without adding twist or otherwise disturbing parallel relationship of the combined filaments. Usually consists of a reinforcing yarn, such as graphite or glass, and a thermoplastic matrix yarn.

**Comminute** \ˈkä-mə-ˌnüt, -ˌnyüt\ [L *comminutus*, pp of *comminuere*, fr. *com-* + *minuere* to lessen] (1626) *v.* To pulverize or reduce to very small sizes, as by grinding.

**Comminution** *n.* Process by which aggregates are reduced to small size.

**Common-ion effect** *n.* The shifting of an ionic equilibrium due to the addition of an ion involved in the equilibrium; usually refers to the repression of dissociation of a weak electrolyte or the decrease in the solubility of an electrolyte brought about by the addition of an ion, which is a dissociation product.

**Comoforming** *n.* A fabrication process that combines vacuum-formed thermoplastic shapes with cold-molded fiberglass-reinforced resin to produce parts having excellent surface appearance and weatherability.

**Comonomer** \(ˌ)kō-ˈmä-nə-mər, -ˈmō-\ [*co-* + *monomer*] (1945) *n.* A monomer that is mixed with one or more other monomers for a polymerization reaction, to make a copolymer.

**Compact** *See powder compact.*

**Compacted yarns** *n.* Air-jet interlaced yarns. Since the entanglement serves only as a substitute for twist, the degree of interlace or tangle is not as great as in air-jet bulked yarns.

**Compacting** *v.* Compacting of a plastic material and the forcing of it through an orifice in more or less continuous fashion. *See extrusion.*

**Compaction** *See intermingling.*

**Compactor** *n.* A machine developed by Fabric Research Laboratories which is used to compact fabrics or to produce warp-stretch fabrics by means of forced crimp and/or shrinkage of the warp yarn.

**Compact spinning process** *n.* A term generally referring to a spinning process carried out using any one of the several small spinning machines of compact design offered by equipment vendors as "packaged" units in which spinning and subsequent processing (drawing, crimping, cutting, etc.) are linked.

**Compatibility** *n.* The ability of two or more substances to mix together or be joined without objectionable separation. In plastics technology the term is most often used in connection with plasticizers, but is also applied to resin pairs or to a resin and prospective compounding ingredients. ASTM tests for compatibility of plasticizers and PVC resins are D 2383 and D 3291. *See also loop test.*

**Compatibility of plasticizers** *n.* Miscibility and stability of one or more plasticizers to plastize a polymer or resin.

**Compatibilizer** *n.* A material that, added to a blend of ordinarily incompatible polymers, suppresses phase separation.

**Compatible shrinkage** *n.* A term used for bonded fabrics to indicate that the face fabric and lining have similar shrinkage. This is necessary to avoid puckering.

**Compensating eyepiece** *n.* An overcorrected eyepiece designed to compensate for certain undercorrections in fluorite and apochromatic objectives.

**Compensator** *n.* An anisotropic substance of known retardation superimposed on the field of view with its vibration directions 45° from the vibration directions of the polarizer and analyzer. When an anisotropic particle is positioned so its slow component is parallel to the slow component of the compensator, the retardations are added. When the particle and compensator slow components are perpendicular, the retardations are subtracted. Compensator retardations may be fixed or variable.

**Compensator, full-wave plate (first-order red)** *n.* A layer of quartz, selenite, calcite, or an oriented polymer film of the proper thickness to produce a retardation equivalent to about 530 nm, the first-order red.

**Compensator, quarter-wave plate** A thin mica (or other crystal) plate or an oriented polymer film of uniform thickness having a retardation of about 130 nm, first-order gray.

**Compensator, quartz wedge** *n.* A wedge, cut from quartz, having continuously variable retardation extending over several orders (usually 3–7) of interference colors. The retardation, which exactly compensates that of a crystal can be found by pushing in the wedge while counting orders until it reaches a position at which the interference color of the crystal appears black. Retardation can be compensated only when the flow component of the crystal and the wedge are perpendicular.

**Complementary colors** *n.* Two colors which, when mixed together in the proper proportions, result in a neutral color. Colored lights, which are complementary, when mixed additively, form white light and follow the laws of additive color mixture. Colorants, which are complementary, when mixed together, form black or gray and follow the laws of subtractive colorant mixture. With the exception of spectrophotometric complementaries, which exist only in theory, colors, which are complementary depend on the illuminant chromaticity considered as the neutral point. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Complete hiding** *See hiding, complete.*

**Complex** *n.* An ion or, sometimes, molecule, which consists of a central atom or ion surrounded by some peripheral atoms, ions, or molecules (ligands) bonded to it.

**Complexation** *n.* The formation of a complex.

**Complex dielectric constant** *n.* Vectorial sum of the dielectric constant and the loss factor; analogous to complex shear modulus and to complex Young's modulus.

**Complexes, catalyst- cocatalyst** *n.* Stereospecific chemical complexes, usually derived from a transition metal halide and a metal hydride or a metal alkyl. An example is in stereospecific polymerization of propylene to crystalline polypropylene.

**Complexing agent** *See chelating agent sequestering agent.*

**Complex modulus (complex dynamic modulus)** *n.* A property of viscoelastic materials subjected to periodic variation or reversal of stress (stress cyling). The stress may be any of the three principal types; the material may be in the solid or liquid state (molten or concentrated solution). In such materials, the strain lags the applied stress in time and when the stress is periodic, the time lag is characterized by a phase angle, $\theta$. The modulus – the ratio of stress to strain – is resolved into two parts, a "real" or in-phase part and an "imaginary" part lagging the real part by $\pi/2$ radians (90°). The resultant "envelope" that develops between the stress and lagging strain is call the hystereis of the stress–strain relationship. For example, in shear, the complex modulus is stated as $G = G' + iG''$, where $i = (-1)^{0.5}$. The vector sum of the two components is called the absolute (dynamic) modulus. The real part is often referred to as the "modulus" while the imaginary part is called the "dynamic viscosity". Both parts vary with frequency, both diminish with rising temperature, and, like static moduli, they are different for different modes of stress. Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Complex shear modulus** *n.* Vectorial sum of the shear modulus and the loss modulus; analogous to complex dielectric constant.

**Complex subtractive colorant mixture** *See subtractive colorant mixture, complex.*

**Complex Young's modulus** Vectorial sum of Young's modulus and the loss modulus; analogous to the complex dielectric constant.

**Compliance** *n.* The degree to which a material deforms under stress; the reciprocal of the modulus. Thus, in each mode of stress, the material is characterized by three moduli and their reciprocals, three compliances. However, when the stress is varying, the "real" and "imaginary" parts of the complex compliances are *not* equal to the reciprocals of their counterparts in the complex modulus. Tensile compliance; the reciprocal of Young's modulus; shear compliance: the reciprocal of shear modulus.

**Compliance, elastic** *n.* Symbol *S.* An elastic constant, which is the ratio of a strain or strain component to a stress or stress component. For a perfectly elastic material it is the reciprocal of the elastic modulus. For a viscoelastic material the modulus and compliance are not reciprocally related due to their different time dependencies. Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York.

**Component substances, law of** *n.* Every material consists of one substance, or is a mixture of two or more substances, each of which exhibits a specific set of properties, independent of the other substances.

**Composite** \käm-ˈpä-zət, kəm-ˈ, *esp British* ˈkäm-pə-zit\ [L *compositus*, pp of *componere*] (1563) *adj.* (1) An article or substance made up of two or more distinct phases of different substances. In the plastics industry the term applies broadly to structures of reinforcing members (*dispersed phase*) incorporated in compatible resinous binders (*continuous phase*). Such composites are subdivided into classes on the basis of the reinforcing constituents: laminate, *particulate* (the dispersed phase consists of unlayered fibers); *flake* (flat flakes forming the dispersed phase); and *skeletal* (composed of a continuous skeletal matrix filled by a resin). (2) Hard or soft constructions in which the fibers themselves are consolidated to form structures rather than being formed into yarns. Rigidity of these constructions is controlled by the density, the modulus of the load-bearing fibers, and the fraction of fusible fibers. Strength is controlled by adhesion and shear-yield strength of the matrix unless fibers are bonded in a load-transferring matrix. (3) A structure made by laminating a non-woven fabric with another non-woven, with other materials, or by impregnating a non-woven fabric with resins. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Composite fibers** *n.* Fibers composed of two or more polymer types in a sheath-core or side-by-side (bilateral) relation.

**Composite laminate** *n.* A term sometimes applied to a laminated plastic bonded to a non-plastic material such as copper, vulcanized fiber, rubber, asbestos, lead, aluminum, etc. An example is the copper-clad laminated plastic used for printed-circuit boards.

**Composite mold** *n.* A mold in which different shapes are produced in one cycle from the several cavities.

*See also family mold.*

**Composite molding** *n.* The process of molding two or more materials in the same cavity in the same shot, but a combination of transfer and compression molding. For example, in making a ring gear, a loose nylon-fiber-filled material is loaded into an open mold around the tooth circle, the mold is closed, and then molten nylon is injected by transfer molding.

**Composite pigment** *n.* Pigment usually made by the mechanical operation of intermixing or blending two or more pigments.

**Composites manufacturing association (CMA/SME)** *n.* Formerly a subgroup of the Society of Manufacturing Engineers, CMA is now a separate entity with 3000 members to promote composites, publish books and tapes, and hold conferences. Its office is at 1 SME Dr, P.O. Box 390, Dearborn, MI.

**Composite structures** *n.* Any material made of more than one component. Composite structures are made from polymers, or from polymers along with other kinds of materials.

**Composition** *n.* (1) A synthetic material containing resins or/and elastomers, and perhaps other components, in specified percentages. (2) The list of constituents and their percentages in such a material.

**Composition rollers** *n.* Printing press rollers made primarily of glue and glycerin.

**Composition roofing** *See built-up roofing.*

**Composition siding** *See hardboard.*

**Compound** \ kəm-ˈ, ˈkäm-ˌ\ [ME *compounen*, MF *compondre*, fr. L *componere*, fr. *com-* + *ponere* to put] (14c) *n, v.* (1) A mixture of resin and the ingredients necessary to modify the resin to a form suitable for processing into finished articles having the desired performance properties. (2) In chemistry, a combination of atoms ionically or covalently bonded in fixed ratios to form a molecule. (3) To produce a plastic compound by blending ingredients with resins in intensive mixers, extruders, or dry-blenders. (4) A pure substance composed of atoms of different elements, whose components cannot be separated by physical means. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Compound curve** *n.* A surface having curvature in two principal directions. Simply curved surfaces, such as cylinders and cones, having only one direction of curvature, may be cut along an element and laid flat. Compound curves, such as spheres and hyperbolic paraboloids, cannot be laid flat without distortion no matter how they are cut. Structures having compound curvature (reinforced-plastic roofs, for example) have high stiffness for their mass.

**Compounders** *n.* Chemical combinations of materials which include all the materials necessary for the finished product. They include Bulk molding compounds (BMC), Sheet-molding compounds (SMC), and Thick molding compounds (TMC). Approximately one-third of all USA polymer production undergoes subsequent compounding.

**Compounder's modulus** *n.* Stiffness measurement extensively used by rubber technologists, expressed as "modulus at 300%" or "300% modulus" (any other percent elongation may be indicated, but 300% is commonly used). By this is meant the tensile stress at the indicated elongation.
*See modulus of elasticity.*

**Compounding** *n.* Mixing basic resins with additives such as plasticizers, stabilizers, fillers, and pigments in a form suitable for processing into finished articles. In some areas of the industry the term includes fusion of the polymer, for example in the production of molding powders by extrusion and palletizing. In the plastisol industry, the compounding step ends with the preparation of the dispersion, fusion being part of the molding step.

**Compounding extruders** Extruders that make use of compounded polymer melt. The melt is produced through either distributive or dispersive mixing techniques.

**Compounding, plastics** *n.* Upgrading of polymers or polymer systems through melt mixing. A compounded plastic has hybrid properties, such as high gloss and good impact strength, or precision moldability and good stiffness.

**Compounding screws** *n.* A typical screw-extruder device, which make use of mixing enhancements such as barriers, flutes, waves, pins, or cavities to overcome the inherent shortcomings in distributive and dispersive mixing. Typically, the screw rotates and axially oscillates. Each turn in the screw's spiral is interrupted by three gaps. The resulting kneading flights are continuously wiped by stationary teeth in the machine's barrel. Uniform shear is introduced at low pressures; making the process particularly well-suited for heat- and shear-sensitive polymers.

**Compounds** *n.* Substances containing more than one constituent element and having properties, on the whole, different from those, which their constituents had as elementary substances. The composition of a given pure compound is perfectly definite, and is always the same no matter how that compound may have been formed.

**Compreg** *n.* A contraction of "**com**pressed im**preg**nated wood", usually referring to an assembly of veneer layers impregnated with a liquid resin and bonded under high pressure.

**Compregnate** *n.* To impregnate and simultaneously or subsequently compress, as in the production of compregs.

**Compregnated wood** *n.* Consolidation of the term "compressed-impregnated wood", referring usually to an assembly of layers of veneer impregnated with a liquid resin and bonded under very high pressures.
*Also known as Compreg.*

**Compressed-air ejection** *n.* The removal of a molding from its mold by means of a jet of compressed air.

**Compressibility** *n.* The relative change in volume per unit change in pressure; the reciprocal of bulk modulus.

**Compression and transfer molding** *n.* In TM the mold halves are brought together under pressure as in Compression molding. The charge of molding compound is then put into a pot and is driven from the pot through runners and gates into the mold cavities by means of a plunger.

**Compression modeling** *n.* A technique principally for thermoset plastic molding in which the molding compound is placed in the heated open mold cavity, mold is closed under pressure, causes the material to flow and compress.

**Compression modulus** *n.* The ratio of compressive stress to compressive strain below the proportional limit. While it is theoretically equal to Young's modulus determined from tensile testing, compressive modulus is usually somewhat greater in plastics.

**Compression mold** *n.* A mold used in the process of compression molding.

**Compression molding** *n.* A method of molding in which a thermosetting molding material, generally preheated, is placed in an open, heated mold cavity, the mold is closed with a top force or plug member, pressure is applied to force the material into intimate contact with all mold surfaces, and heat and pressure are maintained until the material has cured and solidified. The process most often employs thermosetting resins in a partly cured stage, either in the form of granules or putty-resins like masses, or sometimes in preformed shapes roughly conforming to the shape of the mold. Compression molding has also been used with thermoplastics, must notably phonograph records. In this process, the mold is cooled following the compression-flow stage. Compression molding is the oldest form of processing phenolic composite material. In its simplest form, it consists of a force and a cavity that make up a two-piece mold. The mold contains one or more cavities in the shape of the part to be molded. It is heated to 320–380°F, depending on the part's geometry and the closing speed of the press. Then the correct amount of composite material is added, and the two halves of the mold are brought together under 2,000–6,000 pounds of pressure/in.$^2$ of molding area. The heat of the mold softens the phenolic material and, under pressure, it flows to form the shape of the mold. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Harper CA (2000) Modern plastics encyclopedia. McGraw-Hill Professional, New York.

**Compression-molding pressure** *n.* (1) The force per unit of projected area applied to the molding material in a compression mold. The area is projected from all parts of the material under pressure during the complete closing of the mold. (2) The *hydraulic* pressure applied to the compression ram during molding.

**Compression ratio** *n.* In an extruder, the ratio of the volume of the first turn of the feed section to that of the last turn of the metering section. This ratio is a rough indication of the total compaction performed on the feedstock. More precisely called the *channel-volume ratio* or, for a screw of constant pitch, *channel-depth ratio.*

**Compression set** *n.* A permanent deformation remaining after release of a compressive stress. It is a property of interest in elastomers and cushioning materials, such as plastic foams. See, for example, ASTM tests D 395 and D 1565. Sometimes used to mean creep.

*See cold flow.*

**Compression testing** *n.* A method of determining behavior of a material subjected to a uniaxial compressive load.

**Compression zone (compression section)** *n.* The part of an extruder screw, connecting the feed and metering sections, in which the volume per turn is decreasing because of decreasing channel depth, or lead, or both. In some older designs, rarely made today, there were no distinct feed and metering sections and the volume per turn decreased over the entire screw length, so the compression zone was the entire screw. In two-stage screws used for vented operation, the rear metering zone is normally followed by a deep zone of *decompression*, then a second, short compression zone and second metering zone. Where decreasing channel depth is the means of volume reduction, it may be done with a conical screw-root profile or, more usual today, a helical root profile.

**Compressive strength** *n.* The load at which a test specimen fails in compression, divided by the original cross-sectional area perpendicular to the load. For rigid plastics, ASTM test D 695 is used; for rigid foams, D 1621. These tests also prescribe procedures for estimating compressive moduli. The actual mode of failure of a stiff material in a test of compressive strength is usually by diagonal shear.

**Compressive stress** *n.* The compressive load per unit area of perpendicular cross section carried by the specimen during a compression test.

**Compton effect (Compton recoil effect)** *n.* Elastic scattering of photons by electrons results in decrease infrequency and increase of wavelength of X-rays and γ-rays when scattered by free electrons.

**Computer-aided design (CAD)** *n.* Using a computer, and appropriate programs (software), in the engineering design – even to the production of finished working drawings – of parts, tools, molds, and assemblies.

**Computer-aided manufacturing (CAM)** *n.* Using a computer – usually dedicated and typically a minicomputer – with appropriate programs (software), to control parts or all of a manufacturing operation.

**Computer numerical control (CNC, numerical control)** *n.* The use of a dedicated small computer to implement the control of a process or, typically, a machining task.

**Concavity factor** *n.* The entire stress-strain curves of rubbers and elastomers that have no elastic limit are typically concave toward the stress axis (and convex to the strain axis). The concavity factor is the ratio (less than 1) between the energy beneath the extension curve to that beneath the straight line to the same final point.

**Concentration** *n.* (1) Amount of a substance expressed in relationship to the whole. (2) Act or process of increasing the amount of a given substance in relationship to the whole.

**Concentration cell** *n.* Electrolytic cell consisting of an electrolyte and two electrodes of the same metal or alloy that develop a difference in potential as a result of a difference in concentration of ions (most often metal ions) or oxygen at different points in a solution.

**Concentricity** *n.* The characteristic of circles or circular cylindrical surfaces of different radii having a common center. More loosely, the property, in *any* annular shape, of constant radial wall thickness. Concentricity is important in blown film, pipe and tubing, wire-coating, and many noncircular extrusions.

**Conchoidal fracture** *n.* Type of fracture seen when a mineral or other substance, such as glass, breaks to give irregularly curved, usually striated surface, and no cleavage along planes.

**Concrete** *n.* A composite material which consists essentially of a binding medium within which are embedded particles or fragments of aggregate; in Portland cement concrete, the binder is a mixture of Portland cement and water.

*See cement.*

**Concrete block** *n.* A hollow or solid concrete masonry unit consisting of Portland cement and suitable aggregates combined with water. Lime, fly ash, air-entraining agents, or other admixtures may be included. Sometimes incorrectly called cement block.

**Concrete bond plaster** *See bond plaster and concrete bond plaster.*

**Concrete gun** *n.* A spray gun used in applying freshly mixed concrete; compressed air forces the concrete along a flexible hose and through a nozzle.

**Condensate** *n.* Product obtained by cooling a vapor, such that it is converted either to a liquid or a solid.

**Condensation** *n.* (1) The process of reducing a gas or vapor to liquid or solid form. (2) A chemical reaction in which two or more molecules combine with the separation of water or some other simple molecule. If a polymer is formed the process is called *polycondensation.*

**Condensation agent** *n.* A chemical compound that acts as a catalyst and also furnishes a complement of material necessary for a polycondensation reaction to proceed.

**Condensation polymer** *n.* A polymer made by condensation polymerization.

**Condensation polymerization** *n.* A polymerization reaction in which water or some other simple molecule is eliminated from two or more monomer molecules as they combine to form the polymer or cross-links between polymer chains. Examples of resins so made are alkyds, phenol-formaldehyde and urea-formaldehyde, polyesters, polyamides, acetals, and polyphenylene oxide.

**Condensation polymers** *n.*, **by chain mechanisms** Step-growth polymers produced by a polymerization reaction in which the elimination of a small molecule, often water, has occurred, e.g., produced by a condensation polymerization. Important examples include the polyesters, polyamides and phenol-, urea- and melamine-formaldehyde polymers. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Condensation resin** *n.* A resin formed by condensation polymerization.

**Condenser** *n.* The lens system mounted under the stage of the microscope to furnish a cone of light to the specimen. There are two basic types of condensers: bright-field and darkfield.

**Condensers in parallel and series** *n.* If $c_1$, $c_2$, $c_2$, etc. represent the capacitances of a series of condensers and $C$ their combined capacitance,

when in parallel, $C = c_1 + c_2 + c_3 + \cdots$,

when in series, $\frac{1}{C} = \frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3} + \cdots$

Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Conditional match** *n.* A pair of colors, which appear to match only under limited conditions, such as under a particular light source and a particular observer; a metameric match.

**Conditioners** *n.* A process of allowing textile materials (staple, tow, yarns, and fabrics) to reach hygroscopic equilibrium with the surrounding atmosphere. Materials may be conditioned in a standard atmosphere (65% RH, 70°F) for testing purposes or in arbitrary conditions existing in manufacturing or processing areas.

**Conditioning** *n.* Subjecting a test specimen to standard environmental and/or stress history prior to testing. Several “ambient” conditioning atmospheres, approved by ISO, are listed in ASTM specification E 171, and ASTM D 618 provides detailed information on conditioning. Plastics test specimens are usually conditioned at 23°C and 50% RH for several days or more. Test D 638 for tensile properties of plastics specifies “. . . . not less than 40 h. . . .” at these conditions.

**Conditioning time** *See time, joint conditioning.*

**Conductance** (1885) *n.* (1) The electrical term for the reciprocal of resistance, measured by the ratio of current flowing through a conductor to the difference of potential between its ends. The SI unit is the *siemens* (S), replacing the non-deprecated mho, to which it is exactly equal. ASTM D 257 prescribes tests for the resistance and conductance of electrical-insulating materials. (2) In heat transfer, the ratio of heat *flux* through a solid wall or a stagnant fluid film divided by the difference in temperature through the wall or film. The SI unit is $J/(m^2\,K)$. The reciprocal of resistance, is measured by the ratio of the current flowing through a conductor to the difference of potential between its ends. The practical unit of conductance, the mho, the conductance of a body through which 1 A of current flows when the potential difference is 1 V. The conductance of a body in mho is the reciprocal of the value of its resistance in ohms. Dimensions $[\varepsilon\, L T^{-1}]$, $[\mu^{-1} L^{-1} T]$. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The Chemical Rubber Co., Boca Raton, FL.

**Conductimetric analysis** *n.* A method of analysis for certain ions in solution based on measurement of the solution's electrical conductivity.

**Conducting polymer** *n.* One of a class of polymers that, unlike most organic polymers, have high electrical conductivity. Polyacetylene is the best known member and at least one type has been prepared by doping that has conductivity almost equal to that of copper. While these polymers are expected to be useful in a wide range of devices, only a few commercial applications exist.

*Also, see polyelectrolyte.*

**Conductive composite** *n.* A composite material having a volume resistivity less than 500 Ω cm. Such composites may be created by adding metal or graphite powders to ordinary resins. Others are made from inherently conducting polymers. They are useful for static elimination, RF shielding, and in storage-battery components.

**Conductive heat transfer** *See heat transfer.*

**Conductivity** *n.* The current transferred across per unit potential gradient, $K = \mathrm{A/cm^2}$ divided by V/cm. Reciprocal of resistivity.

*Also known as specific conductance.*

**Conductivity (electrical)** *n.* The reciprocal of volume resistivity; the conductance of a unit cube of material. The SI unit is siemens per meter (S/m). It is measured by the quantity of electricity transferred across unit area, per unit potential gradient per unit time. Reciprocal of resistivity. *Volume conductivity* or specific conductance, $k = 1/\rho$ where $\rho$ is the volume resistivity. *Mass conductivity* $= k/d$ where $d$ is density. *Equivalent conductivity* $\Lambda = k/c$ where $c$ is the number of equivalents per unit volume of solution. *Molecular conductivity* $\mu = k/m$ where $m$ is the number of moles per unit volume of solution. Dimensions: volume conductivity $[\varepsilon \mathrm{T}^{-1}]$, $[\mu^{-1}\mathrm{L}^{-2}\mathrm{T}]$, mass conductivity $[\varepsilon \mathrm{M}^{-1}\mathrm{L}^{3}\mathrm{T}^{-1}]$, $[\mu^{-1}\mathrm{M}^{-1}\mathrm{LT}]$. $^{-1}\mathrm{M}^{-1}\mathrm{LT}]$. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Conductivity (thermal)** *n.* Time rate of transfer of heat by conduction, through unit thickness, across unit area for unit difference of temperature. It is measured as cal/s/cm$^2$ for a thickness of 1 cm and a difference of temperature of 1°C. Dimensions $[\mathrm{MLT}^{-3}\theta^{-1}]$. If the two opposite faces of a rectangular solid are maintained at temperatures, $t_1$ and $t_2$ the heat conducted across the solid of section $a$ and thickness $d$ in a time $T$ will be,

$$Q = \frac{K(t_2 - t_1)at}{d},$$

where $K$ is the constant depending on the nature of the substance, designated as the specific heat conductivity. $K$ is usually given for $Q$ in calories $t_1$ and $t_2$ in °C, $a$ in cm$^2$, $T$ in s, and $d$ in cm. Ready RG (1996) Thermodynamics. Plenum Publishing Company, New York. Pethrick RA, Pethrick RA (eds)(1999) Modern techniques for polymer characterization. John Wiley and Sons, New York.

*See heat conductivity.*

**Conductors** *n.* A class of bodies, which are incapable of supporting electric strain. A charge given to a conductor spread to all parts of the body.

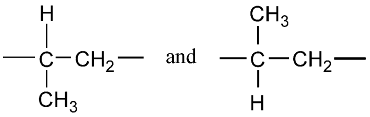
**Cone** *n.* A conical package of yarn, usually wound on a disposable paper core.

**Cone mill** *n.* Old type of mill used for dispersing pigments in media. They usually have conical hopes, and the grinding surfaces are also inclined like the surface of a cone.

**Configuration** *n.* The arrangement of atoms that characterizes a particular stereoisomer is called its configuration. Related chemical structures produced by the cleavage and reforming of covalent bonds; arrangement of polymers along a plastic molecule chain and the structural makeup of a chemical compound, especially with reference to the spatial relationship of the constituent atoms; *trans*- and *cis*-configurations of the carbon–carbon double bond are geometric isomers.

*See conformation.*

**Configurational base unit** *n.* A molecular repeating unit or mer whose configuration is defined at least at one site of stereoisomerism in the main chain of a polymer molecule. *Note*—In a regular polymer, a configurational base unit corresponds to the mer. For example, in regular polypropylene, the mer is $-CH(CH_3)CH_2-$ and the configurational base units are shown in the image, and these two configurational base units are enantiomeric to each other (mirror images).



$$-\overset{H}{\underset{CH_3}{C}}-CH_2- \quad \text{and} \quad -\overset{CH_3}{\underset{H}{C}}-CH_2-$$

**Configurational unit** A molecular unit having one or more sites of defined stereoisomerism (IUPAC).

**Configuration repeating unit** *n.* The smallest set of one, two, or more successive configurational base units that prescribes configurational repetition at one of more sites of stereoisomerism in the main chain of a polymer molecule (IUPAC).

**Conformal coating** *See encapsulation.*

**Conformation** *n.* Different arrangements of atoms that can be converted into one another by rotation about single bonds are called conformations (e.g., *anti*-, *gauche*-conformations).

**Congeal** \kən-ˈjē(ə)l\ [ME *congelen*, fr. MF *congeler*, fr. L *congelare*, fr. *com*- + *gelare* to freeze] (14c) *v.* To change from a liquid or soft state to a solid or rigid state.

**Congo copal** *n.* Most important of the copals used for oil varnishes. It originates in the Belgian Congo (now Zaire). It becomes soluble in vegetable oils after running.

**Congocopalic acid** *See bengucopalic acid.*

**Congo gum** *n.* Fossilized gum resin obtained from the Congo region of Africa (now Zaire). Used mostly in manufacturing varnishes.

**Congolene** *n.* Bicyclic hydrocarbon, obtained from the oily layer resulting from the running of Congo copal.

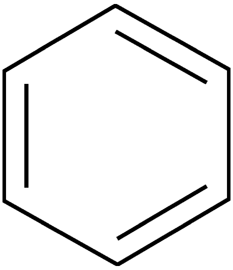
**Conical dry-blender** *n.* A device consisting of two hollow cones joined at their bases by a short cylindrical section, mounted on a central shaft perpendicular to the conicylindrical axis. Material is charged and discharged at openings in the apexes of the cones. Mixing is accomplished by cascading, rolling, and tumbling of the charge as the chamber rotates bout the shaft.

**Conical transition** *n.* In a metering-type extruder screw, the root surface of the screw between the feed section and metering section having the shape of a cone whose diameter increases from that of the deeper feed section to that of the shallower metering section.

**Coning** The transfer of yarn from skeins or bobbins or other types of packages to cones.

**Conjugate acid–base pair** *n.* An acid and the base formed by removal of a proton from the acid, or a base and the acid formed by the addition of a proton to the base (Brønsted–Lowry).

**Conjugated** *n.* In organic chemistry, referring to the regular alternation of single and double bonds between carbon atoms. For example, in the conventional representation of the benzene molecule shown in the image where each single bond represents one pair of shared electrons, each double bond, two pairs.



**Conjugated diene polymerization** *n.* Conjugated dienes often polymerize as bifunctional monomers with 1,4 addition or 1,2 addition. In this process, one double bond remains in the main chain for each monomer.

**Conjugated double bonds** *n.* A chemical term denoting double bonds separated from each other by a single bond. An example is the bonding in 1,3-butadiene, $CH_2{=}CH{-}CH{=}CH_2$.

**Conjugated yarn** *n.* A yarn made from conjugate filaments.

**Conjugate fibers** *n.* A two-component fiber with specific ability to crimp on hot or hot/wet treatment because of differential shrinkage.

*Also see bilateral fibers.*

**Conjugate foci** *n.* Under proper conditions light divergent from a point on or near the axis of a lens or spherical mirror is focused at another point. The point of convergence and the position of the source are interchangeable and are called conjugate foci.

**Conjugate focil** *n.* In an image-forming system, two fields are said to be conjugate with each other when one or more object fields are simultaneously in focus in a single plane, e.g., in Köhler illumination the field diaphram, specimen and ocular front focal plane.

**Conjugation** *n.* The location of the π orbital in such a way that it can overlap other orbitals within the molecule. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Conoscopic observation** *n.* The study of the back focal plane of the objective by removing the eyepiece, by inserting a Bertrand lens, by examining the image at the eyepoint above the eyepiece with a magnifier or by using a phase telescope is called conoscopic because the observations are associated with the cone of light furnished by the condenser and viewed by the objective (cf., orthoscopic).

**Consensus standard** *n.* A standard developed according to a consensus agreement or general opinion among representatives of various interested or affected organizations and individuals.

**Conservation of energy (Chem)** *n.* In a chemical change there is no loss or gain but merely a transformation of energy from one form to another.

**Consistency** *n.* That property of a liquid adhesive by virtue of which it tends to resist deformation. *Note*—Consistency is not a fundamental property but is comprised of viscosity, plasticity, and other phenomena (*See also viscosity and viscosity coefficient*).

**Consistency** *n.* The density, firmness, viscosity, or resistance to flow of a substance, slurry, or aggregate.

*See viscosity.*

**Consistency** *n.* The property of a material or composition which is evidenced by its resistance to flow, represented by an undefined composite of properties, each measurable from the complete, force-rate flow curve as plastic viscosity, yield value and thixotropy. The term is applied to a variety of materials. For Newtonian liquids, consistency is simply viscosity. While “consistency” is an accepted rheological term, it has qualitative meaning only, and is used with qualifying adjectives as “buttery”, “thin”, “high”, etc., in describing plastic flow. Usually measured in an empirical manner and in arbitrary units. Often used as a synonym for viscosity.

**Consistometer** *n.* An instrument for measuring the flow characteristics of a viscous or plastic material.

*See viscometer and rheometer.*

**Consolidation** *n.* Application of heat and pressure to form composite structures.

**Constantan** \ˈkän(t)-stən-ˌtan\ [fr. the fact that its resistance remains constant under change of temperature] (1903) *n.* An alloy containing about 55% copper and 45% nickel and having a low thermal coefficient of resistivity. Its main use in the plastics industry is in thermocouple wire with either iron or cooper as the mating element. Iron-constantan, Type J, and chromel–alumel. Type K, are widely used to sense temperatures in plastics-processing equipment.

**Constant white** *n.* Alternative name for blanc fixed.

**Constitutional formula** *n.* Device used to illustrate the composition of a chemical compound by displaying the individual atoms and radicals, joined together by valency linkages.

**Constitutional repeating unit** *n.* The smallest molecular unit whose repetition describes a regular polymer (IUPAC).

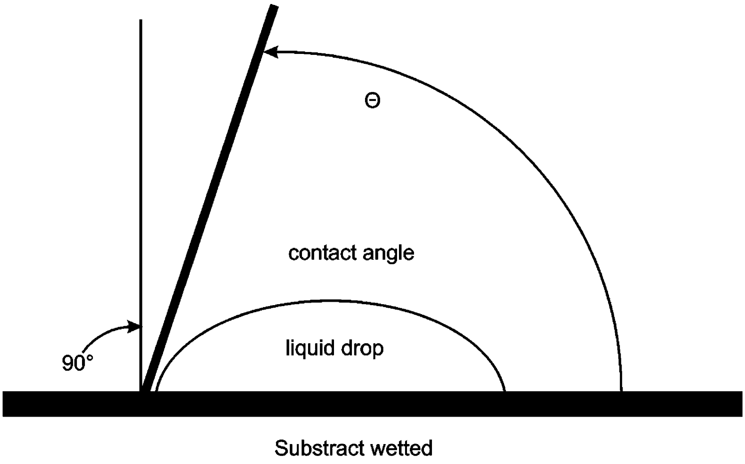
**Constitutive equation** *n.* In material science, an equation that relates stress in a material to strain or strain rate. Simple examples are (1) Hooke’s law, which states that, in elastic solids, strain is directly proportional to stress, and (2) Newton’s law of flow, which states that, in laminar shear flow, the shear rate is equal to the shear stress divided by the viscosity. Few plastic solids and liquids obey either of these laws.

**Constitutive property** *n.* A property, which depends on the constitution or structure of the molecule.

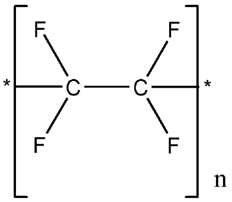
**Consumer’s risk** *n.* In quality control and acceptance sampling, the risk of making a type II error, i.e., of accepting, under a given sampling plan, a lot that is of definitely unacceptable quality.

**Contact adhesive** *n.* A liquid adhesive that dries to a film that is not sticky to other materials but very sticky to itself. A typical contact adhesive is a neoprene elastomer mixed with either an organic-solvent vehicle or an aqueous dispersion medium. The adhesive is applied to both surfaces to be joined and dried at least partly. When pressed together with light to moderate pressure a bond of high initial strength results. Some definitions of “contact adhesive” stipulate that, for satisfactory bonding, the surfaces to be joined shall be no further apart than about 0.1 mm. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Contact angle** *n.* The angle between the edge of a liquid meniscus or drop and the solid surface with which it is in contact. A droplet placed on a horizontal solid surface may remain spherical or spread to a degree that is related to the surface energies of the two materials. The angle between the solid surface and the tangent to the droplet at the curve of contact with the surface is the contact angle, and an example of this measurement is shown. By virtue of measuring such droplet-contact angles for droplets of several liquids of different surface energies, the surface energy of the solid may be calculated as shown in the plot. Mittal KL (2003) Contact angle, wettability and adhesion, vols 1–3. VPS International Science Publishers, Zeist, The Netherlands. Oss CJ (1994) Interfacial forces in aqueous media.



Marcel Dekker, New York. ASTM Test D 724–799, 2003.



**Contact laminating** *See contact-pressure molding.*

**Contact molding** *n.* A process for molding reinforced plastics in which the reinforcement and plastic are placed on a mold.

**Contact-pressure molding (contact molding)** *n.* This term encompasses processes for forming shapes of reinforced plastics in which little or no pressure is applied during the forming and curing steps. It is usually employed in connection with the processes of sprayup and hand-layup molding when such processes do not include the application of pressure during curing.

**Contact-pressure resin (contact resin, impression resin, low-pressure resin)** *n.* A liquid resin that thickens or cross-links on heating and, components are an unsaturated monomer such as an allyl ester, or a mixture of styrene or other vinyl monomer with an unsaturated polyester or alkyd.

**Contact resin** *n.* A liquid resin that thickens or cross-links on heating and, when used for bonding laminates, requires little or no pressure. Typical components are an unsaturated monomer such as an allyl ester, or a mixture of styrene or other vinyl monomer with an unsaturated polyester or alkyd. *See contact-pressure resin.*

**Contact resins** *n.* Liquid resins, which thicken on heating and, when used for bonding laminates, require little or no pressure.

**Container lining** *n.* Protective coating applied to the inner walls of a container to prevent interaction between the contents and the material of construction of the container or to make the walls of the container impervious to the contents.

**Continuous filament** *n.* A single, flexible, small-diameter fiber of indefinite length. *See filament.*

**Continuous-filament yarn** *n.* A yarn formed by twisting together two or more – typically scores – of continuous filaments.

**Continuous phase** *n.* (1) In a suspension or emulsion the continuous phase refers to the liquid medium in which the solid or second-liquid particles are dispersed. The solid particles or droplets are called the *disperse phase.* (2) In a plastic filled or reinforced with solid particles, flakes or fibers, the binding resin is the continuous phase.

**Continuous phase** *n.* The medium or continuum in which the dispersed phase is contained.

*Also called external phase.*

**Continuous polymerization** n. In polymer manufacture, linkage of the various stages of polymerization so that materials flow without interruption from the addition of raw materials to delivery of the finished polymer from the system. Extrusion as film, chip or fiber may be linked to a continuous polymerization line. Because there is no break in the process while the transition from low molecular weight to high occurs, multiple stage reaction vessels may be required and accurate process control is critical.

**Continuous roving** *See roving.*

**Continuous tone** *n.* Tonal gradation without use of halftone dots.

**Contour length** *n.* The maximum value of the end-to-end distance of a polymer chain. If the chain consists of $n$ links of each length $l$ with valence angle $\theta$, the chain length is $nl\sin(\theta/2)$.

*Also known as displacement length.*

**Contraction** *See take-up (twist) or take-up (yarn in fabric).*

**Contraction allowance** *See shrinkage allowance.*

**Contrast ratio** *n.* (1) Ratio of the reflectance of a dry paint film over a black substrate of 5% or less reflectance, to the reflectance of the same paint, equivalently applied and dried, over a substrate of 80% reflectance. (2) The ratio of the luminous reflectance, $Y$ measured on a film over a black substrate, to the $Y$ measure on the same film over a white substrate. The $Y$ of the white and black must be specified. The contrast ratio will vary depending on the thickness of the film and on the concentrations of colorants. Sward GG (ed) (1972) Paint testing manual: physical and chemical examination of paints, varnishes and lacquers, and colors, 13th edn. ASTM Special Technical Publication No, 500, American Society for Testing and Materials, Philadelphia, PA.

**Controlled-atmosphere packaging** *n.* The packaging of a product in a gas other than air, typically an inert gas such as nitrogen.

**Convalent bond** *n.* A bond consisting of a pair of electrons shared between the bonded atoms.

**Convection** \kən-ˈvek-shən\ [LL *convection-*, *convectio*, fr. L *convehere* to bring together, fr. *com-* + *vehere* to carry] (ca. 1623) *n.* Any process by which heat energy or material exchange is effected by flow of the medium. Convection may be *natural*, driven by gravity and density or concentration differences at different points the medium; or *forced*, driven by pumps, blowers, or vibrating devices. Forced convection is almost always faster and more efficient because of the higher velocities and greater turbulence produced.

**Conventional base unit of a polymer** *n.* Base unit, defined without regard to steric isomerism (IUPAC).

**Convergent die** *n.* An extrusion die in which the internal channels of the die leading to the die orifice are decreasing in cross section in the direction of flow.

**Conversation of energy, law of** *n.* Energy can neither be created nor destroyed and therefore the total amount of energy in the universe remains constant.

**Conversation of mass** *n.* In all ordinary chemical changes, the total of the reactants is always equal to the total mass of the products.

**Conversation of momentum, law of** *n.* For any collision, the vector sum of the moment of the colliding bodies after collision equals the vector sum of their moment before collision. If two bodies of masses $m_1$ and $m_2$ have, before impact velocities $v_1$ and $v_2$ and after impact velocities $u_1$ and $u_2$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2.$$

**Conversion** *n.* (1) In a chemical process, the molar percentage of any reactant, often the primary or most costly reactant that is changed into product. (2) In the packaging industry, the intermediate processing and fabrication of plastic film or sheeting into useful forms by slitting, die cutting, heat-sealing into bags, etc. for resale to packagers.

**Conversion coating** *See chemical conversion coating.*

**Converted fabric** *n.* A finished fabric as distinguished from greige fabric.

**Converter** An individual or organization, which buys greige fabrics and sells them as a finished product to cutters, wholesalers, retailers, and others. The converter arranges for the finishing of the fabric, namely bleaching, mercerizing, dyeing, printing, etc., to the buyers' specifications.

**Conversion coating** *See chemical conversion coating.*

**Convertible coating** *n.* Irreversible transformation of a coating after its film formation to a film insoluble in the solvent from which it was deposited. This can be effected by oxidation, thermal cross-linking or catalytic curing. This should not be confused with.

*See non-convertible coating.*

**Convolution** \ˌkän-və-ˈlü-shən\ (1545) *n.* (1) An irregular spiral or twisted condition characteristic of mature cotton fiber. It is visible under a microscopic. The finer fibers are generally more twisted than the coarser fibers. (2) Coil and curl in certain types of textured yarns which provide bulkiness to the yarn. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Cooling** *n.* Processing highly radioactive materials to attain less radioactivity for subsequent use or handling.

**Cooling channel** *n.* A passageway provided in a mold, platen or die for circulating water or other cooling medium, in order to control the temperature of the metal surfaces in contact with the plastic being molded or extruded. Proper sizing and placement of cooling channels can do much to speed processing and optimize properties.

**Cooling fixture (shrink fixture)** *n.* A structure of wood or metal shaped to receive and restrain a part after its removal from a mold, so as to prevent distortion of the part while it is cooling.

**Coordinate bond** *n.* A covalent bond consisting of a pair of electrons donated by only one of the two atoms it joins.

**Coordinate covalent bond** A covalent bond in which both shared electrons appear to have been contributed by one atom.

**Coordination catalyst** *n.* A catalyst comprising a mixture of an organo-metallic compound, e.g., triethylaluminum, and a transition-metal compound, e.g., titanium tetrachloride. Often called Ziegler or Ziegler–Natta catalysts, they are used in polymerizing olefins and dienes.

**Coordination catalysts** *n.* Catalysts comprising a mixture of (a) an organo-metallic compound such as triethylaluminum or a transition-metal compound, such as titanium tetra-chloride. Known as Ziegler or Ziegler–Natta catalysts, they are used for the polymerization of olefins and dienes.

**Coordination compound (Werner complex)** *n.* A complex compound whose molecular structure contains a central atom bonded to other atoms by coordinate covalent bonds based on a shared pair of electrons, both of which are from a single atom or ion. A chelate is an special type of coordination compound.

**Coordination number** *n.* The number of atoms, ions, or molecules surrounding a central atom or ion in a complex, or sometimes, in a solid.

**Coordination polymerization** *n.* Polymerization of vinyl monomers using a catalyst comprising a transition metal salt and a metal alkyl; Ziegler–Natta catalysts for polymerization of ethylene to produce polyethylene.

**Cop** \ˈkäp\ [ME, fr. OE *copp*] (before 12c) *n.* (1) A headless tube upon which yarn or thread is wound. (2) Thread or yarn wound into the shape of a hollow cylinder with tapered ends. (3) Filling yarn wound upon a tapered tube (generally paper).

**Copal** \ˈkō-pəl\ [sp, fr. Nahuatl *copalli* resin] (1577) *n.* A fossil resin used in printing ink vehicles.

**Copal esters** *n.* These are normally regarded as the glyceride esters of run Congo copal, although the term can also be applied to esters of other copals.

**Copal oil** *n.* Another name for the condensed fumes obtained during the running of natural copals.

**Copals** *n.* Gum resins exuded from living plants and fossilized in the ground. Some of the opals are: Zanzibar, amber, kauri, Manila, and Congo.

**Copal varnish** *n.* A high-gloss varnish made with a drying oil, such as linseed oil, and copal.

**Coping** *n.* A protective cap, top, or cover of a wall, parapet, plaster, or chimney; often of stone, terra-cotta, concrete or wood.

**Copolyamides** *Also known as polyether block amide elastomers* – based on a block copolymer and a polyether. A wide range of grades and performance characteristics can be achieved by varying the polyamide and polyether blocks. These high-performance thermoplastic elastomers can withstand high heat and offer good heat-aging characteristics, long flex life, and excellent chemical resistance. Copolyamides are used in demanding medical applications such as catheters and in wire-and-cable jackets, automotive parts, and sporting goods.

**Copolycondensation** *n.* The copolymerization of two or more monomers by condensation polymerization.

**Copolymer** \(ˌ)kō-ˈpä-lə-mər\ (1936) *n.* This term usually, but not always, denotes a polymer two chemically distinct monomers. It is sometimes used for terpolymers, etc, containing more than two types of mer units. Three common types of copolymers are block copolymers, graft copolymers, and random copolymer. The IUPAC term for a polymer derived from two species of monomer, *bipolymer* eschews the foregoing ambiguity but is nevertheless rarely seen or heard.

*See also bipolymer and terpolymer.*

**Copolymer equation** *n.* $F_A/F_B = (r_A f_A/f_B + 1)/(r_B f_B/f_A + 1)$, where $f_A$ is the mole fraction of monomer A in feed, $f_B$ the mole fraction of monomer B in feed, $F_A$ the mole fraction of A in copolymer, $F_B$ the mole fraction of B in copolymer, $r_A$ the reactivity ratio of A, and $r_B$ is the reactivity ratio of B.

**Copolymerization** *n.* The building up of linear or non-linear macromolecules (copolymers) in which many monomers, possessing molecules have one or more double bonds, have been located in every macromolecule of different size which constitutes the copolymerizate, following alternations which may be regular or not.
*See polymerization.*

**Copolymers** *n.* Polymers constructed from two different materials.

**Copper acetoarsenite** *Also known as Paris green, emerald green and Schweinfurt green.*

**Copperas** \ˈkä-p(ə-)rəs\ [ME *copperas*, fr. OF *couperose*, fr. ML *cuprosa*, prob. fr. *aqua cuprosa*, literally, copper water, fr. LL *cuprum*] (14c) *n.*
*See ferrous sulfate.*

**Copper blue** *n.* Another name for *cupri sulfide* (copper (II) sulfide). Syn: covellite.

**Copper bronze** *n.* Name given to a range of metallic powders ranging in color from "pale gold" to the deep "coin bronze". They consist generally of alloys of copper, but recently dyed aluminum powders of similar shades have been produced.
*See also copper powder.*

**Copper carbonate $CuCO_3$** Material frequently used as a poison in antifouling paints.

**Copper-clad laminate** *n.* A laminated plastic surfaced with copper foil or plating, used for preparing printed circuits.

**Copper driers (Deprecated)** Copper salts of acids generally used for driers, such as naphthenic and 2-ethyl hexoic, which are used as fungicides and preservative additives in coatings, but do not function as driers. They are deep green and cannot be used in whites or light colors.

**Copper powder** *n.* Metallic copper and copper bronze powders have some application in anti-fouling paints, and in special primers. Copper bronzes of various colors are produced according to the amount of alloy metal present. In producing finishes from copper and copper bronze powders, great care in formulation is necessary, for these pigments are apt to cause inhibition of drying, discoloration of media, and gelation.

**Copper resinate** *n.* Green compound formed by dissolving copper acetate, verdigris or other copper salt in Venice turpentine, balsam, or similar resinous solutions.

**Copper soap** *n.* Combination of copper with a fatty acid.

**Copper staining** *n.* Usually caused by corrosion of copper screens, gutters or downspouts washing down on painted surfaces.

**Copper sub-oxide** $Cu_2O$. Another name for cuprous oxide [copper(I) oxide].

**Copper sulfate** *n.* $CuSO_4 \cdot 5H_2O$. Used occasionally in pigment manufacture, e.g., Para Brown.
*Also known as blue vitriol and blue stone.*

**Copy** *n.* Material, including art and text, submitted for reproduction. The term is also used to refer the final printed result.

**Coral rubber** *Cis*-1,4-poly(isoprene). Manufactured by Goodrich, USA.

**Cord** *n.* (1) The product formed by twisting together two or more plied yarns. (2) A rib on the surface of a fabric (e.g., corduroy and whipcord).

**Corded selvage** *See loopy selvage.*

**Corduroy** \ˈkór-də-ˌrói\ (ca. 1791) *n.* (1) In wallpaper, a very narrow strip imitating the fabric. The name is derived from the French "corde du roi" or king's cord. (2) A filling-pile fabric with ridges of pile (cords) running lengthwise parallel to the selvage.

**Core** *n.* (1) The central member of a laminate to which the faces of the sandwich are bonded. (2) A channel in a mold, extruder screw or cast-in heating element for circulation of heat-transfer media. (3) Part of a complex mold that forms undercut sections of a part, usually withdrawn to one side before the main members of the mod are opened. (4) The central member of a die for extruding pipe, tubing, wire-coating, or a parison to be blow-molded. (5) The central conductor in a coaxial cable. (6) All of an atom except for its valence shell of electrons; *also called the Kernel.*

**Core and separator** *See core* (4) above.

**Core-bulked yarn** *See textured yarns.*

**Cored screw** *n.* An extruder screw bored centrally from the rear to permit circulation of temperature-controlled liquid within all or part of the screw's length.

**Core spinning** *n.* The process of making a corespun yarn. It consists of feeding the core yarn (an elastomeric filament yarn, a regular filament yarn, a textured yarn, or a previously spun yarn) into the front delivery roll of the spinning frame and of covering the core yarn with a sheath of fibers during the spinning operation.

**Core-spun yarn** *n.* A yarn made by twisting fibers around a filament or a previously spun yarn, thus concealing the core. Core yarns are used in sewing thread, blankets, and socks and also to obtain novelty effects in fabrics.

**Corfam®** *n.* Permeable artificial leather from polyurethane/polyester/polyester fleece, manufactured by DuPont, USA.
*See poromeric.*

**Cork** *n.* The outer bark of *Quercus suber*, a species of oak native to Mediterranean countries, having density in the range 0.22–0.26 g/cm$^3$. Cork is used as a core material [*See core* (1)] in sandwich structures and, in ground form, as a density-lowering filler in thermoplastic and thermosetting compounds for special applications such as flooring, ablative plastics, insulating compositions, and shoe inner soles.

**Cork composite** *n.* A compound consisting of ground cork, resins, and other additives and reinforcements, formed into rods, sheets, etc. Cork composites have relatively low density and are used in sporting goods, for thermal insulation, and ion ablative material.

**Cork dust** *n.* Very finely divided cork, which is used in anti-condensation paints.

**Corkscrew twist** *n.* A place in yarn or cord where uneven twist gives a corkscrew-like appearance.

**Cornice** *n.* (1) A horizontal molding or combination of moldings to finish the top of a wall. (2) Paper simulating the same.

**Corn oil** *n.* Oil obtained from the kernels of Indian corn, maize, *Zea mays*. It is semidrying, lying between cottonseed and soybean oils.

**Corona** \kə-ˈrō-nə\ [L, garland, crown, cornice] (1563) *n.* Cracks on the surface caused by ozone, usually spearing at right angles to a stress, checking, cutting or cracking.

**Corona discharge** *n.* (1) The flow of electrical energy from a conductor to or through the surrounding air or gas. The phenomenon occurs when the voltage difference is sufficient (>5000 V) to cause partial ionization of the gas. The discharge is characterized by a pale violet glow, a hissing noise, and the odor of ozone formed when the surrounding gas contains oxygen. Corona discharge occurs around high-voltage cables, thus making ozone resistance an important factor in compounding plastics for insulation of electrical wire and cables. (2) Curing method involving the bombardment of organic vapors with high-energy electrons at very low pressures in contact with the substrate to be coated.

*See also casing, corona-discharge treatment and glow discharge.*

**Corona-discharge treatment** *n.* A method of rendering inert plastics, primarily polyolefins, more receptive to inks, adhesives, and decorative coatings by subjecting their surfaces to a corona discharge. A typical method of treating film is to pas the film over a grounded metal cylinder above which is located a sharp-edged, high-voltage electrode spaced so as to leave a small air gap between the film and the electrode. The corona discharge oxidizes the film, forming polar groups on vulnerable sites, increasing the surface energy and making the film receptive to inks, etc.

*See also flame treating.*

**Corona, internal** *n.* In electrical cable, fault due to ionization of air between conductor and insulation.

**Corona resistance** *n.* Ability of a material to withstand the effects of corona discharge.

**Correlated** *n.* Different types of merchandise systematically related in color and design, as wallpaper with a fabric, or a group of papers designed to be used together.

**Correlated color temperature** Term used to describe the color of "white" light sources. Specifically, it is the temperature of the Planckian (black body) radiator, which produces the chromaticity most similar to that produced by the light source in question. The temperature is expressed in degrees on the absolute or Kelvin scale, or in mireds (micro-reciprocal degrees), $10^6$/T.

*See color temperature.*

**Correlation** *n.* Relationship, degree of association, or index of prediction between two scores or sets of data. Measures the tendency of one score or set of data to vary concomitantly with the other (e.g., the tendency of students with high IQ to be above average in reading ability). The existence of a strong relationship – i.e., a high correlation – between two variables does not necessarily indicate that one has any causal influence on the other. Usually expressed as a decimal coefficient between −1.00 and +1.00 (Pearson v), where −1.00 indicates a perfect negative relationship, 0 indicates no relationship, and +1.00 indicates a perfect positive relationship. The Pearson v coefficient of correlation can assume any value on a continuum between −1.00 and +1.00.

**Corrosion** \kə-ˈrō-zhən\ [ME, fr. LL *corrosion-*, *corrosio* act of gnawing, fr. L *corrodere*] (14c) *n.* The deterioration of metal or of concrete by chemical or electrochemical reaction resulting from exposure to weathering, moisture, chemicals, or other agents in the environment in which it is placed. Corrosion. National Association of Corrosion Engineers, Houston, TX. Uhlig HH (1971) Corrosion and corrosion control. John Wiley and Sons Inc., New York. Uhlig HH (1948) Corrosion handbook. John Wiley and Sons Inc., New York.

**Corrosion barriers** *n.* A broad term applying to the ability of plastics to resist many environments, but in particular, attack by acids, bases, and oxidants.

**Corrosion coating** *See chemical conversion coating.*

**Corrosion fatigue** *n.* Reduction by corrosion of the ability of a metal to withstand cyclic or repeated stresses.

**Corrosion-inhibiting paint** *See anti-corrosion paint or composition.*

**Corrosion-inhibitive pigment** *n.* A pigment which when made into a paint has the property of minimizing corrosion of the substrate to which it is applied.

**Corrosion inhibitor** *n.* Any of a number of materials used to prevent the oxidation of metals; may be a coating applied to the surface, a paint undercoat, an additive or an element alloyed with the metal.

**Corrosion potential** *n.* Potential that a freely corroding metal or alloy exhibits in a particular solution.

**Corrosion rate** *n.* Speed at which a metal or alloy is wasted away because of corrosion.

**Corrosion resistance** *n.* A broad term applying to the ability of plastics to resist many environments, but in particular, attack by acids, bases, and oxidants.

*See acid resistance, alkali resistance, artificial weathering, chemical resistance, deterioration, permanence, solvent resistance, stain resistance, sulfide straining, light resistance, volatile loss, and weathering.*

**Corrugation mark** *n.* A fabric defect consisting of a crimped, rippled, wavy, pebbled, or cockled area in the fabric spoiling the uniformity of the texture.

**Corundum** \kə-ˈrən-dəm\ [Tamil *kuruntam*; akin to Sanskrit *kuruvinda* ruby] (1804) *n.* Natural aluminum oxide (including many gemstones), extremely hard, used as a filler in plastics to impart hardness, heat resistance, and abrasion resistance.

**Corvic** Poly(vinyl chloride). Manufactured by ICI, Great Britain.

**Cosanic acids** *n.* A series of fatty acids beginning with eicosanic acid ($C_{20}H_{40}O_2$) and ending with nanacosanic acid ($C_{29}H_{58}O_2$), each acid differing from its predecessor by one $CH_2$ group.

**Cosmic rays** *n.* Highly penetrating radiations which strike the earth, assumed to originate in interstellar space. They are classed as: primary, coming from the assumed source, and secondary, those induced in upper atmospheric nuclei by collision with primary cosmic rays.

**Cosmotron** A particle accelerator capable of given them energies to billions of electron volts.

**Cosolvent** *See coupling agent.*

**COT** *n.* The covering material used on various fiber-processing rolls, especially drawing rolls. Leather, cork, rubber, and synthetic materials are frequently employed.

**Cottage steamer** *n.* A chamber used for batch steaming of printed or dyed textiles. Cloth is looped on "poles" on a special cart, which fits into the steamer for processing.

**Cotton** *n.* Staple fibers, surrounding the seeds of various species of Gossypium.

**Cotton count** *n.* The yarn numbering system based on length and weight originally used for cotton yarns and now employed for most staple yarns spun on the cotton, or short-staple, system. It is based on a unit length of 840 yards, and the count of the yarn is equal to the number of 840-yard skeins required to weigh 1 pound. Under this system, the higher the number, the finer the yarn.

*Also see yarn number.*

**Cotton fiber** *n.* A unicellular, natural fiber composed of almost pure cellulose. As taken from plants, the fiber is found in lengths of 3/8 to 2 in. For marketing, the fibers are graded and classed for length, strength, and color.

**Cotton-free** *See dust-free.*

**Cotton-free dry** *See dust-free.*

**Cotton linters** *See linters.*

**Cottonseed oil** *n.* A semidrying oil obtained from the seeds of many types of plants of the genus, *Gossypium*. Its main constituent acids are linoleic (46%), palmitic (29%) and oleic (24%). As oil, it is rarely used in paint, but its fatty acids are used in the manufacture of alkyd resins.

*See Becchi–Millian test.*

**Cottonseed pitch** *See stearine pitch.*

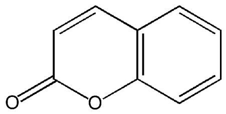
**Cotton system** *n.* A process originally used for manufacturing cotton fiber into yarn, and now also used extensively for producing spun yarns of manufactured fibers, including blends. Processing on the cotton system includes the general operations of opening, picking, carding, drawing, roving, and ring or mule spinning in the production of carded yarns. For combed yarns, three steps, culminating in combing, are included after the carding operation. There have been many modifications of this process, especially in recent years for the so-called “long draft”, or “Casablancas”, system. The cotton system is also proving to be the basis of many hybrid systems for handling wool yarns and for manufacturing other long-staple yarns.

**Couette flow** *n.* Shear flow in the annulus between two concentric cylinders, one of which is usually stationary while the other turns. By measuring the relative rotational velocity and the torque required to maintain steady flow, one can infer the viscosity of the liquid. Flow in the metering section of a single-screw extruder resembles Couette flow, modified by the presence of the flight and, normally, by the pressure rise along the screw.
*See rotational viscometer.*

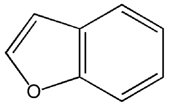
**Coulomb (C)** \ˈkü-ˌläm\ [Charles A. de *Coulomb*] (1881) *n.* (1) A quantity of electricity defined in the SI system as equal to a current of 1 A flowing for 1 s, i.e., 1°C = 1 A/s. (2) Before SI, the quantity of electricity that must pass through a circuit to deposit 0.0011180 g of silver from a solution of silver nitrate. (3) The quantity of electricity on the positive plate of a 1 F capacitor when the potential difference between the plates is 1 V.

**Coulomb’s law** *n.* (1854) The force of attraction or repulsion acting along a straight line between two electric charges is directly proportional to the product of the changes and inversely to the square of the distance between them.

**Coumarin** \ˈkü-mə-rən\ [F *coumarine*, fr. *coumarou* tonka bean tree, fr. S or P; S *cumarú*, fr. P, fr. Tupi *kumarú*] (1830) (cumarin) *n.* A dual-ring aromatic ketone, $C_9H_6O_2$, the sweet-smelling constituent of white clover, also produced synthetically. It is sometimes copolymerized with styrene to increase the deflection temperature above that of polystyrene (*See image*).



**Coumarone** (2,3-benzofuran, cumarone) *n.* $C_8H_6O$. Bicyclic ring compound. Parent substance for the coumarone resins. Properties: colorless liquid, aromatic odor; Sp gr of 1.078; mp of −18°C (−0.4°F); p of 177°C (351°F); insoluble in water; soluble in alcohol and ether; derived from the coal tar naphtha fraction boiling between 150 and 200°C (302–392°F), and having the structure as shown in the image. Syn: benzofuran and cumarone.
*See coumarone-indene resins.*



**Coumarone-indene resin** *n.* Any of a family of resins produced by polymerizing a coal-tar naphtha containing coumarone and indene. The naphtha is first washed with sulfuric acid to remove some impurities, then is polymerized in the presence of sulfuric acid or stannic chloride as a catalyst. Remaining impurities determine the quality of the resin, which can range from a clear, viscous liquid to a dark, brittle solid. Coumarone-indene resins have no commercial applications when used alone, but are used primarily as processing aids, extenders, and plasticizers with other resins and with rubbers.

**Coumarone-indene resin (Cumar)** *n.* Coal tar resins; indene resins; polycoumarone resins; polyindene resins. Resins obtained by heating mixtures of coumarone and indene (such as those that occur in the light-oil fraction from coal-tar refining) with sulfuric acid, so as to cause polymerization to thermoplastic materials with softening points of up to about 150°C (302°F). Properties: these vary from fairly viscous liquids to hard resins; color – pale yellow to nearly black; Sp gr of 1.05–1.10; soluble in hydrocarbon solvents, pyridine, acetone, carbon disulfide, and carbon tetrachloride; insoluble in water and alcohol. Used as components in aluminum paints, concrete curing compounds, pipe oils, rubber compounding, adhesives, chewing gum, printing inks, floor tile binding, and phonograph records.

**Coumarone resins** *n.* Any of the group of thermosetting resins derived by the polymerization of mixtures of coumarone and indene.

**Count** *n.* (1) A numerical designation of yarn size indicating the relationship of length to weight. (2) The number of warp yarns (ends) and filling yarns (picks) per inch in a woven fabric, or the number of wales and courses per inch in a knit fabric. For example, a fabric count of 68 × 52 indicates 68 ends/in. in the warp and 52 picks/in. in the filling.

*Also see yarn number.*

**Counter-current** *n.* Process used in many industries in which material to be dried or extracted is caused to flow against the stream of drying agent or extracting liquid. A typical example is the tunnel drying of pigments. Here the wet filter press cakes and the stream of hot air enters the tunnel from opposite ends. The driest air meets the practically dry pigment so that all moisture is removed. By the time the air has reached the other end, contact with the wet pigment insures that the maximum amount of moisture has been removed by the air stream.

**Counterion** \ˈkaun-tər-ˌī-ən, -ˌän\ (1940) *n.* An ion with a charge which is opposite in sign to that of some ion under consideration.

**Counterions** *n.* The oppositely charged component of *n* electron pair; each ion at $Na^+$ has a counter ion $Cl^-$ when AnCl dissolves in water; the oppositely charged ion accompanying an ionic initiated polymerization reaction.

**Country tar** *See pine tar and kiln burned.*

**Couple** \ˈkə-pəl; "*couple of*" *if often* ˌkə-plə\ [ME, pair, bond, fr. OF *cople*, fr. L *copula* bond, fr. *co-* + *apere* to fasten] (13c) *n.* Two equal and oppositely directed parallel but not collinear forces acting upon a body to form a couple. The moment of the couple or torque is given by the product of one of the forces by the perpendicular distance between them. Dimension $[M L^2 T^{-2}]$.

**Couple acting on a magnet** *n.* Magnetic moment *ml* in a field of strength *H*. If the magnet is perpendicular to the direction of the field

$$C = Hml = HM$$

if the angle between the magnet and the field is $\theta$

$$C = Hml \sin \theta.$$

The couple will be in dyne-cm for cgs electromagnetic units of *H*, *m*, and *l*.

**Coupling** *n.* The linking of a side effect to a principal effect. For composites an anisotropic laminate couples the shear to the normal components, while an unsymmetric one couples curvature with extension. Poisson coupling links lateral contraction to axial extension. The joining together of two or more polymer molecules, which contain terminal chemically reactive groups, by reaction with a third, usually small, molecule capable of reaction with the polymer functional groups which are normally the same.

**Coupling agent** *n.* A chemical capable of reacting with both the reinforcement and the resin matrix of a composite material to form or promote a stronger bond at the interface. The agent may be applied from the gas phase or a solution to the reinforcing fiber, or added to the resin, or both. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

*Also called mutual solvent or cosolvent. See also silane coupling agent, titanate coupler, and adhesion promoter.*

**Coupon** *n.* A representative specimen of a material or sheet product, cut from the product and set aside for testing.

**Courlene** *n.* Poly(ethylene) (fiber), manufactured by Courtaulds, Great Britain.

**Courlene PY** *n.* Poly(propylene) (fiber), manufactured by Courtaulds, Great Britain.

**Course** *n.* The row of loops or stitches running across a knit fabric, corresponding to the filling in woven fabrics.

**Courtelle** *n.* Poly(acrylonitrile). Manufactured by Courtaulds, Great Britain.

**Covalent bond** *n.* A bond that results from sharing electrons (e.g., $H_2O$).

**Covalent solid** *n.* A solid in which atoms are bonded covalently to form a giant extended network.

**Cove ceiling** *n.* A ceiling, which is rounded where it meets the wall.

**Covellite** \kō-ˈve-ˌlīt\ [F *covelline*, fr. Niccolò *Covelli* † 1829 Italian chemist] (1850) *n.* *See copper blue.*

**Cover** *n.* (1) The degree of evenness of thread spacing. (2) The degree to which underlying structure is concealed by the surface material, as in carpets, the degree to which pile covers backing. (3) The ability of a dye to conceal defects in fabric.

**Coverage** *n.* (1) Spreading rate generally expressed in $ft^3$/gal or $m^2$/l. In pigmented coatings, it is related to hiding power. In clear coatings, it refers to the area coated at a desired film thickness. (2) Description of the amount of paint per unit area, which must be applied to achieve a specified contrast ratio. (3) The surface area covered by a given quantity of ink or coating material. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978.

*See mileage and hiding power.*

**Cover factor** *n.* The fraction of the surface area that is covered by yarns assuming round yarn shape.

**Covering power** *n.* (1) Term used occasionally in the paint industry as synonymous with hiding power but which actually has no precise meaning. (2) The ability of an ink to hide the material beneath (substrate) and to produce a uniform, opaque surface. *Also see opacity.*

**Coverstock** *n.* A lightweight non-woven material used to contain and conceal an underlying core material. Examples are the facing materials that cover the absorbent cores of diapers, sanitary napkins, and adult incontinence products.

**Covert** *n.* A medium weight to heavyweight wool or wool blend cloth woven with a steep twill from two or more shades of yarn-dyed fibers to produce a mottled or mélange effect.

**Cowoven fabric** *n.* In aerospace textiles, a fabric in which a reinforcing fiber and a matrix fiber are adjacent to each other as one end in the warp and/or filling direction.

**CP** *n.* (1) Abbreviation for cellulose propionate. (2) Abbreviation for chemically pure, a designation for laboratory chemicals now largely superseded by *analytical reagent*.

*See cellulose acetate propionate.*

**cP** *n.* Abbreviation for the deprecated but still widely used viscosity unit, centipoise.

**CPE** *n.* Abbreviation for chlorinated polyethylene.

**CPET** *n.* Abbreviation for crystalline polyethylene tere-phthalate.

**CPVC** *n.* (1) Abbreviations for chlorinated poly(vinyl chloride). (2) In the paint industry, abbreviations for critical pigment concentration, a source of confusion often encountered in the paint and color literature.

**CR** *n.* Abbreviation for chloroprene rubber (British Standards Institution).

*See neoprene.*

**Cr** *n.* Chemical symbol for the element chromium.

**CR** *n.* Poly(chloroprene).

**CR-39** *n.* Abbreviation for "carbonate resin 39".

*See diethylene glycol BIS-(allyl carbonate).*

**Crab** *n.* A hand device used to stretch carpets in a small area.

**Crabbing** *n.* The process of heating wool or hair fabrics, under tension, in a hot or boiling liquid, then cooling under tension, to provide the fabric with dimensional stability for further wet processing.

**Crack** *n.* A defect in a woven fabric consisting of an open fillingwise streak extending partly or entirely across the fabric.

**Cracking** *n.* (1) Generally, the splitting of a dry paint or varnish film, usually as a result of aging. The following terms are used to denote the nature and extend of this defect: *hair-cracking*. Fine cracks which do not penetrate the top coat; they occur erratically and at random, *checking*, Fine cracks which do not penetrate the top coat and are distributed over the surface, giving the semibalance of a small pattern. *Cracking*. Specifically, a breakdown in which the cracks penetrate at least one coat and which may be expected to result ultimately in complete failure. *Crazing*. Resembles checking, but the cracks are deeper and broader. *Crocodilian* or *ligaturing*. A drastic type of crazing, producing a pattern resembling the hide of a crocodile. (2) The process of breaking down certain hydrocarbons into simpler ones of lower boiling points, by means of excess heat, distillation under pressure, etc., in order to give a greater yield of low boiling products than could be obtained by simple distillation. (3) Cracking is also the treatment of rubber, uncured and cured, by passing it through moving corrugated rolls, as in preparing tires and other vulcanized rubber for reclaiming. Hare CH (2001) Paint film degradation – mechanisms and control. Steel Structures Paint Council, Pittsburgh, PA. Koleske JV (1995) Paint and coating testing manual. American Society for Testing and Materials, Philadelphia, PA. Hess M (1965) Paint film defects. John Wiley and Sons Inc., New York.

**Cracking resistance** *n.* The ability of a coating to resist breaks of the film where the breaks extend through to the surface painted and the underlying surface is visible. The use of a minimum magnification of 10 diameters is recommended in cases where it is difficult to differentiate between cracking and checking.

*See cracking and checking resistance.*

**Crackle finish** *n.* Finish resulting from applying a top coat designed to shrink and crack and expose a more flexible undercoat, usually of a different color.

**Crackle varnish** Clear protective top coat applied over a crackle finish.

**Crack mark** *n.* A sharp break or crease in the surface of a coated or laminated fabric.

**Crack stopper** A method or material used or applied to delay the propagation of a potential or existing crack. Techniques include drilling of holes, installing a load-spreading doubler, or including in the design an interruption in part continuity.

**Crammer-feeder** (force feeder) *n.* A device fitted to the inlet port of an extruder that precompacts a low-density feedstock and propels it into the feed section of the extruder screw. As originally produced by Prodex Corp (now a division of HPM), the crammer-feeder consisted of a conical shell within which turned a decreasing-diameter screw driven independently of the extruder.

**Crash** *n.* A course fabric with a rough, irregular surface made from thick, uneven yarns.

**Crater** *n.* A small, shallow surface imperfection.

**Cratering** *n.* Formation of small bowl-shaped depressions in a paint or varnish film that may or may not expose the underlying surface.

**Crawl** Shrinkage of milled and calendered stock after removal from rolls.

**Crawling** *n.* (1) Defect in which a wet paint or varnish film recedes from small areas of the surface, leaving them apparently uncoated. British synonym is cissing. (2) The contraction of an ink film into drops after printing on a surface, which the ink does not wet completely.

**Crawl space** *n.* A shallow, unfinished space beneath the first floor of a house which has no basement, used for visual inspection and access to pipes and ducts. Also, a shallow space in the attic, immediately under the roof.

**Crayon** *n.* A small stick of pigment in oil or wax. Usually covered with paper for ease of handling. Certain crayons contain water-soluble dyes and are prepared in an aqueous medium.

**Crazing** *n.* An undesirable defect in plastics articles characterized by distinct surface cracks or minute frost-like internal cracks, resulting from stresses within the article that exceed the tensile strength of the plastic. Such stresses may result from molding shrinkage, or machining, flexing, impact shocks, temperature changes, or the action of chemicals and solvents. Hare CH (2001) Paint film degradation – mechanisms and control. Steel Structures Paint Council, Pittsburgh, PA. Koleske JV (1995) Paint and coating testing manual. American Society for Testing and Materials, Philadelphia, PA.

*See also stress cracking.*

**Creaming of emulsion** *n.* Separation of an emulsion into two layers of different concentration. The more concentrated top layer, i.e., the layer containing the greatest number of dispersed droplets per volume, has a creamy appearance. Gentle agitation of the two layers often effects uniformity of the emulsion.

**Crease** *n.* A break or line in a fabric generally caused by a sharp fold. Creases may be either desirable or undesirable, depending upon the situation. A crease may be intentionally pressed into a fabric by application of pressure and heat and sometimes moisture.

**Crease recovery** *See wrinkle recovery.*

**Crease resistance** *n.* Term used to indicate the capacity of a fabric to resist and/or to recover from, creases incidental to its usage.

**Crease retention** *n.* The ability of a fabric to maintain an inserted crease. Crease retention can be measured subjectively or by the relation of a crease in a subsequent state to the crease in the initial state. Crease retention may be strongly dependent on the conditions of use, e.g., normal wear, washing or tumble-drying.

**Creel** \ˈkrē(ə)l\ [ME *creille*, *crele*] (14c) *n.* The spool and its supporting structure on which continuous strands or rovings of reinforcing material are would for use in the filament-winding process.

**Creeling** *n.* The mounting of supply packages in a creel to feed fiber to a process, i.e., beaming or warping.

**Creep** \ˈkrēp\ [ME *crepe*n, fr. OE *crēopan*; akin to ON *krjūpa* to creep] (before 12c) *vt.* Due to its viscoelastic nature, a plastic subjected to a load for a period of time tends to deform more than it would from the same load released immediately after application. The degree of this deformation increases with the duration of the load and with rising temperature. Creep is the permanent deformation resulting from the prolonged application of a stress below the elastic limit. This deformation, after any time under stress is partly recoverable (*primary creep*) upon the release of the load and partly unrecoverable (*secondary creep*). Creep at room temperature is sometimes called *cold flow.* Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Rosato DV (ed) (1992) Rosato's plastics encyclopedia and dictionary. Hanser-Gardner Publications, New York.

*See also andrade creep, delayed deformation, drift, cold flow, compression set, tension set, and strain relaxation.*

**Creeping** *n.* Spontaneous spreading of a liquid on a surface. In the case of an applied film of paint, varnish or lacquer, it refers to the spread of the wet film beyond the area to which it was applied.

**Creep modulus** *n.* The total deformation measured at constant load over a period of time divided into the applied stress. Creep modulus, if known, simplifies some plastic part designs by allowing the designer to use standard formulas for deformation in which the creep modulus, for the expected service life under load, replaces the conventional, short-time modulus.

**Creep rubber** *n.* Natural rubber of a pale- to dark amber color prepared by coagulating natural-rubber latex with acid, then milling this coagulum into sheets. The other basic form of solid natural rubber (i.e., ribbed sheet) is prepared by drying the latex on rolls in the presence of smoke.

**Creep rupture** *n.* The rupture of a plastic under a continuously applied stress that is less than the short-time strength. This phenomenon is caused by the viscoelastic nature of plastics. Creep-rupture tests are generally conducted over a series of loads ranging from those causing rupture within a few minutes to those requiring several years or more.

**Creep strength** *n.* The initial stress at which failure occurs after a measured time under load. Thus, creep strength (at any temperature) must be labeled with the time to failure. Like creep modulus, creep strength is useful to designers for applications in which plastic articles or members will carry sustained loads.

**Cremnitz white** *See carbonate white lead.*

**Crenular cross section** *See cross section.*

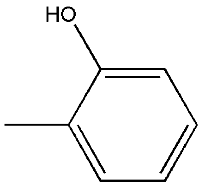
**Crepe** \ˈkrāp\ [F *crêpe*] (1797) *n.* A lightweight fabric characterized by a crinkling surface obtained by the use of:

(1) hard-twist filling yarns, (2) chemical treatment, (3) crepe weaves, and (4) embossing.

**Crepe rubber** *n.* A type of crude or sometimes synthetic rubber pressed into crinkled sheets.

**Cresol** \ˈkrē-ˌsól\ [ISV, irreg. fr. *cresote*] (ca. 1869) (hydroxytoluene, methylphenol) *n.* $H_3CC_6H_4OH$. An important family of coal-tar derivatives, occurring in ortho, meta, and para isomers, and used in the production of phenol-formaldehyde resins and tricresyl phosphate, an important plasticizer for PVC. Three cresols are possible, namely: (a) *o*-cresol, mp 30°C; bp, 191°C; (b) *m*-cresol, mp 4°C; bp, 205°C; (c) *p*-cresol, mp 36°C; bp, 201°C, and these are found together in the crude cresylic acid from coal tar. The main use of the cresols is in the manufacture of cresol-formaldehyde resins, and cresylic acid, rich in the meta isomer, is usually chosen for this purpose.

*Known also as cresylic acid.*



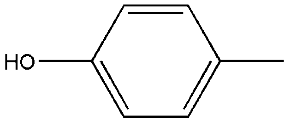
**Cresol resin** *n.* A phenolic-type resin obtained by condensing a cresol with an aldehyde.

**Cresote** *n.* Heavy, high boiling oil obtained from coal and wood tars. A major use for creosote is as a wood preservative, or as a base for the same. Syn: dead oil and pitch oil.

**Cresyl diphenyl phosphate (CDP)** *n.* $(H_3C\text{-}C_6H_4O)PO(C_6H_5O)_2$. A plasticizer for cellulosics, vinyl chloride polymers and copolymers, with a high degree of flame resistance and good low-temperature properties. It is also acceptable for use in food-packaging films. It is most often used, in low percentages of the total plasticizer, as a flame retardant.

**Cresylic acid** *n.* A term sometimes applied to mixture of *o*-, *m*-, and *p*-cresol, which are mildly acidic, but also including wider fractions of phenolic compounds derived from coal tar or petroleum that contain xylenols and other higher-boiling phenols in addition to the cresols. It is used in the production of phenolic resins and tricresyl phosphate.

*See cresol* (*See image*).



**Cretonne** \ˈkrē-ˌtän\ [F, fr. *Creton*, Normandy] (1870) *n. See chintz.*

**Crevice corrosion** *n.* Corrosion which occurs within an adjacent to a crevice formed by contact with another piece of the same or another metal or with a non-metallic material. When this occurs, the intensity of attack is usually more severe than on surrounding areas of the same surface.

**Crimp** *n.* The waviness of a fiber. It determines the capacity of fibers to cohere under light pressure. Crimp is measured by either the number of crimps or waves per unit length or by the decrease in length upon crimping directed by the uncrimped length, expressed as a percent. (2) The difference in distance between two points on an unstretched fiber and the same two points when the fiber is straightened under specified tension. Crimp is expressed as a percentage of the unstretched length. (3) The difference in distance between two points on a yarn as it lies in a fabric and the same two points when the yarn has been removed from the fabric and straightened under specified tension, expressed as a percentage of the distance between the two points as the yarn lies in the fabric.

**Crimp amplitude** *n.* The height of displacement of the fiber from its uncrimped condition.

**Crimp deregistering** *n.* The process of opening a tow band by causing the peaks and valleys of the crimp to lay randomly rather that uniformly.

**Crimped yarn** *See textured yarns* (4).

**Crimp energy** The amount of work required to uncrimp a fiber.

**Crimp frequency** The crimp level, or number of crimps per inch in yarn or tow.

**Crimping** The process of imparting crimp to tow or filament yarn.

**Crimp setting** *n.* An after treatment to set the crimp in yarn or fiber. Usually heat and steam are used, although the treatment may be chemical in nature.

**Crimson antimony** Syn: antimony vermillion.

**Crimson lake** *n.* Pigment derived from cochineal by precipitating the extract with aluminum and tin salts. It has a deep blue-red color. Alternative name is Florentine lake.

**Crimson toner** *n.* Azo pigment produced by coupling 4-aminotoluene-3-sulfonic acid with *β*-oxynaphthoic acid, followed by conversion to the calcium lake.

**Crinkle** *n.* (1) A wrinkled or puckered effect in fabric. It may be obtained either in the construction or in the finishing of the fabric. (2) The term is sometimes incorrectly used to describe the crimp of staple fiber.

**Crinkle finish** Syn: ripple finish.

**Crinkle yarn** *See textured yarns.*

**Crinkling** *See wrinkling.*

**Crinoline** \ˈkri-nᵊl-ən\ [F, fr. I *crinoline*, fr. *crino* horsehair (fr. L *crinis* hair) + *lino* flax, linen, fr. L *linum*] (1830) *n.* A stiff, heavily sized fabric used as an interlining or to support areas such as the edge of a hem.

**Critical angle (C)** (1873) *n.* The angle at which total reflection of a light ray passing from one medium to another occurs. The angle of incidence must be large (55–60°).

**Critical conversion** *n.* The degree of reaction at which the molecular weight distribution curve first extends into the region of infinite molecular weight; gelation occurs after *critical conversion* and before the *upper limit of conversion.*

**Critical damping** *n.* In a damped vibrating system, damping so strong that the system, when displaced from rest, returns to rest in one-half cycle. Compare logarithmic decrement.

**Critical length** *See breaking length.*

**Critical mass** (1964) *n.* The minimum mass the fissile material must have in order to maintain a spontaneous fission chain reaction. For pure $U^{235}$ it is computed to be about 20 pounds.

**Critical micelle concentration (CMC)** *n.* The point beyond which the concentration of single molecules of surfactants remains relatively constant. Much more surfactant may be dissolved to produce clear solutions, but the added increments form micelles in the solution instead of appearing as individual molecules.

**Critical miscibility temperature** *See flory temperature.*

**Critical pigment volume concentration (CPVC)** *n.* That level of pigmentation, PVC, value in the dry paint, where just sufficient binder is present to fill the voids between the pigment particles. At this level, a sharp break occurs in film properties such as scrub resistance, hiding, corrosion resistance, ease of stain removal, etc. Different requirements for each product would dictate different PVC or CPVC ratios. Ceiling paints, for instance, are not required to be very washable and can be formulated at or above CPVC, whereas gloss paints and many exterior formulations are designed well below their CPVC, where CPVC has no significance. CPVC has significance only in flat paints.

**Critical point** (ca. 1889) *n.* The temperature and pressure above which the liquid and gaseous states become indistinguishable.

**Critical relative humidity** *n.* The relative humidity at which the phase transition from the crystalline particle to the liquid droplet occurs.

**Critical shear stress** *n.* In extrusion, the shear stress in the melt at the die wall that signals the onset of melt fracture. The stress is on the order of 0.1–0.4 MPa.

**Critical strain** *n.* In a strength test, the strain at the yield point.

**Critical surface tension** *n.* The value of the surface tension of a liquid, $\gamma_c$, below which a drop of the liquid will wet and spread, forming a zero contact angle on a substrate whose surface energy is characterized by $\gamma_c$. This property is positively correlated with a polymer's solubility parameter.

*See also surface tension and solubility parameter.*

**Critical temperature** *n.* That temperature above which a gas cannot be liquefied by pressure alone. The pressure under which a substance may exist as a gas in equilibrium with the liquid at the critical temperature is the *critical pressure.*

**Crocheting** *n.* The interlocking of loops from a single thread with a hooked needle. Crocheting can be done either by hand or by machine.

**Crocidolite** \krō-ˈsi-dᵊl-ˌīt\ [Gr *Krokydolith*, fr. Gk *krokyd-*, *krokys* nap on cloth (akin to Gk *krekein* to weave) + Gr *–lith* –lite] (1835) *n.* Blue asbestos (Mineral Riebeckite).

*See asbestos.*

**Crocking** *n.* (1) *See bleeding.* (2) Physical transfer of color from one material to another. In ASTM D 1593, a test for resistance to crocking of flexible films subject the test film to rubbing with a 5-cm square of white cotton cloth.

**Crocking** *n.* (1) Removal of color on abrasion or rubbing. (2) Smudging, or rubbing off, of ink. (3) Color pigment in rubber which may not appear on the surface as a bloom but which will rub off and discolor an adjacent surface. (4) Staining of a white cloth by rubbing lightly over a colored surface.

**Crocodiling** *See cracking.*

**Crocoisite, crocolite, crocoite** Native lead chromate mineral of red color.

**Crocus abrasive** Either synthetic or natural iron oxide, crocus is the basis of the rouge used in many fine polishing and buffing operations. It is very soft, approximately 6 on the Mohs scale, bright red, and contains a small amount of silicon dioxide.

**Crocus cloth** *n.* An iron-oxide coated abrasive cloth, used as a polishing agent after most of the work has been done with emery or aluminum oxide, capable of giving a mirror-like finish to metal.

**Crofon** *n.* Optical fibers from polymethyl methacrylate and polyethylene, manufactured by DuPont, USA.

**Crooked cloth** *See baggy cloth.*

**Cross coating** *n.* Application of a coat of paint by a series of strokes or spray passes, each at right angles to the previous series.

**Cross direction** *n.* The width dimension, within the plane of the fabric, that is perpendicular to the direction in which the fabric is being produced by the machine.

*See machine direction.*

**Cross dyeing** *See dyeing.*

**Cross-flow quency** *n.* In cooling extruded polymer filaments, refers to cooling air directed from one side cross the path of the filaments. There may be some type of suction on the opposite side to remove the heated air.

**Cross grain** A pattern in which the fibers and other longitudinal elements deviate from a line parallel to the sides of the piece. Applies to either diagonal or spiral grain or a combination of the two.

**Crosshead** *n.* (1) A device that receives a molten stream of plastic emerging from an extruder, diverts the flow to a direction usually 45° or 90° from the axis of the extruder, and forms the extrudate to a shape such as a parison for blow molding or a jacket around a wire. An essential element of the crosshead is the mandrel, a tubular core with grooves of various shapes and held in place by a perforated plate, web, or spider legs. Material emerging from the space between the mandrel and the crosshead housing is given its final shape by means of a die mounted on the end of the crosshead. (2) The moving member of a testing machine.

**Crosshead die** *See crosshead.*

**Crossing** *n.* Method of obtaining even distribution of paint by means of a brush whereby the direction of brushing each series of strokes lies at right angles to that of the previous series.

**Cross laminate** *n.* A laminate in which the direction of greatest strength in some layers is perpendicular to that direction in other layers. A simple example is a laminate in which alternate layers contain unidirectional reinforcing fibers laid in perpendicular directions.

*See laminated, cross.*

**Cross-linked polymerization** *n.* A bond, atom, or group linking the chains of atoms in a polymer, protein, or other complex organic molecule.

**Cross-linked polymers** Polymers in which linear polymer chains are joined together by covalent chemical bonds.

**Cross-linking** *n.* Applied to polymer molecules, the setting up of chemical links among the molecular chains. When extensive, as in most cured thermosetting resins, cross-linking creates one infusible supermolecule from all the chains. Cross-linking can also occur between polymer molecules and other substances. For example, polyethylene can be cross-linked with carbon-black particles, which have sites to which polyethylene chains can link in the presence of a catalyst. The mixture of resin, filler, and catalyst can be molded as a thermoplastic, then transformed to a thermoset by cross-linking in the curing cycle. Cross-linking can be achieved by irradiation with high-energy electron beams, or by means of chemical cross-linking agents such as organic peroxides. The amount of cross-linking may be expressed in *x*-links per molecular weight or mass between *x*-links, weight between *x*-links sometimes referred to as cross-link density. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Elias HG (1977) Macromolecules, vols 1–2, Plenum Press, New York.

**Cross-linking agent** *n.* A substance that promotes or regulates intermolecular covalent bonding between polymer chains.

**Cross-linking agents (curing agents)** *n.* An additive used with a polymer in order to bring about cross-linking. In rubber technology, the cross-linking agents used are vulcanization ingredients (sulfur, peroxide, etc.). For thermosetting plastics, the cross-linking agents (hardeners) are amines or anhydrides for epoxy resins, or peroxides for unsaturated polyesters.

**Cross-linking index** *n.* The number of cross-linked units per primary polymer molecule, averaged over the whole specimen.

**Cross-linking** *n.* The stabilization of cellulosic or manufactured fibers through chemical reaction with certain compounds in such a way that the cellulose or manufactured polymer chains are bridged across or "cross-linked". Cross-linking improves such mechanical factors as wrinkle resistance. Random cross-linking in manufactured polymers is undesirable and leads to brittleness and loss of tensile strength.

**Crossply** *n.* A layer containing reinforcing fibers mainly running in one direction and perpendicular to the main fiber direction in adjacent layers.

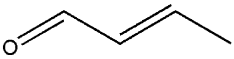
*See also cross laminate.*

**Cross section** (nuclear cross section) *n.* A measure of the probability of a particular process. The nuclear cross section is expressed by $a/bc$, where $a$ is the number of processes occurring, $b$ the number of incident particles, and $c$ the number of target nuclei/$cm^3$. There are nuclear cross sections for fusion, for slow neutron capture, for Compton collision, and for ionization by electron impact.

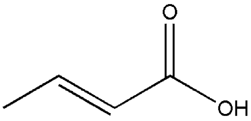
**Cross stitch** *See pinhole.*

**Cross termination** *n.* In free radical copolymerization, termination by reaction of two radicals terminated by monomer units of the opposite type, i.e., $\sim A^* + \sim B^* \rightarrow$ termination, by combination or disproportionation with rate constant $k_{AB}$. Cross-termination is often favored over termination by reaction between two like radicals due to polar effects.

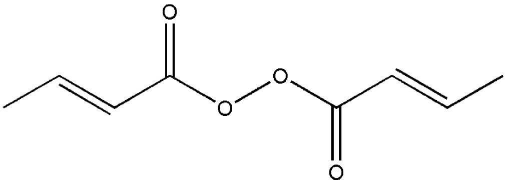
**Crotonaldehyde** A colorless liquid synthesized by the aldol condensation of acetaldehyde, accompanied or followed by dehydration. It can be polymerized by triethylamine to a resin with film-forming properties, or copolymerized with many compounds. Other uses include solvent for PVC, short-stopped in the polymerization of vinyl chloride, and plasticizer synthesis.



**Crotonic acid** (*trans*-2-butenoic acid, *trans*-$\beta$-methacrylic acid) *n.* $CH_3$–CH=CHCOOH. A white crystalline solid prepared by the oxidation of crotonaldehyde. It forms copolymers with vinyl acetate, used as hot-melt adhesives. Esters of crotonic acid are used as plasticizers for acrylic and cellulosic plastics (*See image*).



**Crotonyl peroxide** *n.* A catalyst for the polymerization of vinyl and vinylidene halides.



**Crown** *n.* (1) Of a calender roll, a gradual, small increase in the diameter of a roll toward the center to compensate for the slight deflection due to bending of the roll under pressure. (2) The much ore convex surface of a transmission-belt pulley designed to keep the belt running in the center of the pulley.

**Crowsfeet** *n.* A fabric defect consisting of breaks or wrinkles of varying degrees of intensity and size, resembling bird's footprints in shape, and occurring during wet processing of fabrics.

**Crowsfooting** *n.* (1) Type of film defect where small wrinkles occur in a pattern resembling that of a crow's foot. (2) Type of crystallization on the surface of a varnish or paint film after exposure to the gas test. *See wrinkling. See gas checking.*

**Crude resinous liquid** *See tall oil.*

**Cryogenic** \ˌkrī-ə-ˈje-nik\ (1896) *adj.* Pertaining to very low temperatures, usually temperatures below about −150°C (123 K). Evaluations of plastics at cryogenic temperatures are conducted for potential space applications.

**Cryogenic finishing** *n.* Process by which a material is cryogenically tempered (deep freezing below −300°F). Cryogenic finishing relieves stress in the substrate, thus creating a more uniform micro-structure which extends the life of the material.

**Cryogenic grinding (freeze grinding)** *n.* Thermoplastics are difficult to grind to small particle sizes at ambient temperatures because they soften, cohere in lumpy masses, and clog screens. When chilled by dry ice, liquid carbon dioxide, or liquid nitrogen, thermoplastics can be finely ground to powders suitable for electrostatic spraying and other powder processes.

**Cryohydrate** *n.* The solid, which separates when a saturated solution freezes. It contains the solvent and the solute in the same proportions as they were in the saturated solution.

**Cryoscopy** *n.* Measurement of polymer molecular weight based on freezing point depression.

**Cryptometer** *n.* An instrument for measuring the hiding power or opacity of pigmented composition. It functions on the principle that a film or wedge of the paint is obtained with a uniformly varying thickness. By adjusting the instrumentation, the thickness of film necessary to obliterate can be determined.

**Crystal** *n.* A homogeneous solid having an orderly and repetitive three-dimensional arrangement of its atoms. Crystalline polymers are never wholly crystalline but contain some amorphous material and many crystallites. The "ideal crystal" is a homogeneous portion of crystalline matter, whether bounded by faces or not. Crystalline matter is matter that possesses a triperiodic structure on the atomic scale. It is characterized by discontinuous vectorial properties that give rise to "crystal planes" (1) crystal growth (faces); (2) cohesion (cleavage planes); (3) twinning (twin planes); (4) gliding (gliding planes); and (5) X-ray electron, or neutron diffraction ("reflecting" planes); all of which are parallel to the lattice planes. Hibbard MJ (2001) Mineralogy. McGraw-Hill Companies Inc., New York.

**Crystal lattice** *n.* The regular, repeating arrangement of particles (atoms, ions, and molecules) in a crystal.

**Crystalline** \ˈkris-tə-lən\ [ME *cristallin*, fr. MF & L; MF, fr. L *crystallines*, fr. Gk *krystallinos*, fr. *krystallos*] (15c) *adj.* A substance (usually solid but can be liquid) in which the atoms or molecules are arranged in a definite pattern that is repeated regularly in three dimensions. Crystals tend to develop forms bounded by definitely oriented plane surfaces that are harmonious with their internal structure. They may belong to any of six crystal systems: cubic, hexagonal, tetragonal, orthorhombic, monoclinic, or triclinic.

**Crystalline-amorphous structures** *n.* The typical form of crystalline polymers. Crystalline polymers contain a large number of crystallites, as well as devoids of crystallinity. Most plastics are amorphous at processing temperatures, many retaining this state under all normal conditions.

**Crystalline growth** *n.* (1) The expansion and development of a crystal. The process involves diffusion of the crystallizing material to special sites on the surface of the crystal, incorporation of the molecules into the surface at these sites, and diffusion of heat away from the surface of the crystal. (2) The transformation of disoriented molecules, usually of the same substance, to a higher state of order. This process generally occurs rapidly for small molecules; however, the process is slow for polymer molecules and is arrested at temperatures below the glass transition temperature. Hibbard MJ (2001) Mineralogy. McGraw-Hill Companies Inc., New York.

**Crystalline melting** *n.* The heating of an ordered, crystalline structure polymer above its melts, it behaves like an amorphous polymer in that the molecular configurations become random.

**Crystalline polymers** *n.* Polymers containing both crystalline and amorphous material.

**Crystalline silica** *See silica, crystalline.*

**Crystalline solid** A true solid, one with a regular internal structure.

**Crystallinity** *n.* (1) A state of molecular structure in some resins attributed to the existence of solid crystals with a definite geometric form. Such structures are characterized by uniformity and compactness. (2) The percentage of a polymer sample that has formed crystals. Crystallinity in polymers occurs in two stages: nucleation and growth of nuclei. In most materials, crystallinity forms from growing nuclei to produce reoccurring/repeating structures that form lattices throughout the material; polymers can be crystalline, semicrystalline or non-crystalline (amorphous); crystallinity in a polymer exhibits a distinct endothermic energy transition or melting event (destruction of lattice structure) whereas a non-crystalline polymer shows a glass transition event or just softening.

*See liquid-crystal polymer.*

**Crystallite** \ˈkris-tə-ˌlīt\ [Gr Kristallit, fr. Gk krystallos] (1805) *n.* A perfect portion of an ordinary crystal; that is, a portion with its atoms and molecules arranged in a lattice free of defects. Ordinary crystals are composed of large numbers of crystallites, which may or may not be perfectly aligned with one another.

**Crystallization** (for ink) *n.* (1) A condition in which a dried ink film repels a second ink which must be printed on top of it. (2) Lacquers containing materials, which crystallize out from the medium as the solvent evaporates. (3) Materials in which advantage is taken of the tendency of certain drying oils, notably tung oil, to “frost” or “crystallize” when dried under certain conditions. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds)(1993) Printing ink manual, 5th edn. Blueprint, New York.

**Crystallized polyethylene terephthalate (CPET)** *n.* PET resin to which a fractional percentage of nucleating agent has been added to encourage the development of crystallinity in extruded or molded products. The percent crystalline material is typically between 15 and 35, modulus and strength increase with crystalline content.

*See also polyethylene terephthalate.*

**Crystal polystyrene** *n.* Styrene homopolymer, which, through actually 100% amorphous, was so called because of its excellent clarity and the glitter of the early cube-cut pellets.

*See polystyrene.*

**Crystal structures** *n.* Homogeneous solids having an orderly and repetitive three-dimensional arrangement of its atoms.

**CS** *n.* Abbreviation for casein plastic.

**CSMA** Abbreviation for chemical specialties manufacturer association.

**CSR** Chlorosulfonated poly(ethylene).

**C-stage** *n.* The final stage in the reaction of certain thermosetting resins in which the material is relatively insoluble and infusible. Certain thermosetting resins in a fully cured adhesive layer are in this stage. Sometimes referred to as *Resite*.

*See also A-stage and B-stage.*

**CTA** *See cellulose triacetate.*

**CTFE resin** *See polychlorotrifluoroethylene.*

**Cu** Chemical symbol for the element copper (Latin: cuprum).

**Cube root color difference equation** *n.* Specific color difference equation. The following equations are those recommended by the CIE in 1967 for study:

$$L = 25.29G^{1/3} - 18.38,$$

where $G = 0.0010X + 1.05Y + 0.0004Z$,

$$a = K_a(R^{1/3} - G^{1/3}),$$

where $R = 1.1084X + 0.0852Y - 0.1454Z$ and $K_a = 105.0$ for $R < G$; $K_a = R > G$,

$$b = K_b(G^{1/3} - B^{1/3}),$$

where $B = 0.0062X + 0.0394Y + 0.8192Z$ and $K_b = 30.5$ for $B < G$; $K_b = 53.6$ for $B > A$,

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}.$$

The differences (Δ's) are calculated as sample minus standard. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

See color difference equations.

**Cubic** \ˈkyü-bik\ *adj.* (1) Having the appearance of a cube. (2) Of algebraic equations, containing the unknown to the power 3 and not higher. (3) Characterizing volume measure, as *cubic meter.* (4) The simplest of the six crystal systems, in which the three principal axes are mutually perpendicular and the atomic spacing is the same along all three.

**Cull** \ˈkəl\ [ME, fr. MF *cuillir*, fr. L *colligere* to bind together] (13c) *n.* (1) A rejected material or product. (2) In transfer molding, the material remaining in the transfer pot after the mold has been filled. A certain amount of cull is usually necessary for the operator to be confident that the cavity has been properly filled.

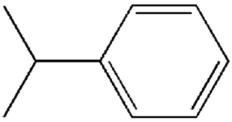
**Culture** *n.* (1) The process of securing the growth of fungi or other microorganisms upon artificial media. (2) The organisms resulting from the culturing process.

**Cultured stone** *n.* A term applied to decorative embedments of natural stones such as marble, granite, terrazzo, and slate in thermosetting resins. They are made by casting the resin, usually a polyester, in molds containing the stones. The embedments are used for counter tops, window sills, wall facings, flooring, giftware, etc.

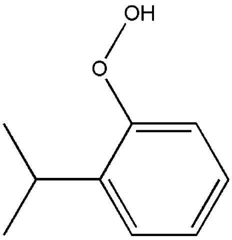
**Cumar gum** *n.* A synthetic resin, used in varnishes to provide alkali-resistance properties.

**Cumarone** *See coumarone.*

**Cumene** (isopropylbenzene, isopropylbenzol, cumol) *n.* $C_6H_5CH(CH_3)_2$. A volatile liquid in the alkyl-aromatic family of hydrocarbons. It is used as a solvent and intermediate for the production of phenol, acetone, and α-methyl styrene; and as a catalyst for acrylic and polyester resins. Properties: bp, 153°C; sp gr, 0.862/20°C; refractive index, 1.506. *Known also as isopropyl benzene* (*See image*).



**Cumene hydroperoxide** *n.* $C_6H_5C(CH_3)_2$-OOH. A colorless liquid derived from an oxidize solution or emulsion of cumene, used as a polymerization catalyst.



**Cumylphenol derivative** *n.* One of a group of polymer intermediates based on cumylphenol that offer higher performance at lower cost than nonylphenol competitors. The free phenol is an accelerator for amine hardeners of epoxy resins. Cumylphenyl acetate and the glycidyl ether are reactive in epoxy systems, giving enhanced strength. The benzoate of cumylphenol aids extrusion of PVC compounds.

**Cup** Efflux cup. *See ford cup.*

**Cup-flow test** *n.* A British standard test (B S 771) for measuring the flow properties of phenolic resins. A standard mold is charged with the specimen material and then closed under preset pressure. The time in seconds for the mold to close completely is the cup-flow index.

**Cupioni** A type of specialty or novelty yarn having slubs or enlarged sections of varying length.

**Cuprammonium rayon** *n.* A regenerated cellulose formed by dissolving cotton or wood-pulp linters in a solution of ammonia and copper oxide (from sulfate), then extruding the solution through spinnerets into warm water, where the filaments harden. The finest filaments (lowest denier) are made this way.

**Cupric sulfide** \ˈkyü-prink\ (1799) *adj. See copper blue.*

**Cuprous (copper) oxide** *n.* $Cu_2O$. Occurs in nature as the mineral, cuprite. Prepared commercially by furnace-reduction of a mixture of cupric oxide and copper. Used as a toxin in anti-fouling compositions.

**Curing** (1) In finishing fabrics, the process by which resins or plastics are set in or on textile materials, usually by heating. (2) In rubber processing, vulcanization. It is accomplished either by heat treatment or by treatment in cold sulfuryl chloride solution.

**Cup temperature** *n.* (1) In injection molding or extrusion, the measured temperature of a glob of melt collected at the injection nozzle or extrusion die in an insulated vessel and presumed to be equal to, or slightly less than, the average melt temperature leaving the machine. (2) (cup-mixing temperature, flow-average temperature In a flowing stream of fluid, the local product of velocity times temperature integrated over the stream cross section, said integral divided by the integral of the local velocity over the cross section. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Cup, weight per gallon** *n.* Brass cup with a volume of exactly 83.3 ml used for quickly determining the wt/gal (or density) of a finished liquid product. Koleske JV (1995) Paint and coating testing manual. American Society for Testing and Materials, Philadelphia, PA. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Curcas oil** *n.* A vegetable oil obtained from the seeds of *Jatropha curcas,* grown in

Central America, and in the Cape Verde Isles, the Comores Isles and in some of the former Portuguese colonies, Siam and the East Indies. The percentage fatty acids as triglycerides are oleic, 62%; linoleic, 19%, and saturated fatty acid, the remainder.

**Curdle** \ˈkər-dᵊl\ [frequentative of $^{2}$*curd*] (1590) *v.* Syn: is coagulation. *See also coagulation and congeal.*

**Cure** *n.* (1) To change the properties of a polymeric system into a final, more stable, usable condition by the use of heat, radiation, or reaction with chemical additives (ASTM). (2) Synonymous with vulcanize. It includes time and temperature of vulcanization.

**Cure, curing, also vulcanization** *n.* To change the physical properties of a material by chemical reaction, which may be condensation, polymerization, or vulcanization.

**Cure cycle** *n.* The schedule of time periods at specified conditions to which a reacting thermosetting plastic or rubber composition is subjected to reach a specified property level.

**Cure or curing** *n.* Conversion of a wet coating or printing ink film to a solid film.

**Cure stress** *n.* Internal stress in cast or molded thermosetting parts, caused by unequal shrinkage in different sections of the parts. Depending on the directions of applied stress in service relative to the principal cure stress, parts may be considerably weaker, than their designers expected them to be.

**Cure time** *n.* The period of time that a reacting thermosetting plastic is exposed to specific conditions to reach a specified property level.

**Curie** \ˈkyúr-(ˌ)ē\ [Marie & Pierre *Curie*] (1910) *n.* Unit for measuring radioactivity. One Curie is the quantity of any radioactive isotope undergoing $3.7 \times 10^{10}$ dis/s.

**Curie's law** The intensity of magnetization,

$$I = \frac{AH}{T},$$

where $H$ is the magnetic field strength, $T$ the absolute temperature, and $A$ is the Currie's constant. Used for paramagnetic substances.

**Curie point** *n.* All ferro-magnetic substances have a definite temperature of transition at which the phenomena of ferro-magnetism disappear and the substances become merely paramagnetic. This temperature is called the "Curie Point" and is usually lower than the melting point. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Curie–Weiss law** *n.* the Curie law was modified by Weiss to state that the susceptibility of a paramagnetic substance above the Curie point varies inversely as the excess of the temperature above that point. This law is not valid at or below the Curie point. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Curl** *See kink.*

**Curing agent (hardener)** *n.* A substance or mixture of substances added to a plastic or rubber composition to promote or control the curing reaction. It is also an additive, which promotes the curing of a film. An agent that does not enter into the reaction is known as a *catalytic hardener* or *catalyst.* A *reactive curing agent* or *hardener* is generally used in much greater proportions than a catalyst, and is actually converted in the reaction. Syn: hardener.

*See also accelerator, hardener, catalyst and cross-linking.*

**Curing agent blush** *n.* A blushing, blooming or sweating caused by applying coatings such as amine cured epoxies under conditions of high humidity.

**Curing agents for epoxy resins** *n.* A catalytic or reactive agent that brings about polymerization causing cross-linking.

**Curing temperature** *n.* The temperature to which a thermosetting or elastomeric material is brought in order to commence and complete its final stage of cure.
*See temperature, curing.*

**Curing time (molding time)** In the molding of thermosets, the time elapsing between the moment relative movement and between the mold parts creases, and the instant that pressure is released. Time necessary for curing.

**Curl** *n.* In paper, distortion of the unrestrained sheet due to differences in structure or coatings from one side to the other. The curl side is the concave side of the sheet.

**Curling** *n.* (1) *See coiling soup.* (2) Curling also refers to excessive warping of sheet goods, or distortion by uneven shrinkage.
*See also crawl.*

**Current** \ˈkər-ənt\ [ME *curraunt*, fr. OF *currant*, pp of *courre* to run, fr. L *currere*] (Electric) *adj.* The rate of transfer of electricity. The transfer at the rate of 1 esu of electricity in 1 s is the electrostatic unit of current. The electromagnetic unit of current is a current of such strength that 1 cm of the wire in which it flows is pushed sideways with a force of 1 dyn when the wire is at right angles to a magnetic field of unit intensity. The practical unit of current is the ampere a transfer of 1 C/s, which is one-tenth the electromagnetic unit. The International ampere is the unvarying electric current which, when passed through a solution of silver nitrate in accordance with certain specifications, deposits silver at the rate of 0.00111800 g/s. The international ampere is equivalent to 0.999835 absolute ampere. The ampere-turn is the magnetic potential produced between the two faces of a coil of one turn carrying 1 A. Dimensions

$$\left[\varepsilon^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{3/2}\,\mathrm{T}^{-2}\right], \quad \left[\mu^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{1/2}\,\mathrm{T}^{-1}\right].$$

Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Current density** Magnitude of current per unit area of a metal surface, usually expressed in mA/ft$^2$ (mA/ft$^2$ or, A/m$^2$).

**Current in a simple circuit** *n.* The current in a circuit including an external resistance $R$ and a cell of electromotive force $E$ and internal resistance $r$,

$$I = \frac{E}{R + r}$$

if $E$ is in volts and $r$ and $R$ in ohms the current will be in amperes. For two cells in parallel,

$$I = \frac{E}{R + r/2}.$$

For two cells in series,

$$I = \frac{2E}{R + 2r}.$$

Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw Hill Science/Engineering/Math, New York.

**Curtain coating** *n.* A method of applying paint to an object by moving it through a falling curtain of paint which may be used with low viscosity plastics or solutions, suspensions, or emulsions of plastics in which the substrate to be coated is passed through and perpendicular to a free flowing liquid "curtain", or "waterfall".

**Curtaining** Syn: sagging.

**Curvature of field** *n.* The image plane formed by a lens is naturally curved. While one part of the field will be in good focus, the rest will need refocusing to be sharp. While the eye may partially correct for this, a camera lens will not, and the final image as photographed will not be in perfect focus over the entire image plane.

**Cushion back carpet** *n.* (1) A unit of yarn number. The number of 100-yard lengths per pound avoirdupois of asbestos yarn or glass yarn, or the number of 300-yards lengths per pound avoirdupois of woolen yarn. (2) A length of woven cloth. (3) The number of needles per inch on a circular-knitting machine. A machine with 34 needles/in. is a 34-cut machine, and a fabric produced thereon is called a 34-cut fabric.

**Cushion carpet** A carpet with padding made as an integral part of the backing.

**Custom color** *n.* Special colors made by adding colorant to paint or by intermixing colors, which permits the retailer to match a color selected by the consumer.

**Custom molder** (Brit: trade molder) *n.* A firm specializing in the molding of items or components to the specifications o another firm that handles the sale and distribution of the item, or incorporates the custom-molded component into one of its own products.

**Cut** *n.* (1) An expression commonly used to designate a typographic printing plate. (2) To dilute with ink, lacquer or varnish with solvents or with clear base; to thin. (3) The proportion of shellac gum in alcohol. A shellac varnish is referred to as a 4 pound or five pound cut, or weight, which means 4 or 5 lbs of shellac gum to 1 gal of alcohol. (4) In the fiber industry, including glass and asbestos, the number of 100-yard lengths of fiber per pound. A now deprecated unit, 1 cut corresponds to a lineal density of 0.0049604 kg/m or 4960.4 texes.

**Cut-layers** As applied to laminated plastics, a condition of the surface of machined or ground rods and tubes and of sanded sheets in which cut edges of the surface layer or lower laminations are revealed (ASTM D 883).

**Cut-off (flash groove, pinch-off)** *n.* In compression molding, the line where the two halves of a mold come together, often along a sharp mating ridge and groove.

**Cut-off saw (traveling cut-off)** In extrusion of pipe, rod, and profiles, a circular saw that periodically swings forward, while moving downline at the same rate as the extruded product, to cut it into desired lengths. When the saw has completed its cut, it swings back at the same time quickly reversing travel to return to its starting point, poised for the next cut.

**Cut pile** A pile surface obtained by cutting the loops of yarn in a tufted or woven carpet.

**Cut selvage** *n.* A cut or break occurring only in the selvage. A cut selvage is caused by incorrect loom adjustment during weaving or improper edge construction. The term also refers to loose edges cut during shearing of the fabric.

**Cut staple** *v.* (1) An inferior cotton fiber that was accidentally cut because it was too damp during ginning. (2) A term sometimes used to denote staple of manufactured fibers.

**Cut tape** *See slit tape.*

**Cutter** (1) A mechanical device used to cut tow into staple. (2) A firm engaged in making up garments from finished fabrics. (3) A person employed in the wholesale garment industry whose specific work is to cut layers of fabric to be formed into garments. Cut velvet:
*See beaded velvet.*

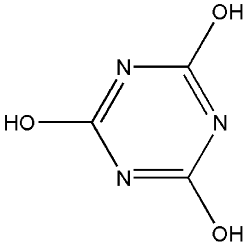
**Cutting in** *v.* Painting of a surface adjacent to another surface which must not be painted, for example, painting the frames of a window and avoiding painting the glass, or the painting of an area on a previously painted surface.

**Cut yarn** A defective yarn, i.e., cut partially or completely through, resulting from malprocessing.

**Cyanoacrylate adhesives** *n.* alkyl -2-cyanocrylates polymerize rapidly via anionic initiation in the presence of weak bases (water, alcohol) at ambient temperatures; highly exothermic reaction yielding brittle polymers; very useful for quickly setting anaerobic adhesives; also useful for suture less topical tissue adhesives (e.g., Dermabond®); and industrial grades are commonly known as "super glue".

**Cyanoguanidine** *See dicyandiamide.*

**Cyanuric acid** \ˌsī-ə-ˈnúr-ik\ [*cyan-* + *urea*] (1838) (1,3,4-triazine-2,4,6-triol, tricyanic acid, tricarbimide) *n.* An acid evolved from the blowing agent, azodicarbonamide, when it decomposes. The acid is corrosive, and is the chief cause of plate-out on components of extruders in the structural-foam process when azodicarbonamide is used as the blowing agent (*See image*).



**Cycle** *n.* The series of sequential operations entering into a repeating batch process or part of the process. In a molding operation, cycle time is the average time elapsing, over several normal cycles, between a particular occurrence in one cycle and the same occurrence in the next cycle.

**Cyclic** *adj.* All cyclic compounds are recognized by their ring structure. Benzene is the simplest and most well-known cyclic compound, consisting of a single ring. Its monocyclic. When two or more rings are involved as with naphthalene, for example, the compound is bicyclic, tricycle, etc. Cyclic compounds may contain from three to six or more carbon atoms in the ring, e.g., Cyclopropane – three atoms; Cyclobutane – four atoms; Cyclopentane – five atoms; Cyclohexane – six atoms.

**Cyclic diolefins resins** *n.* Polymerized products obtained from the cracked distillates of petroleum. They are unsaturated products, with excellent solubility, acid, alkali, and water resistance. A special application is in metallic paint media.

**Cyclic ketone resins** *n.* Cyclohexanone is the primary constituent of these resins, and it is condensed either by the action of alkalis or acids. Mixed condensation products of cyclohexanone and aldehydes are also resinous. The cyclic ketone resins, which are available commercially are notable chiefly by reason of their extremely pale colors and characteristic smell. They are usually very readily soluble in vegetable oils.

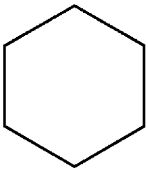
**Cyclic stress strain** *n.* Repeated loading of a yarn on a tensile testing machine and the determination of the physical properties of the yarn during these cycles.

**Cyclic trimmer** *n.* Strictly, a polymer, in cyclic form, that contains three repeating groups. Cyclic trimmer is a by-product found in all commercial polyester and results in deposit buildup in package-dyeing equipment.

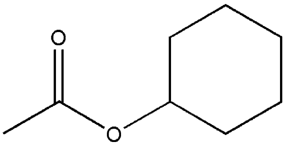
**Cyclized rubber** *n.* A thermoplastic resin produced by reacting natural rubber with stannic chloride or chlorostannic acid. This causes a reduction of the unsaturation and formation of condensed ring structures, typically with two or three rings being fused together. It is claimed (USA Patent 3,205,093) that a solution of cyclized rubber in toluene is one of the few lacquers known to adhere to polyolefins without their being pretreated or the lacquered surface being post-treated with radiation. Other uses include films and hot-melt coatings.

**Cycloalkane** A cyclic hydrocarbon with the general formula $C_nH_{2n}$.

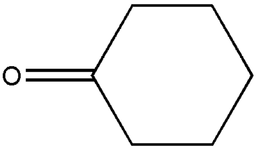
**Cyclohexane** \ˌsī-klō-ˈhek-ˌsān\ [ISV] (ca. 1909) (hexamethylene, hexahydrobenzene) *n.* $C_6H_{12}$. A saturated hydrocarbon with a six-membered ring, cyclohexane is derived from the catalytic hydrogenation of benzene, and is used as a solvent for cellulosics and as an intermediate in the production of nylon (*See image*).



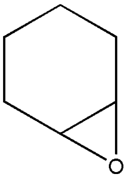
**Cyclohexanol acetate** *n.* $CH_3COOC_6H_{11}$. A non-flammable solvent for cellulosics and many other resins (*See image*).



**Cyclohexanone** \-ˈhek-sə-ˌnōn\ (ca. 1909) (pimelic ketone, ketohexamethylene) *n.* $CH_2(CH_2)_4C{=}O$. A colorless liquid produced by the oxidation of cyclohexane or cyclohexanol. Its most important use is for the manufacturer of adipic acid for nylon 6/6, and caprolactam for nylon 6. It is also an excellent high-boiling, slowly evaporating solvent for many resins including cellulosics, acrylics and vinyls. It is one of the most powerful solvents for PVC, and is often used in lacquers to improve their adhesion to PVC (*See image*).

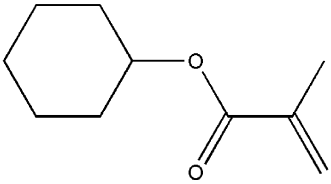


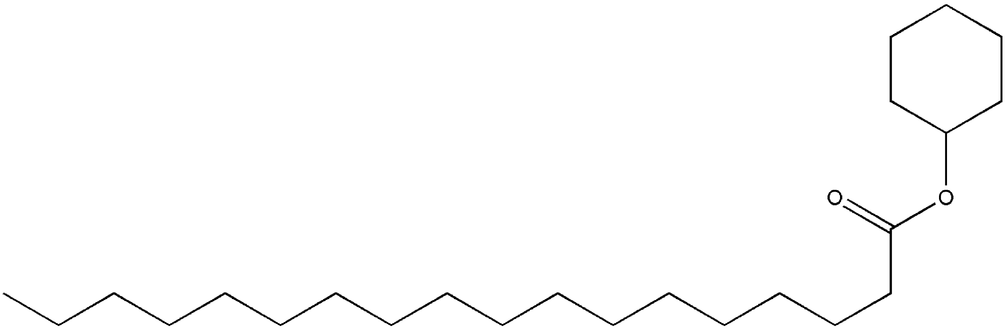
**Cyclohexene oxide** *n.* $C_6H_{10}O$. This epoxide is a highly reactive, colorless liquid that resembles ethylene oxide in most of its reactions. It is useful as an intermediate in the production of many organic chemicals used in plastics. Its epoxide structure is especially useful in applications where an HCI scavenger is required (*See image*).



**Cyclohexnol (hexahydrophenol)** *n.* $CH_2(CH_2)_4CHOH$. A colorless, viscous liquid prepared by the oxidation of cyclohexane or by the hydrogenation of phenol. It is used as an intermediate in the production of nylon 6/6, it is a solvent for cellulosic resins, and it is an intermediate in the manufacture of phthalate-ester plasticizers.

**Cyclohexyl methacrylate** *n.* $H_2C{=}C(CH_3)COOC_6H_{11}$. A colorless monomer, polymerizable to resins for optical lenses and dental parts, and useful for potting electrical components (*See image*).





**Cyclohexyl stearate** *n.* $C_6H_{11}OOCC_{17}H_{35}$. A plasticizer for polystyrene, ethyl cellulose, and cellulose nitrate (*See image*).

**Cycloparaffins** \-ˈpar-ə-fən\ (1900) *n.* Ring compounds of saturated hydrocarbon type based on groupings of methylene radicals ($CH_2$). Typical cycloparaffins are cyclopropane, cyclobutane, cyclopheptane. etc. The cycloparaffins have very good solvent properties, and are constituents of crude petroleum's.

*Known also as naphthenes.*

**Cyclopentane (pentamethylene)** *n.* $C_5H_{10}$. A solvent for cellulose ethers (*See image*).

**Cyclopolymerization** *n.* Polymerization in which ring structures are formed within the polymer chain.

**Cyclotron** \ˈsī-klə-ˌträn\ [*cycl-* + *-tron*; fr. the circular movement of the particles] (1935) *n.* The magnetic resonance accelerator for imparting very great velocities to heavier nuclear particles without the use of excessive voltages.

**Cycolac** *n.* ABS, manufactured by Marbon, USA.

**Cycolon** ABS, manufactured by Marbon, USA.

**Cylinder** *n.* (1) In carding, a large cast iron shell, with an outer diameter of 40–45 in., completely covered with card clothing on the surface. The shell is mounted rigidly on a shaft, which projects at each end to rest in bearings. The cylinder must be accurately balanced since it rotates at speeds of 160 rpm and higher. (2) The main roll, or pressure bowl, on roller printing machines. The engraved rolls that apply color are arranged around the cylinder (3) A slotted cylindrical housing for the needles in a circular-knitting machine. The number of slots per inch in the cylinder determines the cut of the machine. (4) *See drying cylinders.*

(*Also see printing, roller printing*).

**Cylinder loading** *n.* Fibers imbedded so deeply in the wire clothing on a card cylinder that they resist transfer to the doffer cylinder according to the normal fiber path through the card. Causes include improper finish, excess moisture, or static on the fiber. The fiber builds up to such an extent that the carding operation is adversely affected. In extreme cases, the card will be slowed or stopped.

**Cylindrical weave** *n.* A type of woven, knitted, or braided sleeve generated as reinforcement in tubular reinforced-plastic structures such as pipe. Typically, the reinforcement will constitute about half the volume of the finished product; but it can be much less, as in knit-reinforced garden hose.

**Cymatic printing** *n.* This proprietary process owned by KBC is a method in which the oscillations of a musical chord are "caught" on a quartz plate and the vibration patterns photographed. The patterns thus obtained are used in making unique print fabrics of unusual variety and originality. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Cynoper** *See mercuric sulfide.*

# D

**d** *n* \ˈdē\. (1) SI abbreviation for prefix deci-. (2) Abbreviation in use with SIU system for time interval of 1 day (=86,400 s).

**D** (1) Symbol for diameter. (2) Chemical symbol for the hydrogen isotope of atomic weight 2, deuterium.

**$D_{6500}$ or $D_{65}$** *adj.* Refers to the daylight special power distribution curve with a correlated color temperature of 6500°K.
*See daylight illuminates, cie, and correlated color temperature.*

**da** *n.* SI abbreviation for prefix deca-.

**Dabber** \ˈdab-\ [ME *dabbe*] (14c) *n.* Dome-shaped brush of soft hair for applying spirit varnish or for polishing and finishing gilding.

**DABCO** (former trade name, now generic) *n.* Abbreviation for 1,4-diazabicyclo-2,2,2-octane.
*See triethylenediamine.*

**DAC** Abbreviation for diallyl chlorendate.

**Dacron** \ˈdā-ˌkrän\ {*trademark*}. Fiber from poly(ethylene terephthalate). Manufactured by DuPont, USA.

**Dado** \ˈdā-(ˌ)dō\ [It, die, plinth] (1664) *n.* (1) Lower part of an interior wall when paneled or decorated, customarily of chair rail height. (2) Paper that provides this architectural division.
*See wainscot.*

**DAF** Abbreviation for diallyl fumarate, a polymerizable monomer.

**Dagincoleic acid** *n.* $C_{22}H_{44}O_4$. Acid constituent of Borneo dammer. Mp, 170°C.

**Dagingenoleic acid** *n.* $C_{13}H_{26}O_3$. Acidic constituent of Borneo dammer. Mp 126°C.

**DAIP** *n.* Abbreviation for diallyl isophthalate resin.
*See allyl resin.*

**Dalamar yellow** *n.* Pigment yellow 74 and 65 (11741). An azo coupling of *m*-nitro-*o*-anisidine with acetoacet-*o*-anisidine; it is one of the growing group of close chemical relatives of Hansa yellow G (an azo coupling of *m*-nitro-*p*-toluidine with acetoacetanilide). The high strength toner is superior in tinting strength and fastness properties to Hansa yellow G.

**Dalton's law of partial pressures** *n.* The pressure exerted by a mixture of gases is equal to the sum of the separate pressures, which each gas would exert if it alone occupied the whole volume. This fact is expressed in the following formula:

$$PV = V(p_1 + p_2 + p_3,\ \text{etc.}).$$

Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Dam** *n.* A ridge around the perimeter of a mold that retains excess resin during pressing and curing.

**DAM** *n.* Abbreviation for diallyl maleate.
*See allyl resin.*

**Damaged selvage** *See cut selvage.*

**Damask** \ˈda-məsk\ [ME *damaske*, fr. ML *damascus*, fr *Damascus*] (14c) *n.* A firm, glossy, Jacquard-patterned fabric that may be made from linen, cotton, rayon, silk, or a combination of these with various manufactured fibers. Similar to brocade, but flatter and reversible, damask is used for napkins, tablecloths, draperies, and upholstery.

**Dammar (Damar)** \ˈda-mər\ [Malay] (1698) *n.* Natural resinous exudation from trees of the *Dipterocarpaceae* family, which grow chiefly in the East Indies (now Indonesia) and Malaya. Very pale in color (practically colorless to deep yellow). Soluble in hydrocarbons without the necessity of running. Average acid value of 30. A fossil resin used as an ingredient in printing ink varnishes.

**Dammarolic acid** *n.* $C_{56}H_{80}O_8$. Acidic constituent of dammar.

**Dammar wax** *See resene, β.*

**Dammarylic acid** *n.* $C_{38}H_{60}O_3$. Acidic constituent of dammar.

**Dampener** In lithography, cloth-covered, parchment paper, or rubber rollers that distribute the dampening solution to the press plate.

**Dampending (in Tire Cord)** *n.* The relative ability to absorb energy and deaden oscillation after excitation.

**Dampening solution** *See fountain solution.*

**Damping** *n.* Reduction of vibration amplitude due to viscous or frictional resistance within a material or to drag of its environment upon a structure. The vibration may be mechanical, sonic, or electronic. Energy dissipates per cycle is called hysteresis loss. *See also critical damping.*

**Dancer roll** *n.* A roller mounted on an axis, which is movable with respect to axes of other rollers in an apparatus, used to control or measure tension of a continuous web or strand as it passes through a series of rollers. Dancer rolls are used as tension-sensing devices in the extrusion coating of wire, and as tension-maintaining devices in film winding.

**DAP** Abbreviation for diallyl phthalate.

**Darkfield illumination** *n.* Incident or transmitted illumination of the specimen by indirect light whereby no direct light is admitted directly to the objective.

**Dart impact test** *See free-falling-dart test.*

**Darvic** *n.* Poly(vinyl chloride). Manufactured by ICI, Great Britain.

**Dashpot** \ˈdash-ˌpät\ (1861) *n.* (1) A device used for damping vibration and cushioning shock in hydraulic systems. Typically, a dashpot is a liquid- or gas-filled cylinder with a piston that is attached to a moving machine part. (2) A modeling concept useful in visualizing the mechanical behavior of viscoelastic materials, a purely viscous element that may operate alone or connected in series and/or parallel with springs and sliders.

**Datiric acid** \sə-ˈtir-ik\ *n.* $CH_3(CH_2)_{15}COOH$. Another name for margaric acid. A straight chain aliphatic acid. Mp, 59.5°C.

**Daub** \ˈdób, ˈdäb\ [ME, fr. MF *dauber*] (14c) *v.* To apply a coating by crude unskillful strokes.

**Daylight** \ˈdā-ˌlīt\ (13c) *n.* Natural illumination that is the result of various mixtures of direct sunlight covering a wide range of correlated color temperatures.

For precision in definitions, *See north light, artificial daylight, and daylight illuminants.*

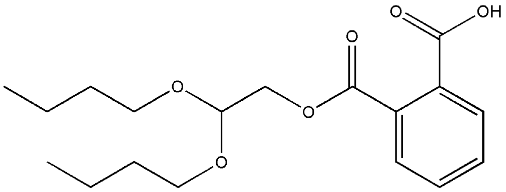
**Daylight fluorescent pigment** *See fluorescent pigment.*

**Daylight illuminants** *n.* **CIE**. Series of illuminant spectral power distribution curves based on measurements of natural daylight and recommended by the CIE in 1965. Values are defined for the wavelength region 300–830 nm. They are described in terms of the correlated color temperature. The most important is $D_{6500}$ because of the closeness of its correlated color temperature to that of Illuminant C, 6774°K. $D_{7500}$ bluer than $D_{6500}$ and $D_{5500}$ yellower than $D_{6500}$ are also used.

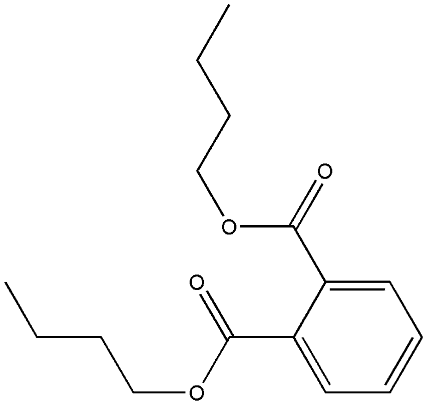
**Daylight opening** *n.* The clearance between two platens of a molding press when in the open position.

**dB** *n.* Abbreviation for decibel.

**DBEP** *n.* Abbreviation for dibutoxyethyl phthalate (*See image*).



**DBP** *n.* Abbreviation for dibutyl phthalate (*See image*).



**DBPC** *n.* Abbreviation for di-*tert*-butyl-*p*-cresol.

**DBS** *n.* Abbreviation for dibutyl sebacate.

**DBTDL** *n.* Abbreviation for dibutyltin dilaurate.

**DC drive** (direct-current drive) *n.* A machine drive, particularly that of an extruder, powered by a direct-current motor. The availability of economical solid-state rectifiers, and the good torque-versus-speed characteristic and tight speed regulation of DC drives have made them the most popular choice today for variable-speed service.

**DCHP** *n.* Abbreviation for dicyclohexyl phthalate.

**DCO** *n.* Non-drying castor oil which has been converted into a drying oil by the catalytic removal of water from its principal fatty acid (80% ricinoleic acid), forming approximately equal quantities with 9–11 and 9–12 unsaturation. The term DCO rather than "dehydrated castor oil" has been suggested and is being used for this oil in order to reduce the tendency to confuse castor oil with DCO, which is entirely different in its properties from the oil from which it is derived.

**DCP** *n.* Abbreviation for dicapryl phthalate.

**DDM** *n.* Abbreviation for 4,4′-diaminodiphenyl methane.

**DDP** *n.* Abbreviation for didecyl phthalate.

**DE** *n.* Abbreviation for diatomaceous earth. *See diatomite.*

**Dead burned calcium sulfate** *See calcium sulfate, anhydrous.*

**Deadcoloring** *See abbozzo.*

**Dead-end polymerization** *n.* A free radical polymerization in which a very active initiator is used so that the rate of polymerization continuously decreases as initiator is consumed and a limiting conversion of monomer to polymer occurs.

**Dead flat** *n.* Of a finish, the quality of having no luster or gloss. Syn: lusterless.

**Dead fold** *n.* A fold that does not spontaneously unfold; a crease.

**Dead oil** *See creosote.*

**Dead zone** *n.* In control work, a range of the quantity sensed in which a small change in the quantity causes no change in the indication of it, nor any control action. Compare induction period.

**Deaerate** \ˌdē-ˈar-ˌāt\ (1791) *vt.* To remove air from a substance. Deaeration is an important step in the production of vinyl plastisols and most casting operations accomplished by subjecting the liquid to a moderate vacuum with or without agitation, to remove air that would cause objectionable bubbles or blisters in finished products.

**Debloomed oil** *See oil, debloomed.*

**Debonding** *n.* In a bonded joint, separation of the bonded surfaces. In a laminate, separation of layers or fibers from the matrix.

**Deborah number** \ˈde-b(ə-)rə ˈnəm-bər\ (De, $N_{De}$). The dimensionless ratio of the relaxation time of a viscoelastic fluid to a characteristic time for the flow process being considered. Relaxation time is often taken as the ratio of viscosity to modulus, while the characteristic time is a significant length divided by average velocity. The Deborah number has been useful in studying such phenomena as die-exit swell in extrusion. If De is high, elastic effects probably dominate; if De is low, the flow is essentially viscous.

**Deburr** \də-ˈbər\. To remove from a machined part rough edges or corners left by the machining operations. Compare deflashing.

**Debye equation** \də-ˈbī i-ˈkwā-zhən\. A relationship for the relative permittivity ($\varepsilon$) of a dielectric material as a function of the electronics and atomic polarizability ($\alpha_a$) and the orientational polarizability terms.

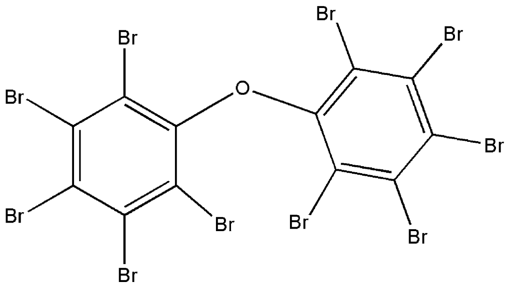
$$(\varepsilon - 1)/(\varepsilon + 2) = (4\pi N_1/3)(\alpha_a + \mu^2/3kT),$$

where $N_1$ is the number of molecules present per $cm^3$, $\mu$ the dipole moment of the molecule concerned, $k$ the Boltzmann's constant, and $T$ is the temperature.

**Deybe–Hűckle theory of strong electrolytes** *n.* This theory assumes that strong electrolytes are completely dissociated in solution, but that the hydrated ions have enough residual attraction for each other that they are not truly independent of each other. The theory assumes that each ion has surrounding it on the average more ions of opposite charge, counterions, than of the same charge, and that the number of counterions near a given ion increases with increasing concentration. The presence of this diffuse ionic atmosphere relatively rich in counterions restricts the movement of each ion in the solution. The theory permits a quantitative prediction of how the conductivity should change with concentration, a prediction that agrees with experimental results. The theory also permits a calculation of the ionic-atmosphere effect on colligative properties. Russell JB (1980) General chemistry. McGraw-Hill Book Co, New York.

**Deca-** {*combining form*} [ME, fr. L. fr. Gk *deka*-, *dek*-, fr. *deka*] (da). SI-acceptable prefix meaning ×10.

**Decabromodiphenyl oxide** \-ˈbrō-(ˌ)mō-(ˌ) dī-ˌfe-nᵊl ˈäk-ˌsīd\ (deca-bromodiphenyl either) *n.* Diphenyl ether in, which all ten phenyl hydrogens have been replaced by bromine, containing 83% bromine. The commercial product, a free-flowing white powder, is much used as a flame retardant in high-impact polystyrene and structural foam, usually with synergistic antimony oxide. Typical would be 12% decabromodiphenyl oxide and 4% antimony oxide in the resin (*See image*).



**Decahydronaphthalene** \-ˈhī-(ˌ)drō-ˈnaf-thə-ˌlēn\ (Decalin®) *n.* A saturated bicyclic hydrocarbon, $C_{10}H_{18}$, essentially two cyclohexane rings fused together, sharing two hydrogen atoms. The commercial product is a mixture of *cis*- and *trans*-isomers. It is a colorless liquid with an aromatic odor, derived by treating molten naphthalene with hydrogen in the presence of a catalyst.

It is a solvent for many resins. Hydrocarbon solvent with a boiling range for the commercial product (175–205°C), slightly higher than that for mineral spirit. Sp gr, 0.894/20°C; flp, 60°C (140°F); refractive index, 1.467; and vp, 2 mmHg/30°C. In Europe, Decaline.

**Decalcomania** \di-ˌkal-kə-ˈmā-nē-ə\ [F *décalcomanie*, fr. *décalquer* to copy by tracing (fr. *dé-* de- + *calquer* to trace, fr. It *calcare*, literally, to tread, fr. L) + *manie* mania, from LL *mania*] (1884) (decal) *n.* A printed design on a temporary carrier such as paper or film, and subsequently transferred to the item to be decorated. Deals are widely used for decorating many materials including plastics, paper, china, glass, furniture, etc. The imprint is adhered to plastic surfaces by means of a pressure-sensitive adhesive, solvent welding, or heat and pressure. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**DECALS** *n.* An abbreviation for decalcomania. A printed design on a temporary carrier.

**Decanedioic acid** Syn: sebacic acid.

**Decantation** \ˌdē-ˌkan-ˈtā-shən\ [NL *decantare*, fr. L de- + ML *cantus* edge, fr. L, iron ring round a wheel] (1633) *n.* Or siphoning off the liquid from a precipitate or sediment or the upper layer of two immiscible liquids as a partial means of separating the phases.

**Decarboxylate** \-ˈbäk-sə-ˌlāt\ (1922) *vt.* To remove from an organic acid its carboxylic-acid groups.

**Decarboxylation** *n.* Removal of carboxyl groups from organic acids, usually as the result of heating.

**Decating** *See decatizing.*

**Decating mark** *n.* A crease mark or impression extending fillingwise across the fabric near the beginning or end of the piece.

**Decatizing** *n.* A finishing process in which fabric, wound tightly on a perforated roller, either has hot water circulated through it (wet decatizing), or has steam blown through it (dry decatizing). The process is aimed chiefly at improving the hand and removing wrinkles.

**Decay** \di-ˈka\ [ME, fr. ONF *decaïr*, fr. LL *decadere* to fall, sink, fr. L *de-* + *cadere* to fall] (15c) *n.* Diminution of a radioactive substance due to nuclear emission of alpha or beta particles, gamma rays or positrons. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Deci-** {*combining form*} [F *déci-*, fr. L *decimus* tenth, fr. *decem* ten] (d). The SI-approved prefix meaning × 0.1.

**Decibel** \ˈde-sə-ˌbel\ [ISV *deci-* + *bel*] (1928) (dB) *n.* In acoustics and electronic circuits, a change in sound intensity or circuit power by the factor $10^{0.1} = 1.259$. These changes correspond to changes in sound *pressure* or circuit *voltage* by the square root of the above factor, 1.122. In acoustics most measurements are referred to a sound-power level of $10^{-12}$ W, corresponding to a sound-pressure level of 0.00002 Pa, the presumed threshold of human audibility. One decibel is the least change in intensity detectable by normal ears. Thus, because of the exponential definition of the decibel, an 80-dB sound is ten times as intense as a 70-dB sound. OSHA regulations prescribe maximum sound levels permitted for employee exposure. In many plants, scrap grinders, which used to be major noise generators, now run much more quietly or are isolated by enclosures, or both. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Decitex** *n.* One-tenth of a tex.

**Deckle** \ˈde-kəl\ [Gr *Deckel*, literally, cover, fr. *decken* to cover, fr. OHGr *decchen*] (1816) (deckle rod and cut-off plate) *n.* In extrusion of film or sheet, or extrusion coating, a small rod or plate attached to each end of the die that symmetrically shortens the length of the die opening, thus facilitating the production of a web of le than the maximum width.

**Deck paint** *n.* A paint having a high degree of resistance to mechanical wear; especially used on surfaces such as porch floors and ships' decks.

**Declination** \ˌde-klə-ˈnā-shən\ [ME *declinacioun*, fr. MF *declination*, fr. L *declination-*, *declinatio* angle of the heavens, turning aside] (14c) *n.* The angle between the vertical plane containing the direction of the earth's field at any point and a plane containing the geographic north and south meridian.

**Decomposition** \(ˌ)dē-ˌkäm-pə-ˈzi-shən\ [F *décomposer*, fr. *dé-* de + *composer* to compose] (ca. 1751) *n.* Breakdown of molecular structure by chemical or thermal action. With polymers, depending on the severity of conditions, decomposition products can range from subpolymers and oligomers down to monomers and even atoms and ions. In similar terms it is the chemical separation of a substance into two or more substances, which may differ from each other and from the original substances. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

*See also degradation.*

**Decomposition temperature** ($T_{dc}$) *n.* The temperature at which a polymer or other material (usually organic compound) decomposes by breaking chemical bonds, symbolized by (no symbol is available, but $T_{dc}$ will be used for this purpose). This property should not be confused with the temperature of depolymerization, $T_{dp}$. {G Zersetzungstemperatur f, F température de décomposition, température f, S temperatura de descomposición, temperatura f, I temperatura di decomposizione, temperatura f}. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers Inc., New York.

**Decomposition potential** \-pə-ˈten(t)-shəl\ *n.* The minimum voltage, which must be applied across a pair of inert electrodes immersed in a medium in order to electrolyze the medium.

**Decompression zone** \ˌdē-kəm-ˈpre-shən ˈzōn\. In a vented extruder, the zone of deep flights immediately forward of the first metering zone and beneath the vent, where unwanted gases and vapors are released from the (typically) foaming melt. In some vented single-screw machines and most twin-screw machines, the two zones are separated by a dynamic value, whose resistance to flow helps to increase the superheating of the melt prior to decompression.

**Décor** \dā-ˈkór, di-ˈ; ˈde-ˌkór, ˈdā-ˌ\ [F *décor*, fr. *décorer* to decorate, fr. L *decorare*] (1897) *n.* The combination of materials, furnishing, and objects used in interior decorating to create an atmosphere or style.

**Decorated** \ˈde-kə-ˌrāt\ [L *decoratus*, pp of *decorare*, fr. *decor-*, decus ornament, honor] (1530) *vt.* Adorned, embellished, or made more attractive by means of color or surface detail.

**Decorating** *n.* The processes used for decorating plastics are defined under the following headings:

*Airless spraying*
*Ashing*
*Decalcomania*
*Decorating*
*Double-shot molding*
*Electroless plating*
*Electrophoretic deposition*
*Electroplating on plastics*
*Electrostatic printing*
*Electrostatic spray coating*
*Embedment decorating*
*Embossing*
*Fill-and-wipe*
*Flexographic printing*
*Flocking*
*Flow coating*
*Gravure coating*
*Gravure printing*
*Hot stamping*
*In-mold decorating*
*Letterpress printing*
*Metallizing*
*Offset printing*
*Painting of plastics*
*Printing on plastics*
*Process*
*Roller coating*
*Rubber-plate printing*
*Screen printing*
*Second-surface*
*Spray coating*
*Spray-and-wipe painting*
*Thermographic-transfer*
*Vacuum metalizing*
*Valley printing*

James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Decorative board** (decorative laminate) *n.* A special term for laminates used in the furniture and cabinetry industries, which are defined by the Decorative Board Section of NEMA as "…a product resulting from the impregnation or coating of a decorative web of paper, cloth, or other carrying medium with a thermosetting type of resin and consolidation of one or more of these webs with a cellulosic substrate under heat and pressure of less than 500 psi" This includes all boards that were formerly called low-pressure melamine and polyester laminates, but does not include vinyls. "Cellulosic" here means impregnated paper, wood, or plywood.

**Decorative painting** *n.* Architectural or aesthetical painting.

**Decorticating** \(ˌ)dē-ˌkór-tə-ˈkā-iŋ\ [L *decortication*-, *decorticatio*, fr. *decorticare* to remove the bark from, fr. *de*- + *cortic*-, *cortex* bark] (ca. 1623) *n.* A mechanical process for separating the woody matter from the bast fiber of such plants as ramie and hemp.

**Decoupage** \ˌdā-(ˌ)kü-ˈpäzh\ [F *découpage*, literally, act of cutting out, fr MF, fr. *decouper* to cut out, fr. *de*- + *couper* to cut] (1946) *n.* Modern technique of "burying" a picture design, which has been affixed to a plain surface, in multiple coats of a clear, varnish-type coating. Many coats are applied until the surface no longer reveals the thickness of the design. This art-form is said to have developed from an old French peasant craft consisting of the decoration of a plain surface with cut-out designs of cloth or paper, and then coating it with shellac, varnish or clear lacquer. Another version is that the art of decoupage was originated by craftsmen of 18th century Europe in an effort to duplicate Chinese and Japanese lacquer-ware. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA, 2004.

**Decyl butyl phthalate** \-ˈbyü-tᵊl ˈtha-ˌlāt\. *See butyl isodecyl phthalate.*

**Decyl-octyl methacrylate** \-ˌme-ˈtha-krə-ˌlāt\. $H_2C{=}C(CH_3)COO\ (CH_2)_nCH_3$, with $n = 7$–9. A polymerizable mixed monomer for acrylic plastics (*See image*).

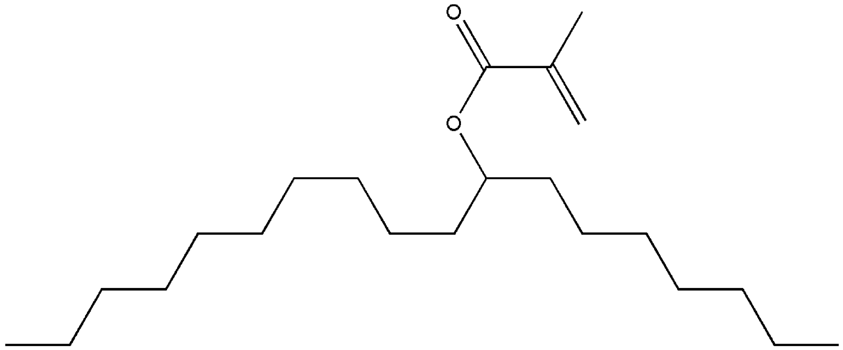
**Decyl tridecyl phthalate** *n.* $C_{10}H_{21}COO\ C_6H_4OOCC_{13}H_{27}$. A plasticizer for vinyls, cellulosics, and polystyrene (*See image*).

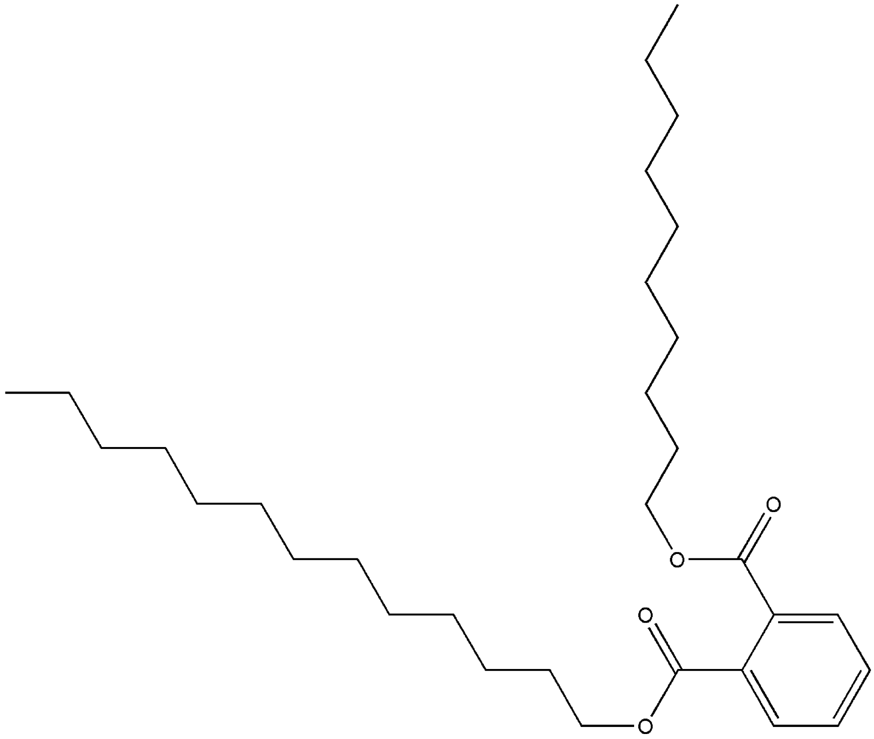
**Deep** \ˈdēp\ [ME *dep*, fr. OE dēop; akin to OHGr *tiof* deep, OE *dyppan* to dip] (before 12c) *adj.* Having depth (in color); often used improperly for dark.

**Deep drawing** *n.* The process of forming a thermoplastics sheet in a mold in which the ratio of depth to the shortest lateral opening is 1 : 1 or greater.

**Deep-dyeing variants** \-ˈver-ē-ənt\ *n.* Polymers that have been chemically modified to increase their dyeability. Fibers and fabrics made there from can be dyed to very heavy depth.

**Defect** \ˈdē-ˌfekt\ [ME, fr. MF, fr. L *defectus* lack, fr. *deficere* to desert, fail, fr.





*de-* + *facere* to do] (15c) *n.* An internal irregularity or flaw in the structure of a crystal.

**Defects** *n.* A general term that refers to some flaw in a textile product that detracts from either performance or appearance properties.

**Definite proportions, law of** *n.* In every sample of each compound substance the proportions by weight of the constituent elements are always the same.

**Deflashing** \di-ˈflash-eŋ\ *n.* The removal of flash or rind left on molded plastic articles by spaces between the mold-cavity edges. Methods include tumbling, blast finishing, use of dry or wet abrasive belts, and hand methods using knives, scrapers, broaching tools, and files. Soft thermoplastic parts are sometimes deflashed by tumbling them while immersed in a severe coolant such as liquid nitrogen.

*See also abrasive finishing and airless blast deflashing.*

**Deflashing equipment** *n.* Equipment used to remove excess, unwanted material from a processed plastic.

**Deflection temperature** \di-ˈflek-shən ˈtem-pə(r)-ˌchúr\ *n.* According to ASTM D 648, the stress-labeled temperature at which a standard test bar, centrally loaded as a simple beam to develop a (theoretical) maximum stress of 455 or 1820 kPa (66 or 264 psi), and warmed at 2°C/min, deflects 0.25 mm. For many years this temperature was called the "heat-distortion point", a term now deprecated and fading from use {*Deflection* G Durchbiegung f, F déflexion f, S deflección f, I deflessione f}.

**Deflocculant** \de-ˈflä-kyə-ˌlāt\. An additive that prevents pigments in suspension from coalescing to form flocs.

*See dispersant (dispersing agent). Also known as deflocculating agent.*

**Deflocculating agent** *n.* A substance that breaks down agglomerates into primary particles or prevents the latter from combining into agglomerates (ISO).

**Deflocculation** *n.* State or condition of a dispersion of a solid in a liquid in which each solid particle remains independent and unassociated with adjacent particles. A deflocculated suspension shows zero or very low yield value.

**Defoamer** \de-ˈfōm- \ (defoaming agent) *n.* A substance that, when added in small percentages to a liquid containing gas bubbles, causes the small bubbles to coalesce into larger ones that rise to the surface and break. Additive used to reduce or eliminate foam formed in a coating or a coating constituent.

**Deformation** *n.* (1) Change in dimension or shape of a plastic product, particularly a test specimen. (2) In a tensile or compression test, the change in length of the specimen in the direction of applied force. Deformation divided by original length equals *elongation*, often expressed as a percent. (3) In a shear mode, the angle of shear in radians. {G Deformation f; Verformung f, F déformation f, S deformación f, I deformazione f}. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Degassing** (breathing) *n.* In injection or transfer molding, the momentary opening and closing of a mold during the early stages of the cycle to permit the escape of air or gas from the heated compound.

*See also deaerate.*

**Degating** *n.* The removal of material left on a -plastic part formed by the passage between the runner and the cavity, i.e., the gate. The operation is sometimes performed automatically by a mold element. Otherwise, the gate may be removed by manual breaking or cutting, sometimes followed by sanding or burnishing.

**Degating equipment** *n.* Equipment used to separate the molded part, automatically or manually, from an injection molded solid runner system.

**Degradable plastic** *See biodegradation.*

**Degradation** \ˌde-grə-ˈda-shən\ (ca. 1535) *n.* A deleterious change in chemical structure, physical properties, or appearance of a plastic caused by exposure to heat (*thermal degradation*), light (*photodegradation*), oxygen (*oxidative degradation*), or weathering. The ability of plastics to withstand such degradation is called *stability.* Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York. Dissado LA, Fothergill CJ (eds) (1992) Electrical degradation and breakdown of polymers. Institution of Electrical Engineering (IEE), London.

*See also artificial weathering, autocatalytic degradation, biodegradation, corro-sion resistance, decomposition, deterioration, dew-cycle weathering test discoloration, pink staining, and xenon-arc aging.*

**Degras** *n.* Natural dark wool grease from, which the various grades of lanolin are prepared.

**Degreaser** \(ˌ)dē-ˈgrē-sər\ *n.* Solvent or compounded material for removing oils, fats, or grease from a substrate. Also the apparatus in which this operation is carried out.

**Degreasing** *n.* Removal of grease, oil and other fatty matter (from metals, fabrics, etc.) by the use of solvents or chemical cleaners, electro, or heat processes.

**Degree of cross-linking** \di-ˈgrē əv ˈkrós-ˈlink-eŋ\ *n.* The fraction of mer units of a polymer that are cross-linked, equal to the quotient of the mer weight and the average molecular weight of segments between cross-links.

**Degree of crystallinity** \ˈkris-tə-ˈli-nə-tē\ *n.* The amount of crystalline material in a partially crystalline polymer, usually expressed as a percentage. For a particular polymer the value depends on the crystallization conditions, especially the rate of cooling and the crystallization temperature. Elias H-Georg (2003) An introduction to plastics. John Wiley and Sons, New York.

**Degree of cure** \ˈkyúr\ *n.* The extent to which curing or hardening of a thermosetting resin has progressed.

*See also A-stage, B-stage, and C-stage.*

**Degree of efflorescence** \ˌe-flə-ˈre-sᵊn(t)s\ *n.* (1) *Flatting and glossing* – A non-uniform decrease or increase in gloss noticed when the surface is illuminated and viewed at near grazing angles. There is no apparent change in color when viewed perpendicular to the surface. (2) *Fine efflorescence* – A barely discernible whitening of the surface when viewed perpendicularly. (3) *Medium efflorescence* – A readily noticeable whitening of the surface without a marked masking of the color. (4) *Heavy efflorescence* – A white deposit sufficient to mask the color.

**Degree of esterification** \-e-ˌster-ə-fə-ˈkā-shən\ *n.* The extent to which the acid groups of terephthalic and/or other acids have reacted with diols to form ester groups in polyester polymer production.

**Degree of freedom** \-ˈfrē-dəm\ (1867) *n.* The number of the variables determining the state of a system (usually pressure, temperature, and concentrations of the components) to which arbitrary values can be assigned.

**Degree of metamerism** \-mə-ˈta-mə-ˌri-zəm\ *n. See metamerism, degree of.*

**Degree of orientation** \-ˌōr-ē-ən-ˈtā-shən\ *n.* The extent of crystalline deformation after application of stress to a polymer.

**Degree of polymerization** \-pə-ˌli-mə-rə-ˈzā-shən\ (DP, chain length) *n.* The average number of monomer units per polymer molecule, $DP = M_n/M_{mer}$, where $M_n$ is the polymer's number-average molecular weight and $M_{mer}$ is the molecular weight of the mer (which may differ from monomer molecular weight). In a polymer having worthwhile mechanical properties, *DP* exceeds 500, and many commercial thermoplastics have *DP*s between 1000 and 10,000. Specifically, the average number of anhydroglucose units (or derivative units) per molecule of cellulose (or cellulose derivative). The type of average obtained depends upon the method used for the determination. Hence, the method must always be specified.

*See also molecular weight.*

**Degumming** \(ˌ)dē-ˈgəm-eŋ\ (1887) *vt.* The removal of gum from silk by boiling in a mildly alkaline solution. Usually accomplished on the knit or woven fabric.

**DEHP (DOP)** *n.* Abbreviation for di(2-ethylehexyl) phthalate.

**Dehydrated castor oil** \(ˌ)dē-ˈhī-ˌdrat-ˈed ˈkas-tər ˈói(ə)l\ *n.* A castor oil chemically treated to improve its drying qualities.

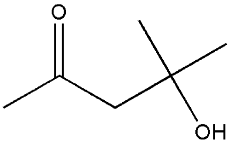
*See DCO.*

**Dehydrated gypsum** \ˈjip-səm\ *n.*

See calcium sulfate, anhydrous.

**Dehydration** *n.* The removal of water from a substance either by ordinary drying or heating, or by absorption, chemical action, condensation of water vapor, or by centrifugal force or filtration. The term is generally applied to the removal of combined water as, for instance, from hydrates.

**Dehydroacetic acid** \(ˌ)dē-ˌhī-drə-ə-ˈsē-tik\ *n.* Abbreviated is DHA. It is a rosin derivative present in hy-drogenated rosin. A heterocyclic compound used as a plasticizer, fungicide, and bactericide (*See image*).



**Dehydrogenated oils** *n.* Semidrying oils which have been converted into drying oils by first treating them with a halogen (usually chlorine), then eliminating hydrogen halide. This results in conjugated double bonds in the fatty acids chain.

**Dehydrogenation** \ˌdē-(ˌ)hī-ˌdrä-jə-ˈnā-shən\ (1866) *n.* The removal of hydrogen from a compound by chemical means.

*See also cracking* (2).

**Dehydrohalogenation** \-ˌha-lə-jə-ˈnā-shən\ *n.* The splitting of hydrogen chloride or other hydrohalide from polymers such as PVC, by action of excessive heat or light.

**Deionization** \(ˌ)dē-ˈī-ə-nə-ˈsā-shən\ *n.* The removal of ions from a solution by ion exchange.

**Deka-** (da). A prefix permitted by SI and meaning × 10.

**Delaminate** \(ˌ)dē-ˈla-mə-ˌnāt\ *vt.* To separate existing layers.

**Delaminated clay** \ˈklā\ *n.* Pigment produced by mechanically separating the platelets of natural kaolin so that particles of approximately 1/4 μm thickness and up to 10 μm in diameter are produced. This pigment is used to increase the opacifying efficiency of titanium dioxide by keeping the titanium dioxide particles separated by the thickness of the calcined clay particle. This spacing allows each titanium dioxide particle to intercept a wavelength of visible light and thereby results in maximum light-scattering efficiency.

**Delamination** *n.* Separation of the wood surfaces at the bonded joints caused by a cohesive failure in the adhesive or a failure of the adhesive at the surface. When the separation occurs in the wood, even though very close to the bonded joint, the separation is termed *wood failure* or *checking* rather than delamination. Magnification is often necessary to determine whether the failure is in the bond or in the wood. The term also applies to failure occurring between successive coatings.

**Delated deformation** \di-ˈlāt- ˌdē-ˌfór-ˈmā-shən\ *vt.* Deformation that is time-dependent and is exhibited by material subjected to a continuing load; creep. Delayed deformation may be recoverable following removal of the applied load.

**Deleafing** *n.* Loss of leafing of metallic pigments in paints, giving rise to reduced metallic luster.
*See leafing.*

**Deliquescence** \ˌde-liˈkwe-sənt\ [L *deliquescent-*, *deliquescens*, pp of *deliquscere*] (1791) *adj.* Property possessed by some materials of absorbing moisture from the air and forming a solution in the water so absorbed.

**Deliquescent** *n.* Said of some salts that are so strongly attractive of water that they can absorb enough from room air to liquefy.

**Delocalized molecular orbital** *n.* An orbital which extends over more than two atoms in a molecule, ion, or larger aggregate.

**Delrin** *n.* Poly(oxymethylene) (from formaldehyde). Manufactured by DuPont, USA.

**Delta *E*, Δ*E*** \ˈdel-tə\ *n.* Total color difference computed by use of a color difference equation. It is generally calculated as the square root of the sum of the squares of the chromaticity difference, $\Delta C$, and the lightness difference, $\Delta L$: $\Delta E = \left[(\Delta C)^2 + (\Delta L)^2\right]^{1/2}$.
*See color difference equations.*

**Delustering** *n.* Subduing or dulling the natural luster of a textile material by chemical or physical means. The term often refers to the use of titanium dioxide or other white pigments as delustrants in textile materials.

**Delustrant** *n.* A chemical agent used either before or after spinning to produce dull surfaces on synthetic fibers to obtain a more natural, silk like appearance.

**Denaturation** \(ˌ)dē-ˌnā-chə-ˈrā-shən\ (1685) *n.* Addition of unpleasant or toxic substances to a product to make it unfit for human consumption.

**Denatured alcohol** *n.* Ethyl alcohol to which denaturant (odorous and/or nauseating substances) has been added in small quantities to make it unpotable without diminishing its solvent power. Typical denaturants are benzene, acetaldehyde, and pyridine.

**Dendrite** \ˈden-ˌdrīt\ (1751) (dendritic) *n.* A branched, treelike crystal habit usually associated with rapid crystal growth.

**Denier** \di-ˈnī(-ə)r\ [ME *denere*, fr. MF *denier*, fr. L *denarius*, coin worth ten asses, fr. *denarius* containing ten, fr. *deni* ten each, fr. *decem* ten] (15c) *n.* A unit of weight expressing the size or coarseness but particularly the fineness of a relatively continuous fiber or yarn. The weight in grams of 9000 m of a fiber in the form of continuous filament. Although deprecated in SI, this is still the most widely used unit of lineal density in the textile industry to indicate fineness of natural or synthetic fibers. 1 denier = $1.1111 \times 10^{-7}$ kg/m. Joseph ML (1986) Textile science, 5th edn. CBS College Publishing, New York.
*See also cut, grex number, and tex.*

**Denier per filament (DPF)** \ˈfi-lə-mənt\ *n.* The denier of an individual continuous filament or an individual staple fiber if it were continuous. In filament yarns, it is the yarn denier divided by the number of filaments. Joespeh ML (1986) Textile science, 5th edn. CBS College Publishing, New York.

**Denier variation** *n.* Usually variation in diameter, or other cross-sectional dimension, along the length of a filament or bundle of filaments. It is caused by malfunction or lack of process control in fiber manufacturing and degrades resulting fabric appearance or performance. Joespeh ML (1986) Textile science, 5th edn. CBS College Publishing, New York.

**Denim** \ˈde-nəm\ [F (*serge*) *de Nîmes* serge of *Nîmes*, France] (1695) *n.* A firm 2 × 1 or 3 × 1 twill-weave fabric, often having a whitish tinge, obtained by using white filling yarns with colored warp yarns. Heavier weight denims, usually blue or brown, are used for dungarees, work clothes, and men's and women's sportswear. Lighter weight denims with softer finish are made in a variety of colors and patterns and are used for sportswear and draperies.

**Densitometer** \ˌden(t)-sə-ˈtä-mə-tər\ (1901) *n.* Instrument to measure the optical density of a transmitting material, or an instrument to measure the negative log of the reflectance of a reflecting material. Such instruments do not measure color. They are widely used in the graphic arts and photographic industries for process control. In spectrographic and dispersive X-ray analysis utilizing photography, they are adapted for scanning and plotting the density of the photographed transparency as a function of the wavelength.

**Density** \ˈden(t)-sə-tē\ (1603) (absolute density) *n.* Mass per unit volume of a substance. The SI unit is kg/m$^3$, but others in common use are g/cm$^3$, lb/ft$^3$, and lb/gallon. It is an important criterion in specifying some plastics, e.g., polyethylene, which can vary in density from 0.92 to 0.98 g/cm$^3$, with significant associated variation in properties such as modulus. Since density decreases with rising temperature, the temperature of measurement should be stated. *See www.astm.org* for current methods of determining density. *See also apparent density, bulk density, bulking value, gradient-tube density method, relative density, and specific gravity.*

**Density, apparent** *See apparent density.*

**Density gradient** \ˈgrā-dē-ənt\ *n.* A gradient of density such as in a gradient column for measuring density of plastic materials.

**Density, optical** Negative log of the transmittance.

*See Beer–Bouguer law and absorption coefficient.*

**Densothene** *n.* Poly(ethylene). Manufactured by Metal Box, Great Britain.

**Dent** *n.* On a loom, the space between the wires of a reed.

**Deoxy-** (desoxy-). A prefix denoting replacement of a hydroxyl group with hydrogen.

**Deoxyribonucleic acid** [*deoxyribose* + *nucleic acid*] (1938) *n.*

*See DNA.*

**DEP** Abbreviation for diethyl phthalate.

**Depolymerization** *n.* The reversion of a polymer to its monomer, or to a polymer of lower molecular weight. Such reversion occurs in most plastics when they are exposed to very high temperatures in the absence of air. Splitting of polymers into molecules or polymers of lower molecular weight. The temperature of depolymerization is symbolized as $T_d$. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers Inc., New York.

**Depolymerized rubber** *n.* Rubber which has been extensively milled or otherwise treated so that it has sufficient solubility in aromatic hydrocarbons for the resulting solution to be used as a varnish or varnish constituent.

**Deposit attack** *n.* Excessive corrosion that may occur under solid substances that may be deposited on a metal surface and thus shield it from ready access to oxygen or ions in the solution. This is a form of concentration cell corrosion.

**Deposition** *n.* (1) Usually referred to in metal treatment as the amount of treatment by weight (mg/ft$^2$). (2) Process of applying a material to a base by means of vacuum, evaporation, sputtering, electrolysis, chemical reaction, vapor methods, etc.

**Depropagation** *n.* The sequential chain scission step during depolymerization responsible for the formation of monomer. Has a lower activation energy than propagation and hence is favored at high temperatures.

**Depth of draw** *n.* In thermoforming, the depth of the lowest point in the formed object relative to the clamped edge of the sheet. *Also see draw ratio* (2).

**Depth of field** (1911) *n.* The thickness of the preparation brought into good focus at a single setting of the focusing adjustment. It lies in the plane of the specimen and decreases with an increase in numerical aperture.

**Depth of finish** *n.* The appearance phenomenon of a coating having an "apparent" depth. *Also referred to as "seeing into the film".*

**Depth of focus** *n.* The thickness of the image of the preparation appearing in good focus at one setting of the focusing adjustment.

**Depth of screw** Syn: *flight depth.*

**Depth of shade** Concept which embodies the subjective or visual equality of concentration of colorants, dyes, or pigments.
*See depth of shade, standard.*

**Depth of shade, standard** *n.* An arbitrarily chosen depth of shade for all hues, from which a uniform depth of shade may be determined for purposes of comparison. Depth of shade can then be described as a multiple or fraction of standard depth (developed primarily, and used most widely, in Europe).

**Derby red** \ˈdər-bē, *esp British* ˈdär-\ *n.* Basic lead chromate.
*See chrome orange, light, and deep.*

**Deregistering (Crimp)** Process of disordering or disaligning the crimp in a tow band to produce bulk.
*Also see threaded-roll process.*

**Derived high polymer** A polymer, which has been produced by chemical alteration of a primary high polymer or a natural high polymer.
*See also primary high polymer.*

**Dermatitis** \ˌdər-mə-ˈtī-təs\ (1876) *n.* Inflammation or irritation of the skin. Industrial dermatitis is an occupational skin disease. There are two general types of skin reaction: primary irritation dermatitis and sensitization dermatitis.

**Descaling** *n.* Removal of mill sale or caked rust from steel by chemical and/or mechanical means, sometimes assisted by flame cleaning.

**Desensitize** \(ˌ)dē-ˈsen(t)-sə-ˌtīz\ (1898) *vt.* To treat non-image areas of a water lithographic plate to make them water-receptive and ink-repellant.

**Desiccant** \ˈde-se-kənt\ (1676) *n.* A substance capable of absorbing water vapor from air and other materials enclosed with it; a drying agent. Typically used to maintain low humidity in a storage or test vessel or package.

**Desiccant dryers** *n.* Materials, which absorb water from air (e.g., silica gel).

**Desiccator** \de-si-ˈkā-tər\ *n.* A plastic or heavy-glass bowl with a tight-fitting lid, containing a drying agent, in which a sample can be kept in a controlled, dry atmosphere, typically under a mild vacuum.

**Designers color** *n.* Opaque watercolor paints that dry flat and are not necessarily permanent.

**Design life** *n.* The period through which a part or product is expected to perform satisfactorily, remaining within preset performance tolerances.

**Desmodur** *n.* Isocyanate grades for polyurethane. Manufactured by Bayer, Germany.

**Desmophen** *n.* Polyester for polyurethanes. Manufactured by Bayer, Germany.

**Desorption** \-ˈsórp-shən\ (1924) *n.* The escape or loss of a substance previously absorbed into, or adsorbed onto, another.

**Destaticization** *n.* The treating of a plastic to minimize its tendency to accumulate static electric charge, or removal of charge.

*See also antistatic agent, static eliminator, and soot-chamber test.*

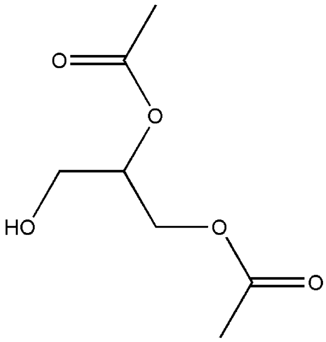
**Destructive distillation** \di-ˈstrek-tiv ˌdis-tə-ˈlā-shən\ (ca. 1831) *n.* Decomposition of an organic material by heating in the absence of air. Destructive distillation of wood, which produces charcoal and several small organic molecules, was once the major source of methanol.

**Destructively distilled pine oil** *See pine oil.*

**Destructively distilled wood turpentine** *See turpentine.*

**Desulfurizing** \(ˌ)dē-ˈsəl-fər-ˌīz-eŋ\ *vt.* An after treatment to remove sulfur from newly spun viscose rayon by passing the yarn through a sodium sulfide solution.

**DETA** *n.* Abbreviation for diethylenetriamine (*See image*).



**Detection limit** *n.* Of chemical quantitative analyses, the least quantity of concentration of the substance being sought that can be detected with a stated level of confidence. This widely used term may be giving way to minimum detectable amount.

**Detergent** \-jənt\ (1616) *adj.* A surface-active agent that possesses the ability to clean soiled surfaces. *Anionic detergent* – A detergent that produces aggregates of negatively charged ions with colloidal properties. *Cationic detergent* – A detergent that produces aggregates of positively charged ions with colloidal properties. *Nonionic detergent* – A detergent that produces aggregates of electrically neutral molecules with colloidal properties.

*See surfactants.*

**Deterioration** \di-ˌtir-ē-ə-ˈrā-shən\ (ca. 1658) *n.* A usually gradual process of permanent impairment in the appearance or application of physical properties.

*See degradation.*

**Deuterium** \dü-ˈtir-ē-əm *also* dyü-\ [NL, fr. Gk *deuteros* second] (1933) *n.* Hydrogen 2; ${}^{2}_{1}H$; "heavy hydrogen." College physics. McGraw-Hill Science/Engineering/Math, New York, 2003.

**Deuteron** *n.* Nucleus of the deuterium atom or the ion of deuterium. Its structure – one neutron and one proton.

**Developed dyes** *n.* Dyes that are formed by the use of a developer. The substrate is first dyed in a neutral solution with a dye base, usually colorless. The dye is then diazotized with sodium nitrate and an acid and afterwards treated with a solution of *β*-naphthol, or a similar substance, which is the developer. Direct dyes are developed to produce a different shade or to improve washfastness or lightfastness.

*See dyes.*

**Developing** *n.* A stage in dyeing or printing in which leuco compounds, dyes, or dye intermediates are converted to the final, stable state or shade.

**Developing ink** *n.* A non-drying greasy ink composition specifically formulated for use in initial fixing or subsequent renewal of the image on a lithographic plate.

**Devolatilization** *n.* The removal from a resin of a substantial percentage of some unwanted volatile matter such as water, solvent, or monomer. Vented extruders have been widely used for this task.

*See extraction extrusion.*

**Dew point** (dew temperature) (ca. 1833) *n.* Temperature of the atmosphere at which the saturation vapor pressure equals the actual vapor pressure of the water vapor in the air and dew begins to form.

**Dewaxing** *n.* Process of removing waxes from natural resins (dammars, shellacs, etc.).

**Dexel** *n.* Cellulose acetate, manufactured by British Celanese, Great Britain.

**Dexsil** *n.* Poly(carborane siloxane), manufactured by Olin, USA.

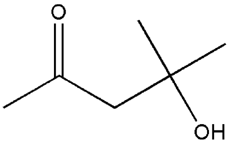
**Dextin** Water-soluble adhesive or thickener prepared by the incomplete hydrolysis of starch by thermostatic (use of diastase), or acid methods. Syn: British gum.

**Dextrorotatory** \ˈdek-(ˌ)strō-ˈrō-t ə-ˌtōr-ē\ (1878) *adj.* To turn clockwise (sym. is D) or toward the right; *esp*: rotating the plane of polarization of light toward the right, <-crystals> – compare levorotatory (rotates light to the left). Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**DGEBA** *n.* Abbreviation for diglycidyl ether of bisphenol.

**D-Glass** *n.* Glass with a high boron content, used for fibers in laminates that require a precisely controlled dielectric constant.

**DHA** *n.* Abbreviation for dehydroacetic acid (*See image*).

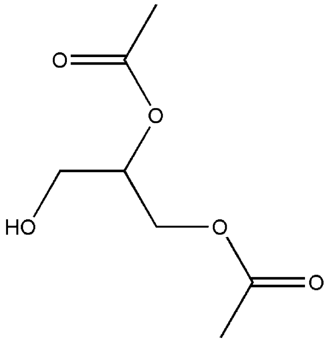


**DHP** *n.* Abbreviation for dihexyl phthalate. *See di(2-ethyl-butyl)phthalate.*

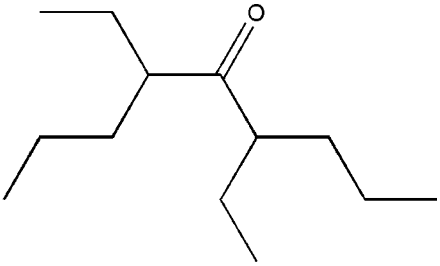
**DHXP** *n.* Same as DHP, preceding.

**Di-** A prefix meaning two or twice. The terms *bi-* and *bis-* are nearly equivalent, assigned with slight differences in meaning according to custom.

**Diacetin** *n.* (glyceryl diacetate. (1,3-diacetin), and 1,2-diacetin, a mixture of isomers. A water-soluble plasticizer, and a solvent for cellulose nitrate and cellulose acetate (*See image*).



**Diacetone alcohol** (4-hydroxy-4-methyl-2-pentanone) *n.* A pleasant-smelling, colorless liquid, miscible with water and most organic liquids, used as a solvent for cellulosic, vinyl, and epoxy resins. Mol. wt., 116.16; Sp gr, 0.9406/20°C; bp, 169°C (760 mmHg); flp, 52°C (125°F). Syn: diacetone (*See image*).



**Diacetyl peroxide** *See acetyl peroxide.*

**Diafoam** *n.* A term sometimes used for syntactic foam that contains gas bubbles in addition to microspheres.

**Diagonal (45°C) flame test** \dī-ˈa-gə-nᵊl\ *n.* *See flammability test.*

**Diagonal grain** *n.* Grain in which the longitudinal elements form an angle with the axis of the piece as a result of sawing at an angle with the bark of the tree or log; a form of cross grain.

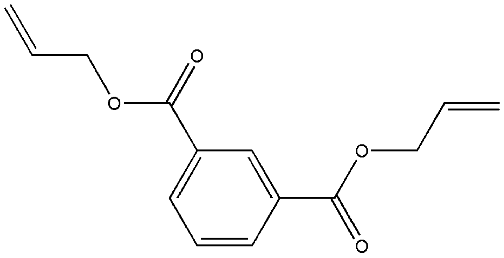
**Diagonal-grained wood** *n.* Wood in which the fibers are at an angle with (i.e., diagonal to) the axis of a piece as a result of sawing at an angle with the axis of the tree.

**Dial** \ˈdī(-ə)l\ [ME *dyal*, fr. ML *dialis* clock wheel revolving daily mfr. L *dies* day] (15c) *n.* In a circular-knitting machine, a circular steel plate with radically arranged slots for needles. A knitting machine equipped with both a dial and a cylinder can produce double-knit fabrics. Tortora PG, Merkel RS (2000) Fairchild's dictionary of textiles, 7th edn. Fairchield Publications, New York.

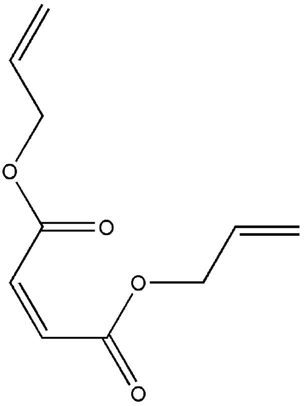
**Diallyl chlorendate (DAC)** *n.* A reactive monomer used as a flame-resisting agent in diallyl phthalate, epoxy, and alkyd resins. It can be used in the monomeric form (a high-viscosity liquid); or in the polymeric form, alone or in conjunction with other flame retardants.

**Diallyl esters** *n.* Series of unsaturated esters, which polymerize rapidly to yield cross-linked resins in the presence of peroxides at relatively low temperatures (e.g., 40–100°C).

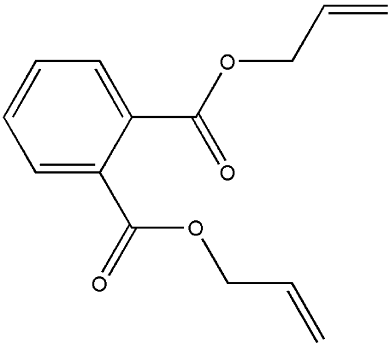
**Diallyl isophthalate** *n.* A polymerizable monomer, used in laminating and molding (*See image*).



**Diallyl maleate** *n.* A monomer that polymerizes readily when exposed to light or temperatures above 50°C (*See image*).



**Diallyl phthalate (diallyl *o*-phthalate, DAP)** *n.* In the monomeric form, DAP is a colorless liquid ester with a viscosity about equal to that of kerosene, widely used as a cross-linking monomer for unsaturated polyester resins, and as a polymerizable plasticizer for many resins. If polymerizes easily, either gradually or rapidly, increasing in viscosity until it finally becomes a clear, infusible solid. The name DAP is used for both the monomeric and polymeric forms. In the partly polymerized form, DAP is used in the production of thermosetting molding powders, casting resins, and laminates (*See image*).



**Diallyl phthalate resins** *n.* Laminating resin prepared by free radical polymerization of diallyl phthalate. The polymer is highly cross-linked, with good thermal stability and retention of electrical properties under conditions of wet and dry heat.

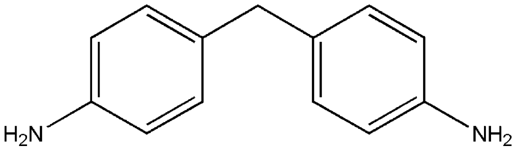
**Di-alphinyl phthalate** *n.* A plasticizer derived by the esterification of primary aliphatic alcohols in the range $C_7$ to $C_9$. It is used in place of dioctyl phthalate in some applications.

**Dialysis** \dī-ˈa-lə-səs\ [NL, fr. Gk, separation, fr. *dialyein* to dissolve, fr. *dia-* + *lyein* to loosen] (1861) *n.* The separation of different-sized molecules by transport in solution through a semipermeable membrane, driven by the difference in chemical potential between the liquids separated by the membrane. The membranes may be any of a wide range of materials, e.g., parchment or microporous films of cellulosic polymers.

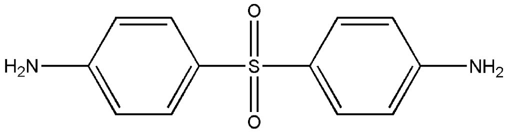
**Diamagnetic materials** \ˌdī-ə-mag-ˈne-tik\. Are those within which an externally applied magnetic field is slightly reduced because of an alteration of the atomic electron orbits produced by the field. Diamagnetism is an atomic-scale consequence of the Lenz law of induction. The permeability of diamagnetic material is slightly less than that of empty space.

**Diamine** \ˈdī-ə-ˌmēn\ [ISV] (1866) *n.* A compound with two amino groups. Hexamethylenediamine, one of the intermediates in the manufacture of nylon-66 salt, is an example of this chemical type.

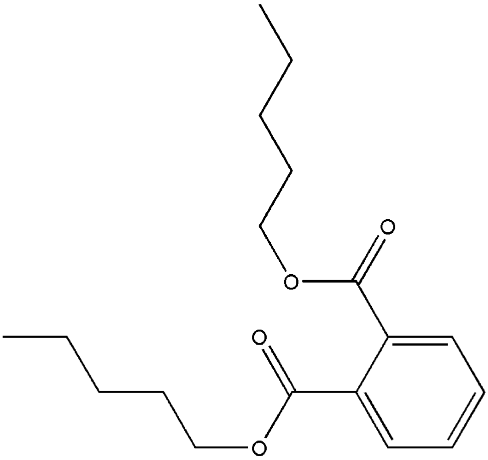
**4,4′-Diaminodiphenylmethane** (DDM, methylenediamine, MD) *n.* A silvery, crystalline material obtained by heating formaldehyde aniline with aniline hydrochloride and aniline. It is used as a curing agent for epoxy resins and as an intermediate in making diisocyanates for urethane elastomers and foams by reaction with phosgene. Possible occupational hazards in the use of DDM are toxic hepatitis and liver damage (*See image*).



**4,4′-Diaminodiphenylsulfone (DDS)** *n.* An epoxy curing agent that gives the highest deflection temperatures among amine-cured epoxies.



**Diamyl phthalate** *n.* $C_6H_4(COOC_5H_{11})_2$. A plasticizer derived by esterification of phthalic anhydride with amyl alcohol, compatible with most vinyls, polymethyl methacrylate, and cellulosics.



**Diaphragm gate** \ˈdī-ə-ˌfram\ (web gate) *n.* In an injection or transfer mold, a gate that forms a complete thin web across the opening of the part, used in the molding of annular and tubular objects.

**Diarylide yellow** A strong yellow toner used in many types of printing inks.
*See benzidine yellow.*

**Diatomaceous calcite** \ˌdī-ə-tə-ˈmā-shəs ˈkal-ˌsīt\ *n.* $2.4\ CaCO_3{\cdot}SiO_2$ (approximate). Liquid blend of $CaCO_3$ and diatomaceous silica that is mined from a single large deposit located in Kansas. Used as an extruder. Sp gr, 2.54; density, 21.2 lb/gal; O.A., 25 lb/100 lb; particle size, 10 µm.

**Diatomaceous earth** (1883) *n. See diatomaceous silica.*

**Diatomaceous silica** *n.* $SiO_2 \cdot 7H_2O$. Pigment White 27 (77811). A form of hydrous silica, processed from natural diatomate, a sedimentary rock of varying degrees of consolidation that is composed essentially of the fossilized siliceous skeletal remains of single-cell aquatic plant organisms called diatoms. Refractive index, 1.42; density, 2.00 g/cm$^3$ (16.7 lb/gal); particle size, 6–10 μm. Syn: diatomaceous earth, diatomite, and the obsolete names of kieselguhr, infusorial earth, tripoli.

**Diatomite** \di-ˈa-tə-ˌmīt\ (1887) (diatomaceous earth, DE, kieselguhr, infusorial earth, siliceous earth, and tripolite) *n.* The naturally occurring deposit of skeletons of small unicellular algae called *diatoms*, consisting of from 83 to 89% silica. Its many uses include fillers for plastics.

**Diazo** \dī-ˈa-(ˌ)zō\ [ISV *diaz-*, *diazo-*, fr. *di-* + az-] (1878) *adj.* –N = N– grouping. Diazo compounds are intermediates for manufacture of dyestuffs.

**Diazo solution** Solution resulting from treatment of an aromatic primary amine with sodium nitrite and mineral acid. Such solutions are stable only below 5°C and are employed as one of the ingredients in the manufacture of azo colors.

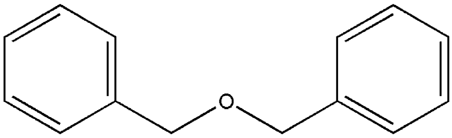
**DIBA** *n.* Abbreviation for diisobutyl adipate.

**Dibasic** \(ˌ)dī-ˈbā-sik\ (1868) *adj.* Pertaining to acids having two replaceable hydrogen atoms, e.g., sulfuric acid, $H_2SO_4$, or to acid salts in which two of the three hydrogens have been replaced by metal(s), e.g., $K_2HPO_4$.

**Dibasic lead phosphite** *n.* $2PbO \cdot PbHPO_3 \cdot 0.5H_2O$. A white, crystalline powder long used as a heat and light stabilizer for PVC and other chlorine-containing resins. It has good electrical properties, and acts as an antioxidant and screening agent for UV light. Less used today because of concern to keep lead out of the environment.

**Dibasic lead stearate** *n.* $2PbO \cdot Pb(OOCC_{17}H_{35})_2$. A good heat stabilizer with lubricating properties.
*See also lead stearate.*

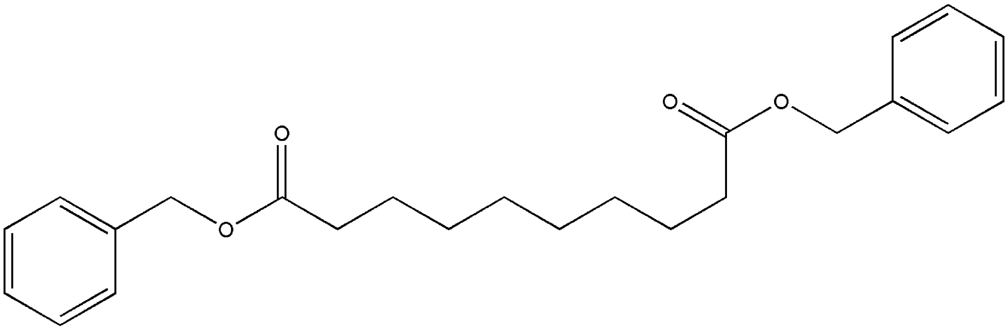
**Dibenzyl ether** $(C_6H_5CH_2)_2O$. A plasticizer for cellulose nitrate.



**Dibenzyl phthalate** *See benzyl phthalate.*

**Dibenzyl sebacate** *n.* $(C_6H_5CH_2OOC)_2(CH_2)_8$. A non-toxic plasticizer, often used in vinyl compounds for lining container closures.

**Diblock polymers** *n.* Block copolymers consisting of two blocks, one of A repeating



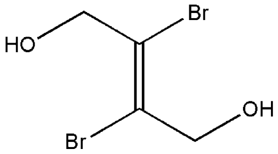
units and one of B repeating units. Thus its structure may be represented as follows:

AAA . . . AAAABBBB . . . BBB.

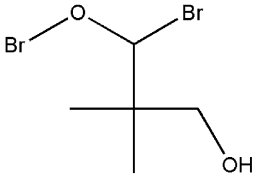
**Diborane** \-ˈbōr-ˌān\ *n.* $B_2H_6$ (boron hydride, boro-ethane). A colorless gas that has been used as a catalyst in the polymerization of ethylene.

**DIBP** Abbreviation for diisobutyl phthalate.

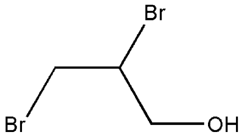
**2,3-Dibromo-2-butene-1,4-diol** *n.* (dibromobutenediol). $HOCH_2C(Br){=}C(BR)CH_2OH$. A low-molecular weight, chemically reactive, brominated primary glycol. It is used as a building block for condensation polymers that can be incorporated into a wide variety of polymers including esters, urethanes, and ethers. It is also used as a flame-retardant monomer for polyurethanes and thermoplastics, and as a substitute for methylene-bis-*o*-chloroniline (MOCA) in urethane foams.



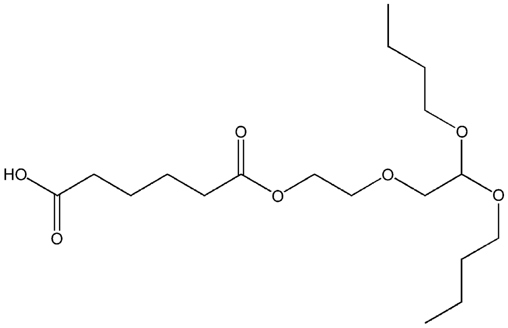
**Dibromoneopentyl glycol** *n.* A high-melting solid, available in powder or flake form, used as a flame retardant for polyester resins. A more convenient liquid material is made by using dibromoneopentyl glycol to form a polyester alkyd that is dissolved in styrene, the resulting liquid being more easily used in polyester reactors. The material is also adaptable to urethane foams, polymeric plasticizers, and coating resins.



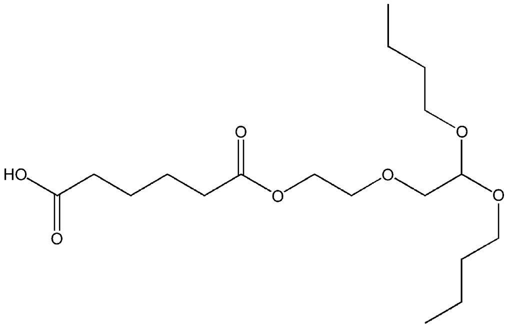
**2,3-Dibromopropanol** *n.* A brominated alcohol used as a component in making fire-retardant urethane foams.



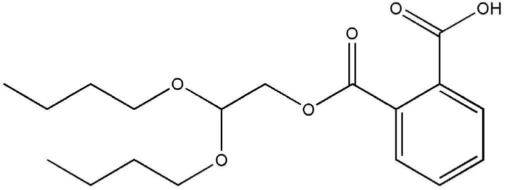
**Dibutoxyethoxy ethyl adipate** *n.* $[C_4H_9OC_2H_4OC_2H_4COO(CH_2)_2]_2$. A plasticizer for cellulose nitrate, ethyl cellulose, polyvinyl butyral, and polyvinyl acetate.



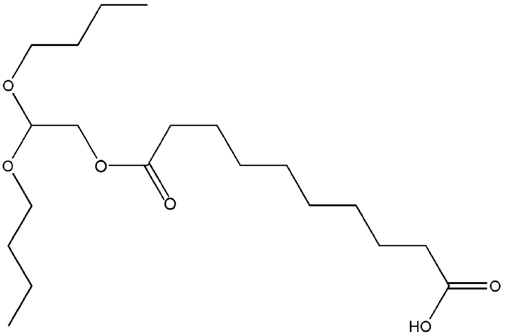
**Dibutoxyethyl adipate** *n.* $(C_2H_4COOC_2H_4OC_4H_9)_2$. A primary plasticizer for PVC and many other resins, imparting low-temperature flexibility and UV resistance. It is widely used as a plasticizer for polyvinyl butyral in the interlayer of safety glass.



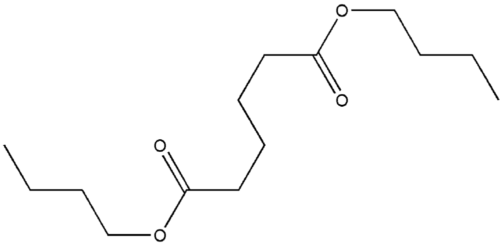
**Dibutoxyethyl phthalate (DBEP)** *n.* $C_6H_4(COOC_2H_4OC_4H_9)_2$. A primary plasticizer for vinyls, methacrylates, nitrocellulose, and ethyl cellulose, imparting low-temperature flexibility and UV resistance. Incorporation of up to 20% of DBEP into vinyl calendaring compounds eliminates defects such as streaks and blisters. In plastisols, DBEP imparts low initial viscosity and low fusion temperatures.



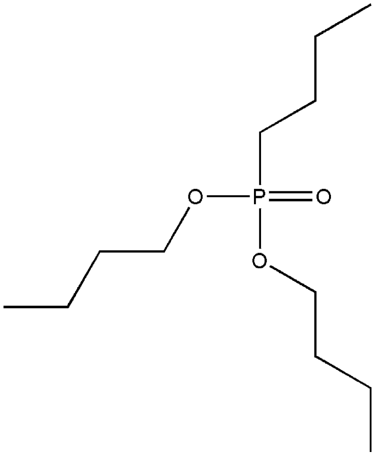
**Dibutoxyethyl sebacate** *n.* $(CH_2)_8(COOC_2H_4OC_4H_9)_2$. A primary plasticizer for PVC and PVAc, with low-temperature resistance.



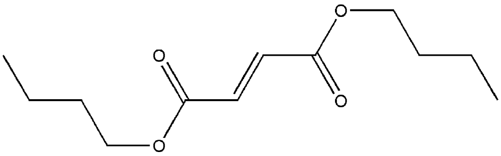
**Dibutyl adipate** \ˌdī-ˈbyü-təl-\ *n.* $(C_4H_9COO)_2(CH_2)_4$. A plasticizer for vinyl and cellulosic resins.



**Dibutyl butyl phosphonate** *n.* $C_4H_9P(O)(OC_4H_9)_2$. A plasticizer and antistatic agent.

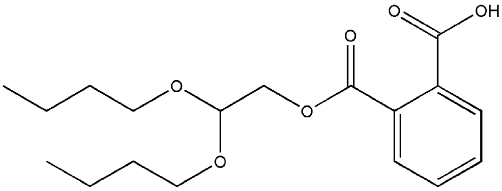


**Dibutyl fumarate** \fyú-ˌmar-ˈnāt\ *n.* $C_2H_2(COOC_4H_9)_2$. Derived from fumaric acid and used as a plasticizer for polyvinyl acetate, polyvinyl chloride, and PVC-AC copolymers.



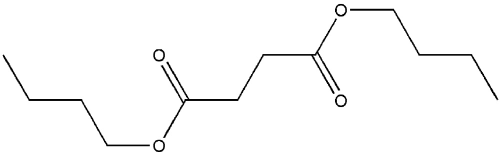
**Dibutyl isosebacate** *n.* $C_8H_{16}(COOC_4H_9)_2$. A plasticizer for vinyls and other thermoplastics.

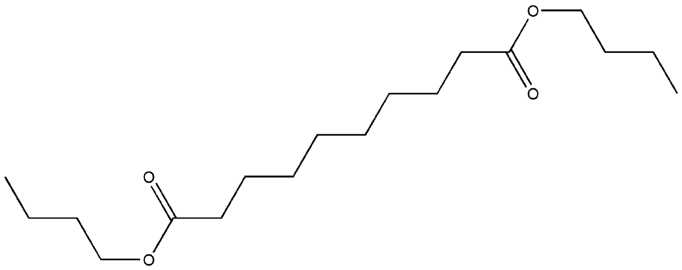
**Dibutyl phthalate** [*phthal*ic acid + $^1$-*ate*] (1925) (DBP) *n.* $C_6H_4(COOC_4H_9)_2$. One of the most widely used plasticizers for cellulose nitrate and other cellulose-ester and -ether lacquers and coatings. It is a primary plasticizer for many other resins, but its high volatility limits its use in vinyls. Sp gr. 1.0484 (20/20°C); flp, cleveland open cup, 171°C (340°F); bp, 340°C.



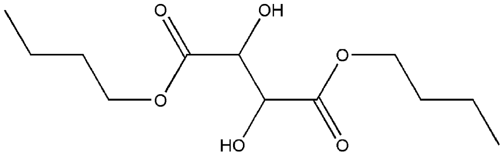
**Dibutyl sebacate (DBS)** *n.* $(CH_2)_8(COOC_4H_9)_2$. A plasticizer, one of the most effective of the sebacate family. It has good low-temperature properties, low volatility, and is compatible with vinyl chloride polymers and copolymers, polyvinyl butyral, and ethyl cellulose. It is non-toxic, suitable for uses in food wrappings.

**Dibutyl succinate** \ˈsək-sə-ˌnāt\ *n.* $(CH_2)_2(COOC_4H_9)_2$. A plasticizer for cellulosic resins.



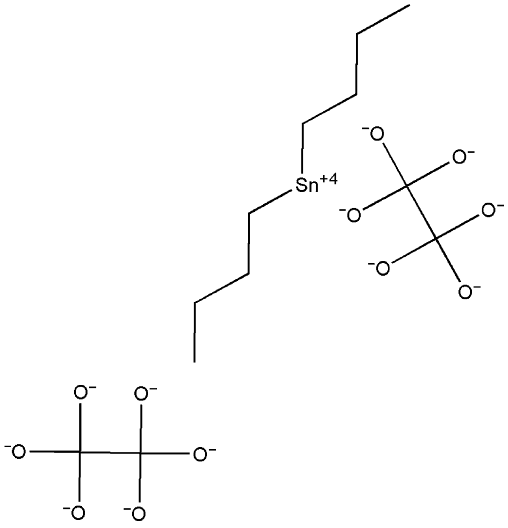


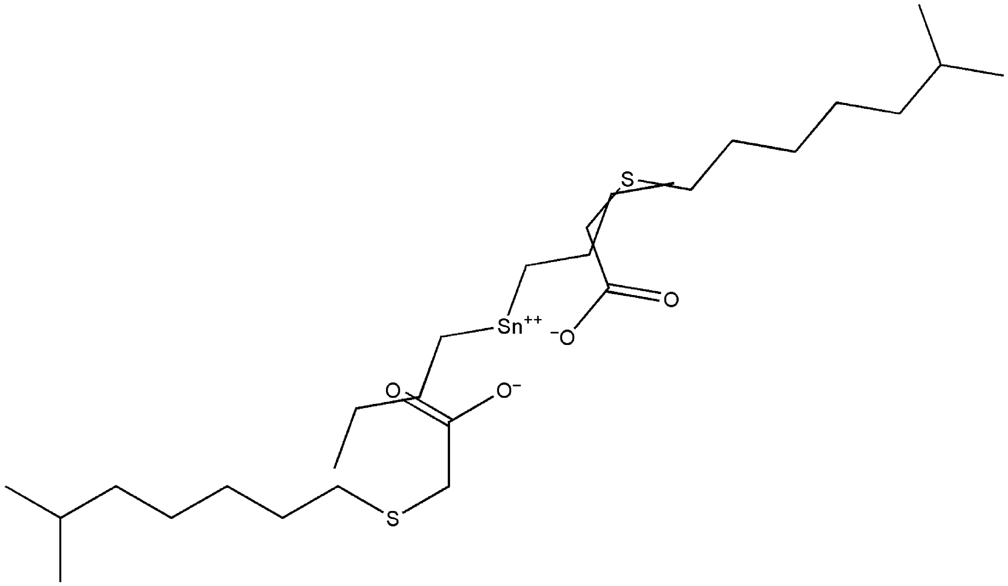
**Dibutyl tartrate** \ˈtär-ˌtrāt\ *n.* $(CHOH)_2(COOC_4H_9)_2$. A lubricant, plasticizer, and solvent for cellulosic resins.



**Dibutyltin bis(isooctylmercapto acetate)** *n.* A stabilizer for rigid PVC, used primarily during the period from 1953 to 1970. Thereafter, improved butyltin and methyltin derivatives, and synergistic mixtures of them with other stabilizers, replaced this stabilizer for most uses.

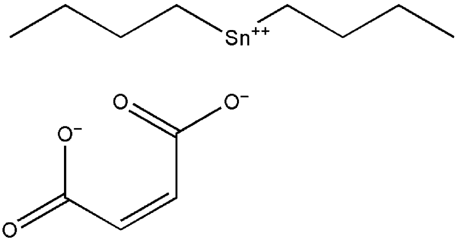
**Dibutyltin di-2-ethylhexoate** *n.* $(C_4H_9)_2Sn(OOCC_7H_{18})_2$. A white, waxy solid made by reacting dibutyltin oxide with 2-ethylhexoic acid. Used as a catalyst for silicone curing and in polyether foams.



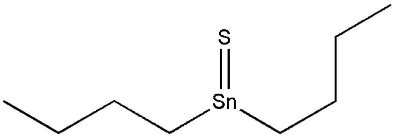


**Dibutyltin dilaurate (DBTDL)** *n.* $(C_4H_9)_2Sn(OOCC_{11}H_{23})_2$. A lubricating stabilizer for vinyl resins, a catalyst for urethane foams and for condensation polymerizations. It is used in vinyl compounds when good clarity is needed, and also imparts excellent light stability. However, it degrades at high processing temperatures.

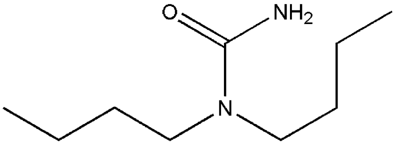
**Dibutyltin maleate** *n.* $[(C_4H_9)_2Sn(OOCCH)_2]_{\chi}$. A white amorphous powder used as a condensation–polymerization catalyst and a stabilizer for PVC. The molecular weight of the material varies, and grades of lower molecular weight tend to be volatile and produce gases. The higher-weight polymers are very effective in rigid PVC.



**Dibutyltin sulfide** *n.* $[(C_4H_9)_2SnS]_3$. An antioxidant and stabilizer for vinyl resins.



**1,1-Dibutylurea** *n.* (*N,N*-dibutylurea) $NH_2CON(C_4H_9)_2$. A polymerizable compound. When copolymerized with simple urea and formaldehyde, permanently thermoplastic resins are obtained.

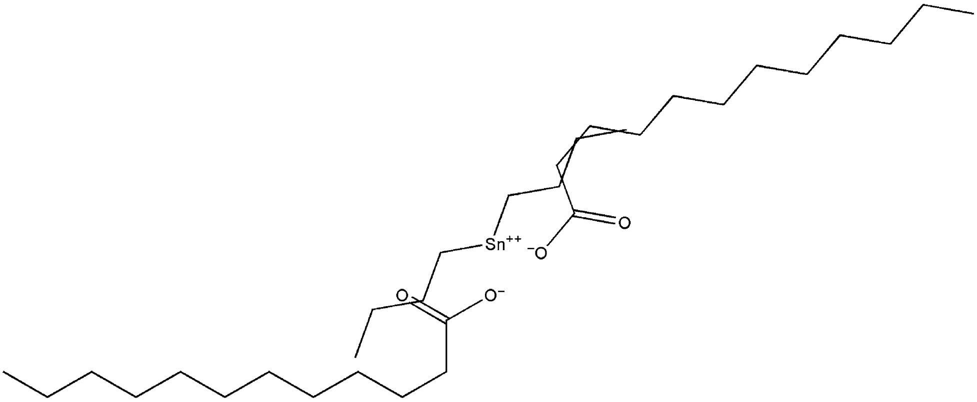


**Dicapryl adipate** *n.* $C_4H_8(COOC_8H_{17})_2$. A plasticizer for cellulosic and vinyl resins, yielding good low-temperature flexibility. Also compatible with polymethyl methacrylate and polystyrene.

**Dicapryl phthalate** *n.* [(DCP) di-(2-octyl) phthalate] $(C_8H_{17}COO)_2C_6–H_4$. A plasticizer for cellulosic and vinyl resins. It is similar to DOP and DIOP, but has low initial viscosity and is preferred in plastisols.

**Dicapryl sebacate** *n.* $(CH_2)_8(COOC_8H_{17})_2$. A plasticizer for vinyl resins and acrylonitrile rubbers, imparting good low-temperature flexibility.

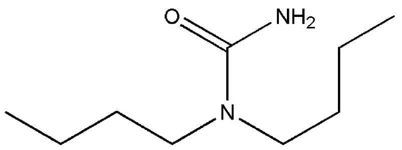
**Dicarboxylic acid** \ˌdī-ˌkär-ˌbäk-ˈsi-lik\ *n.* Any of a large family of organic acids containing two carboxylic (–COOH) groups. Those of greatest importance in the plastics industry are the adipic, azelaic, glutaric,



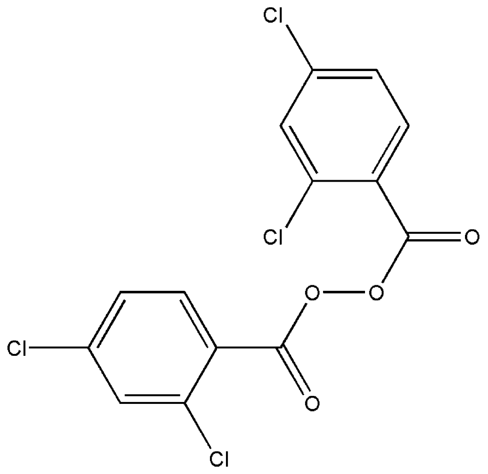
pimelic, sebacic, and succinic acids, esters of which are widely used as plasticizers that impart low-temperature flexibility. They are also used in the production of alkyd and polyester resins, polyurethanes, and nylons.

**Dicers** *n.* One of the two basic types of cold cutting systems. It consists of a die, a cooling area, a drying area (if water was used), and a cutting chamber.

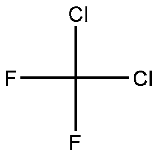
**Dicetyl ether** \-ˈsē-təl ˈē-thər\ (dihexadecyl ether). A mold lubricant.



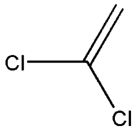
**2,4-Dichlorobenzoyl peroxide** *n.* A cross-linking agent for silicone elastomers. It is sold as a 40% active paste dispersed in silicone fluid (Candox®).



**Dichlorodifluoromethane** \-ˌdī-ˌflúr-ə-ˈme-ˌthān\ (1936) (Freon 12) *n.* $CCl_2F_2$. Long used as a refrigerant, aerosol propellant, and as a blowing agent for foamed plastics that was safer than inflammable hydrocarbons, this accused destroyer of stratospheric ozone is rapidly being phased out of all its former uses.

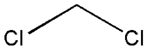


**1,1-Dichloroethylene** *n.* Syn: vinylidene chloride.

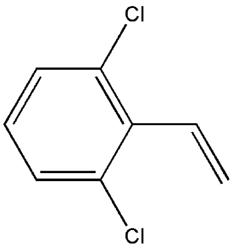


**α-Dichlorohydrin** *n.* $CH_2ClCHOHCH_2Cl$. A cellulosic-resin solvent.

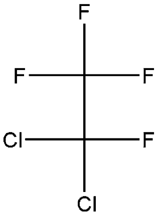
**Dichloromethane** \(ˌ)dī-ˌklō-rō-ˈe-ˌthān\ (1936) *n.* Syn: methylene chloride.



**2,6-Dichlorostyrene** *n.* $Cl_2C_6H_3CH{=}CH_2$. A monomer and comonomer used mainly in plastics research.



**Dichlorotetrafluoroethane** (Freon 114) *n.* $ClF_2CCClF_2$. A fluorocarbon blowing agent used when a low boiling point (3.6°C) is required.

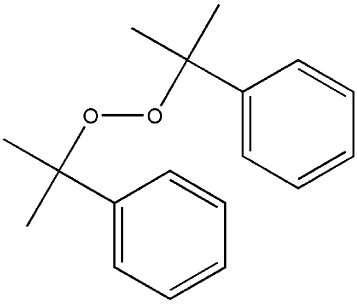


**Dichroism** \ˈdī-(ˌ)krō-ˌi-zəm\ (1819) *n.* (1). A property possessed by many doubly refracting crystals of exhibiting different colors when viewed from different directions. (2) Displaying different colors as a result of changes in concentration or thickness. Such changes do not result from changes in the absorption coefficients for the material, but rather on the change in perceived color resulting from more or less absorption across the visible spectrum as the concentration is changed. The term "dichroism" is frequently used (incorrectly) to describe this effect. Dichromism is predictable on the basis of the laws of subtractive colorant mixture.

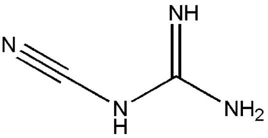
**Dicing** *n.* The process of cutting thermoplastic sheets (or square strands) into cubical pellets for further processing.

**Di-compounds** *n. See under other headings, such as ethyl oxalate for diethyl oxalate, etc.*

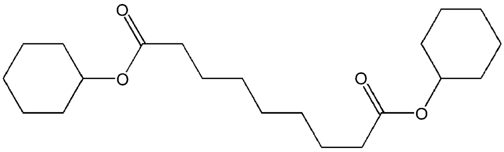
**Dicumyl peroxide** *n.* $[C_6H_5C(CH_3)_2O]_2$. A vulcanizing agent for elastomers, also used to cross-link polyethylene.



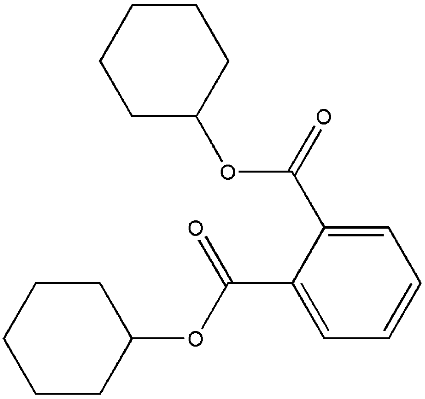
**Dicyandiamide** *n.* (cyanoguanidine) $H_2NC(=NH)NHCN$. The widely used, but incorrect name for the dimmer of cyanamide. Cyanoguanidine is used mainly in the production of melamine, but also as a stabilizer for vinyl resins and curing agent for epoxy resins.



**Dicyclohexyl azelate** *n.* $C_6H_{11}OOCC_7H_{14}COOC_6H_{11}$. A plasticizer for PVC.



**Dicyclohexyl phthalate (DCHP)** *n.* $C_6H_4(COOC_6H_{11})_2$. A plasticizer for PVC and many other resins. It imparts good electrical properties, low volatility, low water and oil absorption, and resistance to extraction by hexane and gasoline. In vinyls DCHP is usually combined with other plasticizers. In cellulose nitrate, polystyrene, polymethyl methacrylate, and ethyl cellulose it serves as a primary plasticizer.

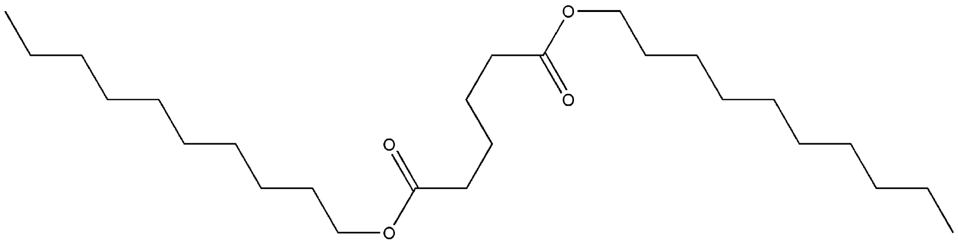


**DIDA** *n.* Abbreviation for diisodecyl adipate.

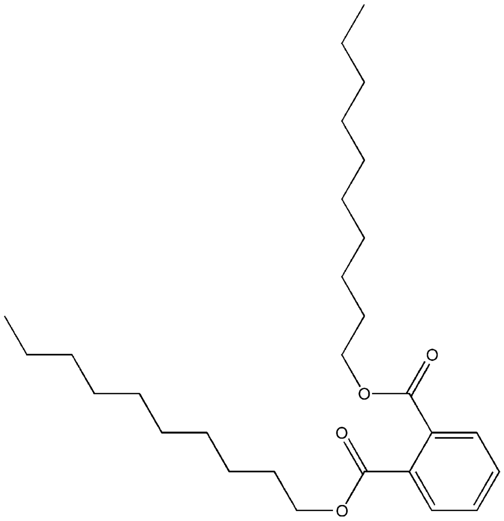
**Didecyl adipate** *n.* $C_4H_8(COOC_{10}H_{21})_2$. A plasticizer for PVC and cellulosics. Its most noteworthy properties are low-temperature flexibility, low volatility, and good electricals.

**Didecyl ether** *n.* $(C_{10}H_{21})_2O$. A processing and mold lubricant.

**Didecyl phthalate (DDP)** *n.* $C_6H_4(COOC_{10}H_{21})_2$. A primary plasticizer for vinyl resins, also compatible with polystyrene and cellulosics. It has the lowest specific gravity of the most common phthalate

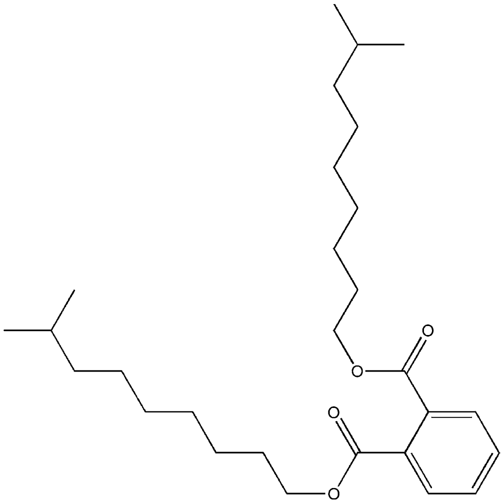


plasticizers, low volatility, and resistance to extraction by soapy water.



**DIDG** *n.* Abbreviation for diisodecyl glutarate.

**DIDP** *n.* Abbreviation for diisodecyl phthalate.



**Die** \ˈdī\ [ME *dī*, fr. MF *dé*] *n.* (1) Extrusion die. (2) The recessed block into which plastic material is injected or pressed, shaping the material to the desired form. The terms *mold cavity* or *cavity* are more often used. (3) Steel-rule die.

*See die cutting.*

**Die adapter** (extrusion) *n. See adapter.*

**Die blade** (die lip). In extrusion, a deformable member attached to a die body that determines the slot opening and that may be adjusted to produce uniform thickness across the film or sheet being made.

**Die block** *n.* That part of an extrusion die that holds the forming bushing and core.

**Die body** *n.* In the USA same as adapter. In Great Britain, the outer body or barrel of an extrusion die.

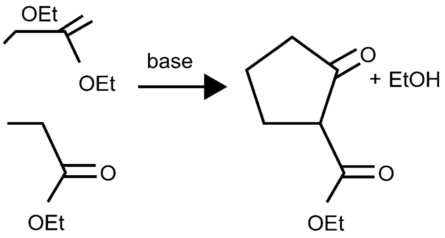
**Die cart** *n.* A sturdy, height-adjustable framework on casters designed to support a heavy extrusion die, such as a sheet die.

**Die characteristic** Of an extrusion die, the relationship between rate of flow of melt through the die, the pressure drop through the die, and the viscosity of the melt. It is defined by the flow equation

$$Q = K\,\Delta P/\eta,$$

in which $Q$ is the volumetric flow rate, $P$ the pressure drop, $\eta$ the effective viscosity at the temperature and shear rate of the melt in the die, and $K$ is the die characteristic. $K$ is dependent on die dimensions and has the dimensions of volume. The die characteristic is linked to the screw characteristic by $\Delta P$, which must be the same for both, whereas $\eta$ usually will not be the same for both.

**Dieckmann reaction** *n.* Cyclization by way of a base catalyzed intramolecular casein type reaction of esters with active delta or epsilon ethylenes (*See image*).



**Die core** *n.* The tapered element in an extrusion die for pipe or tubing that guides the material to the webs of the spider. *Sometimes called the torpedo* or *spreader.*

**Die cutters** *n.* Cuts shapes from sheet stock by sharply striking it with a shaped knife-edge, known as steel rule die.

**Die cutting** (blanking, clicking, and drinking) *n.* The process of cutting shapes from sheets of plastic by pressing a shaped knife-edge through one or several layers of sheeting. The dies are often called *steel-rule dies*, and pressure is applied smartly by hydraulic or mechanical means.

**Die-entry angle** *n.* At the entrance to the land of an extrusion die, the angle included between the adjacent, inside die surfaces. In many rheometer orifices and in some profile dies, the entry angle is 180°, the extreme of abruptness in actual use. Streamlined-entry dies stretch out the reduction and change of cross-sectional shape over a distance, so the included angle at the die lip may be 20–60°. Extreme gradualness is designed into high-speed wire-coating dies, where the approach to the lip is made in several states of decreasing taper, the final included angle being only 6–10°.

**Die gap** (die-lip opening) *n.* In film and sheeting dies, the perpendicular distance between the lips of the die land at any point along the width of the die, usually measured after the die has been brought up to temperature but before extrusion has begun. During extrusion, internal pressure inside the die causes the gap to enlarge slightly, more at the center than at the ends of a center-fed die, necessitating adjustments to attain uniform thickness across the film or sheet.

**Die land** *n.* In an extrusion die, the land is the portion of the die wherein the dimensions of the opening are constant from a point within the die to the discharge point, giving the extrudate its final shape.

**Dielectric** \ˌdī-ə-ˈlek-trik\ [*dia-* + *electric*] (1837) *n.* A material with electrical conductivity less than $10^{-6}$ S/cm (1 μS/cm), thus so weakly conductive that different parts of a sheet can hold different electrical charges. In radio-frequency heating, the term dielectric is used for the material being heated. The term is also used for the non-conductive material separating the conductive elements of a capacitor. Polymeric materials are widely employed as dielectrics. The two most important properties of a dielectric are its dielectric constant and dielectric strength, defined below. Values for some polymeric and other dielectrics at 60 Hz and room temperature are listed here.

| Material | Dielectric constant | Dielectric strength (kV/mm) |
|---|---|---|
| Air | 1.00054 | 0.8 |
| Alumina* | 3.5 | 1.6–6.3 |
| Pyrex glass | 4.5 | 13 |
| Bond paper | 3.5 | 14 |
| Polyethylene | 2.3 | 18–39 |

| | | |
|---|---|---|
| Polypropylene | 2.1–2.7 | 18–26 |
| Nylon 6/6 | 3.6–4.0 | 12–16 |
| Glass-reinforced nylon 6/6 | 4.0–4.4 | 19 |
| Crystal polystyrene | 2.5–2.65 | 20–28 |
| Acrylic resin | 3.3–3.9 | 16 |
| Phenoxy resin | 4.1 | 16–20 |
| Thermoplastic polyurethane | 6–8 | 33–43 |
| GP phenolic | 5–10 | 12–17 |
| Epoxy/glass | 5.5 | 14 |

*At 1 MHz.

Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Dielectric absorption** *n.* An accumulation of electrical charges within the body of an imperfect dielectric material when it is placed in an electric field. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Dielectric breakdown voltage** (breakdown voltage and disruptive voltage) *n.* The voltage at which electrical breakdown of a specimen of electrical insulating material between two electrodes occurs under prescribed conditions.

**Dielectric constant** (1875) (permittivity constant) *n.* Between any two electrically charged bodies there is a force (attraction or repulsion) that varies according to the strength of the charges, $q_1$ and $q_2$, the distance between the bodies, $r$, and $a$ characteristic of the medium separating the bodies (the dielectric) known as the dielectric constant, $\varepsilon$. The force is given by the

$$F = q_1 q_2 / \varepsilon r^2.$$

For a vacuum, $\varepsilon = 1.0000$, values for some other materials are listed above. In practice the dielectric constant of a material is found by measuring the capacitance of a parallel-plate condenser using the material as the dielectric, then measuring the capacitance of the same condenser with a vacuum as the dielectric, and expressing the result as a ratio between the two capacitances.

When the dielectric is a polymeric material whose atoms or molecules may change their positions in an alternating electric field (a *polar* material), frictional energy is dissipated as heat and is characterized by the dissipation factor. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The Chemical Rubber Co., Boca Raton, FL. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Dielectric heat sealing** *n.* A sealing process seed for fusing vinyl films and other thermoplastics films with sufficient dielectric loss whereby two layers of film are heated by dielectric heating and pressed together between two electrodes, an applicator and a platen, the films serving as the dielectric of the so-formed condenser. The applicator may be a pinpoint electrode as in "electronic sewing machines," a wheel, a moving belt, or a contoured blade. Frequencies employed range up to 200 MHz, but are usually 30 MHz or less to avoid interference problems. Harper CA (ed) (2002) Handbook of plastics, elastomers, and composites, 4th edn. McGraw-Hill, New York.

*See also heat sealing.*

**Dielectric heating** (1944) (electronic heating, RF heating, radio-frequency heating, high-frequency heating, and microwave heating) *n.* The process of heating poor (but polar) conductors of electricity (dielectrics) by means of high-frequency fields. At frequencies above 10 MHz sufficient heat for rapid sealing and welding of many plastics can be generated by low, safe voltages. The process of dielectric heating consists of placing the material to be heated between two shaped electrodes that are connected to a high-frequency current supply. These electrodes act as the plates of a capacitor and the material serves as the dielectric separating them. As the field changes polarity, charge-bearing atoms or groups of the dielectric undergo reorientation in an effort to keep their positive poles toward the electrode that is momentarily negative, thus generating molecular friction that is dissipated as heat. The theoretical rate of heating is given by the equation

$$P = 2\pi fCV^2 \tan \delta,$$

where $P$ is the power input (W), $f$ the electrical field frequency (Hz), $C$ the capacitance (f), $V$ the voltage difference between the electrodes (V), and $\tan \delta$ is the loss factor. The actual rate of heating will be somewhat less because of non-uniformity of the field, air gaps between electrodes and material, and losses to the surroundings. Dielectric heating is most effective for materials such as PVC and phenolics that have high loss factors because of their numerous polar groups. Non-polar plastics with low loss factors, such as polystyrene and polyethylene, are impractical to heat dielectrically. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

*See also dielectric heat sealing and microwave heating.*

**Dielectric loss** *n.* Energy dissipated as heat within a polar material subjected to a rapidly alternating, strong electric field. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York. *See dielectric heating.*

**Dielectric phase angle** *n.* The angular difference in phase between the alternating voltage (usually sinusoidal) applied to a dielectric and the resulting current. The angle is often symbolized by $\theta$, the cosine of which is the power factor. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Dielectric properties of polymers** *n.* This term usually means the lack of electrical conductivity or insulting value. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Dielectrics or insulators or non-conductors** *n.* A class of bodies supporting an electric strain. A charge on one part of a non-conductor is not communicated to any other part.

**Dielectric strength** (electric strength) *n.* A measure of the voltage required to puncture an insulating material, expressed in volts per mil of thickness (SI: V/mm). The voltage is the root-mean-square voltage difference between the two electrodes in contact with opposite surfaces of the specimen at which electrical breakdown occurs under prescribed test conditions. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Die lines** *n.* In extrusion and blow molding, longitudinal marks caused y damaged die surfaces or by extrudate build-up on dies.

**Die-lip build-up** *n.* In extruding film and sheet, the gradual accumulation of a bead of resin on the face of the die, parallel to the slit. Similar build-up can occur on dies for shapes.

**Diels–Alder polymers** *n.* Polymers created as a result of a Diels–Alder reaction, by which a 1,3-diene reacts via addition to another unsaturated molecule (the dienophile) to form a cyclic adduct. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York.

**Die manifold** *See manifold.*

**Diene monomers** \ˈdī-ˌēn ˈmä-nə-mər\ *n.* Any of a family of monomers based on unsaturated hydrocarbons having two double bonds.

**Diene polymer** *n.* Any of a family of polymers based on unsaturated hydrocarbons having two double bonds (*diolefins*). When the double bonds are separated by only one single bond, as in 1,3-butadiene ($CH_2{=}CH{-}CH{=}CH_2$), the diene and its double bonds are said to be *conjugated*. In an unconjugated diene the double bonds are separated by at least two single bonds and act more independently. The family includes polymers of butadiene, isoprene, cyclopentadiene, and copolymers with ethylene and propylene. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York.

**Diene polymers** *n.* The family of polymers and copolymers based on unsaturated hydrocarbons or diolefins with two double bonds which includes ethylene, propylene, isoprene, butadiene, and cyclopentadiene.

**Diene value or number** *n.* Amount of maleic anhydride (expressed as equivalents of iodine), which will react with 100 parts of oil under specific conditions. It is a measure of the conjugated double bonds in the oil. *Also known as the maleic anhydride value or maleic value.*

**Die plate** *n.* (1) In injection molds, a member that is attached to the fixed or to the moving head of the press; *mold plate*, (2) In extrusion, especially of pellets or shapes, the die plate is that part of the die assembly that is bolted to the outlet of the die body and contains the orifices that form the melt into continuous strands or a particular cross-sectional shape.

**Die pressure** *n.* In extrusion, the pressure of the melt entering the die.

**Dies, coextrusion** *n.* Dies of nested configuration. Individual polymers flow through separate mandrel passages and are combined in the primary land area. Adjacent polymer layers must exhibit similar flows and adhesion characteristics to form the coextrusion.

**Dieseling** *See burn mark.*

**Dies, engraving** *See dies and hot stamping.*

**Dies, extrusion** *n.* Extrusion converts thermoplastics into a continuous stream of melt, which is then shaped by an extrusion die into uniform cross-sectional shape. The main classes of dies are for film, sheet, coating, pipe, and profiles.

**Dies, hot stamping** *n.* Method of depositing a decorative layer on the surface of a polymer, whereby a hot metal or rubber diem which bears the required design or lettering is placed in contact with the medium to be applied and the surface to be decorated. The application of heat melts the release coating and activates the adhesive. After a short contact, the die pressure is released and the film carrier separated from the plastic surface, leaving a decorative coating transferred in the area of the die.

**Die spider** *n.* In extrusion, the legs or webs supporting the die core within the head of an in-line pipe, tubing, or blown-film die, In many pipe dies, the spider legs are cored to permit application of air or water for cooling the mandrel.

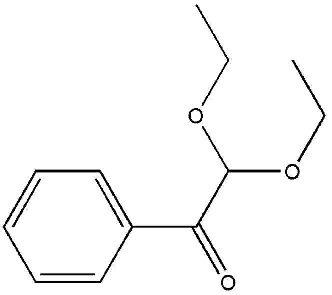
**Dies, pultrusion** *n.* Polymer thermosetting process whereby fibers impregnated with a mixed solution of polymer and the necessary additives are pulled through a heated die. The fibers entering the die are generally saturated with the solution but are solid when exiting from the machine. The process can produce solid, open-sided, hollow shapes that can be cut to length and packaged for shipment.

**Die stamping** *See intaglio.*

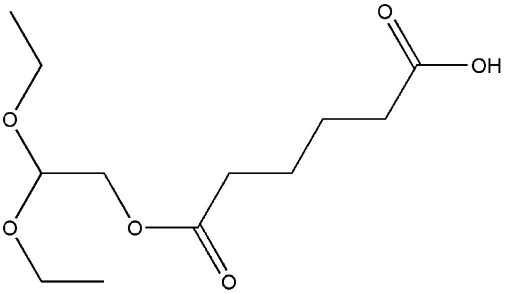
**Die swell** *See extrudate swelling.*

**Die-swell ratio** (extrudate-swelling ratio) *n.* In extrusion, particularly in extruding parisons for blow molding, the ratio of the outer parison diameter or parison wall thickness to, respectively, the outer diameter of the parison die or the die gap. The ratio is affected by the polymer type, its temperature, the die geometry, and the extrusion rate. Some writers have defined the die-swell ratio as the ratio of the *cross section* of the extrudate shortly after emergence to that of the die opening.

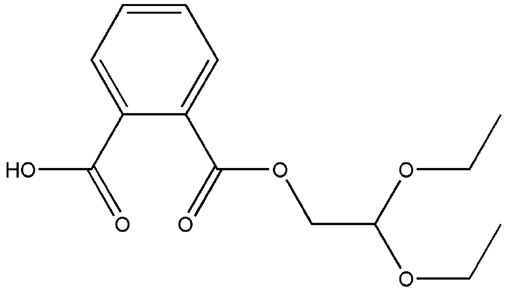
**2,2-Diethoxyacetophenone (DEAP)** *n.* A photo-initiator used for curing acrylate coatings, either in an inert atmosphere or in air with UV light. It absorbs impinging light.



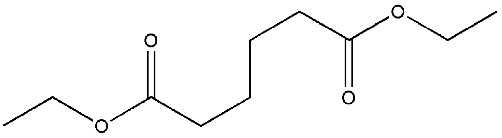
**Diethoxyethyl adipate** *n.* $(CH_2)_4(COOC_2H_4OC_2H_5)_2$. A plasticizer for cellulose resins.



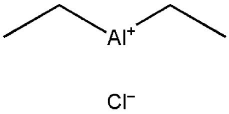
**Diethoxyethyl phthalate** *n.* $C_6H_4(COOC_2H_4OC_2H_5)_2$. A plasticizer for cellulosic and vinyl resins.



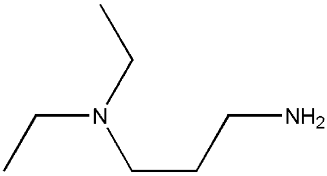
**Diethyl adipate** *n.* $(CH_2)_4(COOC_2H_5)_2$. A plasticizer for cellulosic resins.



**Diethylaluminum chloride** *n.* A colorless liquid that bursts into flame instantly upon contact with air (pyrophoric) and reacts violently with water. It is used as a catalyst in olefin polymerization.

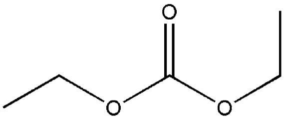


**3-Diethylaminopropylamine** *n.* An epoxy curing agent.



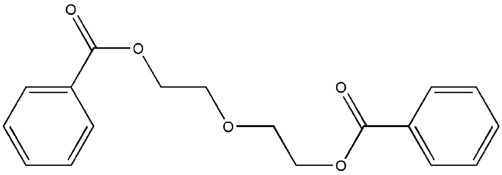
**Di(2-ethylbutyl) azelate** *n.* A plasticizer for PVC, its copolymers, and cellulose esters. It is very compatible and efficient in vinyls, finding its largest use in high-clarity film and sheeting.

**Diethyl carbonate** \ˈkär-bə-ˌnāt\ .tif) (ethyl carbonate) *n.* A solvent for cellulosic and many other resins.



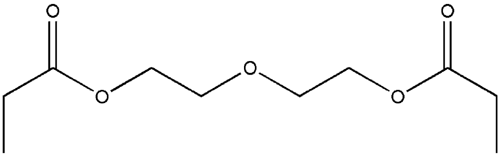
**Diethylene glycol bis-(allyl carbonate)** *n.* The monomer for some polycarbonate polymers.

**Diethylene glycol dibenzoate** *n.* plasticizer for cellulosic resins, polymethyl methacrylate, polystyrene, PVC, polyvinyl acetate, and other vinyls. It imparts good stain resistance.

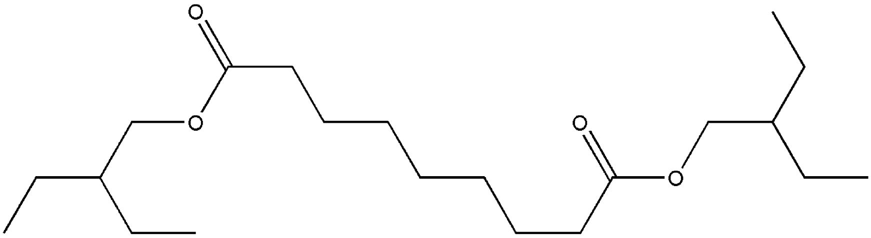


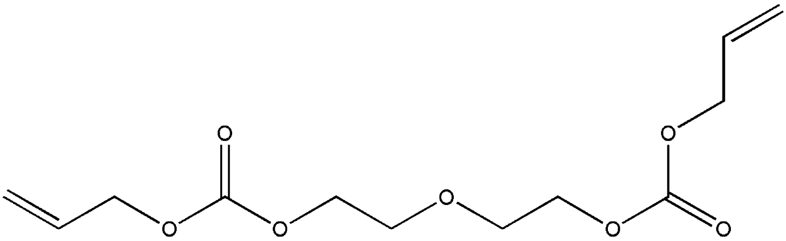
**Diethylene glycol dipelargonate** *n.* [$CH_3(CH_2)_7COOC_2H_4]_2O$. A simple diester of pelargonic acid used mainly as a secondary plasticizer for vinyl resins, but also as a plasticizer for cellulosics. Within the limits of its compatibility it provides economical low-temperature flexibility.

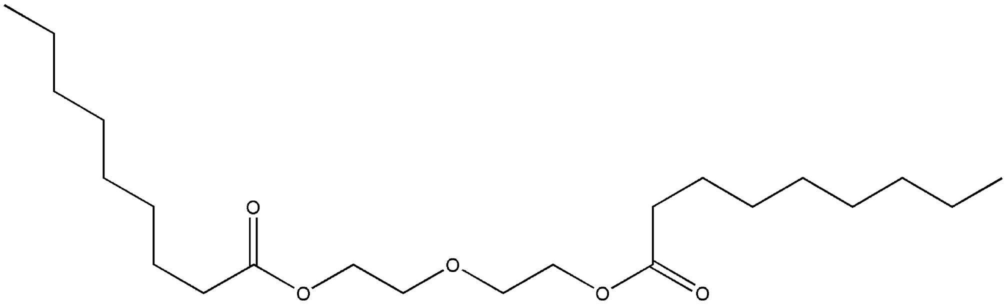
**Diethylene glycol dipropionate** *n.* A plasticizer for cellulosic plastics.

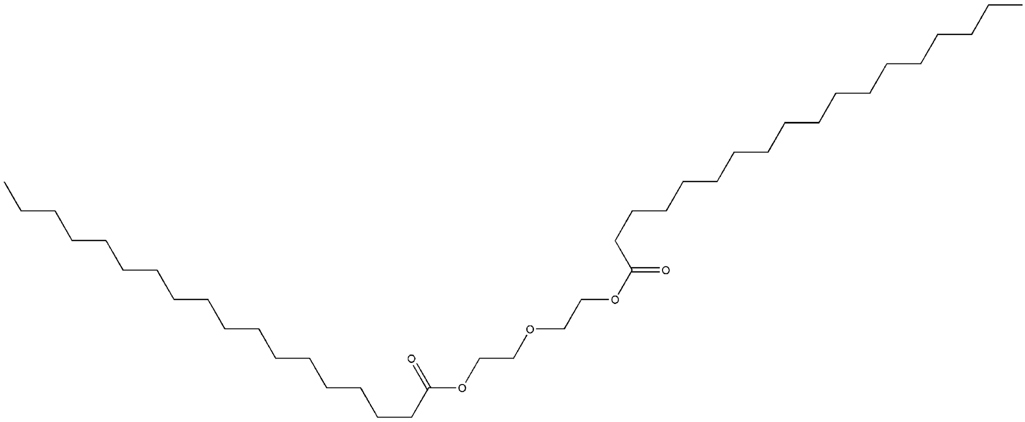


**Diethylene glycol distearate** *n.* $(C_{17}H_{35}COOC_2H_4)_2O$. A plasticizer for cellulose nitrate and ethyl cellulose.

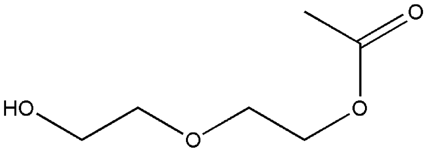






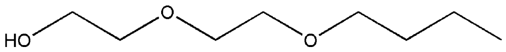


**Diethylene glycol monoacetate** *n.* $HO(CH_2)_2O(CH_2)_2OOCCH_3$. A solvent for cellulose nitrate and cellulose acetate.

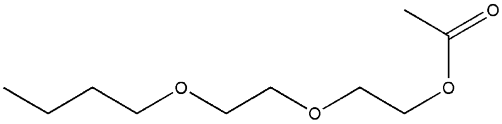


**Diethylene glycol monobutyl ether** *n.* $C_4H_9OCH_2CH_2OCH_2CH_2OH$. A solvent with a high boiling point, used in coatings when very slow drying rates are desired. It is also useful as a dispersant in vinyl organosols, and as an intermediate fore the production of plasticizers.

*See butyl carbitol.*



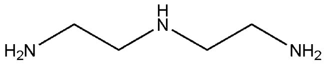
**Diethylene glycol monobutyl ether acetate** *See butyl carbitol acetate.*



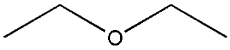
**Diethylene glycol monolaurate** *See diglycol laurate.*

**Diethylene glycol monoricinoleate** *See diglycol ricinoleate.*

**Diethylenetriamine** (DETA, 2,2′-diaminodiethylamine) *n.* A pungent liquid providing fast cures with epoxy resins, even at room temperature.



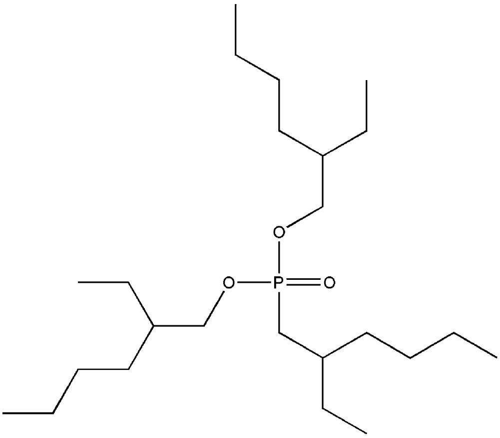
**Diethyl ether** \(ˌ)dī-ˈe-thəl-\ (ca. 1930) *n.* (1) A light volatile flammable liquid used as a sovlent and anesthetic. (2) Any of various organic compounds characterized by an oxygen atom attached to two carbon atoms.



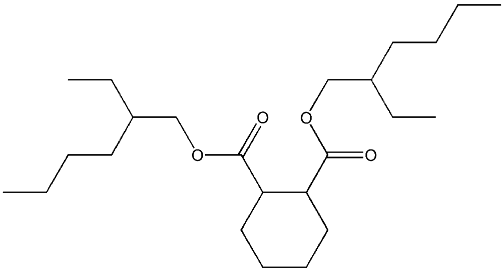
**Di(2-ethylhexyl) adipate** (dioctyl adipate, DOA) *n.* A primary plasticizer for vinyls, cellulose nitrate, polystyrene, and ethyl cellulose. In vinyls, DOA is often used in combination with phthalate and other plasticizers, imparting good resilience, low-temperature flexibility, and resistance to extraction by water. It is FDA-approved for use in vinyl food-packaging films.

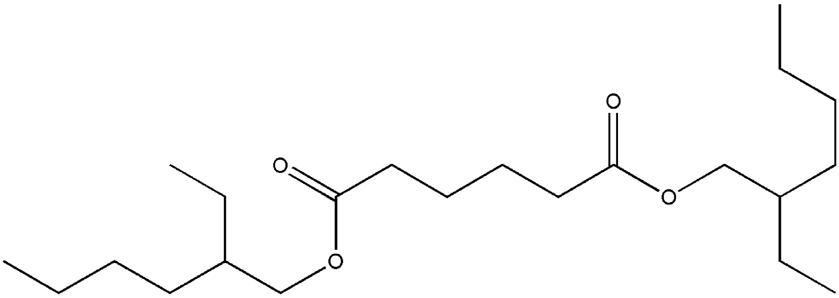
**Di(2-ethylhexyl) azelate** *n.* (dioctyl azelate, DOZ) $(CH_2)_7[COOCH_2–CH(C_2H_5)C_4H_9]_2$. A plasticizer for vinyl chloride polymers and copolymers. It is one of the most compatible of the low-temperature, monomeric plasticizers, has low volatility, and imparts low extractability by water and soapy water. This plasticizer has been approved for food-contact use.

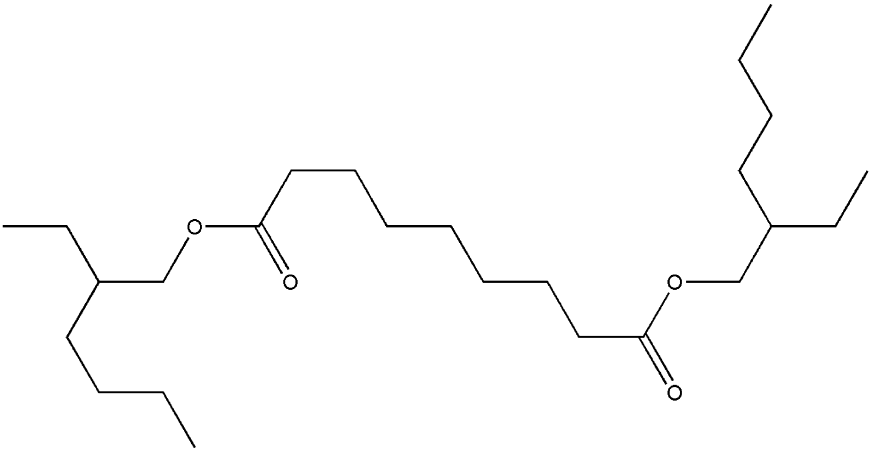
**Di(2-ethylhexyl) 2-ethylhexyl phosphonate** *n.* $C_8H_{17}PO(OC_8H_{17})_2$. A plasticizer and stabilizer.



**Di(2-ethylhexyl) hexahydrophthalate** (dioctyl hexahydrophthalate) *n.* A light-colored liquid, a plasticizer for vinyls.

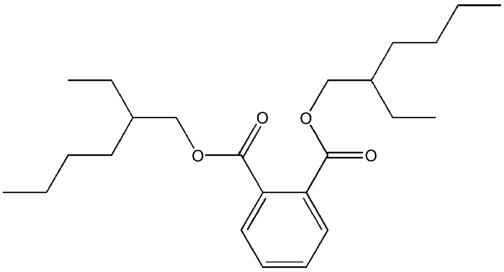






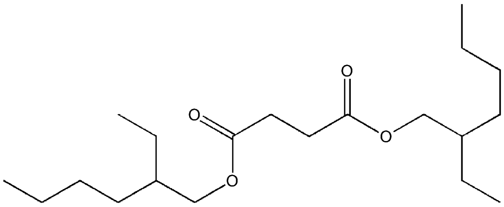
**Di(2-ethylhexyl) isophthalate** (dioctyl isophthalate, DIOP) *n.* A primary plasticizer for PVC, most notable for low volatility and its resistance to marring by nitrocellulose lacquers, in addition to good general-purpose properties. It is also compatible with polyvinyl butyral, vinyl chloride-acetate copolymers, cellulosic resins, polystyrene, and chlorinated rubber.

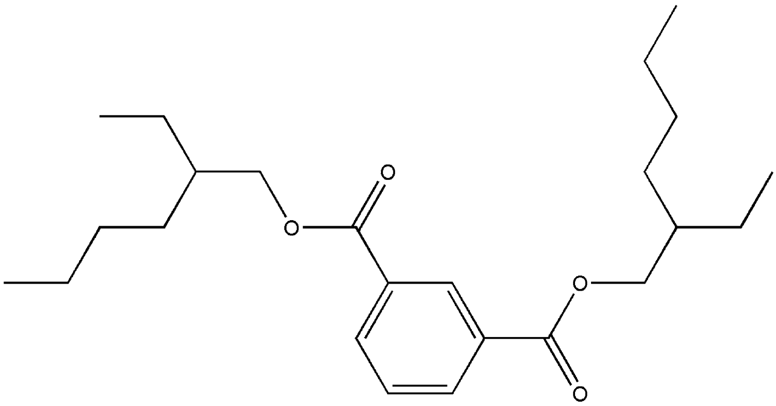
**Di(2-ethylhexyl) phthalate** (dioctyl phthalate, DOP) *n.* $C_6H_4[COO{-}CH_2CH(C_2H_5)C_4H_9]_2$. The most widely used plasticizer for PVC, also compatible with ethyl cellulose, cellulose nitrate, and polystyrene. It is generally recognized as imparting the best all-around good properties vinyls, and is often used as the standard against which other plasticizers are evaluated. DOP has been approved by the FDA for use in packaging films for greaseless foodstuffs of high water content.

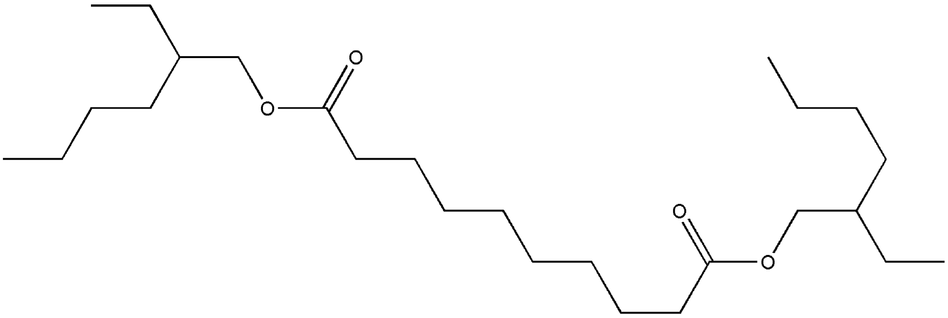


**Di(2-ethylhexyl) sebacate** (dioctyl sebacate) *n.* A plasticizer for vinyl chloride polymers and copolymers, cellulosic plastics, polystyrene, and polyethylene. It imparts good low-temperature properties.

**Di(2-ethylhexyl) succinate** (dioctyl succinate) *n.* A plasticizer.



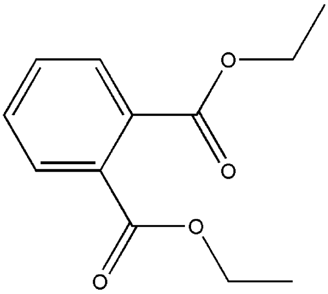




**Di(2-ethylhexyl)-4-thioazelate** *n.* $C_8H_{17}OOC(CH_2)_2CS(CH_2)_4COOC_8–H_{17}$. A plasticizer for cellulose nitrate, ethyl cellulose, polymethyl methacrylate, polystyrene, and vinyl resins.

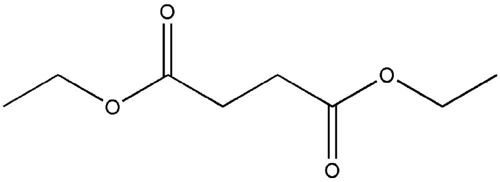
**Diethyl oxalate** \ˈäk-sə-ˌlāt\. *See ethyl oxalate.*

**Diethyl phthalate** (ethyl phthalate) *n.* A plasticizer and solvent for nearly all thermoplastics and coumarone resins. It has been approved by FDA for use in food packaging.

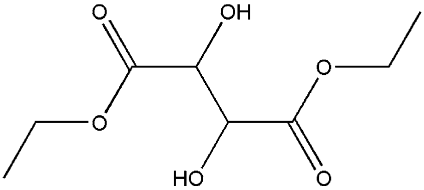


**Diethyl sebacate** *n.* A plasticizer with good low-temperature properties, compatible with PVC and many other thermoplastics.

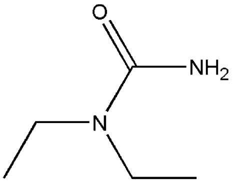
**Diethyl succinate** *n.* Plasticizer for cellulosic resins.

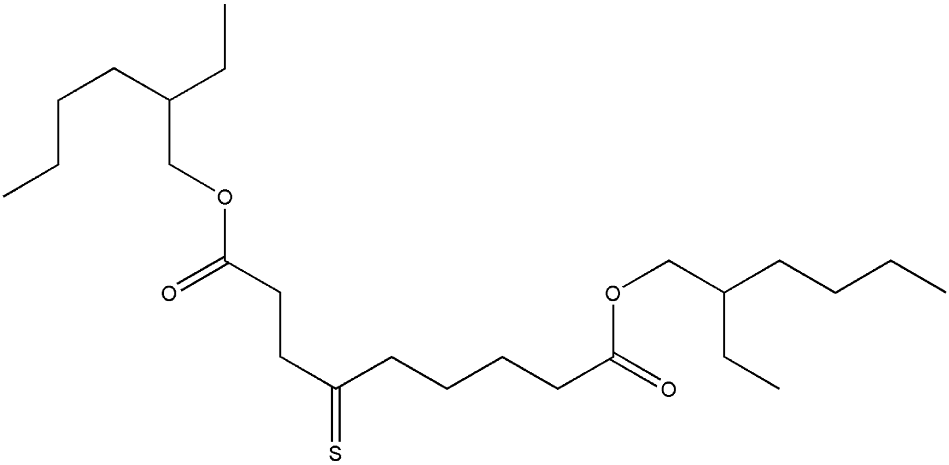


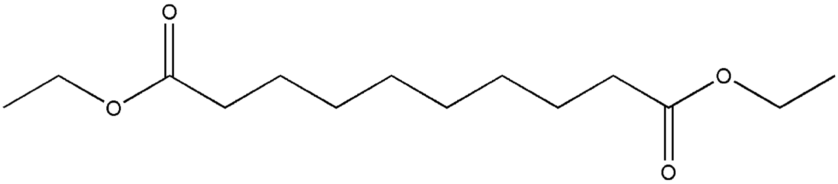
**Diethyl tartrate** *n.* A solvent and plasticize for cellulosic resins.



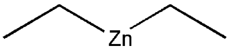
**1,1-Diethylurea** *n.* A white solid polymerizable with simple urea and formaldehyde to form permanently thermoplastic resins.







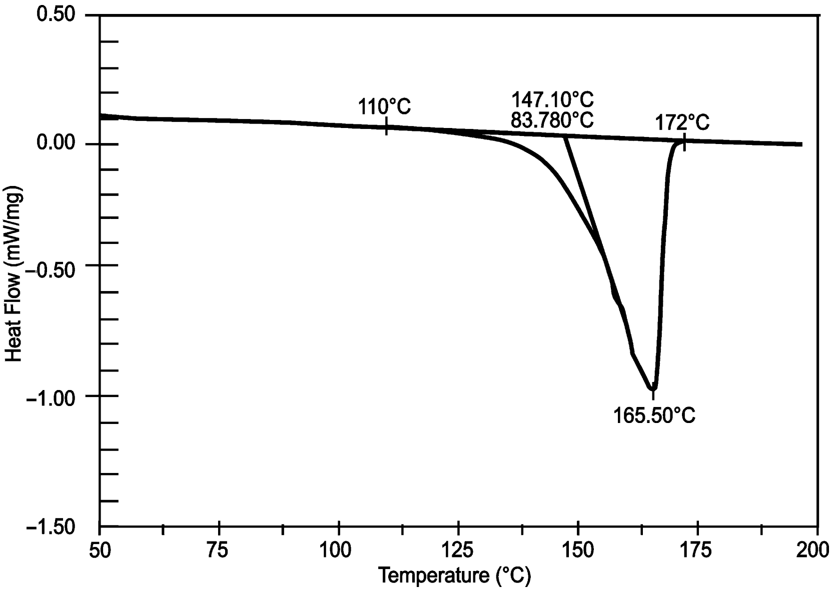
**Diethyl zinc** (1952) *n.* $C_4H_{10}Zn$. A volatile pyrophoric liquid organometallic compound used to catalyze polymerization reactions and to deacidify paper.

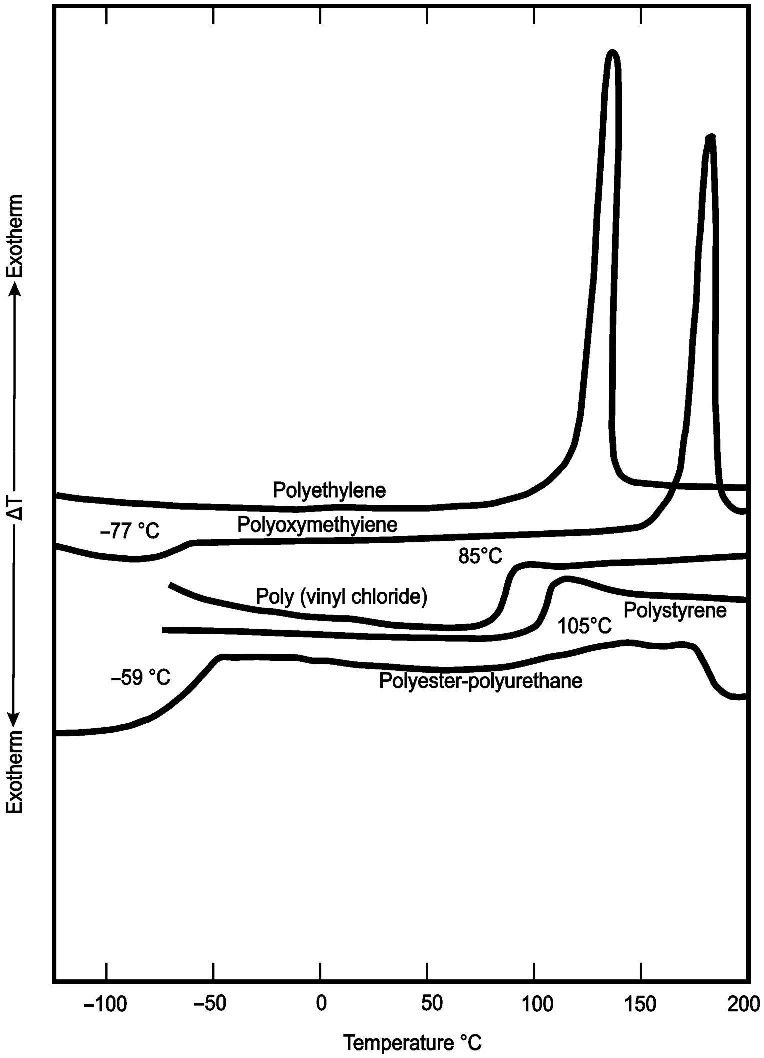


**Differential refractometer** *n.* An instrument used in connection with a chromatographic column in size-exclusion chromatography of polymers (in dilute solution). Two streams, one pure solvent, the other the eluting polymer solution, pass through the instrument, whose signal, proportional to the difference ion refractive indices of solution and solvent, is interpreted as polymer concentration. The instrument is also used to determine the rate of change of refractive index with concentration ($dn/dc$), an important parameter in the computation of weight-average molecular weights from light-scattering measurements in dilute polymer solutions.

**Differential scanning calorimeter (DSC)** *n.* An instrument that measures the rate of heat evolution of absorption of a specimen while it is undergoing a programmed temperature rise (Gooch, 1997). A recorder displays the data as a trace of increase in heat per increase in temperature ($dq/dT$) versus temperature. An example of a DSC thermogram of polypropylene is shown. The DSC has been used to study curing reactions and related properties of thermosetting resins, and heats of decomposition of resins (an example of a DSC instrument is the Perkin-Elmer Diamond DSC).

**Differential thermal analysis (DTA)** *n.* An analytical method in which the specimen material and an inert substance are heated concurrently in separate minipans and the difference in temperature between the two is recorded, along with the temperature of the inert substance (Gooch, 1997). DTA has been useful; in the study of phase transitions and curing and degradation reactions in polymers. An example of a DTA thermogram is shown. An example of a DTA instrument is the Perkin-Elmer Diamond TG/DTA (courtesy of Perkin-Elmer Inc, New York).





**Differentiating solvent** *n.* A solvent, which will discriminate among the strengths of acids or bases.

**Diffraction** \di-ˈfrak-shən\ [NL *diffraction*-, *diffractio*, fr. L *diffringere* to break apart, fr. *dis*- + *frangere* to break] (1671) *n.* Dispersion of light into a spectrum when it strikes an aperture or a slit of width in the same order of magnitude as the wavelength of the light. Diffraction depends on the wave nature of light and occurs in all wave motions. If monochromatic light strikes the edge of an opaque obstacle, bands of light and dark are observed near the edges of the beam. Diffraction is thus a special case of interference.

*See dispersion, light, and diffraction grating.*

**Diffraction grating** (1867) *n.* Device used to disperse a beam of electromagnetic radiation into its constituent wavelengths, i.e., for producing a spectrum. Grating may be prepared by ruling equidistant parallel lines onto a glass surface (transmission grating) or a metal surface (reflection grating). If *s* is the distance between the rulings, *d* the angle of diffraction, then the wavelength where the angle of incidence is 90° is (for the *n*th order spectrum),

$$\lambda = \frac{s \sin\, d}{n}.$$

If *i* is the angle of incidence, *d* the angle of diffraction, *s* the distance between the rulings, and *n* is the order of the spectrum, the wavelength is

$$\lambda = \frac{8}{n}(\sin\, i + \sin\, d).$$

**Diffused light** \di-ˈfyüz-\ [ME *diffused*, pp., fr. L *diffusus*, pp] *n.* Non-directional light.

**Diffuse reflectance** *n.* The ratio of the flux reradiated by diffuse reflection.

*See reflectance, diffuse, and specular reflectance excluded.*

**Diffuse transmittance** *See transmittance and diffuse.*

**Diffusion** *n.* The movement of a material in the body of a plastic. If the concentration (mass of solid per unit volume of solution) at on surface of a layer of liquid is $d_1$ and at the other surface $d_2$, the thickness of the layer *h* and the area under consideration *A*, then the mass of the substance which diffuses through the cross-section *A* in time *t* is,

$$m = \Delta A \frac{(d_2 - d_1)t}{h},$$

where Δ is the coefficient of diffusion.

**Diffusion, autoacceleration** *n.* In some vinyl polymerizations, as the reaction approaches completion and the viscosity of the reaction medium rises, there is a rising rate of increase of molecular weight of the chains that have not yet been terminated. This autoacceleration phenomena greatly affects the diffusivity of the polymer solution.

**Diffusion bonding** *n.* An experimental method of joining materials in which extremely flat and finely finished surfaces are clamped together under high vacuum for a period of hours or days, sometimes at a high temperature, allowing the atoms of each member to diffuse into the other. As of early 1992, the method had been used only with inorganic crystalline materials.

**Diffusion constant** *n* Symbol D. The constant of proportionality in Fick's laws of diffusion between the rate of diffusion and the concentration gradient (Fick's first law) and the variation of concentration with time and concentration gradient (Fick's second law).

**Diffusion couple** *n.* An assembly of two materials in such intimate contact that each diffuses into the other.

**Diffusivity** *n.* (1) (diffusion coefficient). The constant of proportionality in Fick's first law of diffusion, which states that the mass of molar rate of transport (flux) of one molecular species into another is equal to the diffusivity times the gradient of concentration. Several related units are in use, e.g., $cm^2/s$, $ft^2/h$. The SI unit is $m^2/s$, corresponding to flux in $mol/(s\,m^2)$ and gradient in $(mol/m^3)/m$. (2) Thermal diffusivity. Diffusivity or coefficient of diffusion is also given by Δ in the equation

$$\frac{\mathrm{d}Q}{\mathrm{d}t} = -\Delta\left(\frac{\mathrm{d}c}{\mathrm{d}x}\right)\mathrm{d}y\,\mathrm{d}z,$$

where $\mathrm{d}Q$ is the amount passing through an area $\mathrm{d}y\,\mathrm{d}z$ in the direction of $x$ in a time $\mathrm{d}t$ where $\mathrm{d}c/\mathrm{d}z$ is the rate of increase of volume concentration in the direction of $x$. Dimensions $[\mathrm{L}^2\mathrm{T}^{-1}]$.

*See also Fick's law.*

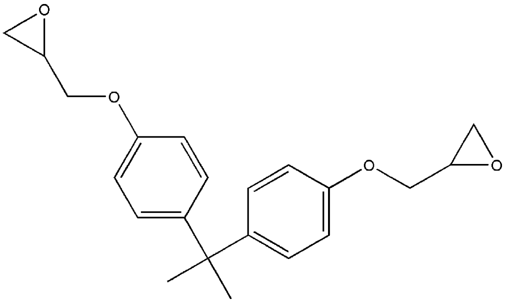
**Diffusivity of heat** *n.* It is given by Δ in the equation

$$\frac{\mathrm{d}H}{\mathrm{d}t} = -\Delta sd\frac{\mathrm{d}T}{\mathrm{d}x}\mathrm{d}y\,\mathrm{d}z,$$

where $\mathrm{d}H$ is the quantity of heat passing through the area $\mathrm{d}y\mathrm{d}z$ in the direction of $x$ in a time $\mathrm{d}t$. The rate of variation of temperature along $x$ is given by $\mathrm{d}T/\mathrm{d}x$, $s$ is specific heat and $d$, density. Dimensions $[\mathrm{L}^2\mathrm{T}^{-1}]$.

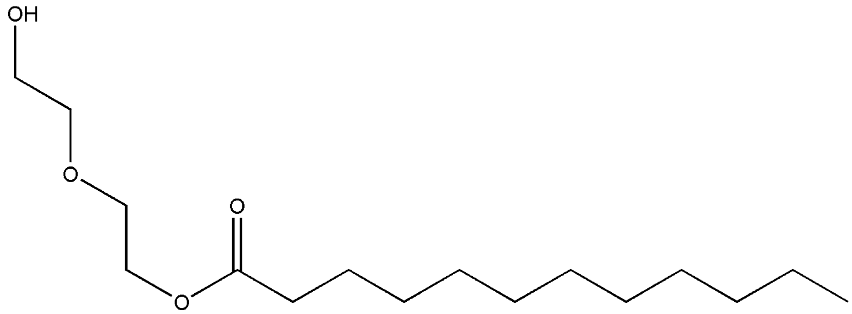
**Digester** \-ˈjes-tər\ (1614) *n.* Jacketed reaction vessel used to decompose, soften, or cook substances at high pressure and temperature.

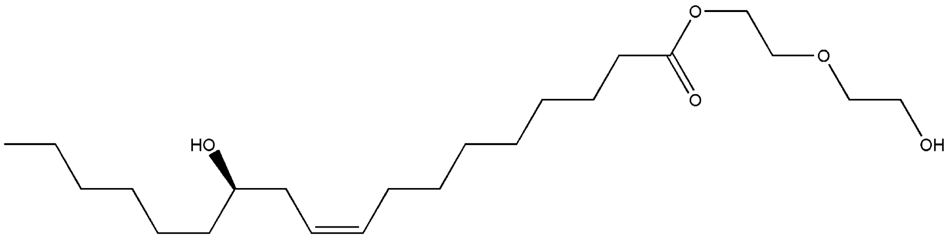
**Diglycidyl ether of bisphenol A (DGEBA)** *n.* The main constituent of most commercial epoxy resins prior to curing, DGEBA is formed by the reaction of excess epichlorohydrin with bisphenol A in the presence of aqueous sodium hydroxide.



**Diglycol laurate** \-ˈglī-ˌkól ˈlór-ət\ (diethylene glycol monolaurate). A plasticizer for ethyl cellulose, cellulose nitrate, polyvinyl butyral, and vinyl chloride-acetate copolymers.

**Diglycol ricinoleate** *n.* (diethylene glycol monoricinoleate) $CH_3(CH_2)_5$–CH(OH) $CH_2CH{=}CH(CH_2)_7COOC_2H_4OC_2H_4OH$.





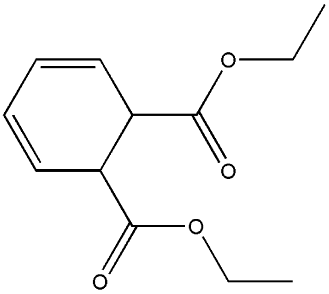
A plasticizer for ethyl cellulose and cellulose nitrate.

**Dihalide** *n.* A compound containing two halogen atoms (of valence = ∼1) per molecule.

**Dihexyl phthalate (DHXP)** *See di(2-ethyl butyl) phthalate.*

**Dihexyl sebacate** *n.* A plasticizer for vinyls.

**Dihydrodiethyl phthalate** *n.* A plasticizer for PVC and cellulose nitrate, with partial compatibility with other thermoplastics.

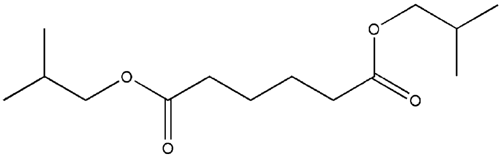


**Dihydroxy anthraquinone lake** \-ˌan(t)-thrə-kwi-ˈnōn-\ *n.*

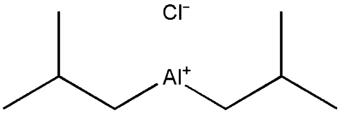
*See alizarin red.*

**Diiobutyl azelate** *n.* $(CH_3)_2CHCH_2OOC(CH_2)_7$. A plasticizer for cellulosics, polymethyl methacrylate, PVC, and polyvinyl acetate.

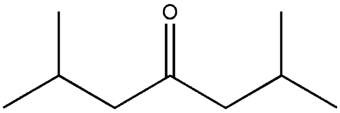
**Diisobutyl adipate (DIBA)** *n.* A plasticizer for most synthetic resins, including cellulosics, PVC, and other vinyls, and FDA-approved for use in food-packaging films. In vinyls, it is a very active solvent and lowers processing temperatures to levels that permit elimination or lower percentages of stabilizers.



**Diisobutyl aluminum chloride** *n.* $[(CH_3)_2CHCH_2]A1Cl$. A catalyst for polymerizing olefins.

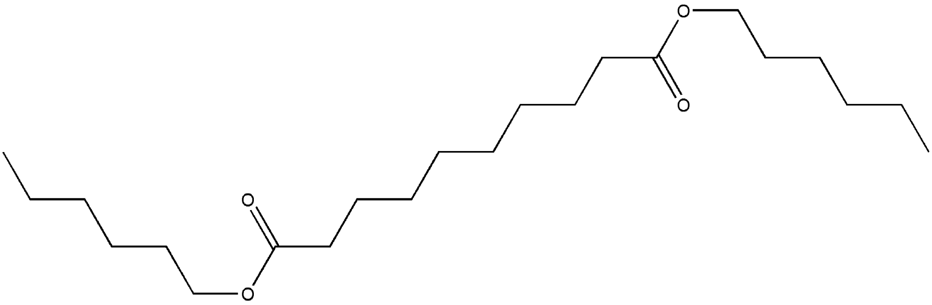


**Diisobutyl ketone** \-ˈkē-ˌtōn\ (2,6-dimethyl-4-heptanone) *n.* A high-boiling ketone with moderate solvent power for cellulose nitrate and vinyl copolymers. Having limited solvency for PVC, it is used as a viscosity modifier in organosols.



**Diisobutyl phthalate (DIBP)** *n.* $C_6H_4[COOCH_2CH(CH_3)_2]$. A plasticizer for vinyls, cellulosics, and polystyrene.

**Diisocyanate** *n.* Any compound containing two isocyanate (–NCO) groups, used in the production of polyurethanes. Many methods have been reported for synthesizing diisocyanates, but the one most widely used is reacting phosgene with an amine in a solvent. Toluene diisocyanate (TDI), the most commonly used, is an 80–20



mixture of 2,4- and 2,6-toluene diisocyanate isomers. Also used are diphenylmethane-4,4′-diisocyanate (MDI), a modified toluene diisocyanate, and polymethylene polyphenyl isocyanate (PAPI). The diisocyanates are key ingredients in the production of urethane foams, fibers, coatings, and solid elastomers.

*See also isocyanate and polyurethane.*

**Diisodecyl adipate (DIDA)** *n.* $(-C_2H_4COOC_{10}H_{21})_2$. A plasticizer for PVC in lower concentrations, e.g. up to 30 phr, at which it imparts low-temperature flexibility and resistance to lacquer marring. It is often used in combination with phthalate and phosphate plasticizers. DIDA is completely compatible with vinyl chloride-acetate copolymers, cellulose acetate-butyrate with high butyral content, cellulose nitrate, ethyl cellulose, and chlorinated rubber. In polystyrene, it may be used up to 25 phr.

**Diisodecyl-4,5-epoxy-tetrahydrophthalate** *n.* A plasticizer for PVC that also acts as a stabilizer and fungistat. It is compatible with cellulose nitrate, ethyl cellulose, polymethyl methacrylate, polystyrene, and other vinyls polymers and copolymers.

**Diisodecyl glutarate** *n.* $(CH_2)_3(COOC_{10}H_{21})_2$. A plasticizer for PVC having low-temperature properties equal to those of dioctyl adipate but with lower volatility and greater resistance to soapy water.

**Diisodecyl phthalate (DIDP)** *n.* $C_6H_4(COOC_{10}H_{21})_2$. A general-purpose plasticizer for vinyl resins, imparting good water resistance and suitable for processing at high temperatures due to its low volatility. It is also compatible with most synthetic resins, e.g., cellulose nitrate, ethyl cellulose, and polystyrene.

**Diisononyl phthalate (DINP)** *n.* $C_6H_4(COOC_9H_{19})_2$. A plasticizer for PVC, cellulosics, and polystyrene. It has lower volatility than dioctyl phthalate with equivalent low-temperature performance and poorer efficiency.

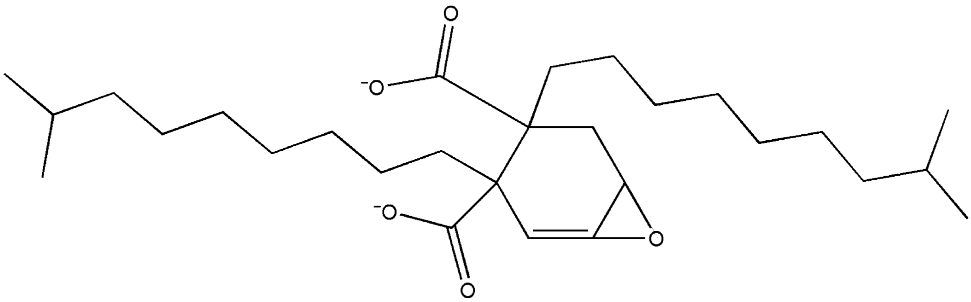
**Diisooctyl adipate (DIOA)** *n.* $(-C_2H_4COOC_8H_{17})_2$. A primary plasticizer for vinyls, cellulose nitrate, polystyrene, polymethyl methacrylate, and ethyl cellulose. Its performance is similar to that of dioctyl phthalate.

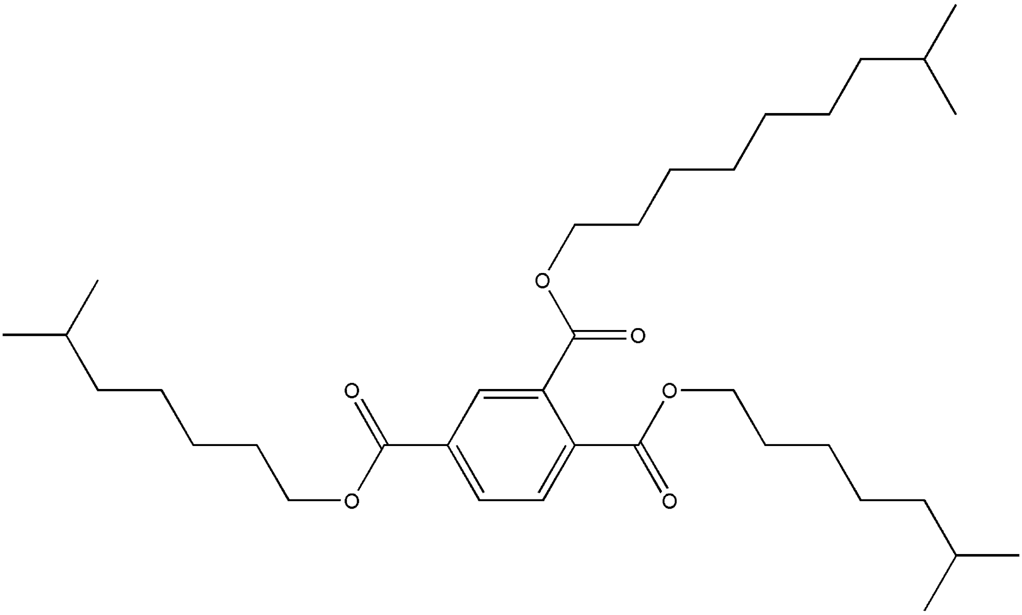
**Diisooctyl azelate (DIOZ)** *n.* $C_7H_{14}(COOC_8H_{17})_2$. A plasticizer for cellulosics resins and polymers and copolymers of vinyl chloride. In vinyls it imparts good low-temperature properties and other characteristics similar to those obtained with dioctyl azelate.

**Diisooctyl fumarate** *n.* $(=CHCOOC_8H_{17})_2$. A plasticizer for PVC.

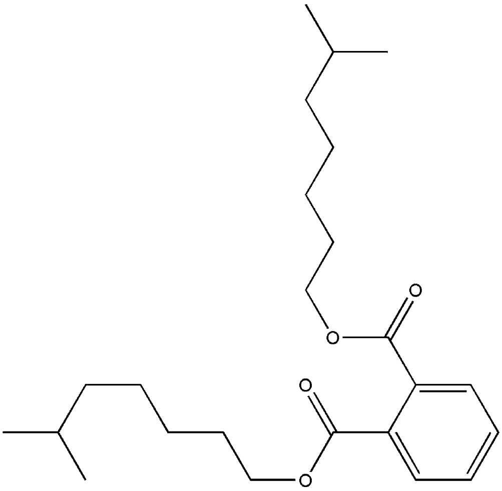
**Diisooctyl isophthalate** *n.* $C_6H_4(COOC_8H_{17})_2$. A plasticizer for PVC, also compatible with cellulose nitrate, ethyl cellulose, polystyrene, and other vinyl resins.

**Diisooctyl monoisodecyl trimellitate** *n.* A plasticizer for cellulosics and vinyl resins.

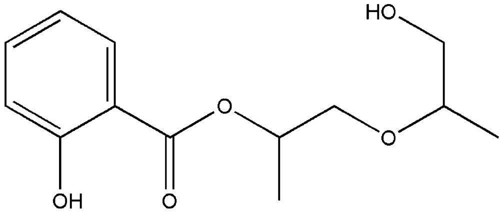




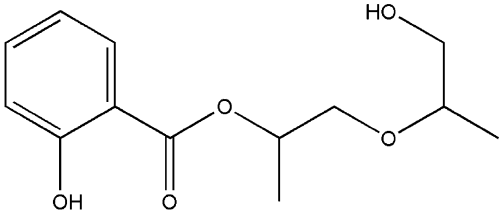
**Diisooctyl phthalate (DIOP)** *n.* $C_6H_4(COOC_8H_{17})_2$. A primary plasticizer for PVC, ethyl cellulose, cellulose nitrate, and polystyrene. In vinyls, its performance is similar to that of dioctyl phthalate except that it is slightly less volatile than DOP and produces better viscosity characteristics in plastisols. DIOP is FDA-approved for food-packaging materials and medical applications involving contact with water, but not with fats.



**Diisooctyl Sebacate (DIOS)** *n.* A plasticizer for vinyl and other resins.



**Diisopropylene glycol salicylate** \sə-ˈli-sə-ˌlāt\ *n.* $HOCH_2CH(CH_3)CH(CH_3)CH_2O–OCC_6H_4OH$. An ultraviolet absorber in plastics.



**Dilatancy** \dī-ˈlā-tᵊn(t)-sē\ (1885) *n.* Flow characterized by reversible, instantaneous increase in viscosity with increasing shear rate. The opposite of *pseudoplasticity.* Dilatancy in a pigment-vehicle system or pigment dispersions commonly results from high pigment loadings. The curve of the plot of shear stress versus shear rate is non-linear with shear stress increasing faster than the shear rate.

*Also known as shear thickening.*

**Dilatometer** \ˌdi-lə-ˈtä-mə-tər\ [ISV] (ca. 1883) *n.* An instrument for measuring the volume changes of a liquid or solid as the sample's temperature changes. A simple liquid dilatometer consists of a small bulb holding a known mass of sample and sealed to a graduated capillary of known diameter. As the sample is heated, its expansion is indicated by its rise up the capillary. From these measurements the volume coefficient of thermal expansion can be estimated (the inverse principle is used in liquid-in-glass thermometers).

**Dilauryl ether** (didodecyl ether) *n.* A lubricant for plastics processing.

**Dilinoleic acid** *n.* $C_{34}H_{62}(COOH)_2$. An unsaturated, dibasic acid used as a modifier in alkyd, nylon, and polyester resins.

**Diluent** \ˈdil-yə-wənt\ [L *diluent-*, *diluens*, pp of *diluere*] (ca. 1721) *n.* A substance that dilutes another substance. In an organosol, a diluent is a volatile liquid such as naphtha that has little or no solvating effect on the resin, but serves to lower the viscosity of the mix, and is evaporated during processing. In the paint industry, a diluent is any substance capable of thinning paints, varnishes, etc. The term is sometimes also used for a liquid added to a thermosetting resin to reduce its viscosity; and for an inert powdered substance added to an elastomers or resin merely to increase the volume (compare: filler).

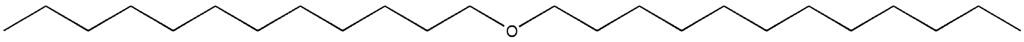
*See also extruder and thinner.*

**Dilute-solution viscosity** (solution viscosity) *n.* (1) A catchall term that can mean any of the interrelated and quantitatively defined viscosity ratios of dilute polymer solutions or their absolute viscosities. (2) The kinematic viscosity of a solution as measured by timing the rate of efflux of a known volume of solution, by gravity flow, through a calibrated glass capillary that is immersed in a temperature-controlled bath. Two common types of viscometer are the Ostwald–Fenske and Ubbelohde. From the viscosities of the solution $\eta$ and the solvent $\eta_o$, and the solution concentration *c*, five frequently mentioned "viscosities" (viscosity ratios, actually) can be derived, as follows:

Relative viscosity: $\eta_r = \eta/\eta_o$;
Specific viscosity: $\eta_{sp} = \eta_r - 1$;
Reduced viscosity: $\eta_{red} = \eta_{sp}/c$;
Inherent viscosity: $\eta_{inh} = (1n\eta_r)/c$;
Intrinsic viscosity: $\eta =$ the limit as $c \rightarrow 0$ of $\eta_{sp}/c$, $=$ the limit as $c \rightarrow 0$ of $\eta_{inh}$.

The intrinsic viscosity, because it is extrapolated to zero concentration from a series of measurements made at different concentrations, is independent of concentration. However, different solvents yield different intrinsic viscosities with the same polymer, so the solvent used must be identified. Some ASTM tests for viscosities of dilute polymer and plastics solutions are D 789, D 1243, D 1601, D 2857, and D 4603, all in Section 08. D 445, and D 446, describing the proper use of the viscometers mentioned above, are in Section 05.

**Dilution ratio** *n.* (1) As used in the surface-coatings industry, dilution ratio is the



volume ratio of diluent to solvent in a blend of theses two constituents that just fails to completely dissolve 8.00 g of nitrocellulose in 100 ml of the blend. The procedure is described in ASTM D 1720, Section 06. It is used to determine the most economical, yet adequate amount of high-cost active solvent required in a nitrocellulose-lacquer system. (2) In most other contexts, dilution ration is the quotient of the concentration of the undiluted solute divided by that of the diluted solution, both concentrations in the same units.

**Dimension** \də-ˈmen(t)-shən *also* dī-\ [ME, fr. MF, fr. L *dimension-*, dimensio, fr. *dimetiri* to measure out, fr. *dis-* + *metiri* to measure] (14c) *n.* A geometric element in a design, such as length or angle, or the magnitude of such a quantity.

**Dimensional formulae** \ -ˈfór-myə-lə\ *n.* If mass, length, and time are considered fundamental quantities, the relation of other physical quantities and their units to these three may be expressed by a formula involving the symbols L, M, and T, respectively, with appropriate exponents. For example; the dimensional formula for volume would be expressed $[L^3]$; velocity $[LT^{-1}]$; force $[MLT^{-2}]$. Other fundamental quantities used in dimensional formulae may be indicated as follows: $\theta$, temperature; $\varepsilon$, the dielectric constant of a vacuum; $\mu$, the magnetic permeability of a vacuum.

**Dimensional restorability** *n.* The ability of a fabric to be returned to its original dimensions after laundering or dry cleaning, expressed in percent. For example, 2% dimensional restorability means that although a fabric may shrink more than this in washing, it can be restored to within 2% of its original dimensions by ordinary home pressing methods.

**Dimensional stability** *n.* The ability of a substance (wood, plastic, etc.) to retain its shape when subjected to varying degrees of temperature, moisture, pressure, or other stress.

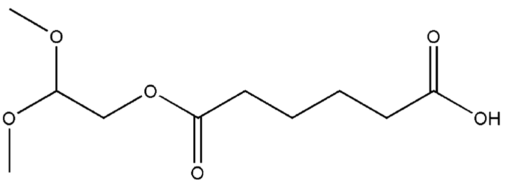
**Dimer** \ˈdī-mər\ [ISV] (ca. 1926) *n.* (1) A molecule formed by union of two identical simpler molecules. For example, $C_4H_8$ is a dimmer of $C_2H_4$, as $N_2O_4$ is of $NO_2$. (2) A substance composed of dimmers.

**Dimer acid** *n.* A coined, generic term for high-molecular-weight, dibasic acids that combine and polymerize with alcohols and polyols to make plasticizers, etc. A trimer acid is analogous having three acid groups.

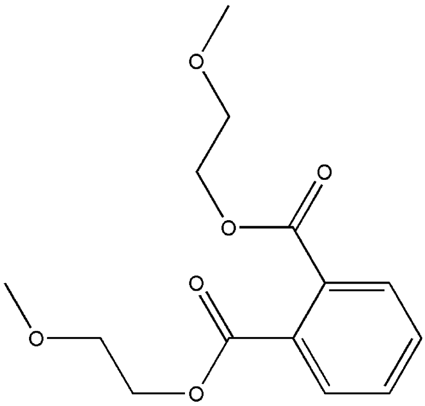
**Dimer acids** *n.* Liquid polycarboxylic acids produced by polymerization of unsaturated fatty acids. Pure dimmer acid is a $C_{36}$ dicarboxylic acid. Commercial dimmer acids are composed of predominantly $C_{36}$ dicarboxylic acid with minor amounts of $C_{18}$ monocarboxylic acid and varying proportions of $C_{54}$ tricarboxylic acid.

**Dimerization** *n.* State of polymerization when two similar molecules have united. The product is described as a dimmer.

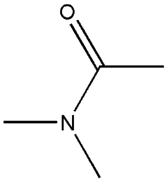
**Dimethoxyethyl adipate** *n.* A plasticizer for cellulose-ester polymers.



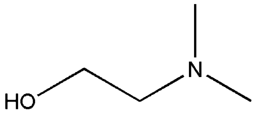
**Di(2-methoxyethyl) phthalate** *n.* A plasticizer, especially for cellulose acetate, but compatible, too, with other cellulosics, polystyrene, and vinyls.



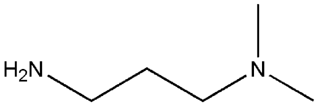
**Dimethyl acetamide (DMAC)** *n.* $CH_3CON(CH_3)_2$. A colorless liquid, a solvent for resins and plastics, a catalyst, and an intermediate.



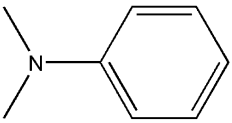
**2-Dimethylamino ethanol (DMAE)** *n.* A colorless liquid derived from ethylene oxide and dimethylamine, a catalyst for urethane foams. It has little odor and toxicity, and resists staining.



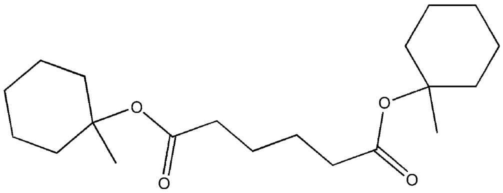
**3-Dimethylaminopropylamine** *n.* A colorless liquid used as a curing agent for epoxy resins.



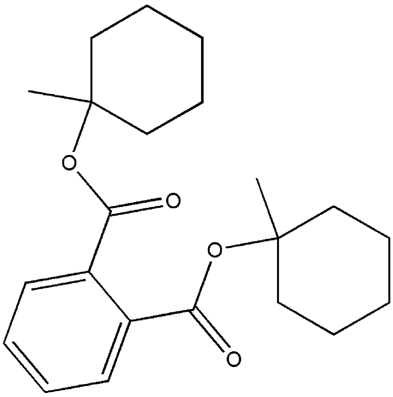
**Dimethylaniline (DMA)** *n.* The term usually means the tertiary amine, *N,N*-dimethylaniline, through ring-substituted isomers are known. This amine is useful as an accelerator in polyester molding and sprayup.



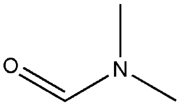
**Di(methylcyclohexyl) adipate** *n.* A plasticizer compatible with most thermoplastics.



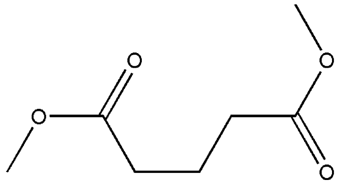
**Di(methylcyclohexyl) phthalate** *n.* A plasticizer for cellulosics, polystyrene, PVC, and other vinyl resins.



**Dimethylformamide (DMF)** *n.* A colorless and very active solvent for PVC, nylon, polyurethane, and many other resins and elastomers, with fairly low volatility. Its strong solvent power makes it useful as a solvent booster in coating, printing, and adhesive work, and in paint strippers. Because it is toxic and readily absorbed through the skin, DMF must be handled, and disposed of, with care.

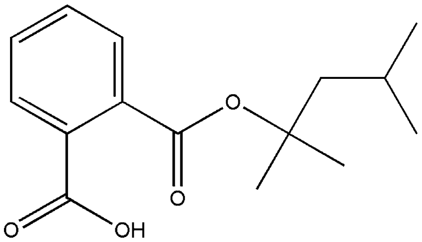


**Dimethyl glutarate (DMG)** *n.* A liquid chemical intermediate, a source of dicarboxylic acid, used in making plasticizers, polyester resins, synthetic fibers, films, adhesives, and solvents.



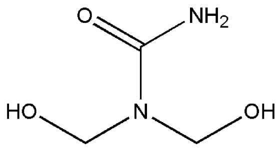
**Dimethyl glycol phthalate** *n.* $C_6H_4(COOCH_2CH_2OCH_3)_2$. A solvent and plasticizer for cellulosics resins.

**Dimethylisobutylcarbinyl phthalate** *n.* A plasticizer for most common thermoplastics.



**Dimethyl ketone** Syn: acetone.

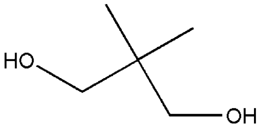
**Dimethylol urea** *n.* A colorless crystalline material resulting from the combination of urea and formaldehyde in the presence of salts or alkaline catalysts, the first or A-stage of urea-formaldehyde resin.



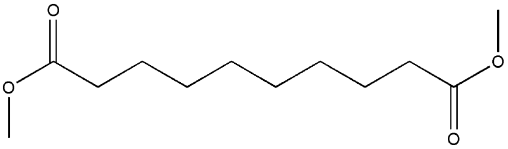
**Dimethyl phthalate** *n.* A non-toxic plasticizer for most common thermoplastics, but with limited compatibility with PVC. Plasticizer for nitrocellulose and cellulose acetate, resins, lacquers, and plastics. Colorless, odorless, lightfast, stable, and non-toxic liquid. Sp gr, 1.189; bp, 282°C; flp, 149°C (300°F).

**Dimethyl polysiloxane** *See polydimethylsiloxane.*

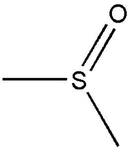
**2,2-Dimethyl-1,3-propanediol** *See neopentyl glycol.*



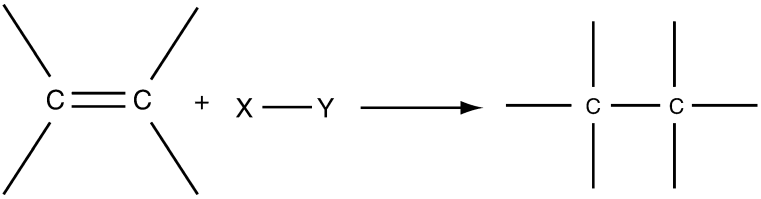
**Dimethyl sebacate** *n.* $[-(CH_2)_4COOCH_3]_2$. A solvent and plasticizer for cellulosics and vinyl resins, also compatible with most other thermoplastics.



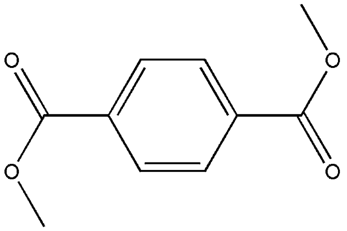
**Dimethyl sulfoxide (DMSO)** *n.* $(CH_3)_2SO$. An active polar solvent useful for dissolving such polar polymers as polyacrylonitrile and for certain polymerization reactions.



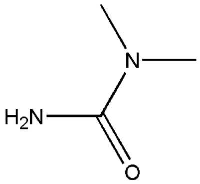
**Dimethyl terephthalate (DMT)** *n.* $C_6H_4$-1,4-$(COOCH_3)_2$. A white crystalline solid generally obtained by the oxidation of



*p*-xylene. The carbomethoxy groups of DMT are typical of those attached to a benzene ring, and their ready participation in alcoholysis reactions is the basis for most of the uses of the material. DMT is used in making polyethylene terephthalate (PET) and polyester fibers therefrom.



**Dimethyl urea** \yú-ˈrē-ə\. $(CH_3NH)_2CO$. Primary condensation product of urea and formaldehyde. When condensed in the presence of alcohols, it forms oil-soluble resins. With mildly acid salts, it may be used as an adhesive.



**Diminution of pressure at the side of a moving stream** *n.* If a fluid of density *d* moves with a velocity *v*, the diminution of pressure due to the motion is (neglecting viscosity),

$$p = \frac{1}{2} dv^2$$

**Dimity** \ˈdi-mə-tē\ [alter. of ME *demyt*, fr. ML *dimitum*, fr. MGk *dimitos* of double threat, fr. Gk *di-* + *mitos* warp thread] (1570) *n.* A sheer, thin, spun cloth that sometimes has cords or stripes woven in. It is used for aprons, pinafores, and many types of dress goods.

**Dimorphous** \(ˌ)dī-ˈmór-fəs\ [Gk *dimorphos* having two forms, fr. *di-* + *-morphos* -morphous] (1832) *adj.* Material which can exist in two distinct crystalline forms having different melting points.

**Dimple** \ˈdim-pəl\ [ME *dympull*; akin to OHGr *tumphilo* whirlpoor, OE *dyppan* to dip] (1602) *v.* A depression or indentation on a surface. Syn: sink mark.

**DIN** *n.* (1) Abbreviation for Deutsches industrie norm (German Industry Standard). (2) Also abbreviation for Deutsches institut für normung (formerly DNA).

**DIN color difference equation** *n.* Color difference equation based on the DIN color order system. It is described in English by Richter in J Opt Soc Am 45:223.

**DIN color system** *n.* Official German standard color system (DIN 6164). The color solid is described in terms of hue (DIN – Farbton), abbreviated F or T, saturation (DIN – Sättigung), abbreviated S, and relative lightness (DIN – Dunkelstufe), abbreviated D.

**Dingler's green** *See chromium oxide green.*

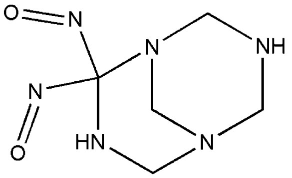
**Di-*n*-hexyl adipate** *n.* $(CH_2)_4(COOC_6H_{13})_2$. An important low-temperature plasticizer for synthetic rubbers and several plastics, including some cellulosics, PVC, and polyvinyl acetate.

**Di-*n*-hexyl azelate (DNHZ)** *n.* $(CH_2)_7(COOC_6H_{13})_2$. A plasticizer for cellulose and vinyl resins. It has been approved for food-contact use, has low volatility and good compatibility.

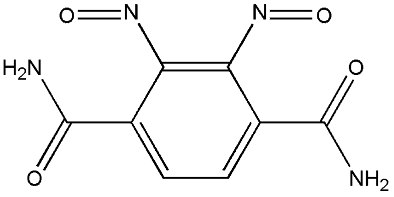
**Dinitraniline** *n.* Base which, when diazotized and coupled with $\beta$-napthol, forms permanent red 2G.

**Dinitraniline orange** *n.* Pigment orange 5 (12075). A monoazo pigment dyestuff prepared by coupling diazotized dinitro aniline to $\beta$-naphthol. It bleeds in organic solvents and has fair heat resistance. Its lightfastness in masstone is good. The good chemical resistance, freedom from toxic metals and high color intensity of dinitraniline orange encourage its use over the less expensive chrome and molybdate oranges in some specialized finishes not requiring good bake or bleed resistance.

**Dinitrosopentamethylenetetramine (DNPT)** *n.* A blowing agent widely used for foam rubber, but of limited use in the plastics industry due to its high decomposition temperature and unpleasant residual odor.



**Dinitrosoterephthalamide (DNTA)** *n.* A chemical blowing agent for vinyls, liquid polyamide resins, and silicone rubbers. It is especially noted for its low decomposition exotherm.



**Dinking** *See die cutting.*

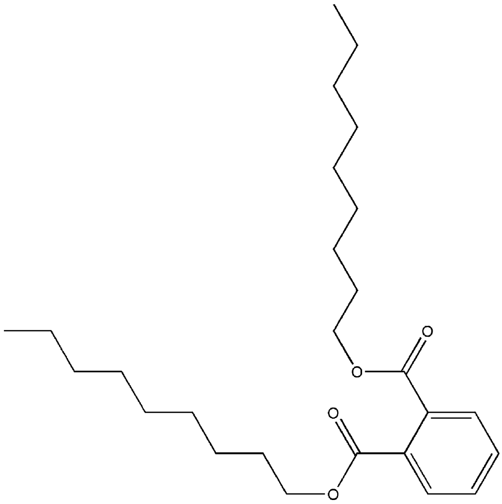
**Di-*n*-octyl, *n*-decyl phthalate (DNODP)** *n.* A mixed plasticizer for PVC and several other thermoplastics.

**Di-*n*-octyltin maleate polymer** *n.* Like the preceding tin stabilizer, this one, too, has been FDA-approved for use in food-packaging compositions up to 3 phr.

**Di-*n*-octyltin-*S,S′*-bis(isooctyl mercaptoacetate)** *n.* A stabilizer for PVC that has been approved for use in food-grade bottles up to 3 phr when made to certain purity specifications.

**Dinonyl adipate (DNA)** *n.* A non-alcohol ester used as a plasticizer for cellulosic, acrylic, styrene, and vinyl polymers.

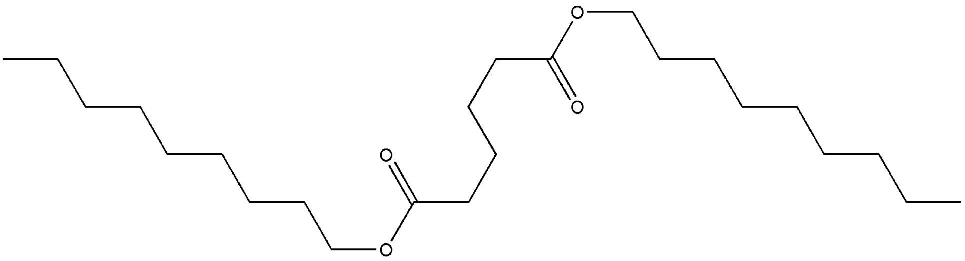
**Dinonyl phthalate (DNP)** *n.* A general-purpose plasticizer for vinyl resins, with low volatility and good electrical properties.



**DINP** *n.* Abbreviation for diisononyl phthalate.

**DIOA** *n.* Abbreviation for diisooctyl adipate.

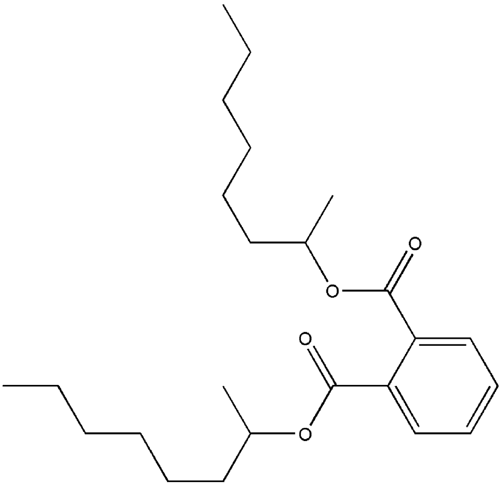
**Dioctyl** *See di(2-ethylhexyl)* – for several compounds for which this shorter prefix is more commonly used.



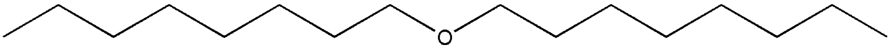
**Dioctyl ether** *n.* A mold and processing lubricant.

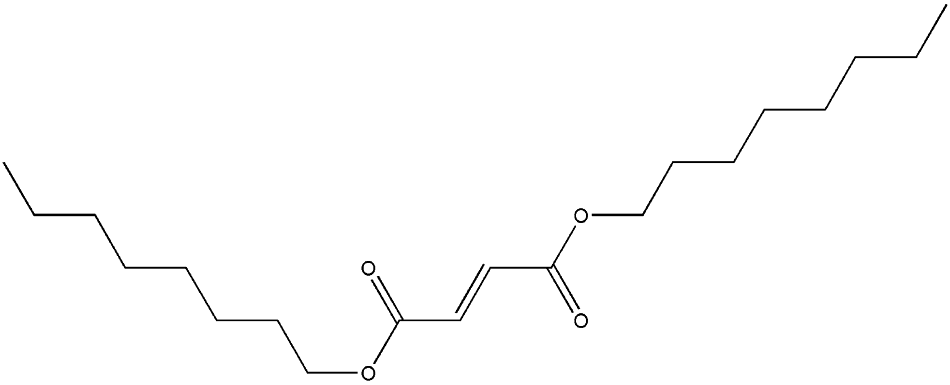
**Dioctyl fumarate (DOF)** *n.* An unsaturated plasticizer for vinyl resins.

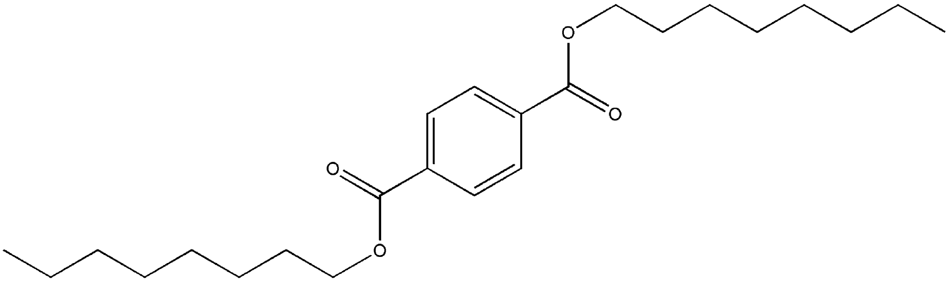
**Di(2-octyl) phthalate (DOP)** *n. See dicapryl phthalate* from which, by addition polymerization, is prepared the transparent, water-white polymer CR-39, one of the allyl-resin family. Since it is difficult and tricky to handle, the resin has found little commercial use aside from optical applications. For these, its excellent optical properties and resistance to scratching, and its low density – half that of glass – have given it wide use in eyeglasses. Other uses include optical filters, instrument windows, welders' masks, and large windows in atomic-energy plants.



**Dioctyl terephthalate (DOTP)** *n.* Although the physical properties of DOTP are similar to those of DOP (the ortho isomer), DOTP is less volatile, imparts slightly better







low-temperature flexibility, and is more resistant to lacquer marring.

**Dioctyltin stabilizer** *See organotin stabilizer.*

**Diofan** *n.* Dispersion of copolymers of vinylidene chloride. Manufactured by BASF, Germany.

**Diol** \ˈdī-ˌōl\ [ISV] (1923) *n.* An acronym for dihydric alcohol, i.e., an alcohol containing two hydroxyl (–OH) groups. Ethylene glycol, $HOCH_2CH_2OH$, and 1,5-pentanediol. $HO(CH_2)_5OH$, are examples.

**Diolefin polymer** \dī-ˈō-lə-fən\ *n. See diene polymer.*

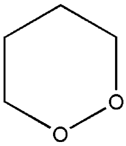
**Diolefin resins** *n.* More generally known as aromatic petroleum residues. By-products from the cracking of petroleum.

**Diolen** *n.* Fiber from poly(ethylene terephthalate). Manufactured by Glanzstoff, Germany.

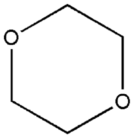
**DIOP** *n.* Abbreviation for diisooctyl phthalate.

**DIOS** *n.* Abbreviation for diisooctyl sebacate.

**Dioxan (dioxane)** \dī-ˈäk-ˌsān\ [ISV] (1912) *n.* Cyclic 1,4 diethylene dioxide. $CH_2CH_2OCH_2CH_2O$. Bp, 101°C; Sp gr, 1.035/20°C; fp, 11°C (52°F); refractive index, 1.423; vp, 26 mmHg/20°C. A water-miscible solvent for cellulose esters.



**1,4-Dioxane** (diethylene ether, diethylene dioxide, and dioxyethylene ether) *n.* $OCH_2CH_2OCH_2CH_2$. A solvent for cellulose esters and other plastics. Dioxane is rarely used today because of its suspected carcinogenicity.



**Di-*o*-xenyl phenyl phosphate** *n.* $(C_6H_5C_6H_4O)_2(C_6H_5O)PO$. A plasticizer for cellulosics, polystyrene, and vinyls.

**DIOZ** *n.* Abbreviation for diisooctyl azelate.

**Dip** \ˈdip\ (1599) *n.* The angle measured in a vertical plane between the direction of the earth's magnetic field and the horizontal.

**Dip** [ME *dippen*, fr. OE *dyppan*; akin to OHGr *tupfen* to ash, Lithuanian *dubus* deep] (before 12c) *v.* (1) Immersion of a textile material in some processing liquid. The term is usually used in connection with padding or slashing process. (2) The rubber compound with which tire cords and other in-rubber textiles are treated to give improved adhesion to rubber.

**Dipcoat** *n.* A paint or plastic coating, which is applied by completely immersing an article in a tank of the coating.

**Dip coating** *n.* A coating process wherein the object to be coated, preheated or at room temperature, depending on the materials, is dipped into a tank of fluid resin, solution, or dispersion, withdrawn and subjected to further heat or drying to solidify the deposit. *See fluidized-bed coating* for a similar process employing powdered resin. *See coating, dip.*

**Dip dyeing** *See dyeing.*

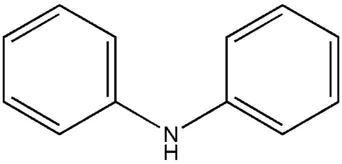
**Dipentene** (commercial product) *n.* Optically inactive form of the monocyclic terpene hydrocarbon limonene. Commercial dipentenes contains a substantial portion of other monocyclic and bicyclic, as well as some oxygenated terpenes having closely related boiling ranges. They are generally obtained by fractional distillation from the crude oils recovered in the several commercial methods of utilizing pine wood, also by isomerization during the chemical processing of terpenes. The four kinds of commercial dipentene are: (1) *Steam-distilled dipentene* – From the crude oleoresinous extract used for the processing of related steam-distilled wood naval stores. (2) *Sulfate dipentene* – From the crude condensate of the vapors generated in the digestion of wood in the sulfate paper pulp process. (3) *Destructively distilled dipentene* – From the lighter portions of the oil, recovered during the destructive distillation of pine wood. (4) *Chemically processed dipentene* – Recovered as a by-product in connection with the chemical treatment and conversion of other terpenes. Used as a solvent, but also has anti-skinning properties. Sp gr, 0.850; flash point, 52°C (Cleveland Open Cup); boiling range, 175 (347°F) to 188°C (370°F). (5) Pure Compound, *di*-limonene, *p*-mentha-1,8-diene $C_{10}H_{16}$, acyclic diene, a colorless liquid, Sp gr, 0.84; bp, 176°C; molecular weight, 136.12, with an orange/lemony odor, used as a solvent for coumarone and alkyd resins, rubber, and natural resins.

**Dip forming** (dip molding) *n.* A process similar to dip coating, except that the fused, cured or dried deposit is stripped from the dipping mandrel. As most frequently used for making vinyl-plastisol articles, the process comprises dipping into the plastisol a preheated form shaped to the desired inside dimensions of the finished article allowing the plastisol to gel in a layer of the desired thickness against the form surface; withdrawing the coated form; heating the deposit to fuse the layer; cooling and stripping off the deposit. Some articles may be inverted after stripping so that the textured inside surface becomes the external surface of the finished article.

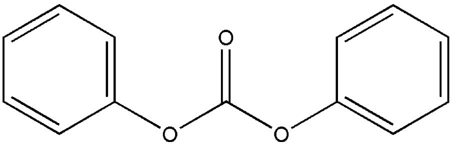
**Dip-grained wood** *n.* Wood, which has single waves or undulations of the fibers, such as occur around knots and pitch pockets.

**Diphenyl** \(ˌ)dī-ˈfe-nᵊl\ *n.* Liquid whose vapor is used as a heat transfer agent in chemical processes. At low pressures, the temperatures obtainable with diphenyl vapor are higher than those obtainable with steam. Syn: biphenyl.

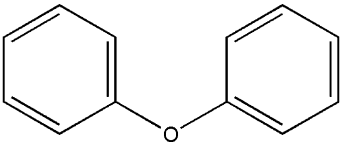
**Diphenylamine** [ISV] (1872) (DPA) *n.* $(C_6H_5)_2NH$. A crystalline solid. Used as a stabilizer for several plastics. Also, a weak secondary base used as a dyestuff intermediate and as an indicator.



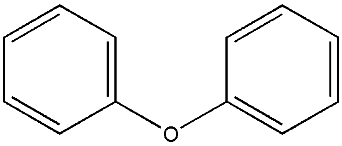
**Diphenyl carbonate** *n.* $(C_6H_5O)_2CO$. The monomer from which polycarbonates are produced.



**Diphenyl decyl phosphite** *n.* A nearly colorless liquid used as a stabilizer for vinyl and polyolefin resins.



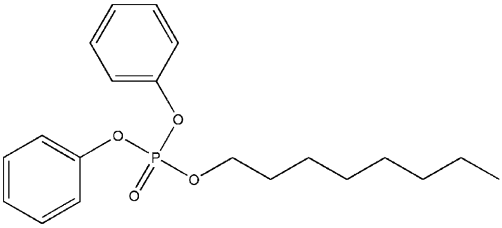
**Diphenyl ether** *n.* A plasticizer. Bp, 252°C; mp, 28°C.



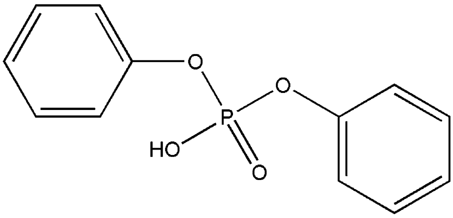
**Diphenyl ketone** *See benzophenone.*

**Diphenyl mono-*o*-xenyl phosphate** *n.* $(C_6H_5O)_2(C_6H_5C_6H_4O)PO$. A plasticizer for cellulosics plastics, polystyrene, and, with limited compatibility, vinyls.

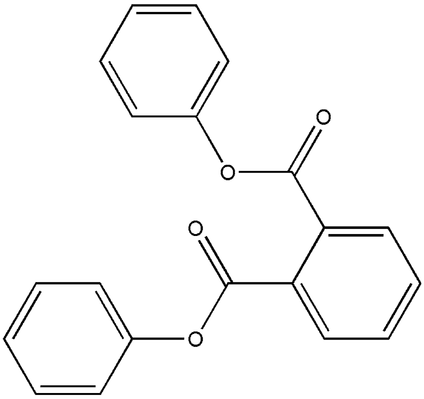
**Diphenyl octyl phosphate (DPOP)** *n.* $(C_6H_5O)_2(C_8H_{17}O)PO$. A flame-retardant plasticizer for PVC and cellulosics resins. It has been approved by DDA for use in food packaging.



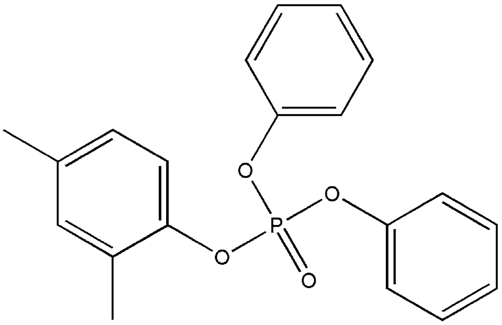
**Diphenyl phosphate** *n.* A permanent plasticizer. *Also called DPP.*



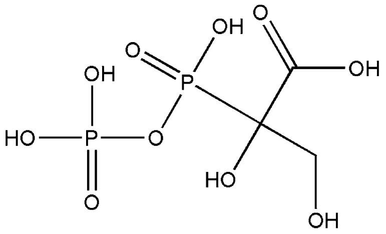
**Diphenyl phthalate (DPP)** *n.* A powder that melts at 75°C. It is used as a solid plasticizer for rigid PVC, cellulosics, and other resins.



**Diphenyl xylenyl phosphate** *n.* A plasticizer for cellulose acetate-butyrate, cellulose nitrate, polystyrene, PVC, and vinyl chloride-acetate copolymers.



**Diphosphoglyceric acid** \(ˌ)dī-ˈfäs-fō-gli-ˌser-ik-\ (1959) *n.* A diphosphate of glyceric acid that is an important intermediate in photosynthesis and in glycolysis and fermentation.



**Dip molding** *See dip forming.*

**Dipole** \ˈdī-ˌpōl\ [ISV] (1912) *n.* (1) A combination of two electrically or magnetically charged particles of opposite sign that are separated by a small distance. (2) Any system of charges, such as a circulating electric current, having the property (a) that no net force acts upon it in a uniform field; or, (b) a torque proportional to sin $\theta$, where $\theta$ is the angle between the dipole axis and a uniform field, *does* act on the charges. In polymers, atoms such as Cl bearing negative charges induce opposite charge in neighboring atoms, thus creating dipoles. Tiny movements of these dipoles in reaction to the changing directions of rapidly alternating fields are the basis for dielectric heating, and (c) it produces a potential, which is proportional to the inverse square of the distance from it. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Dipole bonds** *n.* Chemical bonds formed when the intramolecular interactions are polar covalent (uneven sharing of electron pair). The strength of the dipole–dipole interaction increases with the polarity of the participating molecules.

**Dipole–dipole forces** *n.* Forces between polar molecules.

**Dipole moment** (1926) *n.* The product of the magnitude of the charge at one end of a dipole times the distance between the opposite charges. A mathematical entity; the product of one of the charges of a dipole unit by the distance separating the two dipolar charges. In terms of the definition of a dipole (2), the dipole moment $p$ is related to the torque $T$, and the field strength $E$ (or $B$) through the equation $T = p \times E$.

**Dipole moment, molecular** *n.* It is found from measurements of dielectric constant (i.e., by its temperature dependence, as in the *Debye equation for total polarization*) that certain molecules have permanent dipole moments. These moments are associated with transfer of charge within the molecule, and provide valuable information as to the molecular structure.

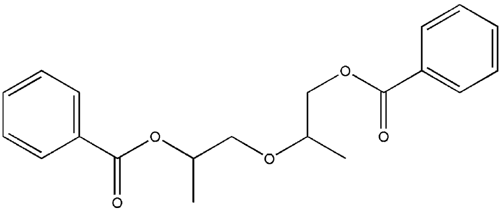
**Dip penetration** *n.* The degree of saturation through a tire cord after impregnation with an adhesive.

**Dip pickup** *n.* The amount of adhesive applied to a tire cord by dipping, expressed as a percentage of the weight of the cord before dipping.

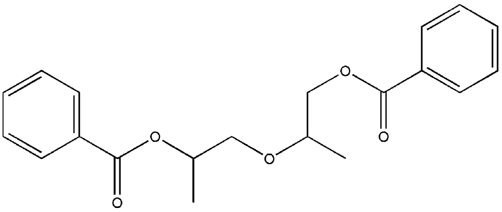
**Dipping** *n.* Method of application in which the complete immersion of an article in the coating is followed by draining. Paints, lacquers, and stains designed for such use are usually designated "dipping". This process may be carried out either at ordinary or elevated temperatures.

*See coating, dip.*

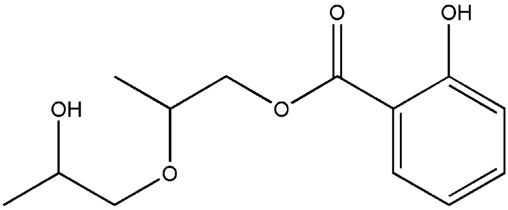
**Dipropylene glycol** *n.* (2,2′-dihydroxydipropyl ether) $(CH_3CHOH–CH_2)_2O$. A high-boiling glycol ether with a low order of toxicity, widely used as a solvent and chemical intermediate. As a solvent it is used with cellulose acetate and nitrate, and is one of the few known solvents for polyethylene. Thus it is used in screening tests to identify polyethylene. As an intermediate, dipropylene glycol reacts with dibasic acids to form alkyd resins, polyester plasticizers, and urethane-foam intermediates.



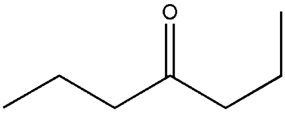
**Dipropylene glycol dibenzoat** A plasticizer for PVC, also compatible with most common thermoplastics, imparting good stain resistance.



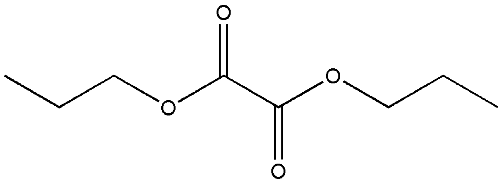
**Dipropylene glycol monosalicylate** (salicylic acid, dipropylene glycol monoester) *n.* A light-colored oil used in ultraviolet-screening agents and plasticizers.



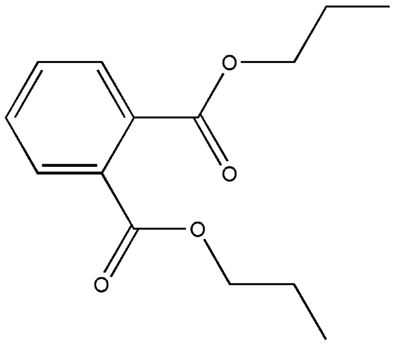
**Dipropyl ketone** *n.* A stable, colorless liquid, a solvent for many resins. Bp, 143°C; flp, 49°C (120°C); vp. 5 mmHg/20°C.



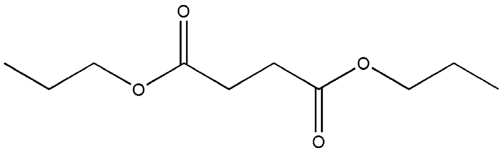
**Dipropyl oxalate** \-ˈäk-sə-ˌlāt\ *n.* An active, high-boiling (211°C) solvent.



**Dipropyl phthalate** *n.* A plasticizer for cellulose acetate and cellulose acetate-butyrate.



**Dipropyl succinate** *n.* Plasticizer. Bp, 246°C; Sp gr, 1.016/4°C.



**Diprotic acid** *n.* An acid with two available $H^+$, or two denotable protons.

**Dip treating** *n.* The process of passing fiber, cord, or fabric through an adhesive bath, followed by drying and heat-treating of the adhesive-coated fiber to obtain better adhesion.

**Di-*p*-xylylene (DPX, DPXN)** *n.* $(-CH_2C_6H_4CH_2-)_2$. The stable dimmer of *p*-xylylene, a white powder. When heated to 600°C in an evacuated chamber, the monomer is regenerated and instantly polymerizes to form a tough, impervious film on any cold surface between the heating pot and the vacuum source.

*See parylene.*

**Diradicals** \-ˈra-di-kəls\ *n.* Molecular species having two unpaired electrons, in which at least two different electronic states with different multiplicities [electron-paired (singlet state) or electron-unpaired (triplet state)] can be identified. For example, $H_2C\cdot{-}CH_2C\cdot H_2$ propane-1,3-diyl (trimethylene).

**Direct coating** *n.* The simplest method of coating, this procedure involves spreading the coating with a knife. The moving fabric substrate is usually supported by a roller or a sleeve. The gap between the knife and the fabric determines coating thickness.

**Direct dyes** *n.* A class of dyestuffs that are applied directly to the substrate in a neutral or alkaline bath. They produce full shades on cotton and linen without mordanting and can also be applied to rayon, silk, and wool. Direct dyes give bright shades but exhibit poor washfastness. Various after treatments are used to improve the washfastness of direct dyes, and such dyes are referred to as "after treated direct colors".

*See dyes.*

**Direct esterification** *n.* In the production of polyethylene terephthalate, the process in which ethylene glycol is reacted with terephthalic acid to form bis-*p*-hydroxyethyl terephthalate monomer with the generation of water as a by-product.

**Direct gate** *n.* A gate that has the same cross section as the runner, i.e., the absence of a distinguishable gate.

**Directionally oriented fabrics** *n.* Rigid fabric constructions containing inlaid warp or fill yarns held in place by a warp-knit structure. Used in geotextiles, coated fabrics, composites, etc.

**Directional reflectance** *See reflectance, directional.*

**Direction of twist** *See twist, direction of.*

**Direct lighting** *n.* Lighting, which is so controlled by a reflector that the major portion of the light directly reaches the spot to be illuminated without redirection, diffusion or reflection.

**Direct printing** *See printing.*

**Dirt** \ˈdərt\ [ME *drit*, fr. ON; akin to OE *drītan*, to defeat] (13c) *n.* Disfiguring foreign material other than microorganisms on or embedded in a dried coating.
*Also called soil.*

**Dirt collection** *n.* The accumulation of dust, dirt, and other foreign matter on a paint surface.

**Dirt resistance** *n.* The ability of a coating to resist soiling by foreign material, other than micro-organisms, deposited on or embedded in the dried coating.

**Disbond** *v.* In an adhesive-bonded joint, to separate at the bond surface. *n* Such as a separation.

**Discharge-inception voltage** *n.* In a dielectric-strength test, the voltage at which discharges begin in the voids within the specimen.

**Discharge printing** *See printing.*

**Discoloration** \(ˌ)dis-ˌkə-lə-ˈrā-shən\ (1642) *n.* (1) Any change from an initial color possessed by a plastic. (2) A lack of uniformity in color where color should be uniform over the whole area of a plastic object. In the second sense, where they are applicable, one may use the more definite terms *mottle*, *segregation*, or *two-tone*. Discoloration can be caused by inadequate blending of ingredients, by overheating, exposure to light, irradiation, or chemical action.

**Discolored pick** *See mixed end or filling.*

**Discontinuities** *See holydays.*

**Discontinuous phase** *See dispersed phase.*

**Dished** *n.* Showing a symmetrical concave distortion of a flat or curved surface of a plastic object, so that, as normally viewed, it appears more concave than its design calls for. Opposite of domed.
*See also warp and sink mark.*

**Dislocation** \ˌdis-(ˌ)lō-ˈkā-shən\ *n.* A structural defect in which the lattice planes in a crystal is incomplete or warped.
*Also known as a line defect.*

**Disorder, crystalline** *n.* Defect in the lattice of a crystal, characterized by local faults in the atomic arrangement.

**Dispersant** \di-ˈspər-sənt\ (1941) *n.* A dispersing agent, often of a surface active chemical, that promotes formation of a dispersion or maintains a state of dispersion by preventing settling or aggregation.

**Dispersant** *n.* In an organosol, a liquid component that has a solvating or peptizing action on the resin, thus aiding in dispersing and suspending it. Additive that increases the stability of a suspension of powders (pigments) in a liquid medium.
*Also known as dispersing agent.*

**Dispersed** *n.* Finely divided or colloidal in nature.

**Dispersed phase** *n.* That phase in an emulsion or suspension which is broken down into droplets or discrete particles and dispersed throughout the other or continuous phase.
*Also called discontinuous phase.*

**Disperse dyes** *n.* A class of slightly water-soluble dyes originally introduced for dyeing acetate and usually applied from fine aqueous suspensions. Disperse dyes are widely used for dyeing most of the manufactured fibers.
*See dyes.*

**Disperse phase** *n.* In a suspension or emulsion, the "disperse phase" refers to the particles of one material individually dispersed, more or less stably, in the continuously connected domain of another material, usually a liquid, known as the *continuous phase.*

**Disperse system** *n.* Any system in which particles (of any size and state) are dispersed in a homogeneous medium. A colloidal solution represents a special kind of disperse system.

**Dispersing agent** *n.* A material added, usually in relatively small percentage, to a suspending medium to promote and maintain the separation of discrete, fine particles of solids or liquids. Dispersants are used, for example, in the wet grinding of pigments and for suspending water-insoluble dyes.

*See dispersant.*

**Dispersion curve** *n.* A graph of the refractive index (ordinate) as a function of wavelength of radiation (abscissa).

**Dispersion, degree of** *n.* Quantity varying reciprocally with aggregate size. The larger the aggregates, the lower the degree of dispersion.

**Dispersion forces** *n.* (1) Weak forces between atoms or molecules due to momentary fluctuations in their electronic charge-cloud distributions. (2) The force of attraction between molecules possessing no permanent dipole. The interaction energy is given by

$$U_p = -\frac{3}{4}h\frac{V_o\alpha^2}{r^6},$$

where $h$ is the Planck's constant, $V_o$ the characteristic frequency of the molecule, $r$ the distance between the molecules, and $\alpha$ is the polarizability.

*Also called London forces.*

**Dispersion, light** *n.* (1) The separation of light into separate wavelengths by means of a dispersion device such as a prism or diffraction grating. Fundamentally, dispersion is related to different wavelengths of light in a given medium. (2) The variation of refractive index with color (or wavelength) of light. The spreading of white light into its component colors when passing through a glass prism is due to dispersion, which, in turn, is due to the fact that the refractive index of transparent substances is lower for long wavelengths than for short wavelengths. A measure of dispersion is $v$ defined as:

$$v = \frac{n_D - 1}{n_F - n_C},$$

where $n_D$ is the refractive index at 589 nm (yellow); $n_F = 486$ nm (blue); $n_C = 656$ nm (red).

*See dispersion curve.*

**Dispersion, particles and liquids** (14c) *n.* (1) A system of two or more phases comprising one or more finely divided materials distributed in another material. Types of dispersions are *emulsions* (liquids in liquids), *suspensions* (solids in liquids), *foams* (gases in liquids or solidified liquids), and *aerosols* (liquids in gases). In the plastics industry, the term dispersion usually denotes a finely divided solid dispersed in a liquid or in another solid. Examples are fillers and pigments in molding compounds, plastisols and organosols. This term is used loosely in many ways with special meanings, which are often implied but not defined. Since the term is decidedly generic and includes all types of colloidal systems, it should not be used on the assumption that it refers to a desirable feature of one type of dispersion. For example, in paint and printing ink technology a "good" dispersion usually means that a pigment is finely divided and deflocculated in the vehicle. Where aggregates are present in the dispersed phase, the material is considered without exception a "poor" dispersion regardless of the state of flocculation. Where the pigment particles are finely divided but flocculated, the material has been called variously a "good" and a "poor" dispersion. (2) A mixing process in which the particles or globules of the discontinuous phase are reduced in size. This may be accomplished by breaking solid particles, as in ball-milling, or by shearing viscous regions, as in kneading or extrusion. (3) Two-phase system in which one phase, called the dispersed phase, is permanently distributed as small particles through the second phase called the continuous phase. Leach RH, Pierce RJ (1993) Printing ink handbook, national association of printing ink manufacturers Inc., 5th edn. Kluwer Academic Press, London, UK. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York. Paint/Coatings dictionary, Federation of societies for coatings technology, Philadelphia, Blue Bell, PA, 1978. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc.

*See also segregation.*

**Dispersion, pigment** *n.* Suspension of pigment particles uniformly in a medium such as a paint vehicle, plastic matrix, etc. The process of dispersing the pigment involves the separation of individual pigment particles, and coating them with the medium.

**Dispersion resin** *n.* A special type of PVC resin with very small spherical particles, usually 1 μm or less in diameter, permitting them to be mixed with plasticizers by simple stirring techniques. They are used in compounding plastisols and organosols.

*See organosol and plastisol.*

**Dispersion resins** *n.* Used as the primary vinyl resin in the production of plastisols and organosols. These resins are fine, white powders, with an average particle size of 1 μm and a bulk density of approximately 15–20 pounds/ft$^3$. The fine particle size, combined with the dense nature of the particle allows these products to be easily dispersed in plasticizers and solvents. The specific selection of a dispersion resin is primarily based on the fusion, rheological and appearance requirements of the end product and the manufacturing process.

**Dispersions** *n.* Systems of two or more phases comprising one or more finely divided materials distributed in another material. Types of dispersion are emulsions (liquids in liquids), suspensions (solids in liquids), foams (gases in liquids or solidified liquids), and aerosols (liquids in gases). Patton TC (1965) Paint flow and pigment dispersion. Interscience Publishers Inc. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York. Kirk-Othmer (1996) Encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York. Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York.

**Dispersive mixing** *n.* Any mixing process in which the principal action is reduction of the size of particles or interlayers. The progress of the process is judged by two criteria, intensity of segregation and scale of segregation.

**Dispersive power** *n.* If $n_1$ and $n_2$ are the indices of refraction for wavelengths $\lambda_1$ and $\lambda_2$ and $n$ the mean index or that for sodium light, the dispersive power for the specified wavelength is

$$\bar{\omega} = \frac{n_2 - n_1}{n - 1}.$$

**Dispersoid** \-ˈspər-ˌsóid\ (1911) *n.* Particles of a dispersion.

**Displacement** \di-ˈsplā-smənt\ (1611) *n.* A reaction in which an elementary substance displaces and sets free a constituent element from a compound.

**Displacement angle** *n.* In filament winding, the angle whose tangent equals the quotient of the advancement distance of the winding ribbon on the equator after one complete turn, divided by (π × the equatorial diameter).

**Displacement or elongation** (at an instant) *n.* The distance of a vibrating or oscillating particle from its position of equilibrium.

**Disproportionation** \-ˌpōr-shə-ˈnā-shən\ (ca. 1929) *n.* A reaction in which one substance acts simultaneously as an oxidizing agent and a reducing agent; auto-oxidation. It can also be written as the termination by chain transfer between macroradicals, to produce a saturated and an unsaturated polymer molecule.

**Dissipation** \ˌdi-sə-ˈpā-shən\ *n.* The loss modulus in a plastic part when imparted with rapid, cyclic changes (or even reversals) of stress. The product of mechanical dissipation is heat, which can raise the temperature of the part and cause it to weaken, creep rapidly, or even fail prematurely. Dissipation can also apply to electrical systems, whereby a material with small dissipation will tend to better insulate heat. This is a desirable property in electrical insulations for high-frequency applications because it minimizes the waste of electrical energy as heat.

**Dissipation factor** (electrical) *n.* The ratio of the conductance of a capacitor in which the test material is the dielectric to its susceptance; or the ratio of its parallel reactance to its parallel resistance. Most plastics have a low dissipation factor, a desirable property in electrical insulations for high-frequency applications because it minimizes the waste of electrical energy as heat. On the other hand, for those plastics with high dissipation factors, e.g., PVC and phenolic, the property provides a fast and economical method of even heating using microwaves and is the basis of electronic preheating of thermosetting molding powders and of electronic sealing of flexible-vinyl films.

*See dielectric heating.*

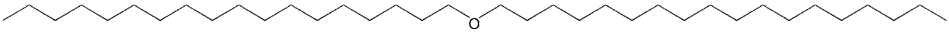
**Dissipation factor** (mechanical) *n.* The ratio of the loss modulus to the modulus of elasticity in a plastic part undergoing rapid, cyclic changes (or even reversals) of stress. As in electrical dissipation, the product of mechanical dissipation is heat, heat that can raise the temperature of the part and cause it to weaken, creep rapidly, or even fail prematurely.

**Dissociation** \(ˌ)di-ˌsō-sē-ˈā-shən\ (1611) *n.* The splitting apart of a molecule to form two fragments; the reaction of an electrolyte with a solvent to form ions. *Sometimes called ionization.*

**Dissociation constant** *n*, $K_{\mathrm{diss}}$. The equilibrium constant for dissociation equilibrium.

**Dissymmetry** \(ˌ)di(s)-ˈsi-mə-trē\ (1845) *n.* Present in a molecule that does not have mirror image symmetry but does have a translational or rotational axis of symmetry.

**Distearyl ether (dioctadecyl ether)** A mold lubricant.



**Distemper** \dis-ˈtem-pər\ [obs. *distemper*, v., dilute, mix to produce distemper, fr. ME, fr. MF *destemprer*, fr. L *dis-* + temperare] (1632) *n.* Heavily pigmented, matt drying composition, capable of being thinned with water, in which the binding medium consists essentially of either glue or casein or similar sizing material.

**Distemper blush** *n.* A flat brush, 5–10 in. wide, well packed, with long bristle.

**Distemper colors** *n.* Colorants suitable for tinting distempers. The two chief requirements are lightfastness in reduced form and fastness of alkali.

**Distemper, oil-bound** *See oil-bound distemper.*

**Distensibility** \-ˈsten(t)-sə-bəl\ [*disten-* (fr. L *distensus*, pp of *distendere*) + *-ible*] (ca. 1828) *adj.* Ability to be stretched.
*See elongation.*

**Distillation** \ˌdis-tə-ˈlā-shən\ (14c) *n.* Process of separation consisting of vaporizing a liquid and collecting the vapor, which is then usually condensed to a liquid.

**Distillation range** *n.* Temperature range over which a mixture of liquids is distilled.

**Distinctness-of-image gloss** *n.* The sharpness with which image outlines are reflected by the surface of an object.

**Distortion** \di-ˈstór-shən\ (1581) *n.* (1) A change in the shape of a solid body, often associated with temperature differences or stress gradients within the body. (2) An apparent change of shape as perceived through an optically imperfect, transparent membrane or reflected from an imperfect mirror.

**Distressing** *n.* In antiquing, the furniture process designed to produce a more authentic look of age or craftsmanship. It attempts to simulate the small visible marks of abuse picked up by a piece of furniture during a long period of use. In simulating natural marring or aging of some kind, it may involve the use of gouges, hammers, chains, and blunt or pointed instruments such as common car keys, a belt buckle or sharp pencil point. Other effects may be achieved with a fine brush or a pointed wood instrument dipped into ink or glaze and placed on a surface. If no natural counterpart to an effect exists, it is not authentically aged and should be considered a novelty finish or accent piece.

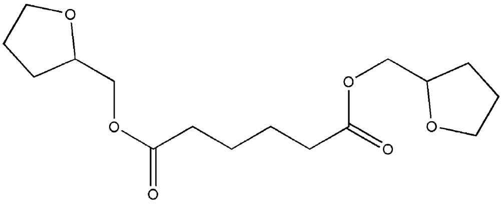
**Distributing roller** *n.* A rubber covered roller, which conveys ink from the fountain to the ink drum of a rotating press.

**Distribution law** *n.* A substance distributes itself between two immiscible solvents so that the ratio of its concentrations in the two solvents is approximately a constant (and equal to the ratio of the solubilities of the substance in each solvent). The above statement requires modification is more than one molecular species is formed.

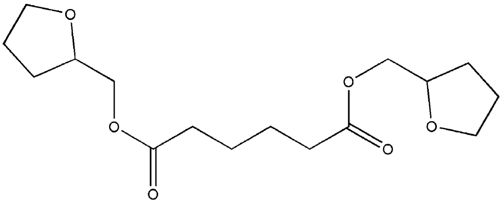
**Distribution length** *n.* In fibers, a graphic or tabular presentation of the proportion or percentage (by number or by weight) of fibers having different lengths.

**Distributive mixing** *n.* Any mixing operation in which the principal action is convection rather than dispersion, resulting in elements of the different phases being more intimately blended, but without much size reduction. Typical is blending of masterbatch pigmented pellets with virgin pellets prior to extrusion or molding, by tumbling.

**Di-*tert*-butyl peroxide** *n.* A member of the alkyl peroxide family, used as an initiator in vinyl chloride polymerization, polyester reactions, and as a crosslinking agent. A stable liquid used as a catalyst for polymerizations at high temperatures of a variety of olefin and vinyl monomers, e.g., ethylene, styrene, and styrenated alkyds.



**Ditetrahydrofurfuryl adipate** *n.* A heterocyclic plasticizer for cellulose acetate-butyrate.



**Ditridecyl phthalate (DTDP)** *n.* $C_6H_4(COOC_{13}H_{27})_2$. A primary plasticizer for PVC, also compatible with cellulosics and polystyrene. In vinyls, it imparts resistance to high temperatures and to extraction by hot soapy water, excellent flexibility, and anti-fogging properties.

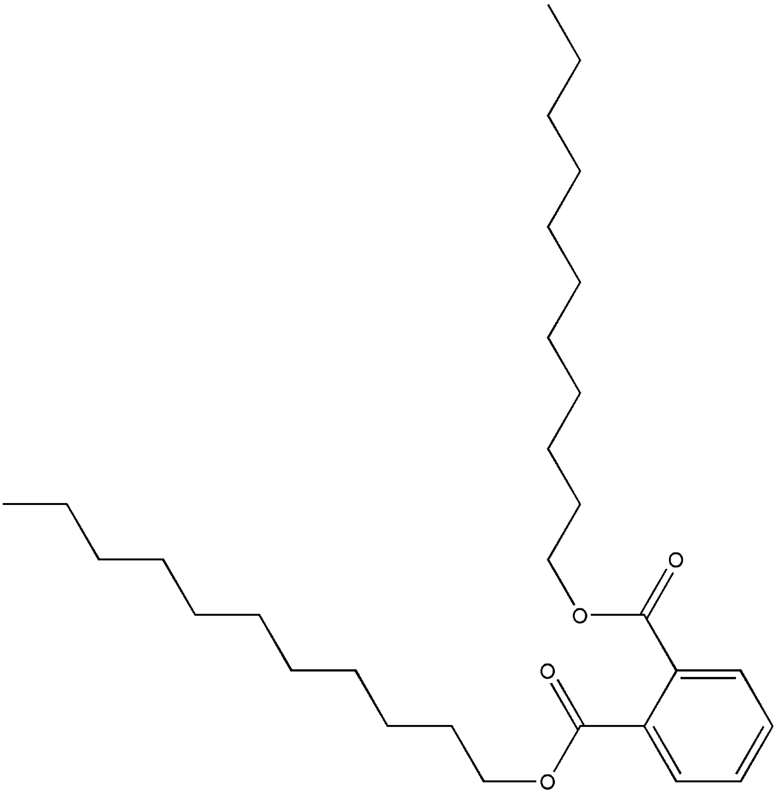
**Ditridecyl thiodipropionate** *n.* $(C_{13}H_{27}OOCCH_2CH_2)_2S$. A stabilizer, plasticizer, and softening agent.

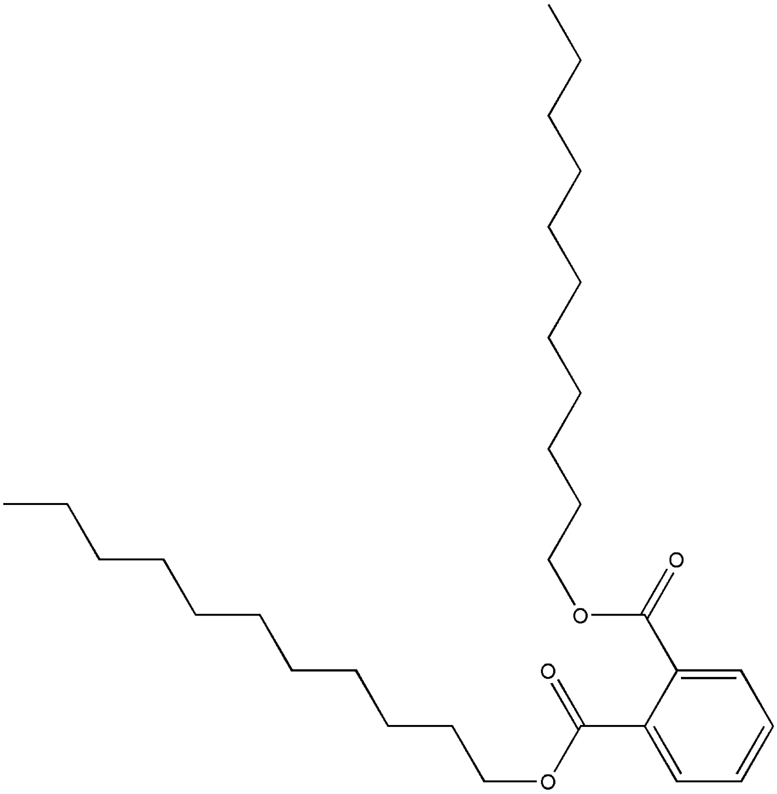
**Diundecyl phthalate (DUP)** *n.* A plasticizer characterized by low volatility and good low-temperature properties compared to other phthalates.

**Divergent die** \də-ˈvər-jənt-\ *n.* A die for hollow articles in which the internal channels leading to the orifice increase in cross section toward the lip.

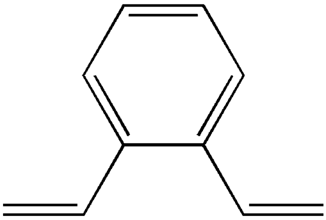
**Divided threadline extrusion** *n.* Spinning of two separate threadlines from one spinneret.

**Divinyl B** Syn: butadiene.





**Divinylbenzene** (DVB, vinylstyrene) *n.* A monomer derived from styrene, used in making ion-exchange resins, synthetic rubbers, and casting resins. The commercial product contains 55% mixed *m-* and *p-* isomers, the rest being ethylvinylbenzenes. It is often used along with styrene as a reactive monomer in the production of polyester resins, to which it imparts a higher degree of crosslinking and superior chemical resistance.



**Divinyl polymerization, polymers** *n.* Polymerization of a monomer, which contains two vinyl groups. When the two double bonds are conjugated (as in 1,3-dienes) the polymerization is called diene polymerization.

**DIY** *n.* Abbreviation for “do it yourself”.

**Dl-limonene** *See dipentine.*

**DLVO theory** *n.* A dispersion stabilizing theory in which zeta potential is used to explain that as two particles approach one another their ionic atmospheres begin to overlap and a repulsion force is developed. The theory was prepared by Dergaquin and Landau in the Soviet Union and Verwey and Overbeck in the Netherlands, thus the DLVO.

**DMA** *n.* Abbreviation for dimethylaniline.

**DMEP** *n.* Abbreviation for di(2-methoxyethyl) phthalate.

**DMF** *n.* Abbreviation for dimethyl formamide.

**DMG** *n.* Abbreviation for dimethyl glutarate.

**DMSO** *n.* Abbreviation for dimethyl sulfoxide.

**DMT** *n.* Abbreviation for dimethyl terephthalate.

**DNA** *n.* Abbreviation for dinonyl adipate.

**DNHZ** *n.* Abbreviation for di-*n*-hexyl azelate.

**DNODA** *n.* Abbreviation for di-*n*-octyl-*n*-decyl adipate.

*See n-octyl-n-decyl adipate.*

**DNODP** *n.* Abbreviation for di(*n*-octyl-*n*-decyl) phthalate.

**DNP** *n.* Abbreviation for dimethyl phthalate.

**DNP** *n.* Abbreviation for dinonyl phthalate.

**DNPT** *n.* Abbreviation for dinitrosopentamethylenetetr-amine.

**DNTA** *n.* Abbreviation for dinitrosoterephthalamide.

**DOA** *n.* Abbreviation for dioctyl adipate or di (2-ethylhexyl) adipate.

**Dobby** \ˈdä-bē\ [perhaps fr. *Dobby*, nickname for *Robert*] (1878) *n.* (1) A mechanical attachment on a loom. A dobby controls the harnesses to permit the weaving of geometric figures. (2) A loom equipped with a dobby. (3) A fabric woven on a dobby loom.

**Doctor** \ˈdäk-tər\ [ME *doctour* teacher, doctor, fr. MF & ML; MF, fr. ML *doctor*, fr. L, teacher, fr. *docēre* to teach] *n.* (1) Device for spreading a thin film of even thickness on base material. In the paint industry, it is used to prepare paint and varnish films of even and predetermined thickness. (2) In gravure printing and coating, a blade that scrapes off the excess ink or lacquer from the surface of the etched cylindrical roll just prior to printing, leaving the "cells" filled with ink or lacquer {*Doctor knife* G Abstreifmesser n; Rakelmesser n, F racle f, S cuchilla de recubrimiento, cuchilla f, I raschiatore m; racla f}.

**Doctor-bar blade** *n.* A scraper mechanism that regulates the amount of adhesive on the spreader rolls or on the surface being coated.

**Doctor mark or streak** *n.* Streak or ridge in coated fabrics caused by a damaged doctor blade.

*Also called knife mark.*

**Doctor roll** *n.* Roller mechanism, which is revolving at a different surface speed, or in an opposite direction, resulting in a wiping action for regulating the adhesive supplied to the spreader roll.

**Doctor streak** *n.* A defect in printed fabrics consisting of a wavy white or colored streak in the warp direction. It is caused by a damaged or improperly set doctor blade on the printing machine.

**Doctor test** *n.* Method for detecting the presence of mercaptan sulfur in gasolines, naphthas, and kerosenes.

**Dodecanoic acid** *See lauric acid.*

**4-Dodecyloxy-2-hydroxbenzophenone** *n.* An ultraviolet inhibitor for polyethylene and polypropylene, also suggested as suitable for PVC, polystyrene, polyesters, and surface coatings such as those based on cellulosic and acrylic resins.

**Doeskin finish** \ˈdō-ˌskin\ *n.* A soft low nap that is brushed in one direction. Cloth with this type of finish is used on billiard tables and in men's wear.

**DOF** *n.* Abbreviation for dioctyl fumarate.

**DOFF** A set of full bobbins produced by one machine (a roving frame, a spinning frame, or a manufactured filament-yarn extrusion machine).

**Doffer** *n.* (1) The last or delivery cylinder of the card from which the sheet of fibers is removed by the doffer comb. (2) An operator who removes full bobbins, spools, containers, or other packages from a machine and replaces them with empty ones.

**Doffer comb** *n.* A reciprocating comb, the teeth of which oscillate close to the card clothing of the doffer to strip the web of fibers from the card.

**Doffer loading** *n.* Fibers imbedded so deeply into the doffer wire clothing that the doffer comb cannot dislodge them to form a traveling web.

**Doffing** *n.* The operation of removing full packages, bobbins, spools, roving cans, caps, etc., from a machine and replacing them with empty ones.

**Dogbone** *n.* A slang term for the dumbbell shape of tensile-test specimens having relatively wide ends for gripping and a narrower, gage-length center within which all plastic deformation and breakage occur. *See tensile bar.*

**Dogskin** *See orange peel* (coatings defect).

**Doily** \ˈdói-lē\ [*Doily* or *Doyley fl* 1711 London draper] (1711) *n.* In filament winding, the planar reinforcement that is applied to a local area between windings to provide extra strength in an area where a cut-out is to be made; for example, a port opening.

**DOIP** *n.* Abbreviation for dioctyl isophthalate. *See di(2-ethylhexyl) isophthalate.*

**Dolomite** \ˈdō-lə-ˌmīt\ [F, fr. *Déodat* de *Dolomieu* † 1801 F geoloist] (1794) *n* $CaCO_3 \cdot MgCO_3$. A mineral having the empirical composition, 1 mol of calcium carbonate and 1 mol of magnesium carbonate. Any calcium carbonate rock containing 20% or more of magnesium carbonate. *See calcium carbonate, natural.*

**Domain** \dō-ˈmān\ [ME *domayne*, fr. MF *domaine*, *demaine*, fr. L *dominium*, fr. *dominus*] (15c) *n.* A region in a ferromagnetic substance within which the magnetic moments of all the atoms are aligned.

**Domains** *n.* A term used in non-crystalline systems in which the chemically different sections of the chain separate, generating two or more amorphous phases.

**Domed** *n.* Having a symmetrical convex protrusion in the surface. Opposite of dished.

**Dominant wavelength** *n.* **CIE**. Wavelength of spectrally pure light which, when additively mixed with the illuminant and adjusted for luminance, would match the color. It is expressed in wavelength units, nm (or µm), and is determined graphically from the chromaticity diagram or by suitable computation. The dominant wavelength of the non-spectral colors, the purples, is described in terms of the dominant wavelength of the green, to which they are the additive complements, followed by the letter c. Thus, a dominant wavelength designation of 520c describes a purple, which is additively complementary to a green having a dominant wavelength of 520 nm. Dominant wavelength describes the hue of a color, although the visual evaluation of constant hue does not necessarily coincide with constant dominant wavelength. Commission Internationale De L'Eclairage (CIE), CIE Central Bureau, Kegelgasse 27, A-1030, Wien, Austria. [English: International Commission on Illumination, Vienna, Austria], www.cie.co.at/headerbasic.html.

**Domino** \ˈdä-mə-ˌnō\ *n.* Early French wallpaper made in small sheets, originally imitating marble, later patterned.

**Donegal** \ˌdä-ni-ˈgól\ *n.* A tweed fabric with colorful slubs woven in, donegal is used for suits and coats.

**Doorframe** *n.* An assembly built into a wall consisting of two upright members (jambs) and a head (lintel) over the doorway; encloses the doorway and provides support on which to hang the door.

**DOP** *n.* Abbreviation for dioctyl phthalate. *See di(2-ethylhexyl) phthalate.*

**Dope** \ˈdōp\ [D *doop* sauce, fr. *dopen* to dip; akin to OE *dyppan* to dip] (1807) *n.* (1) A solution of a cellulosic plastic, historically cellulose nitrate, used for treating fabrics. (2) Cellulose ester lacquer for adhesive or coating purposes.

*See spinning solution.*

**Dope cotton** *n.* Designation of high viscosity nitrocellulose, i.e., 20–30, 40, and 70 s nitrocellulose.

*See nitrocellulose.*

**Dope dyed** *See dyeing, mass-colored.*

**Doping** *n.* The addition of controlled small amounts of a foreign substance to an otherwise pure substance.

**Doppler effect** \ˈdä-plər\ [Christian J. *Doppler*] (1905) (Light) *n.* The apparent change in the wavelength of light, produced by the motion in the line of sight of either the observer or the source of light.

**Doppler effects** *n.* Effects on the apparent frequency of a wave train produced (1) by motion of the source toward or away from the stationary observer, and (2) by motion of the observer toward or from the stationary source; the motion in each case being with reference to the (supposedly stationary) medium. For sound waves, the observed frequency $f_o$, in cycles/s, is given by

$$f_o = \frac{v + w - v_o}{v + w - v_s} f_s,$$

where $v$ is the velocity of sound in the medium, $v_o$ the velocity of the observer, $v_s$ the velocity of the source, $w$ the velocity of the wind in the direction of sound propagation, and $f_s$ is the frequency of source. For optical waves

$$f_o = f_s \sqrt{\frac{c + v_r}{c - v_r}},$$

where $v_r$ is the velocity of the source relative to the observer and $c$ is the speed of light.

**Dormer** \ˈdór-mər\ [MF *dormeor*, fr. L *dormitorium*] (1592) *n.* Gable-like projection or a window set upright in a sloping roof, or the roofed projection in which this window is set.

**DOS** *n.* Abbreviation for dioctyl sebacate.

*See di(2-ethylhexyl) sebacate.*

**Dosimeter** \dō-ˈsi-mə-tər\ [LL *dosis* + ISV *-meter*] (1938) *n.* detector worn by workers to measure the amount of an environmental agent, usually radioactivity, but sometimes noise or noxious gases, to which the worker has been exposed during a working shift or longer period of time.

**Dot** *n.* The individual element of a halftone printing plate.

**DOTP** *n.* Abbreviation for dioctyl terephthalate.

**Dotted Swiss** (ca. 1924) *n.* A sheer cotton or cotton blend fabric with small dot motif, dotted Swiss is used for dress goods, curtains, baby clothes, etc.

**Double back** *n.* A secondary backing glued to the back of carpet, usually to increase dimensional stability.

**Double bond** *n.* A type of covalent bond (pi or π bond in C=C), common in organic chemistry, in which two pairs of electrons are shared between two elements. The double bond may be symbolized either by ":" or "=", as in ethylene, $CH_2:CH_2$, or dimethyl ketone $(CH_3)_2C=O$. Elements possess a definite number of valency linkages or bonds, and these are employed in uniting with other elements. When all these bonds are completely employed in such unions, saturated compounds result. If, however, a residual bond or linkage remains, this may be involved with another in forming a reactive or unsaturated double bond. If a hydrogen atom is removed from each of the carbon atoms, two spare linkages occur, and an unsaturated double bond results. Double bonds are centers of great reactivity, and are able to accept addition of suitable elements such as hydrogen, chlorine, etc., to yield fully saturated compounds. The reactivity of double bonds in drying oils is responsible for their drying (autoxidation) and polymerizing properties.

**Double-bond addition** *n.* Chemical reaction whereby a double-bonded molecule (typically an alkene) is reacted with a reagent to form a single product. When an alkene undergoes addition, two groups add to the carbon atoms of the double bond, and the carbons become saturated.

**Double cloth construction** *n.* Two fabrics are woven in the loom at the same time, one fabric on top of the other, with binder threads holding the two fabrics together. The weave on the two fabrics can be different.

**Double decomposition** *n.* Double decomposition consists of a simple exchange of the parts of two substances to form two new substances.

**Double end** *n.* Two ends woven as one in a fabric. A double end may be intentional for fabric styling, or accidental, in which case a fabric defect results.

**Double helix** (1954) *n.* Physical structure of DNA, whereby two complementary strands are joined by hydrogen bonds between the base pairs. This double strand coils into a helical arrangement.
*See DNA.*

**Double-hung sash** *n.* Window divided into two sections, one lowering from the top and the other rising from the bottom.

**Double knit fabric** (1895) *n.* A fabric produced on a circular-knitting machine equipped with two sets of latch needles situated at right angles to each other (dial and cylinder).

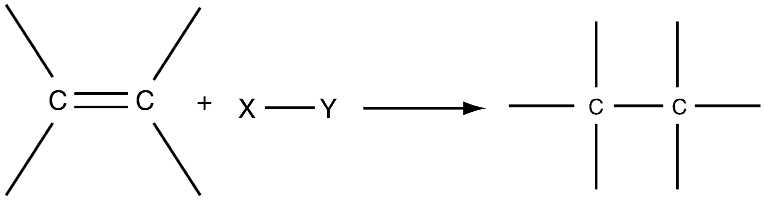
**Double pick** *See mispick.*

**Doubler** (13c) *v.* In filament winding, a local area with extra wound reinforcement, either wound integrally with the part or wound separately and bonded to the part.

**Double-ram press** *n.* A press for injection or transfer molding in which two distinct systems of the same kind (hydraulic or mechanical), or of different kinds, create respectively the injection or transfer force and the clamping force.

**Double refraction** (1831) *n.* The refraction of light in two slightly different directions to form two rays or vector components. Each ray is polarized, and their vibration directions are perpendicular to each other. Furthermore, each ray has a different velocity, and therefore a different refractive index.
*See birefringence.*

**Double-screw extruder** *See extruder, twin-screw.*



**Double seam can** *n.* Can formed by interlocking the edges of both the end and the body, double folding and rolling firmly together.

**Double selvage** *See rolled selvage.*

**Double-shot molding** (two-shot molding, insert molding, two-color molding, and over-molding) *n.* A process for making two-color or two-material parts by means of successive molding operations. The basic process includes the steps of injection molding one part, transferring this part to a second mold as an insert, and molding the second material against the first. Examples of parts made by double-shot molding are computer keys, pushbuttons, telephone-keypad buttons, and other such products in which indicia must resist heavy wear and remain permanently legible. In a modification of the process, cups and the like with differently colored insides and outsides are made automatically by means of a machine equipped with two injection molders and a swinging platen carrying two cup cores indexed around a central tie-bar, bringing the molds into position for each successive shot. This arrangement permits simultaneous molding of both shots. Some of these products are made today by coinjection.

**Double-skinned sheet** *n.* A plastic sheet consisting of a relatively thick center section bonded on each face to thinner layers that differ in color or composition from the center section. Today such sheets are usually made by coextrusion of the three plastic layers and, in many cases, two additional adhesive layers between the core and the skin.

**Double spread** *See spread.*

**Doubletone ink** *n.* A type of printing ink which produces the effect of two-color printing with a single impression. These inks contain a soluble toner, which bleeds out to produce a secondary color.

**Double weave** *n.* A fabric woven with two systems of warp or filling threads so combined that only one is visible on either side. Cutting the yarns that hold the two cloths together yields two separate cut pile fabrics.

**Doubling** *n.* (1) A process for combining several strands of sliver, roving, or yarn in yarn manufacturing. (2) The process of twisting together two or more singles or plied yarns, i.e., plying. (3) A British term for twisting. (4) The term doubling is sometimes used in a sense opposite to singling. This is unintentional plying. (5) A yarn, considerably heavier that normal, produced by a broken end becoming attached to and twisting into another end.

**Dough** \ˈdō\ [ME *dogh*, fr. OE *dāg*; akin to OHGr *teic* dough, *fingere* to shape, Gk *teichos* wall] (dough-molding compound) *n.* A term sometimes used for a reinforced-plastic mixture of dough-like consistency in an uncured or partly cured state. A typical dough consists of polyester resin, glass fiber, calcium carbonate, lubricants and catalysts. The compounds are formed into products either by hand layup or, more usually, by compression molding.

**Douppioni** *n.* A rough or irregular yarn made of silk reeled from double or triple cocoons. Fabrics of douppioni have an irregular appearance with long, thin slubs. Douppioni-like yarns are now being spun from polyester and/or rayon staple.

**Dowel** \ˈdaú(-ə)l\ [ME *dowle*; akin to OHGr *tubili* plug, LGk *typhos* wedge] (14c) (dowel pin) *n.* A hardened steel pin, usually having a slight taper, used to maintain alignment between two or more parts of a mold or machine.

**Dowel bushing** *n.* A hardened steel insert in the portion of a mold that receives the dowel pin.

**Downdraft metier** *n.* A dry-spinning machine in which the airflow within the drying cabinet is in the same direction as the yarn path (downward).

**Downgrade** *n.* In quality control, the lowering of the grade and/or value of a product due to the presence of defects.

**Downtwister** *n.* A cap, ring, or flyer twisting frame.

**Downtwisting** *n.* A process for inserting twist into yarn in which the yarn passes downward from the supply package (a bobbin, cheese, or cone) to the revolving spindle. The package or packages of yarn to be twisted are positioned on the creel, and the ends of yarn are led downward through individual guides and stop motions to the positively driven feed roll and from there to the revolving take-up package or bobbin, which inserts twist.

**Dowtherm®** *n.* The trade name (Dow Chemical Co., TX, USA) of a liquid heat-transfer medium consisting of biphenyl and phenyl ether in eutectic ratio. High-boiling and stable, it is less used today than formerly because of its suspected carcinogenicity. Bp, 258°C. Used for heat transfer.

**DOZ** *n.* Abbreviation for dioctyl azelate. *See di(2-ethylhexyl) azelate.*

**DP** *n.* Abbreviation for degree of polymerization.

**DPA** *n.* Abbreviation for diphenylamine.

**DPCF (DPCP)** *n.* Abbreviation for diphenyl cresyl phosphate, a plasticizer.

**DPP** *n.* Abbreviation for diphenyl phthalate.

**Draft** *n.* A slight taper in a mold wall, proceeding inward from the parting surface to the bottom of the cavity, designed to facilitate removal of the molded object from the mold. When the taper is reversed, tending to impede removal of the article, the term *back draft*, or *reverse draft* is employed. In weaving, a pattern or plan for drawing-in.

**Draft angle** *n.* In a mold, the angle in the profile plane with its vertex at the bottom of the mold or cavity, between the side of the mold and the vertical plane. In most cases, 1° is adequate for smooth ejection of parts from the mold.

**Drafting** *See drawing* (1).

**Draft ratio** *n.* The ratio between the weight or length of fiber fed into various machines and that delivered from the machines in spun yarn manufacture. It represents the reduction in bulk and weight of stock, one of the most important principles in the production of yarn from staple fibers.

**Drag (brush drag)** *n.* Resistance encountered when applying a coating by brush. The British term for this condition is “gummy”.

**Drag flow** *n.* (1) In general, the laminar flow of a viscous liquid that is contained between two surfaces, one of which is moving relative to the other. (2) In the metering section of an extruder screw, the rate of drag flow is the component of total material flow in the down-channel direction caused by the relative motion between the screw and cylinder. If the screw were discharging freely, the output rate would be equal to the drag-flow rate. (3) In a wire-coating die, the flow generated by the relative motion of the wire through the stationary die. In both extruders and wire-coating dies, pure drag flows almost never occur, but are altered in complex ways by opposing or augmenting pressure fields and the non-Newtonia nature of the melts.

**Dragged in filling** *See pulled-in filing.*

**Dragon's blood** *n.* Dark red resinous exudation, obtained from the surface of the fruit of the *Calamus draco* and similar species. Used to some extent as a colorant in coatings.

**Drainage fabrics** *See geotextiles.*

**Dralon** *n.* Poly(acrylonitrile). Manufactured by Bayer, Germany.

**Drape** \ˈdrāp\ [prob. back-form. fr. *drapery*] (1847) *v.* (1) With reference to plastics films and coated fabrics, their ability to hang without creases and to form graceful folds when used as draperies, shower curtains, and the like. (2) In sheet thermoforming, the ability of the preheated sheet to conform to the mold under the influence of gravity.

**Drape-assist frame** *n.* In sheet thermoforming, a frame made from thin wires or thick bars shaped to the periphery of the depressed areas of the mold and suspended above the sheet to be formed. During forming, the assist frame drops down, drawing the softened sheet tightly into the mold and thereby preventing webbing between high areas of the mold and permitting closer spacing in arrays of multiple molds.

**Drape forming** (drape vacuum forming, drape thermoforming) *n.* Forming a thermoplastic sheet into three-dimensional articles by clamping the sheet in a movable frame, heating the sheet, then lowering it to drape over the high points of a male mold. Vacuum is then applied to complete the forming.

*See also sheet thermoforming.*

**Draw back** *n.* A crossed end; an end broken during warping that when repaired was not free or was tied in with an adjacent end or ends overlapping the broken end. The end draws or pulls back when unwound on the slasher.

*Also see sticker* (1).

**Draw crimping** *See draw-texturing.*

**Drawdown** *n.* (1) A film of ink deposited on paper by a smooth edged blade to evaluate the undertone and masstone of the ink. Syn: pulldown. (2) A thin film of even thickness on base material cast by means of a drawdown bar. Syn: casting. (3) In extrusion, the process of pulling the extrudate away from the die at a lineal speed greater than the average velocity of the melt in the die, thus reducing extrudate's cross-sectional dimensions. The term is also used by blow molders to denote the decrease in parison diameter and wall thickness due to gravity.

**Draw down** *n.* The amount by which manufactured filaments are stretched following extrusion.

*Also see drawing* (2).

**Drawdown bar** *n.* Rectangular metal bar designed to deposit a specified thickness of wet coating film on test panels or other substrates.

**Drawdown ratio** *n.* In extrusion of fiber spinning, the ratio of the cross-sectional area of the die opening to that of the finished product. In making sheet or cast film, where the sheet width is nearly equal to the width of the die opening, the ratio of the thickness of the die opening to that of the final sheet is sometimes spoken of as the drawdown ratio.

**Draw frame blends** *n.* Blends of fibers made at the draw frame by feeding in ends of appropriate card sliver. This method is used when blend uniformity is not a critical factor.

**Drawinella** *n.* Cellulose triacetate. Manufactured by Wacker, Germany.

**Drawing** *n.* The process of stretching a thermoplastic filament, sheet, or rod to reduce its cross-sectional area and/or to improve its physical properties by orientation.

**Drawing** *n.* (1) The process of attenuating or increasing the length per unit weight of laps, slivers, slubbings, or rovings. (2) The hot or cold stretching of continuous filament yarn or tow to align and arrange the crystalline structure of the molecules to achieve improved tensile properties.

**Drawing in** *n.* In weaving, the process of threading warp ends through the eyes of the heddles and the dents of the reed.

**Drawn tow** *n.* A zero-twist bundle of continuous filaments that has been stretched to achieve molecular orientation (tows for staple and spun yarn application are usually crimped).

**Drawout** *n.* A method of application in which the coating is applied, usually on paper, by spreading the pigment-vehicle mass evenly with a broad knife. Useful for examination of masstone, undertone, opacity, printing strength, and in some cases, fadeometer ratings of pigments.

**Draw process** *n.* Process for shaping a tubular or solid cylindrical specimen. The process involves passing the material through a die where it is then gripped by a suitable device, which can pull it forward on a mechanical or hydraulic bench. A reduction in the diameter (solid specimens) and wall thickness (tubular specimens) results. Multi-die drawing is necessary in wire production.

**Draw ratio** *n.* (1) A measure of the degree of stretching during the orientation of a fiber or filament, expressed as the ratio of the cross-sectional area of the undrawn material to that of the drawn material. (2) In monofilament manufacture, the filament is wrapped several times around a vertical, driven roll, passed through a warming oven, then wrapped again around a second roll running faster than the first one. In this way the filament is stretched and oriented and its cross section is reduced. The ratio of the surface speed of the second, faster roll to that of the first equals the draw ratio.

**Draw resonance** *n.* A phenomenon occurring in film and filament extrusion in which the extrudate is drawn into a quenching bath at a certain critical speed that creates a cyclic pulsation in the cross-sectional area of the extrudate. The pulsation increases with rising drawing speed until the filament or film eventually breaks at the bath surface. Draw resonance has been observed while extruding polypropylene, polyethylene, and polystyrene.

**Draw sizing** *n.* A system linking draw warping and sizing in a continuous process. A typical system includes the following elements: (1) creel, (2) eyelet board, (3) warp-draw machine, (4) intermingler, (5) tension compensator and break monitor, (6) sizing bath, (7) dryers, and (8) waxing and winding units.

**Draw-texturing** *n.* In the manufacture of thermoplastic fibers, the simultaneous process of drawing to increase molecular orientation and imparting crimp to increase bulk.

**Draw-twisting** *n.* The operation of stretching continuous filament yarn to align and order the molecular and crystalline structure in which the yarn is taken up by means of a ring-and-traveler device that inserts a small amount of twist (usually 0.25–0.5 turn/in.) into the drawn yarn.

**Draw-warping** *n.* A process in which a number of threadlines, usually 800–2000 ends of POY feedstock, are oriented under essentially equal mechanical and thermal conditions by a stretching stage using variable speed rolls, then directly wound onto the beam. This process gives uniform end-to-end properties.

**Draw-winding** *n.* The operation of stretching continuous filament yarn to align or order molecular and crystalline structure. The drawn yarn is taken up on a parallel tub or cheese, resulting in a zero-twist yarn.

**Dressed lumber** *n.* Lumber having one or more of its faces planed smooth.

*Also called dressed stuff and surfaced lumber.*

**Dressing compound** *n.* Bituminous liquid used hot or cold for dressing the exposed surface of roofing felt.

**Dribbling or drooling** *n.* A condition sometimes occurring in injection molding between shots in which melt drips from the withdrawn nozzle. Drooling was a common problem with 6/6 nylon in the 1950s because of depolymerization caused by moisture pickup in feed hoppers and overheating in the old, torpedo-type heating cylinders.

**Drier** (1528) *n.* A composition, which accelerates the drying of oil, paint, printing ink, or varnish. They consist mainly of metallic salts, which exert a catalytic effect on the oxidation and polymerization of the oil vehicles employed and are available in both solid and liquid forms.

*Also called siccative.*

**Drier absorption** *See drier dissipation.*

**Drier dissipation** *n.* A loss in catalytic power of a drier due to a physical absorption or a chemical reaction with certain pigments.

**Driers drop-weight test** (falling-weight test) *n.* Any test of impact resistance in which known weights are dropped once or repeatedly on the test specimen. Examples are ASTM D 4272 (plastic films), D 3029, D 4226, and D 4495 (rigid PVC sheet and parts), and F 736, Section 15 (polycarbonate sheet).

*Also see free-falling-dart test.*

**Drift** *See overspray and creep.*

**Drill** (1743) *n.* A strong denim-like material with a diagonal 2 × 1 weave running toward the left selvage. Drill is often called khaki when it is dyed that color.

**Drop** *n.* One vertical descent of a scaffold.

**Drop black** *n.* Another name for bone black. *See bone black.*

**Drop ceiling** *n.* A form of decoration in which the ceiling paper is brought down to a suitable depth on the walls of a room and divided from the sidewall by a border or molding. Gives the illusion of a lower ceiling.

**Drop cloth** *n.* Cover used to protect floors and furniture, etc., from paint spillage and droppings.

**Dropped stitches** *n.* A defect in knit cloth characterized by recurrent cuts in one or more wales of a length of cloth.

**Drop siding** *n.* An exterior wall cladding of wooden boards (or strips of other material, such as aluminum or vinyl), which are tongued and grooved or rabbeted and overlapped so that the lower edge of each board interlocks with a groove in the board immediately below it. *Also known as novelty siding and rustic siding.*

**Drop stitch** *n.* (1) An open design made in knitting by removing some of the needles at set intervals. (2) A defect in knit fabric.

**Drop wires** *n.* A stop-motion device utilizing metal wires suspended from warp or creeled yarns. When a yarn breaks, the wire drops, activation the switch that stops the machine.

**Drum coloring** *See dry coloring.*

**Drum extruder** *n.* A plasticating machine having a rotating cylindrical element inside a concentric or eccentric housing. Pellets or powder are fed into the gap between drum and housing at the top. Shear action melts the solids and the melt exists through a slot about 270° around from the feed point, usually passing into a pressure-developing device that can form an extruded product. A wiper bar above the die prevents melted material from recirculating.

**Drum tumbler** *n.* A device used to mix plastic pellets with color concentrates and/or regrind. The materials are charged into cylindrical drums that are tumbled end-over-end or rotated about an inclined axis for a time sufficient to thoroughly blend the ingredients.

**Dry** *vt.* To change the physical state of an adhesive on an adherend by the loss of solvent constituents by evaporation or absorption, or both. A film is considered dry when it feels firm to the finger, using moderate pressure. *See also cure and set.*

**Dry back** *n.* The change in color or finish of an ink film as it dries.

**Dry blend** *n.* A dry, free-flowing mixture of resin powder, typically PVC, with plasticizers and other additives, prepared by blending the components in a large, closed mixing bowl with a high-speed rotor at its bottom, stopping the action at temperatures comfortably below the fluxing point. Dry blends are generally more economical feedstocks for extrusion than molding powders and pellets made by plasticating and extrusion, but in some cases have been difficult to process.

**Dry-blend** *v.* To combine ingredients, typically in a high-speed mixer, to produce a dry blend.

**Dry brush** *v.* Technique in which paint or ink is applied sparingly with a semidry brush.

**Dry bulk** *See apparent density.*

**Dry cleaning** (1817) *v.* Removing dirt and stains from fabrics or garments by processing in organic solvents (chlorinated hydrocarbons or mineral spirits).

**Dry color** *v.* Term used loosely to describe dry colored pigments. A concentrated pigment or coloring matter suitable for grinding or dispersing and use in coatings.

**Dry coloring** *v.* The process of combining colorants to molding compounds and resin pellets by tumble-blending them with dyes, pigments, or color concentrates. This process enables custom molders and extruders to carry a large inventory of uncolored compound, preparing smaller batches of colored compounds to customers' specifications.

**Dryer** (1528) *n.* A mechanical device designed to accelerate the drying of inks. Equipment used to remove moisture or water from plastic material or substrates during processing.

**Dry filling** *n.* The application of finishing chemicals to dry fabric, usually by padding. Dry forming: The production of fiber webs by methods that do not use water or other liquids, i.e., air-laying or carding.

**Dry-hard** *n.* Film is considered dry-hard when any mark left by the thumb, exerting maximum downward pressure on a film, is completely removed by a light polishing with a soft cloth.

**Dry-hiding** *n.* Increase in the hiding power of paint, which occurs in the drying process. It is most significant in non-glossy paints, which, after drying, have pigments or extender pigments protruding from the surface of the paint vehicle, which scatter the incident light and add to the hiding.

**Dry hydrate** *n.* Calcium hydroxide; hydrated lime powder.

**Dry ice** (1925) *n.* Solidified carbon dioxide. *See carbon dioxide.*

**Drying** *n.* (1) Process of change of coatings from the liquid to the solid state, due to evaporation of the solvent, physico–chemical reactions of the blinding medium, or a combination of these causes. (2) Process of removing moisture from pigments. It is carried out either in a current of hot air or in a vacuum.

**Drying cylinders** *n.* Any of a number of heated revolving cylinders for drying fabric or yarn. They are arranged either vertically or horizontally in sets, with the number varying according to the material to be dried. They are often internally heated with steam and Teflon coated to prevent sticking.

**Drying of ink** *n.* The conversion of an ink film to a solid state. This can be accomplished by any of the following means, either singly or in combination: oxidation, evaporation, polymerization, penetration, gelation, and precipitation.

**Drying oil** *n.* Any of several plant-derived polyunsaturated oils, such as linseed, oiticica, and tung, that, when exposed to air, form dry, tough, durable films. Linseed oil to be used in paints and varnishes today is usually boiled with cobalt or manganese salts of linoleic or naphthenic acids to shorten its "drying" time.

**Drying temperature** *See temperature drying.*

**Drying time** *n.* (1) Time required for an applied film of a coating to reach the desired stage of cure, hardness, or non-tackiness (*See dry, dry-hard, dust-free time, set-to-touch time, sand-dry, through-dry, dry-to-handle time, touch-dry, tack-free, surface drying, dry-to-recoat time, and dry-to-sand*). (2) The time required for an ink to form a tack-free surface after being applied to the paper, or other printed surface.

**Dry-laid** *n.* Non-woven web made from dry fiber. Usually refers to fabrics from carded webs versus air-laid non-wovens, which are formed from random webs.

**Dry laminate** *n.* A laminate containing insufficient resin for complete bonding of the reinforcement.

**Dry layup** *n.* The construction of a laminate by layering preimpregnated, partly cured reinforcements in or on a mold, usually followed by bag molding or autoclave molding.

**Dry offset** *n.* An indirect letterpress process in which the ink is transferred from a relief plate to a blanket and then to the stock. *Also known as letterset.*

**Dry purge** *n.* In extrusion, preparatory to shutting down operation after the feed hopper has been emptied, running the extruder until no more plastic emerges from the head end.

**Dry rot** (1795) *n.* Special type of brown rot, causing underspread damage in buildings. In the USA, the causal organism is *Portia incrassate.*

**Dry spinning** *See spinning.*

**Dry spot** *n.* An imperfection in reinforced plastics, an area of incomplete surface film where the reinforcement has not been wetted with resin (ASTM D 883).

**Dry spray** *n.* Overspray or bounceback; sand finish due to spray particles being partially dried before reaching the surface.

**Dry strength** *n.* The strength of an adhesive joint determined immediately after drying or curing under specified conditions or after a period of conditioning in a standard laboratory atmosphere.

*See also wet strength and strength, dry.*

**Dry strippable paper** *See strippable coating.*

**Dry tack** *See tack, dry.*

**Dry-through** *n.* Film is considered dry-through when no loosening, detachment, wrinkling or other distortion of the film occurs when the thumb is borne downward while simultaneously turning the thumb through an angle of 90° in the plane of the film. The arm of the operator is kept in a vertical straight line from the wrist to the shoulder and maximum pressure is exerted by the arm.

**Dry-to-handle time** *n.* Time interval between application and ability to pick up without damage.

*See drying time.*

**Dry-to-recoat time** *n.* Time interval between the application of the coating and its ability to receive the next coat satisfactorily.

**Dry-to-sand** *n.* That stage of drying when a coating can be sanded without the sandpaper sticking or clogging.

**Dry-to-touch time** *n.* Interval between application and tack-free time.

*See set-to-touch time.*

**Dry wall** *n.* (1) An interior wall, constructed with a dry-wall finish material such as gypsum board or plywood. (2) In masonry construction, a self-supporting rubble or ashlar (squared building stone) wall built without mortar.

**Dry winding** *n.* Filament winding with preimpregnated roving, as distinguished from *wet winding* in which unimpregnated roving is pulled through a resin just prior to winding on a mandrel.

**DSC** Differential scanning calorimetry, measurement melting temperatures, glass transition temperature and heat of melting; lower temperature range than DTA.

*See differential scanning calorimetry.*

**DSTDP** *n.* Abbreviation for distearylthiodipropionate.

**DTA** *n.* Differential thermal analysis measurement of melting temperature; generates a plot of “heat versus temperature” and semiquantiative, but higher temperature range than DSC. DTA is capable of measuring events (e.g., melting, crystallization, and decomposition) but not heat of melting or crystallization whereas DSC is quantitative and appropriate for thermally characterizing polymers. Abbreviation for differential thermal analysis.

**DTDP** *n.* Abbreviation for ditridecyl phthalate.

**Dual-sensor control** *n.* An improved system for controlling cylinder and plastic temperatures in extruders. For each heating zone, there are two temperature sensors, one in a shallow well slightly beneath the heater, the other deep, just outside the lining layer and near the plastic. An average of the two signals is used to control the electrical heat input (Eurotherm/Welex).

**Dubbing out** *n.* (1) Filling in hollow and irregular surfaces and leveling walls with plaster before regular plasterwork. (2) Forming, very roughly, a plaster cornice, before the final plaster coat is applied.

**Duck** \ˈdək\ [Du *doek* cloth; akin to OHGr *tuoh* cloth] (1640) *n.* A compact, firm, heavy, plain weave fabric with a weigh of 6–50 oz/yard$^2$. Plied yarn duck has plied yarn in both warp and filling. Flat duck has a warp of two single yarns woven as one and a filling of either single or plied yarn.

**Duck eye** *See spinning.*

**Ductile fracture** \ˈdək-tᵊl\ [MF & L, MF, fr. *ductilis*, from *ducere*] (14c) (ductile rupture) *adj.* The breaking or tearing, most commonly in tension, of a test specimen or part after considerable unrecoverable stretching (plastic strain) has occurred. Since the mode of fracture depends on conditions as well as material, the distinction between ductile and brittle fracture, which latter occurs after relatively little, recoverable strain, is not always clear. Low temperatures, especially below the glass transition ($T_g$), and high rates of strain favor brittle behavior, while the opposites favor ductile behavior.

**Ductility** *n.* The amount of plastic strain that a material can undergo before rupture. A ductile material generally shows a yield point.

**Ductor roller** *n.* The roller which is in intermittent contact with the fountain roller and transfers ink to the distribution system of the press. On a lithographic press it is also the roller, which transfers the fountain solution to the dampening rollers.

**Dull** \ˈdəl\ [ME *dul*; akin to OE *dol* follish, OIr *dall* blind] (13c) *adj.* A term applied to manufactured fibers that have been chemically or physically modified to reduce their normal luster. Matte; opposite of bright; low in luster.

**Dullness** *n.* (1) Lack of luster or gloss. (2) Colors of low chroma or saturation.

**Dull rubbing** *n.* Rubbing a dried film of a coating to dull finish, with an abrasive paper, pumice, steel wool and oil or water.

**Dulmadge mixing section** *n.* Invented by F. E. Dulmadge, this mixing section, usually located near the end of an extruder or injection screw, is really three short sections separated by gaps with no flights. In each section, the regular screw flight is replaced by about 20 narrow, closely spaced flight segments with lead angles of about 70°. The melt approaching the first section is subdivided into 20 substreams that, on exiting, are swirled circumferentially before entering the second section, and again, on leaving that one, before entering the third. The main goal was to improve melt-temperature uniformity.

**Dulong and Petit, law of** *n.* The specific heats of the several elements are inversely proportional to their atomic weights. The atomic heats of solid elements are constant and approximately equal to 6.3. Certain elements of low atomic weight and high melting point have, however, much lower atomic heats at ordinary temperatures.

**Dumas nitrogen** *n.* A long used method for determining the percentage of nitrogen in organic materials, invented by A. Dumas in 1830. The sample was first oxidized with red-hot copper oxide, followed by reduction of $NO_x$–$N_2$ over hot copper. Following absorption of $CO_2$ in KOH solution and condensation and absorption of most of the water, the volume of $N_2$ was measured. The method has largely been supplanted by automated analyzers that directly determine C, H, and N spectroscopically and find O by difference.

**Dumbbell** *n.* A piece of rubber cut in the shape of a dumbbell used for physical testing.

*See dogbone.*

**Dumbells** *n.* A defect frequently seen in wet-formed non-woven fabrics; an unusually long fiber will become entangled with groups of regular-length fibers at each end, thus producing a dumbbell-shaped clump.

**Dumont's blue** *np. See cobalt blue.*

**Dungaree** \ˌdeŋ-gə-ˈrē\ [Hindi *dugrī*] (1673) *n.* A term describing a coarse denim-type fabric, usually dyed blue, that is used for work overalls.

**Duplex paper** *n.* Wallpaper, which consists of two separate papers pasted together used to create a highly embossed effect.

**Duplex printing** *See printing.*

**Duplicate cavity plate** *n.* A removable plate that retains cavities, used where two-plate operation is necessary for loading inserts, etc.

**Durability** *n.* Degree to which paints and paint materials withstand the destructive effect of the conditions to which they are subjected.

**Durable press** *n.* A term describing a garment that has been treated so that it retains its smooth appearance, shape, and creases or pleats in laundering. In such garments no ironing is required, particularly if the garment is tumble-dried. Durable press finishing is accomplished by several methods; two of the most common are the following: (1) A fabric that contains a thermoplastic fiber and cotton or rayon may be treated with a special resin that, when cured, imparts the permanent shape to the cotton or rayon component of the fabric. The resin-treated fabric may be precured (cured in finishing and subsequently pressed in garment form at a higher temperature to achieve the permanent shape) or postcured (not cured until the finished garment has been sewn and pressed into shape). In both cases, the thermoplastic fiber in the garment is set in the final heat treatment. This fiber, when heat-set, also contributes to the permanence of the garment shape, but the thermoplastic component of the blend is needed for strength since the cotton or rayon component is somewhat degraded by the durable-press treatment. (2) Garments of a fabric containing a sufficient amount of a thermoplastic fiber, such as polyester, nylon, or acrylic, may be pressed with sufficient pressure and time to achieve a permanent garment shape.

*Also see ease-of-care, permanent finish, and wash-and-wear.*

**Duranit** *n.* Butadiene/styrene copolymer. Manufactured by Hüls, Germany.

**Durene** *n.* (durol, 1,2,4,5-tetramethylbenzene) $C_6H_2(CH_3)_4$. A substance occurring in coal tar, but usually prepared from xylene and methyl chloride in the presence of $AlCl_3$. It has been patented (USA 4,000,120) as an additive to make packaging films of polyolefins and polystyrene photodegradable under direct action of sunlight.

**Durethan** *n.* Polyamides or polyurethanes. Manufactured by Bayer, Germany.

**Durette** *n.* Fiber of iosphthalic acid and *m*-phenylene diamine. Manufactured by Monsanto, USA.

**Durometer** \dú-ˈrä-mə-tər *also* dyu\ [L *durus* hard] (ca. 1879) *n.* An instrument used for measuring the hardness of rubber, plastic, or protective coatings.

*See ASTM test D 2240, also indentation hardness.*

**Durometer hardness** *See indentation hardness.*

**Dust** \ˈdəst\ [ME, fr. OE *dūst*; akin to OHGr *tunst* storm, and prob. to L *fumus* smoke] (before 12c) *n.* One of the size gradings of various gums, being composed of very small pieces, almost as fine as dust.

**Dust free** *n.* (1) Descriptive of the stage in the drying of a paint or varnish film at which dust will no longer stick to the surface. (2) That stage of drying when cotton fibers, that have been dropped onto the film from a height of one inch, can be removed by blowing lightly across the surface of the film.

*Also referred to as cotton-free or cotton-free dry.*

**Dust-free time** *n.* The time required for a freshly applied paint or compound to form a skin on its surface so that dust will not adhere to it.

**Dusting bronzes** *See bronzing.*

**Dust-resistant** *n.* A term applied to a fabric that has been tightly woven so that it resists dust penetration.

**Dutch metal** *n.* Leaves of bright brass which are used for overlaying in the same manner in which gold leaf is applied.

**Dutch pink** *n.* Tint of red. The name is also used for certain yellow lakes, prepared from quercitron, Persian berries, or similar natural yellow coloring matters.

**Dutch process** *n.* Old name for stack process for manufacture of white lead.

**Dutral** *n.* Ethylene/propylene copolymer, manufactured by Montecatini, Italy.

**DVB** *n.* Abbreviation for divinylbenzene.

**Dwell** \ˈdwel\ [ME, fr. OE *dwellan* to go astray, hinder, akin to OHGr *twellen* to tarry] (13c) *vt.* (1) A pause in the application of pressure to a mold, made just before the mold has completely closed, to allow the escape of gas from the molding material. (2) In filament winding, the time that the traverse mechanism is stationary while the mandrel continues to rotate to the appropriate point for a new traverse to begin. (3) In heat sealing, dwell time is the time during which pressure and heat (or microwave energy) are applied to the area to be sealed.

**Dwell time** *n.* The time during a process in which a particular substance remains in one location (e.g., the time during which molten polymer remains in a spinning pack).

**Dye** \ˈdī\ [ME *dehe*, fr. OE *dēah*, *dēag*] (before 12c) *n.* An intensely colored substance that imparts color to a substrate to which it is applied. Retention of the dye in the substrate may be by means of adsorption, solution, mechanical bonding, or by ionic or covalent chemical bonding. The dye substance is devoid of crystal structure. Dyes used for coloring plastics usually dissolve in the plastic melt, unlike pigments, which remain dispersed as undissolved particles. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA, 2004. Complete textile glossary. Celanese Acetate LLC, New York, 2000. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Dye, acid** *See acid dyes.*

**Dye, basic** *See basic dye.*

**Dye fleck** *n.* (1) An imperfection in fabric caused by residual undissolved dye. (2) A defect caused by small sections of undrawn thermoplastic yarn that dye deeper that the drawn yarn.

**Dyeing** *n.* To add soluble colorants that either form a chemical bond with the substrate or become closely associated with it by a physical process in order to change the color. Below is a listing of different types of fabric dyeing and a definition of each. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Dyeing, chain** *n.* A method of dyeing yarns and fabrics of low tensile strength of tying them end-to-end and running them through the dyebath in a continuous process.

**Dyeing, cross** *n.* A method of dyeing blend or combination fabrics to two or more shades by the use of dyes with different affinities for the different fibers.

**Dyeing, high-temperature** *n.* A dyeing operation in which the aqueous dyebaths are maintained at temperatures greater than 100°C by use of pressurized equipment. Used for many manufactured fibers.

**Dyeing, ingrain** *adj* (1766). Term used to describe yarn or stock that is dyed in two or more shades prior to knitting or weaving to create blended color effects in fabrics.

**Dyeing, jet** *n.* High-temperature piece dyeing in which the dye liquor is circulated via a Venturi jet thus providing the driving force to move the loop of fabric.

**Dyeing, mass-colored** *n.* A term to describe a manufactured fiber (yarn, staple, or tow) that has been colored by the introduction of pigments or insoluble dyes into the polymer melt or spinning solution prior to extrusion. Usually, the colors are fast to most destructive agents.

**Dyeing, muff** A *n.* form of yarn dyeing in which the cone has been removed.

**Package dyeing** *See dyeing, yarn dyeing.*

**Dyeing, pad** *n.* A form of dyeing whereby a dye solution is applied by means of a padder or mangle.

**Dyeing, piece** *n.* The dyeing of fabrics "in the piece", i.e., in fabric form after weaving or knitting as opposed to dyeing in the form of yarn or stock.

**Dyeing, pressure** *n.* Dyeing by means of forced circulation of dye through packages of fiber, yarn, or fabric under superatmospheric pressure.

**Dyeing, reserve** *n.* (1) A method of dyeing in which one component of a blend or combination fabric is left undyed. The objective is accomplished by the use of dyes that have affinity for the fiber to be colored but not for the fiber to be reserved. (2) A method of treating yarn or fabric so that in the subsequent dyeing operation the treated portion will not be dyed.

**Dyeing, skein** *n.* The dyeing of yarn in the form of skeins, or hanks.

**Dyeing, solution** *n. See dyeing, mass-colored.*

**Dyeing, solvent** *n.* A dyeing method based on solubility of a dye in some liquid other than water, although water may be present in the dyebath.

**Dyeing, space** *n.* A yarn-dyeing process in which each strand is dyed with more that one color at irregular intervals. Space dyeing produces an effect of unorganized design in subsequent fabric form. The two primary methods are knit-de-knit and warp printing.

**Dyed, space** *n. See dyeing, mass-colored.*

**Dyeing, stock** *n.* The dyeing of fibers in staple form.

**Dyeing, thermal fixation** *n.* A *process* for dyeing polyester whereby the color is diffused into the fiber by means of dry heat.

**Dyeing, union** *n.* A method of dyeing a fabric containing two or more fibers or yarns to the same shade so as to achieve the appearance of a solid colored fabric.

**Dyeing, yarn** *n.* The dyeing of yarn before the fabric is woven or knit. Yarn can be dyed in the form of skeins, muff, packages, cheeses, cakes, chain-wraps, and beams.

**Dyes, basic** *n.* A class of positive-ion-carrying dyes known for their brilliant hues. Basic dyes are composed of large-molecule, water-soluble salts that have a direct affinity for wool and silk and can be applied to cotton with a mordant. The fastness of basic dyes on these fibers is very poor. Basic dyes are also used on basic-dyeable acrylics, modacrylics, nylons, and polyesters, on which they exhibit reasonably good fastness.

**Dyes, cationic** *See dyes, basic dyes.*

**Dyes, fiber-reactive dyes** *n.* A type of water-soluble anionic dye having affinity for cellulose fibers. In the presence of alkali, they react with hydroxyl groups in the cellulose and thus are liked with the fiber. Fiber-reactive dyes are relatively new dyes and are used extensively on cellulosics when bright shades are desired.

**Dyeing, gel** *n.* Passing a wet-spun fiber that is in the gel state (not yet at full crystallinity or orientation) through a dyebath containing dye with affinity for the fiber. This process provides good accessibility of the dye sites.

**Dyes, macromolecular** *n.* A group of inherently colored polymers. They are useful both as polymers and as dyes with high color yield. The chromophores fit the recognized CI classes, i.e., azo, anthraquinone, etc., although not all CI classes are represented. Used for mass dyeing, hair dyes, writing inks, etc. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Dyes, metallized** *n.* A class of dyes that have metals in their molecular structure. They are applied from an acid bath.

**Dyes, naphthol** *n.* A type of azo compound formed on the fiber by first treating the fiber with a phenolic compound. The fiber is then immersed in a second solution containing a diazonium salt that reacts with the phenolic compound to produce a colored azo compound. Since the phenolic compound is dissolved in caustic solution, these dyes are mainly used for cellulose fiber, although other fibers can be dyed by modifying the process.
*Also see dyes, developed dyes.*

**Dyes, premetallized** *n.* Acid dyes that are treated with coordinating metals such as chromium. This type of dye has much better wetfastness than regular acid dye. Premetallized dyes are used on nylon, silk, and wool.

**Dyes, sulfur** *n.* A class of water-insoluble dyes that are applied in a soluble, reduced form from a sodium sulfide solution and are then reoxidized to the insoluble form on the fiber. Sulfur dyes are mainly used on cotton for economical dark shades of moderate to good fastness to washing and light. They generally give very poor fastness to chlorine.

**Dyes, vat** *n.* A class of water-insoluble dyes which are applied to the fiber in a reduced, soluble form (leuco compound) and then reoxidized to the original insoluble form. Vat dyes are among the most resistant dyes to both washing and sunlight. They are widely used on cotton, linen rayon, and other cellulosic fibers. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Asphalt overlay fabrics** *n.* Fabric systems installed between the old and new asphalt layers during pavement resurfacing. The fabric absorbs the tack coat sprayed on the old surface thus forming a permanent moisture barrier to protect the subgrade from strength loss due to water intrusion. The fabric system also helps retard reflective cracking by serving as a flexible layer to diffuse stress.

**Drainage fabrics** *n.* Fabrics used as filter media or separators in subsurface drainage systems. The fabric is installed around the drainage pipe, or coarse stone in the drain; it allows water to pass freely from the soil to the drain, but prevents soil particles from migrating into the drain system. These fabrics are also used as outer coverings in prefabricated drainage composites and serve the same function as a filtering medium.

**Erosion control fabrics** *n.* Fabrics used in the stabilization of embankments and the containment of silt run-off from erodible slopes. In embankment stabilization, the fabric functions as a filter medium behind stabilizing rip-rap revetments. In siltation control, the fabric acts as a filter to contain silt while allowing excess water to drain freely. In turf reinforcement, the mat is used to retain soil while allowing roots and stems to grow through. In fabric-forming systems for the construction of revetments, a double-layer, water-permeable fabric is positioned, then pumped full of structural grout. These systems are alternatives to rip-rap.

**Reinforcement fabrics** *n.* Fabric system used in the construction of steep slopes and retaining walls. By stabilizing the soil mass, they reduce the stress on the retaining wall with corresponding decrease in load-bearing requirements for the wall design. In slope reinforcement, the stabilization permits steeper slope construction than would be possible based on soil properties.

**Subsurface stabilization fabrics** *n.* Fabrics used in the construction on access roads, railroads, parking, and storage areas over soft, unstable soil. The fabric is placed between the subgrade and the stabilizing fill material where it provides separation of subsoil and fill, filtration of moisture at the subsoil/fill interface, and added tensile reinforcement of the compacted fill.

**Dyeing auxiliaries** *n.* Various substances that can be added to the dyebath to aid dyeing. They may necessary to transfer the dye from the bath to the fiber or they may provide improvements in leveling, penetration, etc. Also call dyeing assistants.

**Dyeing plastics** *n.* Process of adding color to plastics to make them attractive in appearance. Color is produced by introduction of either dyes or pigments, which produce color by selectively absorbing, transmitting, reflecting, and scattering specific areas of light energy from wave bands that constitute white light.

**Dye migration** *See migration* (1).

**Dye, mordant** *n.* Term given to a range of dyestuffs, the colors of which are developed when precipitated onto bases to form lakes. Often a salt-forming reaction takes place between the dyestuff and the base.

**Dye pigments** *n.* Dyes that by nature are insoluble in water and can be used directly as pigments without any chemical transformation.

**Dye range** *n.* A broad term referring to the collection of dye and chemical baths, drying equipment, etc., in a continuous-dyeing line.

**Dyes** *n.* Substances that add color to textiles. They are incorporated into the fiber by chemical reaction, absorption, or dispersion. Dyes differ in their resistance to sunlight, perspiration, washing, gas, alkalies, and other agents; their affinity for different fibers; their reaction to cleaning agents and methods; and their solubility and method of application. Various classes and types are listed below.

*Also see color index* (CI).

**Dyes and dyestuffs** *n.* Organic coloring substances. Pigment dyestuffs are virtually insoluble in water and in the usual paint and varnish vehicles. Some examples of pigment dyestuffs are toluidine red, phthalocyanine blue, and arylamide yellow. Some dyes are soluble in water and organic solvents and are classed according to their solubilities, for example, water-soluble dyes, spirit-soluble dyes, and oil-soluble dyes. Harper CA (2000) Modern plastics encyclopedia. McGraw Hill Professional, New York.

**Dye sites** *n.* Functional groups within a fiber that provide sites for chemical bonding with the dye molecule. Dye sites may be either in the polymer chain or in chemical additives included in the fiber. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Dye, spirit-soluble** *See spirit-soluble dye.*

**Dyestuff** *n.* Colorant which can be fixed firmly to a material to be dyed so as to be more or less fast to light, water, soap, etc.

**Dynamic adhesion** *n.* The ability of a cord-to-rubber bond to resist degradation resulting from flexure.

**Dynamic fatigue** *n.* Usually the same as *fatigue.* The “dynamic” modifier is sometimes used by persons who think of creep and creep failure as “static fatigue”.

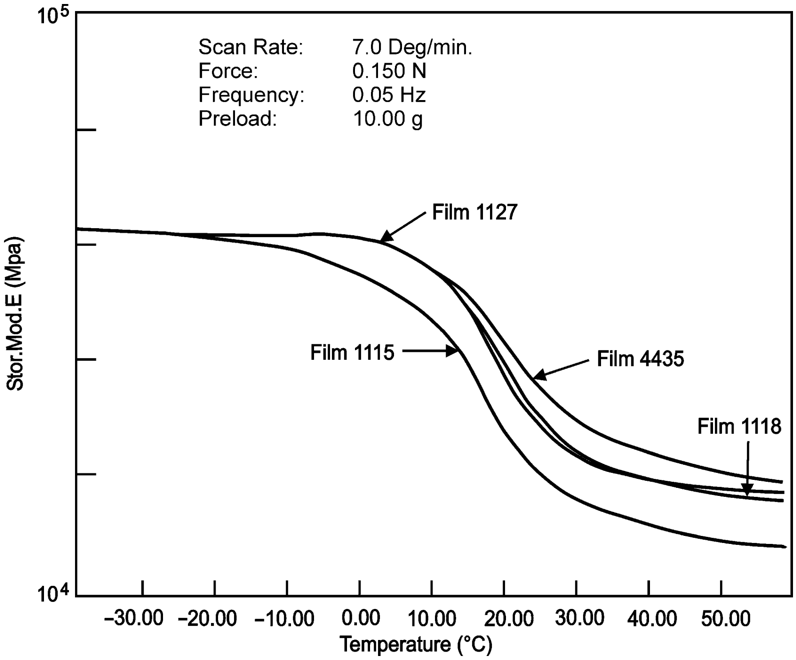
*See alternating stress amplitude. See entries at fatigue.*

**Dynamic mechanical analyzer** *n.* An instrument that can test in an oscillating-flexural mode over a range of temperature and frequency to provide estimates of the "real", i.e., in-phase, and "imaginary", i.e., out-of-phase parts of the complex modulus. The real part is the elastic component, the imaginary part is the loss component. The square root of the sum of their squares is the complex modulus. With polymers, the components and the modulus are usually dependent on both temperature and frequency. ASTM D 4065 spells out the standard practice for reporting dynamic mechanical properties of plastics. An example of a DMA thermogram of different Perkin-Elmer Inc., manufactures the Diamond DMA instrument. Polymer films is shown. Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York.

*See also mechanical spectrometer*

**Dynamic mechanical properties** *n.* (1) The stress–strain properties of a material when subjected to an applied sinusoidally varying stress or strain. For a perfectly elastic material the strain response is immediate and the stress and strain are in phase. For a viscous fluid, stress and strain are 90° out of phase. (2) The mechanical properties of composites as deformed under periodic forces such as dynamic modulus, loss modulus and mechanical damping or internal friction. Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York.

**Dynamic mechanical spectrum** *n.* The information obtained from testing with a mechanical spectrometer. A plot or tabulation of complex modulus or its components versus frequency of oscillation or temperature or both. The mode of stress may be tensile/compressive, flexural, or torsional (shear). Because both abscissa (frequency) and ordinates can range widely, bilogarithmic plots are usual. Sepe MP (1998)



Dynamic mechanical analysis. Plastics Design Library, Norwich, New York.

**Dynamic stress** *n.* A stress whose magnitude and/or direction vary with time, typically cyclically and sinusoidally.

**Dynamic stress relaxometer** *n.* An instrument that measures the relaxation response of an elastomeric material to a prescribed shear deformation over a range of temperature. Basic elements of the instrument are a cone-shaped stator cavity and a conical rotor, both electrically heated. The sample is placed in the stator, which rises to a position to form a constant specimen thickness, forcing out the excess material. After heating to the desired temperature, the rotor is rotated quickly through a small angle, to a known shear deformation. The subsequent drop-off torque, which results from the relaxation of stress within the sample, is recorded over the time it takes for it to decay.

**Dynamic valve** *n.* A device sometimes incorporated in an extruder head to control flow by adjusting the clearance between the conical elements, one stationary, the other rotating with the screw. Dynamic valves of various designs have also been used between the stages of two-stage, vented extruders as an aid to balancing the flow rates in the stages and preventing extrusion out the vent.

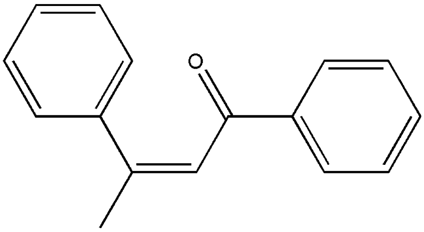
**Dynamic viscosity** *n.* (1) Absolute viscosity as distinguished from kinematic viscosity. (2) In sinusoidally varying shear, the part of the stress in phase with the rate of strain, divided by the strain rate. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.
*See also viscosity.*

**Dynapoint process** *n.* A continuous computer-controlled process for manufacturing tufted carpets with intricate patterns from undyed yarn. The carpet is dyed as it is tufted and the colors and pattern are clearly visible through the primary backing of the carpet.

**Dyne** *n.* In the (now deprecated) cgs system of units, the force required to accelerate a mass of 1 g by 1 cm/s$^2$. The dyne $= 1 \times 10^{-5}$ N. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Dynel** *n.* Vinyl chloride/acrylonitrile copolymer. Manufactured by Union Carbide, USA.

**Dypnone** *n.* (phenyl α-methyl styryl ketone, 1,3-diphenyl-2-butene-1- one) $C_6H_5COCHC(CH_3)C_6H_5$. A plasticizer and ultraviolet absorber.



# E

**e** \ˈē\ {often capitalized, often attributive} (before 12c) *n.* (1) The base of natural logarithms, 2.71828. (2) The charge on an electron, $1.60199 \times 10^{-18}$ C.

**ΔE, Δ*e*** *n.* The total color difference computed with a color difference equation. It is generally calculated as the square root of the sum of the squares of the chromaticity difference, ΔC, and the lightness difference, ΔL:

$$\Delta E = [(\Delta C)^2 + (\Delta L)^2]^{1/2}.$$

**E** *n.* (1) SI abbreviation for prefix exa-. (2) Symbol commonly used for modulus of elasticity in tension
(*See modulus of elasticity*).
For activation energy in the Arrhenius equation and for electric potential. Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York. Connors KA (1990) Chemial kinetics. John Wiley and Sons, New York.

**EA** *n.* Segmented polyurethane fiber.

**EAA** *n.* Abbreviation for ethylene–acrylic acid copolymer.

**Earth pigment** *n.* Class of pigments, which are usually mined directly from the earth, dried, generally Calcined and ground. Typical examples are red and yellow oxides of iron, yellow ochre, raw and burnt siennas, and raw and burnt umbers. Syn: mineral pigments and natural pigments.

**Ease-of-care** *n.* A term used to characterize fabrics that, after laundering, can be restored to their original appearance with a minimum of ironing or other treatment. An ease-of-care fabric generally wrinkles only slightly upon laundering. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.
*Also see durable press and wash and wear.*

**Eave** \ˈēvz] [ME *eves* (singular), fr. OE *efes*; akin to OHGr *obasa* portico, OE *ūp* up] (before 12c) *n.* Lower part of a roof projecting beyond the wall underneath.
*See soffit.*

**Ebonite** \ˈe-be-ˌnit\ (1861) *n.* A hard material made by sulfur vulcanization of rubber.

**Ebonize** \-ˌnīz\ (ca. 1828) *vt.* To blacken with paint or stain to look like ebony.

**Ebulliometry** *n.* Method of measuring molecular weight of polymers under 20,000; based on vapor pressure lowering and boiling point elevation. Pethrick RA, Dawkins JW (eds) (1999) Modern techniques for polymer characterization. John Wiley and Sons, New York.

**EC** *n.* Abbreviation for ethyl cellulose.

**EC** *n.* Ethyl cellulose.

**Ecology** \iˈkä-lə-jē-, e-\ (Gr *Ökologie*, fr. *öko*- eco- + -logie –logy (1873) *n.* The interrelationships of living things to one another and to their environment.

**Ecosystem** \ˌsis-təm\ (1935) *n.* The interaction system of a biological community and its non-living environment.

**ECTFE** *See poly(ethylene-chlorotrifluoroethylene*).

**EDC** *n.* Abbreviation for ethylene dichloride.

**Eddy current** \ˈe-dē ˈkər-ənt\ (1887)(Foucault current) *n.* The current induced in a mass of conducting material by a varying magnetic field.
*Also called Foucault current.*

**Edge bead** *n.* In some cast-film and sheet-extrusion operations, the narrow border at the edge of the sheet, usually somewhat thicker, that must be trimmed off prior to winding or stacking the product.

**Edge crimping** *See texturing, edge crimping method.*

**Edge dislocation** *n.* A dislocation in which a layer of particles in the crystal is incomplete.

**Edge grain** *n.* Wood or veneer so sawed that the annual rings form an angle of 45–90° with the surface of the piece.

*Also called vertical grain.*

**Edge roll** *n.* The curl that develops on the edge of a single-knit fabric preventing it from lying flat.

**Edge runner mill** *n.* Mill consisting of a horizontal, or substantially horizontal, circular pan which may be of cast iron or stone-lined. One or more circular rollers, which may also be of cast iron or suitable stone, are made to rotate edgewise around the pan. The material to be ground, which may be dry pigment or other powder or pigment paste, is disintegrated between the surfaces of the rollers and the pan. Sometimes referred to as putty chaser.

**Edgewise** (1677) *adv.* Plane of the laminate perpendicular to the laminations.

**Edistir** *n.* Poly(styrene). Manufactured by Montedison, Italy.

**EDM** *n.* Abbreviation for electrical-discharge machining.

**EEA** *n.* Copolymer from ethylene and ethyl acrylate. Abbreviation for ethylene–ethyl acrylate copolymer.

**Effective modulus** *n.* Syn: creep modulus.

**Effervescence** \ˌe-fər-ˈves\ [L *effervescere*, fr. *ex-* + *fervescere* to begin to boil, inchoative of *fervēre* to boil] (1784) *vt.* The vigorous evolution of gas, which accompanies some chemical reactions, e.g., treatment of a carbonate with certain mineral acids.

**Efficiency** \i-ˈfi-shən-sē\ (1633) *n.* (1) The efficiency of a machine or process, the ratio of the energy delivered to that supplied. (2) The effectiveness of operation or production, particularly as related to some standard for same. (3) The reciprocal of the unit cost of items for sale (*cost efficiency, economy*). Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

*See also efficiency of reinforcement and plasticizer efficiency.*

**Efficiency of reinforcement** (fiber-efficiency factor) *n.* The percentage of fiber in a reinforced-plastic structure or part contributing to the property of concern. For example, in a unidirectionally reinforced bar, the theoretical efficiency for Young's modulus and fiber-direction tensile strength is 100%. For a sheet molded from chopped-strand mat with all fibers randomly oriented in the sheet plane, the efficiency for in-plane properties is 37%. With chopped strands randomly oriented in three dimensions, efficiency falls to 20%.

**Efflorescence** \-ˈre-sᵊn(t)s\ (1626) *n.* An encrustation of soluble salts, commonly white, deposited on the surface of coatings, stone, brick, plaster, or mortar; usually caused by salts or free alkalies leached from mortar or adjacent concrete as moisture moves through it, *also known as laitance.* {G Ausblühen n, F efflorescence f, S eflorescencia f, I efflorescenza f}. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Effluent limitations** *n.* Any restrictions, established by the government or by management, on quantities, rates and concentrations of chemical, physical, biological, and other constituents which are discharged from paint sources.

**Efflux** \ˈe-ˌfləks\ [ML *effluxus*, fr. *effluere*] (1647) *n.* The process of flowing out, in any given system.

**Efflux viscometer** *n.* A cup type viscometer containing an orifice. Whatever precision and accuracy an efflux instrument may have is essentially dependent upon the dimension of the orifice. The closer an orifice resembles a capillary, the more accurate is the instrument.

*See viscometer, ford cup.*

**Effusion** \i-ˈfyü-zhən\ (15c) *n.* The passage of a substance through a small orifice.

**Eggshell** \ˈeg-ˌshel\ (1835) *adj.* (1) Gloss lying between semigloss and flat. Generally thought to be between 20 and 35 as determined with a 60° glossmeter. (2) An off white color.

**Eggshell finish** *n.* (1) Low sheen (seminat) surface which exhibits surface reflectance (gloss) similar to that from an eggshell. Thus it is a gloss lying between flat and semigloss and is generally thought to be between 20 and 35, as determined with a 60° gloss meter. (2) Paint, which exhibits eggshell gloss.

**E glass** *n.* A low-alkali ($Na_2O + K_2O = 0.6\%$) borosilicate glass, like Pyrex®, with good electrical properties, the most widely used glass–fiber reinforcement for plastics. Major constituents are: $SiO_2$, 54%; CaO, 17%; $Al_2O_3$, 15%; $B_2O_3$, 8%; MgO, 4.7%. The fibers are vulnerable to surface abrasion so are always sized before stranding. Average fiber properties are: density = 2.54 g/cm$^3$; tensile modulus (axial) = 72 GPa; tensile strength = 3.5 GPa.

**Egyptian asphaltum** \i-ˈjip-shən ˈas-ˈfól-təm\ *n. See syrian asphaltum.*

**Egyptian blue** *n.* Blue pigment, of ancient origin, which is substantially a copper silicate, obtained by calcinations.

**EHMWPE** *n.* Abbreviation for extra-high-molecular-weight polyethylene, any of a subfamily of linear PE resins having molecular weights in the range 250,000–1,500,000.

*See also polyethylene.*

**Eicosanic acid** *See cosanic acids.*

**Eilers equation** *n.* A modification of the Einstein equation relating the viscosity $\eta_f$ of a Newtonian liquid filled with spherical particles to the viscosity of the pure liquid $\eta_o$ and extending to concentrations above 10% of filler. It is

$$\frac{\eta_n}{\eta_o} = \left[\frac{1 + 1.25f}{1 - Sf}\right]^2,$$

where $f$ is the volume fraction of spheres and $S$ is an empirical coefficient usually between 1.2 and 1.3. Sudduth RD (2003) J Appl Sci 48(1):25–36.

*See also Mooney equation.*

**Einstein equation** *n.* An equation relating the viscosity $\eta_f$ of a sphere-filled, Newtonian liquid to that of the unfilled liquid $\eta_o$, for volume fractions $f$ of spheres up to about 10%. It is

$$\eta_{rel} = \eta_f/\eta_o = 1 + k_{E}f,$$

where $k_E$ is the Einstein coefficient = 2.5 for spheres. The Einstein equation has been extended to higher concentrations by adding terms in $f^2$, $f^3$, etc., and by correcting for the limiting volume fraction $f_m$ that can be filled by uniform spheres. A versatile model of this type is

$$\eta_{rel} = \frac{1 + af + bf^2 + cf^3}{1 - (f/f_m)},$$

where $a$, $b$, and $c$ are the empirical constants and $f_m \approx 0.7$. The Mooney equation is a form of this model for which $b$ and $c = 0$. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

*See also the Eilers equation and Frankel–Acrivos equation.*

**Einstein theory for mass–energy equivalence** *n.* The equivalence of a quantity of mass m and a quantity of energy $E$ by the formula $E = mc^2$. The conversion factor $c^2$ is the square of the velocity of light. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Ejection ram** *n.* A small supplementary hydraulic ram fitted to a molding press to operate piece-ejection device.

**Ejector pin** (ejector sleeve, knockout pin, KO pin) *n.* A rod, pin, or sleeve that pushes a molding off a force or out of a cavity of a mold. Attached to an ejector bar or plate, it is actuated by the ejector rod(s) of the press or by auxiliary hydraulic or compressed-air cylinders.

**Ejector plate** *n.* A plate that backs up the ejector pins and holds the ejector assembly together.

**Ejector-return pin** (return pin, surface pin, safety pin, and position pushback) *n.* A projection, usually one of several that push back the ejector assembly as the mold closes.

**Ejector rod** *n.* A bar that actuates the ejector assembly when a mold is opened.

**Elaidamide** *n.* $CH_3(CH_2)_7CH{=}CH(CH_2)_7CONH_2$. The amide of *trans*-9-octadecenoic acid, a steroisomer of oleamide used in fractional percentages as a slip agent for polyethylene to be made into film.

**Elaidic acid** *n.* $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$ (octadec-9-enoic acid, *trans*-9-octadeconic acid). Properties: mp, 51°C; bp, 225°C/10 mmHg; iodine value, 90.1.

**Elastic** \i-ˈlas-tik\ [NL *elasticus*, fr. LGk *elastos* ductile, beaten, fr. Gk *elaunein* to drive beat out; prob. akin to Gk *ēlythe* he went, OI *luid*] (1674) *adj.* Ability of a substance to return to its approximate original shape or volume after a distorting force on the substance has been removed. Billmeyer FW Jr (1984) Textbook of polymer science, 3rd edn. Wiley-Interscience, New York.

*See also elasticity.*

**Elastic compliance** *n.* The inverse of the Young's modulus.

**Elastic constant** *n.* Any of the several constants of a constitutive relationship between stress (of any mode) and strain in a material. For an isotropic material stressed in its elastic range, there are (at any temperature) four interrelated constants: tensile modulus *E*, shear modulus *G*, bulk modulus *B*, and Poisson's ratio *μ*. Two expressions of the relations are

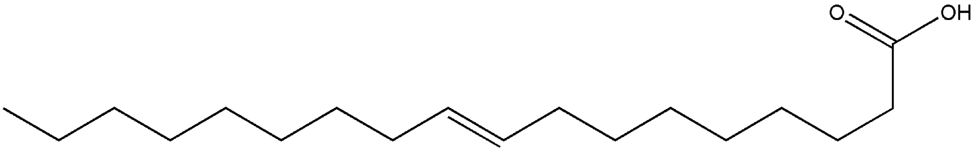
$$G = E/2(1+\mu) \text{ and } B = E/3(1-2\mu).$$

More constants are needed to define the behavior of non-isotropic materials. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Elastic deformation** *n.* A change in dimensions of an object under load that is fully recovered when the load is released. That part of the total strain in a stressed body that disappears upon removal of the stress.

*See also plastic deformation.*

**Elastic design** *n.* Engineering design for load-bearing members based on the assumption that stress and strain are proportional and will be kept well within the elastic range, with working stresses set at half or less of the yield stress. Elastic design based on short-time test measurements may be applicable to the design of plastic products that will be loaded intermittently and for short periods. However, the universal phenomenon of creep in plastics means that, under sustained loads, viscoelastic rather an elastic behavior is the



norm. Even so, elastic design methods can often be used by employing creep modulus and creep strength in place of short-time parameters. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Elasticity** (1664) *n.* A property that defines the extent to which a material resist small deformations from which a material recovers completely when deforming force is removed. When the deformation is proportional to the applied load, the material is said to exhibit Hookean elasticity or ideal elasticity. Elasticity equals stress divided by strain. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The Chemical Rubber Co., Boca Raton, FL.

**Elasticity, Hookean** *n.* The simplest form of stretching elasticity is the Hookean law (e.g., a coiled steel spring). By taking the derivative of the free energy with respect to the relative area change one obtains from the Hookean law that the surface tension is proportional to the surface area (at fixed number of molecules). Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Elasticized fabric** *n.* A fabric that contains elastic threads. Such fabrics are used for girdles, garters, and similar items. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Elasticizer** *n.* A compounding additive that contributes elasticity to a resin such as chlorinated polyethylenes and chlorinated copolymers of ethylene and propylene are blended with PVC compositions to provide elasticity. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York. Nass LI (ed) (1976) Encyclopedia of PVC. Marcel Dekker Inc., New York.

**Elastic limit** *n.* The greatest stress that a material can experience which, when released, will result in no permanent deformation. With some polymers this limit can be well above the proportional limit. Billmeyer FS Jr (1962) Textbook of polymer science. John Wiley and Sons Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Miller ML (1966) Structure of polymers. The Reinhold Publishing Co., New York. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

*See also yield point.*

**Elastic-melt extruder** *See extruder, elastic-melt.*

**Elastic memory** *See memory.*

**Elastic moduli** *n* (1904) (*Young's modulus by bending*). Bar supported at both ends. If a flexure $s$ is produced by the weight of mass $m$, added midway between the supports separated by a distance $l$, for a rectangular bar with vertical dimensions of cross-section $a$, and horizontal dimension $b$, the modulus is,

$$M = \frac{mgl^3}{4sa^3b}.$$

For a cylindrical bar of radius $r$,

$$M = \frac{mgl^3}{12\pi r^4 s}.$$

For a bar supported at one end. In the case of a rectangular bar as described above,

$$M = \frac{4mgl^3}{sa^3b}.$$

For a round bar supported at one end,

$$M = \frac{4mgl^3}{3\pi r^4 s}.$$

Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Elastic moduli** (*Modulus of rigidity*) *n.* If a couple ($C = mgx$) produces a twist of $\theta$ radians in a bar of length $l$ and radius $r$, the modulus is

$$M = \frac{2Cl}{\pi r^4 \theta}.$$

The substitution in the above formulae for the elastic coefficients of $m$ in grams, $g$ in cm/s$^2$, $l$, $a$, $b$, and $r$ in cm, $s$ in cm, and $C$ in dyne-cm will give moduli in dyn/cm$^2$. The dimensions of elastic moduli are the same as of stress $[\mathrm{M\,L^{-1}\,T^{-2}}]$. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Elastic moduli** (*Coefficient of restitution*) *n.* Two bodies moving in the same straight line, with velocities $v_1$ and $v_2$, respectively, collide and after impact move with velocities $v_3$ and $v_4$. The coefficient of restitution is

$$C = \frac{v_4 - v_3}{v_2 - v_1}.$$

Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Elastic modulus** *See modulus of elasticity.*

**Elastic nylon** *See nylon* 6/10.

**Elastic polyamides** *n.* Elements that are combined by chemical processes into long-chain polymers that constitute the fiber-forming substance known as polyamides. Harper CA (ed) (2002) Handbook of plastics, elastomers, and composites, 4th edn. McGraw-Hill, New York.

**Elastic recovery** *n.* That fraction of a given deformation that behaves elastically. A perfectly elastic material has a recovery of 100% while a perfectly plastic material has no elastic recovery. Elastic recovery is an important property in films used for stretch packaging because it relates directly to the ability of a film to hold a load together. Retention of the elastic-recovery stress over a period of time is also important. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Elastic solid** *n.* Solid in which, for all values of the shearing stress below the rupture (shear strength), the strain is fully determined by the stress regardless of whether the stress is increasing or decreasing.

**Elastodynamic extruder** *See extruder, elastic-melt.*

**Elastomer** \-tər-mər\ [*elastic* + *-o-* + *-mer*] (ca. 1939) *n.* Generally, a material that at room temperature can be stretched repeatedly to at least twice its original length and, immediately upon release of the stress, returns with force to its approximate original length. Stretchability and deformation with returnability is one criteria by which materials called plastics in commerce are distinguished from elastomers and rubbers. More explicitly, polymers that stretch and recover reproducibly without permanent change in dimensions (or deformation) are rubber or elastic materials. Elastomers are useful and divese substances tht easily form various rubbery shapes. Many industries rely on parts made from elastomers, especially automobiles, sports equipment, electronics, electrical equipment, and assembly line factories (www.dupontelastomers.com). Another criterion is that, unlike thermoplastics that can be repeatedly softened and hardened by heating and cooling without substantial change in properties, most elastomers are given their final properties by mastication with fillers, processing aids, antioxidants, curing agents, and others followed by vulcanization (curing) at elevated temperatures that cross-links the molecular chains and causes them to be thermosetting systems. However, a few elastomers are thermoplastic systems. Polymers usually considered to be elastomers, at least in some of their forms, are listed in the follow table. {G Elastomer n, F élastomère m, S elastómero m, I elastomero m}.

| Chemical name | Abbreviations |
|---|---|
| Acrylonitrile–chloroprene copolymer | NCR |
| Acrylonitrile–isoprene copolymer | NIR |
| Butadiene–acrylonitrile copolymer | GR-N, NBR, and PBAN |
| Chlorinated polyethylene | CPE |
| Chlorosulfonated polyethylene | CSM, CSR, and CSPR |
| Ethylene ether polysulfide | EOT |
| Ethylene–ethyl acrylate copolymer | EEA, E/EA |
| Ethylene polysulfide | ET |
| Ethylene–propylene copolymer | EPM, EPR |
| Ethylene–propylene-diene terpolymer | EPD, EPDM, EPT, and EPTR |
| Fluoroelastomer (any) | FPM |
| Fluorosilicone | FVSI |
| Hexafluoropropylene–vinylidene fluoride copolymer | FPM |
| Isobutene–isoprene copolymer | Butyl, GR-I |
| Organopolysiloxane | SI |
| Acrylic ester–butadiene copolymer | ABR, AR |
| Polybutadiene | BP, BR, and CBR |
| Polychloroprene | CR |
| Polyepichlorohydrin | CO, CHR |
| Polyisobutene | PIB |
| Polyisoprene, natural | NR |
| Polyisoprene, synthetic | CI, IR, and PIP |
| Polyurethane (polyester) | AU, PUR |
| Polyurethane (polyether) | EU |
| Polyurethane (polyether and polyester) | TPU |
| Styrene–butadiene copolymer | SBR, GR-S |
| Styrene–chloroprene copolymer | SCR |
| Polyethylene–butyl graft copolymer | TPO |
| Styrene–butadiene–styrene triblock polymer | SBS |

A beneficial property of elastomers is that they can be compounded or joined with other materials to strengthen certain characteristics. Other kinds of polymers may be installed next to various other materials, such as metal, hard plastic, or different kinds of rubber, with excellent adhesion. Harper CA (ed) (2002) Handbook of plastics, elastomers, and composites, 4th edn. McGraw-Hill, New York. Harper CA (ed) (2002) Handbook of plastics, elastomers, and composites, 4th edn. McGraw-Hill, New York. Elias HG et al. (1983) Abbreviations for thermoplastics, thermosets, fibers, elastomers, and additives. Polym News 9:101–110. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley. Harper CA (ed) (2002) Handbook of plastics, elastomers, and composites, 4th edn. McGraw-Hill, New York. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Elastomeric** *adj.* Rubber like, and relating to or having the properties of elastomers.

**Elaterite** \i-ˈla-tər-ˌrīt\ [Gr *Elaterit*, fr. Gk *elatēr*] (1826) *n.* Infusible asphaltic pyrobitumen of petroleum origin, sometime described as mineral rubber or mineral Caoutchouc.

**Electret** \i-ˈlek-trət\ [*elect*ricity + magn*et*] (1885) *n.* A disk of polymeric material that has been electrically polarized so that one side has a positive charge and the other a negative charge, analogous to a permanent magnet. Electrets may be formed of poor conductors such as polymethyl methacrylate, polystyrene, nylon, and polypropylene, by heating and cooling them in the presence of a strong electric field. Bar-Cohen Y (ed) (2001) Electroactive polymer (EAP) actuators as artificial muscles. SPIE Press, Bellingham, Washington. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Electrical conductivity** *n.* (1) (Symbol is $\lambda$ expressed in units of $\Omega^{-1}\,\mathrm{m}^{-1}$) A measure of the ease of transporting electric charge from one point to another in an electric field (Ku and Liepins, 1987). (2) The reciprocal of resistivity (resistivity symbol is $\rho$ expressed in units of $\Omega\,\mathrm{m}$). (3) $R = \rho l/A$, where $R$ is the resistance, $\Omega$; $\rho$ the resistivity, $\Omega\,\mathrm{m}$; $l$ the length of material, m; and $A$ is the area of cross-section of material, $\mathrm{m}^2$. {G elektrische Leitfähigkeit f, F conductivité électrique, conductivité f, S conductividad eléctrica, conductividad f, I conduttività elettrica, conduttività f}. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Emerson JA, Torkelson JM (eds) (1991) Optical and electrical properties of polymers: materials research society symposium proceedings, vol 24. Materials Research Society, Warrendale, PA. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York. Seanor DA (1982) Electrical conduction in polymers. Academic Press, New York.

**Electrical-discharge machining** (EDM, spark erosion) *n.* A method of machining molds and extrusion dies in which a conductive tool (often brass) has the inverse shape of the cavity or hole to be machined. A high-voltage DC difference is applied between the tool and the work piece. Capacitive discharge erodes steel from the work piece at about eight times the rate that the tool itself is eroded. Roughing and finishing tools are used. The process is accurate, produces good detail, can cut thin, deep slots, and can be used with hardened steels, thus averting the distortion sometimes caused by hardening after conventional machining. Metal removal is relatively slow. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Electrical finish** *n.* A finish designed to increase or maintain electrical resistivity of a textile material.

**Electrical insulation** *n.* Material with very low conductivity, which surrounds active electrical devices. Common electrical insulation chemicals are fluorine-containing polymers. Dissado LA, Fothergill CJ (eds) (1992) Electrical degradation and breakdown of polymers. Institution of Electrical Engineering (IEE), London. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Electrically conductive polymers** *n.* Electrical properties of polymers are their responses when an electric field is applied to them. Business-machine housings, structural components, and static-control accessories often require plastics that have some degree of electrical conductivity. Additives and fillers imparting such conductivity are metal powders, carbon black, carbon fibers, and metallized-glass fibers and spheres. Inherently conducting polymers are naturally conducting while filled polymers owe their conductivity to the electrical properties of the filler materials. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

*See also conducting polymer.*

**Electrical measurements** *n.* Analog electronics deal with electrical signals that move through a continuous range of voltages. Digital electronics, on the other hand, deal with electrical signals that only assume fixed voltages. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Electrical resistance** *n.* (1) The electrical resistance is the ohmic resistance to the flow of electrical current. Related properties of plastics are insulation resistance, surface resistivity, and volume resistivity. (2) The ability of plastics to withstand various electrical stresses. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

*See arc resistance, break-down voltage, corona resistance, and dielectric strength.*

**Electric field intensity** *n.* The electric field intensity is measured by the force exerted on unit charge. Unit field intensity is the field, which exerts the force of 1 dyn on unit positive charge. Dimensions $[\varepsilon^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{-1/2}\,\mathrm{T}^{-1}]$, $[\mu^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{-1/2}\,\mathrm{T}^{-1}]$. The field intensity or force exerted on unit charge at a point distance $r$ from a charge $q$ in a vacuum

$$H = \frac{q}{r}.$$

If the dielectric in the above cases is not a vacuum the dielectric constant $\varepsilon$ must be introduced. The formula becomes

$$H = \frac{q}{\varepsilon r^2}.$$

The value of $\varepsilon$ is frequently considered unity for air. If the dielectric constant of a vacuum is considered unity the value for air at 0°C and 760 mm pressure is 1.000567. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Electric strength** *n.* Another term for dielectric strength.

**Electrochemical cell** *n.* Any device which converts electrical into chemical energy, or vice versa.

**Electroactive polymers (EAP)** *n.* Polymers that respond to electrical and magnetic stimulus with a significant change in shape and size. An example of an electroactive polymer is poly(vinylidene fluoride) (PVDF) that has been used for pressure sensitive (piezoelectricity) devices such as pressure sensors. Also, some polymers respond to photonic and thermal stimulus. Bar-Cohen Y (ed) (2001) Electroactive polymer (EAP) actuators as artificial muscles. SPIE Press, Bellingham, Washington.

**Electrochemical equivalent** *n.* In an electrolytic cell, the mass of a metal deposited with the passage of 1 C of electricity. In the SI system, the coulomb is defined as 1 A s. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Electrocoating** *n.* An organic finish, which is often applied as a prime coat on steel.

*See electrodeposition.*

**Electrocuring** *n.* Process, which uses an electron beam to cure organic coatings applied to commercial products on a continuous production line.

**Electrode** \i-ˈlek-ˌtrōd\ (1834) *n.* A terminal member in an electrical circuit designed to promote an electrical field between it and another electrode. In the plastics industry electrodes are used in microwave heat sealing and surface treating of films. One of the electrodes may be a press platen or a roll. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Electrodeposition** (1882) *vt.* Method of paint application in which an article to be coated which is an electrical conductor is made one of the electrodes in a tank of water-thinned paint. The other electrode is generally a metal such as copper. The two electrodes are connected to a source of electric power, the polarity of the article to be coated being of the opposite sign to that on the particles in the liquid paint in the tank. The charged particles move towards the articles under the influence of the electric field, and when they give up their charge at the electrode (article) they are deposited and ultimately form a continuous film of paint. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Electrodeposition coating** The process of using a water-borne electrodeposition (E-Coat) paint process instead of a conventional organic solvent-based spray {G Elektrotauchlackierung f, F revêtement par électrodéposition, revêtement m, S revestimiento por electrodeposición, revestimiento m, I rivestimento per elettrodeposizione, rivestimento m}.

**Electrode potential** *n.* (1) The voltage associated with a half-reaction written, by convention, as a reduction; a reduction potential. (2) The difference in potential between an electrode and the immediately adjacent electrolyte referred to some standard electrode as zero potential.

**Electroformed mold** *n.* A mold made by electroplating a model, which is subsequently removed from the metal deposit. The deposit is sometimes reinforced with cast or sprayed metal backings to increase its strength and rigidity. Such molds are used in slush casting of vinyl plastisols and other forming processes done at low pressures.

**Electroforming** *n.* A method of making molds for plastics processes, usually those employing low or moderate pressures, in which a pattern made of preplated wax or flexible material is electroplated.

**Electrokinetic potential** *See zeta potential.*

**Electroless plating** *n.* The deposition of metals on a catalytic surface from solution without an external source of current. The process is used as a preliminary step in preparing plastic articles for conventional electroplating. After cleaning or etching, the plastic surface is immersed in solutions that react to precipitate a catalytic metal in situ, for example first in an acidic stannous chloride solution, then into a solution of palladium chloride. Palladium is reduced to its catalytic metallic state by the tin. Another way of producing a catalytic surface is to immerse the plastic article in a colloidal solution of palladium followed by immersion in an accelerator solution. The electroless plating bath is a solution of several components, including nickel or copper salts, chelating agents, stabilizers, and reducers. Metal reduced from the salt plates on the active sites on the palladium surface, the plated plastic being removed from the bath when the thickness of the electroless deposit is from 3 to 7 μm. The plastic article thus treated can now be plated with nickel or copper by the electroless method, forming a conductive surface that then can be plated with other metals by conventional electroplating.

**Electroless plating equipment** *n.* Equipment used in the deposition and formation of a continuous metallic film on a nonconductive plastic surface without the use of an electric current.

**Electroluminescence** \i-ˌlek-trō-ˌlü-mə-ˈne-sᵊn(t)s\ (ca. 1909) *n.* Generation of light by high-frequency electrical discharge through a gas or by applying an alternating current to a phosphor {G Elektrolumineszenz f, F électroluminescence f, S electroluminiscencia f, I elettroluminescenza f}.

**Electrolysis** \-ˌträ-lə-səs\ (1834) *n.* The passage of an electric current through a medium to produce a chemical change. If a current $i$ flows for a time $t$ and deposits a metal whose electrochemical equivalent is $e$, the mass deposited is $m = eit$. The value of $e$ is usually given for mass in gram, $i$ in ampere, and $t$ in second.

**Electrolyte** (1834) *n.* A substance which produces ions when dissolved solution or when fused, thereby becoming electrically conducting {G Elektrolyt m, F électrolyte m, S electrólito m, I elettrolito m}.

**Electrolytic cell** *n.* An electrochemical cell in which electrical energy is used to produce chemical change; a cell in which electrolysis takes place.

*See cell, electrolytic.*

**Electrolytic dissociation or ionization theory** *n.* When an acid, base or salt is dissolved in water or any other dissociating solvent, a part or all of the molecules of the dissolved substance are broken up into parts called ions, some of which are charged with positive electricity and are called cations, and an equivalent number of which are charged with negative electricity and are called anions.

**Electrolytic solution tension theory** (Heimholtz double layer theory) *n.* When a metal, or any other substance capable of existing in solution as ions, is placed in water or any other dissociating solvent, a part of the metal or other substances passes into solution in the form of ions, thus leaving the remainder of the metal or substances charged with an equivalent amount of electricity of opposite sign from that carried by the ions. This establishes a difference in potential between the metal and the solvent in which it is immersed.

**Electrolytic white lead** *n.* Form of white lead, chemically similar to the stack and chamber types, which is made by the electrolysis of a solution of a lead salt followed by treatment with carbon dioxide gas.

**Electromagnetic adhesive** *n.* An intimate blend of a material that absorbs electromagnetic energy with a thermoplastic of the same composition as the sections to be bonded. The adhesive is applied in the form of a liquid, a ribbon, a wire, or a molded gasket to one of the surfaces to be joined. The two surfaces are brought into contact, then the adhesive is rapidly heated by eddy currents induced by a high-frequency induction coil placed close to the joint. This melts the adhesive which, after cooling, bonds the surfaces together.

**Electromagnetic spectrum** (ca. 1934) *n.* The entire range of wavelengths or frequencies of electromagnetic radiation from the shortest gamma rays to the longest radio waves and including visible light.

**Electromagnetic welding** *See induction welding.*

**Electromagnetic wave** (1908) *n.* One of the waves that are propagated by simultaneous periodic variations of electric and magnetic field intensity and that include radio waves, infrared, visible light, ultraviolet, X-rays, and gamma rays.

**Electromotive force** *n.* The difference in electric potential that causes current to flow in a circuit. The SI unit is the volt (V), defined as the difference of potential between two points of a conductor carrying a constant current of 1 A when the power dissipated between the two points equals 1 W. Thus, in SI, 1 V = 1 W/A.

**Electromotive force** *n.* This force is defined as that which causes a flow of current. The electromotive force of a cell is measured by the maximum difference of potential between its plates. The electromagnetic unit of potential difference is that against which 1 erg of work is done in the transfer of electromagnetic unit quantity. The volt is that potential difference against which 1 J of work is done in the transfer of 1 C. One volt is equivalent to $10^8$ electromagnetic units of potential. The international volt is the electrical potential which when steadily applied to a conductor whose resistance is one international ohm will cause a current of one international ampere to flow. The international volt = 1.00033 absolute volts. The electromotive force of a Weston standard cell is 1.0183 int. volts at 20°C. Dimensions $[\varepsilon^{-1/2}\,M^{1/2}\,L^{-1/2}\,T^{-1}]$, $[\mu^{-1/2}\,M^{1/2}\,L^{3/2}\,T^{-1}]$.

**Electromotive series** *n.* A list of the metals arranged in the decreasing order of their tendencies to pass into ionic form by losing electrons.

**Electron** \i-ˈlek-ˌträn\ [*electr-* + $^{2}$*-on*] (1891) *n.* A (perhaps) fundamental subatomic particle with a very low mass and a unit negative electrical charge; found in the extranuclear region of an atom. The electron is a small particle having a unit negative electrical charge, a small mass, and a small diameter. Its charge is $(4.80294 + 0.00008) \times 10^{-10}$ absolute electrostatic units, it mass $\frac{1}{1837}$ that of the hydrogen nucleus, and its diameter about 10–12 cm. Every atom consists of one nucleus and one or more electrons. Cathode rays and beta rays are electrons.

**Electron** An elementary subnuclear particle having a unit negative electrical charge, $1.602191 \times 10^{-19}$ C, its mass (at rest) is 1/1837 that of a hydrogen nucleus, or $9.10953 \times 10^{-28}$ g, and its diameter is $5.6359 \times 10^{-13}$ cm. Every atom consists of a nucleus of protons and neutrons, and as many orbiting electrons as there are protons in the nucleus. Cathode rays and beta rays are electrons.

**Electron affinity** *n.* The quantity of energy released when a gaseous, isolated, ground-state atom (or, sometimes, ion) gains an electron.

**Electron beam** *n.* A stream of electrons in an electron optical system.

**Electron-beam machines** *n.* The key to the technology is electrobeam (or E-beam) lithography. E-beam lithography is a technique for creating extremely fine patterns (much smaller than can be seen by the naked eye) required by the modern electronics industry for integrated circuits. Derived from the early scanning-electron microscopes, the technique consists of scanning a beam of electrons across a surface covered with a thin film, called a resist. The electrons produce a chemical change in this resist, which allows the surface to be patterned.

**Electron-beam radiation** *n.* Magnetically accelerated electrons focused by electric fields have been used for cross-linking polyethylene in special applications such as wire coating, to improve modulus and temperature resistance. Treatment levels must be carefully controlled since overexposure will cause degradation. Electron beams are also used to cure epoxy-resin coatings, eliminating the need for photoinitiators.

**Electron capture** *n.* A mode of radioactive decay in which an electron from the extranuclear region, usually the *K* shell, is captured by a nucleus.

**Electron curing** *n.* A method for curing polymer matrix composites.

**Electron-deficient compound** *n.* A compound in which insufficient electrons are available to bond all the atoms with conventional (two-center) covalent bonds.

**Electron diffraction** *n.* Used to identify crystalline substances based on the spacing of atomic planes within their structures.

**Electronegativity** *n.* The relative tendency of a bonded atom to attract electrons to itself.

**Electron gas** (ca. 1929) *n.* The delocalized electrons in a metal.

**Electron lens** (1931) *n.* A device for focusing a beam of electrons by means of an electric or a magnetic field.

**Electronic heating** *See dielectric heating.*

**Electronic treating** *See corona-discharge treatment.*

**Electron microprobe** *n.* An instrument that utilizes the bombardment of a small sample with a beam of high-energy electrons to determine the composition, elemental identification and quantification of a material (e.g., Al, O, etc.).

**Electron microscopy** (1932) *n.* Electron microscopy is applied to observe phase domain of a size of 50–1000 Å. This comes true with transmission electron microscopy by applying dyeing techniques such as oxidizing the unsaturated domain with $OsO_4$ and $RuO_4$.

**Electron multiplier** (1936) *n.* A device that utilizes secondary emission of electrons for amplifying a current of electrons.

**Electron paramagnetic resonance** *n.* A method to investigate the behavior of samples containing unpaired electrons (free radicals or compounds comprising an ion whose outer electronic shell is incomplete) in an applied magnetic field.

**Electron probe** (1962) *n.* A microprobe that uses an electron beam to induce X-ray emissions in a sample.

**Electron spectroscopy** *n.* A surface specific technique utilizing the emission of low energy electrons in the Auger process.

**Electron tube** (1922) *n.* An electronic device in which conduction by electrons takes place through a vacuum or a gaseous medium within a sealed glass or metal container and which has various uses based on the controlled flow of electrons.

**Electron volt** (1930) (eV) *n.* The kinetic energy acquired by any charged particle carrying unit electronic charge when it falls through a potential difference of 1 V. One eV is equal to $1.60219 \times 10^{-19}$ J. Multiples of this unit in common use are the keV ($10^3$), MeV ($10^6$), and GeV ($10^9$). The GeV is also written BeV.

**Electrophile** \i-ˈlek-trə-ˌfīl\ (1943) *n.* An atom or group of atoms, which appears to seek electrons in its reactions.

**Electrophoresis** \-trə-fə-ˈrē-səs\ [NL] (1911) *n.* The movement of suspended particles through a fluid or gel under the action of an electromotive force applied to electrodes in contact with the suspension.

**Electrophoretic deposition** *n.* A direct-current process analogous to electroplating, used to coat electrically conductive articles with plastics, deposited from aqueous lattices or dispersions. The cathode may be a non-corrodible metal such as stainless steel, generally serving as the container in which the process is performed. The DC potential is usually under 100 V. The deposited coatings are baked to remove residual water. Among available polymer lattices suitable for the process are PVC, polyvinylidene chloride, acrylics, nylons, polyesters, polytetrafluoroethylene, and polyethylene.

**Electroplating chemicals** *n.* Copper, gold, silver, chromium, and nickel are generally used as the conductive metal for plating. Acrylonitrile–butadiene–styrene resins have been most widely used for electroplated articles. Others in commercial use for the process include cellulose acetate, some grades of polypropylene, polysulfones, polycarbonate, polyphenylene oxide, nylons, and rigid PVC.

**Electroplating on plastics** *n.* Articles of almost any of the common plastics can be plated by conventional processes used on metals after their surfaces have been rendered conductive by precipitation of silver or other conductor. A layer of copper is usually applied first, followed by a final plating of gold, silver, chromium, or nickel. Acrylonitrile–butadiene–styrene resins have been most widely used for electroplated articles. Others in commercial use for the process include cellulose acetate, some grades of polypropylene, polysulfones, polycarbonate, polyphenylene oxide, nylons, and rigid PVC.

(*See electroless plating*). *See also metallizing.*

**Electroplating plastics** *n.* Plastics can be plated by conventional processes used for metals, after their surfaces have been rendered conductive by precipitation of silver or other conductive substance.

**Electrostatic coating** *n.* A coating that creates, electrical charges, and disperses particles or droplets toward the target by a variety of methods {G elektrostatisches Pulversprühverfahren n, F revêtement de poudre électrostatique, revêtement m, S recubrimiento por polvo electrostático, recubrimiento m, I rivestimento con polvere elettrostatica, rivestimento m}.

**Electrostatic detearing** *n.* Process of removing blobs and the thick edges of paint from an article, which has been coated by dipping. The process consists of passing the dipped article, after a limited period of draining, over a grid at a high electrical potential. The blobs and thick edges of paint are removed from the article by attraction to the grid.

**Electrostatic fluidized-bed coating** *n.* A process combining elements of the fluidized-bed method of coating and electrostatic spraying. Pointed electrodes are inserted through the porous bottom of a fluidized-bed container. When the bed is aerated in the usual manner, a potential of about 100 kV is applied between the electrodes and ground. The associated charge repels the fluidized plastic particles into the space above the bed, from which they are attracted to a grounded article to be coated. The article may be at room temperature when inserted in the powder bed, the coating temporarily adhering by electrostatic charge. Subsequent heating fuses the coating.

**Electrostatic forces** *n.* The forces that exist between particles, which are electrically charged.

**Electrostatic printing (electrostatography)** *n.* Contactless printing by any of several methods based on electrostatic principles. Electrophotography depends on light or other electromagnetic energy and photosemiconductors, which are non-conductors of electricity in the dark and conductors when exposed to electromagnetic radiation. Electrography involves the use of a dielectric image, stencil, or facsimile scanning for source to form the image.

**Electrostatic printing** *n.* A printing process employing electrostatic charge to transfer powdered ink from an electrically charged stencil to a plastic film or sheet. The film to be printed is interposed between a grounded metal plate and the stencil. Areas corresponding to those not to be printed are masked on the stencil as in conventional screen printing. The powdered ink is brushed on the back side of the screen, where it receives a charge propelling it toward the grounded plate as an image cloud until intercepted by the film. Post-heating is usually required to fuse the ink to the substrate.

**Electrostatic spray coating** *n.* A spraying process that employs electrical charges to direct the paths of atomized particles to the work surface. Dry plastic powders are charged with the static electricity as they emerge from a spray gun, the nozzle of which is attached to the negative terminal of a high-voltage DC power supply. The charged particles are attracted to the grounded object, which must be at least slightly electrically conductive. The powder coating is subsequently heated to obtain a smooth, homogeneous layer.

**Electrostatic spraying** *n.* (1) A process where paint spray is blown through an electrostatic field. (2) A system of applying paint in which the sprayed paint droplets are given an electrical charge that results in their attraction to the grounded work piece.

**Electrostatic spraying** *n.* Methods of application spraying in which an electrostatic potential is created between the article to be coated and the atomized paint particles. The charged particles of paint are attracted to the article being painted and are then deposited and discharged. The electrostatic potential is used in some processes to aid the atomization of the paint.

**Element** \ˈe-lə-mənt\ [ME, fr. OF & L; OF, fr. L *elementum*] (13c) *n.* A pure substance composed of atoms each having the same atomic number (number of protons). An element cannot be chemically decomposed. Substances, which cannot be decomposed by the ordinary types of chemical change, or made by chemical union.

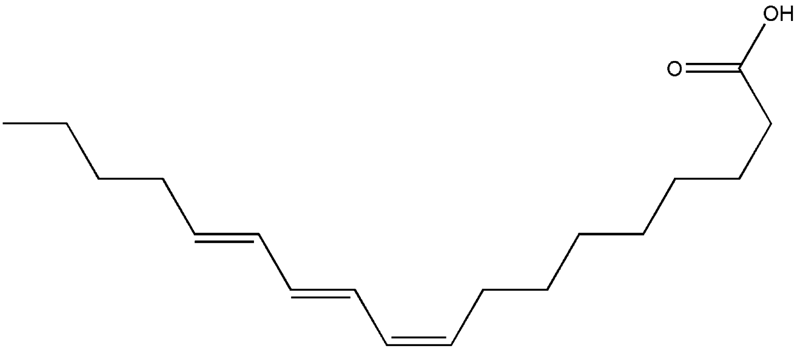
**Elemental analyses** *n.* Method of substrate characterization, by which molecules are broken down to their individual elements.

**Elementary process** A single step of a reaction mechanism.

**Elemi Gum** \ˈe-lə-mē ˈgəm\ [NL *elimi*, prob. fr. Arabic al *lāmi* the elemi] (1543) *n.* Any of various natural oleoresins derived from certain tropical trees, especially *Canarium Iuzonicum* of the Philippines, and used in making varnishes and inks. It is soluble in most organic solvents, and used chiefly to impart elasticity and adhesion to lacquers and varnishes.

**Eleomargaric acid** *n.* Another name for eleostearic acid.

**Eleostearic acid** *n.* $CH_3(CH_2)_3(CH{=}CH)_3(CH_2)_7COOH$. Ocatadeca-9,11,13-trienoic acid. *cis, trans, trans*, 9,11,13-Octadecatrienoic acid. Principal constituent acid of tung oil, characterized by the presence of three conjugated double bonds. Two forms are known, namely $\alpha$ and $\beta$ types, with mps of 49 and 71°C, respectively (*See image*).



Eleostearic acid

**Elimination reaction** *n.* A reaction in which atoms or groups on adjacent atoms in a molecule are removed to leave a double or triple bond between the atoms.

**Ellis model** *n.* A three-constant model of pseudoplastic flow that merges Newton's law of flow, applicable at very low shear rates, with the power law at high rates and provides a smooth transition between the two. For one-dimensional flow the equation is

$$-\frac{dv_z}{dx} = \frac{\tau_{xz}}{\eta_o}\left[1 + \left(\frac{\tau_{xz}}{\tau_{1/2}}\right)^{\alpha-1}\right],$$

where $v_z$ is the $z$-directed velocity perpendicular to coordinate $x$, $\tau_{xz}$ is the opposing shear stress, $\eta_o$ is the zero-shear (Newtonian) viscosity, a is an exponent larger than 1, approximately equal to the reciprocal of the flow-behavior index and $\tau_{1/2}$ is the shear stress at which the viscosity (=shear stress/shear rate) is half $\eta_o$.

**Elmendorf tear strength** *n.* The Elmendorf tear tester, originally developed to test papers and fabrics, has been adapted for plastics films in ASTM D 1922. Acting by gravity, a calibrated pendulum swings through an arc, tearing the specimen from a precut slit. The energy absorbed is indicated by a pointer and scale. Some other modes of measuring tear resistance are spelled out in ASTM D 1004, and D 2582.

**Elongation** \(ˌ)ē-ˌlóŋ-ˈgā-shən\ (14c) *n.* In tensile testing, the fractional increase in length of a marked test length as the test specimen is stretched and stress rises. At any point during the test, percent nominal elongation = 100 × the increase in gage length/original length. Ultimate elongation is the elongation just prior to rupture of the sample and is the "elongation at break" reported in most properties tables.

*See also true strain.*

**Elongational flow** (extensional flow) *n.* Flow caused by stretching a material, usually a hot melt, as in fiber drawing, film blowing, parison draw down, and biaxial stretching of sheet. This flow is always accompanied by a reduction in cross section. The rate of elongation, at any moment during one-dimensional, elongational flow, is given by

$$de/dt = \left(\frac{1}{s}\right)\left(\frac{ds}{dt}\right) = \frac{d(\ln s)}{dt},$$

where $e$ is the true elongation and $s$ is the strand length at time $t$.

**Elongational viscosity** (extensional viscosity, Trouton viscosity) *n.* The viscosity that characterizes an element undergoing elongational flow (above). It is equal to the tensile stress divided by the rate of elongation and for polymers it depends on the rate, but may increase with rate, unlike the usual reduction of shear viscosity with rate. Tensile viscosities are apt to be many times larger than shear viscosities for the same resin, temperature, and deformation rate. Values in the range of $10^4$–$10^7$ Pa s have been reported. For Newtonian liquids, the elongation viscosity is three times the shear viscosity (at the same temperature).

**Elongation at break** *n.* The increase in length when the last component of the specimen breaks.

**Eluent** \ˈel-yə-wənt\ [L *eluent-*, *eluens*, pp of *eluere*] (1941) *n.* In gas and liquid chromatography, the fluid that carries the solute out of the column.

**Elution** [L *elutus*, pp of *eluere* to wash out, fr. *e-* + lavere to wash] (1731) *n.* The removal, in chromatography, of the species adsorbed on the column matrix by a flowing liquid or gas.

**Elutriate** \ē-ˈlü-trē-ˌāt\ [L *elutri atus*, pp of *elutriare* to put in a vat, perhaps fr. *elutrum* vat, fr. Gk *elytron* reservoir, literally, covering] (ca. 1727) *vt.* To purify, separate, or remove by washing.

**Elutriation** *n.* The separation of less massive particles from a sample of distributed particle sizes or densities by upward flow of a liquid or gas.

**Elvanol** *n.* Poly(vinyl alcohol), manufactured by DuPont, USA.

**EMA** *n.* Abbreviation for ethylene–acrylic acid copolymer.

**Embedding** *n.* The process of encasing an article in a resinous mass, performed by placing the article in a simple mold, pouring a liquid resin into the mold to completely submerge the article, sometimes under vacuum so as to suck out hidden air bubbles, curing the resin, and removing the encased article from the mold. In the case of electrical components, the lead wires or terminals may protrude from the embedment. The main difference between embedding and potting is that in potting, the model is a container that remains fixed to the resinous mass. The liquid resin may contain microspheres to reduce the final mass of the embedment.

*See also encapsulation, impregnation, and potting.*

**Embedment decorating** *n.* A technique fur decorating reinforced-plastics articles in which a mat or web of fibrous material printed with a design is embedded in the surface of the article and covered with a transparent gel coat. The technique can be adapted for use in hand lay-up, continuous laminating, pultrusion, and matched-die molding.

**Embossed paper** *n.* Wallpaper run through rollers with raised areas, to provide a light relief effect.

**Embossing** *n.* Any of several techniques used to crease depressed patterns in plastics films or sheeting. In the case of cast film, embossing can be accomplished directly by casting on an inverse-textured belt or roll. Calendered films are frequently embossed by rolls following the calender rolls. Other films or coated fabrics can be embossed subsequent to manufacture by reheating them and passing them through embossing rolls, or compressing them between plates. Extruded sheets, up to 3 mm or thicker, are commonly embossed as the sheets emerge from the extruder with an embossing roll on the takeoff.

**Embroidery** \im-ˈbrói-d(ə)rē\ (14c) *n.* Ornamental designs worked on a fabric with threads. Embroidery may be done either by hand or by machine.

**Emerald green** \ˈem-rəld ˈgrēn\ (1646) *n.* Name applied to two distinctly different green pigments: complex copper acetoarsenite (*also known as Paris green and*

*Schweinfurt green*); and chromium hydroxide.

*See hydrated chromium oxide.*

**Emerald oxide of chromium** *See hydrated chromium oxide.*

**Emery** \ˈem-rē, ˈe-mə-\ [ME, fr. MF *emeri*, fr. OIt *smiriglio*, fr. ML *smiriglum*, fr. Gk *smyrid-*, *smyris*] (15c) *n.* A mixture of mostly corundum and some magnetite that, because of its great hardness, is widely used for grinding and polishing, including tumble-polishing of plastics moldings. Emery is available in many grades from coarse to extremely fine, as powder and bonded to paper and cloth.

**Emery abrasive** *n.* A natural composition of corundum and iron oxide, found in large deposits both in USA and the near East. It is magnetic and partly soluble in hydrochloric acid. The grains are blocky, cut slowly, and tend to polish the material being abraded.

**Emery cloth** *n.* Coated abrasive cloth used for light polishing of metal or for removing rust spots or similar light work; not recommended for large metal surfaces or tough metal, where aluminum oxide cloth is much more satisfactory.

**EMI** *n.* Abbreviation for 2-ethyl-4-methylimidazole.

**Emission** \e-ˈmi-shən\ (1607) *n.* (1) Discharges into the air by a pollution source as distinguished from effluents, which are discharged into water. (2) The emitting of radiation. Emission depends on the temperature to which a material is heated relative to the temperature of its surroundings, on the time, and on the nature of the surface. Basically, therefore, emission is a net rate at which the body emits radiation. As an adjective, it is used to describe the characteristic radiation emitted by elements in a spectroscope, e.g., emission spectrum.

**Emission factor** *n.* The average amount of pollutants emitted from a polluting source per unit of material produced.

**Emissive power** (or emissivity) *n.* Emissive power is measured by the energy radiated from unit area of a surface in unit time for unit difference of temperature between the surface in question and surrounding bodies. For the cgs system the emissive power is given in ergs per second per square centimeter with the radiating surface at 1° absolute and the surroundings at absolute zero.

*See radiation formula.*

**Empirical formula** \-i-kəl ˈfór-myə-lə\ (1885) *n.* A formula expressing the simplest whole-number ratio of atoms of each element in a compound without providing information on the grouping of the atoms. For example, the empirical formula of oleic acid is $C_{18}H_{34}O_2$. Also called simplest formula.

**Emulgator** *See emulsifier.*

**Emulsification** \i-ˌməl-sə-fə-ˈkā-shən\ (1859) *n.* (1) In lithography, a condition resulting from the distribution of fountain solution in the ink. Excessive emulsification will produce poor printing. (2) The process of dispersing one liquid in another (the liquids being mutually insoluble or sparingly soluble in each other). When water is one of the liquids, two types of emulsions are possible: oil-in-water (water is the continuous state), and water-in-oil. The term "oil" describes any organic liquid sparingly soluble in water.

**Emulsified asphalt** *See asphalt emulsion.*

**Emulsifier** (1888) *n.* Substance that intimately mixes, modifies the surface tension of colloidal droplets, and disperses dissimilar materials ordinarily immiscible, such as oil and water, to produce a stable emulsion. The emulsifier has the double task of promoting the emulsification and of stabilizing the finished products. {G Emulgator m, F émulsifiant m, S emulsionante m, I emulsionante m}.

*Also known as emulsifying agent and emuglator*

**Emulsifiers** *n.* A surface-active agent promoting the formation and stabilization of an emulsion.

**Emulsifying agent** *n.* A substance used to facilitate the formation of an emulsion from two or more immiscible liquids, and/or to promote the stability of the emulsion. As surface-active agents, emulsifiers act to reduce interfacial tensions between the several phases. They also act as protective colloids to promote stability.

*See emulsifier.*

**Emulsifying agents** *n.* Materials used to facilitate the preparation of emulsions and to improve their stability.

**Emulsion** \i-ˈməl-shən\ [NL *emulsion-*, *emulsio*, fr. L *emulgēre* to milk out, from *e-* + *mulgēre* to milk; akin to OE *melcan* to milk, Gk *amelgein*] (1612) *n.* Strictly, an emulsion is a two-phase, substantially permanent, intimate mixture of two incompletely miscible liquids, one of which is dispersed as finite globules in the other. However, in plastics and other industries the term is sometimes broadened to include colloidal suspensions of solids such as waxes and resins in liquids. In an emulsion, the liquid that forms globules is known as the dispersed, discontinuous, or internal phase. The surrounding liquid is called the continuous or external phase. The dispersed phase may be held in suspension by mechanical agitation or by the addition of small amounts of emulsifying agents {G Emulsion f, F émulsion f, S emulsión f, I emulsione f}.

**Emulsion paint** *n.* Paint, the vehicle of which is an emulsion of binder in water. The binder may be oil, oleoresinous varnish, resin or other emulsifiable binder. Not to be confused with a latex paint in which the vehicle is a latex.

**Emulsion polymerization** *n.* A polymerization process in which the monomer or mixture of monomers is emulsified in a low-viscosity aqueous medium by means of soaps or other surface-active, solubilizing and emulsifying agents. The emulsion does not require intensive stirring as in suspension polymerization, and produces polymers of higher molecular weight than those produced by bulk or suspension processes. The polymers remain in emulsion, and must be recovered from the latex by freezing or chemical precipitation. The polymerization medium usually also contains a water-soluble initiator, catalyst, or chain-transfer agent. Examples of polymers produced from emulsions are polyvinyl acetate, acrylo-nitrile–styrene terpolymer, PVC, polyethylene, acrylics, and polystyrene.

**Emulsion spinning** *n.* Process by which a polymer matrix suspension of very fine particles is subjected to a high temperature sintering and drawing process, during which the matrix polymer is burnt off and the dispersed particles are coalesced.

**Emulsion stabilizer** *See protective colloid.*

**Emulsoid** \i-ˈməl-ˌsóid\ (ca. 1909) *n.* Colloidal particle, which takes up water. Syn: hydrophile.

**Enamel** \i-ˈna-məl\ [ME, fr. MF *enamailler*, fr. *en-* + esmail enamel, of Germanic origin; akin to OH Gr *smelzan* to melt] (14c) *vt.* (1) A dispersion of pigment in a liquid that forms a solid adherent film, on the surface to which it is applied, by means of oxidation polymerization, or other chemical reaction. The liquid vehicle of an enamel usually contains a thermosetting resin and a solvent. An initial soft film is formed by evaporation of the solvent, then the film hardens or cures at room temperature or during baking. (2) A class of substances having similar composition to glass with the addition of stannic oxide, $SnO_2$, and other infusible substances to render the enamel opaque.

**Enamel blue** *See cobalt blue.*

**Enantiomer** \i-ˈnan-tē-ə-mər\ [Gk *enangtios* + E –*mer*] (ca. 1929) *n.* Either of a pair of chemical compounds whose molecular structures have a mirror-image relationship to each other. An asymmetric molecule that is the mirror image of its stereoisomer. The two isomers are given the prefixes *dextro-* and *levo-*, e.g., *d-* and *l*-lactic acid. The physical properties of pure enantiomers are equal within experimental error, yet mixtures of the two, called racemic mixtures, may have different properties. For example, 50–50 *dl*-lactic acid melts 20°C lower than its pure enantiomers.

**Enantomeric** \-ˌnan-t ē-ə-ˈmer-ik\ *adj.*

**Enantiomeric configurational unit** *n.* Either of two stereoisomeric groups in a polymer that are mirror images at the plane containing the main-chain bonds.

**Enantiomorph** \i-ˈnan-tē-ə-ˌmórf\ [GK *enantios* opposite (fr. *enanti* facing, fr. *en* in + *anti* against) + ISR - morph] (1885) *n.* Enantiomer; also, either of a pair of crystals (as of quartz) that are structural mirror images.

**Enantiotropic** *n.* Compound or an element able to exist in two distinct crystalline forms, depending upon its maintenance above or below a certain transition temperature.

**Encapsulating** \in-ˈkap-sə-ˌlāt-iŋ\ (1876) *v.* The process of combining elements to create a new entity.

**Encapsulation** *n.* The process of applying a fairly thick coating that conforms to the shape of the coated object. The coating, of either thermoplastic or thermosetting resin, may be applied by brushing, dipping, spraying, or thermoforming. The process is much used for the protection and insulation of electrical components and assemblies.

*See also embedding, impregnation, potting, and microencapsulation.*

**Encapsulization** *n.* The enclosure of adhesive particles with a protective film that prevents them from coalescing until such time as proper pressure or solvation is applied.

**Encaustic** \in-ˈkó-stik\ [*encaustic*, adj, fr. L *encausticus*, fr. Gk *enkaustikos*, fr. *enkaiein* to burn in, fr. *en-* + *kaiein* to burn] (1601) *n.* (1) Painted with a mixture of a paint solution and wax, which, after application, is set by heat. (2) Colors, which have been applied to brick, glass, porcelain, and tile and set by the application of heat.

**Encounter** *n.* The period of time during which two reactant particles are trapped by a solvent-molecule cage in a liquid-solution reaction.

**End** *n.* (1) A strand of roving consisting of a given number of filaments gathered together. The group of filaments is considered to be an end or strand before twisting, and a yarn after the twist has been applied. (2) An individual warp yarn, thread, or fiber. (3) A short length or remnant of fabric.

**End-capping** *n.* Conversion, by chemical reaction, of the end groups of polymer chains to less reactive, more stable groups, thus preventing "unzipping" of chains and rendering the polymer itself more stable to processing. An example is the conversion of –OH end groups in polyoxymethylene to acetate groups.

**End grain** *n.* The surface of timber exposed when a tree is felled or when timber is cross-cut in any other way.

**End group** *n.* A chemical group or radical forming the end of a polymer chain. These are normally different from the repeating unit group or groups. Although end groups constitute a minute fraction of the polymer, they may vary considerably from the main-chain chemical structure and may exert effects on polymer properties that are stronger than one would expect from their numbers.

**End-group analysis** *n.* The quantitative determination, by chemical or spectrographic methods, of the number of end groups present in a sample of polymer. With linear, unbranched polymers, the mass of the sample divided by half the measured number of end groups equals the number-average molecular weight.

**Endo-** {*combining form*} [F, fr. Gk, fr. *endon* within; akin to Gk *en* in, OL *indu*, Hittite *andan* within]. (1) A chemical prefix denoting an inner position, for example in a ring rather than in a side chain, or attached as a bridge within a ring. (2) When prefixing "-thermic", denoting that the reaction so labeled takes heat from the surroundings when proceeding from left to right. In both sense, the opposite of Exo-.

**Endothermic** \ˌen-də-ˈthər-mik\ [ISV] (1884) *adj.* Pertaining to a chemical reaction or an operation that is accompanied by the absorption of heat. Opposite of exothermic.

**Endothermic reaction** *n.* A reaction which absorbs heat.

**End out** A void caused by a missing warp yarn.

**End point** (1899) *n.* (1) Maximum distillation temperature when a substance is distilled. (2) Stoichiometric point as shown by an indicator, potentiometer or other means, in a titration. (3) Required values of viscosity, acid values, etc., the attainment of which indicates the conclusion of a process in resin or varnish manufacturing.

**End-to-end distance** *n.* The square root of the average square of the distance from the one of the polymer chain to the other end of the polymer chain.

**Endurance limit** (fatigue limit) *n.* The stress level below which a specimen will withstand cyclic stress indefinitely without exhibiting fatigue failure. Rigid, elastic, low-damping materials such as thermosetting plastics and some crystalline thermoplastics do not exhibit endurance limits.

**Endurance ratio** *n.* The ratio of the endurance limit, under cyclic stress reversal, to the short-time, static strength of a material. If the mode of stress is not specified, tension/compression may be presumed.

**Energy** \ˈe-nər-jē\ [LL *energia* fr. Gk *energeia* activity, fr. *energos* active, fr. *en-* in + *ergon* work] (1599) *n.* The capability of doing work. Potential energy is energy due to position of one body with respect to another or to the relative parts of the same body. Kinetic energy is energy due to motion. cgs units, the erg, the energy expended when a force of 1 dyne acts through a distance of 1 cm; the joule is $1 \times 10^7$ ergs. The potential energy of a mass $m$, raised through a distance $h$, where $g$ is the acceleration due to gravity is

$$E = mgh.$$

The kinetic energy of mass $m$, moving with a velocity $v$, is

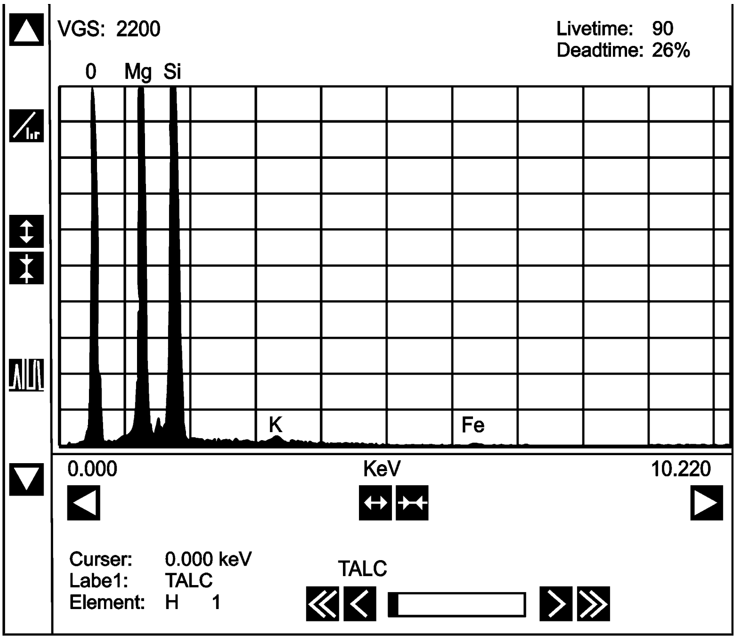
$$E = \frac{1}{2}mv^2.$$

Energy will be given in ergs if $m$ is in g, $g$ in cm/s$^2$, $h$ in cm and $v$ in cm/s.

**Energy absorption** *n.* The energy required to break or elongate a fiber to a certain point.

**Energy, *E*** *n.* The ability to do work.

**Energy dispersive X-ray analysis (EDXRA)** This method of elemental analysis (microanalysis) is often used in conjunction with scanning electron microscopy (SEM). An



Energy dispersive X-ray analysis (EDXRA) spectrograph of talc mica

example of an EDXRA spectrograph is shown. Staniforth M, Goldstein J, Echlin P, L ifshin E, Newbury DA (2003) Scanning electron microscopy and X-ray microanalysis. Springer-Verlag, New York.

**Energy (free energy)** *n.* Usable power (as heat or electricity); also; the resources for producing such power.

**Energy of a charge** *n.* In ergs where $Q$ is the change and $V$ the potential in electrostatic units.

$$E = \frac{1}{2} QV.$$

**Energy of rotation** *n.* If a mass whose moment of inertia about an axis is $I$, rotates with angular velocity $\omega$ about this axis, the kinetic energy of rotation will be

$$E = \frac{1}{2} I\omega^2.$$

Energy will be given in ergs if $I$ is in g cm$^2$ and $\omega$ in rad/s.

**Energy of the electric field** *n.* If $H$ is the electric field intensity in electrostatic units and $K$ the specific inductive capacity, the energy of the field in ergs/cm$^3$ is

$$E = \frac{KH^2}{8\pi}.$$

**Energy-to-break** *n.* The total energy required to rupture a yarn or cord.

**Engineering plastic** *n.* (1) A broad term covering those plastics, with or without fillers and reinforcements that have mechanical, chemical, electrical, and/or thermal properties suitable for industrial applications. R. B. Seymour, an outstanding authority, defined them as polymers thermoplastic or thermosetting, that maintain their dimensional stability and major mechanical properties in the temperature range 0–100°C. He listed the “big five” (among neat resins) as nylons, polycarbonate, acetals, polyphenylene ether, and thermoplastic polyesters. Among many others are acrylics, fluorocarbons, phenoxy, acrylonitrile–butadiene–styrene terpolymer, polyaryl either, polybutylene, chlorinated polyether, polyether, and many polymers reinforced with advanced fibers. At the high end of the spectrum of performance, usable temperature range, and price, unreinforced engineering plastics are dubbed advanced resins.

**Engineering plastics** *n.* Plastics which are modified by using modifiers, additives, fillers and reinforcements.

**Engineering polymers** *n.* Polymers referred to as "commodity thermoplastics", accounting for 85% of total plastics production. The major engineering polymers are ethylene, propylene, styrene, and vinyl chloride, which offer the optimum balance of easy processability and moderate properties at low cost.

**English gallon** *See imperial gallon.*

**English vermillion** *See mercuric sulfide.*

**Engraved-roll coating** *See gravure coating.*

**Engraving** (1601) *n.* Machine-printing (of wallpaper) with etched-out rollers to obtain subtle and fine-effects not possible with surface printing.

**Enhancement ratio** *n.* In a filled or reinforced plastic, the ratio of the modulus of the filled material to that of the neat resin. The ratio is likely to be higher at low strains than high strains because of slippage between filler and matrix.

**Enjay-butyl** *n.* Isobutylene/isoprene copolymer, manufactured by Enjay, USA.

**Enkatherm** *n.* Poly(terephthaloyl oxamidrazone), manufactured by AKZO, The Netherlands.

**Entangled yarns** *See compacted yarns.*

**Entangling** *n.* (1) A method of forming a fabric by wrapping and knotting fibers in a web about each other, by mechanical means, or by the use of jets of pressurized water, so as to bond the fibers (*also see hydroentangling and spunlaced fabric*). (2) *See intermingling.*

**Entering** *n.* The process of threading each warp yarn on a loom beam through a separate drop wire, heddle, and reed space in preparation for weaving. This process may be done by hand or by a semiautomatic machine.

**Enthalpy** \ˈen-ˌthal-pē\ *n* [*en-* + Gk *thalpein* to heat] (ca. 1924) (heat content) *n.* Thermodynamically, the enthalpy of a system is the sum of the internal energy and the pressure–volume product multiplied by the pressure $H = E + pv$ where $H$ is the enthalpy or heat content, $E$ the internal energy of the system, $p$ the pressure, and $v$ is the volume. We are usually concerned about changes in enthalpy rather than absolute values. Enthalpies of polymers are usually stated per unit mass, e.g., kJ/kg, and are ordinarily referred to room temperature, 20–25°C, at which temperature enthalpy is arbitrarily set to zero. The rate of change of enthalpy with temperature is heat capacity.

**Enthalpy ($H$)** *n.* A thermodynamic quantity, which is useful for describing heat exchanges taking place under constant-pressure conditions. The enthalpy of a system is defined as the sum of its energy, $E$, and its pressure–volume product: $H = E + pv$

**Enthalpy of formulation ($\Delta H_f$)** *n.* The enthalpy change for a reaction in which compound is formed from its uncombined elements.

**Entrance angle** (entry angle) *n.* In an extrusion diem the total included angle, never more than 180°, of the main converging surfaces of the flow channel leading to the land area of the die.

**Entropy, S** \ˈen-tre-pe\ [ISV $^{2}$*en-* + Gk *tropē* change, literally, turn, fr. *trepein* to turn]

(1875) *n.* (1) A measure of the unavailable energy in a thermodynamic system, commonly expressed in terms of its changes on an arbitrary scale, the entropy of water at 0°C being assigned the value of zero. (2) When a system (or sample of material) is heated or cooled from one temperature, $T_1$, to another $T_2$, the change in its entropy is given by the equation

$$\Delta S = \int_{T_1}^{T_2} \frac{dQ}{T}.$$

(3) Also, entropy is a thermodynamic quantity, which measures the degree of disorder or randomness in a system.

**Entropy, of elasticity** *n.* A measure of the unavailable energy in a closed thermodynamic system that is also usually considered to be a measure of the system's disorder and that is a property of the system's state and is related to it in such a manner that a reversible change in heat in the system produces a change in the measure which varies directly with the heat change and inversely with the absolute temperature at which the change takes place.

**Environment** \in-ˈvī-rə(n)-mənt\ (1827) *n.* The sum of all external conditions and influences affecting the life, development, and survival of an organism.

**Environmental protection agency (EPA)** *n.* Charged by the clean air amendments of 1970 to the air quality act of 1967 with establishing minimum air quality standards which must be incorporated in regional state standards. These standards are essentially similar to those first promulgated by the Los Angeles region of California in their Rule 66.

**Environmental stress cracking** *n.* The formation of internal or external cracks in a plastic caused by tensile stresses well below its short-time strength, and induced by exposure to heat, solvent vapor, or chemically active solutions. ASTM test F 1248 describes the measurement of the environmental stress-cracking resistance of polyethylene pipe in the presence of a surface-active agent. Other ASTM tests treating this subject are D 1693, D 2561, D 2951, and, in Section 15.03, F 484, F 791, and F 1164.

**Enzyme** \ˈen-ˌzīm\ [Gr *Enzym*, fr. MGk *enzymos* leavened, fr. Gk *en-* + *zymē* leaven] (1881) *n.* Any of numerous proteins or conjugated proteins produced by, and functioning as, biochemical catalysts in living organisms.

**EOS** Abbreviation for equation of state.

**Eosine** \ˈē-ə-sən\ [ISV, fr. Gk *ēōs* dawn] (1866) *n.* $C_{20}H_8Br_4O_5$. Red acid dye used in the manufacture of lake pigments. Sodium salt of brominated fluorescein.

*Also see phloxine.*

**EP** *n.* (1) Abbreviation for epoxy resin or epoxide. (2) (Usually E/P) Abbreviation sometimes used for copolymers of ethylene and propylene.

**EPA** *See environmental protection agency.*

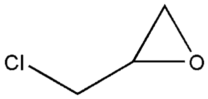
**EPDM** *n.* Elastomer from ethylene, propylene, and a diene. Abbreviation for elastomeric terpolymer from ethylene, propylene, and a conjugated diene.

*See ethylene–propylene rubber.*

**Epi-** (1) A prefix signifying a chemical compound or group differing from a parent compound or group by having a bridge connection. (2) EPI:

*See epichlorohydrin.*

**Epichlorohydrin** \ˌe-pi-ˌklōr-ə-ˈhī-drən\ (ca. 1891) (chloropropylene oxide, EPI) *n.* An active solvent for cellulosic and other resins, and a key reactant for epoxy resins having the structure shown below. EPI is highly reactive with polyhydric phenols such as bisphenol A and forms glycidyls with many compounds containing active hydrogens. Epichlorohydrin (ECH) is used primarily in the manufacture of epoxy resins and synthetic glycerol. The main other uses include the production of epichlorohydrin elastomers, polyamide–epichlorohydrin resins, water treatment chemicals, and a variety of glycidyl derivatives.



**Epichlorohydrin rubber (CO, CEO)** *n.* Any of several elastomers comprising polymers and copolymers of epichlorohydrin, with good high-temperature resistance, low-temperature flexibility, resistance to fuels, oils, and ozone, and low gas permeability. The homopolymer (CO) is a saturated, aliphatic polyether with a chloromethyl side chain. The ECO type is an equimolar copolymer of epichlorohydrin and ethylene oxide.

**Epikote** *n.* Epoxide resin, manufactured by Shell, The Netherlands.

**Episulfide** *n.* The sulfur analog of epoxides in which the sulfur is part of a ring. The two most important members are ethylene sulfide and propylene sulfide. Episulfides are starting materials for polysulfide rubber.

**Epitropic fibers** *n.* Fibers with an altered surface property, e.g., electrically conducting, abrasive, etc.

**EPM** *n.* Elastomer from ethylene and propylene. Abbreviation for ethylene–propylene rubber.

**Epon** *n.* Epoxide resin, manufactured by Shell, The Netherlands.

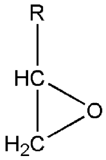
**Epoxidation** \(ˌ)e-ˌpäk-sə-ˈda-shən\ (1944) *n.* A chemical reaction in which an oxygen atom is joined to an olefinically unsaturated molecule to form a cyclic, three-membered either. The products of epoxidation are known as oiranes or epoxides.

**Epoxide** (1930) *n.* Any compound containing the oxirane structure, a three-membered ring containing two carbon atoms and one oxygen atom. The most important members are ethylene oxide and propylene oxide.

**Epoxide equivalent** *n.* The mass of resin in grams that contains 1 g-equivalent of epoxide.

**Epoxidized soybean oil** *See* epoxy plasticizer.

**Epoxy** [*epi-* + *oxy*] (1916) (epoxy group, oxirane group) *adj.* In textiles, a compound used in durable-press applications for white fabrics. It provides chlorine resistance but causes loss of tensile strength. A label denoting an oxygen atom joined in a ring with two carbon atoms, as shown below.



**Epoxy adduct** *n.* Resin having all the required amine incorporated but requiring additional epoxy resin for curing.

***β*-(3,4-Epoxycyclohexyl) ethyltrimethoxy silane** *n.* A coupling agent for reinforced polyester, epoxy, phenolic, melamine, and many thermoplastics.

**Epoxy ester** *n.* An epoxy resin partially esterified with fatty acids, rosin, etc.; single package epoxy.

**Epoxy foam** *n.* Two basic types of epoxy foams are in use, chemical foams and syntactic foams. Chemical-foam compositions contain the resin, curing agent, blowing agent, wetting agent, and a small percentage of an inert organic compound such as toluene to dissipate the exothermic heat of curing, and thus control the foaming action. Because foaming is rapid, the curing agent is withheld until all the other ingredients have been mixed, to be added just prior to casting. These systems may also contain amine-terminated polyamide resins to impart resiliency to the foam. In syntactic foams, the voids are provided by hollow phenolic microspheres and the resin does not foam but acts as a binder for the spheres. Epoxy foams are used in casting, in potting and encapsulating of electrical assemblies, in insulating coatings for chemical-storage tanks, and in cores of laminates for aircraft and boats.

**Epoxy–novolac resin** *n.* A two-step resin made by reacting epichlorohydrin with a phenol-formaldehyde condensate. Such resins are also known as thermoplastic, B-stage phenolic resins that are in a state of partial cure. Whereas bisphenol-based epoxy resins contain up to two epoxy groups per molecule, the epoxy novolacs may have seven or more such groups, producing more tightly crosslinked structures in the cured resins. Thus they are stronger and superior in other properties.

**Epoxy number** *n.* The number of gram-equivalents of epoxy groups per 100 g of polymer, equal to 1/100 of the reciprocal of the epoxides equivalent.

**Epoxy paint** *n.* Paint based on an epoxy resin.

**Epoxy plasticizer** (epoxides plasticizer) *n.* Any of a large family of plasticizers obtained by the epoxidation of vegetable oils or fatty acids. The two main types are (a) epoxidized unsaturated triglycerides, e.g., soybean oil and linseed oil; and (b) epoxidized esters of unsaturated fatty acids, e.g., oleic acid, or butyl-, octyl-, or decyl- esters. Most epoxy plasticizers have a heat-stabilizing effect and they are often used for stabilization in conjunction with other stabilizers. Epoxidized oils generally have good resistance to extrusion and migration and low volatility, but they cannot be used as sole plasticizers in unfilled vinyl compounds and hence are not considered to be primary plasticizers. Certain epoxidized soybean oils have been FDA-approved for food-contact use.

**Epoxy plastics** *n.* Plastics based on resins made by the reaction of epoxides or oxiranes with other materials such as amines, alcohols, phenols, carboxylic acids, acid anhydrides, and unsaturated compounds.

**Epoxy resin** (1950) *n.* Any of a family of thermosetting resins containing the oxirane group (*See epoxy for structure*). Originally made by condensing epichlorohydrin and bisphenol A, epoxy resins are not more generally formed from low-molecular-weight diglycidyl ethers of bisphenol A and modifications thereof; or, another type, by the oxidation of olefins with peracetic acid. Depending on molecular weight, the resins range from liquids to solids. The liquids, used for casting, potting, coating, and adhesives, are cured with amines, polyamides, anhydrides, or other catalysts. The solid resins are often modified with other resins and unsaturated fatty acids. Epoxy resins are widely used in reinforced plastics, have strong adhesion to glass fibers. Epoxies based on epoxidized heterocyclic hydantoin are useful in electrical composites because their thermal expansion coefficient can be matched to that of copper. Their low viscosities are effective in wetting the various reinforcing materials used with them. Fast-curing epoxies are based on the diglycidyl ether of 4-methylol resorcinol (DGEMR). The methylol group appears to effectively catalyze the curing reactions. This resin is curable with all types of conventional epoxy hardeners including aliphatic and aromatic amines, anhydrides, and amidoamines. DGEMR cures approximately thirty times as fast as a conventional bisphenol A epoxy and two to five times as fast as older fast-gelling epoxies, and at lower temperatures. DGEMR may be formulated with flexibilizers and fillers without prolonging gel time. These same properties make the resin well suited for adhesives, coatings, and low-temperature applications.

*See also epoxy–novolac resin.*

**Epoxy resins** *n.* Plastic or resinous materials used for strong, fast-setting adhesives, as heat resistant coatings and binders, etc. Cross-linking resins based on the reactivity of the epoxides group. One common type is the resin made from epichlorohydrin and bisphenol A. Aliphatic polyols such as glycerol may be used instead of the aromatic bisphenol A or bisphenol F.

**Epoxy stabilizer** (epoxides stabilizer) *n.* Most epoxy plasticizers also serve as stabilizers because of the ability of the epoxides group to accept HCl, or to serve as an intermediate, in the presence of metallic salts, to convert HCl to a metallic chloride. Epoxy stabilizers are most often used in conjunction with barium–cadmium and other stabilizers, with which they have a synergistic effect.

**EPR** *n.* Abbreviation for ethylene–propylene rubber.

**EPS** *n.* Abbreviation for expanded polystyrene. *See polystyrene foam.*

**Epsom salts** \ˈep-səm-\ [*Epsom*, England] (1876) *n.* $MgSO_4{\cdot}7H_2O$. Magnesium sulfate. Water-soluble magnesium salt for the preparation of precipitated soaps. Rhombic, colored or white; Sp gr, 1.68.

**Equalizer rod** A metal rod wound with a fine wire around its axis so that ink can be drawn down evenly and at a given thickness across a piece of paper.

*Also called a Meyer rod or bar. See wire-wound rod.*

**Equant** *n.* A shape having nearly equal dimensions.

**Equation of state (EOS)** *n.* For an ideal gas, if the pressure and temperature are constant, the volume of of the gas depends on the mass, or amount of gas. Then, a single property called the gas density (ratio of mass/volume). If the mass and temperature are held constant, the product of pressure and volume are observed to be nearly constant for a real gas. The product of pressure and volume is exactly for an ideal gas. This relationship between pressure and volume is called Boyle's Law. Finally, if the mass and pressure are held constant, the volume is directly proportional to the temperature for an ideal gas. This relationship is called Charles and Gay–Lussac's law. The gas laws of Boyle and Charles and Gay–Lussac can be combined into a single equation of state: $PV = nRT$, where $P$ is pressure, $V$ volume, $T$ absolute temperature, $n$ number of moles and $R$ is the universal gas constant. Anerodynamicists us a different form of the equation of state that is specialized of air. Regarding polymers and monomers, equation of state is an equation giving the specific volume ($v$) of a polymer from the known temperature and pressure and, sometimes, from its morphological form. An early example is the modified Van der Waals form, successfully tested on amorphous and molten polymers. The equation is:

$$v = b + RT/M(P + \pi),$$

where $b$ is the "unfree" specific volume occupied by the polymer molecules, roughly above 90% of $V$, $R$ the universal molar-energy constant, $T$ the absolute temperature, $P$ is the pressure, $M$ an empirical molecular weight that for several thermoplastics has been closely equal to the mer weight, and $\pi$ is an empirical internal pressure much larger than the highest injection-molding pressures. A number of more complex models have since been introduced and tested against experimental data. Atkins PW, Atkins P, De Paula J (2001) Physical chemistry. W. H. Freeman Co., New York. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Equilibrium** \ˌē -kwə-ˈli-brē-əm\ [L *aequilbrium*, fr. *aequilibris* being in equilibrium, fr. *aequi-* + *libra*, weight, balance] (1608) *n.* A state of balance between opposing forces or actions that is either static (as in a body acted on by forces whose resultant is zero) or dynamic (as in a reversible chemical reaction when the velocities in both directions are equal) Chemical: a state of affairs in which a chemical reaction and its reverse reaction are taking place at equal velocities, so that the concentrations of reacting substances remain constant.

**Equilibrium condition** *n.* The condition, that the mass-action expression equals the value of the equilibrium constant for a reaction, which is satisfied when the reaction system is at equilibrium.

**Equilibrium constant** (1929) *n.* The product of the concentrations (or activities) of the substances produced at equilibrium in a chemical reaction divided by the product of concentrations of the reacting substances, which concentration raised to that power which is the coefficient of the substance in the chemical equation.

**Equivalence point** \i-ˈkwiv-lən(t)s ˈpóint\ *n.* The state in a titration at which equal numbers of equivalents of reactants and products have been mixed.

**Equivalent, acid–base** *n.* The quantity of an acid (or base), which will furnish (or react with) 1 mol of $H^+$.

**Equivalent conductance** *n.* The equivalent conductance of an electrolyte is defined as the conductance of a volume of solution containing one equivalent weight of dissolved substance when placed between two parallel electrodes 1 cm apart, and large enough to contain between them all of the solution. $\Lambda$ is never determined directly, but is calculated from a specific conductance. If $C$ is the concentration per cubic centimeter is $C/1000$, and the volume containing one equivalent of the solute is, therefore, $1000/C$. Since, $L_s$ is the conductance of a centimeter cube of the solution, the conductance of $1000/C$ cc, and hence $\Lambda$ will be

$$\Lambda = \frac{1000 L_s}{C}.$$

**Equivalent, redox** *n.* The quantity of an oxidizing agent (or a reducing agent) which will accept (or furnish) 1 mol of electrons.

**Equivalent single yarn number** *See yarn number, equivalent single.*

**Equivalent weight** (1904) (combining weight, equivalent mass) *n.* The atomic or formula weight of a given element or ion divided by its valence in a reaction under consideration. Elements entering into combination always do so in quantities proportional to their equivalent weights. In oxidation–reduction reactions the equivalent weights of the reacting entities are dependent upon the change in oxidation numbers of the particular substances.

**Erioglaucine dye** *See acid dyes.*

**Erlangen blue** *n.* Another name for Prussian blue.

**Erode** \i-ˈrōd\ [L *erodere* to eat away, fr. *e-* + *rodere* to gnaw] (1612) *v.*
*See etch.*

**Erosion** (1541) *n.* (1) Wearing away of the top coating of a painted surface, e.g., by chalking or by the abrasive action of windborne particles of grit, which may result in exposure of the underlying surface. (2) Phenomenon manifested in paint films by the wearing away of the finish to expose the substrate or undercoat. The degree of failure is dependent on the amount of substrate or undercoat visible. Erosion occurs as the result of chalking or by the abrasive action of windborne particles of grit.

**Erosion breakdown** *n.* In an electrical-conductor insulation, deterioration caused by chemical attack of corrosive chemicals such as ozone and nitric acid that are formed by corona discharge from a high-voltage cable. This breakdown can occur even the most chemically polymers, such as fluorocarbons, after long exposure to the condition.

**Erosion control fabrics** *See geotextiles.*

**Erosion resistance** *n.* The ability of a coating to withstand being gradually worn away by chalking or by the abrasive action of water or windborne particles of grit. The degree of resistance is dependent upon the amount of coating retained.
*See erosion.*

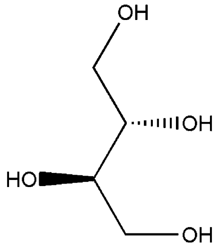
**Erucamide** *n.* $CH_3(CH_2)_7CH{=}CH(CH_2)_{11}COONH_2$. The amide of *cis*-13-docosenoic acid, used in fractional percentages as a slip agent in polyethylene film resins.

**Erucyl alcohol** *n.* $CH_3(CH_2)_7CH{=}CH(CH_2)_{11}CH_2OH$. A monounsaturated, fatty alcohol used as a mold lubricant.

**Erucic acid** \i-ˈrü-sik-\ [NL *Eruca*, genus of herbs, fr. L, colewort] (1869) *n.* $CH_3(CH_2)_7CH{=}CH(CH_2)_{11}COOH$. Unsaturated fatty acid found in many vegetable oils. Properties: mp, 33°C; bp, 281°C/30 mmHg; Sp gr, 0.860/55°C; and iodine value, 75.2. *Also known as cis-13-docosenoic acid.*

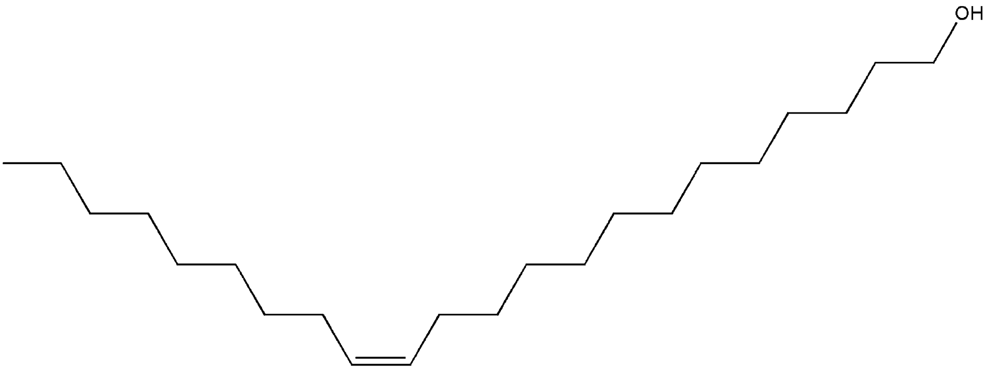
**Erythrene** *n.* 1-3 butadiene. Old syn: butadiene.

**Erythritol** *n.* $H(CHOH)_4H$. Tetrahydric alcohol. Properties: mp, 112°C; bp, 330°C.



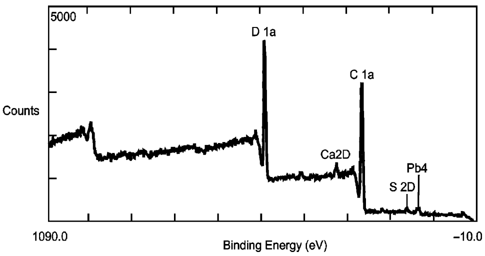
**ESC** *n.* Abbreviation for environmental stress cracking.

**ESCA** Energy spectroscopy chemical analysis. An example of an ESCA spectrum for



Erucic acid

chloride is shown. Siegbahn K (1967) ESCA, atomic, molecular and solid state structure studied by means of electron spectroscopy. Almquist & Siks, Uppsala, Sweden.



**Escaping tendency** *n.* The tendency shown by a substance to escape from its phase to another.

**ESO** *n.* Abbreviation for epoxidized soybean oil.

*See epoxy plasticizers.*

**Esparto wax** \is-ˈpär-(ˌ)tō-\. Hard vegetable wax obtained from esparto grass, indigenous to North Africa and parts of Spain. It is used to some extent as a substitute for carnauba, candellia and similar hard waxes. Properties: mp, approximately 71°C; acid value, 30, saponification value, 75.

**ESR** *n.* Abbreviation for electron-spin-resonance spectroscopy.

**Essential oils** *n.* Volatile oils or essences derived from vegetation and characterized by distinctive odors and a substantial measure of resistance to hydrolysis. Chemically, essential oils are often principally terpenes. Some essential oils are nearly pure single compounds. Some contain resins in solution and are then called oleoresins or balsams. Shahidi F, Bailey AE (eds) (2005) Bailey's industrial oil and fat products. John Wiley and Sons, New York. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Philadelphia, PA, 2001.

**Estane** *n.* Polyurethane. Manufactured by Goodrich, USA.

**Ester** \ˈes-tər\ [Gr. fr. *Essigäther* ethyl acetate, fr. *Essig* vinegar + *Äther* ether] (ca. 1852) *n.* An organic compound with the general formula R–C–O–R′ analogous to an inorganic salt. Esters are formed by reacting an acid with an alcohol, or by the exchange of a replaceable hydrogen atom of an acid for an organic alkyl radical. Esters of many monofunctional alcohols and organic acids are oily, fruity-smelling liquids, forming important families of solvents and plasticizers. When the alcohol selected is polyfunctional, that is, contains two or more –OH groups, and the acid is di- or polybasic, long chains of repeating units can be formed by their reaction. These are polyesters.

**Ester gum** *n.* Resin made from rosin or rosin acids and a polyhydric alcohol, such as glycerol or pentaerythritol. Used as an ingredient in certain printing ink varnishes. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Esterification** \-ˌster-ə-tə-ˈkā-shən\ (ca. 1905) *n.* The chemical process of combining an acid and an alcohol to form an ester. Cellulose acetate is an ester formed by the reaction of acetic acid and the hydroxyl groups of cellulose. Polyethylene terephthalate, the most common fiber-forming polyester, is a product of esterification of terephthalic acid with ethylene glycol. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Ester interchange** (ester exchange) *n.* A reaction between an ester and another compound in which occurs an exchange of alkoxy or acyl groups, resulting in the formation of a different ester. When an ester is reacted with an alcohol, the process is called alcoholysis; reaction between an ester and an acid is called acidolysis. Tester interchanges are used in producing plasticizers, polyvinyl alcohol, acrylics, polyesters, and polycarbonates. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

*See transesterification.*

**Ester number** *n.* Difference between the saponification value and the acid number. Therefore, it is the number of mg of potassium hydroxide necessary to saponify the neutral esters in 1 g of fat, wax, or oil.

**Esters** *n.* A class of organic liquids, used as solvents, which are the products of the reactions of organic acids and alcohols. Examples are ethyl acetate, dioctyl phthalate.

**Esthetics** *See aesthetics.*

**Eta** ($\eta$) *n.* Greek letter; symbol for absolute viscosity.

**Etch** \ˈech\ [D *etsen*, fr. Gr. *ätzen* to etch, corrode, fr. OH Gr *azzen* to feed; akin to OH Gr *ezzan* to eat] (1634) *v.* Wear away or roughen a surface with, or as if with, an acid. Erode is sometimes used as a synonym.

**Etching** (1634) *v.* (1) In lithography, the use of acidic substances to produce a surface in the non-printing areas that is receptive to the fountain solution but not to the ink. (2) In engraving, a treatment with acid or by mechanical means to make certain areas considerably lower than the surface of the engraving.

*See printing, burn-out printing.*

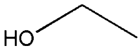
**Etching primer** *See wash primer.*

**ETFE** *n.* Abbreviation for ethylene–tetrafluoroethylene co-polymer.

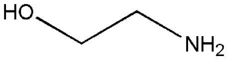
**Ethanal** Syn: acetaldehyde.

**Ethanite** *n.* Synthetic rubber made by the interaction of potassium polysulfide and ethylene dichloride.

**Ethanol** \ˈe-thə-ˌnól, -ˌnōl, *British also* ˈē-\ *n* (1900) *n.* Syn: ethyl alcohol.



**Ethanolamine** \ˌe-thə-ˈnä-lə-ˌmēn\ (1897) *n.* $NH_2(CH_2)_2OH$. Bp, 171°C/150 mmHg. Known also as monoethanolamine, colamine, 2-amino ethanol, and betahyroxyamine.



**Ethanolurea** *n.* $NH_2CONHCH_2CH_2OH$. A white compound melting at 71–74°C. It condenses with formaldehyde to form permanently thermoplastic, water-soluble resins. Simple urea can be incorporated in the condensation reaction to give modified resins with any desired degree of water solubility and flexibility, both of which properties increase with urea content.

**Ethene** \ˈe-ˌthēn\ (1873) *n.* IUPAC's name for ethylene.

**Ethenoid plastics** *n.* (1) Plastics made from monomers containing the polymerizable double-bond group C=C, for example ethylene. Thermosetting ethenoid resins are made from monomers for linear polymers capable of giving crosslinked structures as a result of double-bond polymerization. (2) A British generic term that includes acrylic, vinyl, and styrene plastics.

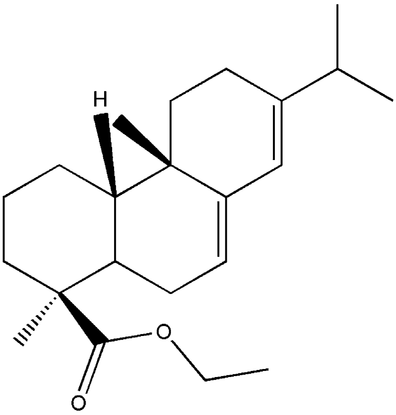
**Ether** \ˈē-thər\ [ME, fr. L *aether*, fr. Gk *aithēr*, fr. *aithein* to ignitem blaze; akin to OE *ād* pyre] (14c) *n.* (1) Any organic compound in which an oxygen atom is interposed between two carbon atoms or organic radicals in the molecular structure. Ethers are often derived from alcohols by elimination of one molecule of water from two molecules of alcohol. (2) Specifically, diethyl ether $(C_2H_5)_2O$.

**Etherified urea resins** *n.* Urea resins in which the methylol groups have been etherified with suitable alcohols. Alcohols commonly used include butyl and octyl alcohols. The etherified resins are characterized by improved hydrocarbon tolerance, some types permitting substantial additions of aliphatic hydrocarbons.

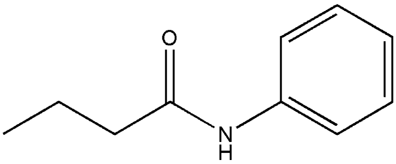
**Ethocel** *n.* Cellulose ether, manufactured by Dow, USA.

**Ethyl** \ˈe-thəl\ [Gr *Ethyl* (now *Äthyl*), fr. *Äther* ether + *-yl*] (1838) *n.* $-C_2H_5$. Monovalent alkyl radical.

**Ethyl abietate** *n.* $C_{19}H_{29}COOC_2H_5$. Amber colored viscous liquid, which hardens upon oxidation. Properties: bp, 350°C; Sp gr. 1.03; flp, 171°C (340°F).

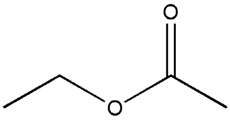


**Ethyl acetanilide** (ethyl phenylacetamide) *n.* A substitute for camphor in the manufacture of celluloid.

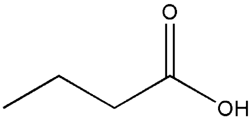


***n*-Ethyl acetanilide** *n.* $C_6H_5N(C_2H_5)CO$ $CH_3$. Properties: bp, 258°C; flp, 124°C (255°F). Substitute for camphor in the nitrocellulose industries.

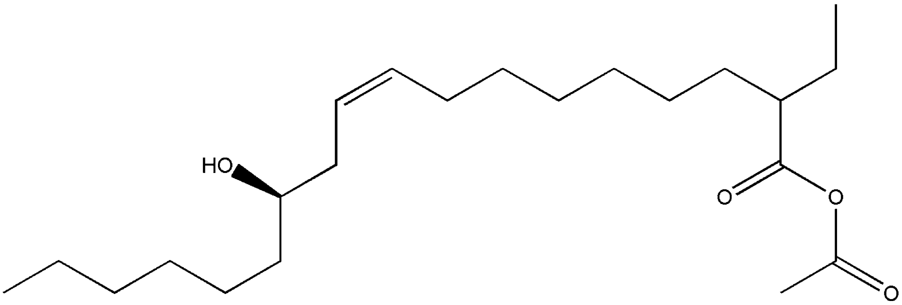
**Ethyl acetate** (1874) *n.* $CH_3COOC_2H_5$. A colorless liquid made by heating acetic acid and ethyl alcohol in the presence of sulfuric acid, then distilling. It is a powerful solvent for ethyl cellulose, polyvinyl acetate, cellulose acetate–butyrate, acrylics, polystyrene, and coumarone–indene resins. It is also used in flexographic and rotogravure inks. Although it is highly flammable, it is the least toxic of common industrial solvents. Properties: bp, 77°C; Sp gr, 0.901/20°C; flp. 0.56°C (31°F); refractive index, 1.373; vp, 77 mmHg/20°C. Also known as acetic ether and acetic ester.



**Ethylacetic acid** *n.* Syn: butyric acid.

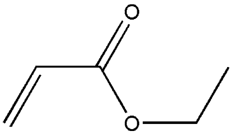


**Ethyl acetyl ricinoleate** *n.* $C_{17}H_{32}$ $(OCOCH_3)$ $COOC_2H_5$. Properties: bp, 400°C; Sp gr, 0.931.



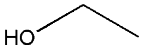
**Ethyl acetyl ricinoleate**

**Ethyl acrylate** *n.* $CH_2{=}CHCOOC_2H_5$. A colorless liquid, insoluble in water; miscible with most organic solvents. Used in the manufacture of synthetic resins. Sp gr, 0.9283; bp, 101°C.



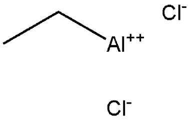
**Ethyl alcohol** (1869) (alcohol, ethanol, and grain alcohol) *n.* An alcohol used, in denatured form, as a solvent for ethyl cellulose, polyvinyl acetate, and polyvinyl butyrate. The industrial grade of undenatured alcohol usually contains 5 wt% water. Properties: bp, 78°C; Sp gr. 0.7938/15°C; refractive index, 1.367. The pure compound is called absolute alcohol.

*Also known as alcohol, grain alcohol, ethanol, fermentation alcohol, spirit of wind, ethyl hydroxide, cologne sprits, and EtOH.*



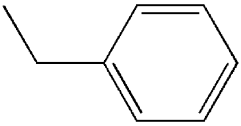
**Ethyl aldehyde** *n.* Syn: acetaldehyde.

**Ethyl aluminum dichloride** *n.* $C_2H_5AlCl_2$. A clear, yellow, flammable liquid, a catalyst for olefin polymerization.

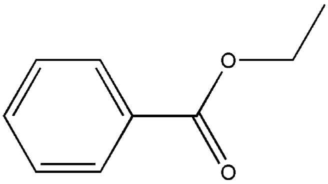


**Ethyl aluminum sesquichloride** *n.* $(C_2H_5)_3Al_2Cl_3$. A catalyst for olefin polymerization.

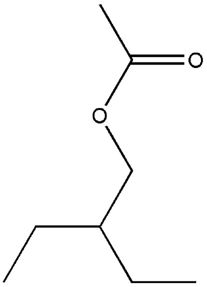
**Ethylbenzene** \ˌe-thil-ˈben-ˌzēn\ [ISV] (1873) *n.* Colorless liquid with an aromatic odor. Used as an intermediate in styrene production and as a solvent. Properties: molecular weight, 106.16; bp, 136°C; Sp gr, 0.8673.



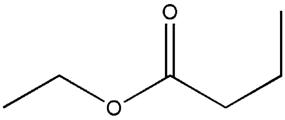
**Ethyl benzoate** (benzoic ether) *n.* A colorless liquid derived by heating ethyl alcohol and benzoic acid in the presence of sulfuric acid. It is a solvent for cellulosics.



**2-Ethylbutyl acetate** *n.* A solvent for cellulose nitrate.

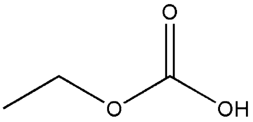


**Ethyl butyrate** (ethyl butanoate) *n.* A solvent for cellulosics.



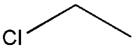
**Ethyl carbamate** *n.* Syn: urethane.

**Ethyl carbonate** (glycol carbonate, 1,3-dioxolan-2-one) *n.* A solvent for many polymers and resins. Syn: diethyl carbonate.



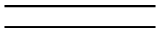
**Ethyl cellulose** (1936) (EC) *n.* An ethyl ether of cellulose formed by reacting cellulose steeped in alkali with ethyl chloride; it is a white granular thermoplastic resin. Since the repeating units are etheric, it is chemically different from other cellulosics, which are esters, and is therefore not compatible with them. EC resin can be injection molded, extruded, cast into film, or used as a coating material. It has the lowest density of all cellulosic plastics, good toughness and impact resistance, and is dimensionally stable over a wide temperature range. Syn: carbitol.

**Ethyl chloride** (ca. 1891) (chloroethane) *n.* A colorless gas at ambient conditions, used in the production of ethyl cellulose by reaction with sodium cellulose.



**Ethyl citrate** *See triethyl citrate.*

**Ethylene (Ethene)** (bicarburetted hydrogen, ethene) *n.* A colorless, flammable gas derived by cracking petroleum and by distillation from natural gas. In addition to serving as the monomer for polyethylene, it has many uses in the plastics industry including the synthesis of ethylene oxide, ethyl alcohol, ethylene glycol (used in making alkyd and polyester resins), ethyl chloride, and other ethyl esters. Properties: molecular weight, 28; bp, −1.025°C; Sp gr of liquid, 0.610/0°C.

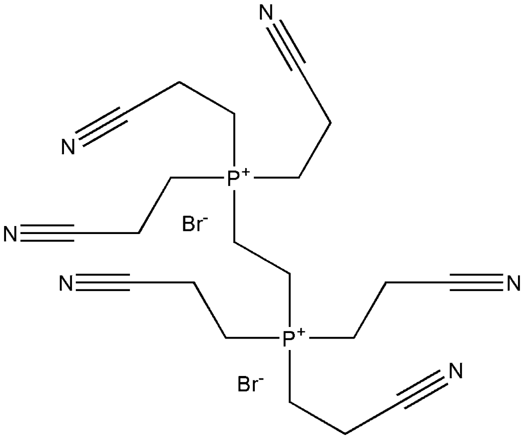


**Ethylene-acid copolymer resins** *n.* Resins that are flexible, specialty thermoplastics created by high-pressure copolymerization of ethylene (E) and methacrylic acid (MAA) or acrylic acid (AA).

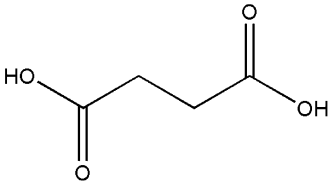
**Ethylene–acrylic acid copolymer (EAA)** *n.* Either of the block or random copolymers of ethylene and acrylic acid whose ionic character gives strong adhesion to metals and other surfaces. Their toughness has created uses in multilayer packaging films and golf-ball covers. Two trade names are DuPont's Surlyn® (block) and Dow's EAA (random).

***N,N′*-Ethylene bis-stearamide** (Acrawax C®) *n.* A lubricant used in acrylonitrile–butadiene–styrene resins, PVC, and polystyrenes.

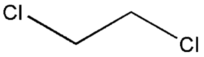
**Ethylene-bis tris-(2-cyanoethyl) phosphonium bromide (ECPB)** *n.* A flame retardant for thermoplastics. In polymethyl methacrylate, 20% ECPB caused the resin to become opaque and reduced its burning rate to zero.



**Ethylene carboxylic acid** *n.* A little used Syn: acrylic acid.



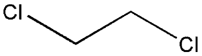
**Ethylene chloride** *n.* Syn: ethylene dichloride.



**Ethylene chlorotrifluoroethylene copolymer (ECTFE, E/CTFE)** *n.* A fluoroplastic with good mechanical, thermal, electrical, processing, and resistance properties.

**Ethylene dichloride** *n.* $ClCH_2CH_2Cl$. Colorless, oily liquid used for metal degreasing; paint and varnish remover. Properties: bp, 83°C; Sp gr, 1.252/20°C; vp, 65 mmHg/20°C; mol wt. 99.

*Also known as 1,2-dichlorethane.*



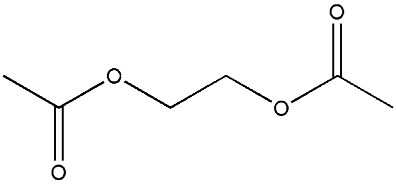
**Ethylene–ethyl acrylate copolymer (EEA, E/EA)** *n.* A family of elastomeric resins similar in appearance to polyethylene, but possessing properties like those of rubber and flexible vinyls.

**Ethylene–ethyl acrylate resins ethylene glycol** *n.* $CH_2OHCH_2OH$. A type of alcohol, completely miscible in water, used in latex and water-based paints to provide stability when frozen; used in heating and cooling systems as a fluid for transferring heat. Bp; 197°C; Sp gr, 1.12/4°C; flp, 111°C (232°F). Used as a diol in manufacturing resins.

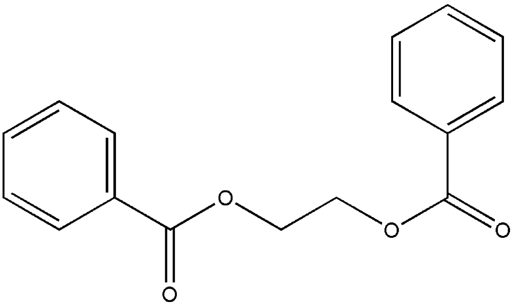
*Also known as ethylene alcohol.*

**Ethylene glycol** (1901) (ethanediol, ethylene alcohol, and glycol) *n.* $HOCH_2CH_2$–OH. A clear, syrupy liquid used as a solvent for cellulosics, particularly cellophane, and in the production of alkyd resins and polyethylene terephthalate.

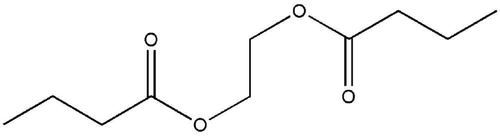
**Ethylene glycol diacetate** *n.* A very slowly evaporating solvent for cellulosic and acrylic resins, sometimes used as a fugitive plasticizer for vinyls and acrylics.



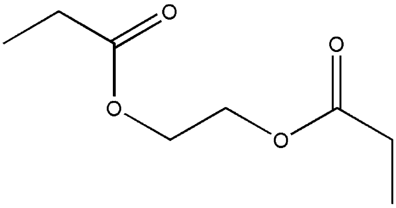
**Ethylene glycol dibenzoate** *n.* A plasticizer for cellulosic resins, having limited compatibility with some vinyl resins.



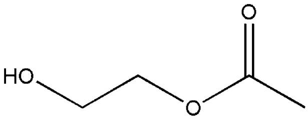
**Ethylene glycol dibutyrate** (glycol dibutyrate). A plasticizer for cellulosic plastics.



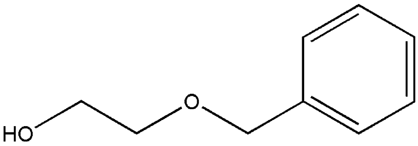
**Ethylene glycol dipropionate** (glycol propionate) *n.* A plasticizer for cellulosic resins.



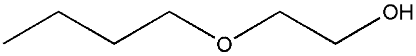
**Ethylene glycol monoacetate** (glycol monoacetate). A solvent for cellulose nitrate and cellulose acetate.



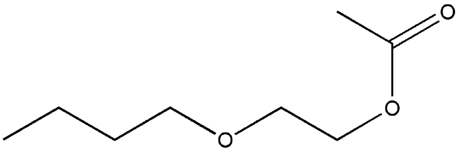
**Ethylene glycol monobenzyl ether** (benzyl cellosolve) *n.* A solvent for cellulose acetate.



**Ethylene glycol monobutyl ether** (2-butoxyethanol, butyl cellosolve) *n.* A colorless liquid used as a solvent for cellulosic, phenolic, alkyd, and epoxy resins, especially in varnish and other coating formulations.



**Ethylene glycol monobutyl ether acetate** *n.* A colorless liquid with a fruity aroma, used as a high-boiling solvent for cellulose nitrate, epoxy resins, and as a film-coalescing aid for polyvinyl-acetate latex.

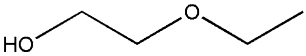


**Ethylene glycol monobutyl ether laurate** *n.* A plasticizer for cellulosics, polystyrene, and vinyls.

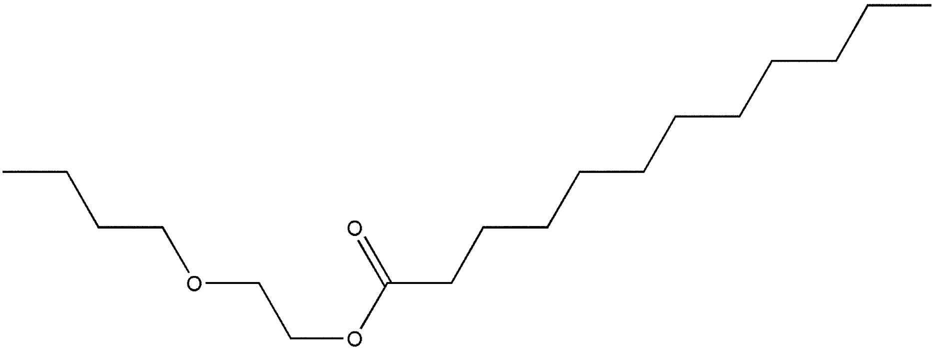
**Ethylene glycol monobutyl ether oleate** *n.* A plasticizer for cellulose nitrate, ethyl cellulose, and PVC.

**Ethylene glycol monobutyl ether stearate** *n.* A plasticizer for cellulose nitrate, ethyl cellulose, polystyrene, and polyvinyl butyral.

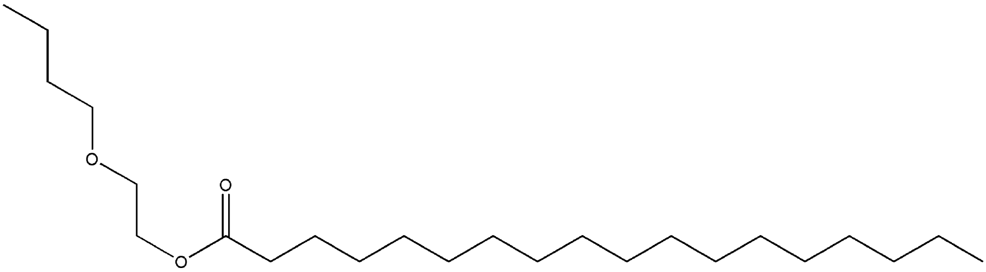
**Ethylene glycol monoethyl ether** (cellosolve, ethyl cellosolve) *n.* A solvent for cellulose nitrate, phenolic, alkyd, and epoxy resins. It is colorless, nearly odorless, has a low evaporation rate, and imparts good flow properties to coatings.



**Ethylene glycol monoethyl ether acetate** (cellosolve acetate) *n.* $C_2H_5OC_2H_4OOCCH_3$. A solvent for cellulose nitrate, ethyl cellulose, vinyl polymers, and copolymers, polymethyl methacrylate,



Ethylene glycol monobutyl ether laurate



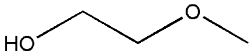
Ethylene glycol monobutyl ether stearate polystyrene, epoxy, coumarone–indene and alkyd resins.

**Ethylene glycol monoethyl ether laurate** *n.* A plasticizer for cellulosic and vinyl resins, and polystyrene.

**Ethylene glycol monoethyl ether ricinoleate** *n.* A plasticizer.

**Ethylene glycol monomethyl ester** *n.* $CH_3OC_2H_4OOCC_{17}\text{–}H_{35}$. A plasticizer for cellulosics and polystyrene, having limited compatibility with other thermoplastics.

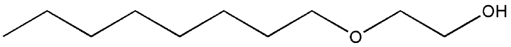
**Ethylene glycol monomethyl ether** (2-methoxyethanol, methyl cellosolve) *n.* A solvent for cellulose esters.

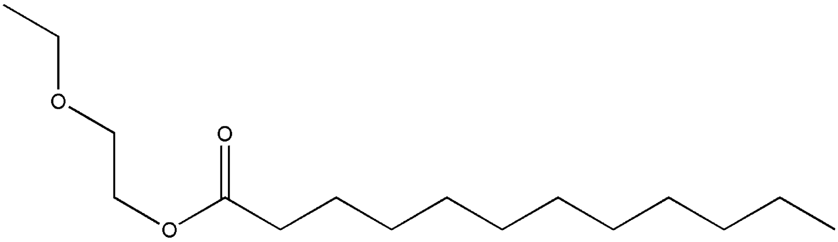


**Ethylene glycol monomethyl ether myristate** *n.* A plasticizer for cellulosic plastics, PVC, and polyvinyl butyral.

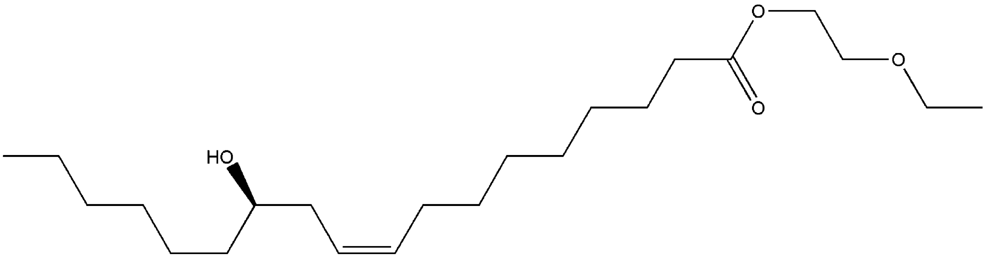
**Ethylene glycol monomethyl ether oleate** *n.* A plasticizer for cellulosic and vinyl resins.

**Ethylene glycol monooctyl ether** *n.* A solvent for cellulose esters, and a plasticizer.

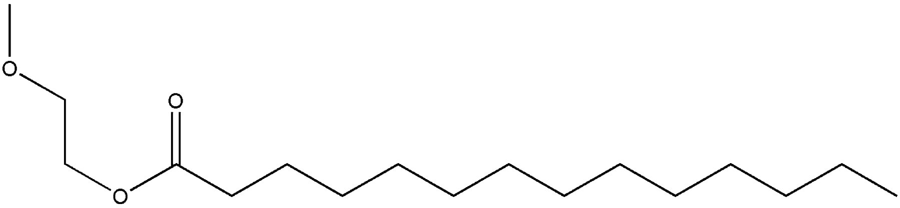




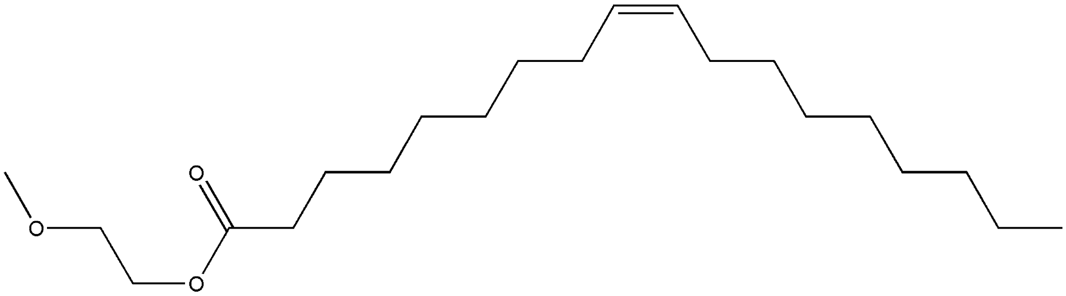
Ethylene glycol monoethyl ether laurate



Ethylene glycol monoethyl ether ricinoleate

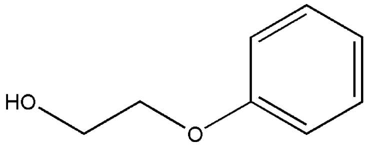


Ethylene glycol monomethyl ether myristate



Ethylene glycol monomethyl ether oleate

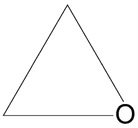
**Ethylene glycol monophenyl ether** *n.* A solvent for cellulosics, vinyls, phenolics, and alkyd resins.



**Ethylene glycol monoricinoleate** (ethylene glycol ricinoleate) *n.* Plasticizer and an intermediate for urethane polymers.

**Ethylene–methyl acrylate copolymer (EA, E/EA)** *n.* An elastomer vulcanizable with peroxides or diamines. It resists attack by oils and temperatures to 175°C.

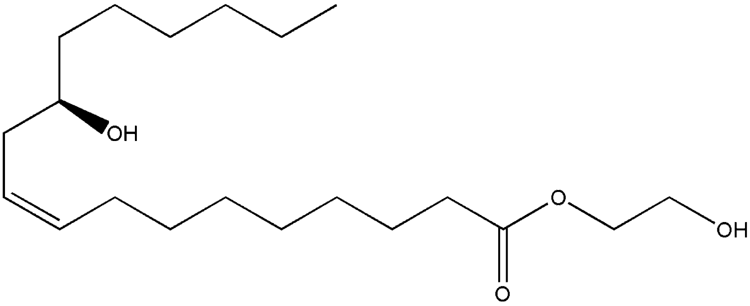
**Ethylene oxide** (1898) (epoxyethane) *n.* A three-membered ring compound with the formula $H_2COCH_2$, colorless, flammable gas at ordinary room temperature and pressure. It is used in organic synthesis, especially in the production of ethylene glycol and it is the starting material for the manufacture of acrylonitrile and nonionic surfactants. Bp, 10.7°C; Sp gr, 0.869. Syn: oxirane and anprolene.



**Ethylene plastic** *See polyethylene.*

**Ethylene, polymerization** *n.* A chemical reaction in which two or more molecules combine to form larger molecules that contain repeating structural units.

**Ethylene–propylene rubber (E/P, EPDM, SPM, and EPR)** *n.* Any of a group of elastomers obtained by the stereospecific copolymerization of ethylene and propylene (EOM, or of these two monomers and a third monomer such as an unconjugated diene (EPDM). Their properties are similar to those of natural rubber in many respects, and they have been proposed as



Ethylene glycol monoricinoleate

potential substitutes for natural rubber in tires.

**Ethylene–tetrafluoroethylene copolymer** *n.* A copolymer of ethylene and tetrafluoroethylene (DuPont Tefzel®), ETFE is readily processed by extrusion and injection molding. It has excellent resistance to heat, abrasion, chemicals, and impact, with good electrical properties.

**Ethylene–urea resin** *n.* A type of amino resin.

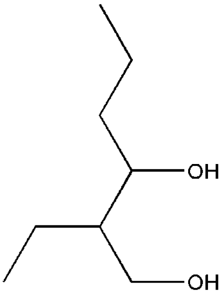
**Ethylene–vinyl acetate copolymer (EVA, E/VAC)** *n.* Any copolymer containing mainly ethylene with minor proportions of vinyl acetate. They retain many of the properties of polyethylene but have considerably increased flexibility, elongation and impact resistance. They resemble elastomers in many ways, but can be processed as thermoplastics.

**Ethylene–vinyl acrylate resins** *n.* Co-polymers of the polyolefins family derived from random co-polymerization of acetate and ethylene.

**Ethylene–vinyl alcohol copolymer (EVAL, E/VAL, and EVOH)** *n.* A family of copolymers made by hydrolyzing ethylene–vinyl acetate copolymers with high VA content. Those containing about 20–35% ethylene are useful as barriers to many vapors and gases, though not to water. Because of their water sensitivity, they are usually sandwiched between layers of other polymers.

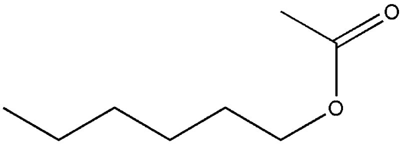
**Ethyl formate** *n.* Solvent for cellulose acetate.

**2-Ethyl-1,3-hexanediol** *n.* A stable, colorless, nearly odorless, a high-boiling liquid with weak solvent action. In two-part urethane systems, the material acts as a viscosity reducer at room temperature. When the urethane mixture is heated to cure it, the diol reacts into the urethane matrix to eliminate solvent emissions.

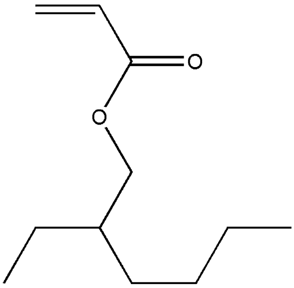


**2-Ethylhexyl-** *n.* An eight-carbon branched-chain radical of the formula $C_4H_9CH(C_2H_5)CH_2$–, often called *octyl* in the plastics industry. For example, the common plasticizer di-2-ethylhexyl phthalate is commonly referred to as dioctyl phthalate and by its abbreviation, DOP.

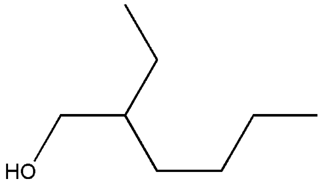
**2-Ethylhexyl acetate** (octyl acetate) *n.* A high-boiling retarder solvent with low evaporation rate and limited water solubility, used primarily in coating formulations based on cellulose nitrate. It is also used as a dispersant in vinyl organosols.



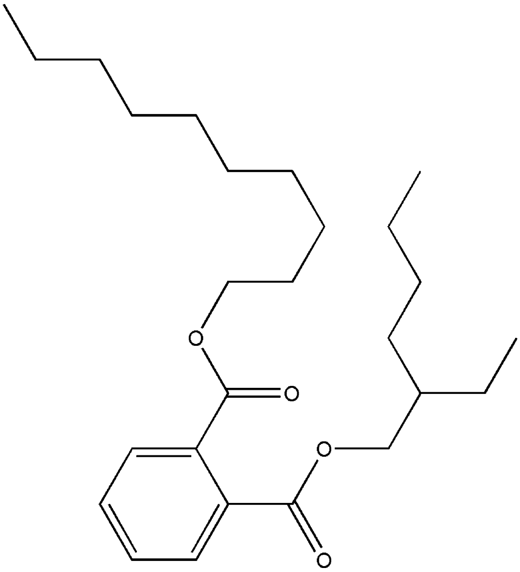
**2-Ethylhexyl acrylate** *n.* One of the monomers for acrylic resins, especially for those used in water-based paints.



**2-Ethylhexyl alcohol** (2-ethylhexanol, octyl alcohol) *n.* $C_4H_9CH(C_2–H_5)CH_2OH$. An involatile solvent with many uses in the plastics industry. As a solvent, it is used in coatings for stenciling, silk screening, and dipping. As an intermediate, the alcohol is an important raw material for the production of the 2-ethylhexyl esters of dibasic acids used as plasticizers, such as dioctyl phthalate, adipate, and azelate.

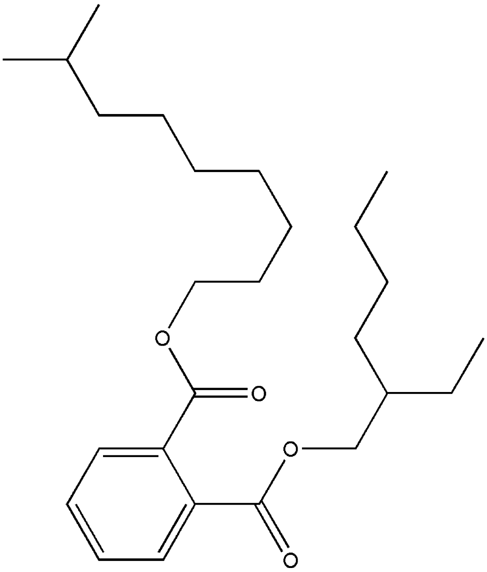


**2-Ethylhexyl decyl phthalate** *n.* A mixed diester plasticizer for cellulosics, polystyrene, PVC, and polyvinyl acetate.

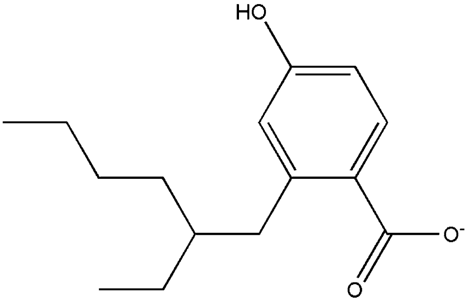


**2-Ethylhexyl epoxytallate** *n.* An epoxy ester used mainly as a combined plasticizer and stabilizer in vinyl compounds. At concentrations as low as 5 phr it reacts synergistically with many metallic stabilizers to provide stability comparable to similar combinations based on epoxidized soybean oils. As a partial replacement for other plasticizers, it imparts good low-temperature flexibility. It is also compatible with vinyl chloride–vinyl acetate copolymers, high-butyral cellulose acetate–butyrate resins, ethyl cellulose, polystyrene, and chlorinated rubbers.

**2-Ethylhexyl isodecyl phthalate** (octyl isodecyl phthalate) *n.* $C_8H_{17}$–$OOCC_6H_4COOC_{10}H_{21}$. A mixed ester compatible with PVC, vinyl chloride–acetate copolymers, cellulose acetate–butyrates with higher butyrate contents, cellulose nitrate, and, in lower concentrations, with polyvinyl butyral. In vinyls, it is somewhat less volatile than dioctyl phthalate and has equivalent low-temperature properties.



**2-Ethylhexyl-*p*-hydroxybenzoate** *n.* A plasticizer for polyamides.

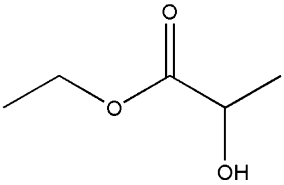


**Ethyl hydroxide** *See ethyl alcohol.*

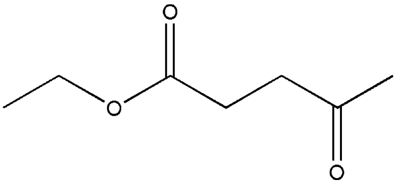
**Ethyl-α-hydroxyisobutyrate** *n.* $C_2H_5OOC(OH)C(CH_3)_2$. A solvent for cellulose nitrate and cellulose acetate.

**Ethylidene acetobenzoate** (ethylidene benzoacetate) *n.* $C_6H_5COO(CH_3–CH)COCH_3$. A solvent for cellulosics and synthetic resins.

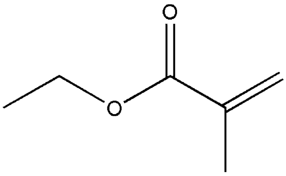
**Ethyl lactate** *n.* $CH_3CH(OH)COOC_2H_5$. Used as a solvent for nitrocellulose and cellulose acetate. Colorless liquid with a mold odor. Properties: mol wt. 118; bp, 154°C; Sp gr, 1.024/20°C; flp, 45°C (113°F); refractive index, 1.4111; vp. 5 minHg/233°C.



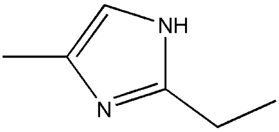
**Ethyl levulinate** *n.* $C_2H_5OOC(CH_2)_2COCH_3$. A solvent for cellulose acetate.



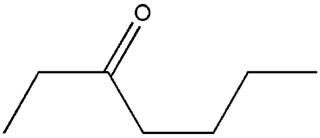
**Ethyl methacrylate** *n.* A readily polymerizable monomer used for certain types of acrylic resins.



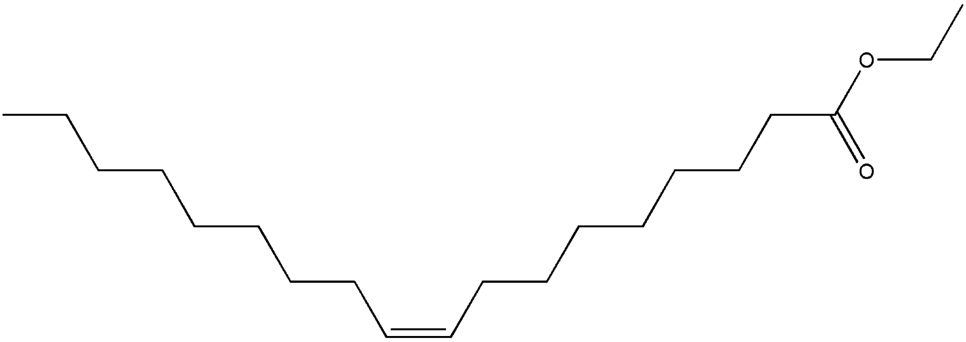
**2-Ethyl-4-methylimidazole (EMI)** *n.* An epoxy resin curing agent with the heterocyclic structure. EMI is used with epoxies formed from epichlorohydrin and bisphenol A or -F, and for novolac epoxy resins. It provides ease of compounding, long pot life, low viscosity, and non-staining characteristics, and yields castings with excellent mechanical and electrical properties.



**Ethyl-*n*-butyl ketone** (2-heptanone) *n.* A stable, colorless liquid with medium volatility, used in solvent mixtures for cellulosic and vinyl resins. When used in vinyl organosols it imparts good lone-time viscosity stability.

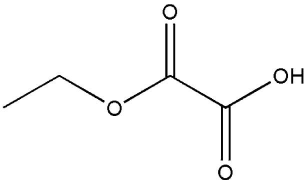


**Ethyl oleate** *n.* $C_2H_5OOCC_{17}H_{33}$. This monounsaturated fatty ester is a solvent, lubricant, and plasticizer.



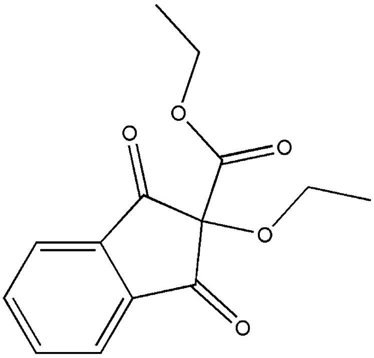
**Ethyl oleate**

**Ethyl oxalate** (oxalic acid diethyl ester) *n.* Colorless, unstable, oily, and aromatic liquid. Solvent for cellulose esters and ethers, many natural and synthetic resins. Sp gr., 1.0920/20°C; bp, 186°C; mp, −40.6°C; fp, 75.6°C (168°F).
*Also known as diethyl oxalate.*

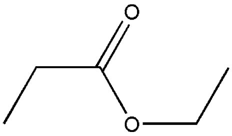


**Ethyl phthalate** *See diethyl phthalate.*

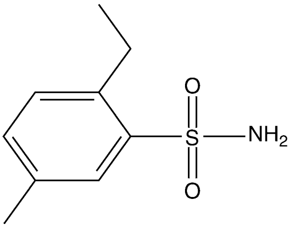
**Ethyl phthalyl ethyl glycolate** (2-ethoxy-1,3-dioxo-indan-2-carboxylic acid ester). A plasticizer compatible with PVC and most common thermoplastics. It has been approved by the FDA for use in food packaging.



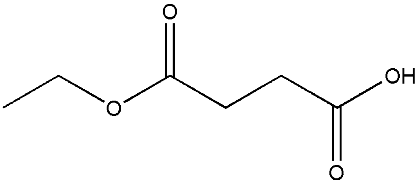
**Ethyl propionate** (propionic acid ethyl ester) *n.* Colorless liquid, fruity odor. Medium boiling solvent for nitrocellulose. Properties: bp, 98°C; Sp gr, 0.912/0°C; flp, 12°C (43.6°F); vp, 43 mmHg/30°C.



***N*-Ethyl-*p*-toluene sulfonamide** (2-ethyl-5-methyl-benzenesulfonamide) *n.* A solid plasticizer for rigid PVC.



**Ethyl succinate** (succinic acid monoethyl ester) *n.* Saturated plasticizer. Properties: bp, 216°C; Sp gr, 1.049.
*Also known as diethyl succinate.*



**EtOH** *See ethyl alcohol.*

**Ettinghausen's effect** [*Von Ettinghausen's*] *n.* When an electric current flows across the lines of force of a magnetic field an electromotive force is observed which is at right angles to both the primary current and the magnetic field: a temperature gradient is observed which has the opposite direction to the Hall electromotive force. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**EU** Abbreviation for polyether type of polyurethane rubber.

**Euhedral** *adj.* Euhedral crystals are those that are bounded by plane faces, cf., anhedral.

**Eupolymer** *n.* Polymer with a molecular weight over 10,000.

**Eutectic** \yú-ˈtek-tik\ [Gk *eutēktos* easily melted, fr. *eu-* +*tēktos* melted, fr. *tēkein* to melt] (1884) *adj.* A term applied to the specific mixture of two or more substances that has a lower melting point than that of any of its constituents alone or any other percentage composition of the constituents.

**EVA** (E/VAC) *n.* Copolymer from ethylene and vinyl acetate.

*See ethylene–vinyl acetate copolymer.*

**Evaporation** \i-ˈva-p(ə-)ˌrā-shən\ [ME, fr. L *evaporatus*, pp of *evaporare*, from *e-* + *vapor* steam, vapor] (15c) *v.* The changing from the liquid to the gaseous or vapor state, as when the solvent leaves the printed ink film.

**Evaporation rate** *n.* A measure of the length of time required for a given amount of a substance to evaporate, compared with the time required for an equal amount of ethyl ether or butyl acetate (rated at 100) to evaporate.

**Evaporation rate, final** *n.* Time interval for complete evaporation of all solvent.

**Evaporation rate, initial** *n.* Time internal during which low boiling solvent evaporates completely.

**Evaporometer** *n.* Instrument for measuring the evaporation rate of a liquid.

**EVE** *See vinylethyl ether.*

**Evenness testing** *n.* Determination of the variation in weight per unit length and thickness of yarns or fibers aggregates such as roving, sliver, or top.

**EVOH** *See ethylene-vinyl alcohol copolymer.*

**Exa** The SI prefix meaning $\times 10^{18}$.

**Excessive clearer waste** *n.* Higher that normal amount of short and regular fibers that become attached to the drafting rolls and are transferred to the clearer brushes to accumulate in abnormal amounts until they are removed manually.

**Excitation** \ˌek-ˌsī-ˈtā-shən\ (14c) *n.* In ultraviolet curing, the first state of the polymerization process, in which the photo-initiator, such as benzophenone amine, is stimulated by UV into a singlet or triplet state, with subsequent formation of free radicals.

**Excitation purity** *See purity, excitation.*

**Excited state** *n.* Any state higher in energy then the ground state.

**Excluded volume** *n.* The volume surrounding and including a given object, which is excluded to another object. This terminology comes from the statistical mechanics of gases, where this function arises in the leading order concentration expression (virial coefficient) for the pressure in the case of gas particles that repeal each other with a hard-core volume exclusion.

**Exempt solvents** *n.* Any solvent that has not been declared photochemically reactive by any of several regulatory agencies, most notably, the Los Angeles Air Pollution Control District. Many alcohols, many esters, some ketones, and mineral spirits are exempt under Rule 66.

**Exfoliate** \(ˌ)eks-ˈfō-lē-ˌāt\ [LL *exfoliatus*, pp of *exfoliare* to strip of leaves, fr. L *ex-* + *folium* leaf] (1612) *v.* Sealing from a surface in flakes or layers.

**Exhaustion** *n.* During wet processing, the ratio at any time between the amount of dye or substance taken up by the substrate and the amount originally available.

**Exo** A chemical-structure prefix meaning attachment to a side chain rather than to a ring. Compare Endo-.

**Exotherm** \ˌek-sō-ˈthərm\ *n.* (1) The temperature/time curve of a chemical reaction giving off heat, particularly the polymerization of a casting resin. ASTM test D 2471 delineates a procedure for measuring this curve, which in practice is strongly dependent on the amount of material present and the geometry of the casting. (2) The amount of heat given off per unit mass of the principal reactant. As yet (1992) no standard method for determining this heat in reacting plastics has been adopted.

**Exothermic** [ISV] (1884) *adj.* Denoting a chemical reaction that is accompanied by the evolution of heat. An example in the plastics industry is the curing reaction of an epoxy resin with an amine hardener. Opposite of endothermic.

**Exothermic reaction** *n.* A reaction, which liberates heat.

**Expandable plastic** *n.* A plastic formulated so as to be transformable into a cellular plastic by thermal, chemical, or mechanical means.

*See cellular plastic.*

**Expanded polystyrene (XPS)** *See polystyrene foam.*

**Expanding agent** *See blowing agent.*

**Expansion coefficient** The fractional change in length or volume of a material for a unit change in temperature.

**Expansion of gases** (Charles' law or Gay–Lussac's law) *n.* The volume of a gas at constant pressure increases proportionately to the absolute temperature. If $V_1$ and $V_2$ are volumes of the same mass of gas at absolute temperatures, $T_1$ and $T_2$,

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}.$$

For an original volume $V_o$ at 0°C the volume at $t$°C (at constant pressure) is

$$V_1 = V_o(1 + 0.00367t).$$

**Expansion of gases** (*General law for gases*) *n.*

$$p_t v_t = p_o v_o \left(1 + \frac{t}{273}\right),$$

where $p_o$, $v_o$, $p_t$, and $v_t$ represent the pressure and value at 0° and $t$°C or

$$\frac{p_1 v_1}{T_1} = \frac{p_2 v}{T_2},$$

where $p_1$, $v_1$, and $T_1$ represent pressure, volume and absolute temperature in one case and $p_2$, $v_2$, and $T_2$ the same quantities for the same mass of gas in another. The law may also be expressed as $pv = RmT$, where $m$ is the mass of gas at absolute temperature $T$. $R$ is the *gas constant*, which depends on the units used. *Boltzmann's molecular gas constant* is obtained by expressing m in terms of the number of molecules. For volume in cm$^3$, pressure in dyne/cm$^2$ and temperature in Centigrade degrees on the absolute scale $R = 8.3136 \times 10^7$. Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York.

**Expansivity** *See coefficient of thermal expansion.*

**Explosive limits** *n.* When combustible vapor is mixed with air in the proper proportions, ignition will produce an explosion. This proper proportion is called the explosive range. The explosive range includes all concentrations of a mixture of flammable vapor or gas in air, in which a flash will occur or a flame will travel if the mixture is ignited. The lowest percentage at which this occurs is the lower explosive limit; and the highest percentage, the upper explosive limit. Explosive limits are express in percent by volume of vapor in air and, unless otherwise specified, under normal conditions of temperature and pressure.

**Exposure meter** (1891) *n.* A device for indicating correct photographic exposure under varying conditions of illumination.

**Exposure rack** *n.* Term given to a frame on which test panels are exposed for durability tests.

**Exposure tests** *n.* Tests, which are conducted to evaluate the durability of a coating or film. They include exposure to ultraviolet light, moisture, cold, heat, salt water, mildew, etc. They can be generated either naturally or artificially.

**Expression** *n.* Removal of a liquid from a solid by pressing, as in the manufacture of vegetable oils from meal cakes.

**Extended length** *n.* The length of a face pile yarn required to produce 1 in. of tufted carpet.

**Extender** \ik-ˈsten-dər\ (1611) *n.* (1) *See extender pigment.* (2) A transparent or semi-transparent white pigment or a varnish that is used to alter the color strength and working properties of an ink, without affecting its hue.

**Extender pigment** *n.* A specific group of achromatic pigments of low refractive index (between 1.45 and 1.70) incorporated into a vehicle system whose refractive index is in a range of 1.5–1.6. Consequently, they do not contribute significantly to the hiding power of paint. They are used in paint to: reduce cost, achieve durability, alter appearance (e.g., decrease in gloss), control rheology, and influence other desirable properties. If used at sufficiently high concentration, an extender may contribute dry hiding and increase reflectance.

**Extensibility** (1611) *n.* (1) The ability of a material to stretch or elongate upon application of sufficient tensile stress. It is expressed as a percentage of the original length. (2) The value of said ability just prior to rupture of the specimen; ultimate elongation.

*See elongation.*

**Extensiometer** *n.* A rheometer for measuring the extensional flow properties of molten polymers. In one early form, the *Cogswell rheometer*, useful at tensile viscosities over $10^5$ Pa/s, unidirectional tensile force was exerted on a polymer rod by a dead-weight acting through a cam and pulley. As the cam rotated, the moment arm exerted by the weight on the rod decreased in proportion to the rod cross section so as to maintain constant stress.

**Extensional strain rate** *See elongational flow.*

**Extensional viscosity** *See elongational viscosity.*

**Exterior finishes** *n.* Coatings, which are expected to possess reasonable durability when exposed to natural weathering.

*See exterior paints and varnishes.*

**Exterior paints and varnishes** *n.* Material formulated for use in conditions exposed to the weather.

**Exterior type plywood** *n.* Plywood bonded with a fully waterproof glueline.

**External mix** Spray equipment in which fluid and air join outside of aircap.

**External phase of an emulsion** Another term for the continuous phase.

**External plasticizer** Post added plasticizer as opposed to plasticization by means of internally combined groups, such as copolymerization.

*See internal plasticizers.*

**External undercut** Any recess or projection on the outer surface of a molded part that prevents its direct removal from its mold cavity. Parts with such undercuts may be molded by splitting the mold vertically and opening the split to withdraw the part; or by providing *side draws*, i.e., mold parts that are withdrawn to the sides to relieve the undercuts.

**Extinction** \ik-ˈstiŋ(k)-shən\ (15c) *n.* If the orientation of the crystals that appear white or colored between crossed polars is changed by rotating the stage, all single crystals will be observed to disappear (become black) four times during complete rotation of the stage. The positions are 90° apart; they reveal the vibration directions of each crystal. These directions will parallel the vibration directions of the two polars when the crystal is extinct.

**Extinction angle** *n.* The angle between the nearer vibration direction and a prominent direction of the crystal. It never exceeds 45°.

**Extinction coefficient** (1902) *n.* An older term synonymous with absorption coefficient.

*See absorption coefficient.*

**Extinction, oblique** *n.* Extinction is oblique if the vibration directions are oblique to the long direction of the crystal.

**Extinction, parallel** *n.* Extinction is parallel if the vibration directions are parallel and perpendicular to the long direction of the crystal.

**Extinction, symmetrical** *n.* Extinction is symmetrical if the vibration directions bisect a prominent angle.

**Extractable** \ik-ˈstrak-tə-bəl\ [ME, fr. L *extractus*, pp of *extrahere*, fr. *ex-* + *trahere* to draw] (15c) *n.* The amount of soluble material extracted from a polymer specimen when it has been exposed to a solvent under specified conditions. In ASTM test D 4754, disks of the polymer and glass separator beads are alternately threaded onto a stainless-steel wire and slipped into a vial containing the test solvent. The tightly closed vial is placed in an oven, and the solvent is sampled and analyzed periodically.

**Extraction** *n.* The transfer of a constituent of a plastic mass to a liquid with which the mass is in contact. The process is generally performed with a solvent selected to dissolve one or more specific constituents; or it may occur as a result of environmental exposure to a solvent.

**Extract printing** *See printing, discharge printing.*

**Extranuclear region** All of an atom except the nucleus.

**Extrudate** (1) The product or material delivered from an extruder, for example film, pipe, profiles, and wire coatings. (2) The extruded melt just as it emerges from the die.

**Extrudate roughness** *See melt fracture.*

**Extruded foam** *n.* Cellular plastic produced by extrusion with the aid of a blowing agent – a decomposable, gas-generating chemical – or by injection into the extruder of a gas such as nitrogen or carbon dioxide, or a highly volatile liquid, such as a pentane.

**Extruded shape** (profile) *n.* Any of a huge variety of cross-sectional shapes produced in continuous or cut lengths by extrusion through profile dies. Some complex shapes reach their final form with the aid of post forming jigs that alter the shape before the extrudate has cooled and become firm.

**Extruder** \-ˈstrü-dər\ [L *extrudere*, fr. *es-* + *trudere* to thrust] (1566) *n.* (1) An extrusion machine. (2) A machine in which molten or semisoft materials are forced under pressure through a die to form continuous tubes, sheets, or fibers. It may consist of a barrel, heating elements, a screw, ram, or plunger, and a die through which the material is pushed to give it shape. (3) In fiber manufacture the machine that feeds molten polymer to an extrusion manifold or that first melts the polymer in a uniform manner then feeds it to a manifold and associated equipment for extrusion. (4) In plastics compounding, a material added to the mixture to reduce its cost per unit volume. The material may be a resin, plasticizer, or filler. (5) A substance, generally having some adhesive capacity, added to an adhesive formulation to reduce the amount of the primary (i.e., more costly) binder required per unit of bonding area. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

*See binder and filler. See also blending resin. Also see screw melter.*

**Extruder barrel** (extruder cylinder) *n.* A thick-walled, cylindrical steel tube, lined with a special hard alloy to resist wear that forms the housing for the extruder screw and contains, between itself and the screw, the plastic material as it is conveyed from feed hopper to die. Barrels are usually surrounded by heating and cooling media, such as electrical heater bands, cast-in-aluminum calrods and tubing for coolant, induction heaters, or, rarely, by a compartmented jacket for the circulation of hot oil or steam. Electrically heated barrels are usually furnished with some means of cooling, such as air blowers or coils through which fluid may be circulated. Small holes drilled radically into (but not through) the barrel accommodate temperature sensors whose signals are used to control the means of heating and cooling.

**Extruder burn** *n.* The local decomposition of the plastic resin inside an extruder caused by the excessive mechanical heating. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Extruder breaker plate** *See breaker plate.*

**Extruder drive** *n.* The system comprising an AC or DC motor, speed reducer (gearbox), screw-shaft bearings, coupling, and controls that supply power to the screw and regulate its speed. To facilitate startup and accommodate various operating conditions, modern extruders are always equipped with some means of varying the screw speed, with close control, over a wide range.

**Extruder, dual-ram** *n.* A modification of the original ram extruder employing two identical units, stroking alternately, and delivering to the same die. Aided by values, the result is the conversion of a batch operation into one that makes continuous extrusions from sinterable resins such as polytetrafluoroethylene and ultra-high-molecular-weight polyethylene.

**Extruder, planetary screw** *n.* A multi-screw device in which a number of satellite screws, generally six, are arranged around one longer central screw. The portion of the central screw extending beyond the satellite screws serves as the final pumping screw as in a single-screw extruder, while the planetary screws aid in plastication and permit the discharge of volatiles toward the hopper. A few of these have served in processing fine powders such as PVC dry-blend.

**Extruder, ram** *n.* An extruder in which the material is advanced through the barrel and die by means of a ram or plunger rather than by a screw. Melting is accomplished either by preheating the feedstock close to the fusing temperature and by conductive heating from the barrel wall, or both. The ram extruder was the earliest type to be used in the plastics industry, dating back to 1870 when cellulose nitrate was extruded into rods. Among plastics today, polytetrafluoroethylene, which softens to a gel but does not achieve a true melt state, is the one mainly processed with ram extruders.

**Extruder screw** *n.* A solid or cored shaft with a continuous helical channel (sometimes two channels) cut into it, usually extending from the feed throat of the extruder barrel to the die end of the barrel. In most screws, the channel varies in its volume per turn of the helix, being larger at the end receiving the feed with its low bulk density, to much less – roughly one-third – in the pumping section at the delivery end. The reduction in volume is usually accomplished by reducing the channel depth but can be done by reducing the helical lead; sometimes a combination of both has been used. The reduction in volume serves several purposes: feeding, compressing the particles and forcing the interstitial air back out the feed hopper, melting the polymer, and developing pressure to overcome resistance at the die. Extruder screws are made of tough steel – SAE 4140 is common – are usually chrome plated, and have flight tips hardened by one of several techniques (*See nitriding and hard-facing alloy*). Many designs have been, and continue to be, developed and marketed for extruder screws. Some terms used in describing extruder screws are defined below.

- **Barrier screw** *See solids-draining screw.*
- **Constant-lead screw** (uniform-pitch screw) *n.* A screw with a flight of constant helix angle over its whole length.
- **Constant-taper screw** *n.* A screw of constant lead and uniformly. **Cored screw.** A screw with a hole bored along its axis for circulation of heat-transfer medium or insertion of a heater. The core may extend only through the feed section or further, even to the screw tip.
- **Decreasing-lead screw** *n.* A screw in which the helix angle decreases steadily over the length of the screw. Channel depth is usually constant.
- **Metering-type screw** *n.* A screw whose final section is of constant lead and relatively shallow depth.
- **Multiple-flighted screw** (multi-flight screw) *n.* A screw having more than one flight, thus having two or more parallel channels.
- **Single-flighted screw** *n.* A screw having just one flight – the usual case, presumed if not otherwise stated.
- **Two-stage screw** *n.* Essentially two metering-type screws in series, typically used for vented operation. The first stage consists of a feed section, compression zone, and metering zone. The second stage consists of a deep, constant-depth section (decompression zone), usually running only fractionally full to permit expansion of bubbles and release of volatiles, followed by a short, steep compression zone and a metering zone of about one-third greater capacity than that of the first stage. There may be a restriction at the end of the first stage.
- **Vented screw** *n.* A two-stage screw with a screw vent in the decompression zone, permitting volatiles to escape through the screw core.
- **Water-cooled screw** *n.* A screw cored in its feed section to permit circulation of water there.
- **Extruder, single-screw** *n.* An extruder with one tubular barrel within which a solid or cored screw rotates. Strong AB (2000) Plastics: materials and processing. Prentice-Hall, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Extruder size** *n.* Traditionally, the nominal inside diameter of the extruder barrel, usually stated in inches or millimeters. However, the output power rating of the drive is more directly related to output capability than is the diameter.
*See also L/D ratio.*

**Extruder, twin-screw** (double-screw extruder) *n.* An extruder with a barrel consisting of two side-by-side intersecting cylinders internally open to each other along their intersection. There are two basic types. If the two internal cylinders are tangentially joined, the two screws are also nearly tangential and are normally of opposite "hands" and counter-rotating, turning downward at their juncture (Welding Engineers). This design permits the use of long vented sections and that feature, together with the milling action of the screws, makes it possible to remove large percentages of volatiles from the feedstock. One of the two screws is extended to become the metering section that provides die pressure. In the second basic type, the two cylinders of the barrel intersect more deeply and the screws intermesh with each other. Rotation may be co- or counter-, depending on whether the screws have the same or opposite "hands". In these machines the intermeshing of the screws traps the plastic and moves it much more positively than in the tangential type, with virtually no back flow, and shear working is less severe. The screws of both types of assembled from segments, each segment designed to perform a particular function. An important application for the second type has been extrusion of rigid PVC compounds from powder, heating gently by conduction and fluxing near the end of the screws and into the die entry and extruding at die pressures up to 100 MPa. Other applications are compounding fluffy polyolefin powders, volatiles extraction, and compounding. Twin-screw machines have also proved useful in reactive extrusion, in which chemical reactions, including polymerization, are performed with the extruder.

**Extrusion** [ML *extrusion*-, *extrusio*, fr. L *extrudere*] (1540) *n.* (1) A shaping/molding process use in plastics processing in which the material is melted and then pushed out the end of the machine, usually through a forming die. (2) Any process by which lengths of constant cross section are formed by forcing a material, e.g., a molten plastic, through a die. Typical shapes extruded are hose, tubing, flat films and sheets, wire and cable coatings, parisons for blow molding, filaments and fibers, strands cut hot or cold to make pellets for further processing, webs for coating and laminating, and many of the above in multiple layers by coextrusion. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

*See compacting and strainer.*

**Extrusion, autothermal** (autogenous extrusion, "adiabatic" extrusion) *n.* An extrusion operation in which the entire increase in enthalpy of the plastic, from feed throat to die, or very nearly all of it, is generated by the frictional action of the screw. In such an operation, which most commercial single-screw extrusions approach closely, the functions of the barrel heaters are to preheat the machine at startup and, during steady operation, to prevent heat loss from the plastic through the barrel to the surroundings.

**Extrusion blow molding** *n.* The most common process of blow molding in which the parison is formed by extrusion.

**Extrusion casting** A term sometimes employed in the industry for the process of extruding unsupported film, especially a composite of two or more integral resin layers formed by coextrusion. Such extrusion-cast composite films possess desired properties on each of the respective sides, e.g., heat-sealability on one side and stiffness on the other, or different levels of slip, or different colors.

**Extrusion coating** *n.* The process of coating a substrate by extruding a layer or molten resin onto the substrate with sufficient pressure to bond the two together without the use of an adhesive. A common application of the process is the coating of foil, paper, or fabric with polyethylene, by extruding a web directly into the nip of a pair of rolls through which the substrate is passing.

**Extrusion coloring** *n.* the method of adding colorants to a plastic compound by dry-blending the colorant with the solid granular resin, extruding the mixture into strands, and cutting these strands into pellets for use in subsequent processing operations.

**Extrusion die** *n.* The orifice-containing element, mounted at the delivery end of an extruder that shapes the extrudate. Elements of the die assembly are (1) the die block, (2) an adapter connecting the die to the extruder, (3) a manifold within the die that distributes the melt to the orifice, (4) in the case of dies for hollow sections, a mandrel inserted in the flow channel to form the interior surface of the extrudate, (5) a spider that holds the mandrel in position, and (6) the land section, i.e., the orifice that gives the extrudate its emergent shape. Extrusion dies are classified in four ways according to the relation between the screw axis and the direction of flow of the extrudate: straight (*in-line*), *offset*, *angle*, and *crosshead*. In an in-line die, the die-discharge channel is coaxial with the screw. In an offset die, those directions are parallel but not coaxial. In an angle die the axis of the die-discharge channel is at an angle, typically 45°, to that of the screw. A crosshead die is an angle die in which the two axes are perpendicular. Sheet and film dies are also classified as to the type of feed. In a *center-feed die*, the melt enters at the lateral center of the manifold and divides into two equal streams that move in opposite directions to the ends of the die. In an end-fed die, the melt enters one end of the manifold and flows toward the other. Theory tells that it is easier to maintain thickness uniformity over the width of the extruded film or sheet is the die is center-fed, but end-fed dies are sometimes used for logistical reasons, especially in extrusion coating.

**Extrusion laminating** *n.* A process in which a plastic layer is extruded between two layers of substrate(s) in a nip of a rubber roll and a chill roll.
*See extrusion coating.*

**Extrusion moldings** *n.* Moldings, which are made from plastic material by forcing the melted resin through a shaped orifice by means of pressure.

**Extrusion plastometer** (melt-indexer) *n.* A simple viscometer consisting of a heated vertical cylinder with two bores, a central one that contains a close-fitting piston and a recess for an orifice block, the other, nearby, for a thermoswitch. The orifice is 2.1 mm in diameter and 8 mm long. Plastic particles are loaded into the bore, allowed to heat for 6–8 min, then the weighted piston is released, and the extrudate is collected for a measured time internal. The melt-flow index (MFI) is stated as the rate of extrusion in grams/10 min. The instrument and its use are described in ASTM D 1238. Originally developed in 1953 for low-density polyethylene, the melt-indexer is now used with many other polymers with specific temperatures and piston weights. It is *essential* to state the condition (*A*–*X*) at which an MFI was measured. Most of the conditions result in shear rates far below those typical of commercial processing (MFI = 1 g/10 min corresponds to about 2 $s^{-1}$. Thus, while the measurement is useful for product identification and quality control, it is a poor indicator of processability. An estimate of a resin's pseudoplasticity may be obtained by running two or more tests with substantially different piston weights.

**Extrusion pressure** *n.* (1) Broadly, pressure indicated anywhere within an extruder. (2) The pressure at the delivery, or head end of the screw in a screw extruder, immediately upstream of the screen pack if one is present. (3) In a ram extruder, the pressure at the face of the ram in contact withy the plastic.

**Exudation** \ˌek-s(y)ú-ˈdā-shən\ (1612) *n.* The undesirable appearance on the surface of an article of one or more of its constituents that have migrated or exuded to the surface. In vinyls, such constituents may be residual emulsifier from the resin, stabilizer, lubricant, or plasticizer. Secondary plasticizers in particular have a tendency to exude when used in excessive percentages. Exudation may appear on a product shortly after it has been made, but more often it is delayed for periods ranging from several weeks to years. Products that do not exude for long periods under ideal storage conditions can be caused to exude by exposure to pressure, heat, high humidity, light, and other environmental agents.

**Eyelet** \ˈī-lət\ [alter. of ME *oilet*, fr. MF *oillet*, dim. of *oil* eye, fr. L *oculus*] (14c) *n.* (1) A series of small holes made to receive a string or tape. A buttonhole stitch is worked around the holes. (2) A type of yarn guide used on a creel. (3) A fabric style with areas of cut-outs surrounded by stitching. Complete textile glossary. Celanese Corporation, New York.

# F

**f** \ˈef\ *n.* (1) SI abbreviation for femto. (2) Symbol for frequency of an oscillating system.

**F** (1) *n.* Chemical symbol for the element fluorine. (2) SI abbreviation for farad.

**Fabric** \ˈfa-brik\ [MF *fabrique*, fr. L *fabrica* workshop structure] (15c) (cloth) *n.* A flexible structure, usually thin relative to its width and length, made up o intermingled yarns, fibers, filaments, or wires. In woven fabrics, the elements are alternately crossed over and under one or more of those oriented in the other directions, typically two perpendicular directions. In non-woven fabrics, such as felts, fibers are randomly oriented. Complete textile glossary. Celanese Corporation, New York.

**Fabricate** \-ˈkāt\ [ME, fr. L *fabricatus*, pp of *fabricari*, fr. *fabrica*] (15c) *vt.* In the broadest sense, this term means to manufacture, devise, or to make an assembly of parts and sections. In the plastics industry it refers to the assembly or modification of preformed plastics articles by processes such as welding, heat sealing, adhesive joining, machining, and fastening. "Fabrication" is *not* generally used to mean basic manufacturing processes such as extrusion, calendering, molding and the like.

**Fabric construction** *n.* The details of structure of fabric. Includes such information as style, width, type of knit of weave, threads per inch in warp and fill, and weight of goods. Complete textile glossary. Celanese Acetate, New York.

**Fabric crimp** *n.* The angulation induced between a yarn and woven fabric via the weaving or braiding process. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Fabric crimp angle** *n.* The maximum acute angle of a single weaving yarn's direction measured from a plane parallel to the surface of the fabric.

**Fabric set** The number of warp threads per inch, or other convenient unit.

**Fabric stabilizer** *n.* Resin or latex treatment for scrims used in coated fabric manufacture to stabilize the scrim for further processing. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Façade** \fə-ˈsäd\ [F *façade*, fr. It *facciata*, fr. *faccia* face, fr. (ass.) VL *facia*] (ca. 1681) *n.* One of the faces of a building, usually that containing the main entrance.

**Face** \ˈfās\ [ME, fr. OF, fr. (assumed) VL *facia*, fr. L *facies*, fr. *facere*] (13c) *n.* The correct or better-looking side of a fabric.

**Face color** *n.* Term used to describe the color observed on paints (particularly, metallic paints) when they are viewed near to the normal (near to the perpendicular). It may also be referred to as the "top color". It is generally used in contrast to the term "flop color," which is the color observed at an angle near to the grazing angle (parallel to the surface).

**Face putty** *n.* Triangular fillet of glazier's putty on the exposed surface of glass.

**Facial (fac-) isomer** *n.* An isomer of an octahedral complex in which three adjacent octahedral positions are occupied by one kind of ligand.

**Faciated yarn** *n.* Yarns consisting of a core of discontinuous fibers with little or no twist and surface fibers wrapped around the core bundle.

**Facing** (15c) *v.* A lining or trim that protects the edges of a garment especially at collars, cuffs, and front closings.

**Faconné** *n.* A broad term for fabrics with a fancy-type weave made on a Jacquard or dobby loom.

**Facsimile** \fak-ˈsi-mə-lē\ [L *fac simile* make similar] (1691) *n.* The exact reproduction of a letter, document, or signature.

**Factice** *n.* Elastomeric products made by reaction of sulfur or sulfuric chloride with vegetable oils.

**Factitious ultramarine** Synthetic ultramarine blue.

*See ultramarine blue.*

**Fadding** *n.* Application of shellac lacquers by means of a pad known as a 'fad.'

**Fadeometer** *n.* (1) Laboratory device used to determine the fastness of a colored fabric to exposure to light. The test pieces are rotated around a light source simulating the sun's rays at 45°N latitude in July between the hours of 9 a.m. and 3 p.m. Fabrics are rated by visual comparison with a gray scale according to degree of fading. (2) An apparatus for determining the resistance of resins and other materials to fading. It accelerates the fading by subjecting the article to high-intensity ultraviolet wavelengths similar to those found in sunlight.

*Also known as fugitometer.*

**Fading** [ME, fr. MF *fader*, fr. *fade* feeble, insipid, fr. (ass.) VL *fatidus*, alter. of L *fatuus* fatuous, insipid] (14c) *v.* Subjective term used to describe the lightening of the color of a pigmented paint following exposure to the effects of light, heat, time, temperature, chemicals, etc. The observed fading may result from deterioration of the pigment, from deterioration of the vehicle, or from a decrease in gloss. A separation of the vehicle from the pigment particle in the interior of the film, with the subsequent introduction of microvoids, which scatter light, may also be interpreted visually as fading. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, Philadelphia, PA. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

*See light resistance.*

**Fahrenheit scale** \ˈfar-ən-ˌhīt, ˈfer-\ [Gabriel D. *Fahrenheit*] (1753) *adj.* Temperature scale on which the freezing point of water is represented by 32°F (0°C) and the bp by 212°F (100°C) under normal pressure at sea level. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Faille** \ˈfī(ə)l\ [F, fr. OF] (1869) *n.* A soft, slightly glossy woven fabric made of silk, rayon, cotton, wool, or manufactured fibers or combinations of these fibers and having a light, flat cross-grain rib or cord made by using heavier yarns in the filling than in the warp.

**Failure, adhesive** *n.* The rupture of an adhesive bond, such that the separation appears to be at the adhesive adherend interface. *Note*—Sometimes termed failure in adhesion. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Falling-ball viscometer** (falling-sphere viscometer) *n.* An instrument well suited to determining polymer-melt viscosity at extremely low shear rates. That is, the limiting Newtonian viscosity. A sphere more dense than the melt is placed between two premolded slugs of the test polymer within a steel cylinder, which is then kept for a preset time in a temperature-controlled oven. From the initial and final positions of the sphere the viscosity can be calculated by Stokes' law (with corrections). By repeating the test with spheres of different densities, a range of low shear rates can be explored. Van Wazer JR, Lyons JW, Kim KY, Colwell RE (1963) Viscosity and flow measurement. Interscience Publishers Inc., New York.

**Falling bodies** *n.* For bodies falling from rest conditions are as for uniformly accelerated motion except that $v_o = Q$ and $g$ is the acceleration due to gravity. The formulate becomes – air resistance neglected,

$$v_t = gt, \quad s = \frac{1}{2}gt^2, \quad v_s = \sqrt{2gs}.$$

For bodies projected vertically upward, if $v$ is the velocity of projection, the time to reach greatest height, neglecting the resistance of the air,

$$t = \frac{v}{g}.$$

Greatest height

$$h = \frac{v^2}{2g}.$$

Giambattista A, Richardson R, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

*See projectiles.*

**Falling-dart impact test** *n.* In addition to the ASTM tests mentioned at free-falling-dart test, several similar tests exist for products such as pipe and bottles as well as sheeting. One procedure is the *staircase method*, also known as the *up-and-down method*, which for a given quantity of testing, provides a good estimate of the impact energy at which 50% of such samples may be expected to break. In the *Probit method*, groups of samples are tested at pre-selected drop heights ranging from that at which most or all of the samples fail to that at which very few or none fail. This method also provides an estimate of the 50% point but, in addition, provides a better estimate of the standard deviation than does the staircase method. Combinations of the two methods have been used to optimize the amount of information per test specimen. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Falling sand abrasion test** *n.* Abrasion resistance of coatings of paint, varnish, lacquer and related products is determined by the amount of abrasive (Ottawa) sand required to wear through a unit thickness of the coating, when the sand falls against it at a specified angle from a specified height through a guide tube. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, Philadelphia, PA.

**False Becke line** *n.* A second bright line, which moves in the direction opposite to the Becke line. It is usually observed with thick particles or when the refractive index difference between particles and mountant is large. It appears as a concentration of reflected light at the low index side of the interface.

**False body** *n.* Thixotropic flow property of a suspension or dispersion. When a composition "thins down" on stirring and "builds up" on standing it is said to exhibit false body. The term "false body" is also used in practice for "buttery" materials, which are characterized by a relatively low viscosity and high yield value.

*See thixotropy.*

**False neck** *n.* In blow molding of containers, a neck construction that is additional to the neck finish of the container and that is only intended to facilitate the blow-molding operation. Afterwards the false neck is removed from the container.

**False twisting** *See texturing, false, twist method.*

**Family mold** (composite mold). A multicavity mold containing a variously shaped cavities, each of which produces a component of an item that is assembled from the components. For example, a family mold for a model-airplane kit would contain a cavity for each part, and components of a complete kit would be produced in one shot.

**Fancy yarn** *See novelty yarn.*

**Fan gate** A shallow gate becoming wider (and usually thinner) as it extends from the runner to the cavity.

**Fantail die** (fishtail die). An extrusion die, usually one making a wide strip or sheet, in which the flow passage diverges from the adapter to the die lip.

**Farad** \ˈfar-ˌad\ [Michael *Faraday*] (1873) (F). The SI unit of electrical capacitance. A capacitor with a 1 V potential between its plates and holding a charge of 1 C has a capacitance of 1 F. Thus 1 F = 1 C/V. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Faraday effect** \ˈfar-ə-ˌdā, -ə-dē-\ [Michael *Faraday*] (1904) *n.* The rotation of the plane of polarization produced when plane-polarized light is passed through a substance in a magnetic field, the light traveling in a direction parallel to the lines of force. For a given substance, the rotation is proportional to the thickness traversed by the light and to the magnetic field strength. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Faraday (F)** A unit of electrical charge: 1 F equals $9.65 \times 10^4$ C. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Faraday's laws** In the process of electrolytic changes equal quantities of electricity charge or discharge equivalent quantities of ions at each electrode. One gram equivalent weight of matter is chemically altered at each electrode for 96,501 int. Coulombs, or 1 F, of electricity passed through the electrolyte. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Farnsworth–Munsell 100 hue test** Test devised to check for both defective color vision and color discrimination ability. The test requires the subject to arrange four sets of randomized colors, contained in plastic caps, in order of hue change. The test can be administered in about fifteen minutes. It may be purchased from Munsell Color Co., Baltimore, MD. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Fashioning** \ˈfash-niŋ\ (15c) *vt.* The process of shaping a fabric during knitting by increasing or decreasing the number of needles in action. Fashioning is used in manufacturing hosiery, underwear, and sweaters.

**Fastness** *See colorfastness.*

**Fastness, fast** The ability of a pigmented or dyed material to resist color change following exposure to the deleterious elements. *Also known as fast to light. See lightfastness and colorfastness.*

**Fastopake inks** Compositions for printing on waxed surfaces.

**Fast ray** The fast ray or fast component for a crystal corresponds to the lower refractive index.

**Fast solvent** Solvent that evaporates rapidly under atmospheric conditions.

**Fast to light** *See fastness, fast.*

**Fat** (14c) *n.* A solid or semisolid ester of the troll glycerol and fatty acids.

**Fat edge** Accumulation of paint in the form of a ridge at the edge of a painted surface.

**Fatice** Sometimes called "artificial rubber" or a "rubber substitute", fatice is made by vulcanizing with sulfur a vegetable oils such as soybean, rapeseed, or castor oil. It is used as a processing aid and extender in natural-rubber compounds and synthetic elastomers.

**Fatigue** \fə-ˈtēg\ [F, fr. MF, fr. *fatiguer* to fatigue, fr. L *fatigare*; akin to L af*fatim* sufficiently] (1669) *n.* (1) Fatigue refers to the resistance of a material to weakening or failure during alternate tension-compression cycles, i.e., in stretch yarns, the loss of ability to recover after having been stretched. (2) A plot of the maximum cyclic stress applied to a fatigue specimen versus the number of cycles to failure, the abscissa being a logarithmic scale (*S–N* curve). Typically the *S–N* curve is linear or slightly concave upward, sloping gently downward, sometimes flattening at the low-stress (right) end, suggesting that there may be an endurance limit. ASTM testing methods, www.astm.org. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Fatigue failure** The cracking or rupture of a plastic article under repeated cyclic stress, at a stress well below the normal short-time breaking strength as measured in a static (0.5-cycle) test. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Fatigue life** The number of cycles of specific alternating stress required to bring about the failure of a test specimen.

**Fatigue limit** Syn: endurance limit.

**Fatigue notch factor** The ratio of the fatigue strength of a specimen with no site of stress concentration (notch) to that of a duplicate specimen having a notch.

**Fatigue ratio** The ratio of fatigue strength at a given number of cycles of stated alternating tensile stress to the static tensile strength.

**Fatigue strength** The maximum-stress level at which a material subjected to cyclic alternating stress fails after a given number of cycles. This is a number read off a fatigue curve that is derived by measuring the cycles to failure of numerous specimens subjected to various known maximum alternating stresses. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Fatigue tests** During testing, specimens are subjected to periodic varying of stresses by means of a mechanically operated device.

**FATIPEC** Acronym for Federation d'Associations de Techniciens des Industries des Peintures, Vernis, Emaux, et Encres d'Imprimerie de l'Europe Continentale (Federation of Associations of Technicians in the Paint, Varnish, Lacquer, and Printing Ink Industries of Continental Europe).

**Fats** Fats are triglycerides (*oils*) or glyceryl esters of higher fatty acids, such as stearic and palmitic. Oils (especially drying oils) are used for the production of alkyd resins, emollients, and cooking oils. Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Philadelphia, PA, 2001. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Martens CR (1961) Alkyd resins. Reinhold Publishing Co., New York.

**Fat turpentine** Oxidized turpentine. Turpentine thickened by exposure to air at elevated temperature or for long periods at ambient temperature.

**Fatty acid** (ca. 1872) *n.* Organic acid of the general formula $C_nH_{2n}O_2$, e.g., butyric acid and stearic acid; organic acids of aliphatic or open chain structure. These are generally classified as saturated or unsaturated. The saturated fatty acids range from $C_4$ to $C_{26}$. Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Fatty acid pitches** Pitch-like residues obtained from the distillation of fats and oils of animal or vegetable origin, or of their fatty acids. Fatty acid pitches include cottonseed pitch, palm oil pitch, wool grease pitch, etc. They have comparatively high acid and saponification values.

**Fatty nitrogen products** Nitrogen-containing compounds derived from vegetable and animal fatty acids.

**Fatty paint** Paint, which has thickened because of oxidation and polymerization of the drying oil vehicle during storage.

**Fatty polyamide** (Versamid®, oldest of many trade names). A polymer formed by the condensation of a dibasic acid having a bulky side group and from 13- to 21-carbon chains, or the dimmer acids, C-36, with di- or polyamines. The commercially important dimmer acids are addition products of unsaturated C-18 fatty acids and can take several forms, giving different structures to the polyamides. They are used in hot-melt adhesives, inks, as epoxy flexibilizers and, in amine form, as curing agents for epoxies. Skeist I (ed) (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Faux Hois** Painted decoration simulating marble, tortoise shell or wood grain.

**Fay** \ˈfā\ [ME *feien*, fr. OE *fēgan*; akin to OHGr *fuogen* to fit, L *pangere* to fasten] (before 12c) *v.* To smooth and fit together, as with two surfaces about to be lap-joined.

**FDA** Abbreviation for food and drug administration, the USA agency within the Department of Health, Education, and Welfare that is concerned with the safety of products marketed for consumer use, particularly those substances that might be ingested, applied to the skin, or used in therapy or prostheses.

*See food and drug administration.*

**Fe** Chemical symbol for the element iron (Latin: ferrum).

**FE** Fluorine-containing elastomers.

**Feather edging** Reducing the thickness of the edge of a dry paint film, e.g., the edge of a damaged area, prior to repainting.

**Feathering** (1) Operation of tapering off the edges of a coat of paint by laying off with a comparatively dry brush. (2) Printing with irregular edges to the design. (3) A ragged or feather edge which shows at the edge of type or cuts. It may be caused by poor ink distribution, bad impression, excessive ink or an ink not suitable for the paper. Printing ink handbook, 5th edn. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1999. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

*Also called laying off.*

**Feculose** A mixture of esters prepared by treating starch with glacial acetic acid and washing the product free of uncombined acid.

**Federation of societies for coatings technology** A not-for-profit organization comprised of affiliated members and members belonging to its constituent societies in USA, Canada, Mexico, and England, located at 492 Norristown Road, Blue Bell, PA 19422-2350 (www.coatingstech.org). Members are engaged in research, engineering, technical development, quality control, supervisory production, administrative management and sales for the manufacture, use or improvement of the finished products or raw materials of the coatings and printing ink industries. Prior to 1975, it was known as the Federation of Societies for Paint Technology.

**Feedback control** A system of controlling a machine or process in which the difference between a measured output variable and its target value is amplified and, through automation, causes an appropriate adjustment of an input machine variable or process condition that will move the output nearer to its target.

**Feed block** In coextrusion, a massive metal block in which the streams of the several extruders are brought together to form the layers of a single stream just before it enters the die.

**Feed bushing** Syn: sprue bushing.

**Feedforward control** Process control in which early process variables are monitored and their disturbances are fed to a process model that computes adjustments of the variables needed to provide the desired process outputs. Compare feedback control.

**Feed hopper** An inverted conical or pyramidal vessel mounted over the feed port of an extruder or injection-molding machine that contains a supply of pellets or powder being fed. Feed hoppers typically have a slender window from bottom to top along one side to permit observation of the feedstock level.

**Feeding** British term for livering.

*See livering.*

**Feed plate** In injection molds, the plate contacting the injection nozzle and containing the sprue and, usually, most of the runner system. Used withy a floating cavity plate, the system provides for separation of runners and sprue from the moldings and stripping of both into separate collectors or chutes.

**Feed port** An opening at the rear end of the barrel of an extruder of injection molder through which plastic powder or pellets fall into the rotating screw or, in older injection machines, in front of the withdrawn ram (raw now).

**Feedscrew** *See extruder screw.*

**Feed zone** The first (rear) zone of an extruder screw that is fed from the hopper, usually of constant lead and greater depth than other zones and officially terminating at the beginning of the compression zone.

**Feel** A journeyman's term for the working qualities of a paint.

*See hand.*

**Feldspar** \ˈfel(d)-ˌspär\ [mod. of obs. Gr *Feldspath* (now *Feldspat*), fr. *G Feld* field + obs. Gr *Spath* (now *Spat*) spar] (1772) *n.* $K_2O{\cdot}Al_2O_3{\cdot}6SiO_2$. Natural potassium aluminum silicate, which occurs in granite. The gradual decomposition of feldspar by natural agencies yields china clay and silica. Any of several anhydrous minerals containing aluminum silicates or alkali or alkaline-earth metals (Na, K, Ca, and Ba) which, when ground, make low-cost, modulus-raising, non-toxic fillers for plastics. McGraw-Hill dictionary of geology and mineralogy. McGraw-Hill, New York, 2002. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Fell** (1) The end of a piece of fabric that is woven last. (2) In weaving, the last filling pick laid in the fabric at any time.

**Felt** [ME, fr. OE; akin to OHGr *filz* felt, L *pellere* to drive, beat] (before 12c) *n.* (1) Matted fibers of wood, cotton, fur, hair, etc., individually or in combination, compacted by rolling under pressure. (2) A non-woven, fibrous material made up of randomly oriented fibers held together by stitching, a chemical binder, or by action of heat or moisture.

**Felt and gravel roofing** *See built-up roofing.*

**Felting** (1686) *n.* (1) The process of exposing wool fibers alone or in combination with other fibers to mechanical and chemical action, pressure, moisture, and heat so that they tangle, shrink, and mat to form a compact material. Felting is generally carried out in a fulling mill. (2) *See needle-punching and needled fabric.*

*Also see fulling.*

**Felting down** Operation of flatting down a dry film of varnish or paint by means of a pad made of felt or similar material, charged with a very fine abrasive powder and lubricated with water or other suitable liquid.

**Femto-** \ˈfem(p)-tō\ [ISV, fr. Dan or N *femten* fifteen, fr. ON *fimmtān*; akin to OE *fīftēne* fifteen (f). The SI prefix meaning $\times 10^{-15}$.

**Fenchol** $C_{10}H_{17}OH$. High boiling alcohol present in terpene solvents. Bp of 201°C, Sp gr, 0.964/20°C, and mp of 38°C.

*Known also as fenchyl alcohol.*

**Fenchone** $C_9H_{16}C{=}O$. Ketonic constituent of terpene solvents, Bp, 193°C; Sp gr, 0.945, refractive index of 1.4625; mp, 5°C.

**Fenchyl alcohol** *See fenchol.*

**FEP** Abbreviation for fluorinated ethylene–propylene resin.

**Fermat's principle** The path followed by light (or other waves) passing through any collection of media from one specified point to another, is that path for which the time of travel is least.

**Fermentation alcohol** *See ethyl alcohol.*

**Ferric** \ˈfer-ik\ (1799) *adj.* (1) Of, relating to, or containing iron. (2) Being or containing iron usually with a valence of three.

**Ferric ammonium citrate** (ca. 1924) *n.* A complex salt containing varying amounts of iron and used for making blueprints.

**Ferric hydroxide** (1885) *n.* $Fe_2O_3{\cdot}nH_2O$. A hydrate of ferric oxide that is capable of acting both as a base and as a weak acid.

**Ferric oxide** (1882) *n.* $Fe_2O_3$. Iron (III) oxide. Stable anhydrous oxide of iron. This constitutes the major ingredient in the chemically prepared synthetic reds. Indian reds, iron oxides, etc., but in the natural red oxides the proportion of ferric oxide varies considerably and is frequently associated with hydrated forms of the oxide.

*See iron oxides.*

**Ferriferro cyanide** *See iron blue.*

**Ferrite** \ˈfer-ˌīt\ (1851) (hard ferrite) *n.* A compound having the general formula $MFe_{12}O_{19}$, in which M is usually a divalent ion such as barium or strontium. These materials are strongly magnetic and can be incorporated into plastics to make bonded permanent magnets, rigid or flexible, and in many forms, including strips.

**Ferrite yellow** $Fe_2O_3{\cdot}xH_2O$. Pigment Yellow 42 (77492) Synthetic type iron oxide with a color range from bright yellow to dark orange. Manufactured by oxidizing ferrous hydroxide to the desired shade of hydrated ferric oxide.

*Also known as yellow iron oxide. See iron oxides, synthetic.*

**Ferrocene** \ˈfer-ō-ˌsēn\ [*ferro-* + *cycl-* + *-ene*] (1952) (dicyclopentadienyl iron) *n.* $(C_5H_5)_2Fe$. A coordination compound of ferrous iron and cyclopentadiene, soluble in PVC and stable to 400°C. Its uses include smoke suppression, a curing agent for silicone resins, an intermediate for high-temperature polymers, and an ultraviolet absorber. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Ferromagnetism** \-ˈmag-nə-ˌti-zəm\ (1896) *adj.* A strong attraction into a magnetic field. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Ferrous oxide** (1873) *n.* FeO. A black easily oxidizable power that is the monoxide of iron.

**Ferrous sulfate** (1865) *n.* $FeSO_4 \cdot 7H_2O$.
*Also known as copperas and green vitriol.*

**Ferrule** \ˈfer-əl\ [alt. of ME *virole*, fr. MF, fr. L *viriola*, dim. of *viria* braclet, of Celtic origin; akin to OIr *fiar* oblique] (1611) *n.* Metal portion of the brush holding bristles, hair, feathers or other fibrous and flexible materials.

**Festoon dryer** A dryer in which cloth is suspended in loops over a series of supporting horizontal poles and carried through the heated chamber in this configuration.

**Festooning** Method of drying employed for heavy fabrics, impregnated with varnish or oils, which involves hanging the treated material over horizontal rods or poles in large drying rooms. While the impregnant is still wet, the fabric is moved gradually to avoid excessive accumulations of impregnant in the bottom of the folds. Process by which wallpaper is hung and dried after being printed. Sticks carry the paper, in long loops, through a drying chamber. Kadolph SJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Festooning oven** An oven used to dry, cure, or fuse plastic-coated fabrics with uniform heating. The substrate is carried on a series of slowly rotating shafts with long loops or "festoons" between the shafts.

**FF** Abbreviation for furan-formaldehyde polymer.
*See furan resin.*

**Fiber** \ˈfī-bər\ [F *fibre*, fr. L *fibra*] (1540) (fibre) *n.* A single homogeneous strand of material having a length of at least 5 mm, that can be spun into a yarn or roving or made into a fabric by interlacing in a variety of methods. Fibers can be made by chopping filaments (converting). Staple fibers may be 1.2–8 cm in length with lineal density from 0.1 to 0.5 mg/m. The natural fibers used by mankind from the earliest times were first supplemented by rayon and acetate, both of which are derived from cellulose. The first commercially successful, wholly synthetic fiber was nylon, introduced in 1939. Then followed acrylic fibers in 1950, polyesters in 1951, and various other polymeric fibers in subsequent years. In 1967 the wholly synthetic, "man-made" fibers surpassed the natural fibers in volume produced. Complete textile glossary. Celanese Acetate LLC, New York, 2000.
*See also manufactured fiber, natural fiber and synthetic fiber.*

**Fiber architecture** The spatial arrangement of fibers in the preform. Each architecture has a definite repeating unit.

**Fiberboard** (1897) *n.* Building material composed of wood or other plant fibers bonded together and compressed into rigid sheets.

**Fiber content** The percent by volume of fiber in a fiber-filled molding compound, or a molding or a laminate. Fiber content is sometimes started as weight percent.

**Fiber direction** (fiber orientation). In a laminate, the direction(s) in which most of the fibers' lengths lie, relative to the length axis of the part.

**Fiber distribution** In a web, the orientation (random or parallel) of fibers and the uniformity of their arrangement.

**Fiber fill** Manufactured fibers that have been specially engineered for use as filling material for pillows, mattress pads, comforters, sleeping bags, quilted outerwear, etc. Polyester fibers are widely used.

**Fiberfill molding** (Fiberfil™). A term used for an injection-molding process employing as a molding material pellets containing short bundles of fiber surrounded by resin.

**Fiberglass** (Fiberglass™). *See glass-fiber reinforcement.*

**Fiber migration** *See migration* (2).

**Fiber number** The linear density of a fiber expressed in units such as denier or tex. *Also see fineness.*

**Fiber optics** (1956) *n.* A term employed for light-transmitting fibers of glass and some plastics, such as polymethyl methacrylate. Each fiber is coated with a material with a refractive index lower than that of the fiber itself, and many fibers may be gathered in a bundle that is jacketed with polyethylene or other flexible plastic. Such bundles transmit light from one end to the other even through curved. Applications are in aircraft and automobile instrument panels, telephone lines, electronics, displays, medical techniques, and packaging. Meeten GH (1986) Optical properties of polymers. Springer-Verlag, New York.

**Fiber placement** In general, refers to how the piles are laid into their orientation, i.e., by hand, by a textile process, by a tape layer, or by a filament winder. Tolerances and angles are specified. Microprocessor-controlled placement that gives precise control of each axis of motion permits more intricate winding patterns than are possible with conventional winding and is used to make composites that are more complex that usual filament-wound structures. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Fiber-reactive dyes** *See dyes.*

**Fiber-reinforced plastic (FRP)** Any plastic material, part or structure that contains reinforcing fibers, such as glass, carbon, synthetic, or metal fibers generally having strength and stiffness much greater than that of the matrix resin, thereby improving those properties, Because glass fibers were used so early and widely, FRP is often used to mean *glass-fiber-reinforced plastics.* Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

*See also advanced composites, composite laminates, and reinforced plastic.*

**Fiber–resin interface** (fiber-matrix interface). The surfaces shared by the fibers and the resin in a fiber-reinforced plastic structure. This interface, and the effects of various *sizes* and chemical treatments on the interfacial bond, are subjects of many past and ongoing studies. Because of the pretreatment of fibers with sizes, the interface has a small but finite thickness.

**Fiber–resin ratio** An expression, as a ratio of fiber to resin, of the fiber content.

**Fiber show** (fiber prominence). In reinforced plastics, a condition in which ends of reinforcement strands, rovings, or bundle unwetted by resin appear on or above the surface. It is believed to be caused by a deficiency in the glass, and may not appear until the part is fully cured. Remedies include measures to improve wet-out, use of resins of optimum viscosity, and reducing exotherm rates, which cause stresses within the laminate, and gel coating after the main body of the part has partly cured. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Fiber spinning** *See spinning.*

**Fiber streak** (fiber whitening). A group of fibers within a translucent laminate that were incompletely wetted by resin, appearing as a whitish defect.

**Fiber stress** The stress acting on the reinforcing fibers in a laminate under load (estimated). Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Fibrets** Very short, fine fibrillated fibers that are highly branched and irregular resulting in very high surface area. Filberts can be produced from a number of substances including acetate, polyester, nylon, and polyolefins. By selection of polymer type and incorporation of additives, they can be engineered to meet a range of specialized requirements. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Fibrids** Short, irregular fibrous products, made by mixing a dilute polymer solution with a non-solvent with agitation. They can also be made by flash spinning and breaking up the resulting filaments. Used in felts, in papermaking, for filtration product, etc. *Also see fibrets.*

**Fibril** \ˈfī-brəl\ [NL *fibrilla*, dim. of L *fibra*] (1664) *n.* A short threadlike element of a synthetic or natural fiber. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Fibrillated-film yarn** *See slit-film yarn.*

**Fibrillation** The phenomenon in which a filament or fiber shows evidence of smaller-scale fibrous structure by a longitudinal raveling of the filament under rapid, excessive tensile or shearing stress. Separate fibrils can then often be seen in the main filament trunk. The whitening of polyethylene when severely strained at room temperature is a manifestation of fibrillation. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Fibrils** A single crystal in the form of a fiber.

**Fibrous asbestos** *See magnesium silicate, fibrous.*

**Fibrous-glass reinforcement** *See glass-fiber reinforcement.*

**Fibrous magnesium silicate** *See magnesium silicate, fibrous.*

**Fick's law** (Fick's first law). (1) The net diffusion rate of a gas across a membrane is proportional to the difference in partial pressure, proportional to the area of the membrane and inversely proportional to the thickness of the membrane. Fick's law is the basic law of diffusion of different molecular species into each other. (2) Combined with the diffusion rate from Graham's law, Fick's law provides the means for calculating exchange rates of gases across membranes. (3) Fick's law states that the flux of a given component will be in the direction in which the concentration of that component decreases most steeply (i.e., opposite the gradient), at a rate given by the product of the mutual diffusivity and the gradient. Fick's law, which has many equivalent forms, is the defining equation for diffusivity. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Field coat** The coat(s) applied at the site of erection or fabrication.

**Field diaphram** The diaphram on the lamp housing which controls the size of the illuminated field of view in Köhler illumination.

**Field painting** Surface preparation and painting operations of structural steel or other materials conducted at the project site.

**Fiery finish** *See burned finish.*

**Figure** \ˈfi-gyər, *British and often USA* ˈfi-gər\ [ME, fr. OF, fr. L *figura*, fr. *fingere*] (13c) (Wood) *n.* The pattern produced in wood surface by irregular coloration and by annual growth rings, knots and such deviations from regular grain as interlocked and wavy grain.

**Filament** \ˈfi-lə-mənt\ [MF, fr. ML *filamentum*, fr. LL *filare* to spin] (1594) *n.* A variety of fiber characterized by extreme length, which permits its use in yarn with little or no twist and usually without the spinning operation required for fibers. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

*See also monofilament.*

**Filamentary composite** A reinforced-plastic structure in which the reinforcement consists of filaments usually oriented to most efficiently withstand the stresses imposed on the structure. The filaments are not woven and in a single lamina they will all be parallel. Wallenberger FT, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York.

**Filament count** The number of individual filaments that make up a thread or yarn. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Filament number** The linear density of a filament expressed in units such as denier or tex.

*Also see fineness.*

**Filament winding** A method of forming reinforced-plastic articles comprising winding continuous strands of resin-coated reinforcing material onto a mandrel. Reinforcements commonly used are single strands or rovings of glass, asbestos (rare today because of carcinogenicity fright), jute, sisal, cotton, and synthetic fibers. Polyester resins are most widely used, followed by epoxies, acrylics, nylon, and various others. To be effective, the reinforcing material must form a strong adhesive bond with the resin. The mandrels may be permanent structures remaining in the finished article, or of flexible or destructible material, or able to be disassembled, i.e., capable of being removed after curing. The process is performed by drawing the reinforcement from a spool or creel through a bath of resin, then winding it on the mandrel under controlled tension and in a predetermined pattern. The mandrel may be stationary, in which event the creel structure rotates about the mandrel; or it may be rotated on a lathe about one or more axes. By varying the relative amounts of resin and reinforcement, and the pattern of winding, the strength of filament-wound structures may be controlled to resist stresses in specific directions. After sufficient layers have been wound, the structure is cured at room temperature or with heat. Wallenberger FT, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York, 2003. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Filament-wound** Made by filament winding.

**Filament yarn** A yarn composed of continuous filaments assembled with or without twist.

*Also see yarn.*

**Filiform** \ˈfi-lə-ˌfórm\ (1757) *adj.* Slender as a thread.

**Filiform corrosion** A type of corrosion that occurs under coatings on metal substrates characterized by a definite thread-like structure and directional growth. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX. Uhlig HH (2000) Corrosion and corrosion control. John Wiley and Sons Inc., New York.

**Filiform corrosion resistance** The ability of a coating to resist that type of corrosion of metal substrates characterized by a definite

thread-like structure and directional growth that occurs under coatings. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX.
*See filiform corrosion.*

**Filing** Manual filing is sometimes used to bevel, smooth, deburr, and fit the edges of plastic moldings and sheets. The process is limited to parts that cannot be tumbled easily, and to plastics with suitable hardness and heat resistance.

**Fill** *n*, *adj*. Syn: weft.

**Fill-and-wipe** A decorating process for articles molded with depressed designs, wherein the general area containing the designs is coated with paint by brushing, spraying, or rolling, then surplus paint is wiped from the undepressed areas surrounding the depressions.

**Filled plastic** Any plastic compound containing a significant percentage of a solid, usually not fibrous or resinous, material whose main purpose may be to dilute the resin, or to provide certain enhanced properties in the compound.

**Filler** \\ˈfi-lər\\ (15c) *n*. (1) A pigmented composition used for filling fine cracks and indentations to obtain a smooth, even surface preparatory to painting. (2) Synonymous with extender. (3) A relatively non-adhesive substance added to an adhesive to improve its working properties, permanence, strength, and other qualities. (4) Any compounding ingredient, usually in dry, powder form, added to rubber in substantial amount to improve quality of lower cost. Fillers have various effects; some are relatively inert, like calcium carbonate and silica, and provide loading for cost reduction; others, like carbon blacks, have a definite and desirable reinforcing effect with improvement in abrasion resistance and other properties. Fillers provide are added to a plastic compound to reduce its cost per unit volume and/or to improve such mechanical properties as hardness, modulus, and impact strength. (5) A filler differs from reinforcement in two respects. Filler particles are generally small and roughly equidimensional, and they do not markedly improve the tensile strength of a product. Reinforcements, on the other hand, are fibrous, having one dimension much longer than the others, and they do markedly improve tensile strength. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York, 1986-, 1990-, 1992-, 1993-editions. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Filler sheet** *n*. A sheet of deformable or resilient material, that when placed between the assembly to be bonded and the pressure applicator, or when distributed within a stack of assemblies, aids in proving uniform application of pressure over the area to be bonded. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Filler coat** A coat of paint, varnish, etc., used as a primer.

**Filler rod** (welding rod). A rod of plastic material used in hot-gas welding, made of the same material as the plastic to be welded.

**Filler specks** Visible particles of a filler, such as wood flour or asbestos, that stand out in color contrast against a background of plastic binder.

**Fillet** \\ˈfi-lət\\ [ME *filet*, fr. MF, dim. of *fil* thread] (14c) *n*. A concavely curved transition at the angle formed by the junction of two plane surfaces, i.e., a rounded inside corner. Also, the material making up the transition. Where the surfaces are likely to endure bending toward or away from each other, the fillet distributes and reduces the stress that would otherwise be magnified at the corner.

**Filling** In a woven fabric, the yarn running from selvage to selvage at right angles to the warp. Each crosswise length is called a pick. In the weaving process, the filling yarn is carried by the shuttle or other type of yarn carrier.

**Filling band** *See mixed end or filling.*

**Filling Barré** *See Barré.*

**Filling bow** *See skewness.*

**Filling of coated abrasives** Clogging of the abrasive coat by swarf. It can be reduced in many operations by using an open coat construction or a lubricant. Syn: loading.

**Filling skewness** *See skewness.*

**Filling snarl** *See snarl.*

**Filling up (or filling in)** A condition in the printing of halftones where the ink fills areas between the dots, and produces a solid rather than a sharp halftone print.

**Filling up** (1) Covering the non-printing areas (on a lithographic plate) with a partially dried ink film. Effect caused by an excessive drier in the ink. (2) A condition in the printing of halftones where the ink fills areas between the dots, and produces a solid, rather sharp halftone print. They may also occur in the printing of type matter. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 5th edn. Kluwer Academic Press, London, UK, 1999. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Filling yarn** *See split-film yarn and weft.*

**Fill-type insulation** Loose insulating material, which is applied by hand or blown into wall spaces mechanically.

**Film** \ˈfilm, *Southern also* ˈfi(ə)m\ {often attributive} [ME *filme*, fr. OE *filmen*; akin to Gk *pelma* sole of the foot, OE *fell* skin] (before 12c) *n.* (1) Customarily in the plastics industry, a web of plastic that is 0.25 mm or less in thickness. Thicker webs are called *sheet*. Films are made by extrusion, casting from solution, and calendaring. (2) In convective heat transfer, the thin, supposedly stagnant layer of fluid next to a heated or cooled surface (such as a pipe wall) that contributes part (or all) of the resistance to transfer of heat from the main body of the fluid to a medium on the opposite side of the wall (or to the wall itself. A closely related concept exists in mass transfer. (3) A layer of one or more coats of paint or varnish covering an object or surface. (4) Any supported or unsupported thin continuous covering or coating. (5) Unsupported, usually organic, non-fibrous, thin, flexible material of a thickness not exceeding 0.010 in. In excess of 0.010 in. thickness, such material is usually called sheet or sheeting. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Film blowing** (blown-film extrusion). The process of forming thermoplastic film wherein an extruded plastic tube is continuously inflated by internal air pressure, cooled, collapsed by rolls, and subsequently wound into rolls on thick cardboard cores. The tube is usually extruded vertically upward, and air is admitted through a passage in the center of the die as the molten tube emerges from the die. An air ring is always employed to speed and control the initial cooling close to the die. Air is contained within the blown bubble by a pair of pinch rolls that also serve to collapse and flatten the film. Thickness of the film is controlled not only by the die-lip opening but also by varying the internal air pressure and by the rates of extrusion and take-off. Extremely thin films (<0.01 mm) and films with considerable biaxial orientation can be produced by this method. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Film build** The rheological property which coatings possess of providing thickness in applied films. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Film casting** The process of making an unsupported film or sheet by casting a fluid resin, a resin solution, or a plastic compound on a temporary carrier, usually an endless belt or circular drum, followed by solidification by cooling or drying, and removal of the film from the carrier. The term *film casting* is also used for the process of extruding a molten polymer through a slot die onto a chilled roll. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Film coefficient** (1) In convective heat transfer, the rate of heat flow through a "stagnant" fluid film adjacent to a solid surface, per unit area of the film, divided by the temperature difference through the film. (2) A similarly structured definition applying to mass transfer through films at fluid interfaces. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Film die** A die for the extrusion of flat or blown film. Flat-film dies are usually of the crosshead and coathanger designs with one lip locally adjustable so as to achieve uniform thickness across the film (*see flexible-lip die*). Blown-film dies are cylindrical, end- or side-fed, with the concentricity/eccentricity of the core and body adjustable for circumferential uniformity of film thickness. That uniformity, which is critical in both types of films for winding even rolls, also depends on the performance of the air ring. Blown-film dies are often oscillated slowly about their axes to distribute the remaining non-uniformity evenly over the final roll width, in that way assuring that the unrolled film will lie flat in spite of slight thickness variations. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Film extrusion** Making plastic films by extruding molten plastic through a film die by film blowing or film casting. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Film formation** Term applied to an extruded sheet of a polymer.

**Film former** A type of resin with qualities of forming a tough, continuous dry film. Example: nitrocellulose.

**Film forming** Ability of a material to form a continuous dry film.

**Film integrity** Continuity of a coating free of defects.

**Filmogen** General term for film forming materials.

**Film slitting** *See slitting.*

**Film thickness** Thickness of any applied coating, wet or dry.

**Film, thickness gauge** Device for measuring film thickness; instruments for measuring either wet or dry films are available.

**Filter aid** Inert, insoluble material, more or less finely divided, used as a filter medium or to assist in filtration by maintaining adequate porosity of the filter cake.

**Filter cake** The solid mass remaining on a filter after the liquid that contained it has passed through.

**Filter cloth** Any cloth used for filtering purposed. Nylon, polyester, vinyon, PBI, and glass fibers are often used in such fabrics because they are not affected by most chemicals.

**Filter fabrics** *See geotextiles and filter cloth.*

**Filter, optical** Any uniform optical device, which transmits radiant energy of limited wavelengths and/or intensity. Filters may be made of glass, quartz, plastic, etc., containing absorbent material. They may consist of thin metallic coatings on glass or plastic; or they may consist of carefully made screens of uniform pore size. Optical filters may be used to modify the spectral distribution of radiant energy (selective filters) or the photometric intensity of radiant energy (neutral filters). Moller KD (2003) Optics. Springer-Verlag, New York. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Filter press** Apparatus for filtering, consisting of a number of flat chambers enclosed between sheets of filter cloth (paper or metal) through which the liquids is forced by a pump, leaving the solid matter in the chambers.

**Filter spectrophotometer** A spectrophotometer that uses filters of fixed, narrow band-pass transmissions of discrete wavelengths spaced across the spectrum, to measure the transmittance or reflectance of materials at these discrete wavelengths. The resulting special data arranged in order constitute an abridged spectrophotometric curve. Thus, the series of filters replaces the dispersion monochromator used in a continuous spectrophotometer. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand, Company, New York.

**Filtration** \fil-ˈtrā-shən\ (1605) *n.* The operation of separating suspended solids from a liquid, or gas, by forcing the mixture through a porous barrier.
*See straining.*

**Fin** *n.* Overflow material protruding from surface of cured, molded articles, usually appearing at mold separation line or mold vent points.
*See flash.*

**Findings** *n.* (1) Miscellaneous items attached to garments and shoes during manufacture. Included are buttons, hooks, snaps, and ornaments. (2) Miscellaneous fabrics in garments such a zipper tapes, linings, pockets, waistbands, and facings.

**Fine end** *n.* (1) A warp yarn of smaller diameter than that normally used in the fabric. (2) A term for a defect in silk warp yarn consisting of thin places that occur when all the filaments required to make up the full ply are not present. This condition is generally caused by poor reeling.

**Fine-etching** *n.* A method of modifying a photomechanically prepared plate by controlled undercutting to change the size of the halftone dots.

**Fine melt** Process of running copals at high temperatures as distinct from low temperature running, which is described as a slack melt.

**Fineness** *n.* (1) A relative measure of fiber size expressed in denier or tex for manufactured fibers. For cotton, fineness is expressed as the mean fiber weight in micrograms per inch. For wool, fineness is the mean fiber width or mean fiber diameter expressed in microns (to the nearest 0.001 mm). (2) For yarn fineness. (3) For fineness of knit fabrics.
*See yarn number.*

**Fineness of dispersion** *n.* A measure of the size and prevalence of oversize particles in the coating or ink. The Hegman Gage is a widely used tool for measuring fineness of particles for coatings and inks supplied by Paul N. Gardner Company Inc., 316 N. E. Fifth Street, Pompano Beach, FL (www.gardco.com). Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 5th edn. Kluwer Academic Press, London, UK, 1999. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Fineness of grind** (deprecated) *n.* The degree of dispersion of a pigment in a printing ink vehicle, usually measured on a grindometer or grind gauge. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Fineness of grind gauge** *n.* A device to measure the fineness of dispersion of a pigment, based on drawing a paint down over a channel of tapered depth and observing the minimum depth at which pigment particles are observed to interfere with the smooth wet surface of the paint. ASTM provides standards for fineness of grind (www.astm.org). The Hegman Gage is a widely used tool for measuring fineness of grind for coatings and inks supplied by Paul N. Gardner Company Inc., 316 N. E. Fifth Street, Pompano Beach, FL (www.gardco.com). Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc., New York. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Fines** *n.* In the classification of powdered or granular materials according to particle size, fines are in portion of the material whose particles are smaller than a stated minimum size. When the particle-size distribution is determined by sieve analysis, the fines are those particles passing the finest sieve and found on the pan, usually designated as "minus 000 mesh", where 000 is the mesh number of that finest sieve. Provder T, Texter J (eds) (2004) Particle sizing and characterization. American Chemical Society, Washington, DC.

**Fine structure** *n.* Orientation, crystallinity, and molecular morphology of polymers, including fiber-forming polymers.

**Finger mark** *n.* A defect of woven fabrics that is seen as an irregular spot showing variation in picks per inch for a limited width. Causes are spreading of warp ends while the loom is in motion and pressure on the fabric between the reed and take-up drum. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Fingernail test** *n.* Gouging a dried film with fingernail to form a subjective, qualitative estimate of the relative hardness and toughness.

**Fingers** \ˈfiŋ-gər\ [ME, fr. OD; akin to OHGR *fingar* finger] (before 12c) *n.* Classification of fossil copals, especially of the Congo type. The pieces of resin have long cylindrical shapes, similar to those of human fingers.

**Finish** \ˈfi-nish\ [ME *finisshen*, fr. MF *finiss*-, stem of *finir*, fr. L *finire*, fr. *finis*] *n.* (1) Refers to the degree of gloss or flatness of a print or any surface. (2) (size) In reinforced plastics, a compound containing a coupling agent and (optionally) a lubricant and/or binder, used to pretreat glass fibers prior to using them as reinforcements.

(3) The surface texture of a molding, a machined or polished surface, or other article. When measured, it is usually stated as the root-mean-square roughness in nanometers or microinches. (4) The final coat in a painting system. (5) Sometimes refers to the entire coating system: the texture, color, and smoothness of a surface, and other properties affecting appearance. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA, 2004. Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Finish coat** *n.* (1) The final layer of plaster applied over a basecoat or other substrate. (2) *See top coat.*

**Finish composition (yard)** *n.* Physical and chemical analysis of the lubricant applied to yarns to reduce friction and improve processability.

**Finished fabric** Fabric that is ready for the market, having passed through the necessary finishing processes. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

**Finishing** *n.* (1) The removal of flash, gates, and defects from plastic articles. (2) The development of a desired texture and/or color on the surfaces of an article when such are not accomplished in compounding and forming the article.

*See grind, polishing, sanding, and the processes listed under decorating.*

**Finishing bar** *n.* A noticeable streak across the entire width of a fabric, usually caused by machine stoppage during processing.

**Finishing spot** *n.* A discolored area on a fabric caused by foreign material such as dirt, grease, or rust.

**Finish insert** (neck insert). In blow molding bottles, a removable part of the mold that aids in forming a specific neck finish of the bottle.

**Finish turns** The actual degree of twist in the final yarn product.

**Finn oil** *See tall oil.*

**Fire clay** *n.* An earthy or stony mineral aggregate, which has the essential constituent hydrous silicates of aluminum with or without free silica. It is plastic when sufficiently pulverized and wetted, rigid when subsequently dried, and of suitable refractoriness for use in commercial refractory products.

**Fire point** *n.* The temperature at which a material, when once ignited, continues to burn for a specified period of time. The fire point is several degrees of temperature higher than the flashpoint. It is the lowest temperature at which a liquid evolves vapors fast enough to support continuous combustion. Troitzsch J (2004) Plastics flammability handbook: principle, regulations, testing and approval. Hanser–Gardner Publications, New York. Babrauskas V (2003) Ignition handbook. Fire Science Publishers, New York. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997.

**Fire resistance** *n.* The property of a material or assembly to withstand fire or give protection from it. As applied to elements of buildings, it is characterized by the ability to confine a fire or to continue to perform a given structural function or both.

*See flammability.*

**Fire-resisting finish** *n.* The preferred term is “fire-retardant coating”.

**Fire resistive** *n.* Refers to properties of materials or designs to resist the effects of any fire to which the material or structure may be expected to be subjected. Fire resistive materials or structures are non-combustible, but non-combustible materials are not necessarily fire resistive. Fire resistive implies a higher degree of fire resistance than non-combustible.

**Fire retardant** *n.* Descriptive term which implies that the described product, under accepted methods of test, will significantly: (a) Reduce the rate of flame spread on the surface of a material to which it has been applied. (b) Resist ignition when exposed to high temperatures. (c) Insulate a substrate to which it has been applied and prolong the time required to reach its ignition, melting, or structural-weakening temperature.

**Fire-retardant chemical** *n.* A chemical or chemical preparation used to reduce flammability or to retard the spread of flame.

**Fire-retardant coating** *n.* A coating, which will do one or more of the following: (1) Reduce the flame spread over which the coating is applied, sometimes at the sacrifice of the coating. (2) Resist ignition when exposed to high temperature. (3) Insulate substrate to which it is applied and thereby prolong time required to reach ignition, melting or structural-weakening temperature.

*See intumescent coatings.*

**First coat** First coating applied in any painting schedule; in some cases, it would be the sealing coat; in others, the priming coat.

**First-down color** *n.* In a multicolor printed material this is the first color printed on the substrate usually subsequently overprinted by other colors.

**First-order kinetics** *n.* A thermal transition that involves both a latent heat and a change in the heat capacity of the material.

**First-order transition temperature** *n.* The temperature at which a polymer freezes or melts.

**First quality** *See yarn quality.*

**Fish eye** *n.* (1) Paint defect which manifests itself by the crawling of wet paint into a recognized pattern resembling small "dimples" or "fish eyes." (2) A visible fault in transparent or translucent plastics, particularly films or thin sheets, appearing as a small globular mass (gel particle) and thought to be caused either by stray resin particles of much higher molecular weight than that of the polymer as a whole, or by inclusion of foreign particles. In rubber technology, such globules are known as "cat eyes". Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, Philadelphia, PA. Paint testing manual: physical and chemical examination of paints, varnishes, lacquers, and colors – STP 500. American Society for Testing and Materials, Philadelphia, PA, 1973. Hess M (1965) Paint film defects. John Wiley and Sons Inc., New York.

*See pinhole.*

**Fish oil** *n.* A natural oil extracted from fish and generally characterized by a rather large group of saturated fatty acids commonly associated with mixed triglycerides (Fish oil: a key to better coatings, manufacturing engineering magazine, 15 October 1987). The fatty acids derived from fish oils are three principal types: saturated, monounsaturated and polyunsaturated with carbon chain lengths ranging from $C_{12}$ to $C_{24}$. Both types and relative amounts of the fatty chains vary widely among different species of fish and different geographical areas. The fish oil commonly used in the coatings industry is *menhaden oil*, produced from *menhaden* *fish* caught along the Atlantic Coast of USA. This oil has an iodine value of about 175. Other common types of fish oils and their iodine values are: herring – 134, anchovy – 199. In addition to glycerides of stearic and the lesser unsaturated fatty acids, fish oils, contain glycerides of clupanodonic acid, which appears to contain four double bonds. The iodine value varies over a wide range, approximately 130–1990. Fish oil is available in Asia, Europe, or anywhere a fishing industry is active. The tendency of fish oils films to yellow considerably is due to the presence of highly unsaturated groups in the molecule. Gooch JW (2002) Emulsification and Polymerization of Alkyd Resins. Kluwer Academic/Plenum Publishers, New York. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978.

**Fishtail die** Syn: fantail die.

**Fission** \ˈfi-shᵊn, -zhᵊn\ [L *fission-*, *fission*, fr. *findere* to split] (ca. 1617) *n.* A nuclear reaction from which the atoms produced are each approximately half the mass of the parent nucleus. In other words, the atom is split into two approximately equal masses. There is also the emission of extremely great quantities of energy since the sum of the masses of the two new atoms is less than the mass of the parent heavy atom. The energy released is expressed by Einstein's equation. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Fissure** \ˈfi-shər\ [ME, fr. MF, fr. L *fissura*, fr. *fissus*] (14c) *n.* A term used in the cellular-plastics industry to denote a separation, crack, or split in a formed cellular article.

**Fitch** *n.* Long handled small brush bound with metal, with which nearly inaccessible areas are painted.

**Five regions of viscoelasticity** *n.* As an amorphous polymer is heated from an extremely low temperature it gains more dimensions of molecular motion and its mechanical behavior changes through five qualitative regions: glassy, slowed elastic, rubbery, rubbery flow, and viscous flow.

**Fixation** *n.* The process of setting a dye after dyeing of printing, usually by steaming or other heat treatment.

**Fixative** *n.* Solution which can be sprayed onto drawings rendered in pencil, chalk and other impermanent and easily removed materials so as to fix them and prevent smudging.

**Fixed oil** *See non-drying oil.*

**Flag** [ME *flagge* reed, rush] *n.* The end of a brush bristle, which divides into two or more branches. Flagging provides the brush with the ability to hold a greater amount of liquid coatings.

**Flair** A subjective term applied to the change in hue of a colored material when the light source is changed. Thus, a color may appear blue in daylight but change to a purple-blue in incandescent light; ultramarine blue is an example of such a blue, so it is said to "flair" red or to have a red "flair". Opposite of color consistency; not to be confused with metamerism, which applies to a pair of colors. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Billmeyer FW, Saltzman M (1996) Principles of color technology. John Wiley and Sons Inc., New York.

*See metamerism.*

**Flake** [ME, of Scand origin; akin to Nor *flak* disk] *n.* (1) A term used to signify the dry, unplasticized, basic form of cellulosic plastics. (2) Glass flakes. (3) As used by Celanese, a term that refers to the granular form in which cellulose acetate and triacetate polymers exist prior to dissolving or feeding into the extrusion or molding unit. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Philadelphia, PA, 2001. Complete textile glossary. Celanese Acetate LLC, New York, 2000.

**Flake board** *n.* Same as particle board.

**Flake shellac** *n.* Orange shellac gum in flake form.

**Flake white** *n.* (1) Another name for white lead of fine textured prepared electrolytically. (2) Variety of white lead, frequently used by artists.

**Flake yarn** *n.* Yarn in which roving or short, soft staple fibers are inserted at intervals between long filament binder yarns.

**Flaking** *n.* That phenomenon manifested in paint films by the actual detachment of pieces of the film itself either from its substrate or from paint previously applied. Flaking (scaling) is generally preceded by cracking or checking or blistering and is the result of loss of adhesion, usually due to stress-strain factors coming into play. Syn: scaling.

*See peeling.*

**Flaking resistance** *n.* The ability of a coating to resist the actual detachment of film fragments, either from its undercoating or substrate. Flaking is generally preceded by cracking, checking or blistering and is the result of loss of adhesion.

*Also known as scaling resistance. See flaking.*

**Flaky web** *n.* A web at the card that shows thick and thin places, approximately 1–6 in.$^2$ in size. This indicates that, instead of a free flow of fibers through the card, either an uneven amount has been fed into the card, or groups of fibers have hesitated in the card and then dropped back into production.

**Flamboyant finish** *n.* A glossy transparent coating with or without colorant, over a bright undercoat, metallic surface or metallic finish.

**Flame** \ˈflām\ [ME *flaume*, *flaumbe*, fr. MF *flamme* (fr. L *flamma*) & fr. OF, fr. *flamble*, fr. L *flammula*, dim. of *flamma* flame; akin to L *flagrare* to burn] (14c) *n.* The visible heat rays, which appears when the ignition of a material is reached. Hydrogen is one of the exceptions since the heat rays are not visible.

**Flame cleaning** *n.* Impingement of an intensely hot flame to the surface of structural steel resulting in the removal of mill scale and the dehydration of any remaining rust, leaving the surface in a condition suitable for wire brushing followed by the immediate application of paint.

**Flame (flash) arrestor** *n.* Devices utilized on vents for flammable liquid or gas tanks, storage containers, cans, gas lines or flammable liquid pipelines to prevent flashback (movement of flame) through the line or into the container, when a flammable of explosive mixture is ignited. Wire screen of 40 meshes is utilized on smaller openings. On larger openings, parallel metal plates or tubes are more effective.

**Flame hardening** *n.* A cheap method, obsolete today, of initially hardening flight tips of extruder screws in which the surface is rapidly chilled (tempered) after being heated with a flame (a process not easy to control). The hardness imparted is gradually lost over a few hundred hours of normal operation, requiring that the process be repeated frequently, defeating the initial saving.

*Also called case hardening and surface hardening.*

**Flame polishing** *n.* A method of finishing a plastic article, particularly a just formed extrudate, in which a carefully controlled flame or stream of hot gas is directed at the surface, melting a thin skin of resin that, when quenched, has a high gloss.

**Flame pretreaters** *n.* Equipment used in the flame pretreatment of polyolefins, by which the polyolefin molding is subjected to prior to the application of a decorative coating (usually in ink). Flame pretreatment is performed in order that the applied coating will have acceptable and permanent adhesion. Flaming consists of exposing the surface to be decorated to a suitable oxidizing flame. This treatment brings about a change to the polymer surface that makes it wet and permits a strong adhesive bond between the molding surface and the coating,

**Flame proofing** *See fire retardant.*

**Flame resistance tests** *See flammability tests.*

**Flame resistant** *adj.* A term used to describe a material that burns slowly or is self-extinguishing after removal of an external source of ignition. A fabric or yarn can be flame resistance because of the innate properties of the fiber, the twist level of the yarn, the fabric construction, or the presence of flame retardants, or because of a combination of these factors.

*Also see flame-retardant and inherent flame resistance.*

**Flame retardant** (1947) *n.* A material that reduces the tendency of plastics to burn. Flame retardants are usually incorporated as additives during compounding, but sometimes applied to surfaces of finished articles. Some plasticizers, particularly the phosphate esters and chlorinated paraffins, also serve as flame retardants. *Inorganic flame retardants* include antimony trioxide, hydrated alumina, monoammonium phosphate, dicyandiamide, zinc borate, boric acid, and ammonium sulfamate. Another group, called *reactive-type flame retardants*, includes bromine-containing polyols, chlorendic acid, and anhydride, tetrabromo- and tetrachlorophthalic anhydride, tetrabromo bisphenol A, diallyl chlorendate, and unsaturated phosphonated chlorophenols. A few neat resins, such as PVC and the fluoro- and chlorofluorocarbons, are flame-retardant. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York, 1986-, 1990-, 1992-, 1993-editions.

*See flammability.*

**Flame retardants** *n.* A chemical or surface covering material that delays ignition and reduces flame spread.

**Flame spray** *n.* Any process whereby a material is brought to its melting point and sprayed onto a surface to produce a coating. The process includes: (1) Metallizing. (2) Thermospray. (3) Plasma flame.

**Flame-spray coating** *n.* A coating process utilizing powdered metals or plastics, in which the powdered materials are heated to the sintering temperature in a cone of flame enroute from a spray gun orifice to the article being coated.

**Flame spraying** *n.* Blowing a powder through a flame that partially melts the powder and fuses it as it hits the substrate.

**Flame spread** *n.* Flaming combustion along a surface; not to be confused with flame transfer by air currents.

**Flame treating** A method of rendering inert thermoplastics, particularly polyolefins, receptive to inks, lacquers, paints, and adhesive by briefly bathing the surface of the article in a highly oxidizing flame. This treatment oxidizes the surface slightly, creating carbonyl and possibly peroxide groups, thereby increasing its surface energy.

**Flammability** \ˌfla-mə-ˈbi-lə-tē\ (1646) *n.* With respect to plastics, flammability is a very broad term that has been the focus of a potpourri of tests and standards generated by many organizations, predominantly in USA by Underwriters Laboratory (UL) and ASTM. The behavior of various plastics when burning, and tests designed to evaluate flammability, encompass six categories: ignitability, burning rate, heat evolution, smoke production, products of combustion, and endurance of burning. Troitzsch J (2004) Plastics flammability handbook. Hanser–Gardner Publications, New York. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

*Also called flammability and burn tests.*

**Flammability and burn tests** These tests are conducted for the purpose of evaluating polymeric materials for combustible properties. The American Society of Testing and Materials (www.astm.org) and National Institute for Standard and Technology (www.nist.gov) provide continuously updated method of evaluating flammability and combustible properties of polymeric materials (adhesives, coatings, plastics, etc.). Troitzsch J (2004) Plastics flammability handbook. Hanser–Gardner Publications, New York. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Flammable** \ˈfla-mə-bəl\ [L *flammare* to flame, set on fire, fr. *flamma*] (1813) *adj.* A substance that is easily ignited, burns intensely, or has a rapid rate of flame spread. Flammable and inflammable are identical in meaning, however, the prefix "in" indicates negative in many words and can cause confusion. Flammable, therefore, is the preferred term. According to I.C.C. Regulations, liquids are flammable if their flash point is 100°F or lower. Troitzsch J (2004) Plastics flammability handbook. Hanser–Gardner Publications, New York.

**Flammable limits** *See explosive limits.*

**Flammable liquid** *n.* Any liquid having a flp below 37.8°C (100°F), except a mixture having components with flp of 37.8°C (100°F) or higher, the volume of which make up 99% or more of the total volume of the mixture. Babrauskas V (2003) Ignition handbook. Fie Science Publishers, New York. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York. Wray HA (ed) (1991) Manual for flash point standards and their use. American Society for Testing and Materials, Philadelphia, PA.

*See combustible liquid.*

**Flange crimping** *n.* Simultaneous crimping of two ends of yarn by using heated snubber pins, then combining both ends on a draw roll after they contact a rubber flange on the draw roll.

**Flannel** \ˈfla-nᵊl\ [ME *flaunneol*] (1503) *n.* Medium weight plain- or twill-weave, slightly napped fabric, usually of wool or cotton, but may be made of other fibers.

**Flapper** \ˈfla-pər\ (ca. 1570) *n.* The movable side of a fiber-crimping chamber that periodically opens or flaps to permit crimped fiber to be expelled from the chamber.

**Flash** (fin) *n.* The thin, surplus web of material that is forced into the parting line between mating mold surfaces during a molding operation and which remains attached to the molded article. For methods of removing flash.

*see deflashing.*

**Flash aging** *n.* A process for rapid reduction and fixation of vat dyes obtained when the printed fabric is padded with caustic soda and sodium hydrosulfite and immediately steamed in air-free steam.

**Flash drying** *n.* (1) Rapid method of drying brought about by the exposure of a coating surface to an elevated temperature or forced draft for a short period of time. (2) Drying at ambient temperature, preparatory for a period of forced drying at elevated temperatures.

**Flash gate** *n.* A long, shallow rectangular gate in an injection mold, extending from a runner that lies parallel to an edge of a molded part along the flash or parting line of the mold.

**Flash groove** (spew groove) *n.* A groove in a mold force that allows the escape of excess material during a compression-molding operation.

**Flashing** *n.* (1) A paint defect in a paint film in which patches glossier than the general finish develop, especially at joints or laps in the coating. (2) The non-uniform appearance, including spotty differences in color or gloss, usually due to improper or non-uniform sealing of a porous substrate. (3) Non-corrosive metal used around angles or junctions in roofs and exterior walls to prevent leaks.

**Flash line** *See parting line.*

**Flash mold** *n.* A mold in which the mating surfaces are perpendicular to the claming action of the press so that, as the clamping force increases, the distance between the mating surfaces decreases, thus permitting excess molding material to escape as flash as the mold closes.

**Flash off** *n.* Causing the greater part of the more volatile solvents in a sprayed coat of lacquer or enamel to evaporate before proceeding with the application of another coat.

**Flash-off time** *n.* Time allowed to elapse between the spray application of successive wet-on-wet coats or the time allowed for the evaporation of the bulk of the solvent before entering into a baking oven.
*See flash drying.*

**Flashover** (1892) *n.* (1) A flammability term. Flashover occurs when hot, combustible gases are generated in burning sections of a building, become mixed with sufficient oxygen upon spreading to non-burning areas, and ignite to cause total surface involvement, but without a progressive flame-spreading stage. (2) In the electrical industry, an electric discharge, around the edge or over the surface of insulation.

**Flash point** (1878). *n* The lowest temperature at which a combustible liquid will give off a flammable vapor that will momentarily burn when exposed to s small flame. The flash point can be determined by the open cup or the closed cup method. The flash point determined by the open cut method is usually somewhat higher than the closed cup method. Wray HA (ed) (1991) Manual for flash point standards and their use. American Society for Testing and Materials, Philadelphia, PA.
*See flammability.*

**Flash points** *n.* The lowest temperature of a liquid at which it gives off sufficient vapor to form an ignitable mixture with the air near the surface of the liquid or within the container used.

**Flash ridge** *n.* That part of a flash mold along which the excess material escapes until the mold is fully closed.

**Flash spinning** *n. See spinning* (5).

**Flat** *n.* In carding, one of the parts forming an endless chain that partially surrounds the upper portion of the cylinder and gives the name to a revolving flat card. Flats are made of cast iron, *T*-shaped in section, about 1 in. wide, and as long as the width of the cylinder. One side of the flat is nearly covered with fine card clothing, and the flats are set close to the teeth of the cylinder so as to work point against point. A chain of flats contains approximately 110 flats and operates at a surface speed of about 3 in./min.

*See flatting down and rubbing.*

**Flat abrasion tester** *See Stoll–Quartermaster universal wear tester.*

**Flat card** *n.* The type of card used for cotton fibers and for cotton-system processing. It is named for the flat wire brushes called flats that are assembled on an endless chain that partially surrounds the main cylinder. The staple is worked between the flats and cylinder, transferred to a doffer roll, and peeled off as a web that is condensed into a sliver. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

*Also see flat.*

**Flat coat** *n.* Coat of filler (British) also incorrectly used when meaning prime coat under enamel. The preferred term is "enamel undercoater." An intermediate coat of paint used as a base for a topcoat.

**Flat duck** *See duck.*

**Flat enamel** *n.* Pigmented coating of low specular gloss, which has the leveling characteristics of a gloss enamel. Enamel has the connotation of both gloss and flow. *See enamel.*

**Flat-entry die** *n.* An extrusion die in which the approach to the land has no taper, i.e., one having a 180° entrance angle.

**Flat film** *n.* Film made by extrusion from a flat die onto a polishing roll. Not to be confused with lay-flat film.

**Flat finish** *See flat paint (finish).*

**Flat grain** *n.* Wood or veneer so sawed that the annual rings form an angle of less than 45° with the surface of the piece.

**Flat knit fabric** *n.* (1) A fabric made on a flat-knitting machine, as distinguished from tubular fabrics made on a circular-knitting machine. While tricot and milanese warp-knit fabrics (non-run) are knit in flat form, the trade uses the term flat-knit fabric to refer to weft-knits fabrics made on a flat machine, rather than warp-knit fabrics. (2) A term used in the underwear trade for plain stitch fabrics made on a circular-knitting machine. These fabrics have a flat surface and are often called flat-knit fabrics to differentiate them from ribbed-knit or Swiss rib fabrics. In this case, the term refers to the texture, not the type of machine on which the fabric was knit. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Flat knitting** *See knitting.*

**Flat knitting machine** *n.* A weft-knitting machine with needles arranged in a straight line in a flat plate called the bed. The yarn travels alternately back and forth, and the fabric may be shaped or varied in width, as desired, during the knitting process. Lengthwise edges are selvages. Flat-knitting machines may be divided into two types: latch-needle machines for sweaters, scarves, and similar articles and fine spring-needle machines for full-fashioned hosiery.

**Flat lacquer** *n.* A lacquer having the appearance of having been rubbed after it has dried.

**Flat paint (finish)** *n.* Paint which dries to a surface which scatters the light falling on it, so as to be substantially free from gloss or sheen.

*See matte finish. Also called flat finish.*

**Flat paint brush** *See flat wall brush.*

**Flat spot** *n.* An imperfection on a glossy painted surface; a spot lacking gloss, usually caused by a porous spot on the undercoat.

**Flat spotting** *n.* A characteristic of certain tire cords. It occurs with all materials but is more noticeable with nylon cord and is associated with nylon cord by users. Nylon exerts a shrinkage force as it becomes heated in tire operation. When the tire is stopped under load, the cord in the road-contact portion of the tire is under less tension than that in other portions of the tire, and it shrinks to conform to the flat surface of the road. When cooled in this position, the cord maintains the flat spot until it again reaches its glass transition temperature in use.

**Flat stone mill** *n.* Type of grinding mill in which the material to be disintegrated is fed between the grinding surfaces of two flat stones, one of which is caused to rotate. The grinding surfaces are specifically prepared with grooves or channels. These mills were used for either dry or wet grinding.

**Flattening agent** *See flatting agent.*

**Flatting agent** *n.* Material added to paints, varnishes and other coating materials to reduce the gloss of the dried film. Any material which, when added to a paint or plastic, lowers the gloss of the final surface. *See flatting pigment.*

**Flatting down** *vt.* Cutting or rubbing down the surface of a paint or varnish with fine abrasives to produce a smooth, dull surface.

**Flatting oil** A varnish-like composition made of heavy-bodied oil dissolved in a thinner, used to reduce paste paint to a flat paint.

**Flatting or flattening** *vt.* (1) Undesirable loss of gloss during drying. (2) Addition of a flatting pigment or agent to a paint or varnish. (3) Addition of a flatting oil to a paint or enamel.

**Flatting pigment** *n.* Any finely divided particle added to a paint formulation in order to decrease the gloss of the dried film. It may be an extruder-type (low refractive index) or a hiding pigment, and it is generally non-chromatic (neutral near-white), although not necessarily so. The reduction in gloss comes about from surface-light scattering, which occurs when light strikes the pigments protruding at the surface. *See extender (pigment) and dry-hiding.*

**Flatting (rubbing) varnish** *n.* Varnish containing a high proportion of hard resin which can be rubbed down after application, to produce a smooth foundation for a finishing coat, or serve as the finish coat itself (not to be confused with a flat varnish). *Also known as rubbing varnish and polishing varnish.*

**Flat top card** *See flat card.*

**Flat varnish** *n.* Varnish formulated with a flatting agent so a to dry with a dull finish (not to be confused with a flatting or rubbing varnish). Syn: matte varnish.

**Flat wall brush** *n.* A paintbrush, usually 4–6 in. (10–15 cm) in width, with long, stiff bristles, usually made of synthetic fiber. Syn: flat paint brush.

**Flax** \ˈflaks\ [ME, fr. OD *fleax*; akin to OHGr *flahs* flax, L *plectere* to braid] (before 12c) *n.* The plant from which the cellulosic fiber linen is obtained.

**Fleece fabric** *n.* A fabric with a thick, heavy surface resembling sheep's wool. It may be a pile or napped fabric of either woven or knit construction.

**Fleming's rule** *n.* A simple rule for relating the directions of the flux, motion, and emf in an electric machine. The forefinger, second finger and thumb, placed at right-angles to each other, represent respectively the directions of flux, emf, and motion or torque. If the right hand is used the conditions are those obtaining in a generator and if the left hand is used the conditions are those obtaining in a motor. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The Chemical Rubber Co., Boca Raton, FL.

**Fleshing** *See flushing.*

**Flex abrasion tester** *See Stoll–quartermaster universal wear tester.*

**Flex-cracking** *n.* Development of small cracks in flexible articles or coatings when these articles are subjected to repeated flexing or bending.

**Flexibility** *n.* (1) Degree to which a coating after drying is able to conform to movement or deformation of its supporting surface, without cracking or flaking. (2) A term relating to the hand of fabric, referring to ease of bending and ranging from pliable (high) to stiff (low).

**Flexibility test** *n.* Test applied to films to ascertain if they are able to accommodate elongations without fracture. Flexibility is usually determined by bending the film, applied to a suitable piece of thin metal, around one or a series of rods or mandrels or a special conical mandrel in a specified time. Syn: bend test.

**Flexibilizer** *n.* A term rarely used for an additive that makes a plastic more flexible. *See plasticizer.*

**Flexible foam** *See polyethylene foam, polyurethane foam, and vinyl foam.*

**Flexible-lip die** *n.* In film and sheet extrusion, a die in which a deep groove, reaching almost to the inside surface of the upper die body just behind the lip, has been machined. Adjusting bolts that can either push or pull on the lip pass through the gap from the upper body. The relative flexibility of the thin steel web from which the upper lip extends facilitates die adjustment to minimize sheet-thickness variations across the sheet.

*See also auto-flex die.*

**Flexible mold** *n.* A mold made of rubber, elastomer, or flexible thermoplastic, used for casting thermosetting plastics or other materials such as concrete and plaster. The mold can be stretched to permit removal of the cured casting, even one with undercuts.

**Flexible wall coverings** *n.* Those which are pliable, such as paper, manmade vinyls and fabrics, as opposed to "liquid" wall coatings, such as paint, or "rigid" like wood paneling or other solid wall products such as ceramic tile.

**Flex life** *n.* Informally, the number of bending-reversal cycles causing a part to fail in a particular service. Most specifically, the number of cycles to failure of a test specimen repeatedly bent in a prescribed manner. The ASTM test for plastics is D 671. The specimen, molded or cut from sheet, is subjected to load reversal at 30 Hz at a predetermined level of outer-fiber stress until it either fails or the test is discontinued. By setting up different stresses for successive specimens, one can develop a graph of stress at failure versus number of cycles to failure (usually plotted on semilogarithmic coordinates), i.e., the flex-life curve of fatigue curve.

**Flexographic decorating** *n.* Printing technique by which images are transformed from a flexible raised plate directly to the material. Flexographic printing presses can process many different materials, including polyethylene, polypropylene, oriented polypropylene, polyester, and nylon. Film thicknesses range from 0.0004 to 0.008 in.

**Flexographic ink** *n.* Quick drying, low viscosity ink based on volatile solvents that are used in the flexographic printing process.

**Flexographic printing** *n.* A rotary process employing flexible rubber or elastomeric printing plates adhered to a roll, inked by a screen roll which in turn is coated from a feed roll immersed in ink.

**Flexography** \flek-ˈsä-grə-fē\ [*flex*ible + -*o*- + -*graphy*] (1954) *n.* A typographic form of printing using rubber plates and relatively thin bodied resin-solvent inks. Formerly known as aniline printing.

**Flexural fatigue** *n.* A physical property expressed by the number of times a material can be bent on itself through a prescribed angle before it ruptures or loses its ability to recover.

**Flexural modulus** (flex modulus) *n.* The ratio, within the elastic limit, of the applied stress in the outermost fibers of a test specimen in three-point, static flexure, to the calculated strain in those outermost fibers, according to ASTM test D 790 or D 790M. For a given material and similar specimen dimensions and manufacture, the modulus values obtained will usually be a little higher than those found in a tensile test such as D 638, and may differ, too, from the moduli found in the cantilever-beam test, D 747.

**Flexural rigidity** *n.* This measure of a material's resistance to bending is calculated by multiplying the material's weight per unit area by the cube of its bending length.

**Flexural strength** (flexural modulus of rupture) *n* The maximum calculated stress in the outermost fibers of a test bar subjected to three-point loading at the moment of cracking or breaking. ASTM test D 790 and D 790M are widely used for measuring this property. For most plastics, flexural strength is usually substantially higher than the straight tensile strength. Also called modulus of rupture, bending strength.

**Flight** *n.* In an extruder screw, the helical ridge of metal remaining after machining the screw channel.

**Flight clearance** *n.* In screw extruders, half the difference between the inside diameter of the barrel and the diameter of the flight surface, usually about 0.1% of the nominal diameter in a new machine. Clearances in older machines may vary along the screw, intentionally or because of differential wear.

**Flight depth** (screw depth, channel depth) *n.* In screw extruders, the radial dimension, at any point along the screw, from the flight surface to the screw root. Some users of the term have taken it to mean half the difference between the internal diameter of the barrel and the screw-root diameter, but this difference is larger than the true flight depth by the amount of radial clearance between flight and barrel. In most (but not all) single-screw extruders, flight depth is much greater at the feed end, decreasing toward the delivery end of the extruder, where it is usually constant for at least several flights.

*See channel–depth ratio and extruder screw.*

**Flint abrasive** *n.* Not flint at all, but actually a natural quartz (silicon dioxide), which fractures into sharp-edged grains and is used on the common sandpaper for wood.

**Flint paper** *n.* An inexpensive paper using a natural quartz as the abrasive, for small sanding jobs on wood. It tends to clog quickly and cannot be used for wet sanding.

**Flip-flop** *n.* Decorative effect with automotive metallized finishes in which there is a difference in color depth and flash when the finish is viewed at different angles. Generally used in application to automotive metallic finishes.

*See travel.*

**Flitter** \ˈfil-tər\ *n*, *vt.* Syn: glitter.

**Float** *n.* (1) The portion of a warp or filling yarn that extends over two or more adjacent filling picks or warp ends in weaving for the purpose of forming certain designs. (2) In a knit fabric, a portion of yarn that extends for some length without being knitted in. (3) A fabric defect consisting of an end lying or floating on the cloth surface instead of being woven in properly. Floats are usually caused by slubs, knottails, knots, or fly waste, or sometimes by ends being drawn in heddle eyes incorrectly or being twisted around heddle wires.

**Floating** *vt.* Defect, which is sometimes apparent in colored paints containing one or more mixtures of different pigments. During drying or on storage, one or more of the pigments separates or floats apart from the others and concentrates in streaks or patches on the surface of the paint, producing a variegated effect. This effect also occurs with single pigment type consisting of multiple particle sizes.
*See flooding.*

**Floating chase** *n.* A mold member, free to move vertically, that fits over a lower plug or cavity, and into which an upper plug telescopes.

**Floating coat** *See brown coat.*

**Floating ends** *See float.*

**Floating platen** *n.* In compression molding, a platen located between the main head and the press table in a multi-daylight press and capable of being moved independently of them.

**Floating punch** *n.* A male mold member attached to the head of a press in such a manner that it is free to align itself in the female part of the mold when the mold is being closed.

**Floats** *n.* A term used in the past for asbestos filler in the form of very fine, short fibers with associated dust.

**Float stitch** *See miss-switch.*

**Flocculate** \ˈflä-kyə-ˌlāt\ (1877) *v.* Cluster of pigment particles formed in paint after the pigment has been wetted or dispersed. The spaces between the particles are filled with vehicle, as distinguished from agglomerates, where the spaces between the particles are filled with air. A group of two or more attached particles held together by physical force such as surface tension, adsorption, or similar forces. Flocculates are much affected by the sample preparation and technique.

**Flocculation** *n.* The formulation of clusters of pigment particles in a fluid medium, which may occur after dispersion has been effected. The condition is usually reversible and the particle clusters can be broken up by the application of relatively weak mechanical forces or by a change in the physical forces at the interface between the liquid and the solid dispersed particles. Flocculation is often visible, as a "Jack Frost" pattern in a flow-out of a dispersion; microscopically, it appears as a lacework or reticulum of loosely clustered particles. It results in more rapid settling although it is usually soft, shows loss of color strength and poor dispersion. A flocculated dispersion of sufficient pigment concentration shows yield value. Surface active agents are often useful in reducing the extent of flocculation and hence the yield value.
*See agglomeration.*

**Flocculation of the vehicle** *n.* In the printing ink industry, sometimes used to mean livering.

**Flock** \ˈfläk\ [ME *flok*, fr. OF *floc*, fr. L *floccus*] (13c) *n.* (1) Short fibers of cotton or synthetic fibers such as polyester, acrylic, or nylon. They are used as reinforcements in phenolic, allylic, and other thermosetting molding compounds, also for decorating plastics by the process of flocking. (2) Wall coverings imitating the surface of damask or cut velvet. Made by shaking finely chopped fibers over a pattern printed in varnish or some other sticky material.

**Flock finish** *n.* Finish produced by the application on a suitable adhesive coat of short fiber cotton, wood, or other fiber, giving a soft suede-like feel and appearance.

**Flock gum** Special spray gun for applying flock finishes.

**Flocking** (flock coating) *vt.* A method of finishing sometimes employed for plastics articles whereby the article is coated with a tacky, slow-drying adhesive, then is dusted with a fibrous material cut into very short lengths to give a finish resembling suede, plush, etc. Fibers for flocking are available in a wide range of materials including acrylic, nylon, polyester, polyolefins, and natural fibers. Machinery for flocking films and fabrics includes gravure printing stations for applying the adhesive in desired patterns and flock heads that distribute a precalculated layer of flock to the web, and retrieve and recirculate surplus flock.

**Flood feeding** *vt.* The usual way of feeding an extruder or screw-injection molder, in which the feed material flows from the feed hopper by gravity and completely fills the feed section of the screw. The actual throughput is thus controlled by screw design, die resistance and temperature conditions within the screw, in contrast to what occurs in starve feeding.

**Flooding** *vt.* (1) A concentration at the surface of a paint film of one of the ingredients of the pigment portion, giving rise to a change in color at the surface. (2) A differential separation of pigments in a dispersed pigment mixture. Floating is a differential separation of pigments (a) by gravity separation in the bulk dispersion; and (b) where the flooding results in a non-uniform or mottled surface coloration. While the terms "flooding" and "floating" are often used interchangeably, they also have been defined as separate, though related, phenomena. "Flooding" refers to uniform color changes and "floating" refers to local excess of one color. (3) Process of color change in which a paint or enamel undergoes homogeneously, from the freshly applied material to the finished dried film in which one or more pigments appear to be "flooding" the surface color. (4) An excess of ink on the printing plate caused by the ink fountain being open too much. In the case of lithographic or offset work, the use of too little water or the absence of an etching material in the water fountain.

*See floating.*

**Floor and deck enamel** *n.* An enamel designed for abrasion resistance.

**Floor paint** *See deck paint.*

**Floor sealer** *n.* Composition of resins, with or without oils, in a solvent; designed to penetrate the wood rather than produce a surface finish.

**Floor varnishes** *n.* Varnishes, which are formulated for the coating of flooring. Their main properties include rapid drying, tack-free surface, toughness and resistance to abrasion, washability, and receptiveness to wax and other floor polishes.

**Flop** Where two different painted panels appear to be a good match for color when viewed at a given angle, but appear different at all other angles.

*Also known as geometric metamerism.*

**Flop color** *n.* Used to describe the color observed on paints (particularly metallic paints) when they are viewed near to the grazing angle, i.e., nearly parallel to the surface. The term is generally used in contrast to the terms "face color" or "top color," the color observed when viewing the surface oat an angle near to the perpendicular.

*See face color.*

**Florals** (1897) *n.* Any wall covering design featuring recognizable flowers and foliage.

**Florentine lake** *See crimson lake.*

**Flory–Fox theory** (or Fox–Flory) *n.* This theory is relates viscosity to molecular dimensions by treating the polymer molecule as a hydrodynamic sphere. In a $\theta$-solvent in which the molecular coil is compact, these authors write the intrinsic viscosity as,

$$[\eta] = KM^{0.5},$$

where $K$ is a constant. When the polymer is dissolved in a solvent that not a $\theta$-solvent, the equation is replaced with

$$[\eta] = KM^{0.5}\alpha_\eta,$$

where $\alpha_\eta$ is an expansions factor that takes into account the expansion of the polymer coil in going from a bad solvent to a good one. Also, the expansion in a good solvent is accompanied by an increase in viscosity ($\eta$) resulting expansion of the polymer molecule due to greater interactions between solvent and polymer.

**Flory–Huggins parameter** *n.* For polymers dissolved in solvents (may be monomers of the polymer), the Flory–Huggins parameter $\chi$ a measure of the interaction energy $\Delta\varepsilon$ (average energy gain per contact; $\Delta\varepsilon$ is a measure of the Gibbs energy and not of the enthalpy; and $\chi$ also contains an entropy contribution, which is often found to depend on the concentration of polymer or solute. Flory PJ (1953) Principles of polymer science. The Cornell University Press, Ithaca, New York.

**Flory–Huggins theory** *n.* (1) A thermodynamic theory of polymer solutions, first formulated independently by Flory and Huggins (in which the thermodynamic quantities of the solution are derived from a simple concept of combinational entropy of mixing and a reduced Gibbs energy parameter, the "$\chi$ parameter" (a dimensionless quantity). The Flory–Huggins theory lead to the equation,

$$\Delta F_1 = RT \ln a_1 = RT[\ln(1 - v_2) + (1 - 1/m)v_2 + \chi_2^2] \qquad \text{(a)}$$

for the partial free energy of the solvent, and to the corresponding equation for for the partial free energy of the polymer,

$$\Delta F_2 = RT[\ln v_2 - (m - 1)v_1 + m\chi v_1^2] \qquad \text{(b)}$$

When the logarithmic term in equation (a) is expressed as a series in $v_2$ and $m$ is replaced by the degree of polymerization, $P$, the convenient equation results,

$$\Delta F_1 = RT[-(v_2/P) - (0.5 - \chi)v_2^2 - (v_2^3/3)\cdots]. \qquad \text{(c)}$$

A numerical parameter, $\chi$, employed by the Flory–Huggins equation accounts for the contribution of the non-combinational entropy of mixing and for the enthalpy of mixing (Hans-Georg Elias, *Macromolecules*, Plenum Press, New York, 1977). The equation assumes that the $\Delta V_{\text{mix}} = 0$, and the enthalpy of mixing does not influence the value of $\Delta S_{\text{mix}}$. The equation represents Flory–Huggins free energy of mixing per molecule. (2) Historical development of theory and equation: Polymer solutions show enormous deviations from Raoult's law. Polymer chemists early realized that the large deviations from the ideal behavior predicted by Raoult's law resulted from the flexibility of polymer molecules. A polymer molecule continuously changes shape, and, in the course of time, takes on a tremendous number of conformations. Therefore, when a polymer is dissolved, there is, in addition to entropy of solution, which results from simple interchange of position, conformational entropy. Flory and Huggins first worked out the statistical theory of polymer solutions, which took conformational entropy into account. They chose a lattice picture, widely used in statistical theories of simple liquids, as a model for the polymer solution. In the lattice picture, the space occupied by the solution is divided into boxes of equal size, and polymer segments and solvent molecules are fitted into these boxes. The number of ways, $\Omega$ that $n_2$ polymer molecules, which occupy $n_2$ sets of $m$ contiguous boxes, can be arranged in a lattice can be computed by classical statistics. The number $\Omega$ is related to the entropy of mixing by Boltzmann's equation, $\Delta S = k \ln \Omega$, where $k$ is Boltzmann's constant; if the entropy computed by this equation represents all of the entropy of mixing, and if $\Delta H^{\mathrm{m}}$ is assumed to be positive and, following Van Laar, is set equal to $kt\chi n_1 v_2$, the free energy of mixing is given by,

$$\begin{aligned}\Delta F^{\mathrm{m}} &= -T\Delta S^{\mathrm{m}} + \Delta H^{\mathrm{m}}\\ &= kT(n_1 \ln v_1 + n_2 \ln v_2 + \chi n_1 v_2),\end{aligned}$$

where $v_1$ and $v_2$ are the volume fractions of solvent and polymer, respectively, $n_1$ and $n_2$ are the number of molecules of solvent and polymer, and $\chi$ is a dimensionless quantity called an interaction parameter that is related to the interaction energy characteristic of a particular polymer-solvent combination. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York. Flory PJ (1969) Statistical mechanics of chain molecules. Interscience Publishers Inc., New York. Huggins ML (1958) Physical chemistry of high polymers. John Wiley and Sons Inc., New York. Flory PJ (1953) Principles of polymer science. The Cornell University Press, Ithaca, New York.

**Flory–Krigbaum theory** *n.* A theory of dilute polymer solutions which describes the distribution of polymer segments as clusters of segments separated by regions of pure solvent. A model for this structure is used which takes account of the excluded volume within the coils.

**Flory–Rehner equation** *n.* The correlation between thermodynamic parameters and the value of an equilibrium swelling of a polymer by a solvent is given by this equation:

$$\begin{aligned}&\ln(1-\varphi_2)+\varphi_2+\chi_1\varphi_2^2\\ &\qquad = -\frac{v_2}{V}\,Vs\left(\varphi_2^{1/3}-\frac{2\varphi_2}{f}\right),\end{aligned}$$

where $\varphi_2$ is the polymer volume fraction in a swollen sample, $v_2/V$ the volume fraction of elasticity active chains, $f$ the functionality, and $\chi$ the interaction parameter. The value of equilibrium swelling can be a practical criterion of solubility. The presence of even a small amount of cross-links hinders chain separation and polymer diffusion into solution. Solvent can penetrate into the polymer and cause swelling. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

**Flory temperature** *n.* The temperature at which, for a given polymer-solvent pair, the polymer exists in its unperturbed dimensions. Syn: theta temperature. Elias HG (1977) Macromolecules, vols 1–2, Plenum Press, New York. Flory PJ (1960) The statistical thermodynamics of solutions. John Wiley and Sons Inc., New York.

**Flow** \ˈflō\ [ME, fr. OE *flōwan*, akin to OHGr *flouwen* to rise, wash, L *pluere* to rain, Gk *plein* to sail, float] (before 12c) *v.* (1) Resistance to movement by a liquid material and divided rheologically into four categories: Newtonian (simple) flow, plastic flow, pseudoplastic flow, and dilatant flow.

(2) Movement of a coating during and after application and before the film is formed. (3) Property which a coating or ink possesses of leveling after application. Coatings may possess excessive flowing properties and may sag or run to an undesirable degree from vertical or inclined surfaces. (4) Inks of poor flow are classed as short or buttery in body, while inks of good flow are said to be long. Gooch JW (1997) Analysis and deformulation of polymeric materials. Plenum Press, New York. Patton TC (1965) Paint flow and pigment dispersion. Interscience Publishers Inc, New York. Eirich FR. Rheology – theory and applications, vol 1 (1956), vol 2 (1958), vol 3 (1967), vol 4 (1967), vol 5 (1969). Academic Press Inc., New York. Green H (1949) Industrial rheology and rheological structures. John Wiley and Sons Inc., New York. Mercurio A (1964) Rheology of acrylic paint resins. Canadian Paint and Varnish, ON.

*See leveling.*

**Flow-behavior index** *See power law.*

**Flow birefrigence** (streaming birefringence) *n.* The difference, Δ*n* between the refractive indices of a flowing polymer solution or melt in the direction of flow and a direction perpendicular to the flow. Usually measured, using one of two techniques, by directing a light beam downward through the liquid in a rotational viscometer. The amount of birefringence is related to the degree of orientation of the polymer chains, in turn related to shear stress and first normal-stress difference in the flowing medium. The measurements are useful for testing molecular theories and rheological models, also for understanding processing problems such as extrudate roughness.

**Flow coating** *n.* A painting process in which the article to be painted is drenched with a paint, either by pouring or by spraying with a mist in a closed or semi-closed chamber. The parts are sometimes rotated during and after drenching to avoid sags and runs. The process is used for coating metallized parts and other irregularly shaped articles that are difficult to paint by ordinary spraying methods.

**Flow curve** *n.* A plot of applied force against the resulting rate of flow. A more in-depth definition is a graph, usually on bilogarithmic coordinates, of shear stress versus shear rate or, sometimes, of apparent or true (corrected) viscosity versus either shear rate or shear stress. For nearly all polymer melts, log–log plots of shear stress versus shear rate of sufficient range exhibit a Newtonian region of slope = 1 at extremely low shear rates, a brief transition region of decreasing slope (“knee”), and a higher-shear region in which the slope is nearly constant or very gradually decreasing and is in the range 0.7–0.25.

*See also pseudoplastic fluid and viscosity.*

**Flower of antimony** *See antimony oxide.*

**Flowers of antimony** *n.* Syn: antimony trioxide.

**Flowing varnish** *n.* A varnish designed to produce a smooth lustrous surface without rubbing or polishing.

**Flow line** Syn: weld line.

**Flow mark** *n.* A defect in a molded article characterized by a way surface appearance, caused by improper flow of the resin into the mold, which itself may have a number of causes.

**Flow molding** *n.* (1) A variation of injection molding used for thick-walled parts. A large gate is used and pressure is maintained on the injected melt so as to fore a little more melt into the mold as each part solidifies from the outside inward, thus minimizing shrinkage and improving consistency of the parts' final dimensions. (2) A process of heating material such as a cloth-backed, plasticized PVC with a high-frequency electric field while pressing the material into a mold made of silicone rubber. In 10–15 s, the PVC is formed to the contours and surface texture of the mold, which can give it the look of hand-tooled leather or similar effects.

**Flow properties** *See melt-flow index, viscosity, pseudo-plastic fluid, and rheology.*

**Flue** \ˈflü\ (1582) *n.* A passageway in a chimney for conveying smoke, gases or fumes to the outside air.

**Fluffing** (1875) *v.* A term describing the appearance of a carpet after loose fiber fragments left during manufacture have worked their way to the surface. Fluffing is not a defect; it is simply a characteristic of new carpets that disappears with vacuuming.

**Fluid** \ˈflü-əd\ (1661) *n.* A gas or a liquid, or, in the supercritical region, a hybrid.

**Fluidity** \flu-ˈi-də-tē\ (1603) *n.* (1) The ease with which a liquid flows under stress. (2) Specifically, the reciprocal of viscosity. The SI unit of fluidity is $(\mathrm{Pa\,s})^{-1}$ or $1/\mathrm{Pa\,s}$, replacing the deprecated cgs unit, the rhe. $1\ \mathrm{rhe} = 10\ (\mathrm{Pa\,s})^{-1}$ (3) The reciprocal of viscosity. The cgs unit is the rhe, the reciprocal of the poise. Dimensions $[\mathrm{M}^{-1}\ \mathrm{L}\ \mathrm{T}]$.

**Fluidization** (ca. 1855) *vt.* A gas-solid or liquid–solid contacting process in which a stream of fluid is passed upwards through a bed of small solid particles, causing them to lift, expand, and behave as a boiling liquid. The process is widely used in the chemical industry for performing reactions in which the solid is either a reactant or a catalyst. In the plastics industry, the main application is in fluidized-bed coating.

**Fluidized bed** *n.* An expanded bed of solid particles, fluidized to create a system with similar properties of a liquid. Fluidized beds are used successfully in a multitude of processes both catalytic and non-catalytic. Among the catalytic uses are hydrocarbon cracking and reforming, oxidation of naphthalene to phthalic anhydride, and ammoxidation of propylene to acrylonitrile. A few of the non-catalytic uses are coating of sulfide ores, coking of petroleum residues, drying, and classification.

**Fluidized-bed coating** *n.* The process of applying plastics coatings to objects of other, higher-melting materials, often metals, wherein a powdered resin is placed in a container provided with a porous or perforated bottom through which a gas is directed upward to keep the resin particles in a state of agitated levitation. The part to be coated is preheated above the resin's softening temperature and lowered into the fluidized bed until a deposit of the desired thickness has formed, then the part is withdrawn and allowed to cool.

**Fluorescein dye** *See acid dyes.*

**Fluorescence** \flú-ˈre-sᵊn(t)s\ [*fluor*spar + opal*escence*] (1852) *n.* Fluorescence is a luminescence that is mostly found as an optical phenomenon in cold bodies, in which a molecule asbsorbs a high-energy photons (low wavelength such as ultraviolet) and emits photons at as a lower-energy photon (longer-wavelength) and usually visible light. The energy difference between the absorbed and emitted photons ($hv$) manifests itself as molecular vibrations or heat in the absorbing matter Usually the absorbed photon is ultraviolet and the emitted light (luminescence) is in the visible range so that humans can observe, but this depends on the absorbance curve and Stokes shift of the particular fluorosphore. Fluorescence is named after the mineral fluorite (calcium fluoride) that exhibits this phenomenon the expression below shows the fluorescence phenomenon,

$$S1 \rightarrow S2 + h\nu,$$

where, $h$ is the Planck's constant, and $\nu$ is the frequency of the fluorescing light. The Kasha–Vavilov rule describes the quantum yield of luminescence that is independent of the wavelength of exciting radiation, and the Jablonski diagram describes most the relaxation mechanism for excited state molecules. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York, www.Wikipedia.org.

**Fluorescent brightening agent** *See brightening agents.*

**Fluorescent dyes** *n.* luminescence, which is mostly found as an According to the Paint/Coatings Dictionary, dyestuffs which exhibit the phenomenon of fluorescence in the visible region of the spectrum. Dyes are characterized as fluorescent if: they absorb invisible radiation, such as ultraviolet and emit visible light; they also absorb primarily visible light and emit visible light; or they absorb visible light and emit invisible radiation, generally infrared. Some dyes fluoresce more strongly than others, i.e., some are only slight fluorescent and some are strongly fluorescent. The former may go undetected as fluorescent dyes. In order to measure the color materials containing fluorescent dyes, the material must be illuminated with light of defined spectral quality, and the light reflected or transmitted by the materials must be passed through the monochromating device after reflectance or transmission, using so-called "reversed optics." Strongly fluorescent pigments are frequently referred to as high visibility pigments; their combined emission and reflectance is generally much higher at certain wavelengths than the reflectance of the perfect diffuser. Paint/Coatings Dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978. Morgans WM (1977) Pigments for paints and inks. Selection and Industrial Training Administration Ltd., London. Lubs HA (ed) (1965) The chemistry of synthetic dyes and pigments (ACS Monograph). Hafner Publishing Co., New York.

**Fluorescent inks** *n.* Inks which exhibit fluorescence, resulting in a very brilliant effect.

**Fluorescent paint** *n. See luminous paint and high visibility paints.*

**Fluorescent pigment** *n.* (1) Inorganic, usually coarse, crystalline, and materials, which emit light when activated by ultraviolet radiation, e.g., zinc sulfide, combined zinc, and cadmium sulfides. A type known as *daylight fluorescent pigments* (*dayglo pigments*) responds to radiation in both the ultraviolet and visible ranges, causing the effect of glowing in normal daylight. These pigments are comprised of fluorescent dyes incorporated in a clear-resin matrix, ground to powder form. Urea and melamine resins have been used as matrices, also a modified sulfonamide resin. (2) Organic dyes or pigments used to manufacture luminescent materials. These include spirit-soluble dyes, oil-soluble dyes, and metallic organic compounds, e.g., rhodamine, eosine, rhodamine tungstate, and zinc salt of 8-hydroxyquinoline. By absorbing unwanted wavelengths of light and converting them into light of desired wavelength, these pigments have the appearance of possessing an actual glow of their own. (3) Pigments, which exhibit the phenomenon of fluorescence in the visible region of the spectrum. Few commercial mineral pigments are fluorescent; most of the fluorescent pigments are made from fluorescent dyes incorporated into an insoluble matrix and ground to a small particle size suitable for use as a pigment.

*See fluorescent dyes.*

**Fluorinated ethylene-propylene resin (FEP, PFEP)** *n.* This member of the fluorocarbon family is a copolymer of tetrafluoroethylene and hexafluoropropylene, possessing most of the desirable properties of PTFE, yet truly meltable and, therefore, processable in conventional extrusion and injection-molding equipment. It is available in pellet form for those operations and as dispersions for spraying and dipping.

**Fluorine-containing polymers** *n.* Polymers in, which one or more hydrogen atoms have been replaced by fluorine. Often used in high-temperature wire and cable insulation, due to their resistance to chemicals and oxidation and broad useful temperature range.

**Fluorite objective** *n.* This objective is corrected both for spherical aberration and chromatic aberration at two wavelengths.

**Fluorocarbon** \ˌflúr-ō-ˈkär-bən\ (1937) *n.* Teflon tetrafluoroethylene (TFE) and Teflon fluorinated ethylene propylene (FEP). Both have remarkable chemical resistance.

**Fluorocarbon blowing agent** *n.* A family of inert, non-corrosive liquid compounds containing carbon, chlorine, and fluorine, originally developed as refrigerants. They are compatible with all resins and leave no residues in molds. For years they were widely used in structural-foam extrusion, in which they were incorporated with the polymer by direct injection through the barrel of the first of two tandem extruders. Fluorinated hydrocarbons are numbered by a three-digit system developed by DuPont for use with its trade name Freon®. The first digit is the number of carbon atoms in the molecule −1, omitted when it is 0 (the methane group), leaving just two digits for them. The second digit equals the number of hydrogens in the molecule +1; the third digit is the number of fluorine atoms. The remaining atoms in these saturated compounds are chlorine. Thus the once-common blowing agents were Freon 11 (trichlorofluoromethane), Freon 12 (dichlorodifluoro-methane), Freon 113 (trichlorotrifluoroethane), and Freon 114 (dichlorotetra-fluoroethane). Because there is strong evidence that these compounds when released to the atmosphere, migrate to the upper levels and catalyze the destruction of UV-blocking ozone by chain reactions, they are being phased out of use of international agreement and are being replaced, in the manufacture of plastics foams, by hydrocarbons, such as neopentane, and by hydrohalocarbons.

**Fluorocarbon elastomer** (fluoroelastomer) *n.* Any fluorocarbon polymer of low $T_g$ and no crystallinity, therefore rubbery. As rubbers, these materials are resistant to high temperature and most chemicals and solvents. Most of the commercial materials are copolymers. In USA, DuPont's Viton® materials are most familiar.

**Fluorocarbon resin** *n.* Any of a family of thermoplastics chemically similar to the polyolefins, with all the hydrogen atoms replaced by fluorine. They are made by addition polymerization from olefinic monomers composed only of fluorine and carbon. The main members of the family are polytetrafluoroethylene, fluorinated ethylene-pro-pylene resin, and polyhexafluoropropylene.

**Fluorocarbons** *n.* Group of compounds containing fluorine atoms, fluoroplastics, or solvents.

**Fluoroethylene** Syn: vinyl fluoride.

**Fluorohydrocarbon resin** *n.* Any resin polymerized from an olefinic monomer composed of carbon, fluorine, and hydrogen only. Included are polyvinylidene fluoride, polyvinyl fluoride, poly-trifluorostyrene, and copolymers of halogenated and fluorinated ethylenes.

**Fluoroplastic** (fluoropolymer) *n.* A plastic based on polymers made from monomers containing one or more atoms of fluorine, or copolymers of such monomers with other monomers, the fluorine-containing monomer(s) being in the greatest amount by mass (ASTM D 883). This is a broad family including:

- Chlorofluorocarbon resin
- Chlorofluorohydrocarbon resin
- Ethylene-chloro-tri-fluoroethylene copolymer
- Ethylene-tetra-fluoroethylene copolymer
- Fluorinated ethylene-propylene resin
- Fluorocarbon resin
- Fluorohydrocarbon resin
- Perfluoroalkoxy resin
- Polychlorotrifluoroethylene
- Polytetrafluoroethylene
- Polyvinylidene fluoride

**Fluoroplastics** *n.* Plastics, which contain the monomer of fluorine.
*See fluorocarbons.*

**Fluoropolymers** *n.* Polymers whose repeating units contain fluorine. Such polymers often have outstanding thermal, thermo-oxidative, and chemical resistance, both to chemical attack and to swelling by solvents.

**Flushed color** *n.* A color base in paste form prepared by flushing.

**Flushed (flushing) colors** *n.* Pigments which have been flushed.
*See flushed pigment and flushing.*

**Flushed pigment** *n.* A pigment obtained by the direct transfer of pigment particles that have been precipitated, from an aqueous phase to a non-aqueous stage (no intermediate drying or pulverizing stage being involved). In the process, the press cake (aqueous or water-wet pigment phase) is mixed and agitated with a non-aqueous vehicle (oil, solvent, and/or resin phase) in a heavy duty mixer. The pigment particles preferentially transfer (flush) to the non-aquerous phase, and the bulk of the essentially clear water is poured off. Any residual water is then vacuumed off at a temperature of about 50°C (122°F).

**Flushing** *v.* A method of transferring pigments from dispersions in water to dispersions in oil by displacement of the water by oil. The resulting dispersions are known as flushed colors. Syn: fleshing.
*See flushed pigment.*

**Fluted core** An integrally woven reinforcing material consisting of ribs between two skins, thus providing unitized sandwich construction.

**Fluted mixing section** In extrusion, a screw section in which several short barrier flights are placed so that the plastic must flow through the high-shear clearance between the flight tip and the barrel. Fluted sections may have the flights parallel to the screw axis or at an angle to the axis.

**Fluting** *n* (1611). Parallel concave grooves used as furniture decoration. Vertical and spiral flutings are common.

**Flux** \ˈfləks\ [ME, fr. MF & ML; MF, fr. ML *fluxus*, fr. L, flow, fr. *fluere* to flow] (14c) *n.* (1) In chemistry and metallurgy, a substance, e.g., borax or fluorspar, used to promote fusion of metals or minerals. (2) In plastics compounding, the term flux is sometimes used for an additive that improves flow properties, e.g., coumarone-indene resin in the milling of vinyl compounds. (3) In heat and mass transfer, the rate of transfer per unit of cross-sectional area perpendicular to the direction of transfer. (4) Luminous flux.

**Flux** (15c) *v.* To melt, fuse, or make liquid. In the early years of the vinyl-plastisol art this term was often used for "fuse" before the latter term came into general use.

**Fluxing temperature** Syn: fusion temperature.

**Flux, luminous** Radiant flux weighted for the relative luminous (visual) efficiency.

**Flux, radiant** *See radiant flux.*

**Fly** *n.* The short, waste fibers that are released into the air in textile processing operations such as picking, carding, spinning, and weaving.

**Flyer** *n.* (1) A device used to insert twist into subbing, roving, or yarn, and to serve as a guide for winding it onto a bobbin. The flyer is shaped like an inverted U that fits on the top of the spindle and revolves with it. One arm of the U is solid and the other is hollow. The yarn enters through the top of the hollow arm, travels downward, and emerges at the bottom where it is wound around a presser finger onto the take-up package. (2) *See loom fly.*

**Flyer spinning** *n.* A method of spinning by means of a driven flyer. It is used primarily for spinning worsted and coarser yarns. *Also see flyer* (1).

**Flyer spinning frame** *See spinning frame.*

**Flyer waste** *n.* During the roving operation, flyer waste refers to fibers that free themselves by centrifugal force from the regular bulk of roving and accumulate on the flyers and adjacent machinery.

**Fly frame** *See roving frame.*

**Flying** *n.* A condition wherein a fine mist or spray of ink is thrown off rapidly moving ink rollers. Syn: misting and spraying.

**FMC color difference equations** *n.* Letters "FMC" are the initials of Friele, MacAdam, and Chickering. There are two different equations, referred to as FMC-1 and FMC-2: FMC-1 is the same as FMC-2, except that the terms $K_1$ and $K_2$ are not included: FMC-2 is:

$$\Delta E = \left[(\Delta C)^2 + (\Delta L)^2\right]^{1/2},$$

where

$$\begin{aligned}
\Delta L &= K_2\,\Delta L_2,\\
\Delta C_1 &= \left[(\Delta C_{\mathrm{rg}}/a)^2 + (\Delta C_{\mathrm{yb}}/b)^2\right]^{1/2},\\
\Delta C_{\mathrm{rg}} &= (Q\,\Delta P - P\,\Delta Q)/\left(P^2 + Q^2\right),\\
\Delta C_{\mathrm{yb}} &= S\,\Delta L_1/\left(P^2 + Q^2\right)^{1/2} - \Delta S,\\
\Delta L_1 &= (P\,\Delta P + Q\,\Delta Q)/\left(P^2 + Q^2\right)^{1/2},\\
\Delta L_2 &= 0.279\,\Delta L_1/a,\\
K_1 &= 5.5669\times10^{-1} + 4.9434\times10^{-2}Y\\
&\quad - 8.2575\times10^{-4}Y^2 + 7.9172\times10^{-6}Y^3\\
&\quad - 3.0087\times10^{-8}Y^4,\\
K_2 &= 1.7548\times10^{-1} + 2.7556\times10^{-2}Y\\
&\quad - 5.7262\times10^{-4}Y^2 + 6.3893\times10^{-6}Y^3\\
&\quad - 2.6731\times10^{-8}Y^4,\\
a^2 &= 1.73\times10^{-5}\left(P^2 + Q^2\right)/1\\
&\quad + 2.73P^2Q^2/\left(P^4 + Q^4\right),\\
b^2 &= 3.098\times10^{-4}\left(S^2 + 2.015\times10^{-1}Y^2\right),\\
P &= 0.724X + 0.382Y - 0.098Z,\\
Q &= -0.48X + 1.37Y + 0.1276Z,\\
S &= 0.686Z.
\end{aligned}$$

$X$, $Y$, $Z$ are the tristimulus values for the standard, $X_1$, $Y_1$, $Z_1$ are the tristimulus values for the sample, $\Delta P$, $\Delta Q$, $\Delta S$ are the above formulate for $P$, $Q$, $S$ substituting $\Delta X = X_1 - X$ for $X$, etc.

**Foam** \ˈfōm\ [ME *fome*, fr. OE *fām*; akin to OHGr *feim* foam, L *spuma* foam, *pumex* pumice] (before 12c) *n.* Dispersion of gas in a liquid or solid. The gas bubbles may be any size. The term covers a wide range of useful products such as insulating foam, cushions, etc. It also describes the undesirable froth in polymer melts, dyebaths, etc.

*See cellular plastic.*

**Foam-backed** *n.* A term describing a fabric laminated to or coated with a layer of rubber or plastic foam.

**Foam casting** (foam molding) *n.* A process withy many variations, depending on the polymers used. In general, a fluid resin or prepolymer containing catalyst is foamed before or during molding by mechanical frothing, or by gas dissolved in the mixture or vapor from a low-boiling liquid.

*See also reaction injection molding.*

**Foamed plastic** Plastics with an apparent density, which are significantly decreased by the presence of numerous cells disposed throughout its mass usually by an expanding gas foam blowing agent. Syn: cellular plastic.

**Foam extrusion** *See extruded foam.*

**Foam fabrication** The process of cutting large slabs, logs, or "buns" of foamed plastics into sections of desired dimensions. The raw slab is conveyed through an array of saws, knives, or hot wires that first remove the uneven top, bottom, and sides, then slice the remaining rectangular block into boards, finally cross-cutting the boards to standard lengths.

**Foaming** A dispersion of gas in a liquid or solid. Foams can be made by mechanically incorporating air, as in the food industry for whipped cream, egg whites, and ice cream.

**Foaming agents** (1) Materials that increase the stability of a suspension of gas bubbles in a liquid medium. (2) Blowing agents in rubber or plastics.

*See blowing agents.*

**Foam-in-place** Refers to deposition of foams at the site of the work, e.g., between two containing walls for insulation, as opposed to bringing the work to the foaming machine.

**Fog** \ˈfóg\ [prob. Scand origin, akin to Dn *fog* spray, shower] (1544) *n.* A colloidal dispersion of a liquid in a gas.

*See bloom and blush.*

**Fogged coat** Non-continuous spray coat.

*See mist coat.*

**Fogged metal** Metal, the luster of which has been sharply reduced by a film of corrosion products.

**Fogging** *See bloom and blushing.*

**Foil** [ME, leaf, fr. MF *foille* (fr. L *folia*, plural of *folium*) & *foil*, fr. L *folium*] (14c) *n.* (1) Refers to very thin membranes (less than 6 mils) of metal such as aluminum. Above 6 mils, the thin metal is called a sheet. (2) In wallcoverings, a very thin sheet of flexible metal on a paper or fabric back. Can be printed with transparent or opaque color, and mottled to resemble marble, tortoise shell, etc.

**Foil decorating** *See in-mold decorating.*

**Folded selvage** *n.* A curled selvage.

**Folded yarn** *See plied yarn.*

**Folding machine** *n.* A machine that folds sheet plastics such as cellulose acetate into shapes such as identification-card envelopes, sheets for ring binders, visible indexes, and the like. An electrically heated blade softens the plastic and folds it into a tight, 180° crease.

**Fold testing** *n.* Mechanical test to determine the ability of a polymer to retain its strength after being folded back and forth.

**Food and drug administration (FDA)** *n.* The FDA is the governmental body that is responsible for the approval of all food additives. All inks, coatings, and other packaging materials coming in direct contact with food or drugs must be shown to be non-migrating, or must be made only from raw materials which are known to be harmless and which are listed in the Code of Federal Regulations, Title 21, in the paragraph covering the intended end use.

*See fda.*

**Footcandle** (1906) $v_2$. A deprecated unit of surface-lighting intensity, equal to 10.76391 lx. The lux (lx) is defined as 1 lumen per square meter (lm/m$^2$).

*See also luminous flux.*

**Footing** *n.* Concrete base on which a foundation sits.

**Foot lambert** *n.* Foot lambert is the unit of photometric brightness (luminance) equal to 1/π candle/ft$^2$.

**Foots** *n.* Sediment which settles from an oil on standing; chiefly albuminous matter. Originally used to describe those solid impurities, which precipitate from raw linseed oil during storage and then settle to the bottom or "foot" of a storage tank. Later used to denote material insoluble in a mixture of equal parts of acetone and linseed or other oil under test, and insoluble in calcium chloride solution under the specific conditions of test method. Also, the term is used to denote that material which is precipitated from the oil by phosphoric acid and which is insoluble in acetone under the specific conditions of test method.

*See also tailings.*

**Force** \\ˈfōrs, ˈfórs\\ [ME, fr. MF, fr. (assumed) VL *fortia*, fr. L *fortis* strong] (14c) *n.* (1) Either half of a compression mold (top force or bottom force), but usually the half that forms the concave surfaces of the molded part. (2) The male half of the mold, which enters the cavity and exerts pressure on the resin, causing it to flow. (3) A basic familiar quantity, familiar to everyone, customarily defined as that which changes a body's state of rest or motion, according to Newton's second law of motion:

$$F = \frac{\mathrm{d}}{\mathrm{d}t}(mv)/g_c = ma/g_c.$$

The second form applies when mass $m$ is constant, as in all industrial applications. Here $F$ is the force, $v$ the velocity, $t$ the time, $a$ the body's acceleration is d$v$/d$t$, and 1/$g_c$ is the proportionality constant relating the dimensions of the three primary quantities. Historically the units of the primary quantities, in whatever system, have been devised so that $g_c$ is exactly 1 and it is often omitted from the equation. In the SI system, 1 N is defined as the force that will accelerate a 1-kg mass 1 s$^{-1}$ (meter per second), making $g_c$ exactly 1.0000 N s$^2$/(kg m). In the English system, however, where "pound" is used to mean either the pound-mass or the pound-force (lb or lb$_f$), the value of $g_c = 32.174$ lb$_f \cdot$ s$^2$/(lb ft)! *Weight* is the downward force exerted on bodies in the earth's gravitational field and results from the as yet unexplained mutual attraction of masses as set forth in Newton's law of universal gravitation. Because the earth is nearly spherical, the distances between bodies on and close to its surface and the earth's center are almost constant and so, therefore is the earth's attractive force on a unit mass at its surface. For convenience, the force is replaced by $g$, the standard "acceleration due to gravity", 9.806,650 m/s$^2$ (32.174 ft/s$^2$). Then, weight, $= mg/g_c$. For precise work, corrections are made for the variation in $g$ with latitude and altitude, but $g_c$ is always constant, even in outer space. Force has other aspects that are unconnected with rate of change of momentum. For example, the forces developed in a tightened bolt or the force exerted by a hydraulic ram on molding compound in a closed mold. One should keep in mind that force is *not identical* to mass times acceleration.

**Force between two charges, Coulomb's law** *n.* If two charges $q$ and $q'$ are at a distance $r$ in a vacuum, the force between them is,

$$F = \frac{qq'}{r^2}.$$

The force will be given in dynes if $q$ and $q'$ are in electrostatic units and $r$ in cm.

**Force between two magnetic poles** *n.* If two poles of strength $m$ and $m'$ are separated by a distance $r$ in a medium whose permeability is $\mu$ (unity for a vacuum), the force between them is

$$F = \frac{mm'}{\mu r^2}.$$

Force will be given in dynes if $r$ is in cm and $m$ and $m'$ are in cgs units of pole strength. The strength of a magnetic field at a point distance $r$ from an isolated pole of strength $m$ is

$$H = \frac{m}{\mu r^2}.$$

The field will be given in gauss if $m$ and $r$ are in cgs units.

**Forced drying** *n.* Drying coatings at a temperature between room temperature and 65.6°C (150°F) as opposed to air drying or baking.

**Forced drying temperature** *n.* Temperature between room temperature and 65.6°C (150°F).

*See baking.*

**Force feeder** *See Crammer–Feeder.*

**Force plate** *n.* The plate that carries the plunger or force plug of a mold and the guide pins or bushings. Since the force plate is usually drilled for steam or water lines, it is sometimes called the *steam plate.*

**Force plug** (plunger, piston) *n.* The portion of a mold that enters the cavity block and exerts pressure on the molding compound, designated as the *top force* or *bottom force* by position in the assembly.

**Ford cup** *n.* Efflux cup used for measuring the viscosity of paint or varnishes.

*See efflux viscometer and viscometer.*

**Ford viscosity cups** *n.* A series of three cylindrical cups with conical bottoms, differing only in the diameters of the orifices at the apexes of the cones, each cup having a capacity of about 100 ml. From the time or efflux, the sample volume and the orifice diameter, the kinematic viscosity of a liquid may be estimated. ASTM test D 1200 (Section 06.01) describes the Ford cup procedures to be used with paints and varnishes.

**Foreign matter** *n.* Anything visibly unrelated to the true nature of the substance under examination.

**Foreign waste** *n.* Thread waste or lint that is twisted in the yarn or woven in the fabric. If such foreign matter is of a different fiber, it may dye differently and thus show plainly.

**Forgeability** *n.* The ability of a solid material to flow without rupture under sudden intense compression. Some plastics have been forged into useful articles.

**Forging** *See cold forming and solid-phase forming.*

**Form (sometimes Forme)** \ˈfóm, ˈfórm\ (15c) *n.* (1) Type and other matter locked in a chase ready for printing. (2) In crystallography, a group of similar faces, e.g., cube, prism, dipyramid, etc. Also, a given polymorphic form of a substance, e.g., Form II of calcium carbonate is aragonite.

**Formability** *n.* The relative ease with which a plastic sheet or rod may be given another permanent shape.

*See thermoformability.*

**Formal charge** *n.* A somewhat arbitrary but useful way of indicating the approximate electrical characteristic or charge of an atom.

**Formaldehyde** \fór-ˈmal-də-ˌhīd, fər-\ [ISV *form-* + *aldehyde*] (1872) (formic aldehyde, methanal, oxymethylene) *n.* HCHO. A colorless gas with a pungent, suffocating odor, obtained most commonly by the oxidation of methanol or low-boiling petroleum gases such as methane, ethane, etc. The gas is difficult to handle, so it is sold commercially in the form of aqueous solutions (formalin), solvent solutions, as its oligomer, paraformaldehyde, and as the cyclic trimer, 1,3,5-trioxane (α-trioxym-ethylene). High-molecular-weight, commercial polymers of formaldehyde are called *polyoxymethylene* or acetal resin. Formaldehyde is also used in the production of other resins such as phenolic resin (phenol-formaldehyde) and amino resin (urea formaldehyde). Syn: methylene oxide, methanal.

*See formalin.*

**Formalin** \ˈfór-mə-lən, -ˌlēn\ [*Formalin*, a trademark] (1893) (formol) *n.* HCHO. Formaldehyde gas commercially available as a 37% wt. solution in water with a small amount of methanol for inhibiting polymerization.

*See formaldehyde.*

**Formed fabric** *See non-woven fabric.*

**Form grinding** *n.* A method of forming circularly symmetrical parts from plastic rod or tubing, employing a grinding wheel shaped to the inverse of the desired contour, a smaller hardened-steel regulating wheel that presses the plastic rod or tube against the grinding wheel, and work-rest blade that supports the work between the two wheels. Water is usually supplied as the coolant, from which the scrap powder can be recovered and reused.

**Formica®** \fór-ˈmī-kə, fər-\. A trademark of the Formica Corporation for high-pressure, decorative laminates of melamine-formaldehyde, phenolic and other thermosetting resins with paper, linen, canvas, glass cloth, etc., often misused by the public in a generic manner.

**Formic acid** (methanoic acid) *n.* HCOOH. The first of the aliphatic acids, with a pungent odor and probably existing mostly in the dimmer form, formic acid is produced by the reaction of carbon dioxide and dry sodium hydroxide followed by treatment with sulfuric acid. It is a solvent for phenol–formaldehyde resins, some polyesters, polyurethanes, and nylons.

**Forming** A general term encompassing processes in which the shapes of plastics pieces such as sheets, rods, or tubes are changed to a desired configuration, usually with the acid of heat. The term is not usually applied to operations such as molding, casting, or extrusion in which shapes or articles are made from molding materials and liquids.

*See also fabricate and thermoforming.*

**Forming box** *See vacuum sizing.*

**Forming cake** *n.* In filament winding, the collection (*package*) of glass-fiber strands on a mandrel during the operation.

**Form lacquer** *n.* Thin lacquer or varnish used to coat concrete forms to prevent concrete from adhering to the forms.

**Formol** Syn: formaldehyde.

**Form roller** *n.* The form roller is that roller in the ink distribution system of a printing press, which is in direct contact with the printing plate and transfers the ink to it.

**Formula** \ˈfór-myə-lə\ [L, dim. of *forma* form] (1618) (Chemical) *n.* A combination of symbols with their subscripts representing the constituents of a substance and their proportions by weight.

**Formula unit** The group of atoms indicated by the formula of a substance.

**Formula weight** (ca. 1920) (molecular weight) *n.* Of a chemical compound, the number obtained by summing the atomic weights of all the compound's atoms. The term is not used with polymers, which are always mixtures of compounds of different molecular weights.

**Formula weight** The sum of the masses of the atoms indicated in a formula, expressed in atomic mass units; the mass of one formula unit.

**Fossil gum resin** *n.* Fossil gums are the so-called hard gums or copals with were exuded from living plants in the form of liquids or semisolids, which have lain in the ground for centuries and thus hardened or fossilized with time. Some of the fossil gum resins are: Amber, Zanzibar, Kauri, Manila, Pontianak, and Congo. *See gym, natural and resin, natural.*

**Fossil resin** *n.* A natural resin obtained from fossilized remnants of plant or animal life. An example is amber, a fossilized resin derived from an extinct species of pine.

**Foster charts** *n.* Graphs for determining color differences in modified MacAdam units from tristimulus and ratio tristimulus measurements made on a tristimulus colorimeter. They are based on the Simon–Goodwin charts and give results, which are a close approximation to those which would be obtained with the S–G charts.

**Foulard** \fu-ˈlärd\ [F] (1830) *n.* A lightweight, lustrous 2/2 twill that is usually printed with small figures on a solid background, foulard is frequently used in men's ties. Foulards are made of silk, filament polyester, acetate, etc.

**Fouling** *n.* Sessile marine organisms on the hulls of ships.

**Foundation** Lower parts of walls on which the structure is built. Foundation walls of masonry or concrete are mainly below ground level.

**Foundry resin** *n.* A thermosetting resin used as a binder for sand in metals founding. The types most commonly used as water-soluble phenol–formaldehyde resins that become insoluble when cured, and cold-setting furfuryl alcohol resins that cure in the presence of an acid catalyst.

**Fountain** \ˈfaún-tᵊn\ [ME, fr. MF *fontaine*, fr. LL *fontana*, fr. L, feminine of *fontanus* of a spring, fr. *font-*, *fons*] (14c) *n.* Part of a printing press, which contains the ink to be fed to the distributing system. In lithography, it is also the part, which feeds the water or fountain solution to the dampening rollers.

**Fountain roller** *n.* The roller that revolves in the ink fountain. In lithography it is also the roller that revolves in the dampening solution.

**Fountain solution** *n.* In lithography, generally a mixture of water, acid, buffer and a gum to prevent the non-printing areas of the plate from receiving ink. To some fountain solutions, alcohols are added. *Also known as dampening solution.*

**Four-dimensional braid** *n.* A type of braided reinforcement used to achieve specially directed strength and resistance to interlaminar shear, often involving mixed fibers of different materials.

**Fourier number** *n* ($N_F$). A dimensionless group important in analysis of unsteady heat transfer in solids, such as sheets being heated or cooled in thermoforming, or cooling of extrudates and moldings, $N_F = \alpha \cdot t/x^2$, where $\alpha$ is the material's thermal diffusivity, $t$ the heating or cooling time, and $x$ is the a thickness or half-thickness in the direction of heat flow.

**Fourier's law of heat conduction** *n.* The fundamental equation for steady heat flow through solids. It is

$$q = -kA\frac{dT}{dx},$$

where $q$ is the rate of heat flow, $k$ the thermal conductivity of the material at temperature $T$, and $A$ is the area through which heat flow is occurring, normal to coordinate $x$ within the material in the direction of heat flow. This is the defining equation for thermal conductivity. The quotient $q/A$ is known as the *heat flux* or *thermal flux*. If the thermal conductivity is constant over the range of temperatures involved or is linearly dependent on temperature, an integrated, simpler version of the law, with an average conductivity, can be used to find the heat flow through a layer of thickness $\Delta x$:

$$q = k_{avg}A(T_2 - T_1),$$

where $T_2$ and $T_1$ are the temperatures on the hot and cold sides of the layer.

**Fourier-transform infrared spectroscopy (FTIR)** *n.* Infrared (IR) spectroscopy is most commonly used for the identification of unknown pure organic compounds. In FTIR, infrared radiation of a broad range of wavelengths is passed through an interferometer and a pathlength difference is introduced into one part of the light beam. This IR beam is then passed through the sample, which absorbs light energies corresponding to various bond-vibration and rotation frequencies. The beam is then focused on a detector, and a computer calculates the absorption of the IR frequencies by the sample, identifying compounds present and their concentration in the sample. An example of a FTIR spectroscope is the Spectrum 100 FTIR Spectrophotometer by Perkin-Elmer Inc., image courtesy of Perkin-Elmer Inc., New York.

**Foxy** Pigment crystals are sometimes arranged in different order by method of application, causing different shades of color when viewed from different angles; this condition is often referred to as "foxy".

**F.P.S. system** *n.* The foot-pound-second system of units. The British system of physical units derived from the three fundamental units of length, mass, and time, i.e., the foot, pound, mass, and the second.

**Fraction** \\ˈfrak-shən\\ [ME *fraccioun*, fr. LL *fraction-*, *fractio* act of breaking, fr. L *frangere* to break] (14c) *n.* Solvent of definite boiling range obtained by fractional distillation.

**Fractional distillation** *n.* Separation of a liquid into its different components by collecting fractions or distillates of restricted boiling range.

**Fractionation** *n.* A method of determining the molecular-weight distribution of polymers based on the fact that polymers of higher molecular weight are less soluble than those of lower molecular weight. Two basic methods in use are (1) Precipitation fractionation, in which phases are separated from a solution of the polymer by incremental addition of non-solvents, stepwise lowering of the solution temperature, or volatilization of the solvent. (2) Extraction fractionation, in which fractions of increasing molecular weight are preferentially extracted from a layer of polymer that has been deposited on a substrate. In either method, a series of fractions is obtained which must be recovered and characterized with respect to molecular weight. A third method that has had some success is ultracentrifugation. Fractionation is also used to prepare polymer specimens having narrow molecular-weight distributions.

*See ultracentrifuge.*

**Fracture** \ˈfrak-chər, -shər\ [ME, fr. L *fractura*, fr. *fractus*] (15c) *n.* The separation of a body, usually characterized as either brittle or ductile. In brittle fracture, the crack propagates rapidly with little accompanying plastic deformation. In ductile fracture, the crack propagates slowly, usually following a zigzag path along planes on which a maximum resolved shear stress occur, and their is substantial plastic deformation. Slower loading and higher temperature favor ductile behavior.

**Fracture mechanics** The study, both theoretical and experimental, of the behavior of cracks in stressed bodies. A basic principle is that fracture is driven by the energy released by the growth of the crack, which begins at a small imperfection such as is found in all bodies.

**Fracture toughness** ($K_c$) *n.* The critical value of the stress-intensity factor in a material beyond, which a crack will start to grow.

**Frame** *n.* (1) A general term for many machines used in yarn manufacturing such as the drawing frame, roving frame, and spinning frame. (2) *See tenter frame.*

**Framework knitting** *See knitting, weft knitting.*

**Frankel–Acrivos equation** *n.* An equation, derived wholly from theoretical considerations, giving the relative viscosity of suspensions of monodisperse spheres in Newtonian liquids. It is

$$\eta_r = \frac{\eta}{\eta_o} = \frac{9}{8}\left[\frac{(f/f_m)^{1/3}}{1-(f/f_m)^{1/3}}\right],$$

where $\eta_o$ is the viscosity of the pure liquid, $\eta$ the viscosity of the liquid containing a volume fraction $f$ of spheres whose density is close to that of the liquid. $f_m$ represents the maximum attainable volume fraction, which depends on the assumed geometry of packing, about 0.7–0.74. The equation well represents the best available data to loadings approaching $f/f_m = 1$. Compare Eilers equation and Mooney equation.

**Frankincense** \ˈfraŋ-kən-ˌsen(t)s\ [ME *fraunk encense*, fr. OF *franc encens*, fr. *franc* (perhaps in sense "of high quality") + *encens* incense] (14c) *n.* A fragrant gum resin from trees of a genus (*Boswellia* of the family *Burseracae*) of Somalia and coastal Arabia that is an important incense resin and was used in ancient times in religious rites and embalming.

*See gum thus.*

**Fraunhofer's lines** *n.* When sunlight is examined through a spectroscope it is found that the spectrum is traversed by an enormous number of dark lines parallel to the length of the slit. These dark lines are known as Fraunhofer's lines. Kirchoff conceived the idea that the sun is surrounded by layers of vapors which act as filters of the white light arising from incandescent solids within and which abstract those rays which correspond in their periods of vibration to those of the components of the vapors. Thus reversed or dark lines are obtained due to the absorption by the vapor envelope, in place of the bright lines found in the emission spectrum.

**Fraying** The slipping or raveling of yarns from unfinished edges of cloth.

**Free energy** *n.* Also Gibb's free energy or change in free energy of a reaction;

$$-\Delta G = T\,\Delta S - \Delta H,$$

where $T$ is the temperature, $S$ is entropy, and $H$ is the enthalpy; if $-\Delta G$ the reaction can proceed, but if $+\Delta G$ then the reverse reaction can proceed; also referred to as the driving force of a reaction; and the decrease in free energy of a constant temperature, constant-pressure process is the measure of the tendency of the process to proceed spontaneously.

**Free energy of formation, $\Delta G_f$** *n.* The free energy change for a reaction in which one mole of a compound is formed from its uncombined elements.

For the chemical reaction,

$$\begin{aligned}&1/2N_2 + 2H_2 + 1/2Cl_2 \rightarrow NH_4Cl,\\ &\Delta G = \Delta H - T\,\Delta S\\ &\Delta G = (-314.4 \times 10^3\,\mathrm{J\,mol^{-1}}),\\ &\qquad - (298.2)(-373.8\,\mathrm{J\,K^{-1}\,mol^{-1}}),\\ &\Delta G = 2.030 \times 10^5\,\mathrm{J\,mol^{-1}},\end{aligned}$$

where $-\Delta G$ indicates that the reaction occurs spontaneously.

**Free energy, F** (Gibbs free energy, $G$) *n.* A thermodynamic quantity, which measures the energy in a system which is available for doing work of expansion. The free energy of a system is defined as the difference between its enthalpy, $H$, and its temperature–entropy product: at constant temperature and pressure, $\Delta G = H - T\Delta S$. If $\Delta G < 0$, then a spontaneous reaction occurs, $\Delta G > 0$, non-spontaneous or a reversible reaction, $\Delta G = 0$, the system is at equilibrium. An example of $\Delta G < 0$ is the melting of ice above 0°C, and $\Delta G > 0$ for the freezing of water above 0°C. Consider a material undergoing a "change of state" at its equilibrium temperature. Gold metal undergoes a change of state (fusion) at its equilibrium temperature (melting temperature, $T_m$) and

$$\Delta S = \frac{\Delta H}{T_m},$$

where $T_m$ can be calculated as,

$$T_m = \frac{12.36 \times 10^3\,\mathrm{J\,mol^{-1}}}{9.250\,\mathrm{K^{-1}}} = 1336\ \mathrm{K}$$

and 1336°K – 273 = 1063°C.

**Free expansion** *n.* Expansion of a substance, usually a gas, against no opposing pressure.

**Free-falling-dart test** *n.* A method of measuring the impact resistance of thermoplastic films by dropping a dart with a hemispherical head onto a film specimen held in a clamping frame. As described in ASTM D 1709, the dart is dropped from a fixed height onto each of ten specimens and the percent failure is noted. Another increment of weight is added and ten more specimens are tested. The process is repeated until 50% of the specimens fail. The weight of the dart at this point, times the drop height, is a measure of the film's impact strength. In ASTM D 4272, another falling-dart test for films, the dart is instrumented and the energy consumed in penetrating the film is computed. ASTM D 3029 describes a similar test for rigid sheets. *See also falling-dart impact test.*

**Free fatty acid** *n.* Unreacted fatty acid present in a coating vehicle.

**Free forming** *n.* A variant of sheet thermoforming in which a bubble is blown into the clamped, heat-softened sheet, either by applying a vacuum to the side that will be convex or pressure to the underside. The method has been used most with cast-acrylic sheet for applications where the best possible optical properties are foremost, such as airplane canopies.

**Free phenol** *n.* The uncombined phenol existing in a phenolic resin after curing, the amount of which is indicative of the degree of cure. The presence of such free phenol can be detected by the Gibbs indophenol test.

**Free radical** (1900) *n.* An atom or group of atoms having at least one unpaired electron. Most free radicals are short-lived intermediates with high reactivity and high energy, difficult to isolate. They are important agents in many polymerization processes and have been detected on corona-discharge-treated films by electron-spin resonance (ESR).

**Free radical chain** *n.* Polymerization of an atom or molecule, which has at least 1 e, which is not paired with another electron.

**Free-radical polymerization** *n.* A reaction initiated by a free radical derived from a polymerization catalyst. Polymerization proceeds by the chain-reaction addition of monomer molecules to the free-radical ends of growing chain molecules. Major polymerization methods such as bulk, suspension, emulsion, and solution polymerization involve free radicals. The free-radical mechanism is also useful in copolymerization, in which alternating monomeric units are promoted by the presence of free radicals. Lenz RW (1967) Organic chemistry of high polymers. Interscience Publishers, New York. Odian G (2004) Principles of polymerization, 4th edn. Wiley-Interscience, New York.

**Free silica** *n.* $SiO_2$. Silica generally present in small amounts in natural deposits of clay-like minerals and diatomaceous earth and usually considered to be a contaminant.

**Free-thaw resistance** *n.* Extent to which water-base paints, utilizing synthetic lattices or synthetic resin emulsions as vehicles: (1) Retain their original properties, free from detrimental changes in consistency. (2) Resist coagulation, or the formation of lumps and specks, when subjected to freezing and subsequent thawing.

**Free volume** *n.* In a liquid or amorphous solid, the specific volume minus the volume occupied by the molecules themselves. Free volume increases with rising temperature, causing viscosity to diminish. The $f_{\mathrm{WFL}}$ is calculated from the specific volume of the amorphous polymer ($v^{\mathrm{o}}{}_{\mathrm{am}}$) and the specific volume of the liquid polymer ($v^{\mathrm{o}}{}_{\mathrm{t}}$) in a polymer–monomer mixture during polymerization (Elias, 1977).

$$f_{\mathrm{WFL}} = \frac{v^{\mathrm{o}}_{\mathrm{am}} - v^{\mathrm{o}}_{\mathrm{t}}}{v^{\mathrm{o}}_{\mathrm{am}}}.$$

The vacant sites of the solid polymer (amorphous) are called “free volume”; no long range order in extensive regions occurs in the amorphous state (e.g., amorphous material is not X-ray crystalline) although indications are that these regions possess a certain order; and theoretically a certain number of vacant sites must be present in the solid polymer. Free volume is mainly responsible for the compressibility of liquids and solids. Also called free volumes $f$: vacant free volume $f_{\mathrm{vac}}$, Williams–Landell–Ferry free volume $f_{\mathrm{WFL}}$, fluctuation free volume $f_{\mathrm{fluc}}$, and free volume for thermal expansion $f_{\mathrm{exp}}$. The effect of system variables on solubility is discussed in Handbook of Solvents, 2001. Miller (1968) noted that “the concept of free volume is easy to grasp, but, quantitatively, its definition runs into snares. Is free volume the specific volume of the liquid (solution) minus the volume of the molecules computed from Van der Waals radii, or minus the volume swept out by the segments as they rotate, or is it some other volume”? The free volume is generally, but necessarily, about 2.5% for all polymers.

**Free-wheeling** *n.* In reference to rolls, spinning without the application of either driving or braking force.

**Freeze grinding** *See cryogenic grinding.*

**Freeze line** Syn: frost line.

**Freezing point** (1747) *n.* Temperature at which a liquid material and solid are in equilibrium with one another, i.e., at a lower temperature the liquid will solidify. Amorphous materials, such as paints or paint vehicles, normally solidify over a temperature range referred to as freezing range.

**Freezing-point depression** *n.* $\Delta T = -K_{\mathrm{FP}} m$, where $T$ is the freezing point depression, $K_{\mathrm{FP}}$ the 1.86 for water, and $m$ is the molality (mol solute/1000 g solvent), The lowering of the freezing point of a solvent brought about by the presence of a solute.

**Frenchback** *n.* A fabric with a corded twill backing of different weave than the face. The backing, which is frequently of inferior yarn, gives added weight, warmth, and stability to the cloth.

**French blue** *See ultramarine blue.*

**French chalk** *n.* $3MgO{\cdot}4SiO_2{\cdot}H_2O$. It is distinguished by its soapy or greasy feel. Chemically, it is substantially a hydrated magnesium silicate. It is supplied commercially as a white or gray powder with Sp gr of 2.4–2.6. Electromagnetic radiation to produce an exceedingly high gloss to wood surfaces. The use also of a little linseed oil on the polishing cloth is involved. *Known also as talc, soapstone, or steatite.*

**French process zinc oxide** *n.* Zinc oxide pigment made from zinc metal.
*See zinc oxide.*

**French ultramarine** *n.* Synthetic ultramarine blue.
*See ultramarine blue.*

**French varnish** *n* A hard-rubbed high-gloss finish, achieved by multiple applications of such varnish.
*See French polish.*

**French veronese green** *See hydrated chromium oxide.*

**Freon®** \ˈfrē-ˌän\ *See fluorocarbon blowing agent.*

**Frequency** \ˈfrē-kwən(t)-sē\ (1600) *n.* Number of vibrations per second, equal to the velocity of light (or any electromagnetic radiation) divided by the wavelength:

$$\nu = \frac{c}{\lambda},$$

where $\nu$ is the frequency, $c$ the velocity $2.99793 \times 10^8$ m/s (for light and for all electromagnetic radiation), and $\lambda$ is the wavelength which is specific for each type of radiation.

**Frequency factor** *n.* The quantity preceding the exponential term in the Arrhenius equation.

**Frequency of vibrating strings** *n.* The fundamental frequency of a stretched string is given by

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}},$$

where $l$ is the length, $T$ the tension and $m$ is the mass per unit length. For a string or wire of circular section of length $l$, tension $T$, density $d$, and radius $r$, the frequency of the fundamental is

$$n = \frac{1}{2rl}\sqrt{\frac{T}{\pi d}}.$$

The frequency in vibrations per second will be given if $T$ is in dynes, $r$ and $l$ in cm and $d$ in g/cm$^3$.

**Fresco** \ˈfres-(ˌ)kō\ [It, fr. *fresco* fresh, of Gmc origin; akin to OHGr *frisc* fresh] (1598) *n.*

Method of painting in which pigments mixed only with water are applied to a freshly laid surface of lime plaster. The painted surface is rendered durable by the pigment absorbing calcium hydroxide from the wet plaster, which is converted into insoluble calcium carbonate as the surface dries. The term is sometimes used incorrectly to denote any form of mural painting.

**Fresco color** *n.* Water paints used for wall decorations.

**Fresnel reflection** *n.* Phenomenon of reflection at the surface or interface where media or materials of different refractive indices join. Fresnel laws state that the angle of reflection is equal and opposite to the incident angle, and that the magnitude of the reflection depends on the angle of the incident light, on the relative refractive indices, and on the polarization of the incident light. When the surfaces are smooth and planar, specular (mirror like) reflection occurs, which is subjectively referred to as specular gloss. When the surfaces are rough, the reflectance at the air-material interface is diffuse, and the surface is observed to be matte-like.

**Fret** [ME, back-formation fr. *fret*, *fretted* adorned, interwoven, fr. MF *freté*, fr. OF, pp of *freter*, *ferter* to tie, bind, prob. fr. (assumed) VL *firmitare*, fr. L *firmus* firm] (14c) *vt.* A geometric band or border motif, consisting of interlacing or interlocking lines.

*Also known as a key or meander pattern.*

**Friction** \ˈfrik-shən\ [ME, fr. MF or L; MF fr. L *friction-*, *frictio*, fr. *fricare* to rub; akin to L to crumble] (1704) *n.* (1) The force resisting the sliding or rolling of one body relative to another with which it is in contact. The *coefficient of friction*, $\mu$, is the quotient of the force required to cause or maintain motion divided by the normal force $N$ exerted by the bodies upon each other, i.e., $\mu = F/N$. With most materials, the force required to initiate motion is somewhat greater than that required to maintain it, so a distinction is drawn between *static* and *dynamic* coefficients of friction. Coefficients of *rolling* friction are generally much lower than coefficients of sliding friction. Dynamic sliding friction is the most important one in plastics processing, but all three have roles in product design and operation. (2) In flowing fluids, particularly liquids, interlaminar friction is believed to be the basis of viscosity.

**Frictional coefficient** *n.* Resistance to sliding or rolling of surfaces of solid bodies in contact with each other.

**Frictional heating** *n.* (1) Heat evolved when two surfaces rub together. For a frictional force $F$ and relative velocity $V$, the rate of heat evolution is $FV$ (SI: J/s). (2) Viscous dissipation within liquids undergoing shear flow. At any point in a laminar-flowing liquid, the rate of viscous dissipation, per unit volume, is equal to the product of the shear rate times the shear stress, which is also equal to the product of the local viscosity and the square of the shear rate. Both these types of functional heating are important mechanisms of plastication in extruders and injection molders.

**Friction calendering** *n.* A process in which an elastomeric compound is forced into the interstices of woven or cord fabrics while passing through the rolls of a calender. The heated compound is fed into the top opening of three adjacent rolls, so that it will cling to the middle roll. The fabric to be impregnated is fed into the lower opening between the rolls. The distance between the rolls is regulated so as to squeeze the fabric without crushing it, and the rolls are operated at slightly different speeds so that the compound is wiped by friction into the meshes of the fabric.

**Friction coefficient** *n.* The coefficient of friction between two surfaces is the ratio of the force required to move one over the other to the total force pressing the two together. If $F$ is the force required to move one surface over another, and $W$, is the force pressing the surfaces together, the coefficient of friction,

$$k = \frac{F}{W}.$$

**Friction false-twist texturing** *See texturing, false-twist method.*

**Friction spinning** *n.* A spinning system in which the yarn receives its twist by being rolled along the longitudinal axis in the nip between two revolving surfaces. The surfaces may rotate at the same or different speeds in the same or opposite directions depending on the particular machine design. Potential advantages include high production capacity, low stress on the fiber in processing, and the capacity to produce very fine counts.

**Friction top can** *n.* Can in which the lid is held in place by friction.

**Friction welding** (angular welding) *n.* A term encompassing spin welding and the newer process of applying rapid angular oscillations to heat the plastic parts to be joined. This variation of the spin-welding process is used for parts that are not symmetrical about an axis of rotation. The equipment must be programmed to stop when the parts of properly positioned for joining.

**Friedel-catalysts** *n.* Strongly acidic metal halides such as aluminum chloride, aluminum bromide, boron trifluoride, ferric chloride, and zinc chloride, used in the polymerization of unsaturated hydrocarbons, e.g., olefins (Friedel–Crafts reactions using such catalysis are named for Charles Friedel and James Crafts, who first used them in 1877). These acidic halides are *also known as Lewis acids.*

**Friedel–Crafts catalyst** *n.* Lewis Acid catalysts such as aluminum chloride or ferric chloride.

**Friel–MacAdam-chickering color difference equations** *See FMC color difference equations.*

**Friezé** \ˈfrēz *or* frē-ˈzā\ [ME *frise*, fr. MF, fr. MDu *vriese*] (15c) *n.* (1) Any decorative horizontal band, as along the upper part of a wall in a room. (2) A type of wallpaper popular in the early 1900s. Generally, a pictorial border, which ran above door height, or, in dining rooms, above the plate rail. (3) A term applied when the pile of a velvet, plush, velour, or other pile fabric is uncut. A friezé fabric is sometimes patterned by shearing the loops at different lengths. Friezé fabrics are widely used for upholstery. (4) A cut-pile carpet made of highly twisted yarns normally plied and heat-set. A kinked or curled yarn effect is achieved. Excellent durability results from the hard-twist pile yarns.

**Fringed micelle** *n.* A model for a partially crystalline polymer widely accepted as explaining many of the properties of such a polymer. Consists of crystallites (the "micelles") embedded in an amorphous matrix.

**Frisket** \ˈfris-kət\ [F *frisquette*, fr. MF] (ca. 1898) *n.* Device, usually of gummed paper placed on the working surface, to block out subsequent painting.

**Frosting** *n.* (1) Formation of a translucent finely wrinkled surface on a film of oil, ink, or paint during drying, particularly when exposed to gas fumes, etc. (2) Salt like deposit on the surface of a topcoat. (3) A clouding of the surface of some rubber and synthetic rubber goods, appearing within a few hours or days after vulcanization. The frosted appearance is different from bloom or blush and cannot be readily removed by washing with a solvent. It may disappear if the article is heated moderately but will generally reappear on cooling. It is thought to be caused by ozone in the air, which produces a maze of minute cracks. Some antioxidants have definite anti-frosting effects. *See color abrasion. See also chalking, bloom, and haze.*

**Frosting marks** *n.* A defect of woven fabric consisting of surface highlights that give a frosted appearance. Frost marks are caused by improper sizing or insufficient warp tension as a result of uneven bending of some warp ends over the picks.

**Frost line** (freeze line) *n.* In the extrusion of blown film, a ring-shaped transition zone of frosty appearance located at the level at which the film reaches its final diameter and is changing from melt to solid.

**Frothing** *n.* A technique for applying urethane foam in which blowing agents or small air bubbles are introduced under pressure into the liquid mixture of foam ingredients.

**Frozen-in strain** (residual strain) *n.* Strain that remains in an article after it has been shaped and cooled to its final form, due to a non-equilibrium configuration of the polymer molecules. Such strains occur when cooling its carried below a certain temperature before stresses of a molding or forming operation have been allowed to relax, Frozen-in strains/stresses can cause warping of large flat members and can lead to crazing at low applied stress levels. Aside from measures that can be taken during processing, post-annealing, sometimes done with the aid of shape-holding jigs, is used to complete the relaxation of stresses.

**FRP** *n.* Abbreviation for fiber-reinforced plastic.

**FSCT** *n.* Abbreviation for federation of societies for coatings technology. Paint technology prior to 1975.

**Fuchsin** \ˈfyük-sən, -ˌsēn\ [F *fuchsine*, prob. fr. NL *Fuchsia*; fr. its color] (1865) *n.* Synthetic rosaniline dyestuff, a mixture of rosaniline and pararosaniline hydrochlorides. Dark green powder of greenish crystals with a bronze luster; faint odor. Soluble in water and alcohol. Used in textile and leather industries; as a red dye; and as a pharmaceutical. Vigo TL (1994) Textile processing, dyeing, finishing, and performance. Elsevier Science, New York. *Also known as basic fuchsin magenta.*

**Fugitive colors** *n.* (1) Coloring matter that exhibits color change or color transfer while wet or during subsequent drying. (2) Inks made from pigments or dyes, which are not permanent, and change or lose color rapidly when exposed to light, heat, moisture, or other conditions. (3) Colorant, pigment or dyestuff, which changes color (fades) rapidly following exposure to light.

**Fugitometer** *See fadeometer.*

**Full-bodied** *See body.*

**Full coat** *n.* (1) Maximum film thickness of a particular coating, which can be properly applied. (2) Application of a coating at a specified film thickness designed to achieve a desired effect.

**Fuller's earth** *n.* $3MgO{\cdot}1.5Al_2O_3{\cdot}8SiO_2{\cdot}9H_2O$. Hydrated magnesium aluminum silicate (attapulgite) used for decolorizing solutions and oils, and as a substitute for absorbent charcoal and as a dusting powder. Density, 2.36 g/cm$^3$ (19.7 lb/gal). Refractive index, 1.50–1.55. Ash M, Ash I

(1998) Handbook of fillers, extenders and dilutents. Synapse Informtion Resources Inc., New York.

*See hydrated magnesium aluminum silicate.*

**Full-fashioned** *n.* A term applied to fabrics produced on a flat-knitting machine, such as hosiery, sweater, and underwear, that have been shaped by adding or reducing stitches.

**Full-flighted screw** *n.* An extruder screw in which the flights extend over the entire length of the screw.

**Full gloss** *See gloss.*

**Fulling** *n.* A finishing process used in the manufacture of woolen and worsted fabrics. The cloth is subjected to moisture, heat friction, chemicals, and pressure which cause it to mat and shrink appreciably in both the warp and filling directions, resulting in a denser, more compact fabric. Vigo TL (1994) Textile processing, dyeing, finishing, and performance. Elsevier Science, New York.

**Fumaric resin** A synthetic, hard resin formed by the reaction of fumaric acid and rosin. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York.

**Fumed silica** (pyrogenic silica) *n.* An exceptionally pure form of silicon dioxide made by reacting silicon tetrachloride in an oxy-hydrogen flame. Individual particles of fumed silica, ranging in size from 7 to 40 nm, tend to link together by a combination of fusion and secondary bonding to form chain-like aggregates with high surface areas that retard the flow of liquids in which they are dispersed. Thus fumed silica is a useful thickening agent, imparting thixotropy to liquid resins that are normally Newtonian, e.g., certain polyesters. Fumed silica is also used in dry molding powders to make them free-flowing and easier to disperse with colorants. Improved electrical properties, prevention of blocking, and reduction of plasticizer migration are other benefits attributed to fumed silica in vinyl compounds. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Informtion Resources Inc., New York. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996. Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York.

**Fume fading** *See gas fading.*

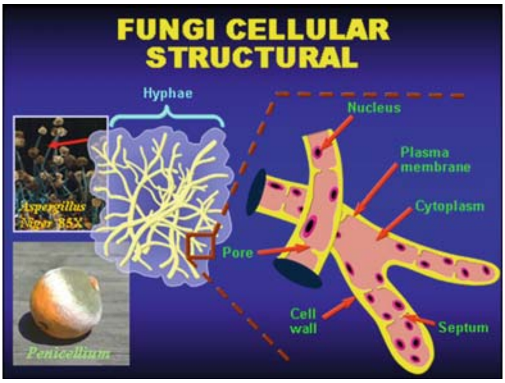
**Fumes** *n.* A gas-like emanation containing minute solid particles arising from the heating of a solid body such as lead, in distinction to a gas or vapor. This physical change is often accompanied by a chemical reaction, such an oxidation. Fumes flocculate and sometimes coalesce. Odorous gases and vapors should not be called fumes. As distinguished from dusts, fumes are finely divided solids produced by other methods of subdividing, such as chemical processing, combustion, explosion, or distillation. Some solids, when heated to a liquid produce a vapor, which, while arising from the molten mass, immediately condenses to a solid without returning to its liquid state. Fumes are much finer than dusts, containing particles from 0.1 to 1.0 µm in size. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997.

**Functional group** *n.* A group of atoms in a molecule, which cause the molecule to undergo a set of characteristic reactions. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Functionality** The ability of a molecule or group to form covalent bonds with another molecule or group in a chemical reaction. Compounds may be mono-, di-, tri-, or polyfunctional, depending on the number of functional groups capable of participating in a reaction. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Fundamental units** *See mass, length, and time.*

**Fungi** \ˈfəŋ-gəs\ *n pl*, - *sing.* Fungus. *See fungus.*



**Fungicidal paint** *n.* Some pigments are used as biocides. For example, zinc oxide I used as a fungicide. Paint, which discourages the growth of fungi on its dry applied film is a fungiciial paint or coating. The fungicidal properties are normally conferred by special additives, although certain pigments such zinc oxide, commonly used in paints, may themselves contribute to the fungicidal properties of the paint. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Fungicidal wash** Wash containing fungicides used before painting and designed to kill existing spores or germinations or to prevent their inception. Many of these substances are toxic (to human beings) used when in concentrated form and therefore need careful handling. Use of the term "antiseptic wash" is deprecated.

**Fungicide** \ˈfən-jə-ˌsīd\ fungicides [ISV] (1889) *n, pl.* An agent incorporated in a plastic compound to control fungus growth, usually by killing the organisms. Most plastics with a few exceptions, notably some of the cellulosics, are inherently resistant to fungus attack. However, many plasticizers are highly susceptible to attack. Examples of fungicides used in plastics are copper-8-quinolinate and tributyltin oxide. Agents that retard fungal growth without killing the organisms are called *fungistats*. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

*See also biocide.*

**Funginertness** (fungus resistance). Not susceptible to the formation of fungus growth. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Fungistat** *n.* An agent incorporated in plastics compounds to control fungus growth without killing the fungi.

*See also biocide.*

**Fungistatic** \ˌfən-jə-ˈsta-tik\ (1922) *adj.* Preventing the growth of a fungus by the presence of some chemical or physical agent but not fungicidal.

**Fungus** \ˈfəŋ-gəs\ fungi [L] (1527) *n sing, -n pl.* Multicellular plant or plants of the phylum, *thallophytae* that contain no chlorophyll and reproduce by sexual or asexual spore. Fungi cells are eucarotic, each cell contains a nucleus. Fungi cause discoloration and growth in or on a coatings surface, i.e., mildew, mold. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

**Fungus resistance** *See mildew (fungus) resistance.*

**Furan** *n.* Furfuran; oxole; tetrole; divinylene oxide, $C_4H_4O$, Molecular Weight: 68.07. Occurs in oils obtained by the distillation of rosin contg pine wood. Prepared by decarboxylation of 2-furancarboxylic acid. Furan has been prepared directly from furfural over hot soda-lime or by dropping furfural on a fused mixture of sodium and potassium hydroxides. Other physical properties: Liquid. $d_4^{19.4}$ 0.9371. $bp_{760}$ 31.36°; $bp_{758}$ 32°. $^{n}D^{20}$ 1.4216. Flash pt, closed cup: −32°F (−35°C). Absorption spectrum: Purvis J (1910) J Chem Soc 97:1648–1655. Insoluble in water. Freely soluble in alcohol and ether. Stable to alkalies; resinifies on evaporation or when in contact with mineral acids. Boiling point: $bp_{760}$ 31.36°; $bp_{758}$ 32°. Wilson J (1941) *Org. Syn.* coll. vol 1, 2nd edn. p274. Hurd R et al. (1932) J Am Chem Soc 54: 2532. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Merck index (2001) 13th edn. Merck and Company Inc., Whitehouse Station, NJ.

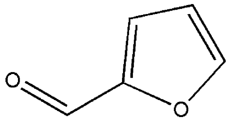
**Furan resin** (furfuryl resin) *n.* A dark-colored, thermosetting resin obtained primarily by the condensation polymerization of furfuryl alcohol in the presence of a strong acid, sometimes in combination with formaldehyde or furfural (2-furaldehyde). The term also includes resins made by condensing phenol with furfuryl alcohol or furfural, and furfuryl–ketone polymers. The resins are available as liquids in a wide range of viscosities that cure to highly cross-linked, brittle substances. They are used for impregnating cured plaster structures, as binders for foundry-sand cores, for binding high explosives, and as wood adhesives. The cured resins exhibit good resistance to chemicals and solvents. Improved resin/catalyst systems have made the older furan systems obsolete and enabled the use of fire-retardant furans in hand layup, sprayup, and filament-winding, competing with polyesters. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

*See furfuryl.*

**Furan prepreg** *n.* Latent catalysts announced in 1972 made it possible to produce furan-resin prepregs of acceptable shelf life, which avoided the difficulties experienced with the wet-layup process. These composites possess good heat and chemical resistance, excellent surface hardness and fire resistance. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Furfural** \ˈfər-f(y)ə-ˌral\ [L *furfur* bran + ISV $^3$*-al*] (1879) (2-furaldehyde, ant oil, furfuraldehyde) *n.* $C_4H_3O{\cdot}HO$. A liquid aldehyde with a bp of 161°C, mp of −36.5°C; Sp gr of 1.159/22°C, obtained by distilling acid-digested corn cobs or the hulls of oats, rice, or cottonseed, and having the structure shown below. Furfural is colorless liquid when first distilled, but darkens on exposure to air. It is used as a solvent, and in the production of furans and tetrahydrofurans.

*See also furan resin.*



**Furnace black** *n.* A form of carbon black obtained by decomposing natural gas and/or petroleum oil under controlled conditions in a furnace and precipitating the pigment in special chambers. *See carbon black.*

**Fuse** Heating a coating component of dispersed resin(s) to a temperature at which it becomes homogeneous.

**Fused acetate** *n.* (1) A hard particle of acetate material of almost any shape or size other than recognizable fiber. Sometimes fused acetate particles resemble rock-like, hardened drops of acetate dope; in other cases fused acetate consists of particles covered with fiber clusters and completely hardened in the center. (2) Acetate yarns in which the individual filaments are coalesced. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Fused Congo** *n.* Congo copal, which has been subjected to a fusing or running process, in order to induce oil solubility.

**Fused driers** *n.* Driers, which are prepared by the direct interaction of the main constituents, stimulated by heat, in the absence of added water. The term is used to distinguish them from driers, which are made by precipitation from aqueous solutions of metallic salts and alkali soaps. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Fused ribbon** *n.* Acetate fabrics in wide widths may be cut into narrow ones by the application of heat. A hot knife blade caused the edges to sear and bead, thereby doing away with selvages on the edges of the goods.

**Fusel oil** \ˈfyū-zəl\ *n.* An arid oily liquid occurring in insufficiently distilled alcoholic liquors, consisting mainly of amyl alcohol, and used especially as a source of alcohols and as a solvent. Alcohols such as normal, iso, and tertiary butyl alcohols, propyl, and isopropyl alcohols, and well as amyl and isoamyl alcohols may be present. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Fusing** *n.* (1) Melting. (2) Uniting, as by melting together.

**Fusion** \ˈfyü-zhᵊn\ [L *fusion-*, *fusio*, fr. *fundere*] (1555) *n.* With respect to vinyl plastisols and organosols, fusion is the state attained by heating when the resin particles have completely dissolved in the plasticizers and solvents present, so that upon cooling a homogeneous solid solution results. Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Fusion** (atomic) *n.* A nuclear reaction involving the combination of smaller atomic nuclei or particles into larger ones with the release of energy from mass transformation. This is also called a thermonuclear reaction by reason of the extremely high temperature required to initiate it.

**Fusion bonding** *n.* Any of several methods that create a thin layer of melt on the plastic surfaces to be joined, which are then pressed together. Fusion bonding is limited to identical or melt-compatible polymers. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Fusion point** Temperature of fusion or melting.

**Fusion temperature** *n.* In vinyl dispersions, the temperature at which fusion occurs. The *optimum fusion temperature* is that at which thermal degradation has not occurred and maximum physical properties are obtained in the final product. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Fustics** \ˈfəs-tik\ [ME *fustyk* smoke tree, fr. MF *fustoc*, fr, Arabic *fustuq*, fr. Gk *pistakē* pistachio tree] (15c) *n.* Yellow coloring matters of natural origin. Old fustic is obtained from the species, *Morus tinctorial*, and consists of moric and morintannic acids. Young fustic is obtained from *Rhus cotinus*, and consists of fustic.

**Fuzz** *n.* An accumulation of short, broken filaments collected from passing glass strands, yarns, or rovings over a contact point. The fuzz may be collected, weighted and used as an inverse measure of abrasion resistance.

**Fuzz ball** *See balling up.*

**Fuzziness** *n.* (1) A term describing a woven fabric defect characterized by a hairy appearance due to broken fibers or filaments. Principle causes are underslashed warp; rough drop wires, heddles, or reed; fabric slippage on take-up drum; rough shuttles; cut glass, dents, or reeds in warped; and damage in slashing. (2) A term describing a fabric intentionally made with a hairy surface; such fabrics are usually produced from spun yarns.

# G

**g** \ˈjē\ *n.* (1) SI abbreviation for gram. (2) Symbol for the acceleration due to gravity at the earth's surface, and, in particular, for the standard value, 9.806650 m/s$^2$. It is sometimes used, erroneously, for the proportionality constant ($g_c$) in Newton's law of momentum change. *See force* (3).

**G** *n.* (1) SI abbreviation for GIGA-. (2) Symbol for shear modulus. In dynamic testing, $G'$ symbolizes the "real" or in-phase part of $G''$ the "imaginary" or out-of-phase component.

**Gabardine** \ˈga-bər-ˌdēn\ [MF *gaverdine*] (1520) *n.* A firm, durable, warp-faced cloth, showing a decided twill line, usually a 45 or 63°C right-hand twill.

**Gable** \ˈgā-bəl\ [ME, fr. MF, of Gr origin; akin to ON *gafl* gable] (14c) *n.* Triangle formed by the edge of a ridged roof and the similarly shaped wall enclosed by the horizontal and raking cornices; called a pediment in classic architecture. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Gableboard** *See bargeboard.*

**Gadoleic acid** *n.* $CH_3(CH_2)_9CH{=}CH(CH_2)_7$ COOH. Fatty acid from marine oils.

**Gage** \ˈgāj\. Alternate spelling of gauge.

**Gahn's ultramarine** *See cobalt blue.*

**Gaiting** *n.* The spacing of the needles in the dial and cylinder in relation to each other on rib (double-knit) and interlock knitting machines. In rib gaiting, the dial needles are midway between the cylinder needles. For interlock gaiting the dial and cylinder needles are in direct alignment.

**Gal [*Galileo* Galilei]** (1914). *n.* 1 gal = cm/s/s. Therefore, where the value of gravity is 980 this is the same as 980 gal. The milligal is now quite commonly used since it is approximate one part in a thousand of the normal gravity of the earth.

**Galatea** \ˌga-lə-ˈtē-ə\ [L, fr. Gk *Galeteia*] *n.* A sturdy, serviceable, warp-effect, five-shaft, left-hand twill-weave fabric, frequently cotton or a cotton blend, used for children's play clothes. Kadolph J, Langford AL (2001) Textiles. Pearson Education, New York.

**Galipot** Another name for Bordeaux turpentine.

**Galley** \ˈga-lē\ [ME *galeie*, fr. OF *galie*, *galee*, ultimately fr. MGk *galea*] (13c) *n.* A shallow metal tray used for holding type.

**Galley proof** A proof taken of type standing in a galley, before it is made up into pages. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Galliolino** *n.* Old name for Naples yellow, which is substantially lead antimoniate.

**Gallon, imperial** *n.* English gallon, equivalent to 277.77 in.$^3$ or 3.54 l. Equals 1.2 USA gallons. USA gallon = 0.833 imperial gallons.

**Gallon, USA** *n.* (1) Volume equal to 231 in.$^3$ For paint, varnish, lacquer, and related products this is measured at 25°C (77°F). (2) Volume of 8.33 lb of water. (3) Equivalent to 3.785 l.

**Galvanic anode** \gal-ˈva-nik ˈa-ˌnōd\. Source of current for cathodic protection provided by a metal less noble than the one to be protected, e.g., magnesium, zinc or aluminum as used for cathodic protection of steel. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX.

*See cathodic protection.*

**Galvanic cell** *n.* (1) Cell consisting of two or more dissimilar metals or alloys in contact with the same body of an electrolytic solution such as seawater. Upon electrically connecting the dissimilar metals, a current flows as the result of accelerated corrosion of the more active of the dissimilar metals or alloys. (2) Electrolytic cell capable of producing electrical energy by electrochemical action. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX.

**Galvanic corrosion** *n.* Increased corrosion above normal corrosion of a metal that is associated with the flow of current to a less active metal in the same solution and in contact with the more active metal. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX.

**Galvanic protection** *See cathodic protection.*

**Galvanized steel** Zinc plated steel.

*See galvanizing.*

**Galvanize** \ˈgal-və-ˌnīz\ (1802) *v.* To coat iron or steel with zinc by immersing in molten zinc to produce a coating of zinc–iron alloy.

**Galvanizing** *n.* Application of a coating of zinc to steel by a variety of methods: barrel-galvanized dipped, electrogalvanized, electro-zinc plated, flake-galvanized, hot-dipped, hot-dip galvanized, mechanically plated, peer-coated galvanized, tumbler-galvanized, and wean-galvanized.

**Gama ($\gamma$) ray** (1903) *n.* High-energy electromagnetic radiation emitted from a nucleus. Giambattista A Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Gamboge** \gam-ˈbōj, -ˈbüzh\ [NL *gambogium*, alteration of *cambugium*, fr. or akin to Portuguese *Camboja* Cambodia] (1712) *n.* $C_{30}H_{35}O_6$. Resinous exudation of intense yellow color obtained from the species, *Guttifera*, which grown in India, Ceylon, Siam, and East Indies. The product is a mixture consisting chiefly of a water insoluble resin (up to 80%), with a water soluble gum (up to 27%). The resin portion is chiefly gambogic acid.

*Also known as cambogia.*

**Gamma-** (1896) *adj.* A prefix usually abbreviated as the Greek letter $\gamma$- and usually ignored in alphabetizing compound names, signifying that the so-labeled substitution is on the third carbon away from the main functional group of the molecule, and generally synonymous with the label "4-". They may be emitted from radioactive substances. They are quanta of electromagnetic wave energy similar to but of much higher energy that ordinary X-rays. The energy of a quantum is equal to $hv$ ergs, where $h$ is Planck's constant ($6.6254 \times 10^{-27}$ erg s) and $v$ is the frequency of the radiation. Gamma rays are highly penetrating, an appreciable fraction being able to traverse several centimeters of lead. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Gamma cellulose** *n.* One of the three forms of cellulose. With beta cellulose it is called hemicellulose. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Paul N. Gardner Co. Inc., FL, 2001.

*Also see alpha cellulose and beta cellulose.*

**Gamma distribution** *n.* A random variable $x$ with density

$$f(x) = \frac{1}{\Gamma(\alpha)\beta^{\alpha}} x^{\alpha-1} e^{-x/\beta}$$

is called a Gamma random variable with parameter $\alpha$ and $\beta$, and its distribution function is called a gamma distribution with parameter α and β.

**Gamma protein** *n.* Protein derived from soya bean meal. The commercial product contains approximately 54% of actual protein. It disperses in water in the presence of a small amount of alkali and is used as an extender for casein in water paints and distempers.

**Gamma ray** (1903) *n.* A quantum of electromagnetic energy emitted from some radioactive materials as they decay. Gamma rays are similar to, but much shorter wavelengths (typically ≈0.03 nm) and much higher energy than ordinary X-rays. They are highly penetrating, capable of passing through several centimeters of lead. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Gamma transition** Syn: glass transition.

**Gamut, color** *n.* Total variety of colors that can be produced by any prescribed method, such as the mixtures of any particular sets of colorants. Gamuts are frequently described by plotting them on a chromaticity diagram.

**Gap** \ˈgap\ [ME, fr. ON, chasm, hole; akin to ON *gapa* to gape] (14c) *n.* In filament winding, an unintentional space between two windings that should lie next to each other.

**Garcia nutans oil** *n.* Vegetable drying oil obtained from the species, *Euphorbiaceae*, which grows in Mexico and Venezuela. It contains over 90% of eleostearic acid and gels in less than 8 min at 282°C. It possesses the following constants: Sp gr of 0.942/15°C, refractive index of 1.525, iodine value of 177.9, and saponification value of 189.

**Garden rocket oil** *n.* Oil with fair drying properties. It has an iodine value of 155, a Sp gr of 0.928, and a saponification value of 192.

**Gardner color standards** *n.* Liquid yellow to brown color standards for describing the color of drying oils, ASTM method D-1544.

**Gardner–Holt bubble viscometer** *See air-bubble viscometer.*

**Gardner–Holt viscosity tubes** *n.* Series of selected glass tubes of constant, standard diameter, which is filled with liquids of various viscosities, except for a small air space at the top. When these tubes are inverted, the air bubble travels through the liquid, and the rate of travel is a measure of the viscosity of the liquid. Empty tubes of similar standard dimensions are filled with liquids of which the viscosity is required, and the rates of travel of the bubbles compared with those of the tubes containing the liquids of known viscosities. Viscosities are compared under controlled temperature conditions (Paul N. Gardner Co. Inc., 316 N. E. Fifth Street, Pompano Beach, FL, www.gardco.com).

**Gardner impact test** (falling-weight test) *n.* A test for the impact resistance of rigid plastic sheets or parts. ASTM D 3029 describes two methods, F and G. In F, a weight with a hemispherical nose falls through a tube to strike the specimen, and G (for which the Gardner Impact Tester is approved), in which the falling weight hits a round-nose striker resting on the specimen. Either the weight or the height of drop may be varied, the former being recommended because of the sensitivity of most plastics to the velocity of impact (determined by height). Several tests on new specimens may be made at each impact-energy level (height × weight), and the fraction of breaks at each level is noted. This procedure efficiently provides information on both the mean energy to break and the standard deviation. Where the mean is of greatest interest, the up-and-down method provides a good estimate with less testing (Paul N. Gardner Co. Inc., 316 N. E. Fifth Street, Pompano Beach, FL, www.gardco.com).

**Gardner mobilometer** *n.* Viscometer used for determining the viscosity of all types of varnishes, oils, and pigmented compositions. The mobilometer consists of a cylinder into which is poured the paint product of which the viscosity is required. Into this is fitted a closely fitting disc attached to the end of a guide rod. Provision is made at the other end of the rod for weighting it, if required, when dealing with viscous products, by including a shallow tray into which weights may be placed. The time is determined for the disc and rod to travel a definite distance into the paint product, and is a measure of its viscosity.

**Garnet abrasive** \ˈgär-nət-\. Almandite, a type of garnet mineral occurring in New York State, is used in coated abrasives. Hardness and toughness are increased by heat treating. It fractures along the cleavage planes of the crude crystals, and the resulting grains have very sharp edges.

**Garnet lac** *n.* Form of shellac prepared from sticklac by a special refining process. The term “garnet” is merely an indication of the deep red color of the material when dissolved in alcohol.

**Garnet paper** (ca. 1902) *n.* The paper generally favored for hand sanding on wood. The abrasive is the same mineral as the semiprecious garnet gem, almandite.

**Garnetting** *n.* A process for reducing various textile waste materials to fiber by passing them through a machine called a garnett, which is similar to a card.

**Gas** \ˈgas\ [NL, alter. of L *chaos* space, chaos] (1779) *n.* A state of matter in which the material has a very low density and viscosity, can expand and contract greatly in response to changes in temperature and pressure, easily diffuses into other gases, and readily and uniformly distributes itself throughout any container. A gas can be changed to the liquid or solid state ink only by the combined effect of increased pressure and decreased temperature (below the critical temperature).

**Gas black** *n.* Another term for carbon black, so called from its manufacture from petroleum gas.
*See carbon black.*

**Gas blue** *n.* Variety of Prussian blue, so called from its origin in certain by-products of coal gas manufacture.

**Gas checking** *n.* Film phenomenon associated with compositions containing vegetable drying oils, or derivatives therefrom, and demonstrated by the formation of crowsfoot-like wrinkles, or wrinkles which have the appearance of crystalline patterns. The phenomenon occurs when susceptible films are allowed by dry in an atmosphere containing the products of combustion of coal gas or natural gas; hence the term, “gas checking”. Syn: crystallizing, crowsfooting, webbing, and frosting.

**Gas chromatography (GC)** (1952) *n.* A method of chemical analysis in which the specimen is vaporized and introduced into a stream of carrier gas (usually helium), the stream then passed through a column packed with adsorbent particles that separate the stream into its constituent molecules. These fractions pass through the column – first adsorbed from, then desorbed into the ongoing stream of carrier gas – at characteristic rates. Their concentrations in the effluent are measured by a detector such as a thermal-conductivity cell. The recorded concentrations are displayed on a strip chart with time as the abscissa. From the positions and areas of the peaks the identities and relative concentrations of the constituents in the sample may be determined. An example of a gas chromatograph combined with a mass spectrometer is the Clarus 500 GC Mass Spectrometer. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

*See also chromatography.*

**Gas crazing** *n.* The wrinkling of a tung oil film under certain drying conditions.

*See gas checking.*

**Gas fading** *n.* A change of shade of dyed fabric caused by chemical reaction between certain disperse dyes and acid gases from fuel combustion, particularly oxides of nitrogen.

**Gas-injection molding** *n.* A specialized technique for molding low-density structures in which a mixture containing cork particles, or glass or phenolic microspheres, glass fibers, and a thermosetting resin is injected into a mold by fluidizing it in a gas stream.

**Gas–liquid chromatography** (1952) *n.* A variation of gas chromatography in which the chromatographic column is packed with a finely divided solid impregnated with a non-volatile organic liquid. The sample to be analyzed is injected into the inlet of the column where it is quickly and completely vaporized. The carrier-gas stream carries it into the packed section, where the vapors contact the impregnated solids. They are absorbed by the non-volatile liquid phase, and then later desorbed into the carrier gas. The vapor of each compound spends a characteristic fraction of time in the condensed phase and the remainder in the mobile gas phase. Each chemical species will tend to migrate at its own rate and will be separated from other species in the time of emergence from the column. The detector senses their concentrations in the effluent and its signal strength is recorded and displayed versus time on a strip chart. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

**Gas permeability** *n.* The ease with which a gas or vapor passes through a membrane, e.g., a plastic sheet or film.

*See permeability.*

**Gas chromatograph, courtesy of Perkin-Elmer Corporation**

**Gas-phase polymerization** *n.* A polymerization process developed by Union Carbide for high-density polyethylene, particularly for a grade for making paper-like films. Purified ethylene and a highly active chromium-containing catalyst in dry-powder form are fed continuously into a fluidized-bed reactor. The resin forms as a powder, thereby avoiding the gel, discoloration, and contamination problems often associated with conventional polymerization processes.

**Gasproof** *n.* Coating composition, which does not gas check when exposed to an atmosphere containing the products of combustion of coal gas.

*See gas checking.*

**Gassing** (1852) *v. See singeing.*

**Gas thermometer** *n.* Where $P_o$, $P_s$, and $P_z$ represent the total pressure with the bulb at 0°C, at the boiling-point of water and at the unknown temperature, respectively, $t_s$ the temperature of steam and $t_z$ the unknown temperature,

$$t_x = t_s \frac{P_x - P_o}{P - P_{os}}$$

(approximately). The total pressure on the gas in the bulb is the algebraic sum of barometric pressure at the time and that measured by the manometer.

**Gas-transmission rate (GTR)** *n.* The quantity of a given gas passing through a unit area of the parallel surfaces of a plastic film in unit time under the conditions of the test. These conditions, including temperature and partial pressure of the gas on both sides of the film, must be stated. The SI unit of GTR is mol/($m^2$ s) but others, some of them involving mixed metric and English units, are still in common use. (www.astm.org) for standard method of gas-transmission rate.

*See ASTM See also permeance and permeability.*

**Gas welding** *See hot-gas welding.*

**Gate** \ˈgāt\ [ME, fr. OE *geat*; akin to ON *gat* opening] (before 12c) *n.* In injection and transfer molding, the channel through which the molten resin flows from the runner into the cavity. It may be of the same cross-section as the runner, but most often is restricted to 3 mm or even much less. A gate whose diameter is less than 0.5 mm is known as a *pinpoint gate*. A *submarine gate* is shaped to conduct the melt below the parting line of the mold and into the cavity at a point just below its edge. Other types of gates are the *fan gate* (a diverging, thin gate), and the *tab gate* (one that extends the runner into the molded part). The term gate is also used for the portion of the plastic molding formed by the gate orifice. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Gate blush (gate splay)** *n.* A blemish or disturbance in the gate area of an injection-molded article. It occurs when the melt fractures as it emerges from the gate due to sudden release of large elastic stresses.

**Gauffrage** *n.* Printing by pressure alone, without the use of a pigment, producing an embossed effect on the paper.

**Gauge** \ˈgāj\ [ME *gauge*, fr. ONF] (15c) (gage) *n.* (1) Any instrument that measures and indicates such quantities as thickness, pressure, temperature, or liquid level. (2) The thickness of a plastic sheet or film, usually given in mils or mm. (3) Any of the standard wire and sheet-metal scales in which the gauge numbers are inversely related to wire diameter or sheet thickness. (4) The number of wales per inch in a knit fabric. (5) On spinning or twisting frames, the distance from the center of one spindle to the center of the next spindle in the same row.

*See strain gauge and wire gauge.*

**Gauge band** *n.* A term used in the packaging-film industry for a thickness irregularity found in rolls of film. A thick area at some locality over the width of a flat film will produce a raised ring in a finished roll. Similarly, a thin area will cause a depressed ring. Such films, when unwound, tend not to lie perfectly flat. With shrinkable films, thin areas are troublesome because it is more likely that they will cause tearing or burn-through during the shrink cycle.

**Gauge length** *n.* On a dog bone-shaped, tensile-test specimen before stress is applied, the distance between two marks on the narrow part ("waist") of the specimen, perpendicular to the direction of pull that will be used to measure elongation. If the specimen is of uniform thickness and width, gauge length may be taken as the nip-to-nip distance between the clamping fixtures.

**Gauge wire** *n.* Used with an extra filling yarn during weaving, this type of standing wire controls the height of fabric pile.

**Gauss** \ˈgaüs\ [Karl French *Gauss*] (1882) *n.* The cgs of magnetic induction (flux density). It is equal to 1 Mx/cm$^2$. It has such a value that if a conductor 1 cm long moves through a magnetic field at a velocity of 1 cm, in an induction mutually perpendicular, the induced emf is one abvolt. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Gauze** \ˈgóz\ [MF *gaze*] (1561) *n.* A thin, sheer-woven fabric in which each filling yarn in encircled by two warp yarns twisted around each other, gauze is similar to cheesecloth. It may by made of silk, cotton, wool, or manufactured fibers. Cotton gauze is primarily for surgical dressings.

**Gavan** \ˈgä-vən\. Persian name for the plant, which yields gum tragacanth.

**Gay–Lussac's law** \ˈgā-lə-ˈsak-\ [Joseph-Louis *Gay-Lussac*, 1778–1850, F chemist and physicist]. Syn: Charles' law. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Gay–Lussac's law of combining volumes** *n.* If gases interact and form a gaseous product, the volumes of the reacting gases and the volumes of the gaseous products are to each other in simple proportions, which can be expressed by small whole numbers. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Gear box (gear reducer)** *n.* Syn: for speed reducer.

**$g_c$** The proportionality constant in Newton's law of momentum change, $g_c$ is often needed to convert viscosities between force units and mass units: $\mu_f = g_c\mu_m$. In SI, $g_c = 1.000000\ \mathrm{N\,s^2/(kg\,m)}$, so a viscosity of, say 100 Pa s is also equal to 100 kg/(m s). *See force.*

**Gear crimping** *See texturing, gear crimping method.*

**Gear pump** A pump consisting of a sturdy housing within which two intermeshing toothed wheels rotate, and inlet and outlet ports. The gears typically have widths about equal to their diameters and may be spur, helical, or, rarely because of their cost, herringbone bears. The inlet port is attached at the waist of the 8-shaped casing where the gears are moving apart; the outlet is at the opposite side. Liquid trapped between the tight-fitting teeth and the casing is borne around to the discharge side where it is displaced and expelled by the meshing of the teeth. Small gear pumps have long been used in producing staple fiber, requiring extremely high melt pressures (up to 100 MPa). Since about the mid-1970s, larger ones have come into increasing use for general extrusion operations where die resistances or filtration requirements generate high pressures, or where close dimensional tolerances on extrudates are desired. Gear pumps have been successfully retrofitted to extruders, providing net higher output, better product quality, and quick return on the additional investment.

**Geiger counter** \ˈgī-gər-\ [Hans *Geiger* † 1945 Gr physicist] (1924) *n.* Detector for radioactivity depending upon ionized particles that affect its mechanism. As its indicates, it both detects and make a count of them possible. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Gel** \ˈjel\ [*gelatin*] (1899) *n.* A semisolid system consisting of a network (three-dimensional network polymer) of solid aggregates within which a liquid is trapped. The initial, jelly-like solid phase that develops during the formation of a resin from a liquid. With respect to vinyl plastisols, gel is a state between liquid and solid that occurs in the initial stages of heating, or upon prolonged storage. *Note*—All three types of gel have very low strength and do not flow like liquids. They are soft, flexible, and may rupture under their own weight unless supported externally (ASTM D 883). A defect in plastic film such as polyethylene or PVC characterized by tiny, hard, glassy particles that appear in an otherwise clear film. These gel particles are believed to be bits of resin of much higher-than-average molecular weight, perhaps cross-linked. Designed gels (three-dimensional network systems swell with solvents and change size predictably, and these properties can be of commercial value such as ion absorbers from aqueous. Bryson HC (1956) Paint faults and remedies. Scientific Surveys, London. Hess M (1965) Paint film defects. John Wiley and Sons Inc., New York. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978. Addad JPC (ed) (1996) Physical properties of polymeric gels. John Wiley and Sons, New York.

*See also gelation and three-deminsional network polymer.*

**Gelatin** \ˈjel-lə-tᵊn\ [F *gélatine* edible jelly, gelatin, fr. It *gelatina*, fr. *gelato*, pp of *gelare* to freeze, fr. L] (1800) *n.* It is a protein product derived through partial hydrolysis of the collagen extracted from skin, bones, cartilage, ligaments, etc. The natural molecular bonds between individual collagen strands are broken down into a form that rearranges more easily. Gelatin melts when heated and solidifies when cooled again. Together with water it forms a semi-solid colloidal gel. Gelatin (also gelatine) is a translucent brittle solid substance, colorless or slightly yellow, nearly tasteless and odorless, which is created by prolonged boiling of animal skin and connective tissue. It has many uses in food, medicine, and manufacturing. Substances that contain or resemble gelatin are called gelatinous. Gelatin is protein type material extracted from animal skins, sinews, tendons, and from bones. Gelatin may be regarded as a pure glue. It dissolves in hot water to give a viscous solution with pronounced gelling characteristics.

Inedible gelatin has useful applications in the production of sizes for various purposes, and in emulsions. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood, Cliffs, NJ.

**Gelatinous** \jə-ˈlat-nəs, -ˈla-tᵊn-əs\ (1766) *adj.* Having the consistency of a very soft elastic solid, the nature and appearance of gelatin.

**Gelation** \ji-ˈlā-shən\ [L *gelation-*, *galatio*, fr. *gelare*] (1854) *n.* The formation of a GEL. With regard to vinyl plastisols and organosols, gelation is the change of state from the liquid suspension of the solid condition that occurs in the course of heating and/or aging, when the plasticizer has been mostly absorbed by the resin, resulting in a dry but weak and crumbly mass. Within normal proportions of resin and plasticizer, this state is attained when the resin particles have soaked up so much plasticizer that they touch each other. As heating progresses, the swollen particles begin to fuse together, resulting in some cohesive strength. Gelation is considered to continue until useful levels of mechanical properties are attained, such as have developed at the clear point. Much confusion has existed regarding the meaning of gelation because in the early years of the art, especially in Europe, *gelation* was used in place of the term fusion, now employed in USA. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Gelation time** *n.* With reference to thermosetting resins, the interval of time between the mixing in of a catalyst and the formation of a gel.

**Gel cellophane** *n.* Regenerated cellulose which has never been allowed to dry out, but has always been stored swollen with water or other solvent. Thin films are frequently used as the semi-permeable membrane in membrane Osmometry.

**Gel coat** *n.* (1) In reinforced plastics, a thin outer layer of resin, sometimes containing pigment, applied to give the structure its surface gloss and finish. It also serves as a barrier to liquids and ultraviolet radiation. The gel coat is the first to be applied to the mold in the lay-up process (after any mold-release agent), becoming permanently bonded to the succeeding layers of reinforcement and resins. In spray-up, the gel coat is applied last, sometimes after partly curing the mains structure. (2) High-build, chemical-resistant, thixotropic polyester coating. Starr TF (1993) Data book of thermoset resins for composites. Elsevier Science and Technology Books, New York.

**Gel dyeing** *See dyeing.*

**Gel effect** *n.* The increase in molecular weight as conversion progresses.

*See autoacceleration and gel.*

**Gel filtration** *n.* Method of polymer fractionation, both preparative and analytical, in which a sample of the polymer in dilute solution is injected into a stream of flowing solvent at the top of a packed column. The elution of the polymer is governed by the size of the polymer molecule. The polymer solute is frequently a biopolymer.

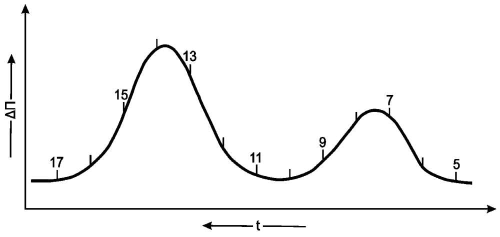
**Gel, gel point, gelation** *n.* The point at which a thermosetting system attains an infinite value of its average molecular weight; infinite viscosity and non-flowing. Allcock HR, Mark J, Lampe F (2003) Contemporary polymer chemistry. Prentice-Hall, New York. Alger MSM (1989) Polymer science dictionary. Elsevier Science Publishers, Barking, Essex, England. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience, Publishers Inc., New York. *See Trommsdorf effect.*

**Gelling** *n.* Any process whereby paint or varnish thickens to jelly-like consistency. *Also see livering.*

**Gelling agent** *See thickening agent.*

**Gel particle** *See gel* (4).

**Gel-permeation chromatography** (1966) *n.* This method is used to provide the molecular weigh and molecular weight distribution of a polymer by a fractionation technique. The polymer must be dissolved in a suitable solvent. It can also be defined as chromatography in which macromolecules such as polymers in a solution are separated by size on a column packed with a gel such as polystyrene. An example of a GPC chromatogram of a typical polymer is shown. Original name for, but now fading synonym of size-exclusion chromatography. An HPLC chromatograph equipped with a gel permeatioin column can measure the molecular weight of polymers. The highest molecular weight fraction exits the column first. Yau WW, Kirkland JJ, Bly DD (2001) Modern size-exclusion chromatography. John Wiley and Sons, New York. Collins EA, Bares J, Billmeyer FW Jr (1973) Experiments in polymer science. Wiley-Interscience, New York.



**Gel point** The stage at which a liquid begins to exhibit elastic properties and increased viscosity. This stage may be observed from the inflection point on a viscosity – time plot. *See gel* (2) (ASTM D 883).

**Gel spinning** *See spinning* (2).

**Gel time (of a drying oil)** *n.* Time required for the oil to form a solid gel under specified conditions of temperature.

**Geminal** *adj.* Description of substitution on adjacent atoms (1,2-chloro-) as opposed to same atom or vicinal (e.g., 1,1-chloro-) positions.

**Genuine ultramarine** *n.* Natural ultramarine blue. *See ultramarine blue.*

**Geodesic** \ˌjē-ə-ˈde-sik, -ˈdē-, -zik\ (1821) *n.* Pertaining to the shortest distance, lying on a surface, between two points on that surface, e.g., a straight line on a plane or great circle on a sphere.

**Geodesic isotensoid** A filamentary structure in which there exists a constant stress in any given filament at all points in its path. Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK.

**Geodesic-isotensoid contour** *n.* In filament-wound, reinforced-plastic pressure vessels, a dome contour in which the filaments are placed on geodesic paths so that the filaments will experience uniform tensions throughout their lengths under pressure loading. Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK.

**Geodesic ovaloid** *n.* A contour for end domes, the fibers forming geodesic lines on the surface of revolution. The forces exerted by the filaments are proportioned to meet hoop and meridional stresses at any point. Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK.

**Geometric metamerism** \-mə-ˈta-mə-ˌri-zəm\ *n.* Phenomenon exhibited by a pair of colors, which appear to be a color match at one angle of illumination and viewing but which are no longer a match when the angle of illumination or viewing is changed. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See goniometachromatism, flop, and metamerism.*

**Geotextiles** *n.* Manufactured fiber products made into fabrics of various constructions for use in a wide variety of civil engineering applications.

**GEP** *n.* Glass-fiber-reinforced epoxy resins.

**Geranium lake** \jə-ˈrā-nē-əm-\ *n.* Type of colorant produced by precipitation of certain acid dyestuffs with barium chloride followed by lead nitrate.

**Germicidal-lamp test** *n.* A quick screening method for evaluating the relative resistance of vinyl compounds to discoloration and degradation upon exposure to light and weather. The specimens are placed approximately three inches below a germicidal lamp with a principal UV wavelength of 253.7 nm. The materials are rated according to the degree of discoloration and plasticizer spewing after a specified interval of time, e.g., 24 or 48 h.

**Gesso** \ˈje-(ˌ)sō [It, literally, gypsum, fr. L *gypsum*] (1596) *n.* Traditional gesso is a material made from chalk and gelatin or casein glue, and painted on wooden panels as a surface for tempera work. Polymer gesso provides a flexible ground that can be applied to canvas and other materials.

**GFK** *n.* Glass–fiber-reinforced plastics.

**Ghatti gum** *n.* Gum obtained from India and Sri Lanka, from *Anogeissus latifolia*, from which it exudes.

*Known also as Ghati gum and Indian gum.*

**Ghosting** (ca. 1957) *n.* (1) A condition found in wall paints of low sheen and moderately strong colors where there is a slight but definitely perceptible bleaching in irregular patterns. (2) Presence of a faint image of a printed design appearing in areas which are not intended to receive that portion of the image. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Gibbs' free energy** *See free energy.*

**Gibbsite** *See aluminum oxide, hydrated.*

**Gibbs' phase rule** *n.* $F = C + 2 - P$, $E$ (the number of degrees of freedom of a system) is the number of variable factors (temperature, pressure, and concentration) of the components, which must be arbitrarily fixed in order that the condition of the system may be perfectly defined. $C$, the number of the components of the system, is chosen equal to the smallest number of independently variable constituents by means of which the composition of each phase participating in the state of equilibrium can be expressed in the form of a chemical equation; the components must be chosen from among the constituents which are present when the system is in a state of true equilibrium, and which take part in that equilibrium; as components are chosen the smallest number of such constituents necessary to express the composition of each phase participating in the equilibrium, zero and negative quantities of components being permissible; in any system the number of components is definite, but may alter with changes in conditions of experiment; a qualitative but not quantitative freedom of selection of components is allowed, the choice being influenced by suitability and simplicity of application. $P$, the number of phases of the system, are the homogeneous, mechanically separate and physically distinct portions of a heterogeneous system; the number of phases capable of existence varies greatly in different systems; there can never be more than one gas or vapor phase since all gases are miscible in all proportions, a heterogeneous mixture of solid substances forms as many phases as there are substances present. Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York.

**Giga-** \ˈji-gə, ˈgi-\ {*combining form*} [ISV, fr. Gk *gigas* giant] (G). SI prefix meaning $\times 10^9$. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Gigging** *See napping.*

**Gilbert** \ˈgil-bərt\ [William *Gilbert*] (1893) *n.* The cgs emu of magnetomotive force. 1 gilbert = 10/4π A t.

**Gilding** \ˈgild\ [ME, fr. OE *gyldan*; akin to OE *gold* gold] (14c) *vt.* Art of covering substances, such as wood, with layers of gold leaf.

**Gilling** *See pin drafting.*

**Gilsonite** \ˈgil-sə-ˌnīt {*trademark*}. A black asphaltic resinous material found in Utah and Colorado used in black printing ink and as an ingredient in the manufacture of cold molding compounds, paints, etc. It is hard, bituminous, and finds application in black japans, Brunswick blacks, stains, baking enamels, and electrical insulating varnishes of many types. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York. Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Informtion Resources Inc., New York. *Also called vintahite.*

***g*-Index** *n.* A measure of polydispersity of molecular-weight distribution in polymers given by

$$g = (M_z/M_w - 1)^{0.5},$$

where $M_z$ and $M_w$ are the viscosity-average and weight-average molecular weights. Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York.

**Gingelli oil** *n.* Another name for sesame oil.

**Gingham** \ˈgiŋ-əm\ [modification of Malay *genggang* striped cloth] (1615) *n.* A woven fabric characterized by a block or check effect produced by weaving in dyed yarns at fixed intervals in both the warp and the filling.

**Glacé** \gla-ˈsā\ [F, fr. pp of *glacer* to freeze, ice, glaze, fr. L *glaciare*, fr. *glacies*] (1847) *adj.* A lustrous, glossy effect imparted to fabrics by finishing.

**Glance pitch** *n.* Another name for Manjak.

**Glass** \ˈglas, ˈglás\ {*often attributive*} [ME *glas*, fr. OE glœs; akin to OE *geolu* yellow] (before 12c) *n.* Any of a wide variety of rigid, amorphous solid materials, but in particular, any of the transparent vitreous glasses formed by cooling molten mixtures of silica, sodium oxide, other alkali-metal and alkaline-earth oxides, lead oxide, alumina, and, for special purposes, other oxides (many organic polymers experience "glassy states" at low temperatures but they are seldom referred to as "glasses"). Glass compositions used in fibrous form as plastics reinforcements include vitrified quartz (pure silica), C glass, E glass, and S glass. The glasses as a family are characterized by high moduli, low tensile strength (except as fibers), very low ultimate tensile elongation, brittleness, and good electrical properties and chemical resistance. Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK. Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA.

**Glass fiber** (1882) *n.* A manufactured fiber in which the fiber-forming substance is glass (FTC definition). In the continuous filament process, glass marbles are melted in an electric furnace and the liquid flows in fine streams through small orifices at the bottom of the melting chamber. The resultant filaments are caught and drawn by a high-speed draw winding mechanism. In the staple fiber process, the streams of molten glass are attenuated into fibers by jets of high-pressure steam or air. These fibers are gathered on a revolving drum and then wound on tubes to form staple fiber sliver or bands that can be drafted, twisted, and plied. Glass fiber is incombustible and will tolerate heat up to 1000°F without material damage. Potential strength is not realized in woven fabrics or even in yarns, because the fiber is brittle and fracture points may develop, but nevertheless, very high tensile strength is obtained in woven fabrics, and is retained at elevated temperatures. The fiber originally was difficult to color but methods have been developed to accomplish this. Moisture absorption is low. Electrical and insulation resistance is high. Glass fiber is used for heat and electrical insulation, filter cloth in the chemical and dye industries, reinforcing belts in tires, novelty fabrics, tablecloths, and fireproof draperies. Because of its brittleness, it is not used in wearing apparel or in household fabrics that have to withstand frequent flexing. Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA.

**Glass–fiber reinforcement** *n.* Any of a family of reinforcing materials for plastics based on single, drawn filaments of glass ranging in diameter from 3 to 20 µm. Single filaments are produced by mechanically drawing molten-glass streams, then the filaments are usually coated with a size or coupling agent which protects them from abrasion (to which the uncoated filaments are very vulnerable) and improves bonding with resins. The filaments are then gathered into bundles called *strands* or larger bundles called *rovings*. The strands may be used in continuous form for filament winding or pultrusion; or chopped into short lengths for incorporation into molding compounds or during spray-up; or formed into fabrics and mats of various types for use in hand lay-up, matched-die molding, and other laminating processes. Glass–fiber reinforcements are classified according to their special properties. E glass is electrical-grade glass, the most common general-purpose type. C glass is the chemically resistant grade, and S glass denotes high tensile strength. Glass fibers coated with nickel by electron-beam deposition are used making molding compounds for electrically conductive articles. Another form of glass reinforcement is glass flakes. Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA.

**Glass finish (size)** *See coupling agent.*

**Glass flakes** *n.* A reinforcing filler produced by blowing molten Type E glass into very thin tubes, then smashing the tubes into small fragments. The flakes pack closely in thermosetting-resin systems, producing strong products with good moisture resistance. Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA.

**Glassine** \gla-ˈsēn\ (1916) *n.* Thin transparent paper treated with urea-formaldehyde resin, used for packaging.

**Glass mat** (fibrous-glass mat) *n.* A thin web of non-woven glass fibers that may or may not contain a small percentage of resin binder.

**Glass microspheres** *See microspheres.*

**Glass-reinforced plastics (GRP)** *See reinforced plastic.*

**Glass–rubber transition** Syn: glass transition.

**Glass spheres** *n.* Solid glass spheres of diameters ranging from 5 to 5000 μm are used as fillers and/or reinforcements in both thermosetting and thermoplastic compounds. The size used most frequently passes a 325-mesh sieve, with an average sphere diameter of 30 μm. The spheres are available coated with various silane coupling agents to improve bonding between polymer and glass. The spheres improve a physical properties and reduce costs of materials and end products. Some small glass spheres are considered to be microspheres. Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA.

**Glass stress** In a filament-would part, typically a pressure vessel, the stress calculated from the load and the cross-sectional area of the reinforcement only.

**Glass transition** (gamma transition, second-order transition, and glass–rubber transition) *n.* A reversible change that occurs in an amorphous polymer or in amorphous regions of a partly crystalline polymer when it is heated from a very low temperature into a certain range, peculiar to each polymer, characterized by a rather sudden change from a hard, glassy, or brittle condition to a flexible or elastomeric condition. Physical properties such as coefficient of thermal expansion, specific heat, and density, usually undergo changes in their temperature derivatives at the same time. During the transition, the molecular chains, normally coiled, tangled, and motionless at the lower temperatures, become free to rotate and slip past each other. This temperature varies widely among polymers. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Glass-transition temperature** ($T_g$) *n.* The approximate midpoint of the temperature range over which the glass transition occurs. $T_g$ is not obvious (like a melting point), and is detected by changes, with rising temperature, in secondary properties such as the rate of change with temperature of specific volume or electrical or mechanical probe. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.

**Glass wood** (1879) *n.* Glass fibers in a mass resembling wool and used for thermal insulation and air filters.

**Glassy state** *n.* A brittle solid state of a material, usually amorphous in structure, and prone to conchoidal fracture. Moreover, the observed $T_g$ can vary significantly with the specific property chosen for observation and on experimental details such as the rate of heating or electrical frequency. A reported $T_g$ should therefore be viewed as an estimate. The most reliable estimates are normally obtained from the loss peak in dynamic-mechanical tests or from dilatometric data. They change to the crystalline state, i.e., devitrify, in time or by the action of temperature, shock, scratching, etc. Glassy materials do not melt at a specific temperature but soften gradually and continuously on heating. Groenewoud WM (2001) Characterization of polymers by thermal analysis, Elsevier Science and Technology Books, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Glaze** \ˈglāz\ [ME *glasen*, fr. *glas* glass] (14c) *v.* Very thin coating of a paint product, usually a semitransparent tinted coating, applied on a previously painted surface to produce a decorative effect.

**Glazing** \ˈglā-ziŋ\ [ME *glasen*, fr. *glas* glass] (14c) *v*. (1) A finishing process that produces a smooth, highly polished, or lustrous surface on a fabric such as chintz. The fabric is treated with starch, glue, paraffin, or shellac, then friction calendered. Synthetic resins are used for a more permanent finish. (2) A shiny fabric appearance produced unintentionally, e.g., by pressing at excessive temperatures. Kadolph J, Langford AL (2001) Textiles. Pearson Education, New York.

**Glazing compound** *n*. A dough-like material consisting of pigment and vehicle, used for sealing window glass in frames. It differs from putty in that it retains its plasticity for an extended period. Weismantal GF (1981) Paint handbook. McGraw-Hill Inc., New York.

**GLC** *n*. Abbreviation of gas–liquid chromatography; a technique by which the separation and identification of volatile components of a mixture is possible.

**Glitter** \ˈgli-tər\ [ME *gliteren*, fr. ON *glitra*; akin to OE *geolu* yellow] (14c) (flitter, spangles) *vt*. A family of decorative pigments comprising light-reflective flakes of sizes large enough so that each flake produces an individually seen sparkle or reflection. They are incorporated into plastics during compounding.

**Global radiation** *n*. The wavelength distribution of sunlight under a given environment (e.g., under windowpane glass).

**Gloss** \ˈgläs, ˈglós\ [prob. of Scand origin; akin to Icelandic *glossa* to glow, akin to OE *geolu* yellow] (1538) *n*. Subjective term used to describe the relative amount and nature of mirror-like (specular) reflection. Different types of gloss are frequently arbitrarily differentiated, such as sheen, distinctness-of-image gloss, etc. Trade practice recognizes the following stages, in increasing order of gloss: *Flat* (or *matte*) – practically free from sheen, even when viewed from oblique angles (usually less than 15 on 85° meter); *Eggshell* – usually 20–35 on 60° meter; *Semigloss* – usually 35–70 on 60° meter; *Full gloss* – smooth and almost mirror-like surface when viewed from all angles, usually above 70 on 60° meter. Gloss of plastics is measured with a glossmeter described in ASTM test D 523. The same meter is used in measuring the resistance of shiny plastic surfaces to abrasion (D 673).

*See also satin finish.*

**Gloss, distinctness-of-image** *n*. The sharpness with which outlines are reflected by the surface of an object.

**Glossing up** *n*. Undesirable burnishing.

*See burnish and burnish resistance.*

**Gloss ink** *n*. An ink that dries with a minimum of penetration into the stock and yields a high luster.

**Glossmeter** *n*. An instrument for measuring the degree of gloss in relative terms. Such instruments measure the light reflected at a selected specular angle, such as 20° (from the perpendicular), 45°, 60°, 75°, or 85°. Results obtained are very dependent on the instrument design, calibration, technique used, types of samples, etc. In essence, a glossmeter is an abridged goniophotometer. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, Paul N. Gardner Co. Inc., FL.

**Gloss oil** *n*. Solution of limed rosin or lined rosin acids in a volatile solvent, used chiefly in surface coatings (when made from tall oil, the source is usually indicated).

**Gloss retention** *n*. Degree to which the original sheen of a coating is retained. Paint and Coating Testing Manual, Koleske, J. V., ed., American Society for Testing and Materials, 1995. Paul N. Gardner Co. Inc., FL.

**Gloss white** *n.* A white mineral pigment used as an ink extender, made by co-precipitation of alumina hydrate and blanc fixe.

**Glow discharge** *See corona discharge.*

**Glowing combustion** *n.* Burning of a solid material without flame but with emission of light from the zone of burning.

**Glue** \ˈglü\ [ME *glu*, fr. MF, fr. LL *glut-*, *glus*; akin to L *gluten* glue] (14c) *n.* Originally, a hard gelatin obtained from hides, tendons, cartilage, bones, etc., of animals. Also, an adhesive prepared from this substance by heating with water. Through general use the term is now synonymous with the term "adhesive".

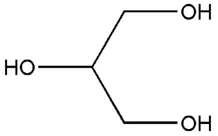
(*See also adhesive, mucilage, paste, and sizing*). (*v*) *See bond.*

**Glue line (bond line)** *n.* The layer of adhesive which attaches two adherents.

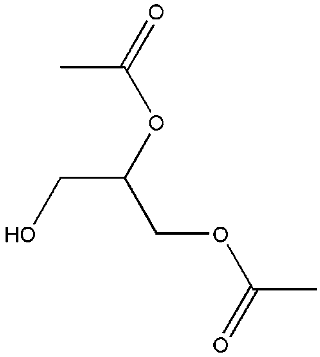
**Glycerides** \ˈgil-sə-ˌrīd\ (ca. 1864) *n.* The esters derived from glycerol. Glycerol is a trihydroxy alcohol and as such is capable of reacting with three monobasic acids. Such fully satisfied esters are described as the triglycerides, and the drying oils are typical members of this class. If only one hydroxy group is reacted with an acid, the resultant product is a monoglyceride, and if two are reacted a diglyceride is obtained. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL.

**Clycerin** \ˈglis-rən, ˈgli-sə-\ [F *glycerine*, fr. Gk *glykeros* sweet; akin to Gk *glykys*] (1838) *n.* *See glycerol.*

**Glycerol** \ˈgli-sə-ˌról, -ˌrōl\ [*glycer*in + -*ol*] (1884) (1,2,3-propanetriol, glycerin, glycerine, glycyl alcohol) *n.* $HO–CH_2CHOH$-$CH_2OH$. The term *glycerol* applies to the pure product; *glycerin* (or *glycerine*) applies to commercial products containing at least 95% glycerol. Glycerol is a colorless, viscous liquid with a sweet taste, long produced as a by-product of soap manufacture (animal fats and vegetable oils are triglycerides of long-chain "fatty" acids). More recently, glycerol has been synthesized from propylene or sucrose (sugar). It uses in the plastics industry include the manufacture of alkyd resins (esters of glycerol and phthalic anhydride), the plasticizing of cellophane, and the production of urethane polymers. Several of its esters are plasticizers for various resins. It has a bp of 290°C, mp of 17°C, and Sp gr of 1.260/15°C. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL. *Also known as glycerin.*



**Glycerol diacetate** *n.* Plasticizer; solvent for cellulose derivatives, alkyds, and shellac. It has a bp of 260°C, Sp gr of 1.176/15°C, flp of 146°C (295°F), refractive index of 1.44. *See diacetin.*



**Glycerol ether acetate** *n.* $C_3H_5(OCH_2$-$_3H_5(OCH_2CH_2OOCCH_3)_3$. A plasticizer for cellulosics and polyvinyl acetate.

**Glycerol monoacetate** *n.* $CH_3COOCH_2$-$CHOHCH_2OH$. A plasticizer for cellulose acetate, cellulose nitrate, and vinyl resins.

**Glycerol monolactate diacetate** *n.* $CH_3CH$ $OHCOOC_3H_5(OOCCH_3)_2$. A plasticizer for cellulose acetate, imparting resistance to gasoline.

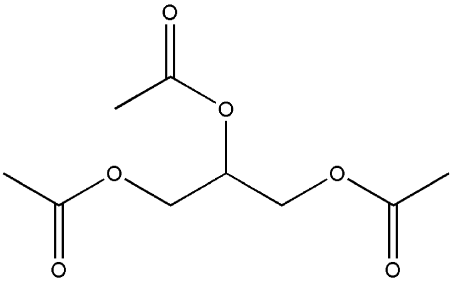
**Glycerol monolaurate (glyceryl monolaurate, lauryl glycerin)** *n.* $C_{11}$–$H_{23}COO$ $CH_2CHOHCH_2OH$. A plasticizer for cellulosic and vinyl resins and polystyrene.

**Glycerol monooleate** *n.* $C_{17}H_{33}COOCH_2$ $CHOHCH_2OH$. A yellow oil, approved by the FDA as a plasticizer for food processing.

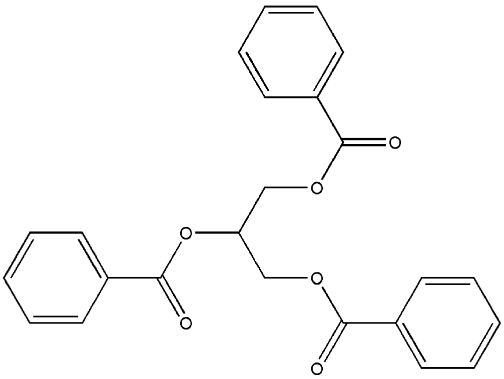
**Glycerol monoricinoleate** *n.* $C_6H1_3CHOH$ $C_{10}H_{18}COOCH_2CHOHCH_2$–OH. A plasticizer for cellulose nitrate, ethyl cellulose, and polyvinyl butyral.

**Glycerol-phthalic anhydride resin** *n.* An alkyd resin made by modifying glycerol phthalate with an equal portion of oil, fatty acid, and natural or synthetic resin. It is used in varnishes, lacquers, and enamels.

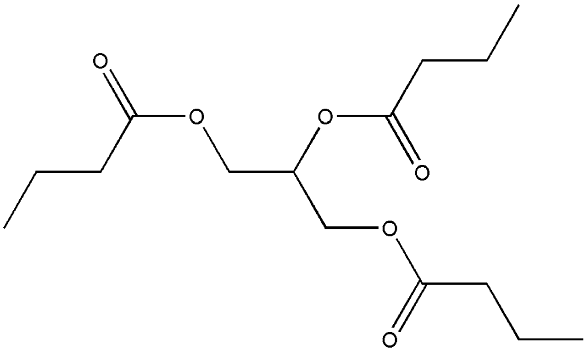
**Glycerol triacetate** \-(ˌ)trī-ˈa-sə-ˌtāt\ (triacetin). A plasticizer for cellulosic resins, polymethyl methacrylate, and polyvinyl acetate. It has been approved by the FDA for food-contact use.



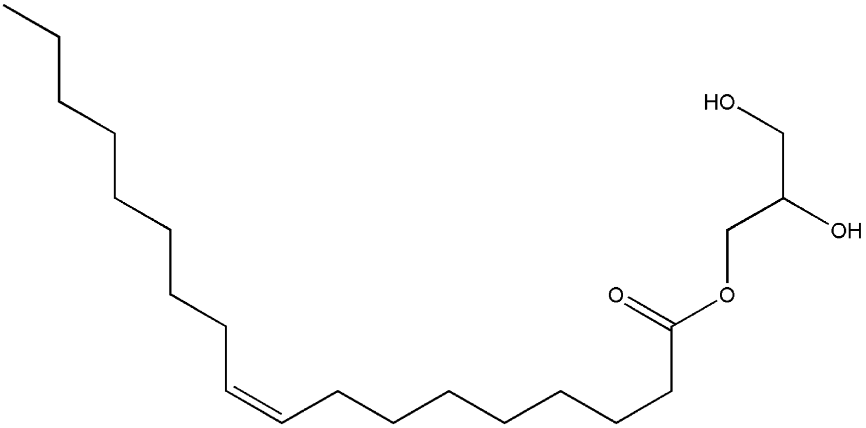
**Glycerol tribenzoate (tribenzoin)** *n.* A colorless, crystalline solid, a solid plasticizer for PVC.



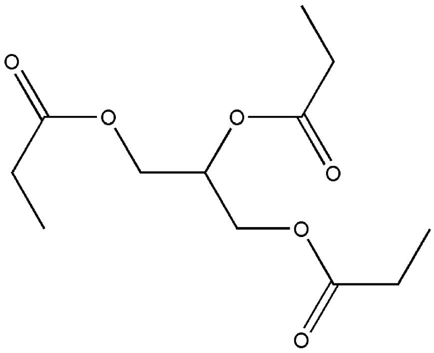
**Glycerol tributyrate (tributyrin)** *n.* A plasticizer for cellulose esters.



**Glycerol tripropionate** *n.* A plasticizer for cellulosic resins and polyvinyl acetate.



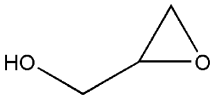
Glycerol monooleate



**Glyceryl tri-(acetoxyricinoleate)** *n.* $C_3H_5(OOCC_{10}H_{18}CHOHC_6H_{13}O\text{–}COCH_3)_3$. A plasticizer for cellulose nitrate, ethyl cellulose, and PVC.

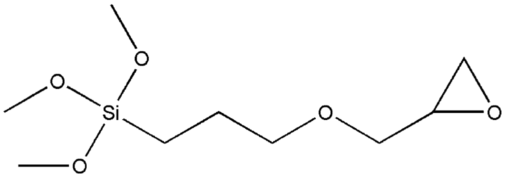
**Glyceryl tri-(12-acetoxystearate)** *n.* $C_3H_5(OOCC_{17}H_{34}OCOCH_3)_3$. A plasticizer for cellulosic and vinyl resins.

**Glycidol** (2,3-epoxy-1-propanol) *n.* A stabilizer for vinyl resins.



**Glycidyl-** *n.* The terminal epoxy group.

**γ-Glycidoxypropyltrimethoxysilane** *n.* A coupling agent for fibrous glass used in reinforced thermosetting and thermoplastic resins.



**Glycidyl-ester resin** *n.* Any of a family of epoxides resins derived from the condensation of epichlorohydrin with polycarboxylic acids, first available in commercial quantities in 1968. The preferred during agents for these resins are anhydrides, polycarboxylic acids, aromatic amines, and phenolics. They are resistant to electrical tracking and weather, have high strength and high modulus, yet are tough, have low viscosity, long pot life, and high reactivity at moderately elevated temperatures. Limitations are poorer properties above 100°C, higher shrinkage, poor alkali resistance, and inability to cure at room temperature. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL.

**Glycidyl-ether resin** *See epoxyresin.*

**Glycol** \ˈglī-ˌkól, -ˌkōl\ [ISV *glyc-* + *-ol*] (1858) *n.* (1) An organic compound having hydroxyl groups on adjacent carbon atoms, for example, propylene glycol, $CH_3CHOHCH_2OH$. The name is also used for non-adjacent dihydric alcohols such as the 1,3-isomer of the above compound, $HOCH_2CH_2CH_2OH$, known as *trimethylene glycol.* (2) Specifically, ethylene glycol.

**Glycol phthalate resin** *n.* A type of thermoplastic polyester used mainly for fibers and oriented films.

*See polyrester, saturated.*

**Glyptal** \ˈglip-tᵊl\ (*trademark*) *n.* An alkyd resin, the reaction product of glycerol and phthalic anhydride (hence: gly p t al) An early product was the basis of a household and laboratory cement, trade named Glyptal. It has been used as a European generic term for alkyd resins and as an alternative to the term “alkyd”.

**Godet roll** \gō-ˈdet-\ *n.* Roll used for transporting and controlling the movement of bundles of fibers and yarns in the processing of these materials.

**Godet stand** *n.* A device used in pairs downstream from the extruder when making monofilament and split-film fibers. One stand is placed before, and another following, a conditioning oven, each consisting of a vertical motor housing driving two or more horizontal drums. The filaments are wrapped repeatedly around the drums to prevent slipping. The post-oven drums are driven at speeds several times those of the first pre-oven set, causing the filaments to be stretched, oriented, and to become much stronger after cooling.

**Gold bronzes** *n.* Metallic powders of gold color produced from aluminum or copper and its alloys.

**Golden chrome** *See chrome yellow, light, and primrose.*

**Gold ink** *n.* A printing ink whose principal pigment consists of bronze powder.

**Gold lacquer** *n.* Vehicle of such color that it will give the effect of gold when applied over aluminum leaf.

**Gold leaf** (ca. 1741) *n.* Very thin leaves of metallic gold used for decorative purposes.

**Gold leafing** *v.* In antiquing, the art of applying a very thin sheet of gold over a "sized" area. It became fashionable in France in the 1700s.

**Gold number** *n.* A measure of the protective ability of hydrophilic colloids. Specifically, the number of milligrams of colloids which, when added to a standard gold solution, is just insufficient to prevent a change in color from red to blue.

**Gold size** *n.* Oleoresinous varnish which dries rapidly to a tacky condition, but which hardens slowly. It is used chiefly as an adhesive for fixing gold leaf to a surface.

**Goniochromatic** *n.* Adjective used to describe a colored material, which exhibits goniochromatism.

**Goniochromatism** *n.* The phenomenon where the color of a material changes as the angle of illumination and/or viewing is changed. McDonald R (1997) Colour Physics for Industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Goniometachromatic** *n.* Adjective used to describe a pair of samples exhibiting goniometachromatism.

**Goniometachromatism** *n.* The phenomenon where the colors of *two* goniochromatic materials match exactly at one set of illumination-viewing angles but no longer appear to match if either the illumination or viewing angles, or both, are changed. Such pairs of samples are also called *geometric metamers.*

**Goniophotometer** *n.* An instrument used to measure the amount of light reflected as a function of the viewing angle when the incident angle is kept constant. Generally, the incident angle may be changed.

**Goniophotometry** *n.* A procedure for evaluating the manner in which materials geometrically redistribute light (*See www.astm.org for relevant standards*).

**Goniospectrophotometer** *n.* An instrument used to measure a spectrophotometric curve at varius angles of incidence and reflectance. The angles of incidence and reflectance may be changed. On goniochromatic samples, the results obtained are dependent on the angles of incidence and reflectance, and on samples exhibiting specular reflectance (glossy materials), the results are also dependent on the total subtended angle of viewing relative to the specular angle. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

**Gouache** \ˈgwäsh\ [F, fr. It *guazzo*, literally, puddle, prob. fr. L *aquatio* watering place, fr. *aquari* to fetch water, fr. *aqua* water] (1882) *n.* Method of painting with opaque colors which have been ground in water and tempered with a preparation of gum. Also, a term used to describe a method of water color painting in which white is employed as a pigment by contrast with the method of attaining whites by allowing the paper to show through. Merriam-Webster's collegiate dictionary, 11th edn.

Merriam-Webster Inc., Springfield, MA, 2004.

**Gout** \ˈgaüt\ [ME *goute*, fr. OF, gout, drop, fr. L *gutta* drop] (13c) *n.* Foreign matter that is accidentally woven into a fabric. It is usually fly or waste that drops into the loom during weaving or that catches in yarns during spinning.

**GP** *n.* (1) Abbreviation for general-purpose, sometimes used to denote types of resins and molding compounds suitable for a wide range of applications. (2) Abbreviation for Gutta–Percha.

**GPC** *n.* Abbreviation for gel-permeation chromatography.

*See size-exclusion chromatography.*

**GR-1** *n.* Former symbol for butyl rubber.

**Grab strength test** *n.* A method for measuring the breaking strength of a fabric sample by mounting the sample in the tensile tester so that only a part of the width of the specimen is gripped in the clamps.

**Gradient elution** *n.* Elution in chromatography using a solvent whose composition is varied during a run.

**Gradient-tube density method** (density-gradient method) *n.* A convenient method, described in ASTM D 1505, for routinely measuring densities of small resin samples, e.g., a single pellet of molding compound. A graduated, vertical glass tube (the gradient tube) is carefully filled with graded solutions of two liquids, the densest at the bottom, the next densest above that, etc, to the least dense at the top. A specimen particle is introduced in the tube and falls to a position of equilibrium that indicates its density by comparison with the positions of calibrated hollow-glass floats. Over weeks or months, the gradient is gradually diminished by diffusion and the column must be reconstituted.

*See www.astm.org for a description of this method.*

**Graffito** \grə-ˈfē-(ˌ)tō, gra-, grä-\ [It, incised inscription, fr. *graffiare* to scratch, prob. fr. *grafio* stylus, fr. L *graphium*] (1851) *n.* Last plaster coat of a fresco ground, which is colored before application. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Graft copolymer** *n.* A copolymer having branches of varying length made up of different monomer units on a common "backbone" chain. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Grafting ratio** *n.* In a graft copolymer, the weight of grafted side chains divided by the weight of the original polymer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Graft polymer or copolymer** *n.* A high polymer, the molecules of which consist of two or more polymeric parts of different composition, chemically united. Such a graft copolymer may be produced, for example, by polymerization of a given kind of monomer with subsequent polymerization of another kind of monomer onto the product of the first polymerization. The union of two different polymers by chemical reaction between their molecular end groups or by reaction producing cross-links between the different molecules would also produce a graft copolymer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Grahamite** *n.* Naturally occurring asphaltum which varies considerably in composition. Some types are completely soluble in carbon disulfide, whereas others may contain as much as 50% of mineral matter.

**Graham's law** [Thomas *Graham*, 1805–1869, Scottish chemist] (1833) *n.* The relative rates of diffusion of gases under the same conditions are inversely proportional to the square roots of the densities of those gases. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Grain** *n.* The direction, size, arrangement, appearance or quality of the fibers in fibrous material such as paper, wood or veneer. To have a specific meaning the term must be qualified. Also, the direction of molecular orientation in a non-fibrous material.

*See types of gain, i.e., cross grain, interlocked grain, coarse grain, close train, diagonal grain, and dip grain.*

**Grain alcohol** (1889) *n.* Syn: ethyl alcohol.

**Graining** (1530) *v.* (1) A process for simulating a grain such as that of wood or marble on a painted surface by applying a stain, either translucent or pigmented, then working it into suitable patterns with tools such as graining combs, brushes, and rags. Weismantal GF (1981) Paint handbook. McGraw-Hill Inc., New York. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Grain raising** *n.* Swelling and standing up of the wood grain caused by absorbed water or solvent. Roughness of wood caused by the application of stains or other materials. Fibers of the wood raise due to swelling by water or certain solvents.

**Gram** \\ˈgram\\ [F *gramme*, fr. LL *gramma*, a small weight, fr. Gk *grammat*-, *gramma* letter, wirting, a small weight fr. *graphein* to write] (1810) *n.* Subunit of mass in the metric system of weights and measures, equal to 1/1000 of a standard kilogram (453.6 g = 1 pound). Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Gram-atom** (1927) (gram-atomic weight) *n.* The mass of an element in grams numerically equal to the elements atomic weight.

**Gram break factor** *See break factor.*

**Gram equivalent** (ca. 1897) *n.* The weight in grams of a substance displacing or reacting with 1.00797 g of hydrogen or combining with 15.9994 g of oxygen.

**Gram molecular weight or gram molecule** (ca. 1902) *n.* A mass in grams of a substance numerically equal to its molecular weight. Gram mole.

**Gram mole, gram formula weight, gram equivalent** *n.* Mass in grams numerically equal to the molecular weight, formula weight or chemical equivalent, respectively.

**Granular (or powder)** \\ˈgran-yə-lər\\ (1794) *adj.* Particles having equidimensional non-spherical shapes.

**Granular polymerization** *n.* A polymerization process in which the monomer, or mixture of monomers, is dispersed by mechanical agitation in a liquid phase, usually water, in which the monomer droplets are polymerized while they are dispersed by continuous agitation. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*Also called suspension polymerization.*

**Granular structure** *n.* Non-uniform appearance of finished plastic material due to retention of, or incomplete fusion of, particles of compound either within the mass or on the surface; or to the presence of coarse filler particles.

**Granulate** (1666) *v.* To reduce plastic sheet, chunks, or scrap to particles about 2–5 mm in size. (2, *n*) A molding compound in the form of small spheres or pellets.

**Granulator** (scrap grinder) *n.* A machine for cutting waste material such as sprues, runners, excess parison material, trim scarp from extrusion and thermoforming, and rejected parts into particles that can be reprocessed. The most common type of granulator is comprised of several thick knives bolted to a heavy cylindrical core, parallel to the core's axis, which is also its axis of rapid rotation. The rotating knives graze stationary knives mounted in the machine's housing, given an action that combines impact with shearing. A screen placed in the discharge opening controls the final particle size.

**Granule** \ˈgran-(ˌ)yü(ə)l\ [LL *granulum*, dim. of L *granum* grain] (1652) *n.* A small particle produced in various size and shapes by hot or cold cutting, of extruded strands or scrap, or by certain polymerization methods. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

*Also see pellets.*

**Grapeseed oil** *n.* Semidrying vegetable oil. Of the fatty acids present, up to 55% may be linoleic acid. Approximate constants for oil from various sources are: Sp gr of 0.925/15°C, refractive index of 1.4899/15°C, saponification value of 190, iodine value of 125–157.

**Graphic arts coatings** *n.* Coatings which are marketed solely for application to indoor or outdoor signs and include lettering enamels, poster colors and bulletin colors.

**Graphite** \ˈgra-ˌfīt\ [Gr *Graphit*, fr. Gk *graphein* to write] (1796) (black lead, plumbago) *n.* A crystalline form of carbon with atoms arranged hexagonally, characterized by a soft, greasy feel. It occurs naturally, but is produced by heating petroleum coke or other organic materials under controlled atmospheric conditions. In powder form, graphite is used as a lubricating filler for nylon and fluorocarbon resins. Too, it is added to compounds to make them electrically conductive. Pyrolytic graphite fibers, made by decomposing organic filaments at high temperatures in controlled atmospheres, are used as reinforcements for high-performance applications. The best graphite fibers are among the strongest and stiffest of all fibrous reinforcements, with strengths to 2.5 GPa and moduli to 500 GPa (360 kpsi and 72 Mpsi). Pierson HO (1994) Handbook of carbon, graphite, diamond and fullerenes. Noyes Data Corporation/Noyes Corporation, New York.

**Graphite fiber** *n.* Although the terms carbon and graphite are used interchangeably to describe these fibers, graphite fibers are more accurately defined as fibers that are 99+% carbonized (crystalline structure as opposed to non-crystalline carbon fiber) while the term carbon is used for any fiber carbonized to 93–95% or more. Pierson HO (1994) Handbook of carbon, graphite, diamond and fullerenes. Noyes Data Corporation/Noyes Corporation, New York.

*See carbon fiber.*

**Graphite paint** *n.* A painting compound consisting of powdered graphite and oil; used to coat metallic structures to inhibit corrosion. Pierson HO (1994) Handbook of carbon, graphite, diamond and fullerenes. Noyes Data Corporation/Noyes Corporation, New York.

**Graphitic mica** *See aluminum potassium silicate.*

**Graphitization** \ˌgra-fə-tə-ˈzā-shən\ (1899) *n.* Corrosion of gray iron in which metallic iron is converted into corrosion products, leaving a residue of intact graphite mixed with iron corrosion products and other insoluble constituents of cast iron and having approximately the original dimensions of the casting.

*Also known as graphitic corrosion.*

**Graphitize** (1899) *vt.* The pyrolysis of an organic material such as pitch or Polyacrylonitrile (PAN) in an inert atmosphere at temperatures between 2500 and 3000°C to produce graphite. Pyrolysis of PAN fibers is a principal source of graphite fibers.

**Grass** \ˈgras\ {*often attributive*} [ME *gras*, fr. OE *græs*; akin to OHGr *gras* grass, OE *grōwan* to grow] (before 12c) *n.* Sessile algae on the side of a ship.

**Grass cloth** (1857) *n.* Originally a handmade product imported from Japan, made by gluing woven native grasses onto paper backing. Printed wallpapers or dimensional wall coverings, especially vinyl, which simulates the same.

**Grasshopper** *n.* A stiff bunch of parallel strands in a fibrous mat.

**Grass-tree gum** *See accroides.*

**Gravel** \ˈgra-vəl\ [ME, fr. OF *gravele*, dim. of *grave*, *greve*, pebbly ground, beach] (13c) *n.* Rounded or semirounded particles of rock that will pass a 3-in. (76.2 mm) sieve and be retained on a No. 4 (4.75 mm) USA standard sieve.

**Gravel roofing** *See built-up roofing.*

**Gravimetric feeder** \ˌgra-və-ˈme-trik-\ (weigh feeder). A device for feeding extruders that continuously meters, by weighing, the rate at which feedstock enters the feed port of the extruder.

**Gravitation** \ˌgra-və-ˈtā-shən\ (ca. 1645) *n.* The universal attraction existing between all material bodies. The force of attraction between two masses $m$ and $m'$, separated by a distance $r$, $k$ being the constant of gravitation,

$$F = k\frac{mm'}{r^2}$$

(if $m$ and $m'$ are given in gram and $r$ in centimeter, $F$ will be in dyne if $k = 6.670 \times 10^{-8}$).Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Gravure** \grə-ˈvyür, grā-\ [F, fr. *graver* to grave, of Germanic origin; akin to OHGr *graban* to dig, engrave] (1893) *n.* One of the methods of printing using the intaglio process, i.e., the ink is placed in cells below the plate surface. Gravure inks are quick drying, low viscosity inks based on volatile solvents. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Gravure coating** (engraved-roll coating) *n.* A roller-coating process in which the amount of coating applied to the substrate web is metered by the depth of an all-over engraved pattern in the application roll. This process is frequently modified by interposing a resilient offset roll between the engraved roll and the web. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Gravure printing** *n.* Depressions in an engraved printing cylinder or plate are filled with ink, the excess on raised portions being wiped off by a doctor blade. Ink remaining in the depressions is deposited on the plastic film as it passes between the gravure roll and a resilient backup roll. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Gravure tissue** *n.* Sheet of paper coated with dichromated gelatin but containing no pigment. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Gray** (Gy) *n.* The SI unit of absorbed radiation dose, defined as the absorption of 1 J/kg of body mass, i.e., Gy = 1 J/kg. The former unit, the *rad*, now deprecated but still being used widely in the USA, equals 0.01 Gy.

**Gray blast (commercial blast)** *n. See NACE no. 3.*

**Gray fabric** *See greige fabric.*

**Gray scale** *n.* An archromatic scale ranging from black through a series of successively lighter grays to white. Such a series may be made up of steps, which appear to be equally distant from one another (such as the Munsell value scale) or may be arranged according to some other criteria such as a geometric progression based on lightness. Such scales may be used to describe the relative amount of difference between two similar colors. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Grazing angle** *n.* Angle of light very nearly parallel to the surface of a material; used to describe incident and/or reflected angles.

**Grease** \ˈgrēs\ [ME *grese*, fr. OF *craisse*, *graisse*, fr. (assumed) VL *crassia*, fr. L *crassus* fat] (13c) *n.* A semisolid lubricant composed of emulsified petroleum oils and soluble hydrocarbon soaps.

**Grease forming** *See mechanical grease forming.*

**Grease paint** (1) Non-drying and non-oxidizing coating for void spaces in ships which can be easily removed for control of the steel sheets. (2) Theatrical make-up.

**Grease proof inks and coatings** *n.* Inks (and coatings) that are resistant to the action of fats, oils and greases.

**Greasiness** *See spewing.*

**Greasing** *n.* Sensitization of the non-printing areas of a lithographic plate resulting in undesirable adhesion of the ink to these areas.

*Also called scumming.*

**Green B, naphthol** *n.* Iron lake of 1-nitroso-2-naphthol-3-carboxylic acid.

**Green B, pigment** *n.* Pigment produced by treating 1-nitroso-2-naphthol with a ferrous salt.

**Green, Brunswick** *See chrome green.*

**Green, chrome** *See chrome green.*

**Green cinnabar** *See chromium oxide green.*

**Green earth** Naturally occurring earth pigment, which is primarily an iron silicate. Used to make lime green. Syn: terre verte.

*See green, lime.*

**Green, emerald** *See emerald green.*

**Green gold** *See nickel azo yellow.*

**Green lake** *n.* Mixture of Prussian blue and Yellow Lake.

**Green, lime** *n.* Term applied to those green pigments, which are employed for their fastness to alkali (lime). For a considerable time it consisted of the green produced from green earth but the term is now applied to other types, e.g., reduced Pigment Green B.

**Green lumber** *n.* Lumber which has not been dried or seasoned.

**Green, Paris** *n.* Pigment consisting essentially or copper acetoarsenite. It is sometimes used in anti-fouling compositions, but its main use is in insecticides.

**Green rouge** *See chromium oxide green.*

**Green stock** *n.* Raw or uncured plastic or rubber stock, which is ready for vulcanization. The term is not applied to crude rubber, synthetic rubber, or resin that has not been compounded.

**Green strength** *n.* Of a perform or incompletely cured molding, the ability to withstand handling without distorting.

**Green tack** *n.* A term used in fabric bonding for the preliminary bond created in the first stage of curing by the wet adhesive process. At this point, the bond is not fully cured and hence is "green".

**Greentone ink blue** *See iron blue.*

**Green vitriol** \-ˈvi-trē-əl\. $FeSO_4 \cdot 7H_2O$. Crystalline ferrous sulfate used in the manufacture of iron blue.

**Green, zinc** *n.* Range of greens made by mixing zinc chromate with iron blue. They are less bright and weaker than the Brunswick greens, but find application where lead-free greens are required.

**Greenockite** \ˈgrē-nə-ˌkīt\ [Charles M. Cathcart, Lord *Greenock* † 1859 English soldier] (1844) *n.* Naturally occurring cadmium sulfide mineral.

**Greige fabric** \ˈgrā(zh)-\ [F *grège* raw (of silk), fr. It *greggio*] (1926) *n.* An unfinished fabric just off the loom or knitting machine.

**Grenadine** \ˌgre-nə-ˈdēn, ˈgre-nə-ˌ\ [F, fr. *grenade* coarse silk fabric, pomegranate] (1852) *n.* (1) A fine, loosely woven fabric in leno weave made with dyed filling yarns and having a clipped dobby design. (2) A silk cord constructed by twisting together several twisted strands.

**Grex** (1) A unit of linear density equal to the weight in grams of 10 km of yarn, filament, fiber, or other textile strand. (2) The system of yarn numbering based on the use of grex units. Kadolph J, Langford AL (2001) Textiles. Pearson Education, New York.

*Also see yarn number.*

**Grex number** *n.* Like *cut* and *denier*, a deprecated measure of lineal density of yarns and fibers, the weight in grams of 10 km of the yarn. A grex number of 1 corresponds to an SI lineal density of $10^{-7}$ kg/m or 0.1 tex.

*See also cut, denier, and tex.*

**Grey fabric** *See greige fabric.*

**Grid** \ˈgrid\ [back-formation fr. *gridiron*] (1839) *n.* Channel-shaped, mold-supporting members.

**Griffith theory** *n.* The idea that, in brittle fracture, crack growth occurs, causing fracture, when the rate of decrease of stored elastic energy equals or exceeds the rate of creation of new fracture-surface energy. The Griffith equation states that, in thin sheets, tensile strength is given by: $\sigma = 2\gamma E/(\pi c)^{0.5}$, where $\gamma$ is the fracture-surface energy per unit area, $E$ the elastic modulus, and $c$ is the half the crack length. Anderson TL (2005) Fracture mechanics. CRC Press, Boca Raton.

**Grind** \ˈgrīnd\ [ME, fr. OE *grindan*; akin to L *frendere* to crush, grind] (before 12c) *v.* (1) To reduce the size of breakable particles by impact or by squeezing them between relatively moving surfaces. (2) To remove material from a part by contact with an abrasive, to change either the part's shape or its finish.

**Grinding** *n.* (1) Process by which pigment particles are reduced in size, mechanically. (2) Its use to describe pigment dispersion in mill bases is deprecated.

**Grinding media charge** *See mill charge.*

**Grinding medium** *n.* Any medium which is used as a means of dispersing pigments or fillers by grinding or dispersing.

**Grinding slab** *n.* A flat piece, usually of glass or stone, on which color is ground from a coarse to a finely divided state, frequently with the medium that is to blend it as a paint.

**Grinding-type resin** *n.* A vinyl resin that must be ground to effect dispersion in plastisols or organosols.

**Grinning** *n.* (1) A flaw in fabric, especially a ribbed fabric, that occurs when warp threads show through the covering filling threads or when the threads have slipped leaving open spaces on either side. (2) A condition that occurs when the carpet backing shows through the pile. (3) A printing term referring to either poor cover where the background shade shows through the print, or to the “two-tone” appearance of a shade printed with incompatible dyes. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Grinning through** *n.* Showing through of the underlying surface due to the inadequate opacity of a paint film, which has been applied to it.

**Gripper loams** Shuttleless looms. These looms employ a projectile with a jaw that grips the end of the filling yarn during the insertion of the pick.

**Grisaille** \gri-ˈzī, -ˈzā(ə)l\ [F, fr. *gris* gray, fr. MF] (1848) *n.* Decorative painting in which objects are rendered in tones of one color, usually gray, often applied on glass, and intended to give the effect of sculptured relief. Merriam-Webster’s collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Grit blasting** *n.* A mold-finishing process in which abrasive particles are blown against mold surfaces in order to produce a controlled degree of roughness. The process is often used on molds for blow molding to assist air escape near the end of the blow, and on other types of molds to produce a desired texture in the product. Rosato DV (ed) (1992) Rosato’s plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York.

*See blast cleaning.*

**Grit number** *See mesh number.*

**Gritty** \ˈgri-tē\ (1598) *adj.* In a coating, roughness resembling grains of sand. Weismantal GF (1981) Paint handbook. McGraw-Hill Inc., New York.

**Grooved barrel** *n.* In an extruder or injection molder, a barrel that has shallow grooves over the first few screw diameters from the feed opening. The groves may be parallel to the machine axis or helical with direction opposite that of the screw. Grooves have been shown to improve feeding of difficult-to-feed materials and to reduce energy consumption per unit of throughput, but can cause overfeeding and attendant problems with screws and materials for which the grooves and screw were not designed. Weismantal GF (1981) Paint handbook. McGraw-Hill Inc., New York.

**Grosgrain** \ˈgrō-ˌgrān\ [F *gros grain* coarse texture] (1869) *n.* A heavy fabric with prominent ribs, grosgrain has a dressy appearance and is used in ribbons, vestments, and ceremonial cloths. Tortora PG (ed) (1997) Fairchild’s dictionary of textiles. Fairchild Books, New York.

**Ground** *n.* (1) Surface applied to a canvas or other support, upon which a picture is painted. (2) Base on which organic agents are precipitated to form lakes. (3) Any surface, which is or will be painted. Gair A (1996) Artist’s manual. Chronicle Books LLC, San Francisco. Mayer R, Sheehan S (1991) Artist’s handbook of materials and techniques. Viking Adult, New York.

**Ground color** *n.* A term describing the plain background color against which a design is created. Mayer R, Sheehan S (1991) Artist’s handbook of materials and techniques. Viking Adult, New York.

**Groundnut oil** Another name for arachis or peanut oil. *See peanut oil.*

**Ground oyster shells** *See calcium carbonate, natural.*

**Ground perlite** *See perlite, expanded.*

**Ground silica** *See silica, crystalline.*

**Ground state** (1926) *n.* The state of lowest energy of a particle.

**Ground wire** *n.* A wire attached between apparatus, containers and instruments and an electrical ground to dissipate an electric or electrostatic charge.

**Group** \ˈgrüp\ {*often attributive*} [F *groupe*, fr. It *gruppo*, of Germanic origin; akin to OHGr *kropf* craw] (1686) *n.* A vertical column of elements in the periodic table, sometimes called a family of elements. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Growth** *See secondary creep.*

**GRP** *n.* Abbreviation for "glass-reinforced plastic".
*See reinforced plastic.*

**Guaiacol** *n.* 2-Methoxyphenol, is a natural organic compound with the molecular formula C7H8O2. It is the monomethyl ether of catectol. It is a yellowish oil drived from guaiacum or wood creosote. It is used medicinally as an expectorant, antiseptic, and local anesthetic. In coating technology, it is used for anti-skinning properties (www.wikipedia.org). Usmani AM (1997) Asphalt science and technology. Marcel Dekker, New York. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Guanidine aldehyde resins** *n.* Reaction products of guanidine aldehydes.

**Guar gum** \ˈgwär ˈgən\ (1950) *n.* The ground endosperms of *Cyanopsis tetra gonolobus.* The free-flowing powder is soluble in cold or hot water and can be gelled with borax. It is used as a thickening agent or protective colloid. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Guide bar** *n.* A mechanism on a warp-knitting machine that directs warp threads to the latch needles.

**Guide coat** *n.* Coat similar to the finish or color coat but of a different color to assure good coverage.

**Guide eye** *n.* In filament winding, a moving metal or ceramic loop (eye) through which the fiber passes as it flows from creel to mandrel.

**Guide pin (dowel pin)** *n.* In compression, transfer, and injection molding, usually one of two or more hardened steel pins that maintain proper alignment of the mold halves that open and close.

**Guide-pin bushing (dowel-pin bushing)** *n.* In molding, a hardened bushing that receives and guides the leader pin, controlling alignment of the mold halves as the mold closes. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Guides** Fittings of various shapes for controlling the path of a thread line. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Guignet's green** *See chrome-oxide green and hydrated chromium oxide.*

**Guillotine** \ˈgi-lə-ˌtēn\ [F, fr. Joseph *Guillotin* † 1814 F physician] (1793) *n.* Cutting device that consists of a single blade that descends between guides for chopping fibers, plastic strands, etc. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Guimet's blue** *n.* Synthetic ultramarine blue.

**Gum** \ˈgəm\ [ME *gomme*, fr. MF, fr. L *cummi*, gummi, fr. Gk *kommi*, fr. Egyptian *qmyt*] (14c) (adhesives) *n.* Any of a class of colloidal substances, exuded by or prepared from plants, sticky when moist, composed of complex carbohydrates and organic acids, which are soluble or swell in water. The term gum is sometimes used loosely to denote various materials that exhibit gummy characteristics under certain conditions, for example. Gum balata, gum benzoin, and gum asphaltum. Gums are included by some in the category of natural resins. Skeist I (ed) (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Gum (lithography)** *n* . A water-soluble colloid such as gum arabic, cellulose gum, etc., used for coating a lithographic plate to make the non-image areas ink-repellent and to preserve the plate for future use. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Gum acacia** *See acacia gum.*

**Gum accroides** *See accroides.*

**Gum animi** *See animi.*

**Gum benzoin** *See benzoin.*

**Gum bloom** *n.* A defect in a painted surface, appearing as a lack of gloss or a haze resulting from the use of incorrect reducer.

**Gum karaya** *See karaya gum.*

**Gum mastic** *n.* A natural resin used for picture varnish to protect oil paintings, water colors and the like.

**Gumming** *n.* (1) Clogging of sandpaper by a coating. (2) Addition of a gum resin to a coating.

**Gummy** *n.* British term for brush drag.

**Gum, natural** *n.* A carbohydrate high polymer that is insoluble in alcohol and other organic solvents, but generally soluble or dispersible in water. Natural gums are hydrophilic polysaccharides composed of monosaccharide units joined by glycosidic bonds. They occur as exudations from various trees and shrubs in tropical areas or as phycocolloids (algae), and differ from natural resins in both chemical composition and solubility properties. Some contain acidic components and others are neutral. Their chief use is as protective colloids and emulsifying agents in food products and pharmaceuticals; as sizing for textiles; and in electrolytic deposition of metals. Examples are: Arabic, tragacanth, guar, and karaya. The word "gum", often used as an adjective, seems to acquire a different meaning from the noun. For example, the resinous products obtained from pine pitch (produced by the parenchyma cells of softwoods) are conventionally called "gum turpentine" and "gum rosin". There are also such "gum reins" as gum benzoin, gum camphor, and others. The so called ester gum is a semi synthetic reaction product of rosin and a polyhydric alcohol. All these are actually resinous products having properties quite different from hose of natural gums. Still further complicating the matter is the common application of the word "gum" to such plant lattices as chicle and natural rubber, which are different from both carbohydrate gums and resins. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Gum rosin** (1712) *n.* Rosin which is produced from the gum turpentine obtained by tapping living pine trees, as distinguished from the wood rosin obtained from the stump and branches of dead trees.

**Gum rubber (pure gum)** *n.* Raw, unvulcanized rubber recovered from the latex of the *hevea* tree or from polymerization of synthetic rubber. Gum runner has almost no useful properties prior to being vulcanized. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Gums** *n.* Although rarely used in the plastics industry, this term is used in kindred industries to include materials that can be dissolved in water to produce viscous or mucilaginous solutions. Thus, water-soluble polymers such as polyvinyl pyrrolidone, polyvinyl alcohol, ethylene oxide resins, polyacrylic acid, and polyacrylamide are regarded as gums. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Gum sandarac** \-ˈsan-də-ˌrak\. Soft resin obtained from *Tetraclinis articulate*, used in the manufacture of paints, linoleum, and oil cloth. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

*Also known as juniper gum.*

**Gum spirits** *See turpentine.*

**Gum thus** *n.* Botanically, the oleoresin from trees of *Boswellia* species native to Arabia and Somaliland. As applied to the naval stores industry, the term refers to the crystallized pine oleoresin or “scarpe” collected from scarified “faces” of trees being worked for turpentine. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

*Also known as olibanum and frankioncense.*

**Gum turpentine** (1926) *n. See turpentine.*

**Guncotton** \-ˈkä-tᵊn\ (1846) *n.* A highly inflammable and explosive form of cellulose nitrate made by digesting clean cotton in a mixture of one part nitric acid and three parts sulfuric acid, the latter acting as a catalyst and scavenger of the water generated in the reaction. As it ages in contact with air, dry guncotton becomes gradually more unstable and dangerous to handle. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Gunk** \ˈgeŋk\ [fr. *Gunk*, trademark for a cleaning solvent] (1943) *n.* A slang term for premix.

**Gunk molding** *See premix molding.*

**GUP** *n.* Glass-fiber-reinforced polyester resins.

**Gusset** \ˈgə-sət\ [ME, piece of armor covering the joints in a suit of armor, fr. MF *gousset*] (ca. 1570) *n.* A tuck in the side of a bag, usually made in symmetrical pairs in both paper and plastic-film bags, that permit the bag to assume nearly rectangular-boxy form when opened. Gussets may be formed in the tubular blown film from which bags are made just before the film enters the pinch rolls.

**Gutta–Percha** \ˌgə-tə-ˈpər-chə\ [Malay *gètah-pèrcha*, fr. *gètah* sap, latex + *pèrcha* scrap, rag] (1845) (GP, PI, and *trans*-1,4-polyisoprene) *n.* A rubber-related, polymeric substance extracted from the milky sap of leaves and bark of certain trees belonging to the family *Sapotaceae*, genera *Palaquium*, and *Payena*, plants native to Malaysia. Its mer has the same empirical formula

as natural rubber, its *cis* isomer. Gutta–Percha is a tough, horny substance at room temperature, but becomes soft and tacky when warmed to 100°C. In the past it was used in compounds for golf-ball covers, electrical insulation, cutlery handles, and machinery belting, and as a stiffening agent in natural rubber, but has been replaced in many of these applications by synthetics. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.
*See also balata.*

**Gutta–Percha, synthetic** *See polyisoprene.*

**Gutter** \ˈgə-tər\ [ME *goter*, fr. MF *goutiere* fr. *goute* drop, fr. L *gutta*] (14c) *n.* A channel at the eaves for conveying away rain water. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Gutzeit test** *n.* Method for testing and estimating small quantities of arsenic and antimony in other materials. Details are given in the *British pharmacopoeia.*

**Gym finish** *n.* Composition of oils and resins in a solvent; designed to produce a high gloss, tough surface finish on wood floors. Weismantal GF (1981) Paint handbook. McGraw-Hill Inc., New York.

**Gynocardia oil** *n.* A drying oil, smelling like linseed oil, and obtained from *Gynocardia odorata*, which grows in India and Pakistan. Its component acids include isolinolenic, linolenic, lin oleic, oleic, and palmitric acids. It has a Sp gr of 0.925/25°C, iodine value of 153–160. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Paul N. Gardner Co. Inc., FL, 2001.

**Gypsum** \ˈjip-səm\ [L, fr. Gk *gypsos*] (14c) *n.* $CaSO_4 \cdot 2H_2O$. Natural crystalline calcium sulfate used as an extender in paint manufacture. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.
*See calcium sulfate. Also known as mineral white.*

**Gypsum, calcined** *n.* $CaSO_4 \cdot \frac{1}{2}G_2O$. Gypsum partially dehydrated by heat.
*See plaster of Paris.*

**Gypsum cement** *See plaster of Paris.*

**Gypsum plaster** *See cement plaster.*

**Gypsum wallboard** *n.* A sheet or slab having an incombustible core, essentially gypsum, surfaced with paper suitable to receive decoration. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.
*Also known as plasterboard.*

# H

**h** \ˈāch\ *n.* (1) SI abbreviation for hour and for the prefix hecto-. (2) Also H, the symbol for channel depth of an extruder screw.

**H** (1) The chemical symbol for the element hydrogen. (2) Abbreviation for the SI unit of magnetic inductance, the henry. (3) Symbol for enthalpy. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Habit** \ˈha-bət\ [ME, fr. OF, fr. L *habitus* condition, character, from *habēre* to have, hold] (13c) *n.* The general shape of a crystal. The same descriptive terms are used in each of the six crystal systems, e.g., rods, plates, tablets, needles, flakes, etc. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York.

**Hackberry tree seed oil** \ˈhak-ˌber-ē-\. Obtained from the kernels of the tree, *Celtis occidentalis.* Its main constituent fatty acid is linoleic acid, present to the extent of over 70%. It has a Sp gr of 0.9204/25°C, refractive index of 1.4794/25°C, saponification value of 191, and an iodine value of 150.

**Hackles** \ˈha-kəl\ [ME *hakell*; akin to OHGr *hāko* hook] (15c) *n.* Thin, needle-like or sliver-like protrusions (ranging from 3 to 6 µm) found on steel plates, which have been blasted with steel or grit. Anderson TL (2005) Fracture mechanics: fundamentals and applications. CRC Press, Boca Raton, FL.

**Haco oil** *n.* Specifically processed whale oil, of German origin, with good drying properties.

**Hagen–Poiseuille equation** (Poiseuille equation) *n.* The equation of steady, laminar, Newtonian flow through circular tubes:

$$Q = \pi R^4 \Delta P / 8\eta L,$$

where $Q$ is the volumetric flow rate, $R$ and $L$ are the tube radius and length, $\Delta P$ the pressure drop (including any gravity head) in the direction of low, and $\eta$ is the fluid viscosity. With the roles of $Q$ and $\eta$ interchanged, this is the basic equation of capillary viscometry. Any *consistent* system of units may be used. This important equation was first derived theoretically in 1839 by G. Hagen and, a year later, inferred from experimental measurements by J. L. Poisuille. In a laminar flow through a circular tube, a simple force balance shows that the shear stress at the wall, $\tau_w = \Delta PR/2L$. By Newton's law of viscosity (*see viscosity*), the shear rate at the wall, $\gamma_w$, must equal the shear stress divided by the viscosity. Solving the above equation for $\Delta PR/2\eta L$, one obtains $\gamma_w = 4Q/\pi R^3$. By applying the Rabinowitsch correction to this expression for Newtonian shear rate, one can get the true shear rate at the wall for a non-Newtonian liquid. An often seen, equivalent, but slightly different form for the Newtonian shear rate at a tube wall is $8V/D$, where $V$ is the average fluid velocity $= Q/(\pi D^2/4)$ and $D = 2R$. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, Cambridge, UK. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York. Anderson TL (2005) Fracture mechanics: fundamentals and applications. CRC Press, Boca Raton, FL. Van Wazer JR, Lyons JW, Kim KY, Colwell RE (1963) Viscosity and flow measurement. Interscience Publishers Inc., New York.

**Hair-cracking** *See cracking.*

**Hairy** *See fuzziness.*

**Half-life** (1907) *n.* The period of time necessary for one-half of a reactant to be consumed in reaction or process. Used to measure the rate of radioactive decay of disintegration. The time lapse during which a radioactive mass losses one half of its radioactivity.

**Half-reaction** An equation for an oxidation or a reduction which specifically indicates the electrons lost or gained.

**Halftone** \ˈhaf-ˌtōn\ (1651) *n.* A printed image composed of dots of varying frequency (number per in.$^2$), size or density, producing tonal gradations. The term is also applied to the process, "plates" and ink used to produce this image.

**Halftone screens** *n.* Transparent plates ruled diagonally with opaque lines at right angles to one another, the distance between them and their thickness being approximately equal.

**Halide** \ˈha-ˌlīd\ (1876) *n.* Any compound including one (or more) of the halogen elements (F, Cl, Br, and I) in its –1 valence state. The term halide is often used to indicate that any of the four principal halogens may be interchangeably present.

**Hall effect** When a steady current is flowing in a steady magnetic field, electromotive forces are developed which are all right angles both to the magnetic force and to the current and are proportional to the product of the intensity of the current, the magnetic force and the sine of the angle between the directions of these quantities.

**Halocarbon plastic** \ˈha-lə-ˌkär-bən-\ (1950) *n.* A term listed by ASTM (D 883) to mean a polymer containing only carbon and one or more halogens. The primary members of the family are the chlorofluorocarbon and fluorocarbon resins.

**Halo effect** (ca. 1928) *n.* Piling up of ink at the edges of printed letters and dots. Also colored or sometimes uncolored areas adjacent to them, caused by the spread of colored or uncolored vehicles. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Halogen** \ˈha-lə-jən\ [Sw, fr. *hal-* + *-gen*] (1842) *n.* The elements of group 7a of the periodic table; fluorine, chlorine, bromine, and iodine (F, Cl, Br, and I). The fifth member, astatine, is rare, radioactive, and unstable, with a half-life less than 9 h, so it is never seen in commerce.

**Halogenated solvents** *n.* The solvents containing halogen (usually chlorine) have improved solvency compared with the hydrocarbons from which they are derived and in addition flammability is reduced. Some of these are highly toxic, and precautions must be taken to avoid inhalation of their vapors.

**Halogenation** (1882) *n.* Process or reaction wherein any members of the halogen group are introduced into an organic compound, either by simple addition or substitution.

**Halogen/phosphorus flame retardant** *n.* Chlorine- and bromine-substituted esters of phosphoric acid or phosphonic acid, used mostly in polyurethane foams to impart fire resistance.

**Hammer finish** \ˈha-mər-\. A paint finish which appears to have been applied over hammered metal; produced by the use of non-leafing metallic pigment, plus tinting pigments, which are mixed in a special binder.

**Hammer mill** (1610) *n.* Type of mill used for pulverizing dry materials in which the disintegration is caused by the action of a number of small hammers.

**Hammett equation** \ˈha-met-\. An equation used in organic chemistry to predict reactions for aromatic compounds.

$$\log \frac{K}{K_o} = \rho\sigma \ or \ \log \frac{k}{k_o} = \rho\sigma,$$

where $K$ or $k$ refers to the reaction of a *m*- or *p*-substituted phenyl compound (e.g., ionization of a substituted benzoic acid) and $K_o$ or $k_o$ refers to the same reaction of the unsubstituted compound (e.g., ionization of benzoic acid), the substituent group constant $\rho$ is a number (+ or −) indicating the relative electron-withdrawing or electron-releasing effect of a particular substituent, the reaction constant $\sigma$ is a number (+ or −) indicating the relative need of a particular reaction for electron withdrawal or electron release; a linear free energy relationship since it is based on the fact that a linear relationship exists between free energy change and the effect exerted by a substituent. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Hand** \ˈhand\ {*often attributive*} ME, fr. OE, akin to OHGr *hant* hand] (before 12c) *n.* The feel of film, fabric, or coated fabric – its flexibility, smoothness, and softness – as judged by the touch of a person.

**Hand-blocked print** *n.* A fabric that has been printed by hand with wooden or linoleum blocks.

*Also see printing.*

**Hand-blocking** *See block printing.*

**Hand lay-up** *n.* Method of forming reinforced plastics articles comprising the steps of placing a web of the reinforcement, which may or may not be preimpregnated with a resin, in a mold or over a form and applying fluid resin to impregnate and/or coat the reinforcement, followed by curing of the resin and extraction of the cured article from the mold. *See lay-up molding.*

**Handle** *See hand.*

**Hand mold** *n.* A mold that is removed from the press after each shot for extraction of the molded article; generally used only for short runs and experimental moldings.

**Hand-screening** *See silk-screening.*

**Hanger wire** *n.* The wire employed to suspend the acoustical ceiling from the existing structure (wood joists, steel bar joists, steel beams, concrete slabs, etc.). Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Hang pick** *n.* A pick that is caught on a warp yarn knot for a short distance, which produces a triangular hole in the fabric. Hang picks usually result from knots that are tied incorrectly, shuttle tension that is too loose, or harness that is timed too early.

**Hang shot** *See hang pick.*

**Hangup** *n.* (1) Stray bits of extrudate that cling to the face of the die and eventually have to be cleaned off. (2) Failure of feed material in a hopper to fall out of the hopper, caused sometimes by arching when the feed opening is only a few times larger than the pellet, but more often by clumping together of sticky particles.

**Hank** \ˈhaŋk\ [ME, of Scand origin; akin to ON *hǫnk* hank; akin to OE *hangian* to hand] (14) *n.* (1) A skein of yarn. (2) A standard length of slubbing, roving, or yarn. The length is specified by the yarn numbering system in use; e.g., cotton hanks have a length of 840 yards. (3) A term applied to slubbing or roving that indicates the yarn number (count); e.g., a 1.5 hank roving.

**Hank shellac** Form of bleached shellac, which, instead of being ground and dried, is pulled into hanks. Contains up to 25% moisture.

**Hansa yellow** \ˈhan(t)sə-\ *n.* Range of yellow pigment dyestuffs which are characterized by clean tones and good fastness to light in mass tones but poor fastness to light in pale tints. Heat resistance is also poor and therefore these pigments should not be used in baking finishes. They are produced by coupling diazotized bases with acetoacetanilide or its substitution products.

**Hanus iodine number** *n.* Method claimed to measure the complete unsaturation of both conjugated and non-conjugated substances. The method employs as a reagent a solution of iodine and bromine in glacial acetic acid.

**Hypalon®** Chlorosulfonated polyethylene, manufactured by DuPont Performance Elastomers. A versatile, high-performance elastomer used extensively in the automotive and general rubber industries.

**Hardboard** \ˈhärd-ˌbōrd\ (1925) *n.* A generic term for a smooth, grainless panel manufactured primarily from interfelted lignocellulosic fibers (usually wood), consolidated under heat and pressure in a hot-press to a density of 31 lb/ft.$^3$ (specific gravity 0.50) or greater, and to which other materials may have been added during manufacture to improve certain properties. In its most common form, it is smooth on one side and has a light waffle-like texture on the reverse side. Used for interior panels or durable siding. It is also available with a smooth surface on both sides, and with a variety of embossed or textured finishes, as well as a perforated form that accepts hooks and fixtures, for converting any wall into a storage area.

**Hard dry** *See dry-hard.*

**Hardener** \ˈhärd-nər\ (1611) *n.* Additive (cross-linking agent, resin, or other modifier) used to promote or control the hardening or curing reaction of a coating, plastic, adhesive or resin system. {G Härter m, F durcisseur m, S endurecedor m, I induritore m}. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See curing agent, catalyst, and cross-linking.*

**Hard-facing alloy** *n.* Any of several metals applied by welding to the contact surfaces (screw-flight tips) to reduce the rate of wear. Colmonoys® are nickel-based, containing boron, chromium, iron, and silicon. Stellites® are cobalt-based, with chromium, and tungsten. They are usually applied into a machined helical groove prior to cutting the main channel, then finish-ground afterward.

**Hard ferrite** *See ferrite.*

**Hard fiber** *n.* Stiff, elongated fibers obtained from leaves or stems of plants. Coarse and stiff, they are used in matting and industrial products. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Hard gloss paint** *n.* A high-gloss enamel, formulated with a hard-drying resin vehicle.

**Hard gums** *n.* Resins exuded from living plants centuries ago, Some of the hard gums are Amber, Zanzibar, Kauri, Pontianak, Manila, and Congo.

**Hardinge mill** *n.* Conical type of ball mill used for grinding rock and similar materials.

**Hard lac resin** *n.* Resin resulting from shellac when treated by fractional solvent extraction to remove the soft resin component. Hard lac resin is claimed to give films, which are harder, and more durable, than those of ordinary shellac. In addition, hard lac resin polymerizes more easily when heated and has better water resistance. Weismantal GF (1981) Paint handbook. McGraw-Hill Inc., New York.

**Hardness** \-nəs\ (before 12c) *n.* (1) The resistance to local deformation. (2) Ability of a coating film, as distinct from its substrate, to resist cutting, indentation, or penetration by a hard object. An arbitrary scale of hardness is based upon ten selected minerals. For metals the diameter of the indentation made by a hardened steel sphere (Brinnell) or the height of rebound of a small drop hammer (Shore Scleroscope) serve to measure hardness. {G Härte f, F dureté f, S dureza f, I durezza f}. *See barcol hardness, brinell hardness, durometer, indentation hardness, knoop hardness number, knoop microhard-ness, Mohn hardness, pendulum-rocker hardness, modulus of elasticity, rockwell hardness, scratch hardness, and vickers hardness.*

**Hardness scale** *See Mohs, scale, knoop hardness number, pencil hardness, and rocker hardness tester.*

**Hard putty** *n.* (1) Linseed oil putty hardened with litharge or basic lead carbonate. (2) A quick setting putty containing water and plaster of Paris.

**Hard rubber** *n.* The material obtained by heating a highly unsaturated diene rubber with a high percentage of sulfur. The first hard rubber was Ebonite, made from natural rubber, and black, as its name implies. Similar products have been made from several of the synthetics. The sulfur is mostly contained in 3- and 4-carbon rings with a few –C–S–C– cross-links.

**Hard size** *n.* A condition found in areas of fabric where the warp contains an excessive quantity of sizing. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Hard stopping** *See hard putty.*

**Hard-surfacing** *See hard-facing alloy and case hardening.*

**Hardware** (ca. 1515) *n.* The physical parts of mechanical devices and electronic control systems.

**Hardwoods** (1568) *n.* Generally, the botanical group of trees that have broad leaves, in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood. Angiosperms is the botanical name for hardwoods.

**Harmonic motion** (1867) *n.* Simple harmonic motion and angular harmonic motion.

**Harness** \ˈhär-nəs\ [ME *herneis* baggage, gear, fr. OF] (14c) *n.* A frame holding the heddles in position in the loom during weaving. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Harness chain** *n.* A mechanism used to control the vertical movements of the harness, or shaft, on a loom.

**Harsh fiber** *n.* Fiber that is rough or coarse to the touch, but not fused or bonded filaments. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Hashab** *n.* Name applied to a fine pale grade of gum acacia.

**Haul-off** *n.* In sheet extrusion, the three-roll stand and cooling-conveyor assembly that polishes and cools the molten sheet emerging from the die, often extended in scope to include the rubber pull rolls and winder. The term has analogous meaning for other extruded products, such as pipe.
*See, too, sheet line.*

**Hazardous substance** *n.* A substance which, by reason of being explosive, flammable, poisonous, corrosive, oxidizing, or otherwise harmful, is likely to cause death or injury. Element or compound which, when discharged in any quantity, presents an imminent and substantial danger to the public health or welfare.

**Haze** *n.* Haze and luminous transmittance are tests to measure the light transmittancy of different types and grades of plastic materials; Haze is defined in ASTM D 1003 as the percentage of transmitted light passing through the specimen which deviates more than 2.5° from the incident beam by forward scattering; luminous transmittance is defined as the ratio of transmitted to incident light. The cloudy or turbid appearance of an otherwise transparent specimen caused by light scattered from within the specimen or from its surfaces (www.astm.org). Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, West Conshohocken, PA. Paint testing manual: physical and chemical examination of paints, varnishes, lacquers, and colors – STP 500. American Society for Testing and Materials, West Conshohocken, PA, 1973.

**Hazen color scale** *n. See apha color scale.*

**Hazy** (1) A relatively small amount of non-settling, finely dispersed matter which is not visibly homogeneous with the mass of the liquid specified, even through the liquid is transparent and transmits most of the light incident upon it. (2) Displaying haze.

**HDPE** *n.* Abbreviation for high-density polyethylene.

*See polyethylene.*

**Head** *n.* (1) In any extrusion operation, the delivery end of the extruder, usually fitted with a hinged gate that may contain a breaker plate and screen pack, to which the adapter and die are attached. (2) In blow molding, the entire apparatus by which the molten plastic is shaped into a tubular parison. This may include an adapter, a parison die, and a melt accumulator.

**Head end** *n.* (1) The beginning of a new piece of fabric in the loom that bears appropriate identification. (2) A small sample of fabric that may be submitted to a customer for approval.

**Headers** *n.* Double wood pieces supporting joists in a floor, or double wood members placed on edge over windows and doors to transfer the roof and floor weight to the studs.

**Head pressure** *n.* In extrusion, the pressure of the melt at the delivery, or head end of the screw, typically as signaled by a pressure transducer mounted in the barrel opposite the tip of the screw. Head pressure is one of the most important indicators of the state of any extrusion operation.

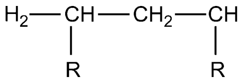
**Head-to-head polymer** *n.* A configuration whereas the functional groups are on adjacent carbon atoms on a polymer chain. A polymer in which the monomeric units are alternately reversed produced from the monomer, $CH_2 = CHR$ Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

(*See image*).

**Head-to-tail polymer** *n.* A structure of the type

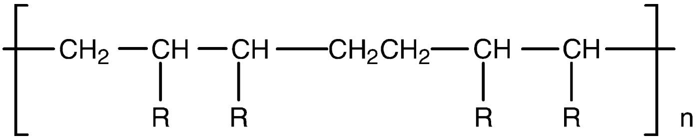
$$\sim\sim CH_2CHX\text{–}CHXCH_2\sim\sim$$

in a vinyl or related type of polymer. During polymerization, it results from a growing chain $\sim\sim CH_2C^*HX$ adding on a monomer ($CH_2{=}CHX$) to give $\text{–}CH_2CHX\text{–}CHXCH_2^*$, the substituted carbon atom being designated the head (*See image*).



$$H_2-\underset{R}{CH}-CH_2-\underset{R}{CH}$$

{G Kopf-Schwanz-Polymerisation f, F polymérisation tête-bêche, polymérisation f, S polimerización cabeza a cola, polimerización f, I polimerizzazione testa-coda,



$$\left[-CH_2-\underset{R}{CH}-\underset{R}{CH}-CH_2CH_2-\underset{R}{CH}-\underset{R}{CH}-\right]_n$$

polimerizzazione f}. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Heartwood** \-ˈwúd\ (1810) *n.* The wood extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may be infiltrated with gums, resins and other materials, which usually make it darker and more decay resistant than sapwood.

**Heat** \ˈhēt\ [ME *hete*, fr. OE *hîte*, *hîtu*; akin to OE *hāt* hot] (before 12c) *n.* Energy which is transit from a hot to a cold object because of the temperature difference, to become warm or hot. Heat is a form of energy associated with the motion of atoms, molecules and other particles matter is composed of. It can be created by chemical reactions (such as burning), nuclear reactions (such as fusion reactions taking place inside the Sun), electromagnetic dissipation (as in electric stoves), or mechanical dissipation (such as friction). Heat can be transferred between objects by radiation, conduction and convection. Temperature is used to indicate the level of elementary movement associated with heat. Heat can only be transferred between objects, or areas within an object, that have different temperatures. By common knowledge, the term heat has been used in connection with the warmth, or hotness, of surrounding objects. The concept that warm objects "contain heat" is not uncommon. During its 350 year development, the science of thermodynamics had established a physical quantity named temperature to quantify the level of "warmth", whereas heat (also improperly called heat change) was defined as a transient form of energy that quantifies the spontaneous transfer of thermal energy due to a temperature difference or gradient. The SI unit for heat is the joule; an alternative unit still in use in the United States and other countries is the British thermal unit. The amount of heat exchanged by an object when its temperature varies by 1° is called heat capacity. Heat capacity is specific to each and every object. When referred to a quantity unit (such as mass or moles), the heat exchanged per degree is termed specific heat, and depends primarily on the composition and physical state (phase) of objects. Fuels generate predictable amounts of heat when burned; this heat is known as heating value and is expressed per unit of quantity. Upon transitioning from one phase to another, pure substances can exchange heat without their temperature suffering any change. The amount of heat exchanged during a phase change is known as latent heat and depends primarily on the substance and the initial and final phase. Heat is a process quantity, as opposed to being a state quantity, and is to thermal energy as work is to mechanical energy. Heat flows between regions that are not in thermal equilibrium with each other; it spontaneously flows from areas of high temperature to areas of low temperature. All objects (matter) have a certain amount of internal energy, a state quantity that is related to the random motion of their atoms or molecules. When two bodies of different temperature come into thermal contact, they will exchange internal energy until the temperature is equalized (that is, until they reach thermal equilibrium). The amount of energy transferred is the amount of heat exchanged. It is a common misconception to confuse heat with internal energy: heat is related to the change in internal energy and the work performed by the system. The term heat is used to describe the flow of energy, while the term internal energy is used to describe the energy itself. Understanding this difference is a necessary part of understanding the first law of thermodynamics. Infrared radiation is often linked to heat, since objects at room temperature or above will emit radiation mostly concentrated in the mid-infrared band (*see black body*). Smith JM, Abbott MM, Abbot M, Van Ness HC (2004) Introduction to chemical engineering thermodynamics. McGraw-Hill Co., New York. Lide DR (ed) (2004) CRC Handbook of chemistry and physics. CRC Press, Boca Raton, FL. Hudson RD Jr (1969) Infrared system engineering. John Wiley and Sons, New York.

(*See also www.wikipedia.org*).

**Heat bodied** *n.* Thickening or polymerizing a drying oil by heat processing.

**Heat-bodied oil** *See oil, heat-bodied.*

**Heat capacity** (specific heat) *n.* The amount of heat required to raise the temperature of a unit mass of a substance one degree. In the SI system, the unit of heat capacity is J/kg K, but kJ/kg K, or J/g K are often more convenient. Conversions from older units are: 1 cal/g°C = 1 Btu/lb°F = 4.186 J/g K. Most neat resins have heat capacities (averaged from room temperature to about 100°C) between 0.92 J/g K for polychlorotrifluoroethylene and 2.9 for polyolefins (The heat capacity of water, one of the highest of all materials, is 4.18 J/g K at room temperature.) A term loosely used as a synonymous with heat capacity but not truly so is specific heat.

**Heat cleaning** *n.* (1) A batch or continuous process in which sizing on glass fibers is vaporized off. (2) Cleaning residual polymer from small extruder screws, dies or other small parts by immersing them in fused salts such as sodium nitrate.

**Heat content** *n.* Syn: enthalpy.

**Heat-convertible resins** *n.* Thermosetting resins which on controlled heating become infusible and insoluble. This phenomenon is associated with cross-linking of the resin molecules.

**Heat distortion** *n.* The degree of deformation of a plastic material under load for a short time at elevated temperature.

**Heat-distortion point** *n.* The former name, now deprecated and fading from use, of deflection temperature.

**Heated-tool welding** *See hot-plate welding.*

**Heat effect** *n.* The heat in calories developed in a circuit by an electric current of $I$ amperes flowing through a resistance of $R$ ohms, with a difference of potential $E$ volts for a time $t$ seconds,

$$H = \frac{RI^2 t}{4.18} = \frac{EIt}{4.18}.$$

Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Heat equivalent, or latent heat, of fusion** *n.* The quantity of heat necessary to change one gram of solid to a liquid with no temperature change. Dimensions $[L^2 T^{-2}]$.

**Heater band** *n.* An electrical heating unit shaped to fit extruder barrels, adapters, die surfaces, etc, for maintaining high temperatures of the banded items and furnishing heat to the plastics within them. Nichrome wires within the bands are embedded in insulation such as magnesium oxide and their ends are welded to screw-type terminals at the end of the band. The ends of cylindrical bands are brought together by Monel bolts to tighten them snugly against the surface to be heated. Service life is greatly increased by operating them at 80% or less of rated wattage, the usual practice.

*See also cast-in heater.*

**Heat forming** *See thermoforming.*

**Heather yarn** \ˈhe-Thər-\ *n.* A term describing mottled or mélange-type yarns.

**Heating cylinder** (heating chamber) *n.* In elderly injection molders, that part of the machine in which the cold plastic pellets were heated to the molten condition before injection. Until the late 1950s, heating cylinders for injection machines were static devices equipped internally with *torpedoes* or *spreaders*, sometimes heated separately that caused the charge to be distributed in a thin annulus with the cylinder. This hastened the heating but was still slow and could degrade the plastic. Today, all new commercial machines are screw-injection types, accomplishing the heating mainly by the frictional action of the screw. This heating and melting process is not only faster but produces a melt of more uniform temperature, less likely to have been scorched. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Heat mark** *n.* An extremely shallow depression or groove in the surface of a plastic article, visible because of a sharply defined rim or a roughened surface.

*See also sink mark.*

**Heat of combustion** *n.* The amount of heat evolved by the combustion of a unit mass, usually one gram-molecular weight, of the substance (kJ/mol). The former unit of heat of combustion, deprecated now but still widely used, was the kcal/mol, equal to 4.186 kJ/mol. Heats of combustion, which are tabulated for many pure compounds, are an important segment of the database of physical chemistry and chemical engineering, for it is from sums and differences in heats of combustion that most heats of reaction are estimated. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Heat of formation, $\Delta H_f$** *n.* The change in enthalpy for a reaction in which 1 mol of a compound in formed from its uncombined elements (*enthalpy of formation*). Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Heat of fusion** (enthalpy of fusion) *n.* The quantity of heat needed to melt a unit mass of a solid at constant temperature (J/kg or J/mol). Because all meltable plastics consist of broad mixtures of homologous molecules having different molecular weights, and because melting points of homologs increase with molecular weight, it is not possible to melt a plastic at a constant temperature. Instead, melting occurs over a range of temperature. With crystalline resins, such as polyethylene, the range may be relatively small, about 20°C, and it is really only for such resins that "heat of fusion" is meaningful and measurable. To estimate the heat of fusion, enthalpy (J/g) is measured beginning at a temperature well below that at which melting begins and carried on to temperatures well above that at which the plastic has completely melted. Plots (or equations) of enthalpy versus temperature for both ranges are extrapolated to the center of the melting range, the "melting point". The difference between the higher and lower enthalpies at that point is taken as the heat of fusion of the plastic. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Heat of polymerization** (enthalpy of polymerization). The difference between the enthalpy of 1 mol of monomer and the enthalpy of the products of the polymerization reaction. Addition polymerizations are exothermic, values ranging from about 35 to 100 kJ/mol, and removal of this heat is an important aspect of reactor design. The reported value of an enthalpy of polymerization may be referred either to the temperature at which the polymerization is usually carried out or to a standard temperature, such as 25 or 18°C. Ready RG (1996) Thermodynamics. Plenum Publishing Co, New York.

**Heat quantity** *n.* The cgs unit of heat is the *calorie*, the quantity of heat necessary to change the temperature of 1 g of water from 3.5 to 4.5°C (called a small calorie). If the temperature change involved is from 14.5 to 15.5°C, the unit is the normal calorie. The mean calorie is $\frac{1}{100}$ the quantity of heat necessary to raise one gram of water from 0 to 100°C. The large calorie is equal to 1000 small calories. The British thermal unit is the heat required to raise the temperature of one pound of water at its maximum density, 1°F. It is equal to about 252 cal. Dimensions of energy $[M L^2 T^{-2}]$. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Heat-reactive phenolic resin** *n.* Phenol-formaldehyde resin which has been manufactured under alkaline conditions and which reacts with oils, rosin, or other unsaturated components during varnish making, through the free methylol groups in its structure along with further condensation of the methylol groups in the resin.

**Heat resistance** *n.* A property of certain fibers or yarns whereby they resist degradation at high temperature. Heat resistance may be an inherent property of the fiber-forming polymer or it may be imparted by additives or treatment during manufacture. *Also see heat stabilized.*

**Heat-resistant finishes** Finishes designed to resist deterioration on continuous or intermittent exposure to a predetermined elevated temperature.

**Heat seal** *n.* A method of uniting two or more surfaces by fusion, either of the coatings or the base materials, under controlled conditions of temperature, pressure, and dwell time.

**Heat sealing** *n.* The process of joining two or more thermoplastic films or sheets by heating areas in contact with each other to the temperature at which fusion occurs, usually aided by pressure. When the heat is applied by dies or rotating wheels maintained at a constant temperature, the process is called *thermal sealing*. In *melt-bead sealing*, a narrow strand of molten polymer is extruded along one surface, trailed by a wheel that presses the two surfaces together. In *impulse sealing*, heat is applied by resistance elements that are applied to the work when relatively cool, then are rapidly heated. Simultaneous sealing and cutting can be performed in this way. *Dielectric sealing* is accomplished with polar materials by inducing heat within the films by means of radio-frequency waves. When heating is performed with ultrasonic vibrations, the process is called *ultrasonic sealing*.

*See also welding.*

**Heat-seal strength** *n.* With heat-sealed flexible films, the force required to pull apart a heat-sealed joint divided by the joined area tested. The strength of a heat seal is sometimes expressed as a percentage of the film's tear strength or tensile strength.

**Heat-sensitive paints** *n.* Coatings, which change color at a specific temperature.

**Heat sensitivity** *n.* The tendency of a plastic to undergo changes in properties, color, or even to degrade at elevated temperatures. Severity of change is always a matter of both temperature and time. ASTM D 794 describes the procedures to be used in determining the permanent effects on plastics of elevated-temperature exposure.

**Heat set inks** *n.* Letterpress and lithographic inks which dry under the action of heat by evaporation of their high boiling solvent.

**Heat-shrinkable film** *n.* A film that is stretched and oriented while it is being cooled so that later, when used in packaging, it will, upon being rewarmed, shrink tightly around the package contents. Blown film made from plasticized PVC is the largest-volume shrink film. Heat-shrinkable tubing of several polymers if widely used in the electronics industry to protect bundles of wiring. ASTM D 2671 (section 10.01) describes a method for testing such tubing.

**Heat sink** (1936) *n.* A device for the absorption or transfer of heat away from a critical part or assembly.

**Heat stability** *n.* The resistance to change in color or other properties as a result of heat encountered by a plastic compound or article either during processing or in service. Such resistance may be enhanced by the incorporation of a stabilizer.

**Heat stability test** *n.* An accelerated test used to predict viscosity stability of coatings with time. The test generally involves measuring viscosity change after the paint has been heat-aged about a week to 10 days at 50–60°C. An excessive increase in viscosity is unacceptable.

**Heat stabilizers** *n.* A stabilizer additive to reduce or eliminate thermal degradation or its effects. Most commonly used with chlorinated polymers, which are particularly thermally sensitive due to their tendency to dehydrochlorinate.

**Heat test** *n.* Test employed for assessing the purity of tung and similar rapidly polymerizing oils. The test involves heating the oil at a specified temperature and noting the time required for gelation to occur. Syn: browne heat test.

*See gel time.*

**Heat transfer** *n.* The movement of energy as heat from a hotter body to a cooler body. The three basic mechanisms of heat transfer are radiation, conduction, and convection. Radiation heating occurs when heat passes from the emitting body to the receiving body through a medium, such as air, that is not warmed. Conduction heating is the flow of heat from a hot region to a cooler one in either single homogeneous substances or two substances in close contact with each other. Convection is the transfer of heat by flow of a fluid, either a gas or a liquid, and either by natural currents caused by differences in density or by forced movement caused by a fan, pump, or stirrer. All three modes of transfer are important in plastics processing {*heat transfer coefficient* G Härte f, F dureté f, S dureza f, I durezza f}.

**Heat-transfer medium** *See thermal fluid.*

**Heat transfer printing** *n.* A method, whereby a printed image is transferred from a carrier to a receiving substrate by the use of heat. In the process, as currently performed, the ink is made up of sublimable dyes in conventional ink vehicles; the carrier is paper, and the receiving substrate is a synthetic fabric.

*Also known as thermal printing.*

**Heavy-bodied** *n.* Having a thick consistency or high viscosity.

**Heavy bodied inks** *n.* Inks of a high viscosity or stiff consistency.

**Heavy-centered pattern** *n.* Spray pattern having most paint in center, less at edges.

**Heavy end** *n.* (1) The higher boiling fraction in distillation. (2) *See coarse thread.*

**Heavy filling** *See coarse thread.*

**Heavy metals** (1974) *n.* Metallic elements with high molecular weights generally toxic to plant and animal life. Examples: mercury, chromium, arsenic, lead, etc.

**Heavy pick** *See coarse thread.*

**Heavy solvent naphtha** *n.* High-boiling coal-tar naphtha generally distilling below 190°C (90/190°C is a usual grade).

**Heavy spar** *See barium sulfate, natural.*

**Hecto-** {*combining form*} [F, irreg. fr. Gk *hekaton*] (h) *n.* The SI prefix meaning ×100.

**Heddle** \ˈhe-dəl\ [prob. alt. of ME *helde*, fr. OE *hefeld*; akin to ON *hafald* heddle, OE *hebban* to lift] (1513) *n.* A cord, round steel wire, or thin flat steel strip with a loop or eye near the center through which one or more warp threads pass on the loom so that the thread movement may be controlled in weaving. The heddles are held at both ends by the harness frame. They control the weave pattern and shed as the harnesses are raised and lowered during weaving.

H

**Hegman gauge** *See fineness of grind gauge.*

**Hehner number** (value). A number expressing the percentage (i.e., grams per hundred grams) of water-insoluble fatty acids in an oil or fat.

**Heisenberg theory of atomic structure** \ˈhī-zən-bərg-\ *n.* The currently accepted view of the structure of atoms, formulated by Heisenberg in 1934, according to which the atomic nuclei are built of nucleons, which may be protons or neutrons, while the extranuclear shells consist of electrons only. If $m$ and $m'$ are given in grams, and $r$ in centimeters, $F$ will be in dynes if $k = 6.670 \times 10^{-8}$.

$$F = k\frac{mm'}{r^2}.$$

Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Heisenberg uncertainty principle** [Gr. Werner *Heisenberg*] (1939) *n.* The product of the uncertainty in the position of a particle times that in its momentum is a constant. It is impossible to determine simultaneously both the position and the momentum of a particle exactly. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Helical screw feeder** \ˈhe-li-kəl-\ *n. See crammer-feeder, screw conveyor.*

**Helical transition** *n.* In the transition zone (compression zone) of an extruder screw, the root surface of the screw describing an advancing spiral surface of increasing radius.

*See also conical transition.*

**Helical winding** *n.* A winding in which the filament or band advances along a spiral path, not necessarily at a constant angle except in the case of a cylindrical article.

**Helio fast rubine 4BL lake** (58055) *n.* This pigment is marketed as an alumina hydrate lake; the parent toner is hard and horny when dried and, consequently, too difficult to disperse. It is black in masstone but yields a purpose tint on reduction with white. Its good lightfastness in dark shades, high color intensity, good chemical and bleed resistance make Helio Fast Rubine 4BL lake particularly suitable for shading full shade durable maroon finishes. On the other hand, its poor lightfastness in very weak pastel shades plus its poor bake resistance at high temperatures make it unsuitable as a white toning agent for high bake exterior white finishes.

**Helio-klischograph** *n.* A method of engraving gravure cylinders by the use of an electronic scanning system which transmits a signal modulated by the density of a positive copy to a diamond cutting head effecting the engraving mechanically rather than by chemical etching. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Helix angle** \ˈhē-liks-\ *n.* (1) Of an extruder screw, the lead angle of the flight with respect to the screw axis, the angle whose tangent $h = t/\pi D$, where $t$ is the axial distance the flight advances per turn (lead) and $D$ is the major (or nominal) screw diameter. (2) In filament winding, the angle between the axis of rotation and the filament at its point of contact with the winding.

**Hellige system or comparator** *n.* Standard instrument for color determination of liquids such as varnishes, oils, etc., based on comparisons which are made against a series of discs of colored glass, and which are carefully graded.

**Hematite** \ˈhē-mə-ˌtīt\ (1540) *n.* $Fe_2O_3$. Natural oxide of iron.
*See ferric oxide.*

**Hemiacetal** \ˌhe-mē-ˈa-sə-ˌtal\ (1893) *n.* Any class of compounds characterized by the grouping C(OH)(OR) where R is an alkyl group and usually formed as intermediates in the preparation of acetals from aldehydes or ketones. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Hemiacetal group** *n.* Functional groups derived from carbonyl groups by addition of one molecule of an alcohol, of the general structure shown: –C–OH–OR–. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Hemicelluloses** \ˌhe-mi-ˈsel-yə-ˌlōs\ [ISV] (1891) *n.* The principal non-cellulosic polysaccharides in wood. Wood contains 28–35% hemicelluloses, the balance being cellulose and lignin. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Hemicolloid** \-ˈkä-ˌlóid\ *n.* Colloidal particle of specified size, both as regards number of molecules in association, and length of chain. This includes substances involving between 20 and 100 molecules, and possessing an overall chain length not exceeding 25 nm.

**Hemihydrate** \-ˈhī-ˌdrāt\ (ca. 1901) *n.* A hydrate which contains one-half molecule of water to one molecule of the compound; the most common such material is partially dehydrated gypsum (plaster of Paris).

**Hemimorphic** \-ˈmór-fik\ [ISV] (ca. 1959) *adj.* A crystal with unlike faces at opposite ends of the same axis.

**Hemipolymer** *n.* A readily soluble polymer with molecular weights between 1000 and 10,000.

**Hemisymmetric** \-sə-ˈme-trik\ *n.* A crystal on which one-half the faces of at least one form are missing.

**Hemp** \ˈhemp\ [ME, fr. OE *hînep*; akin to OHGr *hanaf* hemp, Gk *kannabis*] (before 12c) *n.* A coarse, durable bast fiber of *Cannabis sativa* found all over the world. Used primarily for twines, cordage, halyards, and tarred riggings.

**Hempseed oil** *n.* A semidrying oil obtained from the seeds of *Cannabis sativa*, which grows in India, Manchuria, China, Japan, and some parts of Europe. It is usually classed with soybean, poppyseed, sunflower, and walnut oils, and has an iodine value of approximately 160, arising in the main from the presence of practically 50% of linoleic acid and 25% of linolenic acid. It has some application in manufacture of paints and varnishes.

**Henderson–Hasselbalch equation** *n.* A formula relating the pH value of a solution to the $pK_a$ value of the acid in the solution and the ratio of the acid and the conjugate base concentrations: $\mathrm{pH} = \mathrm{p}K_a +$

$\log([A^-]/[HA])$, where $[A^-]$ is the concentration of the conjugate base and [HA] is the concentration of the protonated acid. For the bicarbonate buffer system in blood,

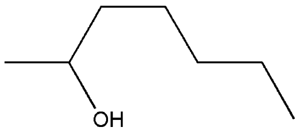
$$pH = pK + \log([HCO_3^-]/[CO_2]).$$

Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

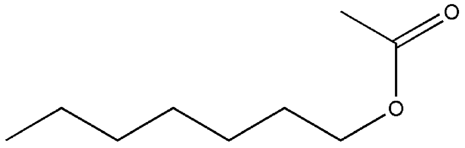
**Henry** \ˈhen-rē\ [for Joseph *Henry*] (H) *n.* The SI unit of electric inductance, the inductance of a closed circuit in which an electromotive force of one volt is produced when the electric current in the circuit varies uniformly at a rate of 1 A/s. The magnetic flux in this situation will be just 1 weber (Wb). Thus, 1 H = 1 V s/A = 1 Wb/A. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Henry's law** [for W. *Henry*] *n.* The mass of a slightly soluble gas that dissolves in a definite mass of a liquid at a given temperature is directly proportional to the partial pressure of that gas. This law holds only for gases that do not chemically react with the solvent. Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

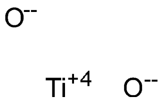
**Heptanol-2** *n.* Another name for methyl amyl carbinol. It has a bp of 160.4°C, vp of 0.9 mmHg/20°C, and a Sp gr of 0.8187/20°C.



**Heptyl acetate** *n.* Bp, 191°C; Sp gr, 0.874.



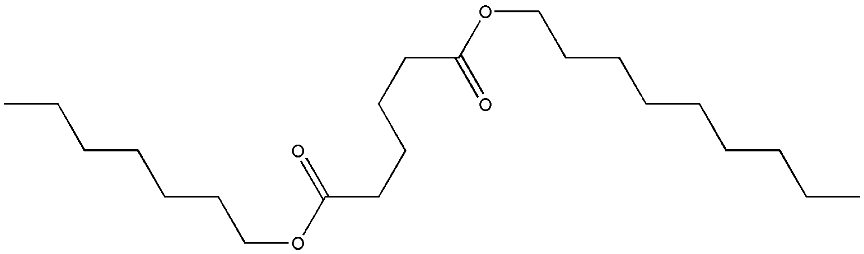
***n*-Heptyl *n*-decyl phthalate** *n.* $C_7H_{15}OOCCF_6H_4COOC_{10}H_{21}$. A general purpose plasticizer for PVC and several other thermoplastics, with lower volatility and better low-temperature performance than dioctyl phthalate. It is excellent for use in vinyl plastisols.



***n*-Heptyl *n*-dinonyl trimellitate** *n.* An aromatic plasticizer similar to trioctyl trimellitate with better low-temperature performance and lower volatility.

***n*-Heptyl *n*-nonyl adipate** *n.* A plasticizer for PVC similar to dioctyl adipate but with better low-temperature performance and lower volatility. It is also approved for use in contact with foods.

**Herbicide** \ˈ(h)ər-bə-ˌsīd\ [L *herba* + ISV –*cide*] (1899) *n.* An agent used to destroy or inhibit plant growth.



**Herringbone** \ˈher-iŋ-ˌbōn\ {*often attributive*} (1659) *n.* A broken twill weave characterized by a balanced zigzag effect produced by having the rib run first to the right and then to the left for an equal number of threads.

**Hertz** \ˈhərts\ [Heinrich R. *Hertz*] (ca. 1928) (Hz) *n.* Cycles per second of any periodic phenomenon. The term and its multiple, megahertz (MHz), were in the past used most frequently for waves in the radio-frequency range, but the hertz is now the SI unit of frequency.

**Hessian** \ˈhe-shən\ {*chiefly British*} (1729) *n.* A name for burlap used in the United Kingdom, India, and parts of Europe.
*Also see burlap.*

**Hess's law of constant heat summation** *n.* The amount of heat generated by a chemical reaction is the same whether the reaction takes place in one step or in several steps, or all chemical reactions, which start with the same original substances and end with the same final substances liberate the same amounts of heat, irrespective of the process by which the final state is reached. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Heterochain polymers** *n.* Polymers which contain more than one type of atom in the polymer chain.

**Heterocyclic compound** *n.* A compound whose molecule includes at least one ring that contains one or more elements other than carbon and hydrogen. A simple example is *pyridine*, $C_5H_5N$, a benzene molecule in which one carbon is replaced by nitrogen.

**Heterocyclic monomers** *n.* Monomer whose molecule includes at least one ring that contains one or more elements other than carbon and hydrogen. A simple example is pyridine, $C_5H_5N$, a benzene molecule in which one carbon is replaced by nitrogen.

**Heterofillament** *Also called heterofil.*
*See bicomponent fibers.*

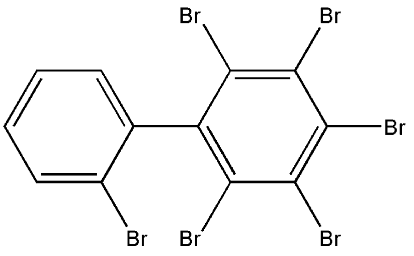
**Heterogeneous** \ˌhe-tə-rə-ˈjē-nē-əs\ [ML *heterogeneus*, fr. Gk *heterogenēs*, fr. *heter-* + *genos* kind] (1630) *adj.* Composed of two or more phases.

**Heteropolymerization** *n.* A special case of addition polymerization involving the combination of two dissimilar unsaturated monomers, the product being a *heteropolymer.*

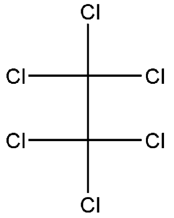
**Hevea rubber** *See rubber, natural.*

**Hexabromide value** \-ˈbrō-ˌmīd ˈval(ˌ)yü\ *n.* Hexabromide value is a measure of the amount of acids of the linolenic types which are present in a mixture of natural fatty acids. Bromine, under suitable conditions, forms addition compounds through addition at the unsaturated linkages. The hexabromides are separated from the dibromides and tetrabromides by reason of the insolubility of the former in cold ether. The hexabromide value is the percentage of hexabromide obtainable from a given material.

**Hexabromobiphenyl** \-ˈbrō-(ˌ)mō-(ˌ)bī-ˈfe-nᵊl\ *n.* $[2,4,6\text{-}(Br)_3C_6H_2\text{–}]_2$. A flame retardant suitable for use in thermosetting resins and thermoplastics such as acrylonitrile–butadiene–styrene resin, nylons, polycarbonate, polyolefins, PVC, polyphenylene oxide, and polystyrene–acrylonitrile. It is insoluble in water, heat-stable, and furnishes a high bromine content in the end product.

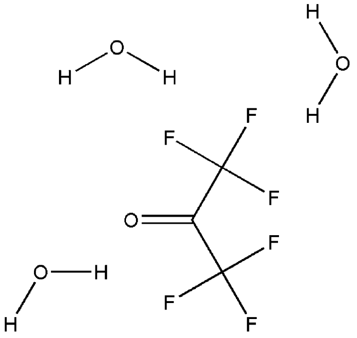


**Hexachloroethane** (carbon hexachloride, perchloroethane) *n.* A substitute for camphor in celluloid manufacture.



**Hexachlorophene** *n.* $(C_6HCl_3OH)_2CH_2$. A white, essentially odorless, free-flowing powder widely used as a bacteriostat in many thermoplastics including vinyls, polyolefins, acrylics, and polystyrene.

**Hexafluoroacetone trihydrate** *n.* A solvent cement, active at room temperatures, for bonding acetal resin articles to themselves and to other polymers such as nylon, acrylonitrile–butadiene–styrene, styrene–acrylonitrile, polyester, cellulosics, and natural or synthetic rubber. It is also a toxic irritant, so it must be handled with care.



**Hexagonal** \hek-ˈsa-gə-nᵊl\ (1571) *adj.* (1) Of a closed plane figure, having six sides. (2) Having the properties of a *regular* hexagon, i.e., all six sides and all six angles equal. (3) One of the six crystal systems, in which there are four principal axes, three in one plane at 120° to each other, the fourth perpendicular to the others. Atomic spacing is equal along the planar axes, different along the fourth. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York.

**Hexahydrophenol** *n.* Syn: cyclohexanol.

**Hexahydrophthalic anhyride (HHPPA)** $C_6H_{10}(CO)_2O$. A curing agent for epoxy resins and an intermediate for the production of alkyd resins.

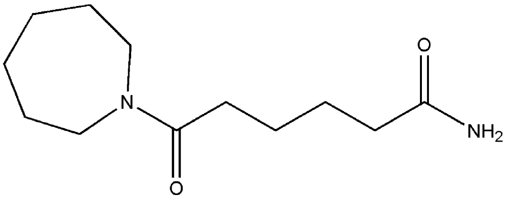
**Hexalin** *See cyclohexanol.*

**Hexalin acetate** *See cyclohexyl acetate.*

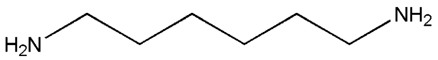
**Hexamethylene** \ˌhek-sə-ˈme-thə-ˌlēn\. Syn: cyclohexane.

**Hexamethylene adipamide** (nylon 6/6). A nylon made by condensing hexamethylene diamine with adipic acid.

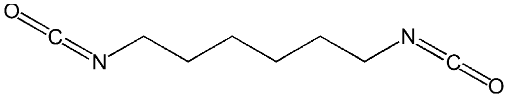
*See nylon 6/6.*



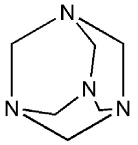
**Hexamethylene diamine** \-ˈdī-ə-ˌmēn\ (1,6-diaminohexane). A colorless solid in leaflet form, which, when condensed with adipic acid, forms nylon 6/6, It has also been used to cure epoxy resins, especially for coatings and usually in a modified form, for example as an epoxy resin adduct.



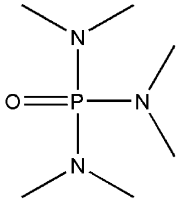
**Hexamethylene-1,6-diisocyanate (HDI)** A colorless liquid, the first aliphatic diisocyanates to be used commercially in the production of urethanes. When used with certain metal catalysts, it produces urethane polymers with good resistance to discoloration, hydrolysis, and thermal degradation.



**Hexamethylenetetramine** (Hexamine) \-ˈte-trə-ˌmēn\ [ISV *hexa-* + *methylene* + *tetra-* + *amine*] (1888) (HMT, methenamine, and urotropine) *n.* $(CH_2)_6$–$N_4$. A bicyclic compound, the reaction product of ammonia and formaldehyde. It is used as a basic catalyst and accelerator for phenolic and urea resins, and a solid, catalytic-type curing agent (hardener) for epoxies (*See image*).



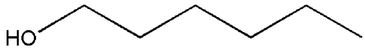
**Hexamethylphosphoric triamide** $[N(CH_3)_2]_3PO$. A pale, water-soluble liquid used as an ultraviolet absorber in PVC compounds.



**Hexane** \ˈhek-ˌsān\ [ISV] (1877) *n.* $C_6H_{14}$. A straight-chain hydrocarbon, extracted from petroleum or natural gas. Commercial grades contain other hydrocarbons such as cyclohexane, methyl cyclopentane, and benzene. Hexanes are used as catalyst-carrying solvents in the polymerization of olefins and elastomers. Sp gr, 0.660; bp, 69°C; solidification range −95 to −100°C; flp, −22°C (−70°F).

**Hexanedioic acid** Syn: adipic acid.

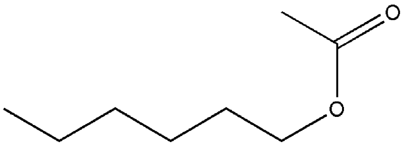
**Hexanol** $CH_3(CH_2)_4CH_2OH$. High-boiling solvent (144–156°C) with a vp of 4 mmHg at 30°C; Sp gr, 0.8186.



**Hexone** *See methyl isobutyl ketone.*

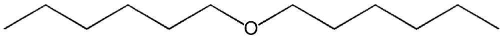
**Hexyl-** \ˈhek-səl\ [ISV] (1869) *n.* The straight-chain radical of hexane, $C_6H_{13}$–.

**Hexyl acetate** $CH_3COO(CH_2)_5{\cdot}CH_3$. Cellulose nitrate, cellulose acetate-butyrate, polyvinyl acetate, polystyrene, phenolics, alkyds, and coumarone-indene resins. It has a bp of 169°C, Sp gr, of 0.890, and vp of 5 mmHg/20°C.

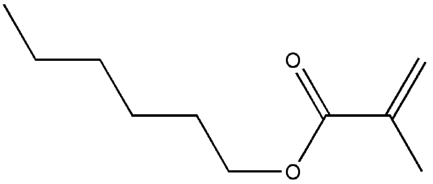


**Hexyl ether** High boiling solvent. It has a bp of 226°C, Sp gr of 0.794/20°C, vp of 0.07 mmHg/20°C, and flp of 77°C (170°F).

***n*-Hexylethyl *n*-decyl phthalate (NODP)** *See n-octyl n-decyl phthalate.*



**Hexyl methacrylate** \-ˌme-ˈtha-krə-ˌlāt\ *n.* A monomer used in producing acrylic resins.



**HF** *n.* Abbreviation for high frequency.

**HF preheating** *See dielectric heating.*

**Hickies** \ˈhi-kēs\ (ca. 1915) *n.* Defects in a print appearing as specks surrounded by an unprinted "halo".

**Hide finishes** *n.* Designed for use on leather. They are based on pigmented nitrocellulose, and completely cover the surface.

**Hiding, complete** *n.* The state of uniform application of paint at such a thickness that, when dry, the substrate is no longer affecting the color, i.e., thickness such that increasing the thickness even slightly does change the *perceived* color. Complete hiding is frequently judged by application of a uniform film over a white and black substrate such as a Morest Chart. It is sometimes defined as the state when a contrast ratio of 0.98 is obtained (although this is seldom complete hiding as judged visually). Visual complete hiding is not necessarily spectrophotometric complete hiding. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, West Conshohocken, PA.

*See contrast ratio.*

**Hiding, incomplete** *n.* The state of application of a coating at such a thickness that the color of the substrate has an effect on the color, which the coating would exhibit if it were applied at complete hiding. Increasing the thickness of the coating thus changes the perceived color. The relative degree of incomplete hiding is frequently described by the contrast ratio. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, West Conshohocken, PA.

*See contrast ratio and hiding, complete.*

**Hiding power** *n.* The ability of a paint, ink, etc., to hide or obscure a surface over which it has been applied uniformly. When expressed numerically, it is generally in terms of the number of square feet over which a gallon of paint, or pound of pigment, as used, can be uniformly spread to produce a specified contrast ratio. Hiding power is usually expressed in square feet per gallon or square meters per liter. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, West Conshohocken, PA.

*See contrast ratio.*

**Hiding power chart** *n.* (1) A paper chart, partially black and partially white. A paint film applied over such a chart gives a visual evaluation of the degree of hiding. If a measurement of the reflectance of the film over the black portion is divided by the measurement of the reflectance over the white portion, the contrast ratio (opacity) is obtained. (2) A chart prepared calculation of the Kubelka–Munk equation for a white substrate of specified reflectance for various reflectances at complete hiding ($R_\infty$) and for various reflectances over black, various contrast ratios, scattering-thickness values (SX). From such a chart, using measurements of reflectances over black and white, or measurements over black and of $R_\infty$, changes in thickness, pigment volume concentration, $R_\infty$ for obtaining a desired contrast ratio (degree of hiding) or $R_\infty$, can be determined. Such charts are frequently called Judd Charts. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, West Conshohocken, PA.

**Hiding, spectrophotometric, complete** *n.* The state of uniform application of a paint film which, when dry, exhibits identical spectrophotometric curves over a perfect white of 100% reflectance and a perfect black of 0% reflectance. In the Kulblka–Munk equations, spectrophotometric hiding is defined as $R_\infty$ at all wavelengths. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials, West Conshohocken, PA.

**Hiding, spectrophotometric, incomplete** *n.* The state of a uniform paint film in which the spectrophotometric curves measured over white and black areas are not identical; addition of more paint is required to achieve complete spectrophotometric hiding or identity of reflectance curves of the film over white and black substrates. Films, which appear visually to be at complete hiding are not necessarily at complete spectrophotometric hiding.

**Hi-flash naphtha** *See naphthas.*

**High-boiling solvent** *n.* A solvent with an initial boiling point above 150°C (302°F).

**High build** *n.* Proceeding thick, dry films per coat.

*See build.*

**High-build coating** *n.* A coating composed of a series of uniform, tile-like films which are applied in thicknesses (minimum 5 mils) greater than those normally associated with paint films and thinner than those normally applied with a trowel.

*See also tile-like coating.*

**High-bulk yarn** *See textured yarns.*

**High density** (1960) *n.* A term to describe a material with heavier than normal weight per unit volume.

*Also see density.*

**High-density overlay** *n.* An overlay consisting of paper that is impregnated with a thermosetting resin and then applied to plywood; provides a smooth, hard, wear-resistant surface for high-quality concrete formwork and decking.

**High-density polyethylene (HDPE)** *n.* This term is generally considered to include polyethylenes ranging in density from about 0.94 to 0.96 g/cm$^3$ and higher. Whereas the molecules in low-density polyethylenes are branched and linked in random fashion, those in the higher-density polyethylenes are linked in longer chains with fewer side branches, resulting in higher-modulus materials with greater strength, hardness, and chemical resistance, and higher softening temperatures.

*See also polyethylene.*

**Higher fatty acid** *See fats.*

**High-frequency** (1892) *n.* Pertaining to the part of the electromagnetic spectrum between 3 and 200 MHz, employed in plastics welding, sealing and preheating operations. Frequencies of 30 MHz and below are the most used.

**High-frequency heating** *n.* Syn: dielectric heating.

**High-frequency welding** *n.* A method of welding thermoplastic articles in which the surfaces to be joined are heated by contact with electrodes of a high-frequency electrical generator.

**High gloss** *See gloss. Also called full gloss.*

**High-impact polystyrene (HIPS)** *n.* Polystyrene whose impact strength has been elevated by the incorporation of rubber particles. The best grades, produced by polymerization of styrene containing dissolved rubber, have better impact resistance than those made by mixing rubber and polystyrene together. Whereas crystal PS has notched-Izod impact between 0.13 and 0.24 J/cm, HIPS resins range between 0.37 and 2.1 J/cm.

**High-intensity mixer** *n.* A type of mixer consisting of a large bowl with a high-speed rotor in its bottom, used for producing dry blends of PVC with liquid and powder additives, also for producing other powder blends. Though there is considerable heating of the charge during mixing, the main constituent is not melted and the mix is discharged in powder form. Compare with internal mixer.

**Highlight** \ˈhī-ˌlīt\ (ca. 1889) *n.* The light or open areas of a halftone print.

**Highlighting** *n.* In antiquing, accenting raised areas on furniture with a lighter tone than the crevices. Produced by rubbing harder. Emphasizing the impression of relief by making certain parts of a finished surface lighter than the general color of that surface.

**High-load melt index** *n.* (1) The rate of flow of a molten resin through an orifice 2.096 mm in diameter and 8.000 mm long at 190°C when subjected to a pressure difference of 2.982 MPa. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

*Also known as the flow-behavior index. See power law.*

**Highloft** *n.* General term for a fiber structure containing more air than fiber. Specifically, a lofty, low-density non-woven structure that is used for applications such as fiberfill, insulation, health care, personal protection, and cleaning material.

**High-low profile** *n.* A pile construction characterized by the presence of two or more pile heights. High-low pile carpets sometimes combine looped and cut surface yarns.

**High modulus** *n.* A term that refers to a material with a higher than normal resistance to deformation.

*Also see modulus.*

**High-molecular-weight high-density polyethylene (HMWHDPE)** *n. See polyethylene* {G Niederdruck-Polyethylen n; Polyethylen hoher Dichte, Polyethylen n, F polyéthylène haute densité (PEHD), polyéthylène m S polietileno de alta densidad, polietileno m, I polietilene alta densità (PE a.d.), polietilene m}.

**High-performance composite** *See advanced composite.*

**High-performance plastic** (advanced plastic) *n.* Any neat, filled, or reinforced resin, thermoplastic or thermoset, that maintains stable dimensions and mechanical properties above 100°C. Some writers consider many of the engineering plastics to be high-performance plastics and the distinction is blurred. Others have limited the term to specialty thermoplastics (generally high-priced) such as polyimide, polytetrafluoroethylene, polyphenylene oxide, and sulfide, liquid-crystal polymers, ultra-high molecular-weight polyethylene, etc.

*See also advanced resin.*

**High-performance polyethylene fiber** *n.* A strong, stiff fiber made from ultra-high-molecular-weight polyethylene by gel-spinning and drawing to a highly oriented state. Produced in the USA by Allied-Signal as Spectra® fiber.

**High pH finish** *n.* A finish, basic in nature rather than acid or neutral, that is applied to yarn or fiber.

**High polymer** (1942) *n.* A polymer with molecules of high molecular weight, sometimes arbitrarily designated as greater than 10,000. All materials commonly regarded as plastics are high polymers, but not all high polymers are plastics.

*See polymer.*

**High-pressure laminate** *n.* A laminate molded and cured at pressures not lower than 6.895 MPa (1000 psi), and more commonly in the range of 8–14 MPa.

*See also decorative board and laminate.*

**High-pressure molding** *n.* A method of molding or laminating in which the pressure used is greater than 1.4 MPa (200 psi) (ASTM D 883).

**High-pressure powder molding** *n.* Some polymers in powder form can be molded by high-pressure compaction at room temperature followed by heating to complete sintering, curing or polymerization reactions. The process is limited to fairly simple shapes, and to polymers that do not release vapors when heated. It has been most successful with semi-crystalline polymers that can be post-heated for a sufficient time at a temperature within the crystalline endotherm of the polymer. Examples of such polymers are polyphenylene oxide, polytetrafluoroethylene, and ultra-high-molecular-weight polyethylene. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**High-pressure spot** *n.* A defect in reinforced plastics: an area containing very little resin, usually due to an excess of reinforcing material.

**High-shrink staple** *n.* Staple with a higher degree of potential shrinkage than regular staple of the same generic fiber. When blended with regular staple and treated (in yarn or fabric form) to induce shrinkage, it produces a high degree of bulk in the product.

**High-temperature dyeing** *See dyeing.*

**High-temperature plasticizer** *n.* Any plasticizer that imparts higher than the normal resistance to high temperatures to plastics compounds in which it is incorporated. An example is di-tridecyl phthalate, which permits vinyl compounds to be used at temperatures up to 136°C.

**High tenacity** *n.* A term to describe a material with a higher than normal tensile strength.

*Also see tenacity.*

**High-visibility paints** *n.* Generally applied to paints containing fluorescent pigments or to paints having high reflectivity because of the use of retroreflective pigments in them. *See fluorescent pigments and retroreflective.*

**High-visibility pigments** *See fluorescent dyes.*

**Hindered isocyanate** \-ˌī-sō-ˈsī-ə-ˈnāt\ *n. See isocyanate generator.*

**HIPS** *n.* Abbreviation for high-impact polystyrene.

**Hiroe** Grade of pale East India resin exported from Macassar.

**Hitch-back** *See sticker* (1).

**HLB value** *See hydrophile–lipophile balance value.*

**HMT** *n.* Abbreviation for hexamethylenetetramine.

**HMWPE** *n.* Abbreviation for high-molecular-weight polyethy-lene.

*See polyethylene.*

**Hob** \ˈhäb\ [ME *hobbe*, fr. *Hobbe*, nickname for Robert] *n.* A master model of hardened steel that is pressed into a block of softer metal to form a number of identical mold cavities. The hobbed cavities are inserted into recesses in a steel mold base and are connected by a runner system. (2, *v*) To form a mold cavity by forcing a hardened steel *hob*, having the inverse shape of the cavity into a soft metal block (that may subsequently be hardened).

**Hold-down groove** *n.* A small groove cut into the side wall of a mold to assist in retaining the molding in the mold as it opens.

**Hold out** (1585) *v.* Ability (or property) to prevent soaking into the substrate.

**Hold paint** *n.* Marine paint for holds of ships.

**Hole** \ˈhōl\ [ME, fr. OE *hol* (fr. neuter of *hol*, adj, hollow) & *holh*; akin to OHGr *hol*, adj, hollow; perhaps akin to OE *helan* to conceal] (before 12c) *n.* The absence of an electron in a semiconductor.

**Holes (Tow)** *n.* In tow opening processes, partial or complete filament breakage within a confined spread of tow, usually circular or oval in shape. Not to be confused with splitting or partial crimp deregistration, which are linear.

**Holiday detector** *n.* Device for detection of pinholes or voids.

**Holidays** Application defect whereby small areas are left uncoated. Syn: misses, skips, voids, discontinuities, and vacations.

**Holland** \ˈhä-lənd\ {*often capitalized*} [ME *holand*, fr. *Holand*, county in the

Netherlands, fr. MD *Holland*] (14 c) *n. See shade cloth.*

**Holland finish** *n.* A glazed or unglazed finish containing oil and a filling material. The finish is applied to cotton fabrics to make them opaque or semi-opaque. The resultant fabric resembles a beetled linen fabric called Holland fabric.

**Hollow filament fibers** *n.* Manufactured, continuous filament fibers, having voids created by introduction of air or other gas in the polymer solution or by melt spinning through specially designed spinnerets.

**Holomicroscopy** \-mī-ˈkräs-kə-pē\ *n.* A three-dimensional photomicrographic process utilizing laser beams and time-differential interferometry to study miscroscopic particles in three dimension. This technology has potential for studying crystalline structures in polymeric materials. Loveland RP (1981) Photomicrograsphy. Krieger Publishing Co., New York. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Homespun** \-ˌspən\ (1591) *adj.* Coarse plain-weave fabric of uneven yarns that have a handspun appearance.

**Homochain polymers** *n.* A polymer containing only one type of atom in the polymer chain.

**Homogeneous** \-ˌjē-nē-əs\ [ML *homogeneus*, *homogenus*, fr. Gk *homogenēs*, fr. *hom-* + *genos* kind] (1641) *adj.* Composed of a single phase.

**Homogeneous polymerization** *n.* Polymerization in which a homopolymer is fanned.

**Homogenizer** \hō-ˈmä-jə-ˌnīz-ər\ (1886) *n.* A machine used to break up agglomerates and disperse elemental particles in fluids, consisting of a positive-displacement pump capable of attaining very high pressure, an orifice through which the material is forced at high velocity, and an impact ring on which the stream impinges, Homogenizers are used in the preparation of monomer emulsions and coating compounds, and for dispersing pigments and plasticizers into resin. The term is not restricted to one type of machine, and is used to describe agitators and masticators as well as high-speed rotor-stator type precision machines with close clearances. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

*See also colloid mill.*

**Homologous series** \hō-ˈmä-lə-gəs\ *n.* A family of organic compounds that have identical functionality with each succeeding member having one more $-CH_2-$ group in its molecule than the preceding member. An example is the series *methanol* ($CH_3OH$), *ethanol* ($CH_3CH_2OH$), *propanol* ($C_3H_7{-}OH$), *butanol* ($C_4H_9OH$), etc. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Homologous temperature** *n.* The ratio of the absolute temperature of a material sample to the absolute temperature at which the material melts.

**Homonuclear** \ˌhō-mə-ˈnü-klē-ər\ (1930) *adj.* Possessing nuclei of atoms of the same element.

**Homopolymer** (1946) *n.* High polymers consisting of molecules that contain (neglecting the ends, branch junctions, and other minor irregularities) either a single type of unit or two or more chemically different types in regular sequence. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See copolymer and polymer.*

**Homopolymerization** *n.* A polymer consisting of a single species of monomer, as polyadenylic acid or polyglutamic acid. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Honan** \ˈhə-ˌnän\ *n.* A pongee-type fabric of the very best Chinese wild silk. Honan is sometimes woven with blue edges.

**Honeycomb** \ˈhə-nē-ˌkōm\ (before 12c) *n.* Manufactured product consisting of sheet metal or resin-impregnated sheet material (paper, fibrous glass, etc.) that has been formed into a network of open-ended, hexagonal cells, each cell's walls being shared with its immediate neighbors. Honeycombs are used as cores for sandwich constructions.

**Honeycomb cores** *n.* Plastic impregnated woven or non-woven fiber fabric material that serves as a core in sandwich construction.

**Honeycombing** *n.* (1) Checks often visible at the surface that occurs in the interior of a piece of wood, usually along the wood drays. (2) Lack of vertical film integrity; formation of cell structure; voids.

**Hookean elasticity** (ideal elasticity) *n.* Stress–strain behavior in which stress and strain are directly proportional, in accordance with Hooke's law. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Hookean spring** *n.* A concept visualized as a coil spring whose extension is proportional to the applied load, useful by analogy in modeling the viscoelastic behavior of polymers. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Hooke model** *See Hookean spring.*

**Hooke's law** [Robert *Hooke*] (1853) *n.* The observation, by Robert Hooke, that, in a body placed in tension, the fractional increase in length is proportional to the applied load divided by the body's cross-sectional area perpendicular to the load. It was later extended to shear and compressive loading. Thomas Young later contributed the idea of the modulus and formulated Hooke's law as $e = \sigma/E$, where $\sigma$ is the applied stress, $E$ the modulus of elasticity of the material, and $e$ is the relative elongation, i.e., the change in length divided by the original length. Few plastics conform to Hooke's law beyond deformations greater than 1 or 2%. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Hook reed** *See reed.*

**Hoop stress** *c.* The circumferential stress in a cylindrical body, such as a pipe, that is subjected to internal (or external) pressure. Hoop stress ($\sigma$) is given as $\sigma = PD/2t$, where $P$ is the pressure, $D$ the mean diameter of the cylinder $(D_o + D_i)/2$, and $t$ is the wall thickness $= (D_o - D_i)/2$. In pipes under internal pressure, the hoop stress is twice the lengthwise stress, so dominates the processes of creep and failure. Hoop stress is an often used term when designing and testing plastic pipe and vessels. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York. Chung DD (1994) Carbon fiber compositers. Elsevier Science and Technology Books, New York.

**Hopper** \ˈhä-pər\ (13c) *n.* In extrusion injection molding, the bin mounted over the feed opening that holds a supply of molding material. The hopper may be intermittently filled or continuously fed (*See hopper loader*). Feeding from the hopper is ordinarily by gravity, but it may be aided by vibrators, stirrers, or screw feeders. In some setups the hopper feeds into a metering device such as a gravimetric feeder or vibratory feeder that meters the rate at which the feedstock enters the extruder or molder.

**Hopper dryer** *n.* A hopper through which hot air flows upward, drying and heating the feedstock. To improve extraction of moisture from the plastic the air may be passed through a desiccant prior to entering the hopper. The attendant preheating also reduces the amount of power the extruder must furnish per unit mass of material fed and can significantly increase the extruder output. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Hopper loader** (hopper filler) *n.* A device for automatically feeding molding powders to hoppers of extruders and injection molders, and maintaining the level of feedstock in the hopper. The functions of drying and blending color concentrates with the feedstock are also sometimes accomplished by loaders. There are two general types: mechanical and pneumatic. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Hopsacking** \ˈhäp-ˌsak-\ [ME *hopsak* sack for hops, fr. *hoppe hop* + *sak* sack] (1888) *n.* A coarse, open, basket-weave fabric that gets its name from the plain-weave fabric of jute or hemp used for sacking in which hops are gathered.

**Horizontal line** *See ring.*

**Hot air shrinkage** *n.* Generally, the reduction in the dimensions of a fabric, yarn, or fiber induced by exposure to dry heat. Specifically, a fundamental property of fibers.

**Hotbench test** *n.* A method of determining gelation properties of plastisols, employing a bar or plate whose temperature rises from one side to the other ("temperature-gradient plate"). The sample is spread on the bar and from the positions at which various changes occur in its state, the temperatures of those changes may be estimated.

**Hot-gas welding** *n.* A welding process for plastics analogous to that used for metals, except that a stream of hot gas is used instead of a flame. Welding guns for plastics consist of a blower behind a heating element, much like a hair drier, and a nozzle that focuses the stream at the weld zone. Either air, or, better, dry nitrogen is used. The heated gas is directed at the joint that has been prepared for welding, while a rod of the plastic being welded is applied to the heated zone and melted into the groove.

**Hot head press** *n.* A pressing machine capable of generating high temperatures and pressures. Used for pressing and processing permanent-press fabrics.

**Hot-leaf stamping** *See hot stamping.*

**Hot-manifold mold** *n.* An injection mold equipped with an internal heater located in the center of the melt stream in the manifold and nozzle system. This type of mold was developed for thermally sensitive resins to provide gentler heating and avoid the decomposition problems experienced with external heating techniques because of excessive temperature differences.

**Hot-melt** \ˈhät-ˌmelt\ (1939) *n.* A fast-drying non-volatile adhesive applied hot in the molten state. Skeist I (ed) (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Hot-melt adhesive** *n.* A thermoplastic adhesive applied to the surfaces to be joined in the molten state, then allowed to cool, usually under pressure. They are convenient, require no drying, and leave no voids in the joint. But they can creep and generally have lower strength than standard adhesives. ASTM has developed a number of tests for hot-melt adhesives, most of them in section 15.06 of the Annual Book of Standards. Skeist I (ed) (1990, 1977, 1962) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Hotmelt coatings** *n.* Compositions, which liquify readily on heating and are applied to various surfaces in molten condition.

**Hot oil expression** *n.* Method of obtaining vegetable oils from seeds by subjecting the oil-bearing seeds to pressure in a suitable press. To facilitate expression of the oil and/or to increase the yield, the seeds are carefully and uniformly preheated before expression. Oils obtained from this process are known as hot-expressed oils.

**Hot-plate welding** (hot-tool welding) *n.* Two plastic surfaces to be joined are first held lightly against a heated metal surface, which may be coated with polytetrafluoroethylene to prevent sticking, until the surface layers have melted. The surfaces are then quickly joined and held under light pressure until the joint has cooled.

*See also thermoband welding and welding.*

**Hot-pressing** *n.* The pressure-forming, between heated platens, of plywood, laminates, particleboard, fiberboard, etc.; usually requires thermosetting resins and heat for curing.

**Hot-runner mold** (insulated-runner mold) *n.* An injection mold for thermoplastics in which the runners and sometimes the secondary sprues are insulated from the chilled cavity plate so that they remain hot during the entire cycle. The plastic in the runners remains molten and is not ejected with the molded part, thus avoiding the normal handling, grinding, and reprocessing of sprues and runners.

**Hot-setting adhesive** *See adhesive, hot-setting.*

**Hot-short** *adj.* Inelastic, not stretchable, and easily broken in tension when hot.

**Hot spray** *n.* Process in which paint is heated prior to spraying to reduce viscosity so that higher solids may be applied.

**Hot spraying** *n.* Spraying of hot lacquers or paints, the viscosities of which have been reduced to spraying consistency by means of heat instead of by the addition of volatile solvents. By such a process it is possible to apply materials with higher solid contents and therefore better build.

**Hot stage** *n.* A microscope stage equipped with heating and cooling at controllable rates, enabling one to observe changes in morphology with temperature, such as spherulite growth in polymers as they are cooled from the melt.

**Hot stamping** (roll-leaf stamping, gold-leaf stamping) *n.* A method of marking plastics in which a special pigmented, dyed, or metallized foil is pressed against the plastic article by a heated die, welding selected areas of the foil to the article. The term also includes a process of impressing inked type into the material when the type is heated.

**Hot surface** *n.* (1) An alkaline surface such as plaster, concrete, etc. (2) An abnormally absorbent surface (British).

**Hot-tack strength** *n.* In heat sealing, the strength of the seal just at the end of the dwell when the die halves part (clearly more a concept than a measurable property).

**Hot-tip-gate molding** *n.* An injection-molding technique used for thin, large-area articles molded in a single cavity. In conventional molding, a sprue connects the machine nozzle with runners leading to each gated cavity. In hot-tip-gate molding, the sprue is eliminated and material is injected directly from the nozzle through a heated bushing that serves as the sprue and gate for the individual cavity. Advantages are faster molding cycles, less material waste and reprocessing, fewer post-molding operations, and reduced sink marks and flow lines. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Hot wire cutter** *n.* A process for splitting some types of plastic foam blocks into smaller pieces whereas heated wires slowly melt through the block as they are fed into the wires by gravity or conveyor belt.

**Houndstooth** \ˈhaún(d)z-ˌtüth-\ (1937) *n.* A term describing a medium-sized broken-check effect; the check is actually a four pointed star.

**Housekeeping** \ˈhaús-ˌkēp-piŋ\ (1550) *n.* Cleanliness, neatness, and orderliness of an area, with the designation of a proper place for everything and everything in its proper place.

**House paint** *n.* Coating designed for use on large exterior surfaces of a building; generally of lower gloss than the coating used on trim areas. Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc. New York. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**HT-1** A type of nylon made from phenylenediamine and iosphthalic or terephthalic acid, with good high-temperature properties. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Lancaster, PA.

**Hubl solution** *n.* Reagent used for the determination of Hubl iodine values, involving iodine and mercuric chloride.

**Huckaback** \ˈhə-kə-ˌbak\ (1690) *n.* A heavy, serviceable toweling made with slackly twisted filling yarns to aid absorption. The cloth has a honeycomb effect. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Hue** \ˈhyü\ [ME *hewe*, fr. OE *hīw*; akin to ON *hȳ* plant down, Gothic *hiwi* form] (before 12c) *n.* The specific quality distinguishing one color from other, such as yellow, red, or blue (color, character, and dominant wavelength) Blue, green, red, etc. White, black, and grays possess no hue.

**Hue, Munsell** *See Munsell hue.*

**Huemann's blue** *n.* Synthetic ultramarine blue.

*See ultramarine blue.*

**Huggins constant** ($k'$) *n.* The slope coefficient of the Huggins equation found to be constant for a series of homologous polymers of different molecular weights dissolved in a particular solvent. Huggins ML (1958) Physical chemistry of high polymers. John Wiley and Sons Inc., New York.

**Huggins equation** *n.* In dilute polymer solutions $\eta_{sp}/c = [\eta] + k'[\eta]^2 c$, where $\eta_{sp}$ and $[\eta]$ are the specific and intrinsic viscosities, $c$ the concentration in g/dL, and $k'$ the Huggins constant; one of several equations (Schulz, Blasche, Huggins, and Kraemer) to extracted values $c \rightarrow 0$ or infinite dilution of solute. By making viscosity measurements at several concentrations, plotting $\eta_{sp}/c$ versus $c$, and extrapolating the line obtained to $c = 0$, the intrinsic viscosity can be evaluated. Then $k'$ = the slope of the line divided by $[\eta]^2$. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Huggins ML (1958) Physical chemistry of high polymers. John Wiley and Sons Inc., New York. *See also dilute-solution viscosity, Staudinger index, and Mark–Houwink equation.*

**Hull paint** *n.* Ships' hull paint, bottom paint.

**Humectant** \hyü-ˈmek-tənt\ [L *humectant-*, *humectans*, pp of *humectare* to moisten, fr. *humectus* moist, fr. *humēre* to be moist] (ca. 1857) *n.* A substance, e.g., sorbitol that promotes retention of moisture. Humectants have been used in antistatic coatings for plastics. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004. Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York.

**Humidity** \hyü-ˈmi-də-tē\ (15c) *n.* (1) The amount of a volatile compound, normally a liquid at the prevailing ambient conditions, present as its vapor in a gas. (2) Specifically, the amount of water vapor present in air, with absolute humidity expressed as the mass of water per unit mass of dry air.

*See relative humidity.*

**Humidity, absolute** (1867) *n.* Mass of water vapor present in unit volume of the atmosphere, usually measured as grams per cubic meter. It may also be expressed in terms of the actual pressure of the water vapor present.

**Humidity blush** *See blushing.*

**Humidity ratio** *n.* In a mixture of water vapor and air, the weight of water vapor per unit weight of dry air.

*Also called specific humidity.*

**Humidity, relative** (1820) *n.* The ratio of the pressure of water vapor present to the pressure of saturated water vapor at the same temperature. The ratio is generally expressed as a percentage or as a decimal fraction.

**Humidity, specific** *See humidity ratio.*

**Hund's rule** The rule which states that two electrons tend to remain unpaired and in separate orbitals of the same energy, rather than paired in the same orbital.

**Hungary blue** \ˈhəŋ-g(ə-)rē\ *n. See cobalt blue.*

**Hungry surface** *n.* Surface, the absorptive powers of which have not been fully satisfied by the coats of paint applied to it, usually resulting in a patchy film.

*Also known as starved surface.*

**Hunter color difference equation** *n.* Generally refers to the color difference equation used for calculating color differences on certain color difference meters (especially those made by Hunter Labs and Gardner Instruments, VA, USA). It is a simplified equation to approximate the NBS equation:

$$\Delta E = [(\Delta a_{\mathrm{L}})^2 + (\Delta b_{\mathrm{L}})^2 + (\Delta L)^2]^{1/2}, \quad (1)$$

where $L = 10Y^{1/2}$, $a_{\mathrm{L}} = 17.5\,(1.02X - Y)/Y^{1/2}$, $b_{\mathrm{L}} = 7.0\ (Y - 0.847Z)/Y^{1/2}$, and the deltas are obtained as the difference of the sample minus the standard. Positive $a$ or $\Delta a$ indicates redness, negative indicates greenness; plus $b$ or $\Delta$ indicates yellowness, minus indicates blueness. Other instruments may use the following version:

$$\Delta E = [(\Delta a_{\mathrm{R}})^2 + (\Delta b_{\mathrm{R}})^2 + (\Delta R)^2]^{1/2}, \quad (2)$$

where $R = Y$, $a_{\mathrm{R}} = 2.75 f_y\ (1.02X - Y)$, $b_{\mathrm{R}} = 0.70 f_y\ (Y - 0.847Z)$, and $f_y = 0.50\ (21 + 0.2Y)/(1 + 0.2Y)$. The particular equation used must be specified. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Huygens' theory of light** \ˈhī-gənz-\ *n* This theory states that light is a disturbance traveling through some medium such as the ether. Thus light is due to wave motion in ether. Every vibrating point on the wave-front is regarded as the center of a new disturbance. These secondary disturbances traveling with equal velocity, are enveloped by a surface identical in its properties with the surface from which the secondary disturbances start and this surface forms the new wave-front. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Hybrid composite** \ˈhī-brəd\ *n.* Advanced composite with a combination of different high-strength continuous filaments in the matrix. Also, composite in which continuous and staple fibers are used in the same matrix.

**Hybrid fabric** *n.* Fabric for composite manufacture in which two or more different yarns are used in the fabric construction. This provides design flexibility to meet performance requirements and controls cost by permitting some lower priced fibers to be used.

**Hybrid orbital** *n.* An atomic orbital formed by combining or mixing two or more ground-state atomic orbitals.

**Hybrid yarn** *n.* In aerospace textiles, a yarn having more than one component.
*Also see commingled yarn.*

**Hydantoin epoxy resin** *See epoxy resin.*

**Hydrate** \ˈhī-ˌdrāt\ (1802) *n.* Compound in which molecules of water, as such, are present. Many crystalline salts contain what is described as water of crystallization. Each molecule of salt is associated with one or more molecules of water. These salts are known as hydrated salts.

**Hydrated alumina** \-əˈlü-mə-nə\ *n.* Syn: alumina trihydrate.

**Hydrated aluminum silicate** *See aluminum silicate* (*clay*).

**Hydrated chromium oxide** *n.* $Cr_2O_3{\cdot}2H_2O$. Pigment Green 18 (77289). Permanent green pigment with excellent lightfastness but lower temperature resistance than chromium oxide and less tinting strength. Density, 2.9–3.7 g/cm$^3$ (24.2–30.8 lb/gal); O.A., 110. Syn: Guignet's green, permanent green, viridian, vert emeraude (transparent), French veronese green, emerald oxide of chromium, Mittler's green, native green, Pelletier's green, emerald green, and smeraldino.

**Hydrated lime** *See calcium hydroxide.*

**Hydrated magnesium aluminum silicate** *n.* $3MgO{\cdot}1.5Al_2O_3{\cdot}8SiO_2{\cdot}9H_2O$. Natural adsorptive clay with a primary constituent of attapulgite clay, which has rodlike particle shape. Density, 2.36 g/cm$^3$ (19.7 lb/gal); O.A., 80–190, particle size, 0.13 μm. Syn: fuller's earth, attapulgite, and palygorskite.

**Hydration** \hī-ˈdrā-shən\ (1850) *n.* The addition of water to another substance. The water may react with the other material, as in the hydration of lime; may be taken up in a mixed chemical/physical affinity (absorption), as in 6/6 nylon and numerous other plastics, in time reaching an equilibrium value for the prevailing conditions; or may simply be drawn into pores of the material by capillary action (wetting).
*See, too, solvation.*

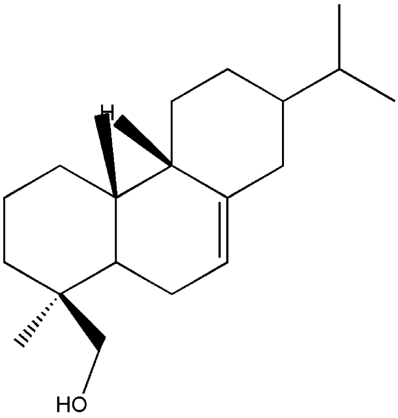
**Hydraulic entanglement** *See hydroentangling.*

**Hydraulic spraying** *n.* Spraying by hydraulic pressure.
*See airless spraying.*

**Hydric** \ˈhī-drik\ (1926) *adj.* Containing or relating to, hydrogen in combination.

**Hydride** \ˈhī-ˌdrīd\ (1869) *n.* A compound containing hydrogen in the −1 oxidation state.

**Hydroabietyl alcohol** Obtained by hydrogenation of Abietic acid (a triple-ring, aromatic acid extracted from rosin) and used as a plasticizer for PVC and some cellulosic resins.



**Hydroblasting** *n.* Cleaning with high-pressure water jet.

**Hydrocarbon** \ˈhī-drō-ˌkär-bən\ (1826) *n.* An organic compound (as acetylene or butane) containing only carbon and hydrogen and often occurring in petroleum, natural gas, coal, and bitumens.

**Hydrocarbon plastics** *n.* Plastics based on resins composed of hydrogen and carbon alone. *Note*—Oxygen and other elements may be present as impurities in the resins, less than 1% by wt.

**Hydrocarbon resins** *n.* Polymers consisting solely of hydrogen and carbon, specifically denoting, within the trade, those resins which are hard and friable, which give good adhesive strength, and lack the cohesive strength typical of elastomeric polymers.

**Hydroentangling** *n.* Process for forming a fabric by mechanically wrapping and knotting fibers in a web through the use of high-velocity jets or curtains of water. *Also see spunlaces fabric.*

**Hydroextractor** *See centrifuge.*

**Hydrogel** *n.* A three-dimensional network of a hydrophilic polymer, generally covalently or ionically cross-linked. The most widely used example is poly(hydroxyethyl methacrylate), especially in medical applications such as implants, blood bags, and syringes.

**Hydrogenated methyl abietate** *n.* $C_{19}H_{31}COOCH_3$. A derivative of Abietic acid, which is extracted from pine rosin, used as a plasticizer for cellulose nitrate, ethyl cellulose, acrylic and vinyl resins, and polystyrene.

**Hydrogenated naphthalenes** *n.* Two commercial solvents are included in this description, namely tetrahydronaphthalene and decahydronaphthalene. The former is a partly hydrogenated naphthalene, whereas the latter is completely hydrogenated.

**Hydrogenated naphthas** *n.* Series of solvents obtained by subjecting the sulfur dioxide extracts of petroleum to hydrogenation.

**Hydrogenated rosin** *n.* Modified rosin obtained by the hydrogenation of rosin at high pressures in the presence of a catalyst.

**Hydrogenated rubber** *n.* Rubber reacted in solution under pressure, in the presence of a suitable catalyst, to yield hydrogenated rubber, in which the unsaturation of natural rubber has been substantially satisfied.

**Hydrogenation** \hī-ˌdrä-jə-ˈnə-shən\ (1809) *n.* The process of passing hydrogen into an unsaturated chemical in the presence of a catalyst to convert the material to a more saturated state (i.e., containing more combined hydrogen).

**Hydrogenation of oils** *n.* Method of treatment employed to convert unsaturated fatty acids or oils into saturated types.

**Hydrogen bonds** (1923) *n.* A very strong attraction between a hydrogen atom, which is attached to an electronegative atom, and an electronegative atom which is usually on another molecule. Jeffrey GA (1997) An introduction to hydrogen bonds. Oxford University Press, New York. Pauk A (2001) Orbital interaction theory of organic chemistry, 2nd edn. Wiley Interscience, New York.

**Hydrogen bromide** (1885) *n.* HBr. A colorless irritating gas that fumes in moist air and yields hydrobromic acid when dissolved in water.

**Hydrogen chloride** (1869) *n.* HCl. A colorless pungent poisonous gas that fumes in moist air and yields hydrochloric acid when dissolved in water.

**Hydrogen cyanide** (1882) *n.* A poisonous usually gaseous compound HCN that has the odor of bitter almonds.

**Hydrogen equivalent** *n.* The number of replaceable hydrogen atoms in one molecule of a substance, or the number of atoms of hydrogen with which one molecule could react.

**Hydrogen fluoride** (1885) *n.* A colorless corrosive gaseous compound HF that yields hydrofluoric acid when dissolved in water.

**Hydrogen iodide** (1885) *n.* An acrid colorless gas HI that fumes in moist air and yields hydriodic acid when dissolved in water.

**Hydrogen ion** (1896) *n.* The cation $H^+$ of acids consisting of a hydrogen atom whose electron has been transferred to the anion of the acid.

**Hydrogen ion concentration (pH)** *n.* The concentration of hydrogen ions in solution when the concentration is expressed as gram-ionic weights per liter. A convenient form of expressing hydrogen ion concentration is in terms of the negative logarithm of this concentration. The negative logarithm of the hydrogen ion concentration is called pH. The significance of pH is still in dispute. Water at 25°C has a concentration of H ion of $10^{-7}$ and of OH ion of $10^{-7}$ mol/l. Thus, the pH of water is 7 at 24°C. A greater accuracy is obtained if one substitutes the thermodynamic activity of the union for its concentration.

*See pH.*

**Hydrogen plastics** *n.* (1) Plastics based on polymers made from monomers containing only carbon and hydrogen. (2) In the plastics industry, hydrocarbon resins are considered to be those thermoplastic resins of low molecular weight made from relatively impure monomers that are derived from coal-tar fractions, cracked-petroleum distillates, and turpentine. The family includes coumarone–indene resins, cyclopentadiene resins, petroleum resins, terpene resins, and many others of little commercial importance. Having little strength, most hydrocarbon resins are rarely used alone. Their primary applications are as binders in asphalt flooring, processing aids in elastomers and polyolefins, and coating additives. Ash M, Ash I (1982–1988) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York.

**Hydrogen peroxide** (1872) *n.* $H_2O_2$. An unstable compound used as an oxidizing and bleaching agent.

$$HO{-}OH$$

**Hydrogen value** *n.* Method of determining hydrogen absorption for unsaturated oils or similar compounds. Hydrogen is reacted with unsaturated oils, and iodine values are calculated from the amount of hydrogen absorbed.

**Hydrolysis** \hī-ˈdrä-lə-səs\ [NL] (1880) *n.* Disruptive reaction consisting of splitting a compound into two parts, one of which combines with the H ion of water and the other combines with the OH ion of water. For example, when vegetable oils or fats are split, the esters are broken down into an avid component and an alcohol component, by taking unto themselves the H and OH ions of water. When alkaline reagents are present, the acids do not appear as such at the end of the reaction, but as the corresponding alkali metal salts. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Hydrolysis (hydrolytic) constant, $K_h$** *n.* The equilibrium constant for a hydrolysis equilibrium.

**Hydrolytic degradation** *n.* Any breakdown of a plastic in which reaction with water or water vapor (steam) plays a role.

**Hydrometer** \hī-ˈdrä-mə-tər\ (1675) *n.* An instrument that senses and indicates the density of a liquid in order to measure the specific gravity of a liquid or solution. A simple type consists of a glass tube with a bulb at its bottom, fine lead shot in the bulb, and a graduated scale within the tube. The amount of shot is adjusted before the top of the tube is sealed so that, when the hydrometer is floated in a liquid of density within its calibrated range, the scale reads the density of the liquids at the meniscus.

**Hydronium ion** \hī-ˈdrō-nē-əm ˈī-ən\ *n.* The hydrated hydrogen ion; represented by $H_3O^+$. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

*Also known as the oxonium ion.*

**Hydroperoxides** \hī-ˈdrō-pə-ˈräk-ˌsīd\ (1937) *n.* Compounds of the type R–O–OH, where R is an alkyl group. Useful as free radial initiators for free radical polymerization. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Hydrophile** *See emulsoid.*

**Hydrophile–lipophile balance (HLB) value** *n.* An empirical value (arbitrary units of 0–20) which is based on the premise that all surfactants combine hydrophilic and lipophilic groups in one molecule and that the proportion between the weight percentages of these two groups for non-ionic surfactants is an indication of the behavior that may be expected from the product. McCutcheon's Emulsifiers and Detergenst (2000) North American Edition, vol 1. McCutcheon Division of McCutcheon Publishing Co., NJ. Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York.

**Hydrophilic** \ˌhī-drə-ˈfi-lik\ [NL *hydrophilus*, fr. Gk *hydr-* + *-philos* –philous] (1916) *adj.* (1) A "water-loving", i.e., material having an affinity for, and readily wetted by water. (2) In lithography, referring to that property of a substance that makes it more receptive to water and fountain solutions than to oils and inks. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

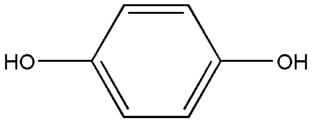
**Hydrophobic** (Chemistry) \-ˈfō-bik\ (1807) *adj.* A substance, which does not absorb or exhibit affinity for water; non-wettable. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Hydrophobic** (Lithography) *n.* Hydrophobic refers to that property of a substance that makes it more receptive to oils and inks than to water and fountain solutions.

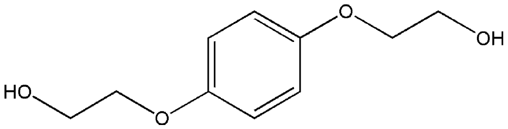
*Also called lipophilic.*

**Hydroquinone** \-kwi-ˈnōn\ [ISV] (ca. 1872) (*p*-dihydroxybenzene, hydroquinol, *p*-hydroxyphenol, qui-nol) *n.* $C_6H_4(OH)_2$. A white crystalline material derived from aniline, used, as are many of its derivatives, as an inhibitor of free-radical polymerization in unsaturated polyester resins and in monomers such as vinyl acetate.

Hydroquinone is almost colorless and can retain its inhibitory action even in the presence of oxygen. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.
(*See image*).



**Hydroquinone di($\beta$-Hydroxyethyl) ether (HQEE)** *n.* A white solid material used as a reactant in the preparation of polyesters, polyolefins, and polyurethanes. As a chain extender in urethane prepolymers, HQEE increases to 150°C the high-temperature resistance of parts molded from the prepolymer.



**Hydroscopic** *adj.* Having the ability to absorb moisture from the atmosphere. All fibers have this property in varying degrees. Complete textile glossary. Celanese Acetate LLC, New York, 2000. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Hydrosol** \ˈhī-drə-ˌsäl\ [*hydr-* + *sol* (fr. *solution*] (1864) *n.* (1) In physical chemistry, a colloidal suspension in water. (2) In the plastics industry, a suspension of resin such as PVC or nylon in water, not necessarily of colloidal nature.
*See also latex.*

**Hydrostatic** \-ˈsta-tik\ [prob. fr. NL *hydrostaticus*, fr. *hydra-* + *staticus* static] (1666) *adj.* Of or relating to fluids at rest or to the pressures they exert or transmit.

**Hydrostatic design basis (HDB)** *n.* One of a series of $10^5$-h or 50-year strength values and forming the basis for choosing the wall thickness of pipe for various diameters and service pressures and temperatures (American Society for Testing and Materials, West Conshohocken, PA, www.astm.org).

**Hydrostatic design stress** *n.* The estimated sustained hoop stress that can exist in a pipe at expected service conditions and over the life of the pipe with a high degree of certainty that failure will not occur.
*See preceding entry.*

**Hydrostatic pressure** *n.* At a distance *h* from the surface of a liquid of density *d*,

$$P = hdg.$$

The total force on an area *A* due to hydrostatic pressure,

$$F = PA = Ahdg.$$

Force in dynes and pressure in dynes/$\text{cm}^2$ will be given if *h* is in cm, *d* in g/$\text{cm}^3$ and *g* in cm/$\text{s}^2$. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York.

**Hydrostatic strength** *n.* The hoop, stress calculated from the following equation, at which a pipe fails because of rising internal pressure, usually in about one minute. The equation is: $\sigma = PD_m/2t$, in which $P$ is the internal (gauge) pressure at rupture, $D_m$ the initial mean diameter (=outer diameter - $t$), and $t$ is the initial wall thickness. This strength is usually less than the tensile strength of the pipe material as determined in a standard tensile test because of the presence in the pipe of longitudinal stress equal to half the hoop stress. The pressure at which the failure occurs is known as the *quickburst pressure.* Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York.

**Hydroterpins** *n.* Hydrogenation products derived from turpentine. They differ from the parent material in that they possess greater stability, i.e., less tendency to oxidation, higher boiling ranges, and slower evaporation rates.

**Hydrous** \ˈhī-drəs\ (1826) *adj.* Containing water usually in chemical association (as in hydrates).

**Hydrous alumina** *n.* Syn: alumina trihydrate.

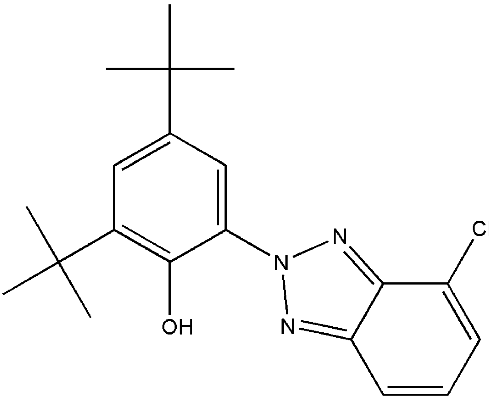
**Hydrous oxides** *n.* Poorly characterized compounds formed from the combination of certain oxides with water or by precipitation from the addition of base to certain ions in aqueous solution.

**Hydrox-, hydroxy-** A chemical prefix denoting the presence of the –OH group in a compound.

**Hydroxide** \hī-ˈdräk-ˌsīd\ [ISV] (1851) *n.* Hydrated metallic oxide; a base; a compound which will give hydroxyl (OH) ions in solution.

**(2-Hydroxpropyl) methyl cellulose** *n.* A mixed ether of cellulose containing both hydropropyl and methyl groups.

**2(2′-Hydroxy-3,5-ditertiarybutylphenyl)-7-chlorobenzotriazol** *n.* An off-white, nontoxic, crystalline powder with high thermal stability, used as an ultraviolet absorber for polyolefins, PVC, polyurethanes, polyamides, and polyesters.

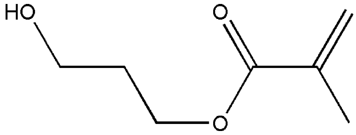


**Hydroxyethyl acetamide** *See N-acetyl ethanolamine.*

**Hydroxyethyl cellulose** *n.* Any of a family of polymeric ethers formed by reacting alkali cellulose with ethylene oxide. Water solubility and applications depend on the degree of substitution of hydroxyenthyl groups for –OH groups, and include textile sizes, adhesives, thickeners, and stabilizers for vinyl polymers.

**Hydroxyethyl cellulose resins** *n.* Prepared by reaction of alkali cellulose with ethylene oxide, which then forms long polyoxyethylene chains by continued reaction with the hydroxyethyl groups.

**Hydroxyethylmethyl methacrylate** *n.* A monomer that polymerizes to a hydrophilic polymer that is rigid when dry but when saturated with water becomes a soft, clear material (Hydron®). Applications include masonry coatings, soft contact lens, and other biomedical devices.



**Hydroxyl** \hī-ˈdräk-səl\ [*hydr-* + *ox-* + *-yl*] (1869) *n.* The chemical group or ion OH that consists of one atom of hydrogen and one of oxygen and is neutral or positively charged.

**Hydroxyl end group** *n.* A polymer chain-terminating (–OH) group.

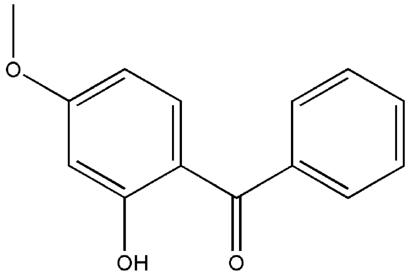
**Hydroxyl group** *n.* –OH. The monovalent group characteristic of hydroxides and alcohols.

**2-Hydroxyl-4-methoxy-5-sulfonbenzophenone** *n.* An ultraviolet absorber for thermoplastics.

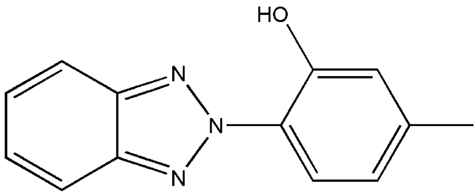
**Hydroxyl value** *n.* A measurement of hydroxyl groups (–OH) in an organic material (American Society for Testing and

Materials, West Conshohocken, PA, www.astm.org). In plasticizers, the hydroxyl value includes –OH groups present in any free unesterified alcohol as well as those of the plasticizer molecule itself. In some plasticizers, large hydroxy values signal that the plasticizer may become incompatible on aging. In urethane technology, hydroxyl number is an important factor in the selection of polyols to achieve desired characteristics in elastomers and foams. Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York.

**2-Hydroxy-4-methoxybenzophenone** *n.* An ultraviolet absorber for numerous thermoplastics.

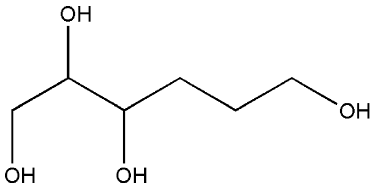


**2(2′-Hydroxy-4′-methylphenyl) benzotriazole** ("Tinuvin P") *n.* A non-toxic crystalline powder with high thermal stability, an ultraviolet absorber for polystyrene, acrylics, PVC, polyesters, and polycarbonates.

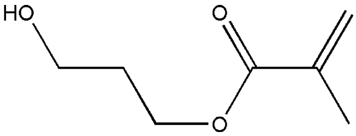


**2-Hydroxy-4-*n*-octoxybenzophenone** *n.* $C_{21}H_{26}O_3$. A pale yellow powder, an ultraviolet absorber for PVC, and several other plastics. It is compatible with highly plasticized vinyls and has a very low order of toxicity.

**Hydroxypropylglycerin** *n.* A pale-straw-colored liquid used as a plasticizer for cellulosic resins and as an intermediate for alkyd and polyester resins.



**Hydroxypropyl methacrylate (HPMA)** *n.* A reactive monomer copolymerizable with a wide variety of acrylic and vinyl monomers, used for thermosetting resins and surface coatings.



**Hygrometer** \hī-ˈgrä-mə-tər\ [prob. fr. F *hygromètre*, fr. *hygr-* + *-mètre* –meter] (1670) *n.* An instrument that senses and indicates the relative humidity (of moisture) in air.

**Hygroscopic** \ˌhī-grə-ˈskä-pik\ [*hygroscope*, an instrument showing changes in humidity + $^1$-*ic*; fr.] (1790) *adj.* Having a strong tendency to absorb moisture from the air. Some resins are hygroscopic, and therefore usually require drying before being extruded or molded.

*See hydroscopic.*

**Hyperon** \ˈhī-pə-ˌrän\ [prob. fr. *hyper-* + $^2$-*on*] (1953) *n.* Any article with mass intermediate between that of the neutron and the deuteron. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

*See meson.*

**Hypogoeic acid** *n.* $C_{15}H_{29}COOH$. Unsaturated fatty acid found in certain vegetable oils. It has a mp of 33°C, and a bp of 236°C/15 mmHg.

**Hypohalous** Compound in which a hydroxyl group is combined with a halogen atom.

**Hysteresis** \ˌhis-tə-ˈrē-səs\ [NL, fr. Gk *hysterēsis* shortcoming, fr. *hysterein* to be late, fall short, fr. *hysteros* later] (1881) *n.* (1) The lagging of the physical effect on a body behind its cause, particularly during repeated cycling. Hysteresis is accompanied by dissipation of energy as heat. If a fatigue specimen is cycled at too high a frequency/or stress, the resulting heat buildup can seriously bias the test and even soften the specimen. (2) The influence of prior history that causes the repetition of a process or its reversal to take a different path from the original. In tensile loading of plastics past the proportional limit but short of failure, the path (stress versus strain) followed upon unloading will generally be at lower stresses than were recorded during loading at the same strains. Open or closed loops may be observed. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Hysteresis loop** *n.* Flow curve for a dilatent (shear thining) material obtained by measurements on a rotational viscometer showing for each value of rate of shear, two values of shearing stress, one for an increasing rate of shear and the other for a decreasing rate of shear. A hysteresis loop characterizes a dilatant material. If no hysteresis loop is obtained, the material is non-dilatant. The area within the loop is a measure of dilatancy (increasing shear thining with increasing shear stress). Dilatancy should not be confused with thixoptropy (shear thining at constant shear stress over time). Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Van Wazer JR, Lyons JW, Kim KY, Colwell RE (1963) Viscosity and flow measurement. Interscience Publishers Inc., New York.

**Hytrel®** *n.* DuPont trade name for a family of copolyester elastomers. Typical reactants from which the elastomers are derived are terephthalic acid, polytetramethylene glycol, and 1,4-butanediol. Powders and pellets are available for extrusion and molding. The products are highly resilient, have good flex-fatigue life at low and high temperatures, and are resistant to oils and chemicals. Some grades termed *segmented copolyesters* are excellent modifiers for PVC, improving processability and imparting resistance to abrasion, impact, and fungi.

**Hz** *n.* SI abbreviation for Hertz. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

# I

**i** \ˈī\ *n.* (1) (also I) Symbol for electric current. (2) Symbol for $\sqrt{-1}$, the coefficient of "imaginary", i.e., out-of-phase, components in complex quantities.

**I** *n.* (1) Chemical symbol for the element iodine. (2) The symbol for electric current. (3) The symbol for moment of inertia. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Iatrochemistry** [Greek *iatros*, "doctor" + chemistry] *n.* Eighteenth-century chemistry was derived from and remained involved with questions of mechanics, light and heat as well as iatrochemistry and notions of medical therapy and the interaction between substances and the formations of new substances. This period was also the time of alchemy (approximately 1550–1750 AD). Iatrochemistry attempted to explain life and physiological processes using the knowledge of physics at that time. From the root word was derived: iatrogenic [Greek *latros "doctor"* + -genic] meaning "caused by a doctor – a symptom or illus brought on untentionally by something that a doctor does or says (www.britannica.com and Microsoft Encarta 2004).

**Iceland moss** \ˈī-slən(d)-, -ˌslan(d)-\ (1805) *n.* Lichen grown in Iceland, Norway and Sweden, which yields a mucilaginous extract, used in sizes and the like. Syn: Cetraria.

**Iceland spar** (1771) *n.* Natural, transparent, double refracting, crystalline form of calcium carbonate. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York.

**Ichnography** *n.* (1) Art of making decorative drawings by the use of compass and rule. (2) The term also refers to the art of tracing plans and illustrations.

**ICI** *n.* (1) Older abbreviation for international commission on illumination (Use international abbreviation CIE).

**Ideal co-polymerization** *n.* A co-polymerization in which, in the simple binary case, the product of the monomer reactivity ratios $r_A$ and $r_B$ for monomers A and B ($r_A$, $r_B$) equals unity. Thus each type of growing center $\sim\sim A^*$ and $\sim\sim B^*$ shows the same preference for adding on or the other monomer during propagation. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ideal elastomer (ideal rubber)** *n.* An elastomer, which on deformation at constant, e.g., by stretching by application of a force *f*, satisfies the conditions

$$(\partial H/\partial l)_{T,P} = 0 \quad \text{and} \quad f = -T(\partial S/\partial l)_{T,P},$$

where $l$ is the length, $T$ the temperature, $P$ the pressure, $S$ the entropy, and $H$ is the enthalpy. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Ideal gas** *n.* A gas whose behavior is described by the ideal-gas law, $PV = nRT$. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Ideal-gas law** *n.* The combination of Charles' and Boyle's laws, usually stated in the form $PV = nRT$, where $P$ is the absolute pressure, $V$ the gas volume, $n$ the number of moles of gas present, $T$ the absolute temperature, and $R$ is the universal molar gas (or energy) constant. $R$ has many numerical values, to be consistent with the units chosen for the variables. In SI, $R = 8.31439\,\text{K/mol K}$. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/ Engineering/Math, New York.

**Ideal liquid** *n.* This term has several meanings in physical chemistry and hydrodynamics. The one relevant to plastics is Newtonian liquid. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Ideal solid** *n.* A material that obeys Hooke's law. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Ideal solution** *n.* Solutions that exhibit no change of internal energy on mixing and complete uniformity of cohesive forces. The behavior of ideal solutions is described by Raoult's law over all ranges of temperature and concentration.

**Ignition** \ig-ˈni-shən\ (1612) *n.* The beginning of burning. Babrauskas V (2003) Ignition handbook. Fie Science Publishers, New York. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/ Engineering/Math, New York.

**Ignition loss** *See ASTM D2584 at flammability.*

**Ignition time** Babrauskas V (2003) Ignition handbook. Fie Science Publishers, New York.

*See flammability.*

**IIR** *n.* Butyl rubber.

**Illuminance** \i-ˈlü-mə-nən(t)s\ (ca. 1938) *n.* The luminous flux incident per unit area of a surface. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Illuminant** \-nənt\ (1644) *n.* Mathematical description of the relative spectral power distribution of a real or imaginary light source, that is, the relative energy emitted by a source at each wavelength in its emission spectrum. Popularly used synonymously with the term "light source" or "lamp". Such usage is not recommended. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Illuminant A (CIE)** *n.* Incandescent illumination, yellow orange in color, with a correlated color temperature of 2856 K. It is defined in the wavelength range of 380–770 nm.

*See correlated color temperature.*

**Illuminant B (CIE)** *n.* An approximation of mean noon sunlight, approximately neutral in hue, with a correlated color temperature of 4874 K. It is defined in the wavelength range of 380–770 nm.

*See correlated color temperature.*

**Illuminant C (CIE)** *n.* An approximation of average daylight, bluish, with a correlated color temperature of 6774 K. It is defined in the wavelength range of 380–770 nm.

*See correlated color temperature.*

**Illuminant D (CIE)** *n.* Daylight illuminants, defined from 300 to 830 nm, the UV portion 300–380 nm being necessary to describe correctly colors which contain fluorescent dyes or pigments. They are designated as D with a subscript to describe the correlated color temperature: $D_{65}$ having a correlated color temperature of 6504 K, close to that of Illuminant C, is the most commonly used. They are based on actual measurements of the spectral distribution of daylight.

**Illuminating** \-ˌnā-tiŋ\ [ME, fr. L *illuminatus*, pp of *illuminare*, fr. *in* + *luminare* to light up, fr. *lumen-*, *lumen* light] (15c) *vt.* Hand decoration of books, as done in medieval times, with drawings and miniature paintings. Also ornamentation and embellishments, usually in red, blue and gold, which were sometimes added to initial letters and borders. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Illumination** \i-ˌlü-mə-ˈnā-shən\ (14c) *n.* The illumination on any surface is measured by the luminous flux incident on unit area. The units in use are: the *lux* (abbreviation lx) 1 lm/m$^2$; the *photo* (abbreviation ph) 1 lm/cm$^2$; the *Foot-candle* (abbreviation fc) 1lm/ft$^2$. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Illumination, diffuse** *n.* Non-specular illumination or non-direct incident light source projected onto the object of observation. Indirect or reflected rays of light are often used as diffuse sources. Also, a scattering lens over a light source will diffuse the rays to reduce specular light.

**Ilmenite** \ˈil-nə-ˌnīt\ [Gr *Ilmenit*, fr. *Ilmen* range, Ural Mts., Russia] (ca. 1827) *n.* FeO·TiO$_2$. Natural iron titanate. It is an iron-black mineral and is one of the main sources of titanium dioxide.

**Ilmenite black** *n.* Opaque black pigment, prepared from the mineral of the same name. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York.

**Image, real** *n.* The image, which would register on a ground glass screen or photographic film placed in that plane. Moller KD (2003) Optics. Springer-Verlag, New York.

**Image, virtual** *n.* This image would appear by construction to be in a given plane, but a ground glass screen or photographic film placed in that plane would show no image. Moller KD (2003) Optics. Springer-Verlag, New York.

**Imbibition** \ˌim-bə-ˈbi-shən\ (15c) *n.* Swelling of a solid, semisolid or gel by absorption of a liquid.

**Imitation gold ink** *n.* A simulated gold ink that uses aluminum powder to produce the metallic luster.

**Immediate elastic deformation** *n.* Recoverable deformation that is essentially independent of time, i.e., occurring in (a time approaching) zero time and recoverable in (a time approaching) zero time after removal of the applied load.

**Immediate set** *n.* The deformation found by measurement immediately after the removal of the load causing the deformation in a short-time test.

**Immersion objective** *n.* A microscope objective that is used with a liquid of refractive index greater than 1.00 between the specimen and objective, and usually between the specimen and substage condenser. Immersion objectives are used when a numerical aperture greater than 1.00 is desired, since this cannot be achieved with a dry objective. Moller KD (2003) Optics. Springer-Verlag, New York.

**Immiscible** \(ˌ)i(m)-ˈmi-sə-bəl\ (1671) *adj.* Not miscible. Any liquid, which will not mix with another liquid, in which case it forms two separate layers or exhibits cloudiness or turbidity. *Compare incompatible.*

**Impact adhesive** *n. See contact adhesive.*

**Impact modifiers** A general term for any additive, usually an elastomer or plastic of different type, incorporated in a plastic compound to improve the impact resistance of finished articles. The improvement is customarily assessed by performance of test specimens in standard tests.

**Impact polystyrene** *n.* An alternative name for high impact polystyrene; usually polystyrene modified with thermoplastic elastomer to provide a tougher material. *See high-impact polystyrene.*

**Impact resistance** *n.* (1) Ability of a coating to resist a sudden blow. Ability to resist deformation from impact. (2) The relative durability of plastics article to fracture under stresses applied at high speeds. A widely used ASTM impact test, www.astm.org, employs the Izod pendulum striker swung from a fixed height to strike a specimen in the form of a notched bar mounted vertically as a cantilever beam. The Charpy tester, an alternative in D 256, uses a specimen in the form of a horizontal beam supported at both ends. ASTM lists some several different impact tests for plastics and plastics products.

*See also brittleness temperature, drop-weight test, free-falling-dart test, and tensile-impact test.*

**Impact strength** *n.* The quantitative measure of the ability of a material to withstand shock loading in a standard test. For plastics the test is usually either the Izod or Charpy test described in ASTM (www.astm.org), and the result is calculated as the energy expended (work done) in breaking a specimen, divided by its width or thickness. Specimens of both tests are usually notched on the wide opposite that where they are struck, though the notch position may be reversed and unnotched specimens may be tested. In SI the convenient reporting unit is J/cm of notch width, or, for unnotched specimens, J/cm. To provide a much simpler stress distribution free of notch effects, researchers, developed the tensile-impact test. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Impact test** *n.* Used to assess the adhesion and flexibility of applied coatings. A weighted plunger is allowed to fall from a specified height onto the front (direct) or back (reverse) of a coated panel. The extent of the damage caused by the impact is used as a basis for assessing the adhesion and flexibility. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Impasto** \im-ˈpas-(ˌ)tō, -ˈpäs-\ [It, fr. *impastare*] (1784) *n.* This term implied a thick application (paste, impasted ) of paint or coloring material. Particularly thick or heavy application of paint. The thinly painted and impasted areas of an oil painting provide texture. Gair A (1996) Artist's manual. Chronicle Books LLC, San Francisco.

**Imperial gallon** *See gallon, imperial.*

**Impingement mixing** *n.* Very intense, rapid and thorough mixing accomplished by causing two fast-moving liquid streams or sprays to meet within a confined space. Typically the streams are resin and curing agent or resin streams containing catalyst in one and accelerator in the other. The technique is used in reaction–injection molding, in spray-up of reinforced plastics, and in foam-in-place molding.

**Impregnated cloth** *n.* A cloth impregnated with resin, varnish shellac, etc.

**Impregnated fabric** *n.* A fabric in which the interstices between the yarns are completely filled, as compared with sized or coated material where the interstices are not completely filled. Not included in the definition is a woven fabric constructed from impregnated yarns, rather than one impregnated after weaving.

**Impregnating insulating varnish** *n.* First coating insulating varnish applied to electrical equipment by means of vacuum–pressure impregnation, or by dipping. Its main purpose is to fill up the voids between the windings and elsewhere. The name distinguishes it from finishing insulating varnishes, which are used primarily to give an effective seal to the outside of windings, to prevent ingress of moisture.

**Impregnation** \im-ˈpreg-ˌnāt, ˈim-ˌ\ [LL *impraegnatus*, pp of *impraegnare*, fr. L *in-* + *praegnas* pregnant] (1605) *vt.* The process of thoroughly soaking a material of an open or porous nature with a resin. When webs or shapes of reinforcing fibers are impregnated with a thermosetting resin in the B stage or with a thermoplastic, and such webs are intended for subsequent shaping or laminating, the masses are called sheet-molding compounds or prepreg. The main difference between impregnation and encapsulation is that in encapsulation an outer protective coating is formed with little or no penetration of the resin into the article, whereas in impregnation there is little or no protective coating.

**Impression** \im-ˈpre-shən\ (14c) *n.* (1) The printing pressure necessary for ink transfer. (2) Also refers to a single print.

**Impression cylinder** *n.* The cylinder on a printing press that holds the material being printed against the printing plate, cylinder, or blanket.

**Impsonite** Naturally occurring asphaltum, found in Oklahoma.

**Impulse sealing** (thermal-impulse sealing) *n.* The process of joining thermoplastic sheets or films by pressing them between elements equipped to provide a pulse of intense heat to the sealing area for a very short time, followed immediately by cooling. The heating element may be a length of thin resistance wire such as nichrome, or a bar heated by a high-frequency electric field and cored for water cooling.
*See also heat sealing.*

**Incandescent** \ˌin-kən-ˈdes-sᵊnt\ [prob fr. F, fr. L *incandescent-*. *incandescens*, pre. part. of *incandescere* to become hot, fr. *in-* + *candescere* to become hot, fr. *candēre* to glow] (1794) *adj.* Luminous in the yellow-to-white range because of being at a high temperature (1250–1550°C).

**Inching** (1599) *v.* A very low rate of mold closing used in many molding operations and often automatically included in the cycle, for the last millimeter or so before the mold faces meet.

**Incident angle** (1628) *n.* The angle between the incident ray and a normal to the surface at the point of incidence. It is the same as "entrance angle" in SAE automotive nomenclature.

**Incident ray** *n.* The center line of the light beam incident upon a surface.

**Inclusion** \in-ˈklü-zhən\ [L *inclusion-*, *inclusio*, fr. *includere*] (1600) *n.* (1) A foreign body or impurity phase in a solid. (2) Presence of foreign material in the finished material.

**Inclusion complex** *See adduct.*

**Incompatibility** \ˌin-kəm-ˌpa-tə-ˈbi-lə-tē\ (1611) *n.* The effect when two or more components of a composition do not blend properly to produce a uniform or homogeneous mixture. It can be characterized by gelatin, curding, precipitation, cloudiness, seediness, and land loss in gloss of blooming oin resulting film.

**Incompatible** \ˌin-kəm-ˈpa-tə-ˈbəl\ [ME, fr. MF & ML; MF. fr. ML incompatibilis, fr. L *in-* + ML *compatibilis* compatible] (15c) *adj.* A term that describes two materials, such as two resins, or a resin and plasticizer, that are incapable of forming a solution of a two-phase blend and that tend to separate after being mixed.

**Incompatible polyblends** *n.* Polymers that do not alloy to form stable compositions.

**Incomplete hiding** *See hiding, incomplete.*

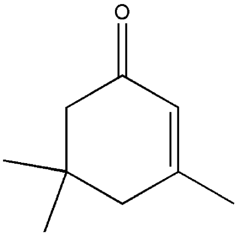
**Indanthrone blue** *n.* A member of a group of vat dye pigments. Relative to phthalocyanine blue, it is considerably redder in hue and superior in bronze resistance; lightfastness is excellent. It shows no tendency toward crystal growth in conventional paint thinners or solvents.

**Indelible ink** \in-ˈde-lə-bəl-\. Compositions, which are made water- and alkali-fast. Used on cloth to withstand laundering.

**Indene** *n.* $C_9H_8$. Colorless liquid with a Sp gr of 1.006 (20/4°C), mp of 3.5°C, bp of 182°C, refractive index of 1.5726, and a flp of 78.3°C. Insoluble in water, soluble in most organic solvents, rapidly absorbs oxygen from the air, forms polymers by exposure to air and sunlight. Derivation: Contained in the fraction of crude coal tar distillates, which boils from 176 to 182°C. Uses: Preparation of synthetic resins.

*See coumarone–indene resins.*

**Indene resins** *n.* A colorless, liquid hydrocarbon, $C_9H_8$, obtained from coal tar by fractional distillation: used in synthesizing resins.



*See coumarone–indene resins.*

**Indentation hardness** *n.* Resistance to penetration by an indenter. The hardness of a material as determined by either the size of an indentation made by an indenting tool under a fixed load, or the load needed to produce penetration of an indenter to a predetermined depth. The instruments commonly used with plastics are the Shore Durometer (indenter A for soft resins and elastomers, D for hard materials) described in ASTM D 2240, and the Barcol Impressor, ASTM D 2583. In D 2240, the authors say, "No simple relationship exists between indentation hardness determined by this method and any fundamental property of the material tested. For specification purposes it is recommended that Test Method D 1415 (Section 09.01) be used for soft materials and method A of D 530 or test D 785 be used for hard materials". D 530 and D 785 use the Rockwell test in which a ball of suitable diameter is pressed into the sample with known force, and the indentation depth is noted. A similar test format is used in D 1415.

*See knoop hardness number and pfund hardness number.*

**Index of metamerism** \-mə-ˈta-mə-ˌri-zəm\. An index to describe the degree of metamerism existing between two samples. There is no standard accepted index. However, a frequently computed index is the color difference, using a specified equation, which exists under a second illuminant when a pair of colors is an exact match under a primary or first illuminant.

**Index of refraction** (1829) (refractive index) *n.* The ratio of the velocity of light in a vacuum to its velocity in the transparent material of interest. It generally varies with the wavelength of the light, being higher at the short wavelengths, also with temperature. When a light beam passes from a less dense medium to a denser medium at an acute angle $\theta_1$ with the interfacial normal, it will be bent closer to the normal in the more dense medium, defining the angle of refraction, $\theta_2$. The index of refraction is given by $\sin\,\theta_1/\sin\theta_2$. This relationship is the basis for measurement of refractive index with an instrument such as the Abbé refractometer (www.astm.org) for transparent plastics). Index of refraction is useful for identification of plastics, as well as minerals and liquids, and is involved in many quantitative analytical methods. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Moller KD (2003) Optics. Springer-Verlag, New York. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The Chemical Rubber Co., Boca Raton, FL.

**India ink** {*often cap 1st* I} (1665) *n.* A liquid ink made of lampblack mixed with a binding material and water.

*Also called Chinese ink.*

**Indian ochre** \-ˈō-kər\. *See iron oxides, natural.*

**Indian red** (ca. 1753) *n.* Natural, Pigment Red 101 (77491). Synthetic Pigment Red 101 (77491). Crystalline copperas (ferrous sulfate in crystal form) is converted by calcinations to ferric oxide, producing a range of light to dark red oxide pigments. The dark shades are known as Indian red. Original Indian reds were a variety of natural red iron oxides obtained from India.

**Indian red ochre** *See iron oxides, natural.*

**Indian yellow** *n.* Purree. A yellow pigment containing the magnesium salt of euxanthic acid.

**India rubber** {*often cap I*} (1790) *n.* *See rubber, natural.*

**Indicator** \ˈin-də-ˌkā-tər\ (1666) *n.* A conjugate acid-base pair in which at least one of the pair is highly colored.

**Indicators** *n.* Substances, which change from one color to another when the hydrogen ion concentration reaches a certain value, different for each indicator.

**Indicatrix** *n.* A three-dimensional construction of the optical relationships in the crystal. Radii proportional in length to refractive index values or velocities may be used to represent principal index directions of the crystal.

**Indicia** \in-ˈdi-sh(ē)ə\ [L, plural of *indicium* sign, fr. *indicare*] (ca. 1626) *n, pl.* Any markings such as symbols, lettering, small pictures, etc., applied to a plastic article to identify it.

**Indigo** \ˈin-di-ˌgō\ [It dialect, fr. L *indicum*, fr. Gk. *indikon*, fr. neuter of *indikos* Indic, fr. *Indos* India] (1555) *n.* $C_{16}H_{10}N_2O_2$ (molecular weight, 262.26). Dark blue, transparent dye produced either by fermentation from the genus, *Indigofera*, indigenous to the Far East, or synthetically.

**Indophenol test** \ˌin-dō-ˈfē-ˌnōl-\ [ISV] *n.* *See Gibbs indophenol test.*

**Induced decomposition reaction** *n.* Chain transfer in a free radical polymerization by reaction of a growing active center with an undissociated initiator molecule, especially with a peroxide.

**Induced electromotive force** *n.* In a circuit is proportional to the rate of change of magnetic flux through the circuit

$$E = \frac{d\phi}{dt},$$

where $d\phi$ is the change of magnetic flux in a time $dt$. The induced current will be given by

$$I = \frac{d\phi}{R\,dt},$$

where $R$ is the resistance of the circuit. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Inductance** \in-ˈdək-tən(t)s\ (1886) *n.* The change in magnetic field due to the variation of a current in a conducting circuit causing an induced counter electromotive force in the circuit itself. The phenomenon is known as *self-induction.* If an electromotive force is induced in a neighboring circuit the term mutual injection is used.

Inductance may thus be distinguished as self- or mutual and is measured by the electromotive force produced in a conductor by unit rate of variation of the current. Units of inductance are the centimeter (absolute electromagnetic) and the Henry, which is equal to $10^9$cm of inductance. The *Henry* is that inductance in which an induced electromotive force of 1 V is produced when the inducing current is changed at the rate of 1 A/s. Thus, 1 H = 1 V/A/s = 1 V s/A = 1 Wb/A. Dimensions: $[E^{-1}L^{-1}T^2]$, $[\mu L]$. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Induction** \-shən\ (14c) *n.* Any change in the intensity or direction of a magnetic field causes an electromotive force in any conductor in the field. The induced electromotive force generates an induced current if the conductor forms a closed circuit. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Induction heating** (1919) *n.* A method of heating electrically conductive materials, usually metallic parts, by placing the part or material is an alternating magnetic field generated by passing an alternating current through a primary coil. The alternating magnetic field induces eddy currents in the piece that generate hysteretic heat. Plastics, being poor conductors, cannot be heated directly by induction, but the process is used indirectly in welding of plastics and has been used to heat extruders and dies. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The Chemical Rubber Co., Boca Raton, FL.

**Induction period** *n.* The time period before a chemical reaction (e.g., polymerization) proceeds that usually includes the production of free radicals or ions; rise in temperature and other reaction conditions before an initiation of polymerization occurs; other necessary periods of time preceding a chemical reaction between one or more chemical species prior to production of a different species. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Induction period (of drying)** *n.* That period prior to set-to-touch in the drying process where there is but a small change in consistency of the binder and the natural inhibitors of the oil are removed by oxidation.

**Induction welding** *n.* A method of welding thermoplastic materials by placing a conductive metal insert between two plastic surfaces to be joined, applying pressure to hold the surfaces together, heating the metallic insert in an alternating magnetic field until the adjacent plastic is softened and welded, then killing the field and cooling the joint.

**Induline** *n.* Range of blue or black dyestuffs belonging to the safranine group. They can be prepared in oil, spirit, and water-soluble forms. They are used as dyes for leather and in lake manufacture.

**Induline bases** *n.* Substances prepared from amidoazobenzene aniline and aniline hydrochloride.

**Industrial fabric** *n.* A broad term for fabrics used for non-apparel and non-decorative uses. They fall into several classes: (1) A broad group including fabrics employed in industrial processes (e.g., filtering, polishing, and absorption). (2) Fabrics combined with other materials to produce a different type of product (e.g., rubberized fabric for hose, belting, and tires; fabric combined with synthetic resins to be used for timing gears and electrical machinery parts; coated or enameled fabrics for automobile tops and book bindings; and fabrics impregnated with adhesive and dielectric compounds for application in the electrical industry). (3) Fabrics incorporated directly in a finished product (e.g., sails, tarpaulins, tents, awnings, and specialty belts for agricultural machinery, airplanes, and conveyors). Fabrics developed for industrial uses cover a wide variety of widths, weights, and constructions and are attained, in many cases, only after painstaking research and experiment. Cotton and manufactured fibers are important fibers in this group, but virtually all textile fibers have industrial uses. The names mechanical fabrics or technical fabrics sometimes have been applied to certain industrial fabrics.

**Industrial finishes or coatings** *n.* Coatings which are applied to factory-made articles (before or after fabrication), usually with the help of special techniques for applying and drying – as opposed to trade sales paints.

*See architectural coatings.*

**Industrial maintenance paints** *n.* High performance coatings, which are formulated for the purpose of heavy abrasion, water immersion, chemical, corrosion, temperature, electrical, or solvent resistance.

*See also maintenance paints.*

**Industrial methylated spirits** *See methylated spirit.*

**Industrial talc** *n.* $Mg_3Si_4O_{10}(OH)_2$. A mineral product varying in composition from that approaching the theoretical formula of talc (which is non-fibrous), to mixtures of talc and other naturally associated minerals, some of which may be fibrous as defined in ASTM D 2946 and/or asbestos.

*See asbestos, magnesium silicate, and fibrous.*

**Industrial talc, asbestos-free** *n.* Industrial talc of which less than 2/100 particles are asbestos, where "asbestos fiber" is defined as being both by a fiber by ASTM D 2946 and one of the asbestiform varieties of serpentine, riebeckite, and cummingtonite (which are chrysotile, crocidolite, and amosite, respectively), anthopyllite, tremolite, or actinolite. The non-asbestiform varieties of these same materials are not asbestos.

**Industrial waste water** *n.* Water discharged from an industrial process as a result of formation or utilization in that process.

**Industrial water** *n.* Water (including its impurities) used directly or indirectly in industrial processes.

**Inert** \i-ˈnərt\ [L *inert-*, *iners* unskilled, idle, fr. *in-* + *art-*, *ars* skill] (1647) *adj.* The term applied to various extended pigments such as asbestine, barites, silica, calcium sulfate, mica, talc, etc. In general, they have poor hiding power but they are inert from a chemical and physical standpoint. While they contribute some desirable properties to paint, they are primarily used to lower the cost.

**Inert additive** *n.* A material added to a plastic compound to improve properties, but which does not react chemically with any other constituents of the composition.

**Inert base** *n.* A paint base, which does not provide hiding, color, or drying properties. Its main function is to provide solid, usually at low cost.

**Inert gas** (1902) *n.* Any of a group of rare gases that include helium, neon, argon, krypton, xenon, and sometimes radon and that exhibit heat stability and extremely low reaction rates.

*Also known as Nobel gas.*

**Inertia** \i-ˈnər-shə, -shē-ə\ [NL, fr. L, lack of skill, fr. *inert-*, *iners*] (1713) *n.* The resistance shown by all matter to any attempt to change its state of motion.

**Inert pair** *n.* The pair of s electrons in an atom with a valence shell containing at least one p electron.

**Inert pigment** *n.* (1) A pigment which remains relatively inactive or chemically unchanged in paints under stated conditions. The term has little significance unless the conditions are stated. (2) Frequently used for extender.

**Inflammable** \in-ˈfla-mə-bəl\ [F, fr. ML *inflammabilis*, fr. L *inflammare*] (1605) (deprecated) *adj.* A general term once used to describe combustible gases, liquids or solids. Now obsolete.

*See flammable.*

**Inflatable structures** Structures opened or enlarged by input of air and, once enlarged, able to retain the air to maintain the distended position.

**Inflow quench** *n.* Cooling air for extruded polymer filaments that is directed radically inward across the path of the filaments. The threadline is completely enclosed in a quench cabinet in inflow quenching.

**Information retrieval** *n.* Recovery of data from a collection for the purpose of obtaining information. Retrieval includes all the procedures used to identify, search, find, and remove specific information or data stored.

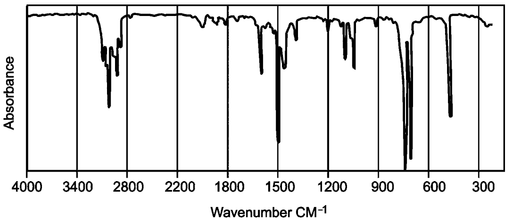
**Infrared** \ˌin-frə-ˈred, -(ˌ)frä-, -fə-\ (1881) *adj.* (1) The region of the electromagnetic spectrum including wavelengths from 0.78 to about 300 μm. Infrared radiation serves as a source of heat. (2) Rays which are longer than visible red light rays and are felt as heat. Infrared radiant energy is used to cure coatings.

**Infrared drying (or IR drying)** *n.* Method of heating for drying, curing, and/or fusing a coating. The radiations involved in this form of heating have wavelengths greater than 780 nm, and they may be derived either from specially designed filament bulbs or special types of gas ovens.

**Infrared heating** *n.* A heating process used mostly in sheet thermoforming and for drying coatings, employing lamps, or heating elements that emit invisible radiation at wavelengths of about 2 μm.

**Infrared (or I.) spectrophotometry** \-ˌspek-trō-fə-ˈtä-mə-tər\ *n.* An analytical instrumental technique based on selective absorption of infrared radiation by organic and inorganic materials, which helps identify them. An example of an infrared spectrum of toluene is shown. Stuart BH (2004) Infrared spectroscopy. John Wiley and Sons, New York.

*See FTIR.*



**Infrared polymerization index (IRPI)** *n.* A number representing the degree of cure of phenolic resins, defined as the ratio of absorbances by the sample, corrected for background absorbance, at wavelengths of 12.2 and 9.8 μm (far infrared). The test is often used in conjunction with the Marquardt index.

**Infrared pyrometer** \-pī-ˈrä-mə-tər\ *n.* A narrow- or broad-band instrument that senses the peak wavelength, $\lambda$ (μm) of IR radiation emanating from a warm surface. By Wien's displacement law, the absolute temperature (K) is given by $2884/\lambda$.

**Infrared spectroscopy** \-spek-ˈträs-kə-pē\ *n.* A technique to identify and quantitatively determine many organic substances such as plastics. All chemical compounds have characteristic intramolecular vibratory motions and can absorb incident radiant energy if such energy is sufficient to increase the vibrational motions of the atoms. With most organic molecules, vibrational motions of the substituent groups within the molecules coincide with the electromagnetic frequencies of the infrared region. An infrared spectrophotometer directs IR radiation through a film or layer or solution of the sample and measures and records the relative amount of energy absorbed by the sample as a function of the wavelength or frequency of the radiation. The chart produced is compared with charts of known substances to identify the sample. Peak area is a measure of the percentage of the various compounds present as generated by the Spectrum 100 FTIR (courtesy of Perkin-Elmer Inc., MA, USA).

**Infrared thermography** \-(ˌ)thər-ˈmä-grə-fē\ (thermographic NDT). A type of nondestructive testing in which damage development during fatigue testing of composites may be detected without interrupting the test by measuring locally generated infrared radiation. The damage is associated with heat developed through two mechanisms: hysteresis and frictional heating from rubbing at the surface of developing cracks.

**Infusible** \(ˌ)in-ˈfyü-zə-bəl\ (1555) *adj.* Not capable of melting when heated, as are all cured thermosetting resins and a few special thermoplastics such as ultrahigh-molecular-weight polyethylene, polybenzimidazole, and aramid resins.

**Infusorial earth** \(ˌ)in-fyü-ˈzōr-ē-əl-\ (1882) *n. See diatomaceous silica.*

**Ingrain** \ˈin-ˌgrān\ (1766) *adj. See dyeing.*

**Inherent flame resistance** *n.* As applied to textiles, flame resistance that derives from an essential characteristic of the fiber from which the textile is made.

**Inherent viscosity** (logarithmic viscosity number) *n.* In measurement of dilute-solution viscosities, the inherent viscosity is the ratio of the natural logarithm of the relative viscosity to the concentration of the polymer in g/dL of solvent: $\ln(\eta_{\mathrm{ref}})/c$.

*See dilute-solution viscosity.*

**Inhibition, inhibitors** *n.* A substance capable of retarding or stopping an undesired chemical reaction. Inhibitors are used in certain monomers and resins to prolong storage life. When used to retard degradation of plastics by heat and/or light, an inhibitor functions as a stabilizer.

**Inhibitive pigment** *n.* Pigment which assists in the prevention of cedar staining or Redwood staining, mildew, corrosion, yellowing, etc.

*See corrosion-inhibitive pigments.*

**Inhibitor** \in-ˈhi-bə-tər\ (ca. 1611) *n.* (1) General term for compounds or materials that have the effect of slowing down or stopping an undesired chemical change such as corrosion, oxidation or polymerization, drying, skinning, mildew growth, etc. (2) A negative catalyst, which prevents or retards vulcanization or oxidation. A good inhibitor will retard vulcanization at room temperature to prevent precure but will not retard at normal curing temperatures.

*Also see corrosion inhibitor and inhibitive pigment.*

**Initial boiling point** *n.* Temperature indicated by the distillation thermometer at the instant the first drop of condensate leaves the condenser tube.

**Initial modulus** The modulus of elasticity extrapolated to zero strain from measurements in the low-strain region.

**Initial viscosity** *n.* A term used in the vinyl plastisol industry to denote the viscosity measured immediately after the plastisol has been mixed. The viscosity normally rises at a declining rate after mixing.

**Initiation** \i-ˌni-shē-ˈā-shən\ (1583) *n.* The initial stage of polymerization usually comprising a compound (e.g., peroxide or hydroperoxide), heat or irradiation or combination that produced a free radial or ion that causes monomers to successfully attach (polymerization phase) in a chain reaction; not condensation polymerization which utilizes a catalyst without an initiator.

**Initiator** \i-ˈni-shē-ˌāt\ [LL *initiatus*, pp of *initiare*, fr. L, to induct, fr. *initium*] (ca. 1573) *vt.* An agent that causes a chemical reaction to commence and that enters into the reaction to become part of the resultant compound. Initiators differ from catalysts in that catalysts do not combine chemically with the reactants. Initiators are used in many polymerization reactions, especially in emulsion polymerizations. Initiators most commonly used in polymerizing monomers and resins having ethenic unsaturation (–C=C–) are the organic peroxides. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Initiator activator** *n.* It is usually necessary to add an activator (e.g., $FeSO_4.7H_2O$) to attain reasonable rates of polymerization when redox initiators (lauroÿl peroxide and fructose) are used at zero degree temperature or below. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Injection blow molding** *n.* A blow-molding process in which parisons are formed over mandrel by injection molding, after which the mandrels and parisons are transferred to blow molds where the final shape is blown. While the parts are being blown, cooled, and ejected, another set of parisons is being injection-molded. Advantages of the process are that it delivers a completely finished part requiring no neck trimming, etc., closer tolerances are possible, and parison-wall thicknesses can be locally varied as desired.

**Injection mold** *n.* A mold used in the process of injection molding. The mold usually comprises two main sections held together by a hydraulic or mechanical clamping press that have sufficient strength and rigidity to contain the high pressure of molten plastic when it is injected. It is provided with channels for mold venting and for circulation of temperature-control media, and with means for product ejection.

**Injection molding** (1932) *n.* The method of forming objects from granular or powdered plastics, most often thermoplastics, in which the material is fed from a hopper into a screw-type plasticator (or heating cylinder in elderly machines), after which the screw or a ram forces the molten compound into a chilled mold. Pressure is maintained until the mass has hardened sufficiently for removal from the mold (in a variation called *flow molding*, a small additional amount of melt is forced into the mold during cooling of the initial charge to offset shrinkage). Machines employing screws for plastication (as must do now days) are either single- or double-stage. In single-stage machines, plastication and injection are done in the same cylinder, injection pressure being generated by forward motion of the screw while rotation is stopped. This process is called *reciprocating-screw injection molding*. In double-stage machines, the material is plasticated by a constantly rotating screw that delivers the melt through a check valve to an accumulator cylinder, from which it is injected into the mold by a piston. This process is called *screw-and-piston injection molding*.

*See also reaction injection molding, hot-tip-gate molding, and two-shot injection molding.*

**Injection molding, molds** *n.* Comprises two main sections held together by a hydraulic or mechanical clamping press, that have sufficient strength and rigidity to contain the high pressure of molten plastic when it is injected. It is provided with channels for mold venting and for circulation of temperature-control media, and with means for product ejection.

**Injection molding nozzles** *n.* A short, thick-walled, hardened-steel tube that conducts the molten plastic emerging from an injection cylinder into the mold. It usually terminates in a hemispherical tip that closely mates a recess in the mold and is enclosed by band heaters that are controlled by a temperature sensor.

**Injection-molding pressure** *n.* (1) The pressure applied to the plastic by the injection screw (or ram) during the injection stroke. (2) The pressure of the melt within the mold cavity just prior to the freezing of the gate.

**Injection nozzle** *n.* A short, thick-walled, hardened-steel tube that conducts the molten plastic emerging from an injection cylinder into the mold. It usually terminates in a hemispherical tip that closely mates a recess in the mold called a *sprue bushing* and is enclosed by band heaters that are controlled by a temperature sensor.

**Injection ram** *n.* In two-stage injection molders and elderly machines having no screws but using contact heating, the piston that applies pressure to the plastic during injection. In single-stage screw-injection machines, the screw doubles as the ram during a brief period of stopped rotation.

**Injection stamping** *n.* A little used modification of injection molding wherein first the plastic melt is injected under relatively low pressure into a mold that is vented during this stage, then, after the cavity is filled, additional clamping pressure is applied to completely close the mold and compress or "stamp" the molded shape. Molds are designed so that even in the venting position no material exudes onto the land areas. Advantages claimed for the process are lower injection time and pressure, and shorter cycle because the injection screw can resume plastication as soon as the mold has been charged.

**Injector molder** *n.* (1) A person or company that operates injection-molding machines. (2) An injection-molding machine.

**Ink** \ˈiŋk\ [ME *enke*, fr. OF, fr. LL *encaustum*, fr. neuter of L *encaustus* burned in, fr. Gk *enkaustos*, verbal of *enkaiein* to burn in] (13c) *n.* A fluid or viscous substance used for writing or printing. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., NJ, 1976.

**Ink adhesion** *n.* The tendency of printing ink to stick to the printed surface and not smear or rub off. An informal test of ink adhesion consists of pressing pressure-sensitive tape over the printed area, waiting a few minutes, then stripping it off and observing the a real fraction of ink coming away on the tape. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Ink compounds** *n.* Additives to remedy deficiencies in the ink vehicle or pigment. Apps E (1963) Ink technology for printers and students, vol 3. L. Hill, London.

**Ink-embossed wallpaper** *n.* Differs from regular embossed wallpaper in that the ink colors are applied at the time the paper is being embossed.

**Ink fountain** *See fountain.*

**Inkometer** *n.* An instrument indicating the tack of an ink in terms of the torque developed by a system of rotating ink-wet rollers. Useful in determining tack differences in series of inks for multicolor wet printing and in the standardization of ink consistency.

**Ink receptivity** *n.* That property of a sheet of paper (or other material) which causes it to accept and/or absorb ink. Wolfe HJ (1957) Printing and litho inks. MacNair-Dorland Co., New York.

**Inks, cover** *n.* Generally opaque, heavy bodied and have a high pigment concentration.

**Inks, dull** *n.* Inks that dry with a dull or matte finish.

**Inks, halftone** *n.* Inks formulated for good reproduction of fine detail such as halftone dots on coated stock. They generally have high tinctorial strength and are finely dispersed.

**Inks, job** *n.* Heavy bodied inks formulated to print on uncoated stock using small sheet-fed presses.

**Inks, quick-setting** *n.* Inks for letterpress and offset which dry by either filtration, coagulation, selective absorption or often a combination of these with some of the other drying methods. The vehicles are generally special resin–oil combinations, which, after the inks have been printed, separate into a solid material, which remains on the surface as a dry film and an oily material which penetrates rapidly into the stock. This rapid separation gives the effect of very quick setting or drying.

**Inlay** \(ˌ)in-ˈlā, ˈin-ˌ\ (1596) *n.* Pattern or design formed by inserting cut shapes of contrasting materials into a surface, usually at the same level.

**Inlay printing** *See valley printing.*

**In-mold decorating** *n.* The process of applying labels or decorations to plastic articles during the molding operation by which they are formed. Two basic methods, each with many variations, are in use. The first employs a preprinted label of plastic film, paper, or cloth that is positioned in the mold prior to molding. During the molding cycle, the label or its printed image fuses to and becomes an integral part of the article. In the second method, the image is printed directly onto the mold surface with wet or dry ink, or applied to the mold by an offset process. In-mold decorating is done with blow molding, injection molding, and casting.

**Inoculum** \i-ˈnä-kyə-ləm\ [NL, fr. L *inoculare*] (1902) *n.* That portion of the pathogen which is transferred to the plant or plant part for inoculation purposes.

**Inorganic** \ˌi-(ˌ)nór-ˈga-nik\ (1794) *adj.* Designation of compounds that generally do not contain carbon. Source: matter other than vegetable or animal. Examples: sulfuric acid and salt. Exceptions are carbon monoxide and carbon dioxide and their derivatives.

**Inorganic coatings** *n.* Coatings based on silicates or phosphates and usually used pigmented with metallic zinc.

**Inorganic fibers** *n.* Fibers that are composed of matter other than hydrocarbons and their derivatives and are not of plant or animal origin.

**Inorganic pigments** *n.* (1) Any pigment derived from naturally occurring minerals or synthesized from inorganic substances. They are always opaque, unlike organic pigments and dyes, and are usually resistant to heat and light. Examples of those used in plastics are titanium dioxide, iron oxides, ultramarines, lead chromates, and cadmium compounds. (2) A class of pigments used in printing ink manufacture consisting of compounds of the various metals. These pigments do not contain carbon such as iron oxide. Example: Chrome yellow.

**Inorganic polymer** *n.* Within the scope of the plastics industry, an inorganic polymer may be defined as a polymer without carbon in its main chain and of a degree of polymerization sufficient for the polymer to exhibit considerable mechanical strength, plastic, or elastomeric properties, and the ability to be formed by processes used with plastics. Organic-group side chains may be present. The inorganic polymers of greatest commercial importance are the silicones. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Inpaint** *n.* To renew damaged areas on paintings or painted surfaces by repainting.

**Insect wax** *See Chinese wax.*

**Insert** \ˈin-ˌsərt\ (ca, 1889) *n.* An article of metal or other material that is incorporated in a plastic molding either by pressing the insert into a recess in the finished molding or by placing the insert into the cavity so that it becomes a part of the molding. A common example is a metal bushing, knurled on the outside, threaded on the inside, for attaching the molded article to another article with a screw or bolt.

**Insert bonding** *n.* Method of incorporating an article of metal or other material in a plastic molding either by pressing the insert into a recess in a finished molding or by placing the insert into the cavity so that it becomes a part of the molding.

**Insert molding** *n.* The process by which components may be molded into a part.
*See double-shot molding.*

**Inserts** An important part of a plastic molding consisting of metal, plastic, or other material that may be molded into position or may be pressed into the molding after the molding is fabricated.

**In-situ foaming** \(ˌ)in-ˈsī-(ˌ)tü\ [L, in position] (1740) *adv, adj.* The technique of depositing a foamable plastic (prior to foaming) into the volume where it is intended that foaming shall occur. An example is the placing of foamable plastics into cavity brickwork to provide insulation. Shortly after being poured, the liquid mix foams and fills the cavity.
*See also cellular plastic.*

**Insoluble** \(ˌ)in-ˈsäl-yə-bəl\ [ME *insolible*, fr. L *insolubilis*, fr. *in-* + *solvere* to free, dissolve] (14c) *adj.* Of low solubility; slightly soluble; and sparingly soluble.

**Inspection** \in-ˌspek-shən\ (14c) *n.* The process of examining textiles for defects at any stage of manufacturing and finishing.

**Instron** *n.* A tensile or other testing machine made by the Instron Corp of Canton, MA. Their machines have been so omnipresent in plastics testing that "Instron" has taken on a near-generic character.

**Instron tensile tester** *n.* A high precision electronic test instrument designed for testing a variety of material under a broad range of test conditions. It is used to measure and chart the load-elongation properties of fibers, yarns, fabrics, webbings, plastics, films, rubber, leather, paper, etc. It may also be used to measure such properties as tear resistance and resistance to compression.

**Insulated-runner mold** *See hot-runner mold.*

**Insulating varnish** *n.* Varnish often used in combination with materials such as mica, fabric, paper, etc., to provide electrical insulation for electrical equipment. These are formulated to have a high resistance to electrical passage.

**Insulation resistance** *n.* (1) The electrical resistance between two conductors or systems of conductors separated only by an insulating material. The resistance of a particular insulation may be measured by dividing the voltage difference applied to two electrodes in contact with, or embedded in a unit area of the specimen by the current flowing between the electrodes. Tests for thermoplastics include ASTM D 2633, section 10.02. (2) *See thermal resistance.*

*See also resistivity.*

**Intaglio** \in-ˈtal-(ˌ)yō\ [It, fr. *intagliare* to engrave, cut fr. ML *intaliare*, fr. L *in-* + LL *taliare* to cut] (1644) *n.* (1) Printing style in which the design is cut into the surface of the cylinder and is thus below the surface. (2) A lustrous, brocade pattern knitted in a tricot fabric.

**Integral-skin molding** *n.* A method of producing urethane-foam articles with substantially non-porous integral skins in one operation. Whereas normal urethane foams are inflated by carbon dioxide generated by reaction of isocyanate with excess water in the mixture (*see urethane foam*), integral-skin foam is expanded by the vapor of a volatilized solvent such as hexane. The mold must be heat conductive so that a layer next to the mold surfaces can be chilled to prevent foaming. The reaction mixture, typically consisting of a polyol, an isocyanate, and the blowing solvent, is introduced rapidly into a closed mold located near the geometric center of the mold. The mold is usually preheated to between 40 and 65°C, but the main heat needed to foam and cure the mass is provided by the reaction exotherm. After the mass has gelled, the skin should be pierced to equalize pressure and prevent shrinkage. The solvent blowing agent can be removed from the finished article by allowing it to stand at ambient conditions for about a day, or by oven drying for half an hour at 140°C. In some instances, integral-skin moldings have replaced composites of vinyl-covered urethane foam articles and cast vinyl skins filled with urethane foam, such as automotive arm rests, crash pads, and instrument-panel covers.

**Integrating sphere** *n.* A sphere coated inside with a highly reflective, diffuse material and used for the measurement of luminous flux. If the internal surface is perfectly diffuse, the intensity of any part of the sphere is the same. Many instruments used for reflectance measurements utilize such a device for measuring the diffuse or total reflectance from a sample material relative to a reference material.

**Integration (colorimetry)** *n.* The process of summing the products of the three values: the illuminant, the observer response characteristics and the reflectance or transmittance of an object at specified wavelengths in order to obtain the tristimulus values.

*See tristimulus values.*

**Intensity** \in-ˈten(t)-sə-tē\ (1665) *n.* (1) The amount of energy per unit (space, charge, and time). (2) The brilliance of a color. (3) The brightness of light.

**Intensity of illumination** (properly called illumination) *n.* Illumination in *lux* of a screen by a source of illuminating power $P$ at a distance $r$ meter, for normal incidence,

$$I = \frac{P}{r^2}.$$

If two sources of illuminating powers $P_1$ and $P_2$ produce equal illumination on a screen when at distances $r_1$ and $r_2$, respectively,

$$\frac{P_1}{r_1^2} = \frac{P_2}{r_2^2} \quad \text{or} \quad \frac{P_1}{P_2} = \frac{r_1^2}{r_2^2}.$$

If $I_0$ is the illumination when the screen is normal to the incident light, then $I$ is the illumination when the screen is at an angle $\theta$. Thus,

$$I = I_0 \cos \theta.$$

**Intensity of magnetization** *n.* The rate of transfer of energy across unit areas by the radiation. In all forms of energy transfer by waves (radiation) the intensity $I$ is given by $I = 0; Uv$, where $U$ is the energy density of the wave in the medium, and $v$ is the velocity of propagation of the wave. The energy density $U$ is always proportional to the square of the wave amplitude.

**Intensity of segregation** *n.* In mixing, the average measure of the deviation in concentration of a component at any point in a mixture from the mean concentration. The standard deviation as determined by sampling is usually used.

**Intensity of sound** *n.* Depends upon the energy of the wave motion. The intensity is measured by the energy in ergs transmitted per second through 1 $\text{cm}^2$ of surface. The energy in $\text{ergs/cm}^3$ in a sound wave is given by

$$E = 2\pi^2 d n^2 a^2,$$

where $d$ is the density in $\text{g/cm}^3$, $n$ is frequency in vibration per sec and $a$ is the amplitude in cm. The energy reaching the ear in unit time will also be proportional to the velocity of propagation.

**Intensive mixer** *See internal mixer.*

**Interaction parameter** *n.* Interaction parameter $\chi$ in solution theory; Flory–Huggins parameter $\chi$; a measure of the interaction energy $\Delta E$, which is a measure of the Gibbs energy, but not of the enthalpy.

**Intercoat adhesion** *n.* The adhesion between two coats of paint.

**Intercoat contamination** *n.* Presence of foreign matter between successive coats.

**Interdeterminancy principle** (uncertainty principle) *n.* The postulate that it is impossible to determine simultaneously both the exact position and the exact momentum of an electron. So this aspect of electronics can only be expressed as a probability.

**Interface** \ˈin-tər-ˌfās\ (1882) *n.* The common surface separating two different phases, e.g., the resin-glass interface in glass–fiber-reinforced plastics.

**Interfacial angle** *n.* That angle between two adjoining faces of a crystal.

**Interfacial angle (polar)** *n.* That angle between the normals to two adjoining faces of a crystal.

**Interfacial polycondensation** *n* Involves polymer formation at or near the interface between two immiscible monomer solutions under very mild reaction conditions.

**Interfacial polymerization** *n.* A polymerization reaction that occurs at or near the interfacial surfaces of two immiscible solutions. A simple example is the often-performed demonstration of making nylon thread from a beaker containing a lower layer of a solution of sebacyl chloride in carbon tetrachloride and an upper layer of hexamethylene diamine solution in water. A pair of tweezers is gently lowered through the upper layer, closed on the interfacial layer of polymer, and then drawn upward to pull with it a continuous strand of nylon 6/10.

**Interfacial tension** (interfacial surface energy) *n.* (1) The tension in, or energy of, the interfacial surface between two immiscible liquids. Measurable, like surface tension by capillary rise or with a du Noüy tensiometer. (2) The molecular attractive force between unlike molecules at an interface. It may be expressed in dynes per centimeter.

**Interfacing** *See interlining.*

**Interference color** *n.* Color which appears in thin films, illuminated with composite light as the result of the reinforcement of some colors (wavelengths) and weakening or elimination of others, depending on the phase differences and amplitudes of the light waves involved. The color produced depends on the angle of incidence, thickness of the film, and the refractive index. Interference color also appears when light strikes narrow slits, the principle of the diffraction grating.

**Interference, constructive** *n.* The retardation of two light beams by exactly one wavelength or even multiples of one wavelength. The two waves reinforce each other, resulting in brightness.

**Interference, destructive** *n.* The retardation of two light beams exactly an odd number of half wavelengths, resulting in darkness as the two waves are perfectly out of phase.

**Interference figure** *n.* The conoscopic pattern of extinction positions of a crystal superimposed on the pattern of interference colors corresponding to the full cone of directions by which the crystal is illuminated, each direction showing its own interference color.

**Interference filter** *n.* Optical filter made with extremely thin alternate layers of metals and dielectrics so that it passes only very narrow wavelength bands. Such filters are frequently used in abridged spectrophotometers where they serve to isolate discrete wavelengths for measuring, thus effectively replacing a dispersion device in a spectrophotometer.

*See spectrophotometer, abridged.*

**Interference microscopy** *n.* Optical microscopy in the most common arrangement of which the incident beam is split into two non-parallel oppositely polarized beams. The beams are reflected back from the specimen and its substrate, respectively, and recombined. The sample beam follows a shorter path length and the beams recombine destructively producing a dark image.

**Interference pigments** *n.* Materials used as pigments, which depend on the interference of light for their color. They are generally made from platelets coated with a thin film of higher refractive index. For example, thin films of titanium dioxide coated on mica flakes are one type manufactured and used today.

*See pearlescent pigments.*

**Interferometry** \ˌin-tə(r)-fə-ˈrä-mə-tər\ [ISV] (1897) *n.* Any system of measurement based on wave interference between split rays of a light beam, one of which takes a longer or more optically dense path than the other, thus delaying it and generating a phase difference between the two rays. Interferometry has been used to measure a great variety of quantities, e.g., the speed of light, film thicknesses, and chemical concentrations in solutions.

**Interfusion** \ˌin-tər-ˈfyüz\ [L *interfusus*, pp of *interfundere* to pour between, fr. *inter-* + *fundere* to pour] (1593) (infusion) *v.* A novel method for emplacing hard-surfacing alloys within extruder barrels and, in future, on other parts. Few details have been released (as of late 1992) but it appears the hard-facing material in powder form is distributed around the barrel surface by centrifugal action while induction heating, and perhaps high pressure, are applied to speed the diffusion of that material into the barrel near its inner surface. The process marketers, Inductamentals of Chicago, claim much slower barrel wear than is experienced by cast-in liners.

*See also bimetallic cylinder.*

**Interhalogen** *n.* A compound of two different halogens.

**Interlaminar shear stress** *n.* Shear stress between layers of a laminate, an important cause of laminate failure and delamination.

**Interlayer** *n.* An intermediate sheet in a laminate.

**Interlining** *n.* A padding or stiffening fabric used in garment manufacture to provide shape retention. Interlining is sandwiched between layers of fabric.

**Interlocked grain** *n.* Wood in which the fibers incline in one direction in a number of rings of annual growth, then gradually reverse and incline in an opposite direction in succeeding rings and then reverse again.

**Interlock knit** *n.* To produce an interlock knit, long and short needles are arranged alternately in both the dial and cylinder; the needles in the dial and cylinder are also positioned in direct alignment. When the long and short needles knit in alternate feeds in both needle housings, a fabric with a type of cross 1 × 1 rib effect is produced.

**Interlock twiner** *n.* A machine for making three-dimensional braided performs in which yarn bundles are entwined by braiders to form the desired shape.

**Intermediate** (1650) *n.* A compound produced from raw materials that is to be used to synthesize end products. For example, benzene, originally distilled from coal tar and now made from petroleum constituents, and its derivatives, cyclohexane, cyclohexanol, and adipic acid are all intermediates in the manufacture of nylon 6/6.

**Intermediate temperature setting adhesive** *n. See adhesive, intermediate temperature setting.*

**Intermingling** *n.* (1) Use of air jets to create turbulence to entangle the filaments of continuous filaments yarns, without forming loops, after extrusion. Provides dimensional stability and cohesion for further processing but is not of itself a texturing process. It is compatible with high-speed spin-drawing and high-speed take-up. When compared with twisting processes, it also permits increased take-up package size. (2) Combining two or more yarns via an intermingling jet. This process can be used to get special effect yarns, i.e., mixing dye variants to get heather effects upon subsequent dyeing.

**Intermittent pattern** *n.* A pattern occurring in interrupted sequence.

**Intermolecular polymerization** *n.* Polymerization which occurs as the result of association between molecules.

**Internal bubble coating** *n.* In blown-film production, the circulation of chilled air or carbon dioxide inside the film bubble to substantially reduce the cooling time and thereby increase the production rate. The same practices have been used in blow molding.

**Internal dye variability** *n.* The change from point to point in dye uniformity across the diameter and along the length of the individual filaments. Affects appearance of the dyed product and is a function of fiber, dye, dyeing process, and dye bath characteristics.

**Internal lubricant** *n.* A lubricant that is incorporated into the compound or resin prior to processing, as opposed to one that is applied to the mold or die. Examples of internal lubricant are waxes, fatty acids and their amines, and metallic stearates such as calcium, lead, lithium, magnesium, and zinc stearates. The lubricants reduce friction and adhesion between polymers and metal surfaces, improve flow characteristics, and enhance knitting at weld surfaces and wetting properties of compounds. They are used primarily in rigid and flexible PRV, high-molecular-weight polyethylene, polystyrene, and acrylonitrile–butadiene–styrene, melamine, and phenolic resins.

**Internally plasticized** *n.* When a product is synthesized from a reaction involving two or more raw materials, it may be said to be internally plasticized if one of the raw materials is able to confer plasticity or flexibility to it. In other words, the product is plasticized because it is build up from a component, which is naturally plastic. For example, an oil-modified alkyd, in which phthalic anhydride and glycerol are combined with drying oil fatty acids, is internally plasticized by reason of the presence of the fatty acid component. If a Congo varnish were made by interaction of run Congo and linseed oil monoglyceride, it could be described as internally plasticized, in contrast to a varnish made by simple dissolution of run Congo in linseed oil, which would be externally plasticized. Also a polyvinyl acetate–acrylic co-polymer is internally plasticized while a polyvinyl acetate homopolymer, into which a plasticizer has been stirred, is externally plasticized.

*See internal plasticizer.*

**Internal mandrel cooling** *n.* In extrusion of tubing and pipe, the mandrel, which is an extension of the die core, is usually cooled internally so that the hot extrudate, cooled from both surfaces, cools faster than if cooled only on the outside, and with better control of dimensions.

**Internal mix spray gun** *n.* Spray gun in which the fluid and air are combined before they leave the gun.

**Internal mixer** *n.* A heavy-duty machine in which the materials to be mixed are strenuously worked and fused by one or more rotors designed so that all parts of the charge pass repeatedly through zones of high shear. The shell and rotors may be cored to permit circulation of heat-transfer liquids to control batch temperature. One type, the banbury mixer has long been used in the compounding plastics and rubbers, doing a good job of both *dispersive* and *distributive* mixing. Internal mixers have the inherent advantage of minimizing dust and fume hazards. The disadvantage of most types is that processing is batch wise rather than continuous.

*See banbury mixer.*

**Internal phase** *n.* In an emulsion, the discontinuous phase. For example, in an oil-in-water emulsion, the oil is the internal phase.

**Internal plasticization** *n.* Plasticization by means of internally combined groups, such as by co-polymerization.

**Internal plasticizer** *n.* An agent incorporated in, or co-polymerized with, a resin during its polymerization to make it softer and more flexible, as opposed to a plasticizer added to the resin during compounding. Common examples occur in oil-modified alkyds, and such materials have considerable practical advantages over externally plasticized systems, where the plasticizer may be lost by evaporation or leached out by water or other agents.

**Internal reflection spectroscopy** *n.* A technique for exposing a sample to an infrared beam in spectroscopy, where a thin sample film is placed in direct contact with the reflecting surface of a prism of high refractive index. The output generated is a spectrum similar to the transmission spectrum of the surface layers of the sample.

**Internal stabilizer** *n.* An agent incorporated in a resin during its polymerization to make it more resistant to high temperatures and other processing and environmental conditions, as opposed to a stabilizer added to the resin during compounding.

**Internal undercut** *n.* Any restriction that prevents a molded part from being directly removed from its core (force).

**International gray scale** *n.* A scale distributed through AATCC that is used as a comparison standard to rate degrees of fading from 5 (negligible or no change) to 1 (severe change). The term is sometimes applied to any scale of quality in which 5 is excellent and 1 is poor.

**Interpenetrating polymer** *n.* A material with two co-continuous phases or a material with two parts intertwined throughout.

**Interpenetrating polymer network (IPN)** *n.* A kind of blend formed by swelling a cross-linked polymer with a monomer, than inducing polymerization of the monomer. Another route is to infuse a cross-linking monomer into a cross-linkable polymer. Zaccaria VK, Utracki L (2003) Polymer blends. Springer-Verlag, New York. Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York.

**Interpolymer** A type of co-polymer in which the two monomer units are so intimately distributed in the polymer that the substance is essentially homogeneous in chemical composition. An interpolymer is sometimes called a *true co-polymer.*

**Inter-society color council (ISCC)** *n.* A USA council made up of delegates from about 30 "member-bodies", i.e., national organizations and professional societies, and of individual members, all of whom have an interest in information about color and in basic concepts of color. Member-body organizations and individual members represent: (1) Creators of color effects in art and design. (2) Manufacturers of colored material. (3) Producers of color reproduction processes. (4) Fields of science and technology. The work of the Council is carried out in study groups, called "problem subcommittees", and is directed by specialists in the color problems under investigation. News of Council activities and newsworthy items in the world of color are published in the ISCC Newsletter, published bimonthly. Annual Council meetings provide a forum for discussion and resolution of color problems. Specialized interest meetings are held periodically. The ISCC is the official USA member of the International Colour Association – Association Internationale de la Couleur.

**Interstice** \in-ˈtər-stəs\ [ME, fr. L *interstitium*, fr. *inter-* + *-stit-*, *-stes* standing (as in *superstes* standing over)] (15c) *n.* A space between objects; such as between atoms in a crystal.

**Intimate blend** *n.* A technique of mixing two or more dissimilar fibers in a very uniform mixture. Usually the stock is mixed before or at the picker.

**Intramolecular polymerization** *n.* Polymerization which occurs within an individual molecule. For example, drying oils consist of triglyceride esters, involving up to three unsaturated fatty acids attached to a single glycerol molecule. Under certain conditions, polymerization is believed to occur between neighboring fatty acid chains in a single molecule.

**Intrinsic viscosity** \in-ˈtrin-zik-\ (limiting viscosity number) *n.* In measurements of dilute-solution viscosity, intrinsic viscosity is the limit of the reduced and inherent viscosities as the concentration of polymer solute approaches zero. It represents the capacity of the polymer to increase viscosity. Interactions between solvent and polymer molecules give rise to different intrinsic viscosities for a given polymer in different solvents. Intrinsic viscosity is related to polymer molecular weight by the equation $[\eta] = K'M^{a}$, where the exponent a lies between 0.5 and 1.0, and, for many systems, between 0.6 and 0.8.

*Also known as limiting viscosity number. See also dilute-solution viscosity, Huggins equation, and viscosity-average molecular weight.*

**Introfaction** *n.* The change in fluidity and wetting capability of an impregnating material, produced by addition of an introfier.

**Introfier** *n.* A chemical that will convert a colloidal solution into a molecular one, by improving the solubility of the colloidal material.

**Intumesce** *n.* To form a voluminous char on ignition. Foaming or swelling when exposed to heat.

**Intumescence** \ˌin-tu-ˈme-sən(t)s\ [F, fr. L *intumescere* to swell up, fr. *in-* + *tumescere* to swell] (ca. 1656) *n.* The foaming and swelling of a plastic when exposed to high surface temperatures or flames. It has particular reference to ablative urethanes used on rocket nose cones, and to intumescent coating. Kidder RC (1994) Handbook of fire retardant coatings and fire testing services. CRC Press, Boca Raton, FL.

**Intumescent coatings** *n.* A coating that, when exposed to flame or intense heat, decomposes and bubbles into a foam that protects the substrate and prevents the flame from spreading. Such coatings are used, for example, on reinforced-plastics building panels. Examples of such coating materials are magnesium oxychloride cement used on urethane foams, and certain epoxy coatings used on polyester panels. Kidder RC (1994) Handbook of fire retardant coatings and fire testing services. CRC Press, Boca Raton, FL.

**Inventory** \ˈin-vən-ˌtōr-ē\. In injection molding or extrusion, the amount of plastic contained in the heating cylinder or barrel.

**Inverse emulsion phase polymerization** *n.* The reversal of emulsion polymerization phases; feeding the aqueous phase into a monomer phase (hydrophobic) where the water particles are dispersed in a monomer phase while agitating (and polymerizing monomers) until the phase shifts to an aqueous phase, and the monomer particles becomes dispersed in an aqueous phase; the phases shift when the aqueous component is more than 50% by volume than the monomer phase. Becher P (2001) Emulsions: theory and practice. American Chemical Society, Washington, DC. Lovell PA, El-Aasser (eds) (1997) Emulsion polymerization and emulsion polymers. John-Wiley and Sons Inc., New York.

**Inversion temperature** (1921) *n.* A temperature at which free expansion of a real gas produces neither heating nor cooling of the gas.

**Investment casting** (lost-wax process) *n.* A metals-casting method in which patterns made from wax or other expendable material are mounted on sprues, then "invested", i.e., covered with a ceramic slurry that sets at room temperature. The set slurry is then heated to melt away the pattern, leaving a mold into which metal is poured.

**Iodine number** (value) *n.* A number expressing the percentage (i.e., gram per 100 g) of iodine absorbed by a substance. It is a measure of the proportion of unsaturated linkages present and is usually determined in the analysis of oils and fats.

*See iodine value.*

**Iodine test** *n.* Test for the detection of starches and dextrins. It involves the addition of a small amount of a solution of iodine in potassium iodide to an aqueous solution of the suspected substance. Starches give purpose or blue colors according to the degree of hydrolyzation, whereas erythrodextrin gives an orange or reddish-brown coloration.

**Iodine value (iodine number)** *n.* The number of grams of iodine that 100g of an unsaturated compound will absorb in a given time under arbitrary conditions. It is used to indicate the residual unsaturation in epoxy hardeners (and many oils); a high value implies a high degree of unsaturation.

**Ion** \ˈī-ən, ˈī-ˌän\ [Gk, neuter of *iōn*, pp of *ienai* to go] (ca. 1834) *n.* An atom, molecule or radical that has become electrically charged by having either gained or lost an electron. When an electron is gained the negatively charged ion is called an *anion.* A positively charged ion is called a *cation.*

**Ion current** *n.* The migration of ions between the electrodes of an electrochemical cell.

**Ion exchange** (1923) *n.* A reversible interchange of ions between a solid phase and a liquid phase in which there is no permanent change in the structure of the solid phase. In the leading application, water softening, an ion-exchange resin extracts “hard”, soap-precipitating calcium, magnesium, and iron ions from the water, replacing them with equivalent amounts of soluble sodium ions. Subsequently, the resin loaded with hard ions may be treated with salt solution (regenerated) to bring it back to the original sodium form, ready for reuse.

**Ion-exchange resins** (1943) *n.* Any of several small granular or bead-like resins consisting of two principal parts: a resinous matrix serving as a structural portion, and an ion-active group serving as the functional portion. The functional group may be acidic or basic. Complete deionization of water is accomplished by use of both acidic and basic resins, in sequence or in mixed beds. Ion-exchange resins are also used for other chemical processes such as electrodialysis.

**Ionic** \ ī -ˈä –nik\ [ISV] (1890) *adj.* Pertaining to an atom, radical, or molecule that is capable of being electrically charged, either negatively (anionic) or positively (cationic) or both (amphoteric), or to a material whose atoms already exist in charged state. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Ionic atmosphere** The space around a given ion in solution, occupied largely by counterions.

**Ionic bond** (1939) *n.* The electrostatic attraction between ions of opposite electrical charge. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Ionic bonding** *n.* Ionic bonding contributes strength and adhesive to end-use properties by providing a moderate form of cross-linking.

**Ionic initiator** *n.* A substance providing either carbonium ions (cationic) or carbanions (anionic) that attack the reactive double bonds of vinyl monomers and add on, regenerating the ion species on the propagating chain. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ionic polymerization** (cationic polymerization, anionic polymerization) *n.* A polymerization conducted in the presence of electrically charged ions that become attached to carboxylic groups on carbon atoms in the polymer chain. The carboxylic groups are produced along the polymer chain by co-polymerization, providing the anionic portion of the ionic cross-links. The cationic portion is provided by metallic ions added to the polymerization mixture. The electrostatic forces binding the chains together are much stronger than the covalent bonds between the molecules in conventional polymers. Some polymers produced by cationic polymerization are polyisobutylene, butyl rubber, polyvinyl ethers, and coumarone–indene resins. A typical product of anionic polymerization is polybutadiene, prepared with an alkali-metal catalyst. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ionic polyurethane** *n.* A urethane resin containing electrical charges in its backbone or side chain. Cationic urethanes (those containing positive changes) can be formed by reacting diisocyanates with diols containing tertiary nitrogen to yield urethanes that are then treated by a quaternization reaction that forms positive charges in the macromolecular backbone or in side chains.

**Ionic solid** *n.* A solid composed of anions and cations in its lattice.

**Ionization [ISV]** (1898) *v.* (1) Loss of an electron by an atom, molecule, or ion. (2) Dissociation of an electrolyte. It also can be written as a chemical change by which ions are formed from a neutral molecule of an inorganic solid, liquid, or gas.

**Ionization chamber** (1904) *n.* A partially evacuated tube provided with electrodes so that its conductivity due to the ionization of the residual gas reveals the presence of ionizing radiation.

**Ionization energy** *n.* The energy used to remove an electron from a gaseous, isolated, ground-state atom (or, sometimes, ion).

*Also known as ionization potential.*

**Ionization foaming** *n.* The process of foaming polyethylene by exposing it to ionizing radiation, which evolves hydrogen from the molten polymer, causing it to foam.

**Ionization potential** *n.* The work (expressed in electron volts) required to remove a given electron from its atomic orbit and place it at rest at an infinite distance. It is customary to list values in electron volts (eV) $1\,\mathrm{eV} = 23{,}053\,\mathrm{cal/mol}$.

*Also known as ionization energy.*

**Ionomer** *n.* Polymers with repeating ionic groups, which tend to form ionic domains that act as physical cross-links. The domains disassociate on heating allowing the material to be processed as a thermoplastic. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ionomer resin** *n.* A polymer containing interchain ionic bonding. In particular, commercial thermoplastics based on metal salts of co-polymers of ethylene and methacrylic acid, produced in the USA by the DuPont Co under the trade name Surlyn®. Ionomers are tough and flexible, the many grades ranging in modulus from 14 to 590 MPa. They have been approved for food-contact applications by the FDA, have outstanding resistance to puncture and impact. Applications include sporting goods (most golf-ball covers), footwear, packaging, automotive, and foams. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York.

**Ion pair** *n.* Pairs of oppositely charged ions held together by columbic attraction without formation of a covalent bond. Experimentally, an ion pair behaves as one unit in determining conductivity, kinetic behavior, osmotic properties, etc. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Ion plating** *n.* A process for deposition of metals for dielectric films onto plastic substrates with a highly adherent bond. The process is performed in a tank similar to a vacuum-metallizing tank. A negative charge is developed on a metal bias plate located behind the plastic substrate. Next, the plating material is converted to a plasma of positive ions by filament or radio-frequency heating. At this point a phenomenon known as Crooke's dark space appears, enveloping the entire surface of the substrate, and establishing a large potential difference between the ions and the charged plastic surface. This causes the ions of the plating material to strike the plastic with high kinetic energy and to form strong bonds. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Ion product** *n.* (1) The product of the concentrations of hydrogen (hydronium) ions and hydroxide ions in water. (2) The mass-action expression for a solubility equilibrium.

**IPA** Abbreviation for isophthalic acid.

**IPN** Abbreviation for interpenetrating polymer network.

**IR** *n.* (1) Abbreviation for infrared. (2) Abbreviation for isoprene rubber (British Standards Insitution), the *cis*-1,4-type of polyisoprene.

**Iridescence** \ˌir-ə-ˈde-sᵊn(t)s\ (1804) *n.* Color produced from light interference phenomenon. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.
*See interference color.*

**Irish gum** *See carrageen.*

**Iron blue** *n.* $FeNH_4F_3(CN)_6$. Any of various pigments prepared by precipitating ferrous ferrocyanide from a soluble ferrocyanide and ferrous sulfate. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Iron driers** *n.* Iron salts of naphthenic acid, 2-ethyl hexoic acids or other acids, which actively accelerate polymerization at elevated temperatures, but are only feebly active at room temperature. The presence of the very dark ferric ion makes them applicable in dark or tinted finishes. The British call then iron soaps. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Iron mill** *n.* Paint mill consisting of a corrugated steel disc revolving tightly against a stationary steel shell. As the pigment particles pass between these moving steel parts, the pigments are dispersed into the vehicle.

**Iron oxides** (1885) *n.* $Fe_2O_3$. Pigments, which are substantially oxides of iron. (1) *Natural*: Ochres, raw and burnt umbers; raw and burnt siennas; red oxides; metallic browns; maroon oxides; and black oxides. Range in $Fe_2O_3$ content: 20–99%. (2) *Synthetic*: Yellow, red, brown, and black oxides. *Red oxide* – $Fe_2O_3$; *Yellow oxide* – $Fe_2O_3 \cdot H_2O$; *Brown oxide* – $FeO_3 \cdot x FeO$; *Black oxide* –$Fe_2O_4$. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Iron oxides, synthetic** (e.g., $Fe_2O_3 \cdot H_2O$) *n.* Iron oxides manufactured by a synthetic process. Kirk–Othmer encyclopedia of chemical technology: pigments–powders.

John Wiley and Sons, New York, 1996. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Iron phosphate coating** *See chemical conversion coating.*

**Iron soaps** (British) *n. See iron driers.*

**Iron titanate** *See ilmenite.*

**Irradiance** \i-ˈrā-dē-ən(t)s\ (1667) *n.* The quotient of the radiant flux incident on an infinitesimal surface element containing the point in question, by the area of that surface element. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Moller KD (2003) Optics. Springer-Verlag, New York.

**Irradiation of polymers** (1901) *n.* The subjection of a material to high-energy particle radiation for the purpose of producing a desired change in properties or of determining the effects of radiation on the material. Thermosetting resins such as unsaturated polyesters, acrylic-modified polyesters, and acrylic-modified epoxies can be cured rapidly at room temperature and without catalysts by exposure to ionizing radiation. However, if the polymer is overdosed, serious degradation can occur. Radiation sources most widely used in the plastics industry are electron accelerators and radioisotopes such as cobalt-60. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Irregular block** *n.* A block (in a polymer structure) that cannot be described by only one species of constitutional repeating unit in a single sequential arrangement. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Irregular polymer** *n.* A polymer whose molecules cannot be described by only one species of constitutional unit in a single sequential arrangement. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Isanolic acid** *n.* Eighteen-carbon fatty acid with acetylene triple bonds at the 9 and 11 positions, and having also an ethylene bond but no hydroxyl substituent. Occurs in isano oil, along with closely related bolekic acid, which is a hydroxy acid.

*Also known as erythrogenic acid.*

**Isano oil** *n.* A fatty oil extracted from an African tree of the same name, used as a flame retardant for acrylic resins. When heated to 200°C it polymerizes and may explode.

*See isanolic acid.*

**ISCC** Abbreviation for inter-society color council.

**Iso-** (1) The strict meaning of this prefix according to chemical nomenclature is "one methyl group on the next-to-last carbon atom, and no other branches". In the plasticizer field, the prefix is used to denote an isomer of a compound, specifically an isomer having a single, simple branching, not limited to methyl, at the end of a straight chain. (2) Equal, same, or constant, as in *isothermal*, at constant temperature. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**ISO** *n.* Abbreviation for international organization for standardization, headquartered in Geneva, Switzerland. ISO publishes standards in many fields, including hundreds on plastics in Field 170. ISO standards are available from American National Standards Institute.

**Isoamyl acetate** Rectified amyl acetate.

**Isoamyl butyrate** *n.* $C_5H_{11}OOCC_3H_7$. A colorless liquid derived by treating isoamyl alcohol with butyric acid, used as a solvent and as a plasticizer for cellulose acetate.

**Isoamyl salicylate (amyl salicylate, orchidae)** *n.* $C_5H_{11}OOCC_6H_4OH$. A colorless liquid used as a plasticizer.

**Isobar** \ˈī-sə-ˌbär\ [ISV *is-* + *-bar* (fr. Gk *baros* weight); akin to Gk *barys* heavy] (ca. 1864) *n.* For chemistry, elements of the same atomic mass but of different atomic numbers. The sum of their nucleons is the same but there are more protons in one than in the other.

**Isobaric** \ˌī-sə-ˈbär-ik, -ˈbar-\ [ISV] (1878) *adj.* Taking place without change in pressure.

**Isobutane** \ˌī-sō-ˈbyü-ˌtān\ [ISV] (1876) (isobutylene, 2-methylpropene) *n.* $(CH_3)_2C{=}CH_2$. A colorless, highly volatile liquid or liquidified gas derived from petroleum, easily polymerized to form polybutene. It has a bp of −6.9°C; a fp of −139°C, a flp of −105°C, and Sp gr of 0.6 (20°C). Uses: Production of isooctane, butyl rubber, polyisobutene resins, *tert*-butanol, methacrylates, co-polymer resins with butadiene, and acrylonitrile.

**Isobutyl acetate** $(CH_3)_2CHCH_2OOCCH_3$. A colorless liquid with a fruity odor, used as a solvent for cellulosic plastics and lacquers. Its properties are similar to those of butyl acetate, except that its evaporation rate is higher.

**Isobutyl alcohol** *n.* $(CH_3)_2CHCH_2OH$. Colorless flammable liquid used as a solvent. Sp gr, 0.806; bp, 108.39.

*Also known as 2-methyl-1-propanol and isopropyl carbinol.*

**Isobutylene** \ˈbyü-tᵊl-ˌēn\ [ISV] (1872) *n.* A colorless, very volatile liquid or flammable gas, $C_4H_8$, used chiefly in the manufacture of butyl rubber.

**Isobutyl isobutyrate** *n.* $(CH_3)_2CHCOOCH_2CH(CH_3)_2$. A colorless liquid with a fruity odor and slow evaporation rate, giving resin solutions with good flow and leveling characteristics. It is used as a solvent for nitrocellulose and vinyl resins.

**Isocyanate** \ˌī-sō-ˈsī-ə-nāt, -nət\ [ISV] (1872) *n.* A compound containing the isocyanate group, –N=C=O, attached to an organic radical or hydrogen. Isocyanates containing just one –N=C=O group (monoisocyanates) have limited uses in the plastics industry. The term is often used to mean a compound containing two –N=C=O groups (diisocyanate) or several such groups (polyisocyanate). However, in the case of a trimer compound containing three –N=C=O groups in a six-membered ring, the term *isocyanurate* is used. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. *See also diisocyanate.*

**Isocyanate-alcohol reaction** *n.* Reaction involving a very reactive chemical group, –N=C=O with an alcohol to form a highly cross-linked polymer, importance in polyurethane formation. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Isocyanate foam** *See urethane foam.*

**Isocyanate generator** (hindered isocyanate) *n.* A mixture of an isocyanate, a phenol, and a polyester that remains stable at room temperature. When heated to 70°C, the phenol and isocyanate components dissociate and react with the polyester to form a polyurethane.

**Isocyanate plastic** *n.* A plastic based on polymers made by the polycondensation of organic isocyanates with other compounds. Reaction of isocyanates with hydroxyl-containing compounds produces polyurethanes having the urethane group –NHC(=O)O–. Reaction of isocyanates with amine-containing compounds produces polyurea having the urea group –NHCONH– (ISO). Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See also urethane and polyurethane foam.*

**Isocyanate resins** *n.* Resins synthesized from isocyanates (–N=C=O) and alcohols (–OH). The reactants are joined through the formation of the urethane linkage and hence this field of technology is generally known as urethane chemistry. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See polyurethanes.*

**Isocyanates** *n.* Compounds containing the isocyanate group –N=C=O, that are very reactive, especially with compounds containing active hydrogen atoms, such as in amines, alcohols, carboxylic acids and water. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Isocyanurate foam** *n.* A foam prepared from an isocyanurate. The unmodified foams have excellent flame resistance but are brittle and of little commercial value. However, isocyanurate foams modified withepoxides, polyimides, or (most commonly) urethane groups and polyols possess flame resistance far superior to that of conventional urethane foams and can be processed into a variety of foam products suitable for insulation. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Isocyanurate plastic** *n.* A plastic based on isocyanate polymers in which trimerization of the isocyanates incorporates six-membered isocyanurate-ring groups in a chain. Elias HG (1977) Macromolecules, vols 1–2, Plenum Press, New York.

**Isocyaurate** *n.* A trimer of an isocyanate, formed by the catalytic cyclization of three isocyanate molecular groups into a six-membered ring. Elias HG (1977) Macromolecules, vols 1–2, Plenum Press, New York.

**Isodecyl octyl adipate** *n.* $C_{10}H_{21}OOCC_4H_8COOC_8H_{17}$. A light-colored, oily liquid used as a plasticizer for vinyls.

**Isodecyl octyl phthalate** *n.* $C_{10}H_{21}OOCC_6H_4COOC_8H_{17}$. A primary plasticizer for vinyls, cellulose nitrate, polystyrene, and ethyl cellulose. In vinyls, it performs better than diethylhexyl phthalate (DOP).

**Isoelectric heating** Form of heating by means of electrical energy, in which a special form of element is employed, and which is submerged in liquid raw materials. In practice a series of such elements is employed.

**Isoelectric point** *n.* The pH value at which a substance or system (e.g., a protein solution) is electrically neutral; at this value, electrophoresis does not occur when a direct electric current is applied. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Isogyres** In a uniaxial interference figure, the two black bars that form a cross and represent the pattern of extinction positions of the crystal. In a biaxial interference figure, the two black, curved bars (brushes) that intersect the isochromatic curves (lemniscates) and represent the pattern of extinction positions of the crystal. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Isoindolinone** *n.* Any of a small family of organic pigments, available in bright yellows and reds. They have good lightfastness, heat stability and bleed resistance.

**Isolated system** *n.* A system, which can exchange neither matter nor energy in any form with its surroundings. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Isomer** \ˈī-sə-mər\ [ISV, back-formation fr. *isomeric*] (1866) *n.* From the Greek *isos* (the same, equal, alike and *meros* (part or portion), isomers are substances comprising molecules that contain the same number and kinds of atoms, and have the same chemical formula, but that differ in structure, so that they form materials whose properties can differ widely. For example, the gas dimethyl ether, $CH_3OCH_3$, and the liquid ethyl alcohol. $CH_3CH_2OH$ differ in both their chemical and physical properties, yet both have the empirical formula $C_2H_6O$. Isomeric polymers are formed by polymerizing isomonomers that link together in different ways. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Isomeric polymers** *n.* Polymers which have essentially the same percentage composition, but differ with regard to their molecular architecture. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Isomerism** (1839) *n.* Existence of molecules having the same number and kinds of atoms but in different configurations. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Isomerized oils** *n.* Oils which have been isomerized from a molecular rearrangement by several means, such as the catalytic action of alkalis, sulfur dioxide, nickel, etc. Isomerized oils exhibit greater reactivity, more rapid polymerization and greater drying rate than their non-isomerized parent oils. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001. Shahidi F, Bailey AE (eds) (2005) Bailey's industrial oil and fat products. John Wiley and Sons.

**Isomerized rubber** *n.* Rubber which has undergone cyclic rearrangement by heating in solution in the presence of a suitable catalyst. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

*Also referred to as cyclized rubber.*

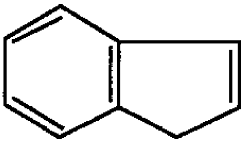
**Isomorphism** \ˌī-sə-ˈmór-ˌfi-zəm\ [ISV] (ca. 1828) *n.* The existence of two or more chemical compounds with the same molecular formula but having different properties, owing to different arrangement of atoms within the molecule, e.g., ammonium cyanate $NH_4CNO$, and urea, $CO(NH_2)_2$, are isomers.

**Isooctyl adipate** *See diisooctyl adipate.*

**Isooctyl palmitate** *n.* $C_8H_{17}OOCC_{15}H_{31}$. A plasticizer for polystyrene and cellulosic plastics.

**Isophorone** *n.* A cyclic, unsaturated ketone with the structure.

It is a powerful solvent for vinyl and cellulosic resins, with moderate power to dissolve nearly all common thermoplastic and (uncured) thermosetting resins.



**Isophorone diisocyanate (IPDI)** *n.* An isocyanate used in the production of urethane elastomers and foams. It is less volatile than toluene diisocyanate, therefore easier to maintain at low levels in workers' airspace and safer to work with. Its structure is modified from that of isophorone, above, in that the oxygen has been replaced by an $–N{=}C{=}O$ group, the double bond is gone, and the top carbon atom in the ring has an additional $–CH_2N{=}C{=}O$ linked to it.

**Isophthalic acid** (benzene-1,3-dicarboxylic acid, IPA) *n.* $C_6H_4–(COOH)_2$. Used instead of phthalic anhydride in making unsaturated polyester resins that, when cured, have good stiffness and resistance to heat and chemicals. Molecular weight, 166.13. Crystalline powder, which melts at 345–348°C; sublimes without decomposition. Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001.

**Isoprene** \ˈī-sə-ˌprēn\ [prob. fr. *is-* + *pr*opyl + *-ene*] (1860) (3-methyl-1,3-butadiene, 2-methyl-1,3-butadiene) *n.* $CH_2{=}C–(CH_3)CH{=}CH_2$. A colorless, volatile liquid derived from propylene or from coal gases or tars, chemically similar to the mer unit of natural rubber. Its polymer of the *cis*-1, 4-type of polyisoprene is chemistry's nearest approach to synthesizing the natural product and it has sometimes been called "synthetic natural rubber". It has a molecular weight of 68.06, a mp of −120°C, and a bp of 34°C. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York.

*Also called 2-methyl-1,3-butadiene, β-methylbivinyl; hemiterpene.*

**Isoprene rubber** *n.* The *cis*-1,4-type of polyisoprene.

**Isopropyl acetate** *n.* $(CH_3)_2CHOOCCH_3$. A colorless, fragrant liquid used as a solvent for cellulose nitrate, ethyl cellulose, polyvinyl acetate, polymethyl methacrylate, polystyrene, and certain phenolic and alkyd resins. It has bp of 90°C, Sp gr of 0.930, flp of 33°F, and a vp of 45 mmHg/20°C.

**Isopropyl alcohol** (1872) (2-propanol, dimethyl carbinol) *n.* $(CH_3)_2CHOH$. A colorless solvent boiling at 82.4°C, moderately polar, which, because of its low toxicity, is enjoying greater use today than formerly in the plastics industry. It has a bp of 82°C, Sp gr of 0.791/15°C, a flp of 62°F, and a vp of 34 mmHg/20°C.

*Also known as propanol-2.*

**Isopropylbenzene** (isopropylbenzol) *n.* Syn: cumene.

**Isopropyl butyrate** *n.* $(CH_3)_2CHCOOC_3H_7$. It has a bp of 128°C and Sp gr of 0.879/0°C.

**Isopropyl cellosolve** *n.* $(CH_3)_2CHOCH_2$-$CH_2OH$. It has a bp of 141°C, Sp gr of 0.906/20°C, and a vp of 8 mm Hg per 30°C.

***p,p′*-Isopropylidenediphenol** *See bisphenol A.*

**Isopropyl myristate** $(CH_3)_2CHOOCC_{13}H_{27}$. A plasticizer for cellulosic resins.

**Isopropyl oleate** *n.* $(CH_3)_2CHOOCC_{17}H_{33}$. A plasticizer for cellulose nitrate, ethyl cellulose, and polystyrene, and, with partial compatibility, vinyl resins.

**Isopropyl palmitate** *n.* $(CH_3)_2CHOOCC_{15}H_{31}$. A plasticizer for cellulose nitrate and ethyl cellulose.

**Isostatic pressing** *n.* The process of molding solid articles from fine powders by enclosing the powder in a closed rubber mold, then immersing the mold in a hydraulic fluid and holding it at a controlled temperature and high pressure for 5–30 min. The pressure is equal in all directions and therefore a consistent-molded object is formed. The method though more costly than force-in-mold pressing and much more limited in the shapes producible, provides pieces of more uniform density and strength. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley. Rosato DV (ed) (1992) Rosato's plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York.

**Isotactic** \ˌī-sə-ˈtak-tik\ (1955) *adj.* (1) Denoting a polymer structure in which monomer units attached to a polymer backbone are identical on one side and/or the other side of the backbone. (2) Pertaining to a type of polymeric molecular structure containing a sequence of regularly spaced asymmetric atoms arranged in like configuration in a polymer chain (ASTM D 883). Materials containing isotactic molecules may exist in highly crystalline form because of the high degree of order that may be imparted to such structures. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See also stereospecific, syndiotactic.*

**Isotactic polymer** *n.* A tactic polymer, the base unit of which possesses, as a component of the main chain, a carbon (or similar) atom with two different lateral substituents. These atoms being so arranged that a hypothetical observer advancing along the bonds constituting the main chain finds each of its substituents in the same steric order. *Note*—Here, hydrogen is counted a substituent (IUPAC). Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*Also see atactic polymer, syndiotactic polymer, and tactic polymer.*

**Isotactic polypropylene** *n.* Polypropylene in which each mer unit has the pendant –$CH_3$ group on the same side of the chain backbone. Commercial PPs are about 90% isotactic, conferring high crystallinity and softening range. In contrast, atactic PP is rubbery and weak. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Isotherm** \ˈī-sə-ˌthərm\ [F *isotherme, adj*] (1859) *n.* Constant temperature line used on graphs of climatic conditions or thermodynamic relations, such as pressure–volume relations at constant temperature. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Isothermal** \ˌī-sə-ˈthər-məl\ [F *isotherme*, fr. *is-* + *-therme* fr. Gk *thermos* hot] (1826) *adj.* When a gas passes through a series of pressure and volume variations without change of temperature, the changes are called isothermal. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Isotope** \ˈī-sə-ˌtōp\ [*is-* + Gk *topos* place] (1913) *n.* In chemistry, one of two or more forms of an element ("nuclides") having the same number of protons in the nucleus but differing in mass number because of different numbers of neutrons. Natural elements are usually mixtures of isotopes; thus the observed atomic weights are average values weighted by isotopic relative abundance. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Isotope dating** A method of determining a period in time using the rate of deterioration of an unstable isotope. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

*See carbon dating.*

**Isotope effect** The dependence of a property such as reaction rate on the mass number of an element. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Isotopes** *n.* Atoms of an element having different numbers of neutrons in their nuclei, and hence, different mass numbers. Isotopes of a given element have the same number of nuclear protons but differing numbers of neutrons. Naturally occurring chemical elements are usually mixtures of isotopes so that observed (non-integer) atomic weights are average values for the mixture. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. *See atomic number.*

**Isotropic** [ISV] (ca. 1860) *adj.* Substances showing a single refractive index at a given temperature and wavelength no matter what the direction of light through the particle. They show no interference colors between crossed polars. Examples are unstrained glasses, unoriented polymers, and compounds in the cubic system. Meeten GH (1986) Optical properties of polymers. Springer-Verlag, New York.

**Isotropic laminate** *n.* A laminate in which the strength properties are equal, or approximately equal, in all directions. Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK.

**Isotropy [ISV]** (ca. 1860) *adj.* A materials state in which the material properties are the same in all directions. Meeten GH (1986) Optical properties of polymers. Springer-Verlag, New York.

**Itaconic acid** \ˌi-tə-ˈkä-nik-\ [ISV, anagram of *aconitic acid*, $C_3H_3(COOH)_3$, fr. *aconite*] (ca. 1872) (methylenesuccinic acid HOO CC $(=CH_2)CH_2COOH$ *n.* A white crystalline powder usually obtained by the oxidative fermentation of sucrose or glucose with *Aspergillyus terreus*. It is capable of polymerization alone, or as a comonomer with acrylic acid, acrylonitrile, styrene, methyl methacrylate, and vinylidene chloride. It is used as an additive in acrylic resins to increase their adhesion to cellulose. By polycondensation of itaconic acid with diols, polyesters are obtained that contain methylene side groups. Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001.

*Also called methylenebutanedioic acid and methylene-succinic acid.*

**IUPAC** *n.* Abbreviation for international union of pure and applied chemistry, headquartered in Oxford, England. Progress in polymer science and technology: 2002 IUPAC World Polymer Congress, Beijing, China, July 7–12, 2002, John Wiley and Sons, New York. IUPAC handbook, 2000–2001. International Union of Pure and Applied Chemistry, Oxford, England, 2000.

**IVE** *Abbreviation for vinylisobutyl ether.*

**Izod impact strength** *n.* A widely used measure of impact strength (www.astm.org) determined by the difference in energy of a swinging pendulum before and after it breaks a notched specimen clamped vertically as a cantilever beam. The pendulum is released from a vertical height of 0.61 m, and the vertical height to which it rises after breaking the specimen is used to calculate the energy expended in that breakage. The notch across the width of the specimen is usually on the side opposite the side impacted, but the reverse setup is provided for and specimens may also be tested unnotched. www.astm.org. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

# J

**J** *n.* (1) The SI abbreviation for joule. (2) In most references to technical publications whose title contains the word "Journal", the abbreviation of that word. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. CRC Press, Boca Raton, FL.

**J-acid** *n.* Fusion product of beta-naphthylamine-3,6-bisulfonic acid with caustic. Used in the manufacture of dyes. *Also known as 2-amino-5-naphthol-7-sulfonic acid and 6-amino-1-naphthol-3-sulfonic acid.*

**Jack** \ˈjak\ [ME *Jacke*, familiar term of address to a social inferiorm nickname for *Johan* John] (1548) *n.* (1) A blade having high and/or low butts used to actuate the movement of latch knitting needles. (2) Part of a dobby head designed to serve as a lever in the operation of the harness of a loom. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Jacket** \ˈja-kət\ [ME *jaket*, fr. MF *jacquet*, dimin. of *jaque* short jacket, fr. *jacque* peasant, fr. the name *Jacques* James] (15c) *n.* (1) A woven or felted tubular sleeve for covering and shrinking on a machine roll. (2) A short coat. (3) In polymer manufacture, an external shell around a reaction vessel. For example, jacketed vessels are used when heat-transfer medium is circulated around the vessel. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Jacquard** \ˈja-ˌkärd\ (1841) *n.* A system of weaving that utilizes a highly versatile pattern mechanism to permit the production of large, intricate designs. The weave pattern is achieved by a series of punched cards. Each card perforation controls the action of one warp thread for the passage of one pick. The machine may carry a large number of cards, depending upon the design, because there is a separate card for each pick in the pattern. Jacquard weaving is used for tapestry, brocade, damask, brocatelle, figured necktie and dress fabrics, and some floor coverings. A similar device is used for the production of figured patterns on some knit goods. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Jalousie** \ˈja-lə-sē\ [F] (1766) *n.* A window with movable, horizontal glass slats angled to admit ventilation and keep out rain. The term is also used for outside shutters of wood constructed in this way. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Jamb** \ˈjam\ [ME *jambe*, fr. MF, LL *gamba*] (14c) *n.* Vertical face inside an opening to the full thickness of a wall; vertical slide members of a window frame, door frame, or lining. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Jamba seed oil** *n.* Non-drying oil, similar to rape oil, obtained from the seeds of *Eruca sativa*. Its main constituent acids are erucic, oleic, and linoleic. Approximate constants: Sp gr, 0.916/15°C; iodine value, 100; saponification value, 173.

**Japan** \jə-ˈpan\ (1688) *n.* Glossy black enamel, either air drying or baking, based on asphaltum and drying oil. Japan should not be confused with black enamels which are produced by pigmentation and do not have an asphaltum base. Ash M, Ash I (1982–1983) Encyclopedia of plastics, polymers, and resins, vols 1–3. Chemical Publishing Co., New York.
*Also known as black Japan.*

**Japan color** *n.* Paste containing pigment and a grinding Japan vehicle, used for lettering and decorating.

**Japan drier** Resinate-base liquid drier. *See resinates, metallic.*

**Japanese lacquer** *n.* A glossy coating obtained by tapping the sap from the Japanese varnish tree (*Rhus vernicifera*) or sumac. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Weismantal GF (1981) Paint handbook. McGraw-Hill Corp. Inc., New York.

**Japan, grinding** *n.* Rapid, hard-drying varnish suitable for use as a vehicle for Japan colors; frequently contains shellac. Weismantal GF (1981) Paint handbook. McGraw-Hill Corp. Inc., New York.

**Japanners' brown** *n.* A brown pigment made by high temperature oxidation of ferrous hydroxide precipitated from a solution of an iron salt. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Japanning** Process of finishing with a baking black Japan.

**Japan wax** (1859) *n.* Product obtained from the berries of trees indigenous to Japan and China. Although described as a wax, it differs from waxes in composition, in that it is a mixture of triglycerides. Mp, 52°C; Sp gr, 0.987/15°C; saponification value, 215; iodine value, 11. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols I–III. Chemical Publishing Co., New York.

**Jar mill** *n.* A small ball mill utilizing a portable jar of porcelain or metal rather than a fixed cylinder for containing the material to be ground and the grinding media. After being charged and tightly closed, the jar is placed on a pair of rubber rollers – one driven, the other idling – and rotated for the desired time, typically overnight. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York. Weismantal GF (1981) Paint handbook. McGraw-Hill Corp. Inc., New York. *See ball mill.*

**Jasmine oil** \ˈjaz-mən-\ [Arabic yāsamīn, from Persian] An essential oil in perfumery, fragranced, and flavoring, dextrorotatory *n.* Origin: any of numerous often climbing scrubs (genus *Jasminum*) of the olive family that usually have extremely fragrant flowers. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Shahidi F, Bailey AE (eds) (2005) Bailey's industrial oil and fat products. John Wiley and Sons, New York. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Jaspé** *n.* (1) A fabric used for suiting, draperies, or upholstery characterized by a series of faint stripes formed by dark, medium, and light yarns of the same color. (2) A term describing carpets having a faint striped effect. Tortora PG, Merkel RS (2000) Fairchild's dictionary of textiles, 7th edn. Fairchild Publications, New York.

**Javalle water** \zha-ˈvel\ *n.* Sodium hypochlorite (NaHClO) dissolved in water, a disinfectant and bleaching solution. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**J-box** *n.* A J-shaped holding device used in continuous operations to provide varying amounts of intermediate material storage such as in wet processing of fabrics and in tow production. The material is fed to the top and pleated to fill the long arm before being withdrawn from the short arm. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

**JCT** *n.* Abbreviation for the journal of coatings technology.

**J-cut** *n.* In tufting cut-pile carpet constructions, uneven cutting of the loops caused by poor adjustment of knives and hooks or excessive tension.

**Jean** \ˈjēn\ [short for *jean fustian*, fr. ME *Gene* Genoa, Italy + *fustian*] (1577) *n.* Cotton twill fabric, similar to denim, but lighter and finer, in a 2/1 weave for sportswear and linings. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Jeffamine®** *n.* Trade mark (Texaco, TX, USA) for polyoxypropyleneamines, grades are 3-diamine, 1-triamaine, liquid form, and corrosive. Used as curing agent for epoxy resin systems in adhesives, elastomers, and foam formulations, and as an intermediate for textile and paper-treating chemicals. Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products – chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York.

**Jersey** \ˈjər-zē\ (1587) *n.* (1) A circular-knit or flat-knit fabric made with a plain stitch in which the loops intermesh in only one direction. As a result, the appearance of the face and the back of a jersey fabric is wholly different. (2) A tricot fabric made with a simple stitch, characterized by excellent drape and wrinkle recovery properties. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Jet** \ˈjet\ [ME, fr. MF *jaiet*, fr. L *gagates*, fr. Gk *gagatēs*, fr. *Gagas*, town and river in Asia Minor] (14c) *n.* Term used to describe the blackness or intensity of the mass tone of black or near black surfaces. It is frequently used to describe dark blues, blue-black, or black pigments. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Jet** A device used to bulk yarns by introducing curls, coils, and loops that are formed by the action of a high velocity stream, usually of air or steam. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

**Jet abrader** *n.* Device used for measuring the abrasion resistance of organic coating materials, in terms of the time required for a controlled jet of fine abrasive particles to abrade through the coating to the substrate.

**Jet-abrasion test** *n.* A test for the abrasion resistance of coatings in which the time required for an air blast of fine abrasive particles to wear through the coating is measured (ASTM D 658, Section 06.01).

**Jet dyeing machine** *n.* A high temperature piece dyeing machine that circulates the dye liquor through a Venturi jet, thus imparting a driving force to move the fabric. The fabric, in rope form, is sewn together to form a loop.

**Jet loom** *n.* A shuttleless loom that employs a jet of water or air to carry the filling yarn through the shed.

*Also weft insertion.*

**Jet molding** (offset molding) *n.* A modification of injection molding designed for molding thermosets. An elongated nozzle or "jet" is attached to the front of the molding cylinder and is provided with a high-watt-density heating element and means for rapid cooling. It is also necessary to control cylinder temperatures carefully to prevent premature hardening of the resin. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Jet printing** *n.* A process, wherein charged ink droplets are emitted from a nozzle and deflected vertically and horizontally by positively and negatively charged electrodes. The operation is analogous to electron beam tracing as in television tubes and, consequently, is extremely fast with speeds of over 1200 words per min easily attained. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Jet spinning** *n.* For most purposes, similar to melt spinning of staple fiber. Hot-gas-jet spinning uses a directed jet of hot gas to "pull" molten polymer from a die lip and instantly draw it into fine fibers. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Jetting** *n.* In injection molding, a wriggly flow of resin from a small gate into the mold cavity, mistakenly referred to as turbulence and probably related to melt fracture. Jetting is the antithesis of the desired laminar flow forming a smooth flow front across the mold. It can cause strength problems in molded parts because of incomplete welding of the wormlike surfaces of the jet. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Jewelers' rouge** \ˈjü-ə-lərs ˈrüzh *esp. Southern* ˈrüj\ *n.* Very fine and pure ferric oxide ($Fe_2O_3$) powder used for polishing metals and plastics. *Rouge paper* contains the same abrasive glued to paper. It also comes in cloth form, called *crocus cloth.* James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Jig** \ˈjig\ [perhaps fr. MF *giguer* to frolic, fr. *gigue* fiddle, of Gr origin; akin to OHGr *gīga* fiddle; akin to ON *geiga* to turn aside] (ca. 1560) *n.* (1) A device for positioning component parts while they are being assembled or otherwise worked on, or for holding tools. (2) A clamping device used to secure a bonded assembly until the adhesive has set. (3) A restraining frame into which freshly molded parts are placed to prevent their warping during annealing or final cooling. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Joggles** \ˈjä-gəl\ [frequentative of $^{1}$*jog*] (1513) (keys) *v.* A term sometimes employed for matching inserts that exactly position the parts of a multipiece mold. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**Joining** \ˈjói-niŋ\ (14c) *n.* The process of assembling plastic parts by means of mechanical fastening devices such as rivets, screws, clamps, etc.

*See also fabricate.*

**Joint** \ˈjóint\ [ME *jointe*, fr. OF, fr. *joindre*] (13c) *n.* The location where two separately made parts are joined with each other by adhesive bonding, welding, or fastening. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

*See also butt joint, lap joint, and scarf joint.*

**Joint filler** *n.* Sealant inserted between abutting ends of wallboard.

**Joint, scarf** *n.* A joint made by cutting away similar angular segments of two adherents and bonding the adherents with the cut areas fitted together. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

*See also joint, lap.*

**Joint, starved** *n.* A joint that has an insufficient amount of adhesive to produce a satisfactory bond. *Note* – This condition may result from too thin a spread to fill the gap between the adherents, excessive penetration of the adhesive into the adherent, too short an assembly time, or the use of excessive pressure.

*See starved joint.*

**Joint tape** *n.* Paper or paper-faced cotton tape, metal, fabric, glass mesh, or other material, sometimes embossed or perforated, which is fixed over the joints between wallboards, to conceal the joints and provide a smooth surface for painting.

**Joist** \ˈjóist\ (ME *joiste*, fr. MF *giste*, fr. (assumed) VL *jacitum*, fr. L *jacēre*] (15c) *n.* A small rectangular sectional member arranged parallel from wall to wall in a building, or resting on beams or girders. They support a floor or the laths or furring strips of a ceiling.

**Jolly balance** *n.* Spring balance for determining the specific gravity of a solid by weighing it alternatively in air and water.

**Joule** \ˈjü(ə)l *also* ÷ˈjaü(ə)l\ [James P. *Joule*] (1882) (J) *n.* The SI unit of work and energy, equal to 1 Nm, that replaces a variety of not-quite-equal older joules as well as numerous calories, all of which equal 4.18–4.19 J. Six different British thermal units are all about equal to 1055 J. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Joule–Thomson effect** *n.* The cooling which occurs when a highly compressed gas is allowed to expand in such a way that no external work is done is known as the Joule–Thomson effect. This cooling is inversely proportional to the square of the absolute temperature. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Journal of coatings technology** (JCT) *n.* The official journal of the Federation of Societies for Coatings Technology.

**Journeyman painter** *n.* One who has had at least 3 years experience and schooling as an apprentice.

**Juniper gum** \ˈjü-nə-pər-\. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

*See gum sandarac.*

**Juta hycica resin** *n.* Brazilian resin occasionally used in certain types of varnishes. It is a very hard and pale-colored material, insoluble in most of the common solvents. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Jute (Burlap)** \ˈjüt\ [Bengali *jhuto*] (1746) *n.* A fiber obtained from the stems of several species of the plant *Corchorus* grown mainly in India and Pakistan. It is used in the form of fiber, yarn, and fabric for reinforcing phenolic and polyester resins. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Jute count** *n.* The weight in pounds of a spindle of 14,400 yards of yarn.

**Jute seed oil** *n.* Obtained from the seed of *Corchorus capsularis*, grown chiefly in Indian, Egypt, and China. It contains linoleic and oleic acids. Iodine value, 103; Sp gr, 0.921/15°C; saponification value, 185; acetyl value 27. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

# K

**k** \ˈkā\ *n.* (1) Abbreviation for SI prefix, kilo-. (2) Symbol for thermal conductivity. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**k′** Symbol for Huggins constant. Huggins ML (1958) Physical chemistry of high polymers. John Wiley and Sons Inc., New York.

**K** (1) Abbreviation for kelvin. (2) Chemical symbol for potassium (Latin: kalium). (3) Symbol for bulk modulus.

**Kakemono** \ˌkä-ki-ˈmō-(ˌ)nō\ [Japanese] (1890) *n.* A painting mounted on a margin of brocade; hung by its top when in use, and rolled up when not in use.

**Kalrez®** Dupont's trade name for fluoroelastomers made from tetrafluoroethylene, perfluorovinylmethyl ether, and a small percentage of cross-linkable monomer. These elastomers combine the rubbery properties of viton with the thermal stability, chemical resistance, and electrical characteristics of tetrafluoroethylene resin. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York.

**Kalsomine** *See calcimine.*

**Kaolin** \ˈkā-ə-lən\ [F *kaolin*, fr. *Gaoling* hill in China] (ca. 1741) (China clay, bolus alba) *n.* A variety of clay consisting essentially of the minerals *kaolinite*, *dickite*, and *nacrite* (all are $Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$). The name kaolin comes from the Chinese *kaoling*, meaning high hill, the name of the mountain in China, which yielded the first kaolin sent to Europe. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York.

**Kaolinite** \-lə-ˌnīt\ (1867) *n.* $Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$. A finely divided crystalline form of hydrated aluminum silicate that occurs as monoclinic crystals with a basal cleavage, resulting chiefly from the alteration of feldspars under conditions of hydrothermal or pneumatolytic metamorphism. It is an important clay mineral. Density, $2.58\,g/cm^3$ (21.5 lb/gal); refractive index, 156; O.A., 32–55; Mohs hardness, 2.5. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Kapok** \ˈkā-ˌpäk\ [Malay] (ca. 1750) *n.* Short, lightweight cotton-like fibers from the seed pod of trees of the family *Bombacabeae.* A very brittle fiber, it is generally not spun. It is used for stuffing cushions, mattresses, etc., and for life jackets because of its buoyancy and moisture resistance. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Vincenti R (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Karaya gum** \kə-ˈrī-ə-\ [Hindi *karāyal* resin] (1916) *n.* Dry exudation from *Sterculia urens*, which grows in India. It swells in water, and has some resemblance to gum tragacanth.

*Also known as gum karaya.* Whistler JN, BeMiller JN (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Karl Fischer reagent** A colored solution of iodine, sulfur dioxide, and pyridine in methanol. It reacts quantitatively with water, becoming colorless. It is used to determine small amounts of water in a wide range of materials, including many polymerics. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Kauri** \ˈkau(-ə)r-ē\ [Maori *kawri*] (1823) *n.* A fossil copal resin used in oleo-resinous varnishes found in New Zealand. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Kauri-butanol value** Volume in ml at 25°C (77°F) of a solvent, corrected to a defined standard, required to produce a defined degree of turbidity when added to 20g of a standard solution of kauri resin in normal butyl alcohol. For kauri-butanol values of 69 and above, the standard is toluene and has an assigned value of 105. For kauri-butanol values below 60, the standard is a blend of 75% *n*-heptane and 25% toluene and has an assigned value of 40. Abbreviation is KB value. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001. Flick EW (1991) Industrial synthetic resins handbook. Williams Andrews Publishing/Noyes, New York.

**Kauri reduction test** Test for measuring the flexibility of a varnish. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Kauri glue** Urea-formaldehyde resin, manufactured by BASF, Germany.

**Kautex** Polyvinyl chloride, manufactured by Kautex Werke, Germany.

**Kautschin** *See dipentine.*

**KB value** A numerical measure of the solvent power of hydrocarbon solvents and oils using a kauri-butanol reagent. The values range from 20, which is a poor solvent, to a high of 105, which is an excellent solvent. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

*See kauri-butanol value.*

**Kel-F elastomer** Co-polymer from vinylidene fluoride and trifluorochloroethylene. Manufactured by M. W. Kellog, USA.

**Kelvin** \ˈkel-vən\ [William Thomson, Lord *Kelvin* (1824–1907)] (1968) (K) *n.* The SI unit of both temperature and difference between temperatures, equal to 1/273.16 of the thermodynamic triple point of water, i.e., the temperature and pressure at which all three phases of water – ice, liquid, and vapor – are in equilibrium. A change or difference of 1K is exactly equal to 1° difference on the Celsius (formerly centigrade) scale, and the temperature 0°C corresponds to 273.15K. Symbol K; the name "degree of Kelvin" (symbol K) was discontinued by international agreement in 1967.

**Kelvin temperature scale** An absolute temperature scale, in which the unit is the Kelvin (K), defined as 1/273.16 of the temperature difference between absolute zero (0K) and the triple point of water. $K = °C + 273$. This scale is used to describe the correlated color temperature of light sources and illuminants in color designations and color rendition. Symbol K. *See correlated color temperature and Kelvin.* Kelvin is used extensively in gas laws and calculation for expansion of gases. Theoretically, all molecular motions cease at 0K or absolute zero temperature. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Keratin** \ˈker-ə-tᵊn\ [ISV] (ca. 1849) *n.* (1) The protein derived from feathers, hair, hoofs, horns, etc. of animals by calcinations. It is sometimes used as filler in plastics, particularly urea-formaldehyde molding compounds, in which it reduces brittleness and permits drilling and tapping. (2) A class of natural fibrous proteins occurring in vertebrate animals and man, characterized by their high content of several amino acids, especially crystine, arginine, and serine. They are generally harder than the fibrous collagen group of proteins. Keratins are insoluble in organic solvents but do absorb and hold water. The molecules contain both acidic and basic groups and are thus amphoteric. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Kernel** \ˈkər-nᵊl\ [ME, fr. OE *cyrnel*, dim. of *corn*] (before 12c) *n.* All of an atom except for its valence shell of electrons; also called the *core*.

**Kerosene** \ˈker-ə-ˌsēn\ [Gk *kēros* + E *–ene* (as in *camphene*] (1854) (*or* kerosene) *n.* A low viscosity oil distilled from petroleum or shale oil, used as a fuel, paint thinner, and alcohol denaturant. Wypych G (2001) Handbook of solvents. Chemtec Publishing, New York.

**Kerr effect** *n.* When plane polarized light is incident on the pole of an electromagnet, polished so as to act like a mirror, the plane of polarization of the reflected light is not the same when the magnet is "on" as when it is "off". It was found that the direction of rotation was opposite to that of the currents exciting the pole from which the light was reflected. Weast RC (1979) CRC handbook of chemistry and physics, 59th edn. CRC Press, Boca Raton, FL.

**Kerrolic acid** *n.* $C_{15}H_{27}(OH)_4COOH$. Monobasic tetrahydroxy acid constituent of shellac.

**Kersey** \ˈkər-zē\ [ME, fr. *Kersey*, England] (14c) *n.* A heavily milled woolen fabric having a high lustrous nap and a "grainy" face, kersey is frequently used in overcoats.

**Ketohexamethylene** Syn: cyclohexanone.

**Ketone** \ˈkē-ˌtōn\ [Gr *Keton*, alter. of *Aceton* acetone] (1851) *n.* An organic compound containing a carbonyl group (C=O) bound to two carbon atoms. The simplest one is acetone $(CH_3)_2C{=}O$. It and the other lower ketones are widely used as solvents for vinyl and cellulosic resins, and as intermediates in the production of resins. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ketone-based resins** *n.* Consist of ether and ketone groups combined with phenyl rings in different sequences. The rigid ketone and phenyl groups produce high thermal stability. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ketone condensation resins** *n.* Resins produced as the result of condensation of ketones and aldehydes, e.g., the resin obtained from methyl ethyl ketone and formaldehyde. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Ketones** *n.* A class of strong organic solvents used in gravure inks; for example, acetone, methyl ethyl ketone (MEK). Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

**Kettle** \ˈke-tᵊl\ [ME ketel, fr. ON ketill (akin to OE *cietel* kettle), both from a prehistoric Germanic word borrowed fr. L *catillus*, dimin. of *catinus* bowl] (13c) *n.* Reaction vessel for varnish or resin manufacture.

**Kevlar®** *n.* DuPont's trade name for poly-(*p*-phenylene terephthalamide) fibers. *See aramid.*

**K-factor** *n.* A term sometimes used (incorrectly) for insulation value or used for thermal conductivity.

**K film** *n.* A chemical wood pulp made by the sulfate process, or paper or paperboard made from such pulp.

**kg** SI abbreviation for kilogram. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Khaki** \ˈka-kē, ˈkä-, *Canad often* ˈkär-\ [Hindi *khākī* dust-colored, fr. *khāk* dust, fr Persian] (1857) *n.* (1) A light yellowish brown. (2) A khaki-colored cloth of cotton, wool, or combinations of these fibers with manufactured fibers used primarily in military uniforms and work clothes. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**KHN** *See knoop hardness number.*

**Kibbled** \ˈki-bəl\ (ca. 1790) *vt.* Broken into small lumps, about 1/4in. diameter, e.g., kibbled glue.

**Kick board** *See baseboard.*

**Kidney oil** *n.* Fraction boiling between 250 and 270°C, obtained by the destructive distillation of rosin.

**Kienle's functionality theory** *n.* Fundamental postulate which covers, among other things, the likelihood of reactions between compounds to form products of high molecular weight; and the relation between size and shape of reacting molecules and physical properties of the reaction products. Fundamentals of polymer science: an introductory text. CRC Press, Boca Raton, FL, 1998. Kroschwitz JI (ed) (1990) Concise dictionary of polymer science and engineering. John Wiley and Sons, New York.

**Kier** *n.* A large metal tank, capable of being heated uniformly, used for wet processing.

**Kier boiling** Process of boiling cellulosic materials in alkaline liquors in a kier at or above atmospheric pressure.

**Kieselguhr** \ˈkē-zəl-ˌgur\ [Gr *Kieselgur*] (1875) *n.* Alternate name for diatomite. *See diatomaceous silica.*

**Kiln** \ˈkiln, ˈkil\ [ME *kilne*, fr. OE *cyln*, fr. L *culina* kitchen, fr. *coquere* to cook] (before 12c) *n.* An oven, furnace, or heated enclosure used for processing a substance by burning, firing, or drying.

**Kiln dried** *n.* Lumber dried in chambers. Heat is controlled to prevent cracking and warping. Syn: kiln seasoned.

**Kiln seasoned** *See kiln dried.*

**kilo-** \ˈkē-(ˌ)lō *also* ˈki-\ *combining form* [F, mod. of Gk *chilioi*] (k). The SI prefix meaning $\times 10^3$.

**Kilogram** \-ˌgram\ [F *kilogramme*, fr. *kilo* + *gramme* gram] (1797) (kg) *n.* One of the basic units of SI, the mass of a particular platinum cylinder kept at the International Bureau of Weights and Measures in Paris. One avoirdupois pound = 0.4535924kg. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Kinel** Polyimide, manufactured by Rhone Poulenc, France.

**Kinematics** \ˌki-nə-ˈma-tiks\ [F. *cinématique*, fr. Gk *kinēmat*-, *kinēma* motion, fr. *kinein* to move] (1840) *n. plural but singular in construction.* A branch of dynamics that deals with aspects of motion apart from considerations of mass and force.

**Kinematic viscosity** (kinetic viscosity) *n.* The absolute (dynamic) viscosity of a fluid divided by the density of the fluid. The SI unit is $m^2/s$, but the cgs unit, the *stoke*, which equals $10^{-4} m^2/s$, is still in wide use, as is its submultiple, the centistoke. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK.

**Kinetic energy** (1870) *n.* Energy associated with the motion of an object. An object of mass *m* moving at velocity *v* has kinetic energy $1/2mv^2$. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Kinetic-energy correction** *n.* (1) In the Izod, Charpy, and tensile-impact tests, a subtraction of the kinetic energy imparted to the broken-off part of the specimen. (2) In measurement of dilute-solution viscosity a correction for the energy required to accelerate the liquid in the reservoir to its higher velocity in the capillary. A similar correction is theoretically needed in melt rheometry, but has so far been found to be much smaller than the errors of measurement. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

**Kinetics** \kə-ˈne-tiks *also* kī-\ (ca. 1859) *n.* A branch of dynamics concerned with the relations between the movement of bodies and the forces acting upon them. Connors KA (1990) Chemical kinetics. John Wiley and Sons, New York.

**Kinetic theory** (1864) *n.* Either of two theories in physics based on the fact that the minute particles of a substance are in vigorous motion. The first theory is that the particles of a gas move in straight lines with high average velocity, continually encounter one another and thus change their individual velocities and directions, and cause pressure by their impact against the walls of a container.

*Also known as the kinetic theory of gases.* The second theory is that the temperature of a substance increases with an increase in either the average kinetic energy of the particles or the average potential energy of separation (as in fusion) of the particles or in both when heat is added.

Also known as the kinetic theory of heat. Connors KA (1990) Chemical kinetics. John Wiley and Sons, New York.

**Kink** \ˈkiŋk\ [D; akin to MLGr *kinke* kink] (1678) *n.* (1) In fabrics, a place where a short length of yarn has spontaneously doubled back on itself. (2) In yarn, *see snarl.*

**Kinking** *n.* The doubling back of yarn on itself to relieve torque imparted by twisting or texturing.

*See kink.*

**Kira-ye** [Japanese]. A print with a mica background.

**Kirchhoff's law** (emissivity). $1 = \varepsilon_R + \varepsilon_T + \varepsilon_A$, where $\varepsilon_R$ is the energy reflected, $\varepsilon_T$ the energy transmitted through the material, and $\varepsilon_A$ is the energy absorbed by the material, which is reemitted. The ability to reemit the energy is the emissivity. The common emissivity ($\varepsilon$) of a material is equal to $1 - \varepsilon_R$. This is an indicator of the property of a material to absorb radiation such as white light or infrared radiation and a perfect absorber of energy is a black body, where $\varepsilon = 1$. Driggers RC, Cox P, Edwards T (1998) Introduction to infrared and electro-optical systems. Artech House Inc., Aylesford, UK. Klocek P (ed) (1991) Handbook of infrared materials. Marcel Dekker, New York.

**Kirksite** An alloy of aluminum and zinc, easily castable at relatively low temperatures, often used for molds for blow molding. Its high thermal conductivity hastens cooling.

**Kling test** A method for determining the degree of fusion between flexible vinyl sheets, coated fabrics, and thin sections of cast or molded parts, by immersing the folded specimen in a solvent and observing the elapsed time at which disintegration commences. Useful solvent systems comprise methyl ethyl ketone, tetrahydrofuran, ethyl acetate, and carbon tetrachloride. The preferred solvent system is one that will initiate degradation within 5–10 min in a fully fused specimen. Wickson EJ (ed)

(1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Kneader** \ˈnēd-\ [ME *kneden*, fr. OE *cnedan*; akin to OHGr *knetan* to knead] (before 12c) *n.* A mixer with a pair of intermeshing blades, often S-shaped, used for working plastic masses of semidry or rubbery consistency. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Knee break-out test** *n.* A method to evaluate the performance of fabrics, especially boys' wear, when subjected to abrasion, stretch, and impact forces under conditions which simulate ordinary wear at the knee. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Kneeing** *n.* Abnormal behavior of a spinning threadline (especially in melt spinning) in which one or more filaments form an angle (knee).

**Knife coating** *n.* A method of coating a substrate in which the substrate, in the form of a continuous moving web, is coated with a plastic whose thickness is controlled by an adjustable knife or bar set at a suitable angle to the substrate.

*See spread coating and air-knife coating.*

**Knife mark** *See doctor mark.*

**Knife test** *n.* Test for brittleness, toughness, and tendency to ribbon, by cutting a narrow strip of the coating from the test panel, with a knife. It is not recommended as a test for adhesion, as other methods are more accurate. Weldon DG (2001) Failure analysis of paints and coatings. John Wiley and Sons, New York. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Knifing filler** *n.* Filling composition suitable for application with a filling knife as distinct from one made for brush application.

**Knit-de-knit** *See texturing.*

**Knit fabric** *n.* A structure produced by interlooping one or more ends of yarn or comparable material.

*Also see knitting.*

**Knit-miss** *n.* A form of tricot knitting in which yarns on each bar of a two-bar machine are knit at alternate courses only. This type of knitting permits the use of heavy-denier yarns without creating undesirable bulkiness in the fabric. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Knitting** *n.* A type of knitting in which the yarns run lengthwise in the fabric. The yarns are prepared as warps on beams with one or more yarns for each needle. Examples of this type of knitting are tricot, milanese, and raschel knitting. (a) *Milanese Knitting*: A type of run-resistant warp knitting with a diagonal rib effect using several sets of yarns. (b) *Raschel knitting*: A versatile type of warp knitting made in plain and Jacquard patterns; the latter can be made with intricate eyelet and lacy patterns and is often used for underwear fabrics. Raschel fabrics are coarser than other warp-knit fabrics, but a wide range of fabrics can be made. Raschel knitting machines have one or two sets of latch needles and up to 30 sets of guides. (c) *Tricot knitting*: A run-resistant type of warp knitting in which either single or double sets of yarn are used. *Also see tricot.* (d) *Weft knitting*: A common type of knitting, in which one continuous thread runs crosswise in the fabric making all of the loops in one course. Weft knitting types are circular and flat knitting. (e) *Circular knitting*: The fabric is produced on the knitting machine in the form of a tube, the threads running continuously around the fabric. (f) *Flat knitting*: The fabric is produced on the knitting machine in flat form, the threads alternating back and forth a cross the fabric. The fabric can be given shape in the knitting process by increasing or decreasing loops. Full-fashioned garments are made on a flat knitting machine. *Also see flat-knit fabric* {*knitted fabric* G Gewirke n, F tissu tricoté, tissu m, S género de punto, génaro m, I tessuto a maglia, tessuto m}. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education. New York. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Knockout** \ˈnäk-ˌaút\ (1887) *n.* Any part or mechanism of a mold whose function is to eject the molded article. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Knoop hardness number, KHN** *n.* The indentation hardness determined with a Knoop indenter, and calculated as follows:

$$\mathrm{KHN} = \frac{L}{A_\mathrm{p}} = \frac{L}{l^2 C_\mathrm{p}},$$

where $L$ is the load in kilogram applied to the indenter, $l^2$ the measured length of long diagonal of the indention in millimeters, $C_\mathrm{p}$ the indenter constant relating $l^2$ to $A_\mathrm{p}$, and $A_\mathrm{p}$ is the projected area of indention in mm$^2$. www.astm.org. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Knoop hardness test** *n.* An indentation hardness test using calibrated machines to force a rhombic-based pyramidal diamond indenter having specific edge angles, under specified conditions, into the surface of the material under test and to measure the long diagonal after removal of the load. www.astm.org. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Knoop indenter** *n.* Pyramidal diamond of prescribed dimensions used for testing the indentation hardness of organic coatings. In a more restricted sense, a type of diamond hardness indenter having edge angles of 172°, 30°, and 130°. www.astm.org. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Knoop microhardness** *n.* A test employing a diamond indenter whose point is an obtuse pyramid that makes an indentation of length seven times its width. This tester makes smaller, shallower indentations than Brinell or Vickers, suiting it to testing hardnesses of surfaces, as in case-hardened steel, or coatings. The Knoop hardness number (KHN) is equal to $14.2\,P/L^2$, where $P$ is the applied load in grams and $L$ is the length in millimeters of the long axis of the indentation. www.astm.org. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Knot sealer** *n.* Solutions of various resins in alcohol, used to seal knots in new wood.

**Knot tenacity** (knot strength) *n.* The strength of a yarn specimen containing an overhand knot to measure, by comparison with the strength of the unknotted yarn, its sensitivity to compression or shearing. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Knotting** Fairly concentrated solution of shellac in alcohol, used for sealing knots in new wood. Paint/coatings dictionary. Federation of Societies for Coatings

Technology, Philadelphia, Blue Bell, PA, 1978.

**Knuckle area** *n.* In reinforced plastics, the area of transition between sections of different geometry in a filament-wound part. Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK.

**Kodar** Polyester, manufactured by Eastman, USA.

**Kodel-2** Polyester from terephthalic acid and 1,4-dimethylol cychlohexane, manufactured by Eastman, USA.

**Kodel-10** Poly(ethylene terephthalate), manufactured by Eastman, USA.

**Koettstorfer number** *See saponification value.*

**Kohinoor test** *n.* A test for scratch hardness employing a series of pencils of different hardnesses.

**Kohlrausch–Williams–Watts equation** *n.* This empirical equation aids designers of load-bearing products made of plastics and reinforced plastics.

$$G(t) = G_0 e^{-(t/t_0)^m},$$

where $G(t)$ is the stress-relaxed modulus of the test piece at time $t$ from application of the load, $G_0$ the modulus at the reference time $t_0$, usually in the range of a set of measurements on the logarithmic time scale, and $m$ is the material-specific constant between 0.33 and 0.5 for many polymers and composites. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Kordofan gum** \ˌkór-də-ˈfan-\ *n.* Another name for gum acacia, derived from the Sudanese providence of Kordofan. Whistler JN, BeMiller JN (ed) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Kraemer equation** For dilute polymer solutions, an equation relating the inherent viscosity to intrinsic viscosity and concentration. It is

$$\eta_{\text{inh}} = (\ln \eta_r)/c = [\eta] + k''[\eta]^2 c,$$

where $\eta_r$ is the reduced viscosity, $[\eta]$ the intrinsic viscosity, and $c$ the concentration in g/dl.

*See also Huggins equation and dilute-solution viscosity.* Huggins' constant, $k'$, and Kraemer's, $k$, are related by: $k' - k'' = 0.5$. Thus, since $k'$ is often between 0.6 and 0.8, $k''$ will often lie between 0.1 and 0.3. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Huggins ML (1958) Physical chemistry of high polymers. John Wiley and Sons Inc., New York.

**Kraemer–Sarnow method** (K&S) *n.* Softening point. Method of determining the softening points of resins and aliphatic materials. www.astm.org. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Kraftcord** This yarn produced by tightly twisting plant fiber is sometimes used in carpet backings. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Kraft pulps** *n.* Pulps prepared in the alkaline liquor consisting of sodium hydroxide, sodium carbonate, and sodium sulfide. *Also called sulfate pulp.*

**Kraft yarn** *n.* A yarn made by twisting a strip of paper manufactured from kraft pulp.

**Kralastic** *n.* ABS, manufactured by USA Rubber, USA.

**Krebs–Stormer viscometer** *n.* This is the most commonly used viscometer in the paint industry. Paint consistency is measured by its resistance to stirring by a two-vane paddle. The two vanes are offset to avoid channeling in viscous paints. Approximate weights are added to a platform on a string attached to a pulley, which is connected to the paddle until a speed of 100 rpm is reached, generally measured by a stroboscopic timer. The grams required to reach this speed are then converted, by using a conversion table, to Krebs units. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.
*See viscometer.*

**Krebs unit** *n.* A unit used in reporting viscosity measurements made with the weight-driven stormer viscometer used primarily for evaluating the viscosity of formulated paint and coating materials. A Krebs unit is the weight in grams that will turn a paddle-type rotor, submerged in the sample, 100 rev in 30 s.

**Kroy shrinkproofing process®** *n.* Continuous process for shrinkproofing wool tops in which there is a direct chlorination step with no intervening chemical reaction followed by anti-chlorination and neutralization. Provides better hand and strength than conventional shrinkproofing. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

**Kryston** *n.* Polyester, manufactured by Goodrich, USA.

**Krytox** *n.* Perfluorinated polyether, manufactured by DuPont, USA.

**KU** *See Krebs units.*

**Kubelka–Munk equation** (apply to a single wavelength of light) *n.*

$$R = \frac{1 - R_g(a - b \coth bSX)}{A - R_g + b \coth bSX}$$

coth = hyperboliccontangent; abbreviation $(e^{\mathrm{u}} + 1/e^{\mathrm{u}})/(e^{\mathrm{u}} - 1/e^{\mathrm{u}})$ (1)

$$SX = \frac{1}{b}\left(\operatorname{arc\,coth}\frac{a - R}{b} - \operatorname{arc\,coth}\frac{a - R_g}{b}\right),$$

arc coth = inverse hyperboliccontangent, (2)

where $R$ is the reflectance over substrate of reflectance $R_g$, $R_g$ the reflectance of substrate,

$$a = \frac{S + K}{S} = \frac{1}{2}\left(\frac{1}{R_\infty} + R_\infty\right),$$

$$b = (a^2 - 1)^{1/2} = \frac{1}{2}\left(\frac{1}{R_\infty} + R_\infty\right),$$

$S$ the unit scattering coefficient expressed in $X -1$, $X$ the thickness (or product of thickness times concentration), $R_\infty$ the reflectance at infinite thickness (complete hiding), and $K$ is the unit absorption coefficient expressed in $X-1$.

When hiding in complete (substrate is completely obscured), the first equation reduces to

$$\frac{(1 - R_\infty)^2}{2R_\infty} = \frac{K}{S}$$

and for a mixture of pigments

$$\left(\frac{K}{S}\right)_{\mathrm{MIX}} = \frac{C_1K_1 + C_2K_2 + C_3K_3 + \cdots}{C_1S_1 + C_2S_2 + C_3S_3 + \cdots}, \qquad (3)$$

where the $C$'s refer to relative concentrations of pigments in the mixture (Ec's = 100%) and subscripts identify the pigments. When all of the scatterings come from a single component (such as white pigment in a pasted color or the fiber in a textile), the denominator of the above equation is determined by the *S* of this component, and the equation becomes simply

$$\left(\frac{K}{S}\right)_{\mathrm{MIX}} = C_1\left(\frac{K}{S}\right)_1 + C_2\left(\frac{K}{S}\right)_2 + C_3\left(\frac{K}{S}\right)_3 + \cdots \quad (4)$$

The latter is referred to as the single constant K–M equation compared to the third one using separate *K*'s and *S*'s, which is called the two-constant equation. The above equations are those most widely used for computer color matching. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Kubelka–Munk theory** *n.* A theory describing the optical behavior of materials containing small particles, which scatter and absorb radiant energy. It is widely used for color matching calculations. The mathematical equation describes the reflectance or transmittance in terms of an absorption coefficient, *K*, and a scattering coefficient, *S*. The K–M theory is based on the assumption of multiple scattering, that is, reflectances from one particle to other particles before the reflected radiant energy is observed. This assumed behavior is in contrast to the Mie theory, which is based on an assumption of single isolated scattering of individual particles. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Kusters dyeing range** *n.* Continuous dye range for carpets. The unit wets the carpet, applies dyes and auxiliary chemicals by means of a doctor blade, fixes the dyes in a festoon steamer, and washes and dries the carpet in one pass through the range. An optional auxiliary unit may be installed to randomly drip selected dyes onto the background shade for special styling effects. This process is called TAK dyeing. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

***K*-value** *n.* An alternate name for thermal conductivity.

**Kynol** *n.* Phenol-formaldehyde fiber, manufactured by Carborundium, USA.

# L

**l** \ˈel\ {*often capitalized, often attributive*} (before 12c) (also L). Symbol for length.

**L** (1) Abbreviation for SI-permitted (but discouraged) volume unit, the liter, redefined in 1964 to be exactly $1\,\mathrm{dm}^3$. (2) Symbol for length or magnetic inductance. (3) Abbreviation for lightness, generally used in color order systems to describe the perception of the amount of light reflected or transmitted by materials.

*See lightness and luminance.*

**Labeling** \ˈlā-b(ə-)liŋ\ (1601) *vt.* To affix a precut, printed, flexible material to the surface of a product.

**Labradorite** \ˈla-brə-ˌdór-ˌīt\ [*Labrador* Peninsula, Canada] (1814) *n.* Calcium sodium aluminum silicate, hardness 6 Mohs scale, used as a wear resistant filler in deck paints. Herbst W, Hunger K (2004) Industrial organic pigments. John Wiley and Sons, New York.

**Lac** \ˈlak\ [Persian *lak* & Hindi *lākh*] (1598) *n.* Resin secreted by the female of the insect, *Lacccifer iacca*, and deposited on the twigs of various species of trees in Indian and Indochina. After refining, the resin is known as shellac. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

**Lace** \ˈlās\ [ME, fr. MF *laz*, fr. L *laqueus* snare] (14c) *n.* Ornamental openwork fabric, made in a variety of designs by intricate manipulation of the fiber by machine or by hand. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Lace stitch** In this knitting stitch structure, loops are transferred from the needles on which they are made to adjacent needles to create a fabric with an open or a raised effect. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**L acid** *See cleve's acid.*

**Lac dye** Red dye obtained by the maceration of lac.

**Lacquer** \ˈlac-kər\ [Portuguese lacré sealing wax, fr. *laca* lac, fr. Arabic *lakk*, fr. Persian *lak*] (1592) *n.* (1) A solution of a film-forming natural or synthetic resin in a volatile solvent, with or without color pigment, which when applied to a surface forms an adherent film that hardens solely by evaporation of the solvent. The dried film has the properties of the resin used in making the lacquer. The word derives from the *lac* insect, which secreted the resinous substance from which *shellac* solutions were (and stilla are) made. Today most lacquers are made with cellulosic, alkyd, acrylic, and vinyl resins. (2) Finish on Chinese and Japanese lacquer ware. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

*See spirit varnish.*

**Lactam** [ISV *lact-* + *am*ide] *n.* A cyclic amide obtained by removing one molecule of water from an amino acid. An example is caprolactam.

**Lactic acid** (1790) (milk acid, α-hydroxypropionic acid) *n.* $CH_3CHOH$ $COOH$. A colorless or yellowish liquid with several applications in plastics. Reacted with glycerine, it forms an alkyd resin. It is a catalyst for vinyl polymerizations, and an additive for phenolic casting resins. It has a bp of 122°C/15 mmHg, mp of 18°C, and Sp gr of 1.2

*Also known as alpha-hydroxypropionic acid and milk acid.*

**Lac wax** Wax obtained from lac consisting of myricyl and ceryl alcohols, free and combined with various fatty acids.

**Ladder polymers** (double-stranded polymer). A polymer comprising chains made up of fused rings. Examples are cyclized (acid-treated) rubber and polyimidazopyrrolone.

**Laid-in fabric** A knit fabric in which an effect yarn is tucked in, not knitted into, the fabric structure. The laid-in yarns are held in position by the knitted yarns.
*See axial yarn.*

**Laitance** \ˈlā-tᵊn(t)s\ [F, fr. *lait* milk, fr. L *lact*-, *lac*] (ca. 1902) *n.* Milky white deposit on new concrete; efflorescence.

**Lake** A type of organic pigment prepared from water-soluble acid dyes, precipitated on an inert substrate by means of a metallic salt, tannin, or other reagents. Lakes were used in plastics at one time, but have been replaced by more permanent pigments.

**Lake** \ˈlāk\ [F laque lac, fr. OP *laca*, fr. Arabic *lakk*] (1598) *n.* Special type of pigment consisting essentially of an organic soluble coloring mater combined more or less definitely with an inorganic base or carrier. It is characterized generally by a bright color and more or less pronounced translucency when made into an oil paint. Under this term are included two (or perhaps three) types of pigments: (a) The older original type composed of hydrate of alumina dyed with a solution of the natural organic color. (b) The more modern and far more extensive type made by precipitating from solution various coal-tar colors by means of a metallic salt, tannin, or other suitable reagents, upon a base or carrier either previously prepared or coincidently formed. (c) A number combining both types in varying degree might be regarded as a third class.

**Lake Bordeaux B** Red dyestuff produced from 2,3-hydroxy naphthoic acid and 2-naphthylamine-1-sulfonic acid. The calcium and manganese toners are known as Bordeaux R Toner and Maroon Toner B.B., respectively. The latter has good lightfastness.

**Lake dyes** Dyes used for the making of lakes by combination with, or adsorption on, salts of calcium, barium, chromium, aluminum, phosphotungstic acid, or phosphomolbybdic acid.

**Lake of acid yellow 1** Acid Yellow 1, Lake (10316). A nitro dye prepared by precipitation from an aqueous solution by a metal salt, i.e., aluminum or barium chloride.

**Lake red C** Pigment Red 53 (15585). Red dyestuff derived from 6-chlor-3-toluidine-4-sulfonic acid, and $\beta$-naphthol. When laked with barium chloride, bronze scarlet is obtained.

**Lake red P** Pigment produced by coupling diazotized *p*-nitroaniline-*o*-sulfonic acid with betanaphthol.

**Laketine** A transparent ink used for extending letterpress or lithographic inks.

**Lallemantia oil** Drying oil obtained from the seeds of *Lallemantia iberica*, found in parts of Asia and Europe. It has Sp gr of 0.934/20°C, iodine value of 190, and saponification value of 190. Its main constituents are linolenic and linolenic glycerides.

**LALLS** *See low-angle laser-light scattering.*

**Lambda zero ($\lambda_0$)** In dispersion staining, the wavelength at which both particle and liquid have the same refractive index.

**Lambert** \ˈlam-bərt\ [Johann H. *Lambert* † 1777 German physicist & philosopher] (1915) *n.* A deprecated unit of illumination equal to 1lm/cm$^2$. The SI unit is the *lux* (lx), equal to 1lm/m$^2$, i.e., $10^{-4}$ lambert.
*See also luminous flux.*

**Lambert's law of absorption** *See Bouguer's law.*

**Lambert's law of reflection** The flux reflected per unit solid angle is proportional to the cosine of the angle measured from the normal (perpendicular) to the surface. If the reflected flux is isotropic, the surface is said to be a perfect Lambertian reflector or a perfect diffuser.

**Lamé** \lä-ˈmā, la-\ [F] (1922) *n.* A fabric woven with flat metal threads, usually silver or gold, that form either the background or the pattern.

**Lamellae** \lə-ˈme-lə\ [NL, fr. L, dim. of *lamina* thin plate] (1678) *n.* Thin, flat scales or plates.

**Lamellae structure** Plate-like single crystals that exist in most crystalline polymers. A thin, flat scale or part.

**Lamina** \ˈla-mə-nə\ [L] (ca. 1656) *n.* A single layer or ply within a laminate.

**Laminar flow** Flow without turbulence, i.e., the movement of one layer of fluid past another layer with no eddying between them. Most melt flow, even at high velocities, is laminar. With sudden changes in melt velocity, such as may occur at some extrusion-die entries and at injection-mold gates, laminar flow may be disrupted by melt fracture.

*See Reynolds number. Also see jetting.*

**Laminar scale** Rust formation in heavy layers.

**Laminate** \ˈla-mə-ˌnāt\ (1665) (1, *n*). A product made by bonding together two or more layers of material or materials. The term most usually applies to preformed layers joined by adhesives or by heat and pressure. However, some authors apply the term to composites of plastic films, with other films, foils, and papers, even though they have been made by spread coating or by extrusion coating. In the reinforced-plastics industry, the term refers mainly to superimposed layers of resin-impregnated or resin-coated fabrics or fibrous reinforcements that have been bonded together, usually by heat and pressure, to form a single piece. Wallenberger FT, Weston NE (eds)(2003) Natural fibers, plastics and composites. Springer-Verlag, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Laminate, high pressure** Laminates molded and cured at pressures not lower than 1000 psi, and commonly in the range of 1200–200 psi.

**Laminated fabric** Fabric composed of a high-strength reinforcing scrim or base fabric between two plies of flexible thermoplastic film. Usually open scrims are used to permit the polymer to flow through the interstices and bond during calendering.

**Laminated glass** A structure consisting of two or more parallel sheets or shells of glass interleaved with, and bonded to, layers of tough, sticky plastic, typically polyvinyl butyral or polycarbonate. The former resin is used in the "safety-glass" windshields of USA-made cars. The glass will splinter under a heavy blow, but it is very resistant to penetration and the shards stick to the interlayer.

**Laminated, cross** A laminate in which some of the layers of materials are oriented at right angles to the remaining layers with respect to the grain or strongest direction in tension. *Note* – Balanced construction of the laminations about the center line of the thickness of the laminate is normally assumed.

*See also laminated, parallel.*

**Laminated, parallel** A laminate in which all the layers of materials are oriented approximately parallel with respect to the grain or strongest direction in tension.

*See also laminated, cross.*

**Laminates** Products made by bonding together two or more layers of material and materials.

**Lamination** (ca. 1676) *n.* The process of preparing a laminate. Also, any layer in a laminate.

**Lampblack** \-ˈblak\ (1598) *n.* Pigment Black 6 (77266). A bulky black soot obtained from the incomplete combustion of creosote or fuel oils, of duller and less intense blackness than channel black and other carbon blacks, and having a blue undertone and a small oil content. Syn: Paris black.

**Land** (1) The horizontal bearing surface of a semipositive or flash mold by which excess material escapes. (2) The bearing surface along the top of the flights of an extruder screw. (3) The final shaping surface of an extrusion die, usually parallel to the direction of melt flow. (4, *pl*) The mating surfaces of any mold, adjacent to the cavity depressions that, when in contact, prevent the escape of material.

**Land area** The area of those surfaces of a mold that contact each other when the mold is closed, measured in a plane perpendicular to the direction of application of the closing pressure.

**Land width** (flight width). Of an extruder screw, the distance across the tip of the flight, perpendicular to the flight faces.

**Lane length** In an extrusion die, the distance across the land in the direction of melt flow between the lands.

**Lanital** Fiber from milk albumin. Manufactured by Snia Viscosa, Italy.

**Lanolin** \ˈla-nᵊl-ən\ [L *lana* wood + ISV $^{3}$-*ol* + $^{1}$-*in*] (1885) *n.* Purified wool grease. *See adepts lanae and anhydrous.*

**Landed force** A force with a shoulder that seats on the land in a landed positive mold.

**Lap** (1800) *n.* (1) Region where a coat extends over an adjacent fresh coat. The object of the painter is usually to effect a joint between the two coats without showing the lap. (2, *v*) To place one coat of finishing material alongside another, partly extending over it, causing increased thickness where the two coats are present. (3) To overlap or partly cover one surface with another, as in shingling. (4) The length of the overlap, as the distance one tile extends over another.

**Lap joint** (1823) *n.* A joint made by placing one surface to be joined partly over another surface and bonding or fastening the overlapping portions. Compare butt joint and scarf joint.
*See joint, lap.*

**Lap siding** *See clapboard.*

**Lap winding** A variant of filament winding consisting of convolutedly winding a resin-impregnated tape onto a mandrel of the desired configuration. The process has been used for making large chemical- and heat-resistant, conical or hemispherical parts such as heat shields for atmospheric-reentry vehicles.

**Lapis lazuli** \ˌlap-əs-ˈla-zə-lē, -ˈla-zhə-\ [ME, fr. ML, fr. L *lapis* + ML *lazuli*, general of *lazuhum* lapis lazuli, fr. Arabic *lāzaward*] (15c) *n.* A rich blue semiprecious stone; either used decoratively or ground and powdered for use as an ultramarine pigment. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Lapis lazuli blue** Natural ultramarine blue. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Lapping** A term describing the movement of yarn guides between needles, at right angles to the needle bar, or laterally in relation to the needle bar, or laterally in relation to the needle bar during warp knitting.

**Lapping time** *See wet-edge time.*

**Lase** \ˈlāz\. An acronym for load at specified elongation: the load required to produce a given elongation of a yarn or cord.

**Laser** \ˈlā-zər\ [*l*ight *a*mplification by *s*timulated *e*mission of *r*adiation] (1960) *n.* Laser is an acronym coined from the bold-face letters in light application by stimulated emission of radiation. Early lasers were made of synthetic-ruby rod, silvered at one end face, semisilvered at the other, and surrounded by a toroidal flash lamp. Today, the (neodymium–yttrium–aluminum–garnet (NdYAG) laser, with higher productivity than the ruby laser, has taken over many of its jobs. Lasers have been useful in drilling, perforating, cutting, and welding operations with plastics and other materials. Medium-power $CO_2$ lasers are preferred for machining plastics because they produce light at a wavelength of 10.6 mm, which is completely absorbed by plastics. Lasers have been useful in the analysis of polymers by laser mass spectrometry, in initiating polymerizations, and in curing polymers. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Laser-ionization mass spectrometry** A technique for chemical analysis of transparent and opaque plastics, capable of detecting all the elements but hydrogen and helium.

**Lashed-in filling** *See pulled-in filling.*

**Lastrile** Fiber from co-polymers with 10–15% acrylonitrile and an aliphatic diene. Lastrile is a generic name.

**Lastril fiber** A manufactured fiber in which the fiber-forming substance is a co-polymer of acrylonitrile and a diene composed of at least 10% by weight, but not more than 50% by weight, of acrylonitrile [–$CH_2$–CH (CN)–] units (FTC definition).

**Latch needle** One of the two types of knitting machine needles. The latch needle has a small terminal hook with a latch that pivots automatically in knitting to close the hook. The fabric loop is cast off. The latch then opens, allowing a new loop to be formed by the hook, and loop-forming and casting-off proceed simultaneously.

*Also see spring needle.*

**Latch plate** A plate used for retaining a removable mold core of relatively large diameter, or for holding insert-carrying pins on the upper part of a mold. Release of the pins or core is effected by moving the latch plate.

**Latent crimp** Crimp in fibers that can be developed by a specific treatment. Fibers are prepared specially to crimp when subjected to specific conditions, e.g., tumbling in a heated chamber or wet processing.

**Latent heat** (ca. 1757) *n.* The quantity of heat necessary to change 1 g of liquid to vapor (latent heat of vaporization) without change of temperature; heat necessary for change of state being negative or positive heat (e.g., fusion, evaporation, and melting). For example, the latent heat of fusion of ice water is 80 cal/g. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Latent heat of fusion** *See heat of fusion.* Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Latent heat of vaporization** The quantity of heat required to change a unit mass (or sometimes a mole) of a liquid to its vapor, the two phases remaining in equilibrium at constant temperature, most commonly the *normal boiling point*, i.e., the temperature of boiling at a pressure of 101.325 kPa. The convenient SI units are J/g, kJ/kg, or kJ/mol. Because high polymers decompose without boiling, their heats of vaporization cannot be directly measured.

**Latent solvent** An organic liquid that has little or no solvent effect on a particular resin until it is activated by either heat or a mixture with a true solvent.

**Latex** \ˈlā-ˌteks\ [NS *latic-*. *latex*, from L. fluid] (1835) (*pl* lattices or latexes) *n.* (1) An emulsion of a polymeric substance in an aqueous medium. (2) The sap of the *hevea* (rubber) tree and other plants, or emulsions prepared from the same. Latices of interest to the coatings and plastics industry are based mainly on styrene-butadiene co-polymers, polystyrene, acrylics, and vinyl polymers and co-polymers. (3) Fine dispersion of rubber or resin, natural or synthetic, in water; the synthetic is made by emulsion polymerization. Latex and emulsion are often used synonymously in the paint industry. Emulsified monomers once polymerized become solids or plasticized gel particles and not emulsions but aqueous suspensions. Lovell PA, El-Aasser MS (eds) (1997) Emulsion polymerization and emulsion polymers. John Wiley and Sons, New York. Martens CR (1964) Emulsion and water-soluble paints and coatings. Reinhold Publishing Co., New York. Vanderhoff JW, Gurnee EF (1956) Motion picture investigation of polymer latex phenomena. TAPPI 39 (2):71-77. Vanderhoff JW, Tarkowski HL, Jenkins MC, Bradford EG (1966) Theoretical considerations of the interfacial forces involved in the coalescence of latex particles. J Macromol Chem 1 (2):361-397.

*See also hydrosol*

**Latex mechanical stability** The ability of latex to resist coagulation under influence of mechanical agitation.

**Latex paint** A paint containing a stable aqueous dispersion of synthetic resin, produced by emulsion polymerization, as the principal constituent of the binder. Modifying resins may also be present. Lovell PA, El-Aasser MS (eds)(1997) Emulsion polymerization and emulsion polymers. John Wiley and Sons, New York. Martens CR (1964) Emulsion and water-soluble paints and coatings. Reinhold Publishing Co., New York.

**Lath** \ˈlath *also* ˈlat͟h\ [ME, fr. (ass.) OE *lættħ-*; akin to OHGr *latta* lath, Welsh *llath* yard] (13c) *n.* One of a number of thin narrow strips of wood nailed to rafters, ceiling joists, wall studs, etc., to make a groundwork or key for slates, tiles or plastering. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill, New York.

**Lattice energy** The energy necessary to separate 1 mol of a crystalline solid into a gaseous collection of the units at the lattice points (*exception*: in the case of a metallic solid a gaseous collection of *atoms* is formed). Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Lattice pattern** In filament winding, a pattern with a fixed arrangement of open voids producing a basket-weave effect. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Laundry blue** Synthetic ultramarine blue.

*See ultramarine blue.*

**Lauric acid** \ˈlór-ik-, ˈlär-\ [ISV, fr. L *laurus*] (1873) *n.* $CH_3(CH_2)_{10}COOH$. Fatty acid occurring in many vegetable fats as the glyceride, especially in cocoanut oil and laurel oil. It has a Sp gr of 0.833, mp of 44°C, and refractive index of 1.4323.

*Also called dodecanoic acid.*

**Lauroyl peroxide** $[CH_3(CH_2)_{10}C(O){-}]_2$. A peroxide used as an initiator in free-radical polymerizations of styrene, vinyl chloride, and acrylic monomers.

**Lauryl alcohol** \ ˈlór-əl-, ˈlär-\ (1922) *n.* $C_{12}H_{26}O$ A liquid mixture of this and other alcohols used in making detergents.

**Lauryl methacrylate** $H_2C{=}C(CH_3)COO(CH_2)_{11}CH_3$. A monomer used in the production of acrylic resins.

**Lawn** \ˈlón\ [ME, fr. *Laon*, France] (15c) *n.* A light, thin cloth made of carded or combed yarns, this fabric is given a crease resistant, crisp finish. Lawn is crisper than voile but not as crisp as organdy.

**Law of constancy of interfacial angles** In all crystals of the same substance (in the absence of polymorphism), angles between corresponding faces are identical. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Law of mixtures** (rule of mixtures). Properties of binary mixtures lie between the corresponding properties of the pure components and are proportional to the volume fractions $v$ (sometimes weight or mole fractions) of the components. For example, the density $\rho$ of a blend is given by:

$$\rho_{\mathrm{m}} = \rho_1 v_1 + \rho_2 v_2 = \rho_2 + (\rho_1 - \rho_2).$$

The "law" works well for properties of unidirectional composites, such as modulus $\mu$, but often fails for melt viscosities of blends, where maxima and minima above or below the viscosities of the neat resins are common. Another rule suggested by Arrhenius for mixture viscosities has the form:

$$\log \mu m = x_i \log \mu_1 + x_2 \log \mu_2,$$

where the $x_i$ are the mole fractions. While this rule has a different form than the preceding one and fits the mixture data of some systems, it, too, cannot provide maxima or minima.Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Law of rational indices** The lengths of intercepts of different crystal faces on any crystallographic axis are in ratios of small integers. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Lay** \ˈlā\ (1590) *n.* (1) The length of twist produced by stranding singly or in groups, such as fibers or rovings; or the angle that such filaments make with the axis of the strand during a stranding operation. The length of twist of a filament is usually measured as the distance parallel to the axis of the strand between corresponding points on successive turns of the filament. (2) The term is also used in the packaging of glass fibers for the spacing of the roving bands in the package expressed as the number of bands per inch.

**Lay-flat film** Film that has been extruded as a wide, thin-walled, circular tube, usually blown, cooled, then gathered by converging sets of rollers and wound up in flattened form.

**Lay-flat width** In blown-film manufacture, half the circumference of the inflated film tube.

**Laying off** Final light strokes of the brush during a painting operation.
*See feathering.*

**Lay-up** The tailoring and placing of reinforcing material – mat or cloth – in a mold prior to impregnating it with resin. The reinforcement is usually cut and fitted to the mold contours.
*See also sheet-molding compound.*

**Lay-up molding** (hand-lay-up molding). A method of forming reinforced plastics articles comprising the steps of placing a web of the reinforcement, which may or may not be preimpregnated with a resin, in a mold or over a form and applying fluid resin to impregnate and/or coat the reinforcement, followed by curing of the resin and extraction of the cured article from the mold. When little or no pressure is used in the curing process, it is sometimes called *contact-pressure molding*. When pressure is applied during curing, the process is often named for the method of applying pressure, e.g., *vacuum-bag molding* or *autoclave molding*. A related process is spray-up molding. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Carley.

**LCP** *See liquid-crystal polymer.*

**LC polymer** Abbreviation for liquid-crystal polymer.

**LC$_{50}$** The concentration, in parts per million, of a substance in air that is lethal to 50% of the laboratory animals exposed to it.

**LC$_{50}$ test** (lethal dose 50%). A toxicity test based on the results of animal experiments, the results of which mean that half the animals die from a given dosage of the substance tested.

*See oral dose* ($LD_{50}$).

**LDPE** Abbreviation for low-density polyethylene.

*Also see polyethylene.*

**L/D ratio** In an extruder, the ratio of the flighted length of the screw to its nominal diameter.

**Lea** (1) One-seventh of an 840-yard cotton hank, i.e., 120 yards. (2) A standard skein with 80 rev of 1.5 yards each (total length of 120 yards). It is used for strength tests. (3) A unit of measure, 300 yards, used to determine the yarn number of linen yarn. The number of leas in 1 lb is the yarn number. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Leaching** (1796) *v.* The process of the extraction of a component from a solid material by treating the material with a solvent that dissolves the component of interest but not the remaining principle material. Natural leaching occurs when rain water dissolves soluble salts from soil. Some components of a paint coating leach from the dried film after application to a substrate when exposed to rain or when immersed in water.

**Leaching rate** Milligrams of water-soluble material released per cm$^2$/day from an immersed anti-fouling paint in seawater.

**Leacril** Poly(acrylonitrile), manufactured by ACSA, Italy.

**Lead** \ˈled\ [ME *leed*, fr. OE *lēad*; akin to MHGr *lōt* lead] (before 12c) *n.* Element (Pb) found mostly in combination and used in pipes, cable sheaths, batteries, solder, and shields against radioactivity. Powders of this metal have also been employed as fillers in plastics. Hibbard MJ (2001) Mineralogy. McGraw-Hill, New York.

**Lead** \ˈlēd\. Of an extruder screw, the distance parallel to the screw axis from any point on the screw thread to the corresponding point on the next turn of that thread, or pitch.

**Lead acetate** (1885) *n.* $Pb(C_2H_3O_2)_2{\cdot}3H_2O$. Crystalline salt, soluble in water and used in the manufacture of lead pigments; also used in production of varnishes. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Lead azide** (1918) *n.* $Pb(N_3)_2$ A crystalline explosive compound used as a detonating agent.

**Lead carbonate** (1873) *n. See basic lead carbonate.*

**Lead carbonate, black** *See carbonate white lead.*

**Lead chrome green** *See chrome green.*

**Lead chrome pigment** Any of a series of inorganic pigments including yellows, oranges, and greens, used in PVC, polyolefins, cellulosics, acrylics, and polyesters.

**Lead dioxide** (1885) *n.* $PbO_2$. A poisonous compound used as an oxidizing agent and as an electrode in batteries.

**Lead drier** One of many organic lead salts, which are soluble in paints and varnishes; used to speed the drying and hardening of the oil vehicle.

**Leaded zinc oxide** Mixed pigment comprising zinc oxide and basic lead sulfate. Several grades are possible and vary in the proportions of the individual ingredients. Leaded zinc oxides are either mechanical mixtures of the two ingredients, or are made by heating together roasted zinc ore, lead sulfide ore and coal. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Leader-pin bushing** *See guide-pin bushing.*

**Leading flight face** (leader flight). The forward or front side of the flight of an extruder screw, the rear side being the *trailing flight face.*

**Lead in oil** Basic carbonate white lead ground in linseed oil; formerly wide use, now replaced largely by titanium dioxide pigments. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Lead monoxide** (ca. 1909) *n.* PbO A yellow to brownish red poisonous compound used in rubber manufacture and glassmaking. *See litharge.*

**Lead naphthenate** Lead soap of naphthenic acids. Used as a drier.

**Lead nitrate** $Pb(NO_3)_2{\cdot}2H_2O$. Crystalline salt soluble in water and used in the manufacture of lead chromes.

**Lead octoate** Lead soap of 2-ethylhexanoic acid. Used as a drier.

**Lead oxide** (ca. 1926) *n.* Either yellow lead oxide, PbO (litharge) or red lead oxide, $Pb_3O_4$. Both are used as pigments, though much less today in USA than formerly because of concerns about lead's toxicity and the need to keep it out of the environment. The oxides are sometimes used as fillers in radiation-shielding applications. *See litharge.*

**Lead phosphite, dibasic** $2PbO{\cdot}PbHPO_3{\cdot}1/2H_2O$. Fine white acicular crystals. Pigment grade is the dibasic lead salt of phosphorous acid. Used as an anti-corrosive white pigment, and for its ability to eliminate bleed-through of cedar and redwood stains in latex paints. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Lead-restricted paint** Normally, a paint having a lead content below a given limit, as used for applications where the presence of lead may be harmful. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Lead salicylate** (dibasic lead salicylate) $Pb(C_6H_4OHCOO)_2{\cdot}H_2O$. A white crystalline material formerly used as a heat stabilizer.

**Lead stabilizer** Any of a large family of highly effective heat stabilizers that are limited to use in applications where toxicity, sulfur staining, and lack of clarity are not objectionable. Examples are: basic lead carbonate, basic lead sulfate complexes, basic silicate, or white lead, co-precipitated lead silicate, and silica gel, dibasic lead maleate.

**Lead stearate** $Pb(C_{17}H_{35}COO)_2$. A white powder used as a vinyl-resin stabilizer and lubricant in extrusion compounds, and, earlier, in phonograph-record compounds. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons, New York.

**Lead sulfide** (ca. 1898) *n.* PbS. Mineral which occurs as galena and is one of the chief sources of lead. It can be prepared by passing hydrogen sulfide gas into an acid solution of lead nitrate. It is the compound responsible for darkening of paints when a lead-pigmented paint is exposed to sulfur-containing gases. Hibbard MJ (2001) Mineralogy. McGraw-Hill, New York.

**Lead titanate** $PbTiO_3$. A yellow buff-colored pigment, which possesses good resistance to weather and chalking. Pale yellow solid; insoluble in water. Its Sp gr is 7.52. Derivation: interaction of oxides of lead and titanium at a high temperature. Contains lead sulfate and lead oxide as impurities.

**Lead white** *See carbonate white lead.*

**Leaf green** *See chromium oxide green.*

**Leafing** A phenomenon produced by metallic pigments forming a layer parallel to the surface of the print and providing a high metallic luster.

**Leafing** The ability of an aluminum or gold bronze to provide a brilliant or silvery appearance. The flat pigment particles align themselves parallel with the coated surface providing a high reflection of light.

**Leather cloth** A term sometimes used, especially in Europe, for plastic-coated fabric with a leather-like texture.

**Le Châtelier's principle** When a system at equilibrium experiences a stress, it will adjust, if possible, so as to minimize the effect of the stress.

**Lecithin** \ˈle-sə-thən\ [ISV, fr. Gk *lekithos* yolk of an egg] (1861) *n.* A liquid, obtained in refinement of soya beans or cottonseed; used in paints to promote pigment wetting and to control pigment settling and flow properties. Weismantal GF (1981) Paint handbook. McGraw-Hill, New York.

**Lecyar model** A model for viscosities for polymer blends, which do not obey simple mixture laws. The Lecyar model can accommodate a viscosity minimum, maximum, or both in the composition range from 0 to 100% of one polymer intimately blended with another. For a given shear rate and temperature it has the form:

$$\ln \eta_B = Am_1^3 + Bm_2^3 + Cm_1^2 m_2 + Dm_1 m_2^2,$$

which $A$ and $B$ are the natural logarithms of the neat resins 1 and 2, $C$ and $D$ are the natural logarithms of interaction viscosities that must be evaluated from measurements on blends, and $m_1$ and $m_2$ are the mass fractions of the two components ($m_1 + m_2 = 1$). Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.

**LEFM** Abbreviation for linear elastic fracture mechanics.

**Legging** *n.* The drawing of filaments or strings when adhesive-bonded substrates are separated.

**Legs** The stringy effect that is apparent when cemented surfaces are separated shortly after the bond is made. Long legs or strings are indicative often of a weak bond, whereas short legs indicate a strong bond. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Leguval** Unsaturated polyester, manufactured by Bayer, Germany.

**Leipsic yellow** *See chrome yellow, light and primrose.*

**Leithner's blue** *See cobalt blue.*

**Lemon yellow** (1807) *n.* Any of two families of yellow pigments, one being mixtures of barium chromate with zinc carbonate, the other mixtures of lead chromate and lead carbonate.

**Length** The property of an ink whereby it can be stretched out into a long thread without breaking. Long inks have good flow in the fountain. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds)(1993) Printing ink manual, 5th edn. Blueprint, New York.

**Leno weave** \ˈlē-(ˌ)nō-\ [per. fr. F *linon* linen fabric, lawn, fr. MF *lin* flax, linen, fr. L *linum* flax] (1821) *n.* A weave in which the warp yarns are arranged in pairs with one twisted around the other between picks of filling yarn as in marquisette. This type of weave gives firmness and strength to an open weave fabric and prevents slippage and displacement of warp and filling yarns. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Let down** (1) The process of paint manufacturing in which the pigment paste (mill base) is reduced (let down) by the addition of the remaining ingredients of the formula. (2) Reducing the intensity or depth of a colored pigment through the addition of a white, or sometimes colorless, pigment.

**Let-go** An area in laminated glass over which an initial adhesion between interlayer and glass has been lost. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York. Weismantal GF (1981) Paint handbook. McGraw-Hill, New York.

**Let-off** A device used in coating by calendering or extrusion to suspend a coil or reel from which the material to be coated is fed to the coating machine.

**Letterpress** \ˈle-tər-ˌpres\ (ca. 1765) *n.* The process of printing from an inked raised surface when the paper is impressed directly upon the surface. Wijnekur FJM (1967) Elsevier's dictionary of the printing and allied industries in four languages. Research Institute for the Graphic and Allied Industries, TNO, Amsterdam, Elsevier Publishing Co., New York.

**Letterpress printing** The process used for paper is adapted to plastics by the use of special inks and transfer rolls, and possibly a modification of press speed. Flexible printing plates are usually employed, made of vinyl or rubber. It is the oldest method of printing flat plastic substrates and uses a press for relief printing from metal type or raised surfaces formed from wood, metal, or linoleum. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Letterset** *See dry offset.*

**Levapren** Ethylene/vinyl acetate co-polymer. Manufactured by Bayer, Germany.

**Leveler** Group of steel rollers that bend any edges that are not flat prior to coating. Also, a process in the aluminum industry that flattens strip so that the thickness is the same from one side to the other.

**Leveling** (1) The measure of the ability of a coating to flow out after application so as to obliterate any surface irregularities such as brush marks, orange peel, peaks, or craters which have been produced by the mechanical processes of applying or coating. (2) The property of a freshly spread aqueous polish to dry to a uniform and streak-free appearance. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978. Martens CR (1968) Technology of paints, varnishes and lacquers. Reinhold Publishing Co., New York.

**Levigation** \ˌle-və-ˈgā-shən\ [L *levigatus*, pp of *levigare* to make smooth, fr. *levis* smooth (akin to Gk *leios* smooth and perhaps to L *linere* to smear) + *-igare* (akin to *agere* to drive)] (1612) *n.* Process of mixing a pigment with water and washing. The percentage of salts and heavy particles is reduced or eliminated by controlled sedimentation. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Levorotatory** \ˌle-və-ˈrō-tə-ˌtōr- ē\ (1873) *adj.* Turning toward the left or counterclockwise: esp: rotating the plane of polarization toward the left – compare *dextrorotatory.* Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Lewis acid** \ˈlü-əs-\ [Gilbert N. *Lewis* † (1946) American chemist] (1944) *n.* A substance that is capable of accepting an unshared pair of electrons from a base to form a covalent bond.

**Lewis-acid catalyst** *See Friedel–Crafts catalysts.*

**Lewis–Nielsen equation** An equation derived from the theory of mixtures that provides an estimate of the modulus of a short-fiber, thermoplastic composite. It is given below.

$$E_c = \frac{E_r(1 + 2AB\phi_f)}{1 - B\psi\phi_f},$$

where

$$B = \frac{(E_f/E_r) - 1}{(E_f/E_r) + 2A}$$

and

$$\psi = 1 + \frac{(1 - V)\phi_{fr}}{2V_r}.$$

In these expressions, $E_c$, $E_f$, and $E_r$ are the moduli of the composite, fiber, and resin, $\phi_f$ is the volume fraction of fiber, $A$ is the average aspect ratio of the fiber, and $\psi$ is the maximum packing fraction. Application of the equation is limited to small strains. Wallenberger F, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York. Murphy J (1998) Reinforced plastics handbook. Elsevier Science and Technology Books, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Lewis structure** A method of indicating the assignment of valence electrons in an atom, molecule, or ion by representing them as dots placed around symbols, which represent the cores, or kernels, of the atoms. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Lexan®** General electric's trade name for their polycarbonate resins produced by reacting bisphenol A and phosgene, the first commercial PC resins.

*See also polycarbonate resin.*

**Leyden blue** *See cobalt blue.*

**Li** Chemical symbol for the element lithium.

**Licanic acid** $CH_3(CH_2)_3(CH{=\!=}CH)_3(CH_2)_4COCH_2COOH$. Constitutes 75–80% of the fatty acid of oiticica oil; mp, 75°C. Shahidi F, Bailey AE (eds) (2005) Bailey's industrial oil and fat products. John Wiley and Sons, New York. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Lieberman–Storch method** Procedure for the qualitative detection of rosin in vehicles. The rosin may be present as either free rosin (abietic acid), esterified rosin, or metal salts. In Europe, the Lieberman–Storch–Morawski test is more commonly used. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Lift** (1) The complete set of moldings produced in one cycle of a molding press.

**Lifting** Softening and raising or wrinkling of a previous coat by the application of an additional coating; often caused by the solvents.

**Ligand** \ˈli-gənd, ˈlī-\ [L *ligandus*, gerundive of *ligare*] (1949) *n.* An atom, molecule, or ion bonded to the central atom in a complex.

**Light** \ˈlīt\ [ME, fr. OE lēoht; akin to OHGr *lioht* light, L *luc*-, *lux* light, *lucēre* to shine, Gk *leukos* white] (before 12c) *n.* (1) Electromagnetic radiation of which a human observer is aware through the visual sensations that arise from the stimulation of the retina of the eye. This portion of the spectrum includes wavelengths from about 380 to 770 nm. Thus, it is incorrect to speak of ultraviolet "light" because the human observer cannot see radiant energy in the ultraviolet region. (2) *Adj.* meaning high reflectance, transmittance, or level of illumination as contrasted to dark, or low level of intensity. Moller KD (2003) Optics. Springer-Verlag, New York. Johnson SF (2001) History of light and colour measurement: a science in the shadows. Taylor and Francis, London, UK. McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Light absorbance** (absorbance, absorptivity). The percentage of the total luminous flux incident upon a test specimen that is neither reflected from, nor transmitted through the specimen. Compare light reflectance and light transmittance.

**Light end** (1) The low boiling fraction in distillation. (2) *See fine end* (1).

**Light reflectance** (reflectance, reflectivity). The fraction of the total luminous flux incident upon a surface that is reflected, generally a function of the color (wavelength) of the light. Johnson SF (2001) History of light and colour measurement: a science in the shadows. Taylor and Francis, London, UK. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

*See also light absorbance and light transmittance.*

**Light resistance** (light fastness, color fastness). The ability of a plastic material to resist fading, darkening, or degradation upon exposure to sunlight or ultraviolet light. Nearly all plastics tend to change color under outdoor conditions, due to characteristics of the polymeric material and/or pigments incorporated therein. Tests for light resistance are made by exposing specimens to natural sunlight or to artificial light sources such as the carbon arc, mercury lamp, germicidal lamp, or xenon arc lamp. ASTM D 4459 and D 4674 describe procedures for testing light fastness of plastics for indoor applications. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

*See also artificial weathering.*

**Light scattering (Rayleigh, Mie, and Frankhoffer)** In a dilute polymer solution, light rays are scattered and diminished in intensity by a number of factors including fluctuations in molecular orientation of the polymer solute. Observations of the intensity of light scattered at various angles provide the basis for an important method of measuring weight-average molecular weights of high polymers. Kokhanovsky

AA (2004) Light scattering media optics. Springer-Verlag, New York. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Berne BJ (2000) Dynamic light scattering: applications to chemistry, biology and physics. Dover Publications, New York. Brown W (1996) Light scattering: principles and development. Oxford University Press, UK. Pethrick RA (ed) (1999) Modern techniques for polymer characterization. John Wiley and Sons, New York. Elias (1977) Macromolecules, vols 1–2. Plenum Press, New York. Miller ML (1966) The structure of polymers. Reinhold Publishing Co., New York.

*See also low-angle laser-light scattering.*

**Light source** An object, which emits light or radiant energy to which the human eye is sensitive. The emission of a light source can be described by the relative amount of energy emitted at each wavelength in the visible spectrum, thus defining the source as an illuminant, or the emission may be described in terms of its correlated color temperature. Johnson SF (2001) History of light and colour measurement: a science in the shadows. Taylor and Francis, London, UK. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

*See illuminant and correlated color temperature.*

**Light stabilizer** An agent added to a plastic compound to improve its resistance to light-induced changes.

*See also stabilizer and ultraviolet stabilizer.*

**Light transmittance** (luminous transmittance, light transmissivity). The ability of a material to pass incident light through it, whether specular or diffuse. ASTM (www.astm.org) prescribes several tests of this property in plastics. *Transmissivity* is the ratio of the intensity of the transmitted light to that of the unreflected incident light. Fox AM (2001) Optical properties of solids. Oxford University Press, UK.

*See also opacity.*

**Light-fastness** ad (1950). The resistance of coated, printed or colored material to the action of sunlight or artificial light. Syn: colorfastness.

**Lightness** (before 12c) *n.* (1) Achromatic dimension necessary to describe the three-dimensionality of color, the others being hue and saturation. Sometimes the lightness dimension is called “brightness”. In the Munsell color order system, the lightness dimension is called “value”. (2) Perception by which white objects are distinguished from gray and light objects from dark ones.

**Lignin** \ˈlig-nən\ (1822) *n.* The major non-carbohydrate constituent of wood and woody plants, functioning in nature as a binder to hold the matrix of cellulose fibers together. Lignins are obtained commercially from by-products of coniferous woods, for example, by treating wood flour with a derivative of lignosulfonic acid. They are used as extenders in phenolic resins, and sometimes as reactants in the production of phenol-formaldehyde resins. Hoadley RB (2000) Understanding wood. The Taunton Press, Newtown, CT.

**Lignin plastic** A plastic based on lignin resins.

**Lignin resin** A resin made by heating lignin or by reaction of lignin with chemicals or resins, the lignin being in greatest amount of mass.

**Lignostone** Compressed wood. Manufactured by Röchling, Germany.

**Ligroin** (ligroine, benzine). Any of several saturated petroleum–naphtha fractions boiling in the range 60–135°C (68–275°F), used as solvents. The term *benzine* is depreciated due to confusion with *benzene*, and should not be used.

**Lime** \ˈlīm\ [ME, fr. OE *līm*; akin to OHGr *līm* birdlime, L *limus* mud, slime, and perhaps to L *linere* to smear] (before 12c) *n.* A caustic highly infusible solid that consists of calcium oxide often together with magnesium oxide, that is obtained by calcining forms of calcium carbonate (as shells or limestone). Syn: calcium oxide.

**Lime blue** Mixture of ultramarine and terra alba. Another type of lime blue is made from methylene blue by adsorption on natural earth.

**Lime green** *See green, lime.*

**Lime putty** *See putty.*

**Lime red** Lake produced by adsorbing magenta on a natural earth.

**Lime yellow** Lake produced by adsorbing auramine or other yellow dyestuff on a natural earth.

**Limed rosin** Commercial calcium resinate made by the direct interaction of lime and rosin.

**Limestone** *See calcium carbonate and calcium carbonate, natural.*

**Lime washing** Coating with limewash made from hydrated lime or by slaking quick lime, to which tallow is sometimes added. Syn: whitewash, whitening.

**Limiting oxygen index** A relative measure of flammability that is determined as follows. A sample is ignited in an oxygen/nitrogen atmosphere. The oxygen content is adjusted until the minimum required to sustain steady burning is found. The higher the value, the lower the flammability. Troitzsch J (2004) Plastics flammability handbook: principle, regulations, testing and approval. Hanser–Gardner Publications, New York. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997.

**Limiting viscosity number** The IUPAC term for intrinsic viscosity.

**Limonite** \ˈlī-mə-ˌnīt\ [Gr *Limonit*, fr. Gk *leimōn* wet meadow; akin to Gk *limnē* pool] (1823) *n.* A native hydrous ferric oxide of variable composition that is a major ore of iron.

*See iron oxides, natural.*

**Line etching** A print made up of lines or pigmented areas and lighter spaces free from shading.

**Lineal density** The meaning of Denier. Mass per unit length expressed as grams per centimeter, pounds per foot, or equivalent units. It is the quotient obtained by dividing the mass of a fiber or yarn by its length.

**Linear elastic fracture mechanics (LEFM)** A theory of fracture, applicable to brittle plastics (and other brittle materials), based on the assumption that the material is Hookean up to the point of fracture, with yielding restricted to a small volume near crack tips in the stressed material.

**Linear expansion** *See coefficient of thermal expansion.*

**Linear low-density polyethylene (LLDPE)** The original low-density polyethylene (LDPE), produced at high pressure, has a highly branched structure. Using Ziegler–Natta catalysts and low pressure, with a small percentage of 1-butene or other comonomer, one can produce a more linear PE with density between 0.919 and 0.925 g/cm$^3$. LLDPE films have the gloss and clarity of LDPE films, but are stronger, so can be blown thinner to carry design loads. Because of higher melt viscosity, screw modifications are usually necessary for processing LLDPE in extruders designed for LDPE. Odian GC (2004) Principles of polymerization. John Wiley and Sons, New

York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Linear polymer** A polymer in which the molecules form long chains without branches or cross-linking. The molecular chains of a linear polymer may be intertwined, but the forces tending to hold the molecules together are physical rather than chemical and therefore can be weakened by heating. Linear polymers are thermoplastic. Odian GC (2004) Principles of polymerization. John Wiley and Sons, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Linear unsaturated polyesters** *See polyester, unsaturated.*

**Linear viscoelasticity** Viscoelasticity is characterized by a linear relationship between stress, strain, and strain rate.

**Linen** \ˈli-nən\ [ME, fr. OE *līnen*, fr. *līn* flax, fr. L *linum* flax; akin to Gk *linon* flax, thread] (before 12c) *adj.* Cellulosic fibers derived from the stem of the flax plant or a fabric made from these fibers. Linen fibers are much stronger and more lustrous that cotton; they yield cool, absorbent fabrics that wrinkle easily. Fabrics with linen-like texture and coolness but with good wrinkle resistance can be produced from manufactured fibers and blends.

**Linen lea** The number of 300-yard hanks contained in 1lb.

**Liner** (1) A continuous, usually flexible coating on the inside surface of a filament-wound pressure vessel, used to protect the laminate from chemical attack or to prevent leakage under stress. (2) In extruders and injection molders, the hard-alloy interior surface of the cylinder. Decades ago, some of these were separately fabricated and pressed into the steel cylinders. Today they are centrifugally cast into cylinders.

**Linet** A French-made lining fabric of unbleached linen.

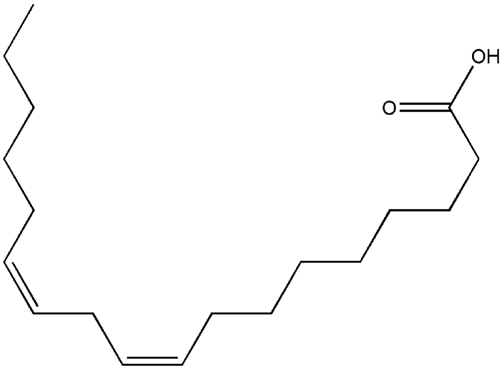
**Lining fabrics** (1) Muslin or canvas used underneath fine wallpapers to avoid small cracks possibly opening up in a plaster wall and showing through. (2) Fabric that is used to cover inner surfaces, especially when the inner surface is of a different material than the outer. May refer to garment lining, lining for boxes, coffins, etc. Generally of smooth, lustrous appearing fabrics, but also of felt and velvet. Both manufactured fibers and natural fibers are used.

**Lining paper** Plain paper applied before the wallpaper. Assures a smoother surface and better adhesion.

**Lining tool** (British). A small flat fitch with a slanting edge, used for painting lines with the help of a run. Syn: liner.

**Linoleates** \lə-ˈnō-lē-ˌāt\ (ca. 1865) *n.* Generally the salts or soaps of linseed fatty acid. Cobalt, lead, and manganese linoleates are widely used as driers in printing ink.

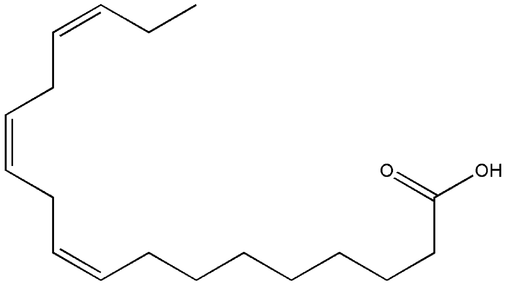
**Linoleic acid** \ˌli-nə-ˈlē-ik-\ [Gk *lin*on flax + ISV *oleic* (*acid*)] (1857) *n.* $C_{18}H_{32}O_2$. *cis*, *cis*-9,12 Octadecadienoic acid. An 18-carbon, straight-chain fatty acid with two double bonds that may be in the 9 and 12 or 9 and 11 positions. It is found in nature as its glyceryl trimester in many vegetable oils and is a starting material for some plasticizers for plastics. It has a mol wt of 280.44, bp of 230°C, iodine value of 181.1.



**Linolein** Glyceride of linoleic acid. It is one of the constituents of linseed oil, which induces the drying properties.

**Linolenate driers** Certain metal salts of, and soaps of, linseed fatty acids.

**Linolenic acid** \ˌli-nə-ˈlē-nik-\ [ISV, irreg. fr. *linoleic*] (1887) *n.* $CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7CO{-}OH$. *cis*, *cis*, *cis*-9,12,15-Octadecatrienoic acid. Tri-poly-unsaturated fatty acid component of linseed and other drying oils, It has a bp of 230°C/17 mmHg, an acid value of 201.6, and iodine value of 273.7. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.



**Linoleum and oilcloth varnishes** Special highly flexible and elastic varnishes.

**Linoleum, floor and wall covering** Made from oxidized linseed oil or combinations of drying oils, wood flour and/or ground cork, resins and pigment, rolled out and compressed onto an asphalt saturated felt, burlap, or other backing. Heat, which fuses and sets the oils and resins to form strong binding agents, is applied to the mixture during compression.

**Linon A jour** A gauze-like linen fabric used as dress goods.

**Linoxyn** Semisolid, highly oxidized linseed oil; used in the manufacture of linoleum.

**Linseed oil** (15c) *n.* Drying oil from seeds of the flax plant *Linum usitatissimum*, a mixture of glyceryl esters of linolenic (25%), oleic (5%), linoleic (62%), stearic (3%), and palmitic (5%) acids. The oil is refined by treatments, which remove water and mucilaginous material and is then described as refined oil, according to the method of treatment. Further processing produces boiled oil, blown oil or bodied oil. This best known and most widely used oil in the paint industry if characterized by its relatively short drying time. Its high degree of unsaturation, to which its good drying characteristics can be partially ascribed, is due to the presence of large percentages of linolenic and linoleic triglycerides. Many years ago the oil was obtained from seed by mechanical pressure, including both hydraulic presses and later expellers. In recent years, the more modern solvent extraction is used. Oils thus obtained show lower percentages of impurities and better overall quality. Linseed oil responds very readily to a variety of refining techniques and is used in the paint industry both as a drying oil and as an ingredient in a wide array of modified resins of many varieties. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Lint** \ˈlint\ [ME] (14c) *n.* Particles and short fibers that fall from a textile product during the stresses of use.

**Lint ball** *See balling up.*

**Lintel** \ˈlin-təl\ (ME, fr. MF, fr. LL *limitaris* threshold, fr. L, constituting a boundary mfr. *limit-*, limes boundary] (14c) *n.* Horizontal beam supported at each end and spanning an opening. Usually supports the structure above it.

**Linters** (ca. 1889) *n.* Short fibers that adhere to cotton seeds after ginning. Used in rayon manufacture, as fillers for plastics, and as a base for the manufacture of cellulosic plastics.

**Lipophilic livering** \ˌlī-pə-ˈfi-lik-\. An increase in the consistency of a paint resulting in a rubbery or coagulated mass.

**Liquid chromatography (LC or HPLC)** Any chromatographic process in which the moving phase is a liquid, in contrast to the moving gas phase of gas chromatography. Materials, which can be run through a liquid chromatograph are liquids or solutions. An example of a liquid chromatograph is the Series 200 LC Plus Diode Array System by Perkin-Elmer. Kroschwitz JI (ed) (1990) Polymers: polymer characterization and analysis. John Wiley and Sons, New York.

**Liquid crystal** (1891) *n.* A liquid in which the molecules are oriented parallel to each other resulting in birefringence and interference patterns visible in polarizing light. Collins PJ (1997) Introduction to liquid crystals: chemistry and physics, vol 1. Taylor and Francis, New York.

**Liquid-crystal polymer** (LC polymer, liquid-crystalline polymer, and mesomorphic polymer). A polymer capable of forming regions of highly ordered structure (*mesophase*) while in the liquid (melt or solution) phase. The degree of order is somewhat less than that of a regular solid crystal. Four types have been identified: rod-like, including aromatic polyamides, esters, azomethines, and benzobisoxazoles; helical, mostly natural materials such as polypeptides; side-chain (*comb polymers*); and block copolymers with alternating rigid and flexible units. These polymers are described as *nematic*, in which the mesogens (ordered regions) show no positional order, only long-range order; *Cholesteric* or *chiral*, a modified nematic phase in which the orientation direction changes from layer to layer in a helical pattern; and *smectic*, in which the mesogens have both long-range order and 1- or 2-dimensional positional order. Liquid-crystal polymers are difficult to get into the molten condition because

TCLC plus system.

the solid crystals generally decompose before melting. The most commercially successful ones to date are those processed in solution, e.g., poly(*p*-phenylene terephthalamide) (Kevlar). LC polymers are also classified as *lyotropic* and *thermotropic*. Lyotropic ones show their liquid-crystalline character only in solution, while thermotropic ones can show it in the melt without the presence of a solvent. Collins PJ (1997) Introduction to liquid crystals: chemistry and physics, vol 1. Taylor and Francis, New York.

**Liquid crystal polymer resins** Self-reinforcing plastics because of their densely packed fibrous polymer chains. Odian GC (2004) Principles of polymerization. John Wiley and Sons, New York.

**Liquid driers** Solutions of soluble driers in volatile organic solvents, usually hydrocarbons.

**Liquid emulsion polymer coating** Synthetic resin emulsion (latex) which produce hard, tough coatings having a high luster. Usually non-buffable or semibuffable, and referred to and sold as self-polishing floor wax.

**Liquid injection molding (LIM)** A process of injection-molding thermosetting resins in which the uncured resin components are metered, mixed, and injected at relatively low pressures through nozzles into mold cavities, the curing or polymerization taking place in the mold cavities. The process is most widely used with resins that cure by addition polymerization such as polyesters, epoxies, silicones, alkyds, diallyl phthalate, and (occasionally) urethanes.

**Liquid-junction potential** A voltage produced across the junction between two dissimilar liquids.

**Liquid reaction molding (LRM)** Older Syn: reaction injection molding.

**Liquid resin** (deprecated). *See tall oil.*

**Liquid rosin** Syn: tall oil.

**Liquid solvent wax** Mixture of waxes and other ingredients in a solvent base. Must be polished for luster and are occasionally colored. *Sometimes called, simply, solvent wax.*

**Liquid water emulsion wax** Dispersion of wax and other modifying materials in water.

**Liquifying stress** The ease with which concentrated inks can be liquefied by remilling after storage.

**Liquor ratio** In wet processing the ratio of the weight of liquid used to the weight of goods treated.

**Lisle yarn** [*Lisle* Lille, F] (1851) *n.* A high-quality cotton yarn made by plying yarns spun from long combed staple. Lisle is singed to hive it a smooth finish.

**Lithium** \ˈli-thē-əm\ [NL, fr. *lithia* oxide of lithium, fr. Gk *lithos*] (1818) (Li) *n.* Element number 3, the least dense of all the metals (density = 0.534 g/cm$^3$), with valence of +1, and highly reactive. Lithium aluminum hydride ($LiAlH_4$) is an important catalyst in organic reductions and lithium is a component of many greases, e.g., the high-temperature lubricant, lithium stearate.

**Lithium carbonate** (1873) *n.* $Li_2CO_3$. A crystalline salt used in the glass and ceramic industries.

**Lithium fluoride** (1944) *n.* LiF. A crystalline salt used in making prisms and ceramics and as a flux.

**Lithium niobate** [*niob*ium + $^1$-*ate*] (1966) *n.* $LiNbO_3$. A crystalline material whose physical properties change in response to pressure or the presence of an electric field and which is used in fiber optics and as a synthetic gemstone.

**Lithium stearate** $LiOOCC_{17}H_{35}$. A white crystalline material used as a lubricant in plastics.

**Lithographic inks** Inks used in the lithographic process. The principal characteristic of a good lithographic ink is its ability to resist excessive emulsification by the fountain solution.

**Lithographic varnish** Heat-bodied refined linseed oils used as vehicles for printing and lithographic inks.

**Lithography** \li-ˈthä-grə-fē\ [Gr *Lithographie*, fr. *lith-* + *-graphie* –graphy] (1813) *n.* A process of planographic printing involving two different areas on the plate, one receptive to ink, the other receptive to fountain solution. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York. Printing ink handbook. National Association of Printing Ink Manufacturers, Inc., NJ, 1976.

*Also see stereolithography for three-dimensional formation of objects.*

**Lithographed paper** Wallpaper made by the printing process used for billboards and posters. Lithography exploits the affinity of color for the greasy material in which the design is put on the roller. a transfer process.

**Lithographic chalk** A greasy crayon, composed of soap, wax, oil and lampblack, for drawing designs on a lithographic plate prior to etching.

**Lithographic inks** Inks used in the lithographic process. The principal characteristic of a good lithographic ink is its ability to resist excessive emulsification by the fountain solution.

**Lithographic stones** Slabs of limestone, three or four inches thick, the surfaces of which are smoothed or grained, for use in lithographic printing.

**Lithographic varnishes** Heat-bodied refined linseed oils used as vehicles for printing and lithographic inks.

**Lithol red** $C_{20}H_{13}N_2O_4SM^*$ ($M^* =$ Na, Ba, or Ca). Pigment Red 49 (15630). Pigment made by combining the intermediates, tobias acid and beta-naphthol. This type of red is available as sodium, barium, and calcium toners, also lakes; the sodium is the lightest shade, the barium is what may be termed a medium shade, and the calcium lithols are deep reds and maroons.

**Lithol rubine** Pigment Red 57 (15850). Azo pigment made by diazotizing paratoluidine-*meta*-sulfonic acid, and coupling with 3-hydroxy-2-naphthoic acid. Pigment is used as the calcium salt. Most frequently encountered in the resinated form, it is characterized by its distinctly brilliant deep masstone and its blue intense tint.

**Lithopone** \ˈli-thə-ˌpōn\ [ISV *lith-* + Gk *ponos* work] (ca. 1884) *n.* $BaSO_4 \cdot ZnS$. Pigment White 5 (77115) (Charlton white, Orr's white, and zinc baryta). A mixed pigment obtained by the interaction (*metathesis*) of equimolar solutions of barium sulfide and zinc sulfate, from which precipitate barium sulfate and zinc sulfide, both white.

**Lithrage** PbO. Oxide of lead made by controlled heating of metallic lead. Pure litharge has Sp gr of 9.53, mp of 888°C, and mol wt of 223.21. Used as a raw material in the manufacture of pigments and driers and infrequently as a catalyst in pains.

**Litre** \ˈlē-tər\ [*variant* of liter]. The volume of a kilogram of water at 4°C, equal to 1.06 quarts or 61.02 in.$^3$.

**Little Joe** A one- or two-station dry offset proof press.

**Live centers** Point at the very center at each end of the roll. This is usually a center point of the journal at which the roll turns. The roll is driven from this point and is considered concentric from the same point.

**Live edge** *See wet edge.*

**Live-feed molding** *See multi-live-feed molding.*

**Livering** The progressive, irreversible increase in consistency of a pigment-vehicle combination. Livering in the majority of cases arises from a chemical reaction of the vehicle and the solid dispersed material, but it may also result from polymerization of the vehicle.

**Living polymers** A polymerization reaction in which there is no termination, and the polymer chains continue to grow as long as there are monomer molecules to add to the growing chain.

**Living ring** *See revolving spinning ring.*

**LLDPE** Abbreviation for linear low-density polyethylene.

**Ln** (1) Abbreviation for Lumen. (2) Abbreviation for natural logarithm, i.e., logarithm to the base *e* (=2.71828. . .).

**Load cell** An instrument, most often part of a machine for testing mechanical properties and some rheometers, that senses the force applied to the specimen (or piston).

**Locking pressure** The pressure applied to an injection or transfer mold to keep it closed during molding.

**Locking ring** A slotted plate in an injection or transfer mold that locks the parts of the mold together and prevents the mold from opening while the plastic is being injected.

**Loft** The properties of firmness, resilience, and bulk of a fiber batting, yarn, fabric, or other textile material.

**Logarithm** \ˈló- gə-ˌri-thəm\ *n.* The exponent that indicates the power to which a number is raised to produce a given number. A common logarithm (log) has a base of 10 and a natural (ln) or Napierian logarithm has a base of *e* (irrational number 2.71828. . .). Conversion of log to ln: ln $N = 2.303 \log N$.

**Logarithmic decrement** \ˌló-gə-ˈrith-mik ˈde-krə-mənt\ (Δ) In a damped, vibrating system, the natural logarithm of the ratio of the amplitude of any oscillation to the amplitude of the succeeding oscillation. Where damping is mild, the ratio of the amplitude of any oscillation to the amplitude of the succeeding oscillation. Where damping is mild, the ratio of amplitudes several vibrations apart will usually give a more accurate estimate. The equations are:

$$\Delta = \ln(A_i/A_i + 1)$$

and

$$\Delta = (l/n)\ln(A_i/A_i + n).$$

**Logarithmic viscosity number** The IUPAC term for inherent viscosity.

**Log normal distribution** (logarithmic normal distribution). A statistical probability-density function, characterized by two parameters, that can sometimes provide a faithful representation of a polymer's molecular-weight distribution or the distribution of particle sizes in ground, brittle materials. It is a variant of the familiar normal or Gaussian distribution in which the logarithm of the measured quantity replaces the quantity itself. Its mathematical for is

$$f(x) = \frac{1}{\sqrt{2\pi}\beta} x^{-1} \mathrm{e}^{-(\ln x-\alpha)/2\beta^2} \mathrm{d}x$$

or

$$f(\ln x) = \frac{1}{\sqrt{2\pi}\beta} \mathrm{e}^{-(\ln x-\alpha)/2\beta^2} \mathrm{d} \ln x,$$

$\alpha$ and $\beta$ are the mean and standard deviation of $\ln x$. Anti-$\ln \alpha$ is called the *log mean* of *x*. To test the suitability of this distribution, one plots the cumulative percent of members having weights or sizes below *x*, versus *x*, on lognormal probability paper and looks for linearity in the plot.

**Logotype (or logo)** \ˈló-gə-ˌtīp, ˈlä-\ (ca. 1816) *n.* Name of a company or product in a unique design used as a trademark in advertising.

**Logu** Sluggish, low snap or recovery. A condition formed in poorly cured or overloaded vulcanizers.

**London dispersion forces (London forces)** [fr. Fritz London (1930) *n.* Identifies weak intermolecular forces based on transient dipole interactions. One of *van der Waals forces*, also called dispersion forces, but distinct from dipole–dipole forces. These forces arise from momentary fluctuations in the electron charge cloud density in a atom or molecule. Changes in symmetry of the electron cloud that causes a momentary dipole moment and attractive/repulsive charges. The larger a molecule is and the more electrons it has, the more polarizable it will be, and thus the larger the London forces can be. Molecular shape and other factors are also important. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Lone pair** A pair of electrons, which belongs to only one atom and hence is not shared (VB model).

**Long oil** High ratio of oil to resin in a medium. (1) *Long oil alkyd* – an alkyd resin containing more than 60% of oil as a modifying agent. (2) *Long oil varnish* – an oleoresinous varnish, other than alkyd, containing more than 25gal of oil/100lb of resin. A long oil varnish is usually slower drying, tougher and more elastic than a short oil varnish.

*See also short oil varnish and medium oil varnish.*

**Long-chain branching** In a polymer's structure, the presence of arms (branches) off the main chain that are about as long as the main chain. In making low-density polyethylene, a typical molecule may contain 50 short branches and only one or zero long branch, yet the presence of long branches greatly broadens the molecular-weight distribution. Polymers containing long branches tend to be less crystalline than the corresponding polymers without long branches.

**Long-fiber-reinforced thermoplastic** A palletized thermoplastic resin for injection molding, usually nylon 6/6 or polypropylene, produced by pultrusion from continuous-filament glass yarn, and cut to lengths of 9–13mm (about three times the length of short-fiber pellets). Nylon containing 50wt.% longer-fiber glass is about 15% stronger and stiffer than its short-fiber mate, with double the notched-Izod impact strength.

**Long staple** A long fiber. In reference to cotton, long staple indicates a fiber length of not less that 1–1/8in. In reference to wool, the term indicates fiber 3–4in. long suitable for combing.

**Longo** A colloquialism used in the filament-winding industry, designating an article that is wound longitudinally or with a low-angle helix.

**Loom** \ˈlüm\ [ME *lome* tool, loom, fr. OE *gelōma* tool; akin to MD al*lame* tool] (15c) *n.* A machine for weaving fabric by interlacing a series of vertical, parallel threads (the warp) with a series of horizontal, parallel threads (the filling). The warp yarns from a beam pass through the heddles and reed, and the filling is shot through the "shed" of warp threads by means of a shuttle or other device and is settled in place by the reed and lay. The woven fabric is then wound on a cloth beam. The primary distinction between different types of looms is the manner of filling insertion. The principal elements of any type of loom are the shedding, picking, and beating-up devices.

In shedding, a path is formed for the filling by raising some warp threads while others are left down. Picking consists essentially of projecting the filling yarn from one side of the loom to the other. Beating-up forces the pick that has just been left in the shed, up to the fell of the fabric. This is accomplished by the reed, which is brought forward with some force by the lay. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Loom Barré** A repeated unevenness in the fabric, usually running from selvage to selvage, and caused by uneven let-off or take-up or by a loose crank arm.

**Loom-finished** A term describing fabric that is sold in the condition in which it comes from the loom.

**Loom fly** Waste fibers that are inadvertently woven into a fabric.

**Loop elongation** The maximum extension of a looped yarn at maximum load, expressed as a percentage of the original gauge length. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Loop pile** Carpet construction in which the tufts are formed into loops from the supply yarn.

**Loop selvage** A weaving defect at the selvage of excessive thickness or irregular filling loops that extend beyond the outside selvages.

**Loop tenacity** The strength of a compound strand formed when one strand of yarn is looped through another strand, then broken. It is the breaking load in grams divided by twice the measured yarn denier or decitex. Loop tenacity, when compared with standard tenacity measurements, is an indication of the brittleness of a fiber.

**Loop test** A simple test (ASTM 3291) for evaluating the compatibility of vinyl resin plasticizers based on the fact that a material under compressive stress will exude plasticizer more rapidly. A specimen in sheet form is folded double, forming a loop with internal radius equal to the sheet thickness. At intervals, the bend of the loop is reversed 360° and the former inside surface of the loop is examined for evidence of plasticizer spewing.

**Looped filling** A woven-in loop caused by the filling sloughing off the quill or by the shuttle rebounding in the box.

**Looped pile** A pile surface made of uncut looped yarns.

**Looped year** *See kink.*

**Looping** (1832) *v.* Generally, a method of uniting knit fabrics by joining two courses of loops on a machine called a looper.

**Looping bar** A bar inserted in the bottom of an extrusion métier around which the dried filaments pass as they leave the spinning cabinet.

**Loopy yarn** *See textured yarns.*

**Loose edge** *See slack selvage.*

**Loose end** *See tight or loose end.*

**Loose filling** A fabric defect that is usually seen as short, loose places in the filling caused by too little tension on the yarn in the shuttle or by the shuttle rebounding in the box. Loose filling can often be felt by an examiner when passing a hand over the surface of the fabric.

**Loose pick** *See slack pick.*

**Loose punch** A male portion of a mold constructed so that it remains attached to the molding when the press is opened, to be removed from the part after demolding.

**Lopac** Co-polymer from methacrylonitrile and styrene or $\alpha$-methyl styrene (9:1). Manufactured by Monsanto, USA.

**Loss angle** The inverse tangent of the electrical dissipation factor.

*See dielectric loss angle.*

**Loss compliance** The "imaginary" part of the complex compliance.

*See compliance and complex modulus.*

**Loss dielectric** A loss of energy evidenced by the rise in heat of a dielectric placed in an alternating electric field. It is usually observed as a frequency-dependent conductivity.

**Loss factor** The product of a power factor and dielectric constant of a dielectric material.

**Loss modulus** "*G*" – the component of applied shear stress, which is 90° out of phase with the shear strain, divided by the strain. Syn: viscous modulus, hysteretic modulus, imaginary modulus, and out-of-phase modulus.

**Loss of drier** *See drier dissipation.*

**Loss of gloss** A paint defect in which a dried film of paint loses gloss, usually over a period of several weeks.

**Lost end** An end on a section or tricot beam that has been broken at some stage in warping and has not been repaired by a knot.

**Lost-wax process** *See investment casting.*

**Lot** \ˈlät\ [ME, fr. OE *hlot*; akin to OHGr *hlōz*] (before 12c) *n.* A unit of production or a group of other units or packages that is taken for sampling or statistical examination, having one or more common properties and being readily separable from other similar units.

**Lot number** The number used by the manufacturer to identify an entity of production.

**Louvers** \ˈlü-vər-\ [ME *lover*, fr. MF *lovier*] (14c) *n.* Slats placed at an angle, as in shutters.

**Lovibond color system** A system of color specification by means of numbers proportional to the optical densities of three glass filters (yellow, red, and blue) required to modify a standard light source (such as daylight or incandescent lamp light) to produce a color match. The carefully calibrated glasses should be used as described by the manufacturer, Tintometer Ltd., UK, in order that results in different laboratories will agree. Lovibond specifications have long been used as the basis for describing the colors of edible oils and vegetable oils used for paint vehicles.

**Lovibond tintometer** Optical comparison instrument manufactured by Tintometer Ltd., for use of Lovibond glasses.

*See lovibond color system.*

**Low-angle laser-light scattering** A technique for determining weight-average molecular weights of polymers in solution. The low angle – 2° to 10° – reduces the number of measurements needed and simplifies their interpretation, as compared with conventional, wide-angle light scattering. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Berne BJ (2000) Dynamic light scattering: applications to chemistry, biology and physics. Dover Publications, New York.

**Low-density polyethylene (LDPE)** This term is generally considered to include polyethylenes having densities between 0.915 and 0.925 g/cm$^3$. In LDPE, the ethylene molecules are linked in random fashion, with many side branches, mostly short ones. This branching prevents the formation of a closely knit pattern, resulting in material that is relatively soft, flexible, and tough, and which will withstand moderate heat.

*See also high-density polyethylene and polyethylene.*

**Lower explosive limit** Lower limit of flammability or explosibility of a gas or vapor at ordinary ambient temperatures expressed in percent of the gas vapor in air by volume. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997.

*See explosive limits.*

**Low-pressure injection molding** A term sometimes used for the process of injecting a fluid material such as a vinyl plastisol into a closed mold, using a grease gun or similar low-pressure equipment.

**Low-pressure laminate** Various definitions place the upper limit of pressure for this term at from 6.9 MPa down to pressures obtained by mere contact of the piles. According to ASTM D 883, the upper limit is 1.4 MPa (200 psi). The Decorative Board Section of the National Electrical Manufacturers' Association (NEMA) has recommended abandonment of the term "low-pressure laminate" in favor of *decorative board* in the case of "...a product resulting from the impregnation or coating of a decorative web of cloth, paper, or other carrying media with a thermosetting resin and consolidation of one or more of these webs with a cellulosic substrate under heat and pressure of less than 500 psi". This includes all boards that were formerly called low-pressure melamine and polyester laminates, but not vinyls.

*See also contact-pressure molding and laminate.*

**Low-pressure molding** Molding or laminating in which the pressure is 1.4 MPa (200 psi) or less (ASTM D 883).

**Low-pressure resin** *See contact-pressure resin.*

**Low rows** A carpet defect characterized by rows of unusually low pile height across the width of the goods.

**Low-temperature flexibility** All plastics that are flexible at room temperature become less so as they are chilled, finally becoming brittle at some low temperature. This property is often measured by torsional tests over wide ranges of temperature, from which apparent moduli of elasticity are calculated. Some relevant ASTM tests are D 1043, D 3295, D 3296, D 3374 (Section 07.02), and D 1055 (Section 09.01).

*See also brittleness temperature and clashberg point.*

***L*-sealer** A heat-sealing device, used in packaging, that seals a length of flat, folded film on the edge opposite the fold and simultaneously seals a strip across the width at 90° from the edge seals. The article to be packaged may be inserted between the two layers of folded film prior to sealing. When it is desired to sever the continuous length of sealed compartments into individual packages, a heated wire or knife is incorporated between two sealing bars that form the bottom of the *L*. These bars then make the top seal of the filled bag and the bottom seal of the next bag to be filled.

**Luana** A fabric characterized by a crosswise rib effect, usually made with a filament yarn warp and a spun yarn filling.

**Lumband oil** This oil is obtained from the nuts of the tree, *Aleurites moluccana*. Although a product of an Aleurites tree, it contains no elaeostearin. It dries somewhat better than soybean oil.

*Also called candlenut oil.*

**Lubricant** \ˈlü-bri-kənt\ (ca. 1828) *n.* A substance that tends to make surfaces slippery, reduce friction, and prevent adhesion.

**Lubricant bloom** *See bloom.* The term *lubricant bloom* should only be used when the exudation is known to be caused by a lubricant contained in the plastic compound or applied to it during processing.

**Lucite®** \ˈlü-ˌsīt\ Poly(methyl methacrylate). DuPont's trade name for methacrylate-ester monomers and polymers (*acrylic*), including PMMA and several other resins, and for certain products made from such resins.

**Lumen** \ˈlü-mən\ [NL *lumin*-, *lumen*, fr. L, light, air shaft, opening] (1873) (lm) *n.* The SI unit of luminous flux.

**Luminance** \ˈlü-mə-nən(t)s\ (1880) *n.* The luminous intensity of light reflected or transmitted by a material in a given direction per unit of projected area of the material, as viewed from that direction.

**Luminescent** (1889) *n.* Emitting light not due to high temperature, usually caused by excitation by rays of a shorter wavelength. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Luminescent pigment** A pigment that produces striking effects in darkness or light. Dainth J (2004) Dictionary of chemistry. Oxford University Press, UK. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

*See fluorescent pigment and phosphorescent pigment.*

**Luminosity curve, CIE** Graph representing the luminous intensity of wavelengths in the visible spectrum relative to the maximum intensity at the same wavelength. The relative luminosity curve is described by the *Y*-color matching function in the CIE System. The shape of the curve depends on the area of the retina being stimulated and on the intensity of the incident light. Thus, the CIE luminosity curves for the 2° and 10° observers are slightly different, and those for daylight vision, i.e., photopic vision, and for dark-adapted vision, i.e., scotopic vision, are extremely different.

**Luminous** \ˈlü-mə-nəs\ [ME, fr. L *luninosus*, fr. *lumin*-, *lumen*] (15c) *adj.* (1) Adjective used to imply dependence on the spectral response characteristic of the Standard Observer defined in the CIE System. Thus, the luminous reflectance or the luminous transmittance is described by the *Y*-tristimulus value in the CIE System. The adjective is applied to many measures of light, such as intensity, density, etc., and always indicates the measures are weighted for the relative luminous sensitivity of the human observer. (2) Material emitting or spearing to be emitting, visible radiant energy.

**Luminous directional reflectance** Reflectance of a surface for specified directions of illumination and view is the ratio of the brightness of the surface to the brightness that an ideally diffusing, perfectly white, surface would have if illuminated and viewed in the same manner. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Luminous energy** (ca. 1931) *n.* Energy transferred in the form of visible radiation. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Luminous flux** (1925) *n.* The total visible energy emitted by a source per unit time. The SI unit is the *lumen* (lm), defined as the luminous flux emitted in a solid angle of 1 steradian (sr, the solid central angle that cuts out of a spherical surface a square whose side is equal to the radius) by a point source having a uniform intensity of 1 cd. Therefore, 1 lm = 1 cd sr.

*See flux, luminous.*

**Luminous paint** (ca. 1889) *n.* Paint which exhibits fluorescence. (1) *Fluorescent paint* – contains pigments, which are capable of absorbing energy from the blue or ultraviolet end of the spectrum and reemitting it in the form of light in the visible wavelengths. A fluorescent paint ceases to “glow” if the activating source is removed. (2) *Phosphorescent paint* – contains pigments (phosphors) which absorb energy at one wavelength and emit it over a period of time, in the form of light at a longer wavelength in the visible spectrum. It differs from a fluorescent paint in that it continues to glow after the stimulating source has been removed. (3) *Radioactive* or *self-luminous paint* – normally, this is a phosphorescent paint containing a portion of radioactive compounds, and in such a paint the phosphor is permanently activated by absorbing energy from the bombardment by the radioactive rays and emits light in the visible spectrum. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Luminous transmittance** Syn: light transmittance.

**Luparen** Poly(propylene), manufactured by BASF, Germany.

**Luphen** Phenoplast, manufactured by BASF, Germany.

**Lupolen** Poly(ethylene) (high pressure), manufactured by BASF, Germany.

**Luran** Co-polymer from styrene/acrylonitrile, manufactured by BASF, Germany.

**Luster** \ˈləs-tər\ [MF *lustre*, from OI *lustro*, fr. *lustrare* to brighten, fr. L. to purify ceremonially, fr. *lustrum*] (ca. 1522) *n.* (1) Type of surface reflectance, or gloss, where the ratio of specular reflectance to diffuse reflectance is relatively high, but not so high as that from a perfect specular reflector (mirror). (2) Another term for gloss.

**Lustering** (1582) *v.* The finishing of yarn or fabric by means of heat, pressure, steam, friction, calendering, etc., to produce luster.

**Lusterless** (ca. 1522) *adj.* An adjective describing a non-glossy or non-reflecting surface with respect to illumination of the surface, dull in appearance.

**Lux** \ˈləks\ [L, light] (1889) (lx) *n.* The SI unit of illuminance, defined as the illuminance produced by a luminous flux of 1 lm uniformly distributed over a surface of 1 $m^2$. That is, 1 lx = 1 lm/$m^2$.

**Lycra** \ˈlī-krə\. Elastomer from segments of polyether and polyurethane, manufactured by DuPont.

**Lyocell fiber** A manufacturing cellulose fiber made by direct dissolution of wood pulp in an amine oxide solvent, *N*-methylmorpholine-*N*-oxide. The clear solution is extruded into a dilute aqueous solution of amine oxide, which precipitates the cellulose in the form of filaments. The fiber is then washed before it is dried and finished. The solvent spinning process for making lyocell fiber is considered to be environmentally friendly because the non-toxic spinning solvent is recovered, purified, and recycled as an integral part of the manufacturing process. No chemical intermediates are formed, the minimal waste in not hazardous, and energy consumption is low. Wood pulp is a renewable resource, and the fiber is biodegradable. Characteristics: lyocell fiber is stronger than other cellulosic fibers. It is inherently absorbent, having a water imbibition of 65–75%. Lyocell retains 85% of its dry tenacity when wet, making it stronger when wet than cotton. The fiber has a density of 1.15 g/$cm^3$. End uses: lyocell fiber is suitable for blending with cotton or other manufactured fibers. Because of its molecular structure, lyocell has the tendency to develop surface fibrils that can be beneficial in the manufacture of hydroentabled and other non-wovens, and in specialty papers. For apparel uses, the fiber's unique fibrillation characteristic has enabled the development of fabrics with a soft luxurious hand. The degree of fibrillation is controlled by cellulose enzyme treatment.

**Lyophilic** \ˌlī-ə-ˈfi-lik\ (1911) *adj.* Describing a substance that easily forms colloidal suspensions. Such ability when the suspending medium is water is called *hydrophilic*. A PVC plastisol is an example of a lyophilic suspension.

**Lyophobic** \ˌlī-ə-ˈfō-bik\ (1911) *adj*. Characterizing a material, which exists in the colloidal state without any significant affinity for the medium.

**Lyotropic** *See liquid-crystal polymer.*

**Lyotropin polymer** Polymers that decompose before melting but that form liquid crystals in solution under appropriate condition. They can be extruded from high concentration dopes to give fibers of high modulus and orientation for use in advanced composites, tire cord, ballistic protective devices, etc.

# M

**m** \ˈem\ *n.* (1) Abbreviation for meter. (2) Abbreviation for the SI prefix milli-. (3) (usually italicized) Abbreviation for chemical positional prefix meta-.

**M** *n.* (1) Abbreviation for prefix mega-. (2) Symbol for molecular weight. (3) Symbol for being moment.

**mA** *n.* Abbreviation for milliampere.

**MAC** *n.* Maximum allowable concentrations of solvent vapors, also known as *threshold limit values.* These values refer to air-borne concentrations of substances and represent conditions to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect. *See maximum allowable concentration.*

**MacAdam color difference equation** *n.* A color difference equation developed by David MacAdam, which is now used as modified by Hugh Davidson and Fred Simon to incorporate the effect of lightness on the chromaticity differences:

$$\Delta E = \Big[1/K\big(g_{11}\,\overline{\Delta x^2} + 2g_{12}\,\Delta x\,\Delta y + g_{22}\,\overline{\Delta y^2} + G\,\overline{\Delta Y^2}\Big]^{1/7},$$

where $g_{11}$, $2G_{11}$, and $g_{22}$ are the constants depending on the chromaticity coordinates, $x$ and $y$, and $K$ and $G$ are the constants depending on the luminous reflectance or transmittance, $Y$. This color difference is frequently calculated from charts prepared by Simon and Goodwin, which have the required constants built-in.

**MacAdam limits** *n.* The theoretical limit or gamut of colors, which can be obtained at various limits of luminance ($Y$). Thus, the gamut of colors, which can be obtained theoretically, decreases steadily as the luminance ($Y$) increases.

**Machinability** \mə-ˌshē-nə-ˈbi-lə-tē\ (ca. 1864) *vt.* (1) In fabricating materials by such operations as drilling, lathe-turning, and milling, the ease with which the material is removed.

**Machine-printing** *n.* The method by which the bulk of modern wallpapers are produced. Machine-printing employs a rotary press and a series of cylinders or rollers to turn out wallpaper at high speeds. Raw paper stock is first given a coating of the ground color by a special machine, after which the paper proceeds in a continuous web to the rotary press where the top colors are applied, and it is then festooned on specially heated drying racks.

**Machine shot capacity** *See shot capacity.*

**Machine twist** *n.* A hard-twist sewing thread, usually of three-ply construction spun with S-twists and plied with Z-twist, especially made for use in sewing machines.

**Machining of plastics** *n.* Many of the machining operations used for metals are applicable to rigid plastics, with appropriate variations in tooling and speeds [*see machinability* (1), above]. Among such operations are blanking, boring, drilling, grinding, milling, planning, punching, routing, sanding, sawing, shaping, tapping, threading, and turning.

**Mach number ($N_{Ma}$)** *n.* The ratio of a fluid velocity or the relative velocity of an object moving through a fluid to the velocity of sound in the fluid. All fluids (liquids and gases) have Mach numbers.

**Macrolattice** *n.* A repeating structure in very small microfibrils of alternating crystalline and amorphous regions. Yarn properties are thought to be governed by morphology at the macrolattice scale.

**Macromolecule** \ˌma-krō-ˈmä-li-ˌkyü(ə)l\ [ISV] (ca. 1929) *n.* The large ("giant") molecules that make up high polymers, both natural and synthetic. Each macromolecule may contain hundreds of thousands of atoms.

*See polymer.*

**Macromonomers** *n.* High molecular weight monomers.

*Also called macromens.*

**Macroscopic** \ˌma-krə-ˈskä-pik\ [ISV *macr-* + *scopic* (as in *microscopic*)] (1872) *adj.* Visible to the naked eye, as opposed to *microscopic.*

**Madder lake** *n.* Lightfast, non-bleeding, red-colored pigment prepared from the coloring matter of madder root.

**Madder lakes** *n.* A class of solvent-resistant and lightfast pigments; generally dirty in appearance.

**Madras** \ˈma-drəs; mə-ˈdras, -ˈdräs\ [*Madras,* India] (ca. 1830) *n.* A lightweight, plain weave fabric with a striped, checked, or plaid pattern. True madras is "guaranteed to bleed".

**Magdala red** *n.* $C_{30}H_{21}N_4Cl$. Red dyestuff.

*Known also as naphthalene red.*

**Magnesia** \mag-ˈnē-shə, -zhə\ [NL, fr. *magnes carneus*, a white earth, literally, flesh magnet] (1755) *n.* MgO. (1) Magnesium oxide. (2) Sometimes used incorrectly in the printing ink industry to mean magnesium carbonate. Syn: magnesium oxide.

**Magnesite** \ˈmag-nə-ˌsīt\ (1815) *n.* $MgCO_3$. Mineral, magnesium carbonate, principally used as a filler or extender.

**Magnesite floor** *n.* Hard composition floors in which magnesium oxychloride is the binder. This binder is formed in laying the floor, when magnesium oxide is combined with a strong solution of magnesium chloride. Fillers which may be added to this binder are: asbestos, cork, sand, wood flour, marble dust, talc, leather, etc. This great variety of fillers produces magnesite floors having variable porosity, resiliency, appearance, and durability.

**Magnesium carbonate** (1903) (magnesia alba, precipitated magnesium carbonate) *n.* $MgCO_3$. A white powder of low density, prepared by metathesis, used as a filler or modifier in phenolic resins. This carbonate also occurs naturally as *magnesite.*

**Magnesium carbonate, precipitated** *n.* Chemically, this is the same as magnesite, but physically it has a much better color, in bulk being a very intense white. It is usually a very fine light powder of rather high oil absorption.

**Magnesium chloride** (ca. 1910) *n.* A bitter deliquescent salt $MgCl_2$ used especially as a source of magnesium metal.

**Magnesium glycerophosphate** *n.* $MgPO_4C_3H_5(OH)_2$. A colorless powder, derived by the action of glycerophosphoric acid on magnesium hydroxide, used as a stabilizer for plastics.

**Magnesium hydrogen phosphate trihydrate** *n.* Dibasic magnesium phosphate, magnesium monohydrogen *ortho*phosphoric acid with magnesium oxide, used as a non-toxic stabilizer for plastics.

**Magnesium hydroxide** (ca. 1909) *n.* $Mg(OH)_2$. Used as a thickening agent for polyester resins. Its action is slower than that of magnesium oxide.

**Magnesium hydroxychloride cement (Sorel cement, magnesium oxychloride cement)** *n.* A mixture of magnesium chloride and magnesium oxide that reacts with water to form a solid mass, presumed to be magnesium hydroxychloride, Mg(OH)Cl. It has been useful as an intumescent coating for urethane foams and other materials such as polystyrenes, nylons, acetals, polyesters, and silicones.

**Magnesium oxide** (ca. 1909) (magnesia, periclase) *n.* A white powder used as filler and as a thickening agent in polyester resins. It occurs naturally as the mineral *periclase*, but it is usually made in purer form by calcining magnesium hydroxide or carbonate.

**Magnesium phosphate, dibase** *n.* *See magnesium hydrogen phosphate trihydrate.*

**Magnesium phosphate, monobasic** (magnesium dihydrogen phosphate) *n.* $Mg(H_2PO_4)_2{\cdot}2H_2O$. A white, hygroscopic, crystalline powder derived by reacting phosphoric acid with magnesium hydroxide. It is used as a flame retardant and stabilizer for plastics.

**Magnesium phosphate, tribasic** *n.* $Mg_3(PO_4)_2{\cdot}8H_2O$ or ${\cdot}4H_2O$. A fine, soft white powder derived by reacting magnesium oxide and phosphoric acid at a high temperature, used as a non-toxic stabilizer.

**Magnesium silicate, fibrous** *n.* $3MgO{\cdot}2SiO_2{\cdot}2H_2O$. A fibrous chrysotile mineral white to gray powder, chemically inert used as extender and/or filler in paints and caulks. Pigment grades are used for their high temperature resistance, high oil absorption and water demand. Density, 2.48–2.56 g/cm$^3$ (20.7–21.3 lb/gal); O.A., 50–180. Syn: asbestos, chrysotile, and fibrous asbestos.

**Magnesium silicate, non-fibrous** *n.* $3MgO{\cdot}4SiO_2{\cdot}H_2O$. Pigment White 26 (77718). A hydrated magnesium silicate extender of filler of wide range of composition. Soft white, gray or yellow shade. Natural product (talc) used in paint, rubber, ceramics, paper and roofing compounds. Density, 2.7–2.8 g/cm$^3$ (22.5–23.3 lb/gal); O.A., 30–50; particle size, 0.5–2.5 μm. Syn: talc and asbestine.

**Magnesium soap** *n.* A magnesium salt of a fatty acid, e.g., magnesium stearate, precipitated by an inorganic magnesium salt from a solution of sodium or potassium soaps. *See also soap, metallic.*

**Magnesium soaps** Saponification products of magnesium and various fatty acids.

**Magnesium stearate** *n.* $Mg(OOCC_{17}H_{35})_2$. A white, soft powder used as a lubricant and stabilizer.

**Magnetic field due to a current** *n.* The intensity of the magnetic field in oersted at the center of a circular conductor of radius $r$ in which a current $I$ in absolute electromagnetic units is flowing,

$$H = \frac{2\pi I}{r}.$$

If the circular coil has $n$ turns the magnetic intensity at the center is

$$H = \frac{2\pi nI}{r}.$$

The magnetic field in a long solenoid of $n$ turns per centimeter carrying a current $I$ in absolute electromagnetic units

$$H = 4\pi nI.$$

If $I$ is given in amperes the above formulae becomes

$$H = \frac{2\pi I}{10r}, \quad H = \frac{2\pi nI}{10r}, \quad H = \frac{4\pi I}{10}.$$

**Magnetic field due to a magnet** *n.* At a point on the magnetic axis prolonged, at a distance $r$ cm from the center of the magnet of length $2l$ whose poles are $+m$ and $-m$ and magnetic moment $M$, the field strength is oersted is

$$H = \frac{4mlr}{(r^2 - l^2)^2}.$$

If $r$ is large compared with $l$,

$$H = \frac{2M}{r^3}.$$

At a point on a line bisecting the magnet at right angles, with corresponding symbols,

$$H = \frac{2ml}{(r^2 + l^2)^{3/2}}.$$

For large value of *r*,

$$H = \frac{M}{r^3}.$$

**Magnetic field intensity or magnetizing force** *n.* It is measured by the force acting on unit pole. Unit field intensity, the oersted is that field which exerts a force of 1 dyne on unit magnetic pole. The field intensity is also specified by the number of lines of force intersecting unit area normal to the field, equal numerically to the field strength in oersted. Magnetizing force is measured by the space rate of variation of magnetic potential and as such its unit may be the **Gilbert per centimeter**. The gamma ($\gamma$) is equivalent to 0.00001 oersted. Dimensions

$$\left[\varepsilon^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{1/2}\,\mathrm{T}^{-2}\right], \quad \left[\mu^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{-1/2}\,\mathrm{T}^{-1}\right].$$

**Magnetic filler** *n.* Any permanently magnetizable material in powder form that may be incorporated into plastics to produce molded or extruded-strip magnets. Major ones in use are Alnico, rare earths, and, most used in plastics, hard ferrite.

**Magnetic flux** (1896) *n.* Through any area perpendicular to a magnetic field is measured as the product of the area by the field strength. The unit of magnetic flux, the **Maxwell,** is the flux through a square centimeter normal to a field of 1 G. The line is also a unit of flux. It is equivalent to the Maxwell. Dimensions

$$\left[\varepsilon^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{1/2}\right], \quad \left[\mu^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{1/2}\,\mathrm{T}^{-1}\right].$$

**Magnetic induction** *n.* Results when any substance is subjected to a magnetic field is measured as the magnetic flux per unit area taken perpendicular to the direction of the flux. The unit is the Maxwell per square centimeter or its equivalent, the gauss. Dimensions

$$\left[\varepsilon^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{3/2}\right], \quad \left[\mu^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{-1/2}\,\mathrm{T}^{-1}\right].$$

If a substance of permeability of $\mu$ is placed in a magnetic field *H*, then the magnetic induction in the substance is

$$M = \mu H.$$

If *I* is the magnetic moment for unit volume, or intensity of magnetization

$$M = H + 4\pi I.$$

The susceptibility,

$$k = \frac{I}{H}, \quad \mu = 1 + 4\pi\kappa.$$

**Magnetic inks** *n.* Inks made with pigments, which can be magnetized after printing. The printed characters can be recognized later by electronic reading equipment.

**Magnetic moment** (1865) *n.* The magnetic moment of a magnet is measured by the torque experienced when it is at right angles to a uniform field of unit intensity. The value of the magnetic moment is given by the product of the magnetic pole strength by the distance between the poles. Unit magnetic moment is that possessed by a magnet formed by two poles of opposite signs and of unit strength, 1 cm apart. Dimensions

$$\left[\mu^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{-1/2}\mathrm{T}^{-1}\right], \quad \left[\varepsilon^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{3/2}\right].$$

If the poles are separated by a distance, which is great compared with the dimensions of the magnet, then the magnetic moment of a magnet of length *1* whose poles have values of $+m$ and $-m$ is $m = ml$.

**Magnetic permeability** *n.* A property of materials modifying the action of magnetic poles placed therein and modifying the magnetic induction resulting when the material is subjected to a magnetic field or magnetizing force. The permeability of a substance may be defined as the ratio of the magnetic induction in the substance to the magnetizing field to which it is subjected. The permeability of a vacuum is unity. Dimensions

$$[\varepsilon^{-1}\,\mathrm{L}^{-2}\,\mathrm{T}^{2}], \quad [\mu].$$

**Magnetic pole or quantity of magnetism** *n.* Two unit quantities of magnetism concentrated at points unit distance apart in a vacuum repeal each other with unit force. If the distance involved in 1 cm and the force 1 dyne, the quantity of magnetism at each point is one cgs unit of magnetism. Dimensions

$$\left[\varepsilon^{-1/2}\,\mathrm{M}^{1/2}\mathrm{L}^{1/2}\right], \quad \left[\mu^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{3/2}\,\mathrm{T}^{-1}\right].$$

**Magnetic potential or magnetomotive force** *n.* At a point is measured by the work required to bring until positive pole from an infinite distance (zero potential) to the point. The unit is the *Gilbert*, that magnetic potential against which an erg of work is done when unit magnetic pole is transferred. Dimensions

$$\left[\varepsilon^{1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{3/2}\,\mathrm{T}^{-2}\right], \quad \left[\mu^{-1/2}\,\mathrm{M}^{1/2}\,\mathrm{L}^{1/2}\,\mathrm{T}^{-1}\right].$$

**Magnetic quantum number, $m_\mathrm{l}$** (1923) *n.* A quantum number, which indicates the orbital occupied by an electron.

**Magnetic separator** *n.* A device that removes tramp iron and steel from a stream of mainly non-magnetic material, such as reground plastic or mixed wastes, by passing the stream close to strong magnets. Some design parameters for magnetic separators are given in Section 21 of Perry and Green (1997). Perry RH, Green DW (eds) (1997) Chemical engineers' handbook, 6th edn. (and the two preceding editions). McGraw-Hill, New York

**Magnetite black** \ˈmag-nə-ˌtīt ˈblak\ (1851) *n.* $Fe_3O_4$. Magnetic iron oxide.
*See black iron oxide.*

**Magnification, empty** *n.* A higher magnification than necessary to resolve detail.

**Magnification, maximum useful (MUM)** *n.* The maximum magnification necessary to resolve detail. Magnification in excess of MUM gives no additional resolving power. It can usually be estimated as being 1000 times the NA of the objective.

**Magnifying power** *n.* The magnifying power of an optical instrument is the ratio of the angle subtended by the image of the object seen through the instrument to the angle subtended by the object when seen by the unaided eye. In the case of the microscope or simple magnifier the object as viewed by the unaided eye is supposed to be a distance of 25 cm (10 in.).

**Mahlstick** \ˈmól-\ *variant of maulstick.* Long stick, padded at one end, on which a painter can rest his hand to steady if when working.

**Mahogany sulfonates** *n.* Soaps, the sodium salts of sulfonic acids from petroleum refining sludge; used in synthetic resin production, as are sorbitan oleates and laurates, polyoxyethylene esters.

**Maintenance paints** *n.* Coatings used to maintain manufacturing plants, offices, stores and other commercial structures, hospitals and nursing homes, schools and universities, government and public buildings, and both building and non-building requirements in such areas as public utilities, railroads, roads, and highways, and including industrial paint, other than the original coatings, the primary function of which is protection. Residential maintenance is excluded.
*See also industrial maintenance paints.*

**Makeready** *n.* The preparation and correction of the printing plates, before starting the printing run, to insure uniformly clean impressions of optimum quality. All preparatory operations preceding a production run.

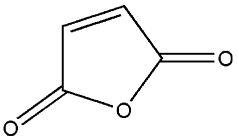
**Makrolon** Polycarbonate from bisphenol A and phosgene base units. Manufactured by Bayer, Germany.

**Malachite** \ˈma-lə-ˌkīt\ *n.* [alt of ME *melochites*, fr. L *molochites*, fr. Gk *molchitēs*, fr. *molochē*, *malchē* mallow] (1656) $CuCO_3 \cdot Cu(OH)_2$. Basic carbonate of copper, which occurs naturally. The color varies from a bright emerald to a dark green.

**Malachite green** *n.* (1) Bluish-green dyestuff made from dimethyl aniline and benzaldehyde. It is often sold in the form of its oxalate. (2) A green lake pigment produced for a basic dye, used in the manufacture of printing inks.

**Maleic Acid** \mə-ˈlē-ik-, -ˈlā-\ *n.* [F, *acide maléique*, alter. of *acide malique* malic acid, fr. its formation by dehydration of malic acid] (1857). $COOH(CH)_2COOH$. Dibasic acid used in the manufacture of synthetic resins.

**Maleic anhydride** (1857) (2,5-furandione) *n.* A compound crystallizing as colorless needles, obtained by passing a mixture of benzene and air over a heated vanadium pentoxide catalyst, and having the structure shown below. It has many applications in plastics, including the production of alkyd, polyester, and vinyl-copolymer resins, and as a curing agent for thermosetting resins such as phenolics and ureas. About half the maleic anhydride produced in the USA is used in the manufacture of unsaturated polyester resins, to which it imparts fast curing and high strength. Used in manufacturing synthetic resins and maleinized oils, mp, 56°C; bp, 202°C; acid value, 1.143.



**Maleic anhydride value** *See diene value or number.*

**Maleic ester resin** *n.* A synthetic resin made from maleic acid or maleic anhydride and a polyhydric alcohol.

**Maleic resin** *n.* A resin made from a natural resin and maleic anhydride or maleic acid.

**Maleic resins** *n.* A class of resins obtained from the condensation of maleic anhydride with rosin, terpenes, etc.

**Maleic value** Another name for diene value.

**Maleinized oil** *n.* Oil which has been reacted, through its double bonds, with maleic anhydride.

**Mallory fatigue test** *n.* A test to measure the endurance properties of tire cord.

**Maltese cross** (1877) *n.* A dark shadow, having the shape of a maltese cross, seen in polymer (e.g., polyethylene) spherulities when viewed under a polarizing microscope.

**MAN** Abbreviation for methacrylonitrile.

**Mandrel** \ˈman-drəl\ [prob. mod. of F *mandrin*] (1665) *n.* (1) The core around which paper, fabric, or resin-impregnated fibrous glass is wound to form pipes or tubes. (2) In extrusion, an extension of the core of a pipe or tubing die, internally cooled by circulating water or other fluid, that guides and cools the internal surface of the tube as it emerges from the die proper. The mandrel is an important determiner of the final internal diameter of the tube.

**Mandrel test** *n.* Test for determining the flexibility and adhesion of surface coatings, so named because it involves the bending of coated metal panels around mandrels.

**Manganese black** \ˈmaŋ-gə-ˌnēz \. $MnO_2$. Manganese dioxide. A black pigment.

Principal uses are as a drier and as a colorant for ceramics.

**Manganese brown** *n.* There are two types of manganese browns: (1) Burnt turkey umber. (2) A brown oxide pigment, made artificially as a by-product from chlorine manufacture.

**Manganese dioxide** (1882) *n.* $MnO_2$. A dark insoluble compound used especially as an oxidizing agent, as a depolarizer of dry cells, and in making glass and ceramics.

**Manganese driers** *n.* (1) Material containing chemically combined manganese used to accelerate the oxidation and polymerization of an ink film. (2) These include manganese dioxide, the hydrated oxide, manganese acetate, sulfate and borate. The organic driers are salts of various organic acids such as naphthenic or 2-ethyl hexoic. Manganese driers are characterized by their reddish-brown colors and their surface drying activity.

**Manganese green** *n.* Strong green pigment, with good alkali resistance, prepared by roasting manganese dioxide and barium hydroxide together under oxidizing conditions.

**Manganese violet** *See mineral violet.*

**Manifold** \ˈma-nə-ˌfōld\ (1855) *n.* A pipe or channel with several inlets or outlets. With reference to blow molding, extrusion, and injection molding, a manifold is a piping or distribution system that receives the outflow of the extruder or molder and divides or distributes it to feed several blow-molding heads or injection nozzles.

**Manila** \mə-ˈni-lə\ (1834) *adj.* Fiber obtained from the leaf stalks of the abaca plant. It is generally used for cordage.

**Manila copal** *n.* Natural resins, two types of which are used in varnish manufacture, in which they are described as hard and soft manilas. The hard type requires running and is used to some extent in oil varnishes. The soft type is readily soluble in industrial alcohol and forms the basis of spirit paper and other air-drying varnishes; the native name for the soft type, obtained by tapping, is Melengket.

**Manjak** *n.* Intense black, naturally occurring asphaltum, obtained from Barbados. It differs from other asphaltums used in the trade by reason of its unusual staining power and difficult solubility. Prolonged high-temperature treatment is necessary in order to effect a reasonable solution in drying oils, and a substantial amount of mineral matter always remains undissolved. It is used alone, or with gilsonite, in black bituminous finishes of many types. Syn: glance pitch.

**Man-made fiber** Syn: synthetic fiber.

**Mannich reaction** *n.* The condensation of ammonia or a primary or secondary amine with formaldehyde and a compound containing at least one hydrogen atom of pronounced activity. The active hydrogen replaced by an aminomethyl or substituted aminomethyl group. This reaction has been employed in producing “mannich polyols” for use in making urethane foams.

**Mannite** \ˈma-ˌnīt\ [F, fr. *manna*, fr. LL] (1830) *n.*

*See mannitol.*

**Mannitol** \ˈma-nə-ˌtól\ [ISV] (1879) *n.* $C_6H_8(OH)_6$. A hexahydric alcohol which has been used in the production of synthetic oils and alkyd resins. Bp, 278°C/1 mmHg; mp, 166°C.

*Known also as mannite.*

**Manufactured fiber** *n.* A class name for various genera of fibers (including filaments) produced from fiber-forming substances which may be: (1) Polymers synthesized from chemical compounds, e.g., acrylic, nylon, polyester, polyethylene, polyurethane, and polyvinyl fibers. (2) Modified or transformed natural polymers, e.g., alginic and cellulose-based fibers such as acetates and rayons. (3) Minerals, e.g., glasses. The term manufactured usually refers to all chemically produced fibers to distinguish them from the truly natural fibers such as cotton, wool, silk, flax, etc.

**Manufactured unit** *n.* A quantity of finished adhesive or finished adhesive component, processed at one time. *Note* — The manufactured unit may be a batch or a part thereof.

**Marble** \ˈmär-bəl\ [ME, fr. OF *marbre*, fr. L *marmor*, fr. Gk *marmaros*] (12c) *n.* (1) Limestone that has crystallized to varying extent, often with veined inclusions, and occurring in many colors. Its preponderant constituent is calcium carbonate. (2) A smooth round sphere of any hard non-metal in the size range from about 0.7 to 2.5 cm.

**Marble flour** *See calcium carbonate, natural.*

**Marbling, marbleizing** *n.* Imitating with finishing materials, as in antiquing, the figure and texture of polished marble or other decorative stones, usually by stippling or mottling in conjunction with graining, scratching and spattering.

**March, non-conditional** *See non-conditional match.*

**Margaric acid** *See daturic acid.*

**Marine borers** *n.* Mollusks and crustaceans that attack submerged wood in salt and brackish water.

**Marine coatings** *n.* Paints and varnishes specifically formulated to withstand water immersion and exposure to marine atmosphere. *See also spar varnish.*

**Marine varnishes** *See marine coatings and spar varnish.*

**Marker** *n.* In the floor coverings industry, a distinctive threadline in the back of a carpet that enables the installer to assemble breadths of carpet so that the pile lays in one direction or so that patterns match.

**Mark–Houwink equation** *n.* Also referred to as Kuhn–Mark–Houwink–Sakurada equation; allows prediction of the viscosity average molecular weight $M_v$ for a specific polymer in a dilute solution of solvent by $[\eta] = KM_v^a$, where $K$ is a constant for the respective material and $a$ is a branching coefficient; $K$ and $a$ (sometimes $a^\eta$) can be determined by a plot of log $[\eta]$ versus $\log M_v^a$ and the slope is $a$ and intercept on the $Y$-axis is $K$. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Marking nut oil** *n.* Oil that resembles cashew nut shell liquid in that it is phenolic and quite unlike the glyceride vegetable oils. *Known also as dhobi marking nut oil or bhilawan oil.*

**Marl** A yarn made from two rovings of contrasting colors drafted together, then spun. Provides a mottled effect.

**Marlex** Poly(ethylene), manufactured by Phillips, USA.

**Marouflage** *v.* To glue a canvas to a wall which is to be covered by a mural painting.

**Marquardt index** *n.* In an infrared-absorption study of the cure advancement of a phenolic resin, the Marquardt index is the numerical difference in percent transmission between the absorption peaks at 12.2 and 13.3 µm. As the resin cure progresses, the intensity of the 13.3-µm absorption increases more rapidly than that of the initially stronger 12.2-µm peak.

**Marquetry** \ˈmär-kə-trē\ [MF *marqueterie*, fr. *marqueter* to checker, inlay, fr. *marque* mark] (1563) *n.* Decorative inlay.

**Marquisette** \ˌmär-kwə-ˈzet\ [*marquise* + -*ette*] (1908) *n.* A lightweight, open-mesh fabric made of cotton, silk, or manufactured fibers in a leno, doup, or gauze weave. Marquisettes are used for curtains, dresses, mosquito nets, and similar end uses.

**Mar resistance** *n.* The resistance of a glossy plastic surface to abrasive action. It is measured (ASTM D 673) by abrading a specimen to a series of degrees, then measuring the gloss of the abraded spots with a glossmeter and comparing the results to that of the unbraided area of the specimen. *See also gloss.*

**Married fiber clump** *n.* A defect that occurs in converter top. It consists of a group of unopened, almost coterminous fibers with the crimp in register.

**Martens heat-deflection temperature** *n.* The temperature at which, under four-point loading, a bar of polymer deflects by a specified amount. For amorphour polymers, the Martens temperature is about 20°C below the glass-transition temperature. *Compare deflection temperature.*

**Martius yellow** *n.* Calcium derivative of naphthalene yellow.

**Mask** \ˈmask\ [MF *masque*, fr. OIt *maschera*] (1534) *n.* A stencil used for spray-painting plastics, consisting of a relatively thin sheet shaped to fit the part to be painted with openings for areas to be painted.

**Masking** *n.* Temporarily covering that part of a surface to which it is not desired to apply a coating.

**Masking tape** *n.* Adhesive backed paper tape used to mask or protect parts of a surface not to be finished.

**Masonry** \ˈmā-sən-rē\ (13c) *n.* The art of the mason in shaping, arranging and uniting stone, brick, building blocks, tile and similar materials, to form walls and other parts of a building.

**Masonry conditioner** *n.* A solvent-based, pigmented primer coating formulated to have great penetrating power so as to prepare masonry (especially chalky stucco) to receive finish coats. Particularly important under latex paints.

**Masonry paint** *n.* An alkali-resistant coating, usually a latex paint, used for masonry substrates.

**Mass** \ˈmas\ [ME *masse*, fr. MF, fr. L *massa*, fr. Gk *maza*; akin to Gk *massein* to kneed] (15c) *n.* (1) Quantity of matter, whose unit, the kilogram, is one of seven base units of the SI system. The term is often confused with *weight* in everyday use, probably because, when weighed on an equal-arm balance, the mass being determined is compared with standard masses, ordinarily referred to as "weights". Although the kilogram-force (*kilopond*) has long been used and is still being used, it has no place in the SI system. (2) Units of mass – the gram is 1/1000 the quantity of matter in the International Prototype kilogram; one of the three fundamental units of the cgs system. The British standard of mass is the pound, of which a standard is preserved by the government. The USA standard mass is the avoirdupois pound defined as 0.45359 Kg. Giambattista A, Richardson R, Richardson B (2003) College physics. McGraw-Hill Science, New York. Kricheldorf HR, Swift G, Nuyken O, Huang SJ (2004) Handbook of polymer synthesis. CRC Press, Boca Raton, FL.

*See also weight and force.*

**Mass-action expression, *Q*** The product of the concentrations or partial pressures (or, better, activities) of the products in a reaction, divided by those of the reactants. Each term is raised to an exponential power corresponding to the coefficient written before the corresponding substance or species in the balanced equation. Pure solids and liquids are omitted, as are substances present in large excess, and therefore almost constant concentration.

**Mass–action law** *n.* For a homogeneous reacting system, the rate of chemical reaction is proportional to the active masses of the reacting substances, the molecular concentration of a substance in a gas or liquid being taken as its active mass.

**Mass action, law of** *n.* At a constant temperature the product of the active masses on one side of a chemical equation when divided by the product of the active masses on the other side of the chemical equation is a constant, regardless of the amounts of each substance present, at the beginning of the action. At constant temperature the rate of the reaction is proportional to the concentration of each kind of substance taking part in the reaction.

**Mass by weighing on a balance with unequal arms** *n.* If $W_1$ is the value for one side, $W_2$ the value for the other, the true mass,

$$W = \sqrt{W_1 W_2}.$$

**Mass color** *n.* The color, when viewed by reflected light, of a pigment-vehicle mixture of such thickness as to obscure completely the background.

*Sometimes called over-tone or mass-tone.*

**Mass defect** (ca. 1923) *n.* Difference between atomic mass and mass number of a nuclide.

*See packing fraction.*

**Mass dyeing** *See spin drying.*

**Mass–energy equivalence** *n.* The equivalence of a quantity of mass and a quantity of energy when the two quantities are related by the equation $E = mc^2$. The conversion factor $c^2$ is the square of the velocity of light. The relationship was developed from **relativity theory**, but has been experimentally confirmed.

**Mass (fiber) strength** *n.* The force per unit of lineal density required to break a fiber. The SI measure is newton per (kilogram/meter), or Nm/kg. Long used in the staple-fiber industry has been the unit gram-force per denier. 1 $g_f$/denier = 88,259 Nm/kg.

**Massicot (massocot)** *n.* Another name for lead monoxide.

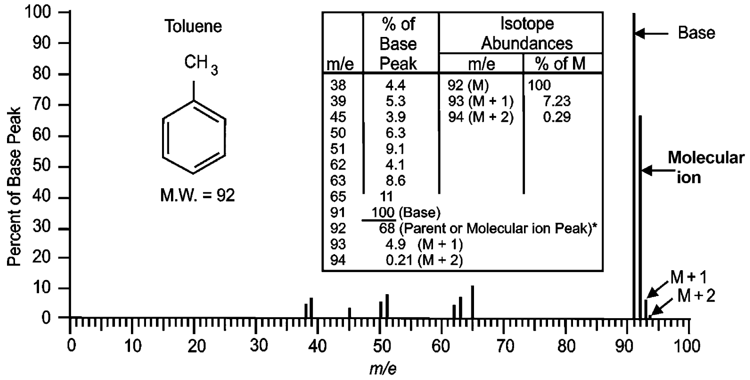
*See litharge.*

**Mass number** (1923) *n.* The total number of nucleons (protons and neutrons) in an atom.

**Mass polymerization** *See bulk polymerization.*

**Mass spectrometry** (spectroscopy) (1943) (MS) *n.* Mass spectrometry is an analytical technique in which a material (e.g., a polymer) is pyrolyzed, the fragment molecules are injected into a vacuum chamber where they are ionized with an electron gun, accelerated in an electric field, and forced through a magnetic field, the paths of the more massive molecules deflecting (curving) less than the lighter ones. A detector registers the mass number and ion count at each mass number and from this information develops a spectrum. An analyst can determine the composition of the original polymer from his interpretation of the spectrum fragments. The MS method may be supplemented by gas chromatography, which can identify the types of chemical structures in the fragments. An example of a MS spectrum of toluene is shown. Kroschwitz JI (ed) (1990) Polymers: polymer characterization and analysis. John Wiley and Sons, New York. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

**Mass tone** *n.* The color produced by a single color dispersed full strength in a suitable vehicle.



| | % of | Isotope | |
|---|---|---|---|
| | Base | Abundances | |
| m/e | Peak | m/e | % of M |
| 38 | 4.4 | 92 (M) | 100 |
| 39 | 5.3 | 93 (M + 1) | 7.23 |
| 45 | 3.9 | 94 (M + 2) | 0.29 |
| 50 | 6.3 | | |
| 51 | 9.1 | | |
| 62 | 4.1 | | |
| 63 | 8.6 | | |
| 65 | 11 | | |
| 91 | 100 (Base) | | |
| 92 | 68 (Parent or Molecular ion Peak)* | | |
| 93 | 4.9 (M + 1) | | |
| 94 | 0.21 (M + 2) | | |

**Mass spectrometer spectrum of toluene**
**(Courtesy of John Wiley & Sons)**

**Masstone** *n.* (1) A pigment-vehicle mixture which contains a single pigment only. (2) Occasionally, this term is used more loosely to describe a pigment-vehicle mixture, which contains no white pigment. *See mass color.*

**Masstone color** *n.* The color of a masstone paint applied at complete hiding.

**Masterbatch** A term used in the rubber industry for rubber compounds containing high percentages of pigments and/or other additives, to be added in small amounts to batches during compounding. The term is often used in the plastics industry for color concentrate.

**Master curve** *n.* The curve one gets by applying the principle of time–temperature equivalence to viscoelastic data on, say, relaxation modulus or creep.

**Mastic** \ˈmas-tik\ [ME *mastik*, fr. L *mastiche*, fr. Gk *mastichē*, prob. back-formation fr. *mastichan*] (14c) *n.* (1) A solid resinous material obtained from the mastic tree (*Pistacia lentiscus*) and used in adhesives and lacquers. (2) *Asphalt mastic*, a composition of mineral matter with resin and solvent. (3) Any pasty material used as a waterproof coating or as cement for setting tile.

**Masticate** \ˈmas-tə-ˌkāt\ [LL *masticatus*, pp of *masticare*, fr. Gk *mastichan* to gnash the teeth; akin to Gk *masasthai* to chew] (1649) *v.* To work rubber on a mixing mill or in an internal mixer until it becomes soft and plastic. Synonymous with breakdown.

**Mastication** *n.* Intense shearing of unvulcanized rubber by working in a roll mill or internal mixer to reduce its molecular weight preparatory to compounding and molding.

**Mastication of resins** *n.* Process of hot working of resins, which is believed to reduce molecular complexity and to confer solubility. It has been used in natural copals, and advantages of this treatment are that thermal cracking is avoided and pale colors maintained. Patented methods include treatment between rotating rollers, sometimes in the presence of solvents.

**Mat** *n.* A fabric or felt of glass or other reinforcing fibrous material cut to the contour of a mold, for use in reinforced-plastics processes such as matched-die molding, hand lay-up, or contact-pressure molding. The mat is usually impregnated with resin just before or during the molding process.

**Matched-die molding** *n.* A reinforced plastic manufacturing process in which close-fitting metal matching male and female molds are used to form the part using pressure, temperature, and time cycle.

**Matched-mold thermoforming** *n.* A sheet-thermoforming process in which the heated plastic sheet is shaped between male and female halves of a matched mold. The molds may be of metal or inexpensive materials such as plaster, wood, epoxy resin, etc., and must be vented to permit the escape of air as the mold closes.
*See sheet thermoforming.*

**Matching, color** *n.* Act of making one material appear to match another color. If the achieved match is dependent on the conditions of illumination and viewing, the match is termed conditional or metameric. If the achieved is independent of the quality of the illuminant viewer, or viewing conditions, the match is termed non-conditional or non-metameric.

**Matelassé** *n.* A soft, double or compound fancy-woven fabric with a quilted appearance. Heavier types are used as draperies and upholsteries. Crepe matelassé is used for dresses, wraps, and other apparel. Matelassé is usually woven on a Jacquard loom.

**Maximum permissible stress** *See allowable stress and factor of safety.*

**Maxwell** \ˈmaks-ˌwel\ [James Clerk *Maxwell*] (1900) *n.* The cgs emu magnetic flux is the flux through a cm$^2$ normal to a field at 1 cm from a unit magnetic pole.

**Maxwell model** (Maxwell element) *n.* A concept useful in modeling the deformation behavior of viscoelastic materials. It consists of an elastic spring in series with a viscous dashpot. When the ends are pulled apart with a definite force, the spring deflects instantaneously to its stretched position then motion is steady as the dashpot opens. A simple combination of these two types provides a fair analogic representation of real viscoelastic behavior under stress.
*See also Voigt model.*

**Maxwell's rule** *n.* A law stating that every part of an electric circuit is acted upon by a force tending to move it in such a direction as to enclose the maximum amount of magnetic flux.

**MBK** *n.* Abbreviation for methyl butyl ketone.

**MBS** *n.* Abbreviation for methacrylate-butadiene-styrene resin. These are mixtures of PMMA and butadiene-styrene co-polymers, formulated in a variety of types with markedly different characteristics according to their composition and molecular weight. MBS resins can be processed by all the usual thermoplastics processes.

**Mc** *n.* Abbreviation for megacycle, one million cycles, loosely used to mean 1 MHz, one million cycles *per second.*

**MC** *n.* Methyl cellulose.

**MD** *n.* (1) Abbreviation for machine direction. (2) Abbreviation for methylene dianiline, little used because of its carcinogenicity.

**MDI** *n.* Abbreviation for diphenylmethane-4,4′-diisocyanate.
*See diisocyanate.*

**MDPE** *n.* Abbreviation for medium-density polyethylene.
*See polyethylene.*

**Measling** *n.* The appearance of spots or stars under the surface of the resin portion of an epoxy/glass–fiber laminate (from *measles*).

**Mechanical adhesion** *n. See adhesion, mechanical and adhesion specific.*

**Mechanical equivalent of heat** *n.* A conversion factor that transforms work or kinetic energy into heat. Probably the best known one is 788 ft-lb per British thermal unit; others are 2545 Btu per horsepower-hour, $4.186 \times 10^7$ ergs/cal, and 3413 Btu/kW h. In SI there is no need for such factors because work, heat, and electrical energy are all measured in joules (1 J = 1 m N = 1 W s).

**Mechanical finishing** *n.* Changing the appearance or physical properties of a fabric by a mechanical process such as calendering, embossing, bulking, compacting, or creping.

**Mechanical grease forming** *n.* A method of sheet thermoforming used with acrylic sheet when excellent opticals are imperative and the shape desired cannot be produced by free forming. The mold surface is covered with a 1- to 2-mm-thick layer of felt soaked with melted grease that must be cleaned off the sheet after forming.

**Mechanically foamed plastic** *n.* A cellular plastic in which the cells have been produced by gases introduced by physical means.

*See also cellular plastic.*

**Mechanical properties** *n.* Those properties of a material that are associated with elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain.

**Mechanical property** *n.* Any property of a material that defines its response to a particular mode of stress or strain. Such properties include elastic moduli, strength, and ultimate strain in several modes, impact strength, abrasion resistance, creep, ductility, coefficient of friction, hardness, cyclic fatigue strength, tear strength, and machinability. Many ASTM tests in Section 08 are devoted to the mechanical properties of plastics.

**Mechanical spectrometer** *n.* An instrument (Rheometrics Inc., NJ, USA) capable of applying an alternating tensile/compressive (or flexural or torsional) deformation of constant amplitude to a plastic specimen in the frequency range from 0.002 to 80 Hz and measuring the variation of force so caused and the phase angle between the deformation and the force. For this information one can calculate the "real" and "imaginary" parts of the various moduli (*See ASTM, www.astm.org*).

**Mechanism** *n.* The set of steps (elementary processes) which together comprise an overall reaction.

**Mechanisms** *n.* Step-by-step pathway from reactants to products showing which bonds break and which bonds form in what order.

**Media** *n.* Aggregate used to effect dispersion in certain types of production equipment, such as ball, pebble, and sand mills. The media vary in size and composition. Some examples are: steel balls, natural stones or pebbles, synthetic ceramic balls, glass beads, and sand.

**Media mill** *n.* Any mill using any one of the various types of grinding media, e.g., sand, steel ball, pebble, etc.

**Median** \ˈmē-dē-ən\ *n.* The value in an arrayed set of repeated measurements that divides the set into two equal-numbered groups. If the sample size is odd, the medium is the middle value. The median is a useful measure of the center when the distribution is strongly skewed toward low or high values. *Compare arithmetic mean.*

**Medium** \ˈmē-dē-əm\ [L, fr. neuter of *medius* middle] (1593) *n.* In paints or enamels, the continuous phase in which the pigment is dispersed; thus, in the liquid paint in the can, it is synonymous with vehicle, and in the dry film it is synonymous with binder.

**Medium (art)** *n.* In a general sense, the particular material with which a work of art is executed: oils, water color, chalks, lithographic stone, pen and ink, etc. It may also refer to the liquid with which powdering pigments are ground to make artist's paint, and in a more restricted sense, to the liquid used to render such paint more fluid and workable.

**Medium oil varnish** *n.* Varnish of medium oil content usually containing from 18 to 25 gal of oil per 100 lb of resin.

*See long oil and short oil.*

**Medium yellow** *n.* A pigment based on pure, monoclinic lead chromate.

**Mega-** [Gk, fr. *megas* large] (M) *adj combining form.* The SI prefix meaning $\times 10^6$.

**Megahertz** \ˈme-gə-ˌhərts, -ˌherts\ [ISV] (1941) *n.* A unit of vibrational frequency equal to $10^6$ cycles/s, i.e., $10^6$ Hz.

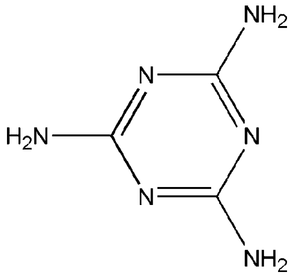
**Megapoise** *n.* One million poises. This unit is used for materials of very high viscosity, e.g., asphalts.

*See viscosity and poise.*

**MEK** *n.* Abbreviation for methyl ethyl ketone.

**MEKP** *n.* Abbreviation for methyl ethyl ketone peroxide.

**Melamine** \ˈme-lə-ˌmēn\ [Gr *Melamin*] (ca. 1835) (2,4,6-triamino-1,3,5-triazine) *n.* $C_3N_3(NH_2)_3$. A cyclic unsaturated compound, derived from cyanuric acid, with the structure shown below. It reacts with formaldehyde to give a series of heat reactive resins. Melamine's main use is for melamine-formaldehyde resins.



**Melamine–formaldehyde resins** (melamine resin) *n.* Any of a group of thermosetting resin of the amino-resin family, made by reacting melamine with formaldehyde. The lower-molecular-weight uncured melamine resins are water-soluble syrups, used for impregnating paper, laminating, etc. High-molecular-weight resins, usually cellulose-filled, are powders widely used from 1950 to 1970 for plastic tableware.

**Melamine/phenolic resin** *n.* A mixture of melamine- and phenol-formaldehyde resins that combines the dimensional stability and ease of molding of phenolics with the wider range of colorability of the melamine resins.

**Melamine resins** (1939) *n.* Any of the class of thermosetting resins formed by the interaction of melamine and formaldehyde.

**Melan, melamin** *n.* Melamine/formaldehyde pre-polymers. Manufactured by Henkel, Germany.

**Melatrope** *n.* The center of rotation of the isogyres in biaxial interference figures representing the point of emergence of rays that, in the crystal, travel along the optic axes.

**Melbrite** *n.* Melamine/formaldehyde resin. Manufactured by Montedison, Italy.

**Melded fabric** *n.* A non-woven fabric of a base fiber and a thermoplastic fiber. The web is hot-calendered or embossed at the softening point of the thermoplastic fiber to form the bond.

**Meldola blue** *n.* Methylene blue type of dye.

*Known also as new blue or naphthol blue.*

**Melengket** *n.* Native name for soft Manila copal obtained by tapping.

**Melissic acid** *n.* $CH_3(CH_2)_{28}COOH$. Monobasic fatty acid constituent of beeswax. Mp, 90°C.

**Melt** \ˈmelt\ (1854) *n.* A material, solid at room temperature, that has been heated to a molten condition.

**Melt-bead sealing** *See extruder-bead sealing.*

**Melt blend** *See biconstituent fiber.*

**Melt blowing** *n.* The formation of a non-woven by extruding molten polymer through a die then attenuating and breaking the resulting filaments with hot, high-velocity air or steam. This results in short fiber lengths. Short fibers are then collected on a moving screen where they bond during cooling.

**Melt coating** *See extrusion coating.*

**Melt-draining screw** *See solids-draining screw.*

**Melt-dyed** *See dyeing, mass colored.*

**Melt extruder** *n.* A short extruder, typically of constant channel depth and lead throughout, designed to receive a molten feed and raise its pressure for extrusion through a die, such as a pelletizing die.

**Melt flow** *n.* The rate of extrusion of molten resin through a die of specified length and diameter. The conditions of the test (e.g. temperature and load) should be given. Frequently, however, the manufacturer's data lists only the value, not the condition as well.

**Melt-flow index (MFI, melt index)** *n.* The rate of flow, in gram per 10 min, of a molten resin through an orifice 2.096 mm in diameter and 8.000 mm long at a specified temperature and weight of piston pressing on the melt. Numerous combinations of temperatures and weights are listed in ASTM (www.astm.org) various thermoplastics. This single-point flow measurement is useful in controlling production quality and resin purchasing, but most of the MFI conditions are at much lower shear than those prevailing in commercial processing, so MFI is not a reliable guide to processing behavior. MFI is inversely related to viscosity and decreases rapidly as the molecular weight in a resin family increases.

**Melt fracture** *n.* In extrusion, the distortion of the extrudate as it emerges from a die. The effect ranges from minor, regular ridges and valleys at 45° or 90° to the axis of the extrudate to violent wriggling and curling and, at its most extreme, breaking up of the extrudate into fragments.

**Melting point (melting range)** *n.* In pure compounds, the temperature at which the transition from solid to liquid occurs, requiring heat input. Polymers, being broad mixtures of homologs, melt over a substantial range of temperature, the shorter chains melting first with rising temperature, the longer ones later. Crystalline polymers have narrower, more distinct melting ranges than amorphous polymers.

*See also heat of fusion.*

**Melting zone** *n.* In a well-designed extruder screw, the section, to be coincident with the transition section, in which most, if not all, of the melting of the feedstock occurs. The pumping section, in which the plastic is presumed to be fully melted, is sometimes called the *melt zone.*

**Melt instability (melt-flow instability)** *n.* A term applied to the early manifestations of melt fracture.

**Melton** \ˈmel-tᵊn\ [*Melton* Mowbray, town in England] (1823) *n.* A heavily full, hard, plain coating fabric that was originally all wool but is now also seen in wool blends.

**Melt pressure** *n.* The gauge pressure exerted at any point in a processing apparatus that develops pressure. In extruders, melt pressure in the head is usually monitored. In injection machines the location is analogous but melt pressures have also been measured in mold cavities. Not to be confused with (though related to) injection-molding pressure.

**Melt spinning** *See spinning.*

**Melt spinning process** *n.* Molten polymer is pumped first through sand-bed filters, then through one to thousands of tiny orifices, called jets or spinnerets by small gear pumps operating at extremely high pressures. The fibers are then oriented to realize their optimal strength and modulus, four times or more that of the unoriented fibers. *See spinning.*

**Melt strength** *n.* The strength of a plastic while in the molten state. This property is pertinent to extrusion of a parisons for blow molding, to drawing extrudates from dies, as in making monofilaments and cast film, and to sheet thermoforming. It is also important when a plastic film is reheated for shrink-packaging. This property is very difficult to measure because of the ease with which a filament stretches in elongational flow at the temperatures of interest.

**Melt temperature** *n.* The temperature of molten or softened plastic at any point within the material being processed. In extrusion and injection molding, melt temperature is an important indicator of the state of the material and the process. Many types of instruments, most of them based on thermocouples or resistance thermometers, have been employed in extruders, where melt temperature is usually measured in the head and sometimes in the die. In thermoforming, temperatures of softened sheets are measured with infrared pyrometers.

**Melt viscosity** *n.* The resistance to shear in a molten resin, quantified as the quotient of shear stress divided by shear rate at any point in the flowing material. Elongational viscosity, which comes into plan in the drawing of extrudates, is analogously defined. In polymers, the viscosity depends not only on temperature and, less strongly, on pressure, but also on the level of shear stress (or shear rate).

*See viscosity, power law, and pseudoplastic fluid.*

**Membrane osmometry** *n.* The pressure difference between a solution and the pure solvent is measured for the case where the solvent is separated from the solution by a semipermeable membrane, isothermally; the measurement yields $\Delta p$ (change in pressure) which corresponds to $M_n$ number average molecular weight – a colligative property of polymer solutions:

$$\mathrm{d}G = V\,\mathrm{d}p - S\,\mathrm{d}T,$$

where $G$ is the Gibbs energy ($H-TS$), $p$ the pressure, $S$ the entropy, $H$ the enthalpy, and $T$ is the temperature.

**Memory zone** (elastic memory, plastic memory) *n.* The tendency of a plastic article to revert in dimensions to a size previously existing at some stage in its manufacture. For example, a film that has been oriented by hot stretching and chilled while under tension, will, upon reheating, tend to revert to its original pre-stretched size due to its "memory".

*See also orientation.*

**Menaccanite** Old name for the titanium mineral, ilmenite.

**Mending** *n.* A process in woven fabric manufacture in which weaving imperfections, tears, broken yarns, and similar defects are repaired after weaving; especially on woolen and worsted fabrics to prepare them for dyeing, finishing, or other processing.

**Mer** \mər\ [ISV, fr. Gk *meros* part] *n.* Derived from the Greek *meros*, meaning a part or unit, the mer is the smallest repeating structural unit (mono + mer) of a polymer (poly + mer). In addition polymers such as polyethylene the mer weight is the same as the monomer's molecular weight. Saving a small correction for end groups, the molecular weight of a polymer chain equals the mer weight times the degree of polymerization. Dimers, trimers, tetramers, oligomers, and polymers contain two, three, four, several, and many mer units, respectively.

*See monomeric unit.*

**Meraklon** *n.* Poly(propylene). Manufactured by Montecatini, Italy.

**Mercadium orange** *See cadmium–mercury sulfides.*

**Mercerization** \ˈmər-sə-ˌrīz\ [John *Mercer* † 2866 English calico printer] (1859) *vt.* A treatment of cotton yarn or fabric to increase its luster and affinity for dyes. The material is immersed under tension in a cold sodium hydroxide (caustic soda) solution in warp or skein form or in the piece, and is later neutralized in acid. The process causes a permanent swelling of the fiber and thus increases its luster.

**Mercurials** \(ˌ)mər-ˈkyur-ēl-əls\ (1676) *n.* Fungicides and bactericides containing mercury.

**Mercuric chloride** (1874) (corrosive sublimate, mercury bichloride) *n.* $HgCl_2$. White crystals, used as a polymerization catalyst for PVC. Mercuric chloride is highly toxic, so must be handled with care and requires special disposal procedures.

**Mercuric sulfide** *n.* HgS. Pigment Red 106 (77766). (1) A naturally occurring mineral, cinnabar. (2) Synthetically produced by addition of Hg to alkali sulfides depending on temperature, the colors vary from red orange to bluish red. Has good alkali resistance. Density, 8.0 g/cm$^3$ (66.6 lb/gal); O.A., 11–15. Syn: are vermilion, carmine vermilion, Chinese vermilion, English vermilion, patent vermilion, cinnabar, cenobrium, cinaper, cinoper, cynoper, vermiculus, zunsober, and red cinnabar.

**Mercury–cadmium lithopones** *n. See cadmium–mercury lithopones.*

**Merge** *n.* A group to which fiber production is assigned based on properties and dyeability. All fibers within a merge can be expected to behave uniformly, and for this reason, can be mixed or used interchangeably.

**Meridional (mer-) isomer** *n.* An isomer of an octahedral complex in which a plane contains three identical ligands and the central ion.

**Merino** \mə-ˈrē(ˌ)nō\ [Spanish] (1810) *n.* (1) Wool from purebred Merino sheep. Merino wool usually has a mean fiber diameter of 24 µm or less. (2) A yarn of blended wool and cotton fibers.

**Merinova** *n.* Casein fiber, manufactured by Snia Viscosa, Italy.

**Mesh** \ˈmesh\ [ME, prob. fr. MD *maesche*; akin to OH Gr *masca* mesh, Lithuanian *mazgos* knot] (14c) *n.* (1) The square opening of a sieve. (2) The number of apertures per linear inch in a woven or electroformed metal screen or sieve, made especially for laboratory testing of high gravity dry powders or pigments for fineness and impurity content. Such screens are available to a mesh size of about 400.

**Mesh analysis** *See sieve analysis.*

**Mesh fabrics** *n.* A broad term for fabric characterized by open spaces between the yarns. Mesh fabrics may be woven, knit, lace, net, crochet, etc.

**Mesh number** *n.* (1) The designation of size of an abrasive grain. Its name is derived from the openings per linear inch in the control sieving screen. Syn: grit number. (2) The deprecated, but still widely used (in USA) nomenclature for screen sizes, meaning the number of wires per inch of screen width. In standard square-mesh screens used in sieve analysis, the count and wire diameter are the same in both directions. Thus, the widths of the standard-screen openings (inches) are in approximate inverse proportion to the mesh numbers, $\approx 0.6\ (\text{mesh number})^{-1}$. Modern nomenclature, in accordance with SI, designates open-mesh screens by the minimum width of the openings in millimeters.

**Mesitylene** *n.* $C_6H_3(CH_3)_3$. Powerful high-boiling hydrocarbon solvent. Bp, 165°C.

**Mesityl oxide** (4-methyl-3-pentene-2-one) *n.* $CH_3COCH{=}C(CH_3)_2$. An oily, colorless liquid used as a powerful solvent for cellulosic and vinyl resins, and as an intermediate in the production of plasticizers. Bp, 130°C; flp 25°C (78°F); vp, $<10$ mmHg per 30°C.

**Mesocolloid** *n.* Between hemicolloids and encolloids in size. Colloid particles limited to aggregates of from 100 to 1,000 molecules and from 25 to 250 nm long.

**Mesomerism** *n.* Essentially synonymous with resonance. The term is particularly associated with the picture of pi electrons as less localized in an actual molecule than in a Lewis formula. The term is intended to imply that the correct representation of a structure is intermediate between two or more Lewis formulae.

**Meson** \ˈme-ˌzän, ˈmā-, ˈmē-, -ˌsän\ [ISV *mes-* + ²*-on*] (1939) *n.* Two types of particles of mass intermediate between that of the electron and proton have been discovered in cosmic radiation and in the laboratory. The one particle with mass about $215m_e$ is called $\mu$-meson, the other with about $280m_e$ $\pi$-meson. Mesons of both positive and negative charge have been found and there is now reasonably good evidence for neutral mesons. Both types of mesons decay spontaneously. Some evidence exists for a meson of mass about $100m_e$.

**Mesopic vision** *n.* Vision at luminosities intermediate between luminosities required for completely photopic or completely scotopic vision; sometimes called twilight vision.

**Meta-** prefix [NL & ML, fr. L or Gk; L, fr. Gk, among, with, after, fr. *meta* among, with, after; akin to OE *mid*, *mith* with, OH Gr *mit*] (*m*-). A prefix used in naming aromatic organic compounds, ignored in alphabetization that designates the 3- and 5-positions relative to the substituted 1-position in a benzene ring. *Compare ortho- and para-* (3).

**Metafiltration** *n.* Edge filtration through superimposed metallic strips with beveled edges, involving a change from coarse filtration (due to the strips) to fine filtration (due to the filter bed formed in their interstices).

**Metal** \ˈme-tᵊl\ [ME, fr. OF, fr. L *metallum* mine, metal, fr. Gk. *metallon*] (14c) *n.* An element, which has high electrical and thermal conductivities, a characteristic luster, and a low ionization energy, electron affinity, and electronegativity.

**Metal alloying** *n.* Combining two or more metals into an alloy, materials with different advantages exist. The number of available alloys increases factorially, each with its specific set of properties.

**Metal chelate polymers** *n.* A polymer which contains metal atoms bonded to organic functional groups by coordinate bonds.

**Metal decorating** *n.* The process of lithographic printing on metal. The term most often applies to the can coating industries and includes the coating of can liners, outside basecoats and overprint varnishes as well as lithographic printing. The coatings are generally applied by direct roller coating or by spray onto tinplate or aluminum, on individual metal sheets, or by continuous coil coating.

**Metallic bond** *n.* Bonding present in metals. Metallic bonding can be described as the movement of valence electrons throughout the metal lattice.

**Metallic brown** *See brown iron oxide pigment.*

**Metallic elements** *n.* Are distinguished from the non-metallic elements by their luster, malleability, conductivity and usual ability to form positive ions. Non-metallic elements are not malleable, have low conductivity and never form positive ions.

**Metallic fiber** *n.* A manufactured fiber composed of metal, plastic-coated metal, metal-coated plastic, or a core completely covered by metal (FTC definition). They are available in "yarn" form as well as in staple form for spinning with other fibers. A core yarn with a metal surface is produced by twisting a strip of metal around yarn of natural or manufactured fibers. The most important characteristic of metallic fiber and the chief reason for its use in textiles is glitter. Metallic fibers are used as a decorative accent in fabrics for apparel, bedspreads, towels, draperies, and upholstery. A relatively new application for metallic fibers is in carpet pile, where they are being used in small percentages for control of static electricity.

**Metallic fillers** *n.* Powdered nickel, etc., to impart special properties, usually conductivity.

**Metallic-flake pigment** *n.* Flat, thin particles of either aluminum, copper or copper alloy that reflect light specularly when incorporated into a plastic substance or coating vehicle with their reflecting surfaces approximately parallel. The aluminum pigments reflect very strongly throughout the visible spectrum, producing brilliant blue-white highlights. The copper-based pigments, called gold bronzes but actually brasses, range from the characteristic red copper to progressively more yellow with rising zinc content.

**Metallic inks** *n.* Inks composed of aluminum or bronze powders in varnish to produce gold or silver color effects.

**Metallic paint** *n.* Paint which, on application, gives a film with a metallic appearance. This effect is normally produced by the incorporation of fine flakes of such metals as copper, bronze or aluminum. The aluminum used may be leafing or non-leafing, the former giving a far more brilliant metallic effect. These metals can be used in tinted or colored media to give polychromatic finishes.

*Also known as metallic pigmented paint.*

**Metallic pigment** *n.* Particles or flakes of non-oxidized metals or alloys used as pigments to modify the optical characteristics of a paint, to hide the substrate, modify the color or adjust other properties. The metals most commonly used as aluminum, bronze, and zinc.

*See also metallic paint.*

**Metallic pigmented paint** *See metallic paint.*

**Metallic pigments** *n.* A class of pigments consisting of thin opaque aluminum flakes or copper alloy flakes. Added to plastics, they produce unusual silvery and other metal-like attractive effects.

**Metallic soap** *n.* Salts derived from metals and organic acids, usually fatty acids. They include not only the sodium and potassium salts, which are popularly known as soaps, but compounds such as lead linoleate, calcium resinate, aluminum stearate, etc.

*See soap, metallic.*

**Metallic solid** *n.* A solid in which positive ions are bonded together by delocalized electrons.

**Metallized glass** *n.* Glass spheres, flaks, or fibers that have been coated with silver or aluminum and, as fillers, provide increased electrical conductivity and light-reflecting pigmentation.

**Metallizing** \ˈme-tᵊl-ˌīz\ (1594) *vt.* (1) Applying a thin coating of metal to a non-metallic surface. May be done by chemical deposition or by exposing the surface to vaporized metal in a vacuum chamber. (2) *See flame spray.* (3) Adding metallic pigments, such as aluminum, to a paint. (4) A term covering all processes by which plastics (and some other base materials) are coated with metal. The most commonly used processes are described under *electroless plating, silver-spray process, and* *vacuum metallizing*. Other methods include spraying with metallic pigments, chemical reduction, gas plating and vapor pyrolysis.

**Metallizing agents** *See electroplating chemicals.*

**Metalloid** *n.* An element which has properties that are intermediate between those of a typical metal and those of a typical non-metal.

*Also called a semimetal.*

**Metal marking** *n.* In the coil coating industry, the degree or amount of a defect left on the surface of a film when the edge of a piece of metal is pulled across its surface. Pencil line marks on a painted surface caused by scratching with metal.

*Also known as coin marking or marring.*

**Metal oxide catalysts** *n.* $CrO_3$, $CrO_2Cl_2$, etc.

**Metal primer** *n.* The first coat of paint on metal; a primer. One coat.

**Metal spraying** *n.* Application of a spray coat of metal (usually zinc or aluminum) onto a prepared surface (usually shot blasted mild steel). The metal to be sprayed is rendered molten by passing it, in wire or powder form, through a flame pistol which projects the semi-molten metal onto the surface by means of a jet of compressed air.

**Metamer** *n.* (1) One of a pair of colors which matches the other color when viewed in a described way but which does not match under all viewing conditions. For example, if the light source, observer or angle of viewing is changed, the color will no longer match the other color of the pair. (2) From the Greek *meta* (change, transposition, and transfer) and *meros* (part or portion), the term metamer was formerly used in chemistry for a specific kind of isomer having to do with group-positional differences in molecules of the same composition and functionality. The term isomer is now used in this limited sense (as well as in broader ones).

*See metameric pair.*

**Metameric color match** *n.* A color match between two materials in which the colors are identical under some lighting conditions but not under others. Metameric color matches are common when different pigments or dyestuffs are used to color the two materials.

**Metameric match** *n.* A conditional identity of color exhibited by a pair of colors, each with different spectral distribution curves.

*Also known as conditional match. See metamerism.*

**Metameric pair** *n.* A pair of colors, which match when viewed in a described way but which do not match if the viewing conditions are changed. thus, a metameric pair of samples exhibit the same tristimulus values for a described set of viewing conditions (observer, light source, geometry of the illumination, and viewing arrangement) but have different spectral distributions. Hence, they exhibit a match, which is conditional only.

*See conditional match and metamerism.*

**Metamerism** *n.* A term sometimes used in the color industry for the phenomenon exhibited by two surfaces that appear to be of the same color when viewed under one light source (e.g., sunlight), but that appear different when viewed under a different light source (e.g., incandescent lamp). The term *geometric metamerism* refers to a change in perceived color of a surface with a change in viewing angle. Metamerism should not be confused with "flair" or color constancy, which terms apply to the apparent color change exhibited by a single color when the spectral distribution of the light source is changed or when the angle of illumination or viewing is changed.

*See metameric pair.*

**Metamerism, degree of** *n.* Metamerism exists in varying amounts, depending on the magnitude of the differences in the spectral distribution curves of the two colors. Thus, the degree of metamerism may be slight to moderate to severe and is generally described by one of a number of types of metamerism (or metameric) indices.

**Metamerism index** *See index of metamerism.*

**Metap weave-knit process** *n.* A technique combining weaving and knitting in one operation with two independent yarn systems wound on warp beams. In the fabrics produced, woven strips are linked together with wales of stitches. Generally the fabrics have 75–85% woven and 25–15% knitted structure.

**Metastable** \-ˈstā-bəl\ [ISV] (1897) *adj.* A temporary state of structure in a plastic, such as a crystalline plastic in which the final crystallinity is attained after passage of hours or days following molding. No physical or mechanical tests should be made while the test material is in a metastable condition (unless data regarding that condition are desired).

**Meter** \ˈmē-tər\ *n* [F *mètre*, fr. *Gk metron* measure] (1797). (1) (m, meter) The SI unit of length, one of the seven basic units of the system, defined as 1,680,763.73 wavelengths of the radiation in vacuum corresponding to the transition between the levels $2p_{10}$ and $5d_5$ of the krypton-86 atom (an orange spectral line). One foot equals (exactly) 0.3048 m. (2) Any device for measuring a physical or chemical quantity in which the measurement is indicated digitally, or analogically on a scale. In this sense, -meter is often used as a suffix, as in *thermometer.*

**Metering pump** *n.* A positive displacement device that pumps a measured amount of polymer solution to the spinnerets.

**Metering screw** *n.* An extruder screw whose final section, from four to ten flights, has a shallow channel of constant depth and lead. As its name suggests, the metering section of such a screw is intended to regulate the amount delivered per rotation of the screw. It also provides time for the equalization of melt temperature and helps to control the steadiness of the extrusion rate.

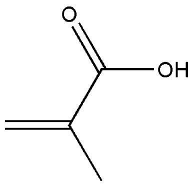
**Metering zone (metering section)** *n.* The final portion of a metering screw that builds pressure to force the melt through the screens and die. The metering section usually has a constant lead and a shallower channel than the preceding sections of the screw.

**Methacrylate ester** \ˌme-ˈtha-krə-ˌlāt\ [ISV] (1865) *n.* Any of the esters of methacrylic acid having the general formula $CH_2{=}C(CH_3)COOR$, wherein R is usually methyl, ethyl, isobutyl, or *n*-butyl to *n*-octyl. These esters are polymerizable to acrylic resins.

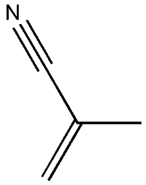
**Methacrylate plastic** *See acrylic resin.*

**Methacrylate resins** *n.* A class of resins produced by the polymerization of methacrylate esters.

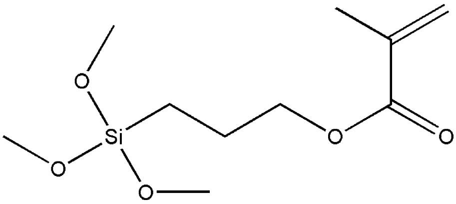
**Methacrylic acid** \ˌme-thə-ˈkri-lik-\ [ISV] (1865) (α-methacrylic acid, 2-methyl-2-propenoic acid) *n.* $CH_2{=}C(CH_3)COOH$. A colorless liquid prepared by the acid hydrolysis of acetone, from which are derived all of the methacrylate compounds. Most important of these are the esters, especially methyl methacrylate.



**Methacrylonitrile** (MAN, α-methyl acrylonitrile) *n.* A vinyl monomer containing the nitrile group whose homopolymers are true thermoplastics with good mechanical strength and high resistance to solvents, acids, and alkalis. Modified properties can be obtained through blending, grafting, or co-polymerization with other monomers such as styrene and methyl methacrylate. **MAN** is also used as a replacement for acrylonitrile in preparing nitrile elastomers.

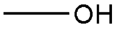


**γ-Methacryloxypropyltrimethoxy silane** *n.* $CH_2{=}CHCOO(CH_2)_3SI(O{-}CH_3)_3$. A silane coupling agent used in reinforced polyesters, epoxies, and many thermoplastics to achieve improved adhesion between resin and glass fibers.



**Methanol** \ˈme-thə-ˌnól, -ˌnōl\ [ISV] (1894) (carbinol, methyl alcohol, and wood alcohol) *n.* $CH_3OH$. A colorless, toxic liquid usually obtained by synthesis from hydrogen and carbon monoxide. It is sometimes called *wood alcohol*, but the methanol obtained from the destructive distillation of wood also contains additional, contaminating compounds. Methanol is used as an intermediate in producing formaldehyde, phenolic, urea, melamine, and acetal resins, and as a solvent for cellulose nitrate, ethyl cellulose, polyvinyl acetate, and polyvinyl butyral.

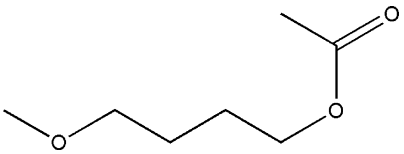
*Also known as methyl alcohol, carbinol, wood alcohol, colonial spirits, and MeOH.* Syn: formaldehyde.



**Methenamine pill test** *See flammability tests.*

**Method of least squares** *See regression analysis.*

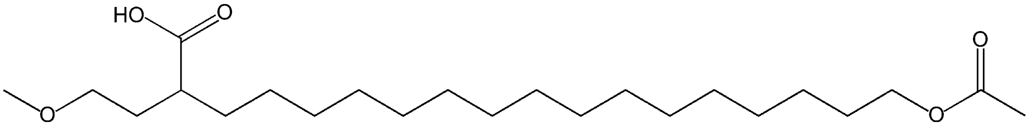
**Methoxybutyl acetate** *n.* $CH_3OCH(CH_3)CH_2CH_2COOCH_3$. High-boiling solvent. Bp, 169°C; flp, 60°C (140°F).



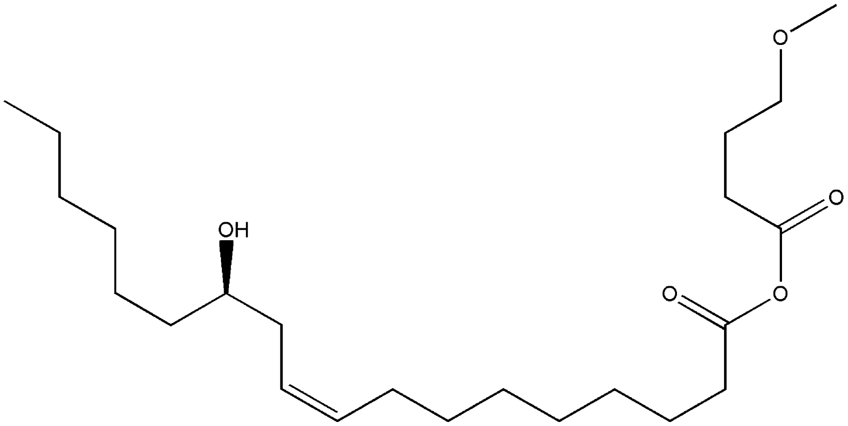
**Methoxyethylacetoxy stearate** *n.* $C_{17}H_{34}(OCOCH_3)COOCH_2CH_2OCH_3$. A plasticizer for vinyl and cellulosic resins.

**Methoxyethylacetyl ricinoleate** *n.* A plasticizer for cellulosic and vinyl resins. *n* (1,2-propylene glycol monostearate) $C_{17}H_{35}{-}COOCH_2CH_2OCH_3$. A solvent and plasticizer for cellulosic plastics.

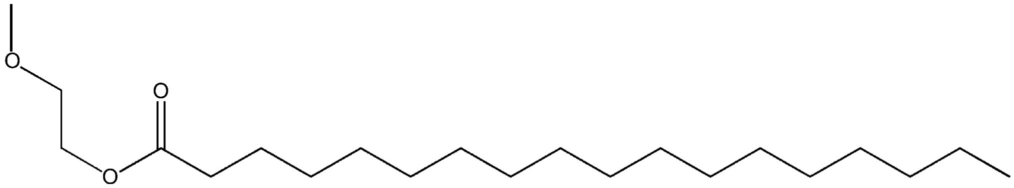
**Methoxyl group** *n.* The monovalent group, $-OCH_3$, characteristic of methyl alcohol and its esters or ethers.



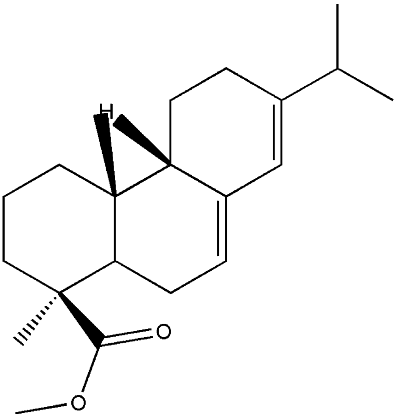
**Methoxyethylacetoxy stearate**



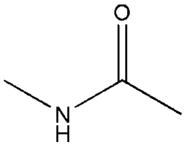
**Methoxyethylacetyl ricinoleate**



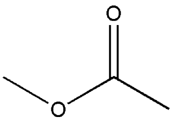
**Methyl abietate** *n.* $C_{19}H_{29}COOCH_3$. A derivative of abietic acid (from rosin) used as a plasticizer for cellulosic, acrylic, and vinyl resins, polystyrene, and urea–formaldehyde resins.



***N*-Methyl acetamide (NMA)** $CH_3CONHCH_3$ *n.* A solvent useful in making aromatic-mer polymers, such as polyimides.

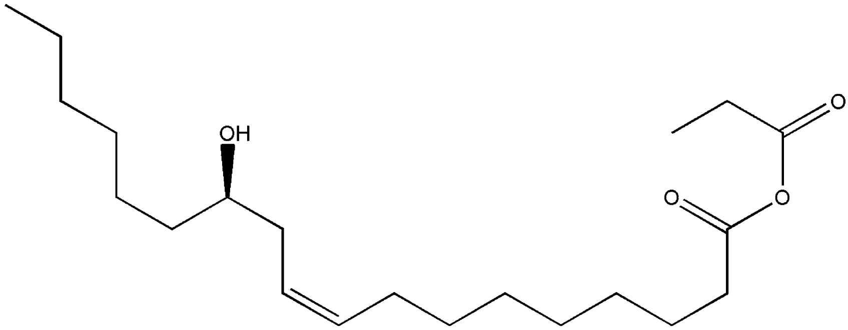


**Methyl acetate** (1885) *n.* $CH_3COOCH_3$. A colorless, volatile liquid with a fragrant odor, a solvent for acetyl cellulose and cellulose esters. A low-boiling ester solvent, exhibiting rapid evaporation; bp, 58°C, vp, 173 mmHg per 20°C.



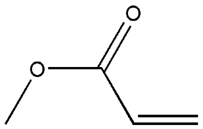
**Methylacetyl ricinoleate** *n.* $C_{17}H_{32}(OCOCH_3)COOCH_3$. A plasticizer for some vinyl resins and polystyrene.

**Methyl acrylate** *n.* $CH_2{=}CHCOOCH_3$. A colorless, volatile liquid, a monomer for



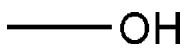
**Methylacetyl ricinoleate**

acrylic resins used in the manufacture of synthetic resins. Sp gr, 0.953; bp, 80.5°C.

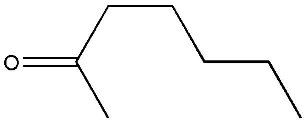


**Methyl alcohol** (ca. 1847) *n.* Syn: methanol.

**Methyl amyl carbinol** *See heptanol*-2.

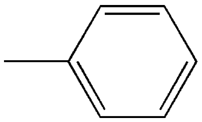


**Methyl amyl ketone** *n.* Boiling range, 147–153°C; flp, 106°F; vp, 4 mmHg per 20°C. *Also known as MAK and 2-heptanone.*

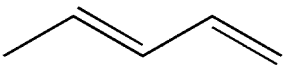


**Methylated spirit** *n.* A mixture of ethyl alcohol and a small amount of methyl alcohol; used industrially as a solvent for paints, lacquers, and varnishes.

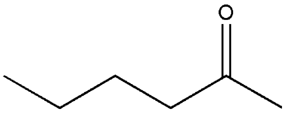
**Methyl benzene (methyl benzol)** *n.* Syn: toluene.



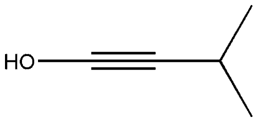
**Methyl butadiene** *n.* Syn: isoprene.



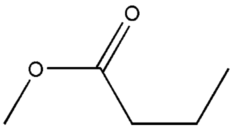
**Methyl butyl ketone (MBK, propylacetone)** *n.* $CH_3COC_4H_9$. A solvent for vinyl and many other resins, often used in conjunction with methyl ethyl ketone to control the drying rate of lacquers. a higher content of MBK slows the rate. Boiling range, 114–137°C; flp. 73°F; vp, 10 mmHg per 20°C. Also known as *MBK and 2-hexanone.*



**Methyl butynol** *n.* $HC{=}CCOH(CH_3)_2$. A viscosity stabilizer and solvent for some nylons.



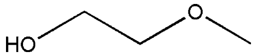
**Methyl butyrate** *n.* $CH_3(CH_2)_2COOCH_3$. A medium-boiling solvent for ethyl cellulose and cellulose nitrate. Bp, 102°C.



**Methyl cellosolve** *See ethylene glycol monoethyl ether.*

**Methyl cellosolve®, acetate** Ether-ester solvent. Bp, 143°C; vp, 6 mmHg per 30°C.

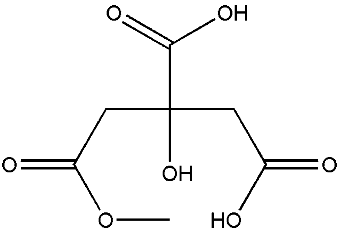
**Methyl cellosolve®, methoxyethanol** *n.* $CH_3OC_2H_4OH$. Ether-alcohol solvent, Bp, 124°C.



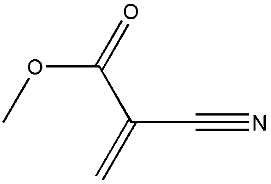
**Methyl cellulose** *n.* A cellulose ether in which some of the cellulosic –OH groups have been replaced by $–OCH_3$. The degree of substitution determines properties and uses as thickeners and emulsifiers. Commercially, a granular, white, flakey material, which acts as a water-soluble thickener and stabilizer; used in water-based paints.

**Methyl chavicol** *n.* Ether constituent found in some terpene solvents. Boiling range, 215–216°C.

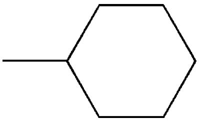
**Methyl citrate (tri)** *n.* Plasticizer with solvent properties, Bp, 176°C per 16 mmHg.



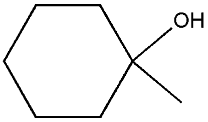
**Methyl-2-cyanoacrylate** *n.* A fast setting adhesive used for bonding cellulosics, nylon, polyesters, acrylics, polystyrene, and polyurethanes to each other and to other materials such as woods, metals, and glass. Catalyzed by atmospheric moisture or lightly applied methanol, the adhesive polymerizes without loss of solvent. For best results, the surfaces to be bonded should mate closely.



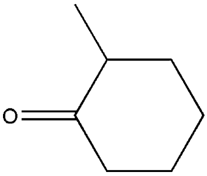
**Methyl cyclohexane** *n.* $CH_3C_6H_{11}$. Hydrocarbon solvent. Bp, 101°C.



**Methyl cyclohexanol** *n.* $CH_3C_6H_{10}OH$. Alcoholic solvent. Because of its high boiling range, 160–180°C, it is used to improve flowing properties. Small quantities added to weaker solvents often exert a very pronounced effect on the viscosity of a given solution. Flp, 60°C (140°F).

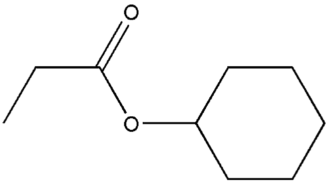


**Methyl cyclohexanone** *n.* High-boiling solvent. Boiling range, 160–170°C; flp, 49°C (120°F); vp, 4 mmHg per 30°C. It is often used in small amounts to improve flow or brushing properties.

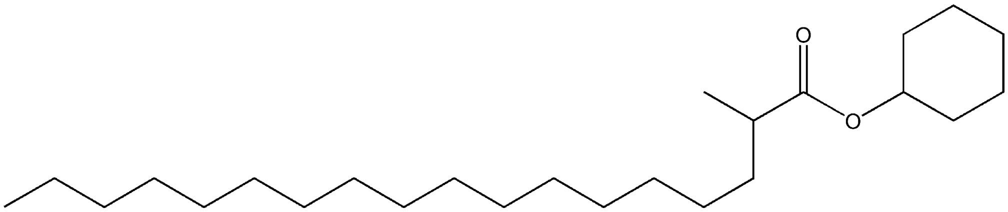


**Methyl cyclohexyl acetate** *n.* Boiling range, 175–190°C; flp, 68°C (155°F).

*Known also as methyl hexaline acetate and sextate.*

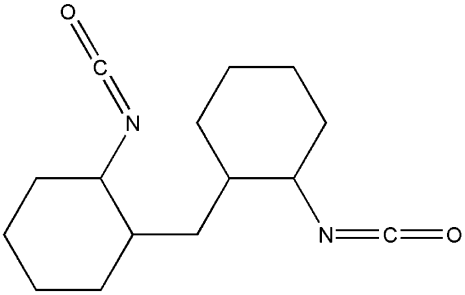


**Methyl cyclohexyl stearate** *n.* $CH_3(CH_2)_{16}COOC_6H_{10}CH_3$. Boiling range for the commercial product, 220–240°C per 4 mmHg; flp, 170°C (338°F).



**Methyl cyclohexyl stearate**

**2,2′-Methylene-bis-(cyclohexyl isocyanate)** ($H_{12}MDI$) *n.* A diisocyanate used in making urethane elastomers and foams.

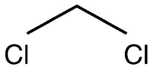


**2,2′-Methylene-bis-(6-*tert*-butyl-4-ether phenol)** *n.* An antioxidant for acrylonitrile-butadiene-styrene packaging, appliances, pipe, and automotive items.

**2,2′-Methylene-bis-(6-*tert*-butyl-4-methyl phenol)** *n.* A phenolic-type antioxidant for polyolefins and acrylonitrile-butadiene-styrene resins.

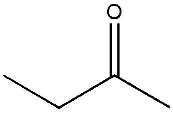
**Methylene blue** *n.* Blue 9 (52015). A thiazine dye used to make a type of lime blue.

**Methylene chloride (dichloromethane, methylene dichloride)** *n.* $CH_2–Cl_2$. A low-boiling chlorinated hydrocarbon which is a colorless, fairly dense, non-flammable liquid used as a solvent for cellulose triacetate and vinyl resins, a solvent in the polymerization of polycarbonate resins, and as a reactant for certain phenolic resins. It was widely used as a paint stripper and solvent for cured epoxy resins, but is less used now in the effort to keep chlorinated solvents out of the atmosphere. Bp, 40°C; vp. 230 mmHg per 10°C; Sp gr. 1.34/4°C.
*Also known as dichloromethane.*

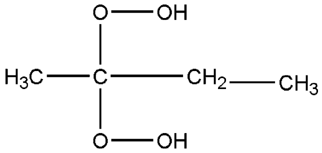


**Methylene group** *n.* The radical $–CH_2–$ or $=CH_2$, existing only in combination.

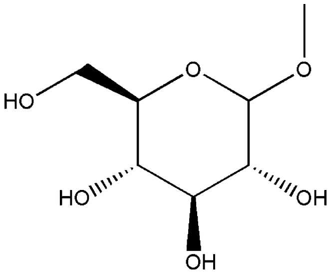
**Methyl ethyl ketone** (1876) (MEK, 2-butanone) *n.* $CH_3COC_2H_5$. A low-boiling colorless, flammable solvent, possessing all the properties of acetone without its extremely high volatility. One of the most widely used solvents for several thermoplastics including cellulosics, acrylics, polystyrene, and vinyl co-polymers. Bp, 80°C; flp, 3°C (35°F); vp, 77 mmHg per 20°C.
*Also known as MEK and butanone.*



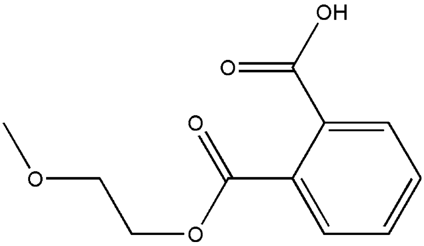
**Methyl ethyl ketone peroxide (MEKP, MED, and peroxide)** *n.* A complex peroxide mixture made by reacting hydrogen peroxide with MED, with the approximate formula $(CH_3COOC_2H_5)_3$. MEKP is an initiator for free-radical polymerization and a curing agent for polyester resins. In combination with an accelerator such as cobalt naphthenate, MEKP can bring about cure at room temperature. Because it is unstable, it is often handled in solution. MEKP should be kept only in small quantities and stored in a freezer when not in use.



**Methyl glucoside** *n.* $CH_2OHCH(CHOH)_3CHOOCH_3$. A plasticizer for alkyd, amino and phenolic resins. It is also used as a polyol for urethane-foam production.

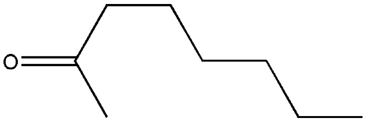


**Methyl glycol phthalate (di)** *n.* Plasticizer. Boiling range, 210–260°C per 20 mmHg; flp, 174°C (345°F).

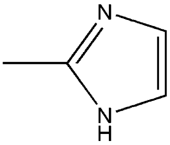


**Methyl group** *n.* The radical $–CH_3$, existing only in combination.

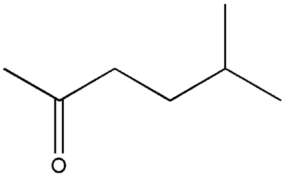
**Methyl hexyl ketone (2-octanone)** *n.* $CH_3COC_6H_{13}$. A colorless, high-boiling liquid with a pleasant odor, used as a solvent for epoxy coatings. Boiling range, 169–173°C; vp. 3 mmHg per 30°C.



**Methylimidazole (EMI)** *n.* An epoxy-resin curing agent with a heterocyclic structure. EMI is used with epoxies formed from epichlorohydrin and bisphenol A or -F, and for novolac epoxy resins. It provides ease of compounding, long pot life, low viscosity, and non-staining characteristics.

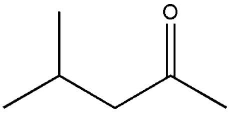


**Methyl isoamyl ketone (5-methyl-2-hexanone)** *n.* $CH_3COC_2H_4CH(CH_3)_2$. A colorless liquid with a pleasant odor, used as a solvent for cellulose esters, acrylic resins, and certain vinyl polymers. It has a high solvent power and low evaporation rate, making it useful as a retarder solvent that promotes flow-out of coatings and reduces blushing.

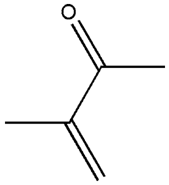


**Methyl isobutyl ketone (MIBK, hexanone, 4-methyl-2-pentanone)** *n.* $(CH_3)CHCH_2COCH_3$. A solvent with a moderate evaporation rate, used with cellulosic, vinyl, alkyd, acrylic, phenolic, and coumarone-indene resins, and polystyrene. Bp, 118°C; flp, 74°F; vp. 13 mmHg per 20°C.

*Known also as hexone and MIBK.*

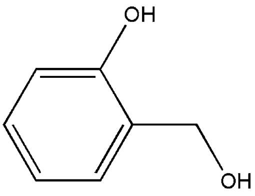


**Methyl isopropenyl ketone** *n.* $CH_2{=}C(CH_3)COCH_3$. A flammable liquid used as a co-polymerizable monomer.

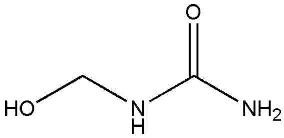


**Methyl methacrylate** (1933) *n.* $C_5H_8O_2$. A volatile flammable liquid that polymerizes readily and is used as a monomer for resins.

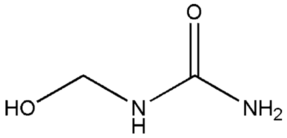
**Methylol phenol** \ˈme-thəl-ōl ˈfē-ˌnōl\ *n.* A phenol having one or more $–CH_2OH$ groups in its ring, a first stage in the formation of phenolic resin by reaction of phenol with formaldehyde.



**Methylol urea** *n.* $H_2NCONHCH_2OH$. Colorless crystals derived from combination of urea with formaldehyde, the first stage in the production of urea–formaldehyde resins.

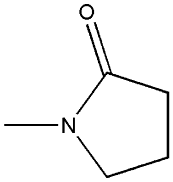


**Methylolurea** *n.* $H_2NCONHCH_2OH$. First stage in the formation of urea formaldehyde resins. Reaction products of urea and formaldehyde. Monomethylol urea is obtained by reacting one molecule of formaldehyde and one molecule of urea.

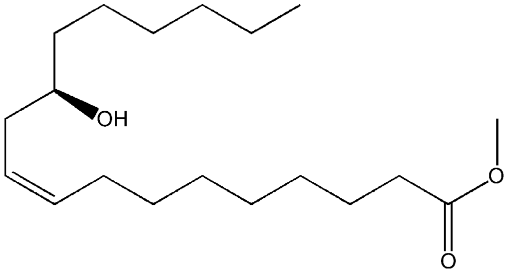


**Methylpentene resin** Syn: poly(4-methylpentene-1).

**1-Methyl-2-pyrrolidinone (NMP)** *n.* $(CH_3)\overline{NCH_2CH_2CH_2C} = O$. A solvent with a low order of inhalation toxicity, good thermal and chemical stability, and a high flash point. It is capable of dissolving resistant resins such as polyamide-imides, epoxies, urethanes, nylon, and PVC. It is a solvent of choice for spinning PVC fibers from solution. Previously known an *N*-methyl-2-pyrrolidone.

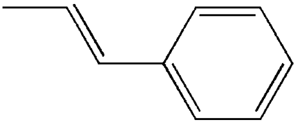


**Methyl ricinoleate** *n.* $CH_3(CH_2)_5CH(OH)CH_2CH{=}CH(CH_2)_7COOCH_3$. A plasticizer for cellulosic resins, polyvinyl acetate, and polystyrene with the composition of methyl ester of ricinoleic acid. Bp. 245°C per 10 mmHg; Sp gr. 0.9236.

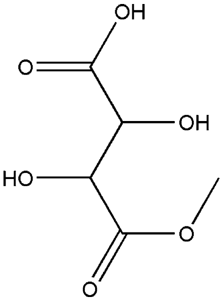


**Methyl rubber** *n.* Poly(2,3-dimethylbutadiene). Manufactured by Bayer, Germany.

**$\alpha$-Methylstyrene** *n.* $C_6H_5C(CH_3){=}CH_2$. A colorless liquid, easily polymerizable by heat or with catalysts, and typically co-polymerized with methyl methacrylate or styrene.



**Methyl tartrate (di)** *n.* A plasticizer with a bp of 280°C.



**Methyl violet** *n.* A class of strong purple dyes and pigments.

**Metier** \ˈme-ˈtyā, me-ˈ\ [F, fr. (assumed) VL *misterium*, alter. of L *ministerium* work, ministry] (1792) *n.* A spinning machine for producing manufactured fibers. The bank of cells or compartments and associated equipment used in the dry spinning of fibers, such as cellulose acetate and cellulose triacetate.

**Metier twist** *n.* The amount of twist present in yarn wound at the métier.

**Metre** \ˈmē-tər\ *chiefly British variant of meter.* The basic unit of length in the International System of Units (SI), equal to 39.37 in. SI spelling of meter.

**Metrication** \ˌme-tri-ˈkā-shən\ (1965) *n.* Any act tending to increase the use of the International System of Units (SI).

**Metric count** *n.* The number of kilometers per kilogram of yarn.

**Metrology** , *n.* (from greek ‘metron’ (measure), and -logy) is the science of measurement. Metrology includes all theoretical and practical aspects of measurement. It is a field of study which has been highly politicized and nationalized with sharp even severe rhetoric.

**Mev** Abbreviation for million electron volts, a measure of kinetic energy for subatomic particles ($1\ \text{MeV} = 1.60219 \times 10^{-13}\ \text{J}$).

**Meyer bar** *n. See wire-wound rod and equalizer rod.*

**Mezzotints** \ˈmet-sō-ˌtint, ˈmed-zō-\ [mod. of It *mezzatinta*, fr. *mezzo* (feminine of *mezzo*) + *tinta* tint] (1738) *n.* Prints made from ground (e.g., crossed in several directions with knife-edge cuts) copper plates, the burred surface of which is scraped away to create the design.

**MF** *See melamine–formaldehyde resin.*

**MFC** *n.* Abbreviation for multifunctional concentrate.

*See color concentrate.*

**MFI** *n.* Abbreviation for melt-flow index.

**Mg** *n.* Chemical symbol for the element magnesium.

**M-glass** *n.* A high-modulus glass whose fibers are sometimes used for reinforcing plastics when high modulus at moderate cost is desired. Major constituents are $SiO_2$ 54%, CaO 13%, MgO 9%, BeO, and $TiO_2$ 8% each, $Li_2O$ and $CeO_2$ 3% each, and $ZrO_2$ 2%. Fiber density is 2.89 g/cm$^3$, modulus ($E$) is 110 GPa, and tensile strength is 3.5 GPa.

**MHz** *n.* Abbreviation for megahertz.

**MI** *n.* Abbreviation for melt index, a term replaced by melt-flow index.

**MIBK** *n.* Abbreviation for methyl isobutyl ketone.

**Mica** \ˈmī-kə\ [NL, fr. L, grain, crumb; perhaps akin to Gk. *mikros* small] (1777) *n.* Any of a family of crystalline silicate minerals characterized physically by a perfect basal cleavage, consisting essentially of orthosilicates of aluminum and potassium. They occur naturally, mainly as the minerals *muscovite* (white mica), *phlogopite* (amber mica), and *biotite*; and are also synthesized from potassium fluorilicate and alumina. Micas are used as fillers in thermosetting resins, imparting good electrical properties and heat resistance. A grade having high aspect ratios (HAR) with flakes 3–5 µm thick and aspect ratios as high as 200 can be processed, although the optimum aspect ratio appears to be about 70. The larger flakes increase flexural modulus and strength, have lower moisture content, and raise the deflection temperature of compounds containing them. *See aluminum potassium silicate.*

**Micaceous iron oxide** *n.* Naturally occurring iron ore which resembles mica only in appearance and not chemically. It is converted to a grayish pigment, which has value as a constituent of anti-corrosive paints and protective coatings. Density, 4.90 g/cm$^3$ (40.8 lb/gal); O.A., 11/200 lb; hardness (Mohs), 6.0; ph, 7.7.

**Mica fillers** *n.* High-aspect-ratio minerals used traditionally in thermosets as phenolics and epoxies for mechanical improvements, as well as for electrical and heat insulation benefits.

**Micelle** \mīi-ˈsel\ *n* [NL *micella*, fr. L *mica*] (1881) A colloidal particle formed by the reversible aggregation of dissolved molecules. Micelles may be in the shape of spheres, cylinders, or platelets. Soaps, detergents, and other emulsifying agents used in emulsion polymerization contain micelles generally composed of from 50 to 100 molecules of emulsifier, within which the polymerization reaction may be initiated.

**Michel–Levy chart** *n.* A chart relating thickness, birefringence, and retardation so that any one of these variables can be determined when the other two are known.

**Micro-** ($\mu$) *adj.* The SI prefix meaning $\times 10^{-6}$.

**Microballoons** *n.* (1) Tiny, hollow plastic spheres used to reduce evaporation of liquids such as oils by floating a layer of spheres on the surfaces of stored liquids. (2) Syn: microspheres.

**Microbial degradation** *n. See biodegradation and pink staining.*

**Microcrystalline** \ˈmī-krō-ˌkris-tᵊl\ (1886) *n.* Pertaining to crystallinity that is visible only under a microscope, sometimes taken to mean that the crystals referred to are no larger than 1 µm.

**Microcrystalline silica** *See silica, microcrystalline.*

**Microcrystalline silicate** *n.* A derivative of chrysotile asbestos, consisting of tiny rod-shaped particles of hydrated magnesium silicate. The particles have hydroxyl groups on their surfaces that bond with hydrogen-bonding sites on the molecules of a fluid in which they are incorporated. The material has also been used as a viscosity-building agent in unsaturated polyester and other resins.

**Microcrystalline wax** *n.* Any of a group of petroleum-derived waxes that differ from paraffin waxes in having finer crystal structure, higher melting points – between 60 and 93°C, higher liquid viscosities, and greater ductility. They are used in fiberboard coatings, paper-container linings, and polishes.

**Microdenier** Refers to fibers having less than 1 denier per filament or 0.1 tex per filament.

**Microemulsions** *n.* Transparent solutions of water and oil, which are thermodynamically stable and which spontaneously form when the components are brought in contact.

**Microencapsulation** \-in-ˈkap-sə-ˌlāt\ (1963) *vt.* The process of encasing a small solid particle or a discrete amount of liquid or gas in a capsule. The term applies to capsules ranging in diameter from a few micrometers to about 500 µm. The capsule is usually made of a synthetic plastic, although waxes, glass, and metals are also used. Methods used for forming polymeric microcapsules fall into three broad classes: phase separation, interfacial reaction, and physical methods. Phase separation methods include coacervation, applying meltable dispersions, and spray-drying of a suspension of the material in a vaporizable solvent, in-situ polymerization, and chemical-vapor deposition. The physical methods include fluidized-bed coating processes, spray coating, electrostatic coating methods, and extrusion. Typical examples of microencapsulation are "carbonless" carbon paper, timed-release drugs and fertilizers, and battery separators.

**Microgel** *n.* A small particle of cross-linked polymer of very high molecular weight and containing closed loops. Microgels may be present in trace amounts due to impurities in monomers, and can influence polymer properties and molecular-weight studies.

**Micrometer (μm)** \mī-ˈkrä-mə-tər\ [F *micromètre*, fr. *micr-* + *-mètre* –meter] (1670) *n.* (1) Instrument for measuring small lengths under the microscope. (2) Micrometer caliper; instrument used in measuring the dry film thickness of a coating or the thickness of metal or other materials. (3) The usual unit of length for light microscopical measurements (1 μm = $10^{-3}$ mm): it is still often referred to by its former name, "micron".

**Micrometre** *n.* A unit of length measure used to describe the wavelength of radiant energy equal to one-thousandth part of a millimeter or one-millionth of a meter, 1000 nm. This term is replacing the term micron. Micrometer is designated as μm.

**Micron** \ˈmī-ˌkrän\ [NL, fr. Gk *mikron*, neuter of *mikros* small] (1885) *n.* This long deprecated but still used length unit and its abbreviation, the Greek letter μ, were dropped by action of the General Conference on Weights and Measures on October 13, 1967. The symbol "μ" is to be used solely as the abbreviation for the prefix micro-. The old micron should now be spoken as micrometer (μm) or $10^{-6}$ m.

**Micronaire method** *n.* A means of measuring fiber fineness by determining the resistance of a sample to a flow of air forced through it.

**Micronized pigment** Pigment with a narrow, particle-size distribution.

**Micronizer mill** Used for the dry grinding of pigments. Pre-crushed crudes or solids are fed into a relatively flat, cylindrical grinding chamber, the opening being in the bottom or top plate. The fluid medium, superheated compressed air or steam, enters the grinding chamber through nozzles located in the peripheral wall. The grinding action is done by the pigment particles hitting each other. The fines are carried out through an opening in the center of the mill, the coarser, larger particles return for further grinding.

**Microorganisms** \-ˈór-gə-ˌni-zəm\ [ISV] (1880) *n.* In paint technology, bacteria and fungi, which are harmful to liquid paint and dry paint films. Bactericides and fungicides are added to paints to inhibit the growth of these organisms.

**Microphotograph** \-ˈfō-tə-ˌgraf\ [ISV] (1858) *n.* A small, microscopic photograph, in which the image is minified; it requires enlarging or the use of a lens system in order to view it (cf., photomicrograph).

**Microporous** \ˈmī-krə-ˌpōr, -ˌpór\ [ISV] (1884) *n.* Having pores of microscopic dimensions. Some plastic films and fabric coatings are rendered microporous in order to permit the passage of water vapor ("breathing") while preventing the penetration of raindrops.

**Microscopy** \mī-ˈkräs-kə-pē\ (ca. 1665) *n.* The application of any tool or technique helpful in characterizing microscopic objects.

**Microspheres** \ˈmī-krə-ˌsfirs\ (1894) *n.* Tiny, hollow spheres of glass or plastic used as fillers to impart low density to plastics, such plastics being known as *syntactic foams.* Plastics used to make microspheres include phenolic, epoxy and a co-polymer of vinylidene chloride and acrylonitrile. The last contains a heat-activated blowing agent that expands the spheres either before their incorporation into a matrix polymer or afterward. The co-polymer spheres impart better mechanical properties to the matrix than do the glass or epoxy microspheres.

*See also glass spheres.*

**Microstructure** \ˈmī-krō-ˌstrək-chər\ [ISV] (1885) *n.* The detailed structure of plastics as seen through light and electron microscopes, approximately the magnification range of 100–100,000×, including such features as crystalline form, spherulites, voids, distribution of filler and pigment particles, discontinuous-phase particles in blends, and, in reinforced plastics, configuration, length distribution, and cross-section distribution of yarns and, within the yarns, the filament ends, etc.

**Microvoids** (1) A region in a polymer of lower electron density than its surroundings, of about 100 Å in size and amounting to about 1% of the volume. (2) Small voids or holes in a paint medium of such size that when filled with air (or some other material of different refractive index) they scatter light much as a pigment does because of the difference in refractive index between the material in the void and the vehicle. Some air-filled microvoids account for the white color of snow, for example.

*See bubble coating.*

**Microwaveable** (1973) *vt.* Said of plastics for kitchen use, and of the utensils made from them, that are heated little or not at all by the direct action of the high-frequency waves generated by microwave ovens, and that withstand many repeated heating by the foods contained in them without warping, shrinking, or staining.

**Microwave drying** *n.* Drying of printing inks by the use of microwave radiation. The presence of polar materials is a prerequisite.

**Microwave heating** *n.* A heating process similar to dielectric heating, but using frequencies in the $10^9$–$10^{10}$ Hz (radar) range. The Federal Communications commission has allocated the specific frequencies 915, 2450, and 5850 MHz for industrial use. Microwave ovens similar to those used in restaurants and households for rapidly cooking foods have been used experimentally for preheating molding powders, vacuum-bag curing, autoclave molding, and curing of nylon over wraps. Plastic films coated with water-containing materials such as polyvinylidene chloride can be dried rapidly and economically by microwave energy. Line speeds about 5 m/s have been attained with polyethylene film, by means of a microwave cabinet only 2.4 m long.

**Middle chrome** *See chrome yellow, light, and primrose.*

**Mie theory** *n.* Theory which relates the scattering of a single spherical particle in a medium to the diameter of the particle, the difference in refractive index between the particle and the medium, and the wavelength of radiant energy in the medium which is incident on the particle.

This theory relates to the direct observation of the scattering of a single particle as compared to the Kubelka–Munk theory, which relates to multiple scattering between particles. Mie theory also takes into account the absorption, which the particle may also exhibit.

**Migration** *n.* (1) Movement of certain materials in a coating or plastic (e.g., plasticizers in vinyl) to the surface or into an adjacent material. (2) Movement of dye from one area of dyed fabric to another. Includes movement of color from the dyed area to the undyed area of cloth. (3) Movement of fibers which go from the center to the outside surface of yarn and back again periodically.

**Migration of plasticizer** *n.* In plasticized thermoplastics or elastomers, the movement of molecules of plasticizer from their interior locations when the article was originally formed to the surface layer of the article, where the plasticizer appears as a greasy or oily layer and may be rubbed off or dissolved away. The phenomenon occurs most often in vinyl compounds containing incompatible plasticizers.

**Mil** \ˈmil\ [L *mille* thousand] (1721) *n.* A unit of thickness equal to 0.001 in., often used for specifying diameters of wires and glass fibers, and thicknesses of films. It is gradually being replaced by the SI units, the millimeter and micrometer. 1 mil = 0.0254 mm = 25.4 µm.

**Milanese knitting** *See knitting.*

**Mildew** \ˈmil-ˌdü, -ˌdyü\ [ME, fr. OE *meladēaw* honeydew; akin to OH Gr *militou* honeydew] (14c) *n.* Superficial growth produced by fungi on various surfaces forms of organic matter and on living plants which are exposed to moisture: it results in discoloration and decomposition of the surface. Two types are common: (1) Spore type, which resembles caviar in appearance and (2) Mycelium or filament type.

**Mildewcide** *n.* Chemical agent which destroys retards or prevents the growth of mildew.

**Mildew (fungus) resistance** The ability of a coating to resist fungus growth that can cause discoloration and ultimate decomposition of a coating's binding medium.
*See mildew.*

**Mileage** *n.* The surface area covered by a given quantity of ink or coating material.

**Milk acid** *See lactic acid.*

**Milkiness** *n.* Whitish or translucent appearance in an unpigmented liquid coating or film which could normally be transparent.

**Mill** [ME *mille*, fr. OE *mylen*, fr. LL *molina*, molinum, fr. feminine and neuter of *molinus* of a mill, of a millstone, fr. L *mola* mill, millstone; akin to L *molere* to grind] (before 12c) (1, *n*). In the plastics industry, the term mill is generally taken to refer to a roll mill such as a two-roll mill used in compounding. More broadly, it includes all mechanical devices for converting raw materials into a conduction ready for use, as well as machine tools that cut materials with rotating bits and many types of size-reduction machines (1552) (2, *v*) To process components of a plastic mixture in a two-roll mill.

**Mill base** *n.* The portion of the coating formulation which is charged in the dispersion mill.

**Milled fibers** Small lengths of glass filaments produced by hammer-milling continuous glass strands. They are useful as anticrazing and reinforcing fillers for adhesives.

**Mill end** *n.* A remnant or short length of finished fabric.

**Miller indices** The notations usually used for naming crystal faces; they have the form *hkl.* These notations are based on the assignment of crystallographic axes and on an expression of the intercepts of the face on the three axes (hexagonal has four.)

**Milli-** *combining form* [F, fr. Latin *milli-* thousand, fr. *mille*] (m). The SI prefix meaning $\times 10^{-3}$.

**Millimeter of mercury (mmHg)** *n.* A unit of pressure: $1\,\text{mmHg} = \frac{1}{760}$ atm.
*Also known as Torr.*

**Millimicron** \ˌmi-lə-ˈmī-ˌkrän\ [ISV] (1904) (deprecated) *n.* A unit of length used to describe the wavelength of electromagnetic radiation, particularly that in the visible region, equal to $10^{-9}$ m. The use of this term is largely being replaced by the term nanometer.

**Milling** *n.* (1) The process of treating fabric in a fulling mill, i.e., fulling. (2) In silk manufacturing the twisting of the filaments into yarn. (3) A grinding process, i.e., ball-milling of dyes and pigments.

**Millipoise** *n.* One-thousandth part of a poise (measure of viscosity) or 1/10 of a centipoise.

**Millitre** *n.* One-thousandth of a liter.

**Mill run** *n.* A yarn, fabric, or other textile product that has not been inspected or that does not come up to the standard quality.

**Mills, ball, and pebble** *n.* Roll mills, such as two-roll mills used in compounding.

**Mill scale** *n.* The heavy oxide layer formed during hot fabrication or heat treatment of metals.

**Milori blue** A green shade iron blue pigment. A pigment of the ferriferrocyanide family.
*Also called Chinese blue. See iron blue.*

**Milori green** *See chrome green.*

**Mineral** \ˈmin-rəl, ˈmi-nə-\ [ME, fr. ML *minerale*, fr. neuter of *mineralis*] (15c) *n.* Any naturally occurring, homogeneous inorganic substance having a definite chemical composition and characteristic crystalline structure, color and hardness.

**Mineral acids** *n.* Strong inorganic acids, e.g., nitric, sulfuric, hydrochloric, etc.

**Mineral black** *n.* Black pigment made by grinding and/or heating black slate, shale, or salty coal coke, or coal. It usually contains a high percentage of carbon, mixed with substantial amounts of mineral matter, which may include aluminum silicate, and oxides of silicon, iron, calcium, and magnesium. By comparison with true carbon blacks, its staining strength is inferior.
*See also biddiblack.*

**Mineral brown** *See brown iron oxide pigment.*

**Mineral fibers** A generic term for all non-metallic, inorganic fibers, which may be natural, such as asbestos, or manufactured from such sources as rock, ore, alloys, slag, or glass.

**Mineral fillers** *n.* Minerals compounded into plastics that provide one or more mechanical or thermal property improvements to the polymer matrix. They can be either extenders or reinforcing fillers.

**Mineral oil** (1805) *n.* Any liquid product of petroleum within the viscosity range of products commonly called oils and consisting of high molecular weight hydrocarbons.

**Mineral orange** *See orange mineral.*

**Mineral pigments** *See earth pigment.*

**Mineral spirits** (1927) (naphtha) *n plural but singular or plural in construction.* An aliphatic-hydrocarbon fraction of petroleum evolved in the distillation range of about 150–200°C. An example is “VM&P naphtha”, used as a diluent in organosols. It is a petroleum fraction with boiling range between 300 and 400°F. Due to having a low aromatic hydrocarbon content, with volatility, flash point, and other properties this makes it suitable as a thinner and solvent in paints, varnishes, and similar products. Syn: is petroleum spirits.

*See also odorless solvent.*

**Mineral surfaced roofing** *n.* Felt or fabric saturated with bitumen, coated on one or both sides with a bituminous coating and surfaced on its weather side with mineral granules.

**Mineral violet** (77742) *n.* A complex manganese ammonium phosphate. Its very low tinting strength, low color intensity and low hiding power largely restrict its use to toning white finishes, in which service it offers low cost and excellent bake and bleed resistance; however, tints fade severely in steam sterilizers. Because of its poor alkali resistance, it is not suitable for some household appliance finishes; in such cases, quinacridone violet can be used to advantage. Syn: manganese violet, permanent, fast violet, and nurnberg violet.

**Mineral white** *See gypsum.*

**Miniemulsion** *n.* A form of emulsion in which an organic liquid is dispersed into a continuous aqueous phase. Unlike a conventional emulsion, where the droplets may be of the order of 10 µm or greater, the droplets sizes are submicron. This is accomplished through a combination of high shear, and surfactant/costabilizer combination. The surfactant prevents emulsion degradation via calescence (as in a conventional emulsion), while the costabilizer prevents diffusional degradation caused by Ostwald ripening.

**Minimized spangle** *n.* Galvanized sheet obtained by treating the regular galvanized sheet during the solidification of the zinc to restrict the normal spangle formation. This product usually has a dull appearance not characterized by a high degree of uniformity, and dissimilarity from coil to coil is not unusual. This minimizes the crystalline pattern from photographing through the applied coating resulting in a smoother appearing finish.

**Minimum care** *n.* A term describing home laundering methods. Minimum care fabrics, garments, and household textile articles can be washed satisfactorily by normal home laundering methods and can be used or worn after light ironing. Light ironing denotes ironing without starching or dampening and with a relatively small expenditure of physical effort.

**Minimum detectable amount (MDA)** *n.* In chemical analysis, the least amount of a substance being sought that balances two risks, type I, the risk of falsely finding the substance to be present when in fact it is not, and type II, the risk of not detecting that least amount. Typically, the two risks are made equal and, if both are 5%, the MDA is very nearly four times the standard deviation of the method. Lowering the risk increases MDA.

**Minimum deviation** *n.* The deviation or change of direction of light passing through a prism in a minimum when the angle of incidence is equal to the angle of emergence. If $D$ is the angle of minimum deviation and $A$ the angle of the prism, the index of refraction of the prism for the wavelength used is

$$n = \frac{\sin \frac{1}{2}(A + D)}{\sin \frac{1}{2}A}.$$

**Minimum perceptible difference** *n.* The minimum color difference, which can be observed between two colors. The magnitude is dependent on the conditions of viewing, i.e., size, illumination level and character, surrounding area, adaptation, etc.

*See just noticeable difference.*

**Minium** *n.* Naturally occurring and synthetically prepared red lead oxide; used as a pigment.

**Minute value** *n.* Voltage with a unit thickness of insulator (e.g., varnish) will withstand for 1 min without breakdown.

**Mipolam** *n.* Poly(vinyl chloride). Manufactured by Dynamit Nobel, Germany.

**Mirbane oil** *n.* Nitrobenzene. Liquid with an almond-like smell, used as a deodorant, chiefly in polishes.

*See nitrobenzene and oil of mirbane.*

**Mired** *n.* A unit used to measure the reciprocal of color temperature, equal to the reciprocal of a color temperature of 10 K. Derived from micro-reciprocal-degree.

**Mirlon** *n.* Polyamide, manufactured by Viscose-Suisse, Switzerland.

**Miscibility** \ˈmi-sə-bəl\ [ML *miscibilis*, fr. L *miscēre* to mix] (1570) (solubility) *adj.* The greatest percentage of one liquid or polymer that forms a true, homogeneous solution, i.e., a single phase, in another liquid of polymer. Few binary polymer systems are miscible over the entire range of composition, but many have limited miscibility at either end of the range. Miscibility usually increases with rising temperature.

*See also compatibility.*

**Misclip** *See scalloped selvage.*

**Mispick** *n.* A weaving defect in which a pick is improperly interlaced, resulting in a break in the weave pattern. Mispicks can result from starting the loom on the incorrect pick after a pick-out.

**Misses** *See holidays.*

**Missing end** *See end out.*

**Miss-stitch** *n.* A knitting construction formed when the needle holds the old loop and does not receive new yarn. It connects two loops of the same course that are not in adjacent wales.

*Also known as float-stitch.*

**Mist coat** *n.* (1) Very thin sprayed coat. (2) A thin coat of volatile thinners, with or without a small amount of lacquer, which is sprayed over a dry lacquer film to improve the smoothness and luster.

**Misting** *See flying.*

**Mitt** *See painter's mitt.*

**Mittler's green** *See hydrated chromium oxide.*

**Mixed aniline point** *n.* Minimum equilibrium solution temperature of a mixture of two volumes of aniline, one volume of sample, and one volume of normal heptane of specified purity. Refer to ASTM D 1012.

**Mixed end or filling** *n.* Warp or filling yarn differing from that normally used in the fabric, e.g., yarn with the incorrect twist or number of plies, yarn of the wrong color, or yarn from the wrong lot.

**Mixer** \ˈmik-sər\ (ca. 1611) *n.* Any of a wide variety of devices used to intermingle two or more materials to some defined state of uniformity. Some equipment intended mainly to provide size reduction may also accomplish mixing. Types used in the plastics industry are:

Ball mill
Banbury mixer
Centrifugal impact mixer
Change-can mixer
Colloid mill
Conical dry-blender
Disk-and-cone agitator
Drum tumbler
High-intensity mixer
Homogenizer
Intensive mixer
Internal mixer
Kneader
Mill
Propeller mixer
Ribbon blender
Rod mill
Roll mill
Sand mill
Static mixer
Tumbling agitator
Vibratory mill

**Mixing, entropy, free energy** *n.* The change in free energy $\Delta G_{\text{mix}}$, for mixing two substances at certain temperature $T$, is given by the Gibbs function:

$$\Delta G_{\text{mix}} = \Delta H_{\text{mix}} - T\,\Delta S_{\text{mix}}.$$

Because the solution process is an endothermic process for most solutions, the heat of mixing, $\Delta H_{\text{mix}}$, is a positive quantity. The entropy of mixing, $\Delta S_{\text{mix}}$, is normally positive because of the more random nature of solutions compared with that of the unmixed components. A necessary, although not sufficient, condition for a polymer to dissolve is that $\Delta G_{\text{mix}} \leq 0$, and if $\Delta G_{\text{mix}} \approx 0$ then mixing is marginal, and if $\Delta G_{\text{mix}} \geq 0$ then components will not mix.

**Mixing screw** *n.* Any extruder screw that incorporates some modification (from standard designs) intended to improve mixing, mainly distributive mixing but sometimes improving dispersion, too. One simple method is to insert one or more rings of closely spaced pegs arranged circumferentially in the screw channel and having nearly the same height as the flight. The pegs divide and re-divide the melt streaming in a complex but regular path down the channel, accomplishing a kind of braiding of substreams.

*See also Dulmadge mixing section, Maddock mixing section, and cavity-transfer mixer.*

**Mixing varnish** *n.* General term for a variety of varnishes, or paint vehicles, that are used by mixing with: (1) Aluminum pigment. (2) Pigments paste in oil or colors in oil. (3) Other vehicle types, such as gloss oil (if the mixing varnish is long in oil), or a spar varnish (if the mixing varnish is short in oil) to produce a desired oil length for the complete vehicle. (4) The mill base discharged from pigment-dispersing equipment, as contrasted to the "grinding" varnish for vehicle in which the pigment has been dispersed. (5) Paint, to alter its properties.

*See aluminum mixing varnish.*

**Mixing white** *n.* A white ink, either transparent or opaque, used in making tints.

**Mixture** \ˈmiks-chər\ [ME, fr. MF, fr. OF *misture*, fr. L *mixtura*, fr. *mixtus*] (15c) *n.* A combination of two or more different substances intermingled with varying percentage composition (unlike a true solution), in which each component retains its chemical identity.

**MKS system** *n.* A system of units derived from the meter, kilogram, and second. Now superceded for scientific purposes by the SI units, which are based on the MKS system.

**MMA** *n.* Abbreviation for methyl methacrylate.

**$M_n$** *n.* (1) Abbreviation for number-average molecular weight. (2) Chemical symbol for the element manganese.

**Mo** *n.* Chemical symbol for the element molybdenum.

**Mobility** *n.* The property of a material which allows it to flow when a shearing force larger than the yield value has been applied. The coefficient of mobility is the rate of shear induced by a shearing force per square cm of 1 dyne in excess of the yield value. Mobility pertains to plastic materials and is the analogue of fluidity. It is calculated from the slope of the straight-line portion of the flow curve. The coefficient of mobility is the reciprocal of the coefficient of plastic viscosity.

**Mobilometer** *n.* Rheological instrument for measuring the consistency of paints and similar products. The "mobility" is determined by the time in seconds required for a loaded perforated disk to pass through a specified depth of the sample contained in the cylinder.

*See Gardner mobilometer.*

**MOCA®** *n.* DuPont's trade name for methylene-bis-*o*-chloroaniline, much used until about 1980 as a curing agent for urethane rubbers and epoxy resins, prior to its being declared to be a carcinogen by OSHA.

**Mock dyeing** *n.* A heat stabilization process for yarns. The yarns are wound onto packages and subjected to package dyeing conditions (water, pressure, and temperature) but without dye and chemicals in the bath.

**Mock leno** *n.* A combination of weaves having interlacings that tend to form the warp ends into groups (with empty spaces intervening) in the cloth, thereby giving an imitation of the open structure that is characteristic of leno fabrics. Mock leno fabrics are used for summer shirts, dresses, and other apparel, and as a shading medium in Jacquard designs.

**MOD** *n.* Modacrylic fibers (EEC abbreviation).

**Modacrylic fibers** \ˌmä-də-ˈkri-lik-\ [*mod*ified *acrylic*] (1960) *n.* A manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of less than 85% but at least 35% by weight of acrylonitrile units (Federal Trade Commission). Characteristics: although modacrylics are similar to acrylics in properties and application, certain important differences exist. Modacrylics have superior resistance to chemicals and combustion, but they are more heat sensitive (lower safe ironing temperature) and have a higher specific gravity (less cover). End uses: the principal applications of modacrylic fibers are in pile fabrics, flame-retardant garments, draperies, and carpets.

**Modacrylics** *n.* Generic name for a fiber containing between 35 and 85% acrylonitrile repeating units in the polymer chain [poly (acrylonitrile)], excluding rubbers, manufactured by Viscose-Suisse, Switzerland.

**Modal** Generic name for fibers from regenerated cellulose of modified structure.

**Moderator** \ˈmä-də-ˌrā-tər\ (ca. 1560) *n.* A material used for slowing down neutrons in an atomic pile or reactor. Usually graphite or "heavy water" (deuterium oxide).

**Modes of appearance** *n.* Various manners in which colors can be perceived, depending on spatial distributions and temporal variations of the light causing the sensation. Five modes are generally recognized: surface mode, volume mode, film (or aperture) mode, illumination mode and illuminant mode. The first two of these, surface mode and volume mode, together make up the object mode. Color perceived as falling on an object, thus filling space around the object, describes the illumination mode. The illuminant mode is the appearance of the glow from a light source. The film or aperture mode describes color perceived in space, where no object is discernible.

**Modified phenolic resins** *n.* Resins in which the basic phenolaldehyde product has been modified by the introduction of rosin or other natural resin. The products are often esterified.

**Modified resin** *n.* Any synthetic resin into which has been incorporated a natural resin, an elastomer, or an oil that alters the processing characteristics or physical properties of the material.

**Modifier** \ˈmä-də-ˌfī(-ə)r\ (1583) *n.* Any chemically inert ingredient added to an adhesive formulation that changes its properties.

*See also additive, filler, extender, and plasticizer.*

**Modulus** \ˈmä-jə-ləs\–li [NL, fr. L, small measure] (1753) *n, pl.* (1) A modulus is a measure of a mechanical property of a material, most frequently a stiffness property. (2) The absolute value of a complex number or quantity, equal to the square root of the sum of the squares of the "real" and "imaginary" parts. (3) Modulus at 300% *n*: The tensile stress required to elongate a specimen to three times its original length (200% elongation) divided by 2. Although other elongations are used, 300% is the one most often employed for rubbers and flexible plastics.

*See compressive modulus, flexural modulus, shear modulus, modulus of elasticity and modulus of resilience.*

**Modulus in compression** *See compressive modulus.*

**Modulus in flexure** *See flexural modulus.*

**Modulus in shear** *See shear modulus.*

**Modulus of elasticity** *n.* (1) (elastic modulus, tensile modulus, and Young's modulus) The ratio of nominal tensile stress to the corresponding elongation below the proportional limit of a material. Since elongation is dimensionless, modulus has the units of stress. The relevant ASTM test is D 638. In contrast to structural metals such as mild steel, the stress–strain graphs for many plastics exhibit some curvature, even at very low strains. Since there is then no significant linear region whose slope would give the modulus, a secant modulus at 1–3% elongation may be reported for stiff materials. (2) More generally, any of the several elastic moduli characterizing behavior in shear (torsion), flexure, or change in volume under pressure. In SI, all types of elastic moduli are reported in pascals, usually megapascals (MPa) 1000 psi = 6.894,757 MPa.

*Also known as elastic modulus or Young's modulus. See hardness. See bulk modulus.*

**Modulus of resilience** *n.* The energy that can be absorbed per unit volume of a stressed specimen without creating a permanent deformation. It is equal to the area under the stress–strain graph from zero to the elastic limit divided by the volume of specimen undergoing deformation.

**Modulus of rigidity** *See shear modulus.*

**Modulus of rupture (MOR)** *n.* During a stress versus strain test, tensile pull test, of a material a stress (force or load) is approached where the material ruptures, breaks and separates which is sometimes referred to as the modulus (stress/strain) at rupture. Also referred to as the ultimate tensile strength and force at break.

**Mohair** \ˈmō-ˌhar, -ˌher\ [mod. of obs. It *mocaiarro*, fr. Arabic *mukhayyar*, literally, choice] (1619) *n. See angora* (1).

**Mohr balance** Balance used to measure the specific gravity of fluids.

**Mohs hardness** \ˈmōz-, ˈmōs-, ˈmō-səz-\ [Friedrich *Mohs* † 1839 German mineralogist]. A system of ranking materials according to their ability to scratch, and resist being scratched by, lower-ranking materials, diamond being the hardest material known and having the highest rank. Mohs' original scale ranked diamonds as 10, corundum as 9, etc., and talc as 1. The scale has been modified to recognize some newer hard materials ranking in the large gap between corundum and diamond. The modified scale is listed below, in order of decreasing a scratch hardness. There is a strong positive correlation between rank on the Mohs scale and *Knoop microhardness.*

*See also scratch hardness.*

**Mohs scale** [Friedrich *Mohs* † 1839 German mineralogist] (1879) *n.* Scale for

| Modified Mohs number | Material |
|---|---|
| 15 | Diamond |
| 14 | Boron carbide |
| 13 | Silicon carbide |
| 12 | Fused alumina |
| 11 | Fused zirconia |
| 10 | Garnet |
| 9 | Topaz |
| 8 | Quartz or stellite® |
| 7 | Vitreous silica |
| 6 | Orthoclase |
| 5 | Apatite |
| 4 | Fluorite |
| 3 | Calcite |
| 2 | Gypsum |
| 1 | Talc |

determining the relative hardness of a mineral, according to is resistance to scratching by one of the following minerals: (1) Talc. (2) Gypsum. (3) Calcite. (4) Fluorite. (5) Apatite. (6) Feldspar. (7) Vitreous silica (8) Quartz. (9) Topaz. (10) Garnet. (11) Fused zirconia. (12) Fused alumina. (13) Silicone carbide. (14) Boron carbide. (15) Diamond. Other useful hardnesses are: fingernail, slightly more than (2); penny, about (3); pocket knife, slightly more than (5); window glass (5.5) and a steel file (6.5).

*See hardness.*

**Moiety** \ˈmói-ə-tē\ [ME *moite*, fr. OF *moité*, fr. LL *medietat-*, *medietas*, fr. L *medius* middle] (15c) *n.* An indefinite amount of a constituent present in a material or compound.

**Moil** A rarely used Syn: molding flash.

**Moiré** \mó-ˈra, mwä\ [F *moiré*, fr. *moiré* like moire, fr. *moire*] (1818) *n.* A wavy or watered effect on a textile fabric, especially a corded fabric of silk, rayon, or one of the manufactured fibers. Moiré is produced by passing the fabric between engraved cylinders, which press the design into the material, causing the crushed and uncrushed parts to reflect light differently.

**Moire effect** *n.* An optical effect, which results from light interference, exhibiting a pattern of light and dark areas. The effect of superimposing a repetitive design, such as a grid, on the same or a different design to produce a pattern distinct from its components.

**Moire papers** *n.* Wallpapers having a watered silk sheen effect.

*See Moire effect.*

**Moisture absorption** *n.* The pickup of water vapor by a material upon exposure for a definite time internal to an atmosphere of specified humidity and temperature. No ASTM test exists for this property. Moisture absorption should not be confused with water absorption, for which there *is* an ASTM test.

**Moisture barrier** *n.* Treated paper or metal that retards or bars water vapor, used to keep moisture from passing into walls or floors.

**Moisture content** The amount of moisture in a material under prescribed conditions and expressed as a percent of the mass of the moist specimen that is, the mass of the dry substance plus the moisture. Also, it can be described as the water in solid waste. Expressed as the percentage of weight lost when a sample is dried at more than 100°C until it reaches a constant weight.

**Moisture equilibrium** *n.* The condition reached by a sample when the net difference between the amount of moisture absorbed and the amount desorbed, as shown by a change in weight, shows no trend and becomes insignificant.

**Moisture-free weight** *n.* (1) The constant weight of a specimen obtained by drying at a temperature of 105°C in a current of desiccated air. (2) The weight of a dry substance calculated from an independent determination of moisture content (e.g., by distillation with an immiscible solvent or by titration with Fischer reagent.

**Moisture properties** *n.* All fibers when exposed to the atmosphere pick up some moisture; the quantity varies with the fiber type, temperature, and relative humidity. Measurements are generally made at standard conditions, which are fixed at 65% RH and 70°F. Moisture content of a fiber or yarn is usually expressed in terms of percentage regain after partial drying.

**Moisture regain** *n.* The loss of weight on drying, expressed as percent of dry weight, of a pre-dried material exposed for a specified time to a specified humidity and temperature, then over-dried at a temperature above 100°C. ASTM D 885 (Section 07.01) describes a procedure recommended for rayon yarns and tire cords.

**Moisture sensitivity** *n.* (1) The degree to which the performance of a plastic part or product is affected by changes in its moisture content or, for some persons, by changes in the relative humidity of the environment in which the product is situated. (2) The degree to which processing performance is affected by moisture pickup prior to processing.

**Moisture-set inks** *n.* Inks that dry or set principally by precipitation. The vehicle consists of a water insoluble resin dissolved in a hygroscopic solvent. Drying occurs when the hygroscopic solvent has absorbed sufficient moisture either from the atmosphere, substrate or external application to precipitate the binder. An important characteristic of these inks is their low odor.

*See steam-set ink.*

**Moisture vapor permeability** *See specific permeability (of a film to moisture).*

**Moisture–vapor transmission** Rate of movement of moisture vapor through a membrane.

*See water–vapor transmission rate.*

**Moisture–vapor transmission rate (MVTR)** *See water–vapor transmission rate.*

**Molality (molal concentration; *m*)** *n.* A concentration unit: the number of moles of solute per kilogram of solvent.

**Molal solution** *n.* A solution that contains 1 mol of the solute per kilogram of the solvent.

**Molar heat of fusion, $\Delta H_{fus}$** *n.* The heat necessary to melt 1 mol of a substance.

**Molar heat of solution, $\Delta H_{sol}$** *n.* The heat liberated (if negative) or absorbed (if positive) when 1 mol of solute dissolves in a solvent.

**Molar heat of vaporization, $\Delta H_{vap}$** *n.* The heat necessary to vaporize 1 mol of a substance.

**Molarity (molar concentration, *M*)** *n.* A concentration unit: number of moles of solute per liter of solution.

**Molar solution** (1 M) *n.* A solution that contains 1 mol of solute per liter of solution.

**Molar volume, $V_m$** *n.* The volume occupied by 1 mol of a substance. For an ideal gas, $22.4\,\mathrm{l\,mol^{-1}}$.

**Mold** \ˈmōld\ [ME, mod. of OF *modle*, fr. L *modulus*, dim. of *modus* measure] (13c) *n.* A hollow form or matrix into which a liquid or molten plastic material is placed and which imparts to the material, upon cooling or curing, its final shape as a finished article (14c) *v.* To impart shape to a plastic mass by means of a confining cavity or matrix, by a process usually involving high pressure and changes in temperature. The term *molding* is usually employed for processes using dry thermoplastic or thermosetting compounds, and in injection or transfer molding. The term *casting* is preferred for processes employing liquids – solutions or suspensions – that are sufficiently fluid to be poured into a mold and to fill it by gravity flow. Glenz W (ed) (2001) A glossary of plastics terminology in 5 languages, 5th edn. Hanser–Gardner Publications Inc., Cinicinnati. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Lancaster, PA.

**Mold base** *n.* An assembly of ground-flat steel plates, usually containing dowel pins, bushings and other components of injection or compression molds excepting the cavities and cores.

**Mold-clamping force** *See clamping force.*

**Mold efficiency** *n.* In a multimold blow-molding system, the percentage of the total turn-around time of the mold actually required for forming, cooling, and ejecting the part.

**Molding** *n.* (1) A projecting or depressed surface, generally used at or around edges of walls, furniture, etc., either plain or decorated, employed to ornament a wall surface, cornice or capital. (2) In plastics processing, any process at some stage of which the plastic is softened or melted, usually by heating, and forced to flow into a shaped cavity or mold that essentially determines all the final dimensions of the product. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Lancaster, PA. Glenz W (ed) (2001) A glossary of plastics terminology in 5 languages, 5th edn. Hanser–Gardner Publications Inc., Cinicinnati.

**Molding compound** *n.* Granules or pellets of a resin containing all desired additives such as plasticizes, stabilizers, colorants, processing aids, and fillers, prepared by blending these ingredients with the neat resin, then reducing the hot mix to pellets by extrusion or milling, cutting, and chilling, ready for further processing into finished products.

*See also molding powder.*

**Molding cycle** *n.* (1) The sequence of operations necessary on a molding press to produce a set of moldings. (2) The period of time occupied by the complete sequence of operations required for the production of one set of moldings.

**Molding index** *n.* A practical measure of the difficulty of molding of thermosetting compound. A calculated weight of the candidate molding powder, is placed into a flash-type cup mold that has been preheated to the temperature prescribed for the material. The mold is closed and the total minimum force required to close it is reported as the molding index of the compound.

**Molding powder** *n.* This term usually denotes pellets or granules of a neat resin or a molding compound.

*Also see dry blend.*

**Molding pressure** *n.* The pressure applied to the ram of an injection machine or press to force the softened plastic to completely fill the mold cavities. It is expressed in force per unit of cross-sectional area of the ram surface acting upon the material.

**Molding shrinkage** (mold shrinkage, shrinkage, and contraction) *n.* The fractional difference in corresponding dimensions between a mold cavity and the molding made in the cavity, both the cavity and the molding being at normal room temperature when measured. Shrinkage is often found to be different in different directions. It may be expressed as a percent, in mils/in., or mm/m.

**Mold pressure** *n.* The pressure measured inside a mold cavity, usually by a flush-mounted pressure transducer, at any time during a molding cycle, but in particular the highest pressure recorded during the cycle. *Compare with melt pressure.*

**Mold release** *See parting agent.*

**Mold seam** *n.* A visible line on a molded or laminated piece, often very slightly raised above the general surface, impressed by the parting line of the mold.

**Mole** \ˈmōl\ [Gr *Mol*, short for *Molekulargewicht* molecular weight, fr. *molekular* molecular + *Gewicht* weight] (1902) (mol) *n.* (1) In SI, the mole is defined as the amount of a substance of a system that contains as many elementary entities as there are atoms in 0.012 kg of carbon-12. The elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles. (2) In practical usage, a mass of a substance equal to its molecular weight. To agree with the SI definition, the mass must be in grams. However, engineers often find it convenient to work with pound-mole, kilogram-mole, and even ton-mole of materials. If the mass unit is not prefixed, the mole is always the gram-mole. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York. Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York.

**Molecular formula** (ca. 1903) *n.* A formula expressing the actual number of atoms of each element in one molecule.

**Molecularity** *n.* The number of molecules which collide to form the activated complex in an elementary process.

**Molecular orbital (MO)** (1932) *n.* An electronic energy level in a molecule and the corresponding charge-cloud distribution in space.

**Molecular orientation** *See orientation.*

**Molecular sieve** (1926) *n.* A porous mineral or synthetic inorganic material, such as a zeolite (hydrous silicate), usually in the form of porous pellets or fine granules, having the ability to strongly absorb molecules of other (fluid) materials.

**Molecular solid** *n.* A solid in which molecules are held together by dipole–dipole or London forces.

**Molecular volume (molar volume)** *n.* The volume occupied by 1 mol, numerically equal to the gram-molecular weight divided by the density at the prevailing pressure and temperature.

**Molecular weight** (1880) (formula weight, molecular mass) *n.* The sum of the atomic weights of all atoms in a molecule. In most non-polymeric compounds the molecular weight is a known constant value. In high polymers, the individual molecules range widely in the number of atoms they contain, and therefore, in molecular weight. Hence an average must be used to characterize a particular sample of polymer. The two averages most commonly used are *number-average molecular* weight ($M_n$) and weight-average molecular weight ($M_w$). Methods for determining these averages include measurements of light scattering and osmotic pressure in solutions, sedimentation in an ultracentrifuge, and depression of freezing points and vapor pressures of solutions, dilute-solution viscosity, end-group titration, and spectroscopy. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York. Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York.

**Molecular-weight distribution** *n.* The percentages by number (or weight) of molecules of various molecular weights that comprise a given specimen of a polymer. Two samples of a given polymer having the same number-average molecular weight may perform quite differently in processing because one has a broader distribution of molecular weights than the other. Two basic groups of methods are used for measuring molecular-weight distribution. Fractionation methods, which actually divide the specimen into portions having relatively narrow ranges of molecular weight, include: fraction precipitation and fraction solution (the two most widely used), chromatography, liquid-liquid partition, ultra-centrifugation, zone refining, and thermo gravimetric diffusion. After fractionation by any of these methods, the weight percent of each fraction is plotted versus the average molecular weight for that fraction to obtain a histogram of the distribution, which may be smoothed into a curve. Non-fractionation methods include light-scattering studies, electron microscopy, dilute-solution viscosity, size-exclusion chromatography, ultra-centrifugation, and diffusion. A popular measure of the breadth of a distribution is the ratio of weight-average to number-average molecular weight, $M_\mathrm{w}/M_\mathrm{n}$. Odian G (2004) Principles of polymerization. Wiley Interscience, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers, New York.

*See also polydispersity.*

**Molecular-weight distribution, poisson** *n.* The ratio of the weight-average ($M_\mathrm{w}$) to the number-average ($M_\mathrm{n}$); gives the range of the distribution. MWD gives a general picture of the ratio of the large, medium, and small molecular chains in the plastic. Odian G (2004) Principles of polymerization. Wiley Interscience, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers, New York.

**Molecular weights of polymers** *n.* The sum of the atomic weights of all atoms in a molecule. In most non-polymeric materials, the molecular weight is a fixed constant value. In high polymers, the molecular weight weights of individual molecules vary widely so that must be expressed as averages, shown by a bar above the symbol, e.g., $\overline{M}n$. Number-average molecular weight,

$$M_n = \sum n_i M_i / \sum n_i$$
$$= \sum w_i / \sum (w_i/M_i),$$

where $n_i$ is the number of molecules with molecular weight $M_i$, $w_i$ the weigh fraction of material having molecular weight, $M$, $\Sigma n$ is the total number of molecules and weight-average $M_\mathrm{w}$

$$M_\mathrm{w} = \sum w_i M_i / \sum w_i.$$

$Z$-average $M_z$

$$M_z = \sum w_i M_i^2 / \sum w_i M_i.$$

Methods of determining molecular weight include osmotic pressure, light scattering, gel permeation chromatography, dilute solution viscosity, vapor pressure, freezing temperatures, and others. Odian G (2004) Principles of polymerization. Wiley Interscience, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers, New York.

**Molecule** \ˈmä-li-ˌkyü(ə)l\ [F *molécule*, fr. NL *molecula*, dim. of L *moles* mass] (1794) *n.* The smallest unit quantity of a compound that can exist by itself and still retain the chemical identity of the substances as a whole. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Mole fraction (*X*)** *n.* A concentration unit: the number of moles of one component in a solution divided by the total number of moles of all components. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Mole percent (mol%)** *n.* Mole fraction multiplied by 100. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Moleskin** \ˌskin\ (1668) *n.* A heavy sateen-weave fabric made with heavy, soft-spun filling yarns. The fabric is sheared and napped to produce a suede effect.

**Moltopren** *n.* Polyester or polyether + diisocyanate + water (foam). Manufactured by Bayer, Germany.

**Mol volume** *n.* The volume occupied by a mol or a gram molecular weight of any gas measured at standard conditions is 22.414 l. A molal solution contains 1 mol/1000 g of solvent. A molar solution contains 1 mol or gram molecular weight of the solute in 1 l of solution.

**Molybdate orange** \mə-ˈlib-ˌdāt\ *n.* 25Pb $CrO_4 \cdot 4PbMoO_4 \cdot 1PbSO_4$. Pigment Red 104 (77605). Bright orange, inorganic pigment, which is a solid solution of lead chromate, lead molybdate, and lead sulfate. Exhibits excellent hiding and tinting strength, brilliant hue, good permanency, but only fair chemical resistance.

**Molybdate orange pigment** *n.* Any of a range of solid solutions of lead chromate, lead molybdate, and lead sulfate, used as dark-orange to light-red pigments for plastics. Their advantages are high opacity, bright color, light-fastness, good heat stability, and freedom from bleeding.

**Molybdenum disulfide** (ca. 1931) (molybdic sulfide, molybdenum sulfide) *n.* $MoS_2$. A black, shiny, flaky-crystalline material used as a filler in nylons, fluorocarbons, and polystyrene to improve stiffness and strength, and, principally, to provide lubricity. The compound occurs naturally as the ore *molybdenite.*

**Molybdenum FR** Any of several molybdenum compounds, such as the oxide or ammonium dimolybdate $(NH_2)_2Mo_2O_7$, added to plastics to improve their fire retardancy (FR) and smoke suppression.

**Mombassa gum** *See animi.*

**Moment of force or torque** *n.* The effectiveness of a force to produce rotation about an axis, measured by the product of the force and the perpendicular distance from the line of action of the force to the axis. cgs unit – the dyne-centimeter. If a force $F$ acts to produce rotation about a center at a distance $d$ from the line in which the force acts, and force has a torque,

$$L = Fd.$$

**Moment of inertia** *n.* A measure of the effectiveness of mass in rotation. In the rotation of a rigid body not only the body's mass, but also the distribution of the mass about the axis of rotation determines the change in the angular velocity resulting from the action of a given torque for a given time. Moment of inertia in rotation is analogous to mass (inertia) in simple translation. The cgs unit is g cm$^2$. Dimensions – $[M\,L^2]$. If $m_1$, $m_2$, $m_3$, etc., represent the masses of infinitely small particles of a body; $r_1$, $r_2$, $r_3$, etc., their respective distances from an axis of rotation, the moment of inertia about this axis will be

$$I = m_1 r_1^2 + m_2 r_2^2 + m_3 r_3^2 + \cdots$$

or

$$I = \sum mr^2.$$

Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Momentum** \mō-ˈmen-təm, mə-\ [NL, fr. L, movement] (1610) *n.* Quality of motion measured by the product of mass and velocity. cgs unit –1 g cm/s. A mass $m$ moving with velocity $v$ has a momentum, $M = mv$. If a mass $m$ has its velocity changed from $v_1$ to $v_2$ by the action of a force $F$ for a time $t_1$,

$$mv_2 - mv_1 = Ft.$$

**Momentum flux** *n.* In hydrodynamics, an interpretation of shear stress $\tau$ in which each of the six shear components of the stress tensor is viewed as the rate of flow, per unit of shear area, and perpendicular to that area, of momentum directed along a principal axis in the surface of shear. In laminar flow through a circular orifice, with radial coordinate $r$ and axial coordinate $z$, the only non-zero shear component is $t_{rz}$, the flux of $z$-directed momentum in the $r$-direction. Newton's law of viscosity for this situation becomes

$$t_{rz} = -\mu(\mathrm{d}v_z/\mathrm{d}r),$$

where $v_z$ is the fluid velocity at any radius $r$ and the viscosity $\mu$ has the dimensions: (momentum/area-time) shear rate, and for which the SI unit is $1\ [\mathrm{kg\,m/s/m^2\,s}]/\mathrm{s}^{-1} = 1\ \mathrm{kg/m\,s} = 1\ \mathrm{Pa\,s}$. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The CRC Press, Boca Raton, FL.

**Monkey** *n.* Trade term for a batch of resin which has become thermoset and unusable during processing. Syn: giff.

**Monk's cloth** *n.* Wallcoverings that simulate a basket-weave material of cotton, jute, or flax.

**Mono-** A prefix designating the entity that follows it as the only one or as containing only one of that kind, e.g., monomer, or monohydric alcohol.

**Monobasic** \ˌmä-nə-ˈbā-sik\ [ISV] (1842) *adj.* (1) Pertaining to acids having one active hydrogen per molecule, e.g., hydrochloric acid, HCl. (2) Designating an acid salt in which one hydrogen (of two or three) has been replaced by a metal, e.g., potassium monophosphate, $KH_2PO_4$.

**Monocarboxylic acid** \-ˌkär-(ˌ)bäk-ˈsi-lik\ (ca. 1909) *adj.* Any organic acid containing a single –COOH group in the molecule. Many of the larger acids of this type are derived from natural fats and oils and are used in the production of alkyd resins and polyesters. Esters of oleic, stearic, pelargonic and richinoleic acid, all monocarboxylic, are widely used as plasticizers.

**Monochloroethylene** *n.* Syn: vinyl chloride.

**Monochromatic color scheme** *n.* Combining of colors in a room based on one color used in various values and saturation or chromas.

**Monochromatic emissive power** *n.* The ratio of the energy of certain defined wavelengths radiated at definite temperatures to the energy of the same wavelengths radiated by a black body at the same temperature and under the same conditions.

**Monochromatic light** *n.* Light of a single wavelength. It may be obtained by the use of a laser or by gaseous discharge tubes in combination with proper filters. An approximation is obtained by interference filters or monochromators. The degree of monochromaticness depends upon the dispersion device and accompanying optical scheme used to separate the different wavelengths from a continuous or "white" light source. Emission lines from elements which, when excited, emit light, such as mercury, sodium, etc., are most nearly true monochromatic light. Moller KD (2003) Optics. Springer-Verlag, New York.

**Monochromator** \ˌmä-nə-ˈkrō-ˌmā-tər\ [*monochromatic* + illumin*ator*] (1909) *n.* A device for dispersing white light into individual wavelengths, generally a prism or diffraction grating. Moller KD (2003) Optics. Springer-Verlag, New York.

**Monochrome** \ˈmä-nə-ˌkrōm \ [ML *monochroma*, fr. L, feminine of *monochromos* of one color, fr. Gk *monochrōmos*, fr. *mono-* + *-chrōmos* –chrome] (1662) *n.* Painting in different values and chromas of one hue. Moller KD (2003) Optics. Springer-Verlag, New York.

**Monoclinic** \ˌmä-nə-ˈkli-nik\ [ISV] (ca. 1864) *adj.* Of a crystal (or crystal system) having two axes that are mutually perpendicular to the third one, but not to each other. An example is the $\beta$-form of elemental sulfur, which is stable between 112 and 119°C, but slowly converts to the rhombic form below 112°C. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York. Hibbard MJ (2001) Mineralogy. McGraw-Hill Co. Inc., New York.

**Monocyclic terpenes** *n.* Heterogeneous mixture of monocyclic, bicyclic and other related terpene hydrocarbons recovered or removed in the fractionation of certain terpenes or other essential oils, or as a by-product in the chemical conversion of pinenes; generally sold under trade names.

**Monodisperse** \ˌmä-nō-dis-ˈpərs\ [*mon-* + *disperse*, adj, fr. *disperse*, v.] (1925) *adj.* Of a polymer, all the molecules having the same molecular weight. It has long been possible to make (nearly) monodisperse polystyrene of various molecular weights and a few other monodisperse polymers are now available as laboratory chemicals. Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York.

*Compare polydisperse.*

**Monodispersity** *n.* Refers to a polymer system, which is homogeneous in molecular weight, i.e., lacks molecular weight distribution. Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York.

**Monofil** *See monofilament.*

**Monofilament** \ˌmä-nə-ˈfi-lə-mənt\ (1940) *n.* A single filament of indefinite length, strong enough to function as a yarn in textile operations or as an entity in other applications. Monofilaments are generally produced by extrusion. Their outstanding uses are in the fabrication of brush bristles, surgical sutures, fishing lines, racquet strings, screen materials, ropes, and nets. The finer monofilaments are woven and knitted on textile machinery. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

M

**Monoglyceride** \ˌmä-nə-ˈgli-sə-ˌrīd\ (1860) *n.* Partial ester of glycerol in which one of the three hydroxyl groups is reacted with an organic acid.

**Monolithic flooring** *See seamless flooring.*

**Monomer** \ˈmä-nə-mər\ [ISV] (1914) *n.* A relatively simple compound that can react with itself or other compounds to form long-chain compounds by either. (1) Utilizing its $C=C$ bonds for addition. (2) By having two or more functional groups that can react with receptive groups in other molecules. Monomers are the basic building blocks of polymers. Monomer is sometimes referred to as *mer.* Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See monomeric unit (mer) and polymer.*

**Monomeric** Pertaining to a monomer.

**Monomeric cement** *See adhesive.*

**Monotropic** *n.* Of a material or element having two forms, one of which is metastable toward the other. The metastable form tends to change spontaneously to the stable form but the reverse change does not occur.

**Monotype printing** *n.* Process of printing from mechanically assembled pieces of type, each of which bears one character.

**Montan wax** \ˈmän-tᵊn-\ [L *montanus* of a mountain] (1908) (lignite wax) *n.* A hard, white wax derived from *lignite* (a lower-grade hydrocarbon fossil mineral between peat and bituminous coal). It is sometimes described as a bitumen wax. The crude product is very dark in color, almost black, but after refining it becomes pale yellow. Its mp varies from 72 to 82°C; its acid value, from 25 to 99; and its saponification value, from 58 to 104. The wax is used as a mold lubricant.

**Monthier's blue** *See iron blue.*

**Mooney equation** (M. Mooney) *n.* An empirical modification of the Einstein equation applicable to higher solids concentrations, and relating the viscosity of a suspension of monodisperse spheres $\eta_f$ to that of the pure liquid $\eta_o$.

$$\ln(\eta_f/\eta_o) = 2.5f/(1 - Sf),$$

where $f$ is the volume fraction of solids and $S \cong 1.4$ for spheres (ASTM, www.astm.org). Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK.

*See also Eilers equation.*

**Mooney scorch time** *n.* For a rubber specimen tested in a Mooney viscometer, the time elapsing after the minimum torque has been reached for torque to increase by five "Mooney units".

**Mooney viscosimeter** *n.* An instrument invented by M. Mooney in 1924, used to measure the effects of time of shearing and temperature on the comparative viscosities of rubber compounds. It consists of a motor driven disk, tooth-surfaced on the sides, enclosed within a die cavity formed by two halves maintained at controlled temperature and closing force. The specimen is a double disk, joined at the edges and trapped between the die halves and the rotor (ASTM, www.astm.org).

**Mop board** *See baseboard.*

**Moplen** *n.* Poly(ethylene) and poly(propylene), manufactured by Montedison, Italy.

**Mop polishing** *n.* (1) Application of a modified French polish with a camel hair "mop" to carved work. (2) Polishing by friction with a rotary mop.

**Mordant dyes** *n.* Dyes, which develop their characteristic colors when precipitated on suitable bases to form lakes. It is often possible to obtain considerable variation in the color of the final lake by altering the metallic radical of the base. Mordant dyes in their original state are colorless.

**Mordants** \ˈmór-dᵊnt\ [ME, fr. MF, pp of *mordre* to bite, fr. L *mordēre*; perhaps akin to Sanskrit *mrdnāti* he presses, rubs] (1791) *n.* Substances capable of uniting with both dyes and textile fibers so as to improve the bond between dye and textile and give improved textures and alter the colors.

**Moresque** *n.* A multicolored yarn formed by twisting or plying single strands of different colors.

**Morphological analysis** *n.* The identification of particles based on easily observed microscopical characteristics.

**Morphology** \mór-ˈfä-lə-jē\ [Gr *Morphologie*, fr. *morph-* + *-logie* –logy] (1830) *n.* The study of the physical form and structure of a material. This includes a wide range of characteristics, extending from the external size and shape of large articles to dimensions of crystal lattices but, with polymers, it most often refers to microstructure. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Mortar** \ˈmór-tər\ [ME *morter*, fr. OF *mortier*, fr. L *mortarium*] (14c) *n.* (1) Material used in a plastic state which can be troweled, and becomes hard in place, to bond units of masonry structures (*Note* — The word "mortar" is used without regard to the composition of the material, and is defined only with reference to its use as a bonding material as contrasted with the words "stucco" and "plaster"). (2) A mixture of gypsum plaster with aggregate or hydrated lime, or both, and water is to produce a trowelable fluidity.

**Mosaic** \mō-ˈzā-ik\ [ME *musycke*, fr. MF *mosaique*, fr. OIt *mosaico*, fr. ML *musaicum*, alter. of LL *musivum*, fr. L *museum*, *musaeum*] (15c) *n.* (1) Picture or surface decoration made by embedding small pieces of colored stone, marble, pottery, or glass in mortar.

**Mosley's law** *n.* The frequencies of the characteristic X-rays of the elements show a strict linear relationship with the square of the atomic number.

**Mote** *n.* A small piece of seed or vegetable matter in cotton. Motes are removed by boiling the fiber or fabric in sodium hydroxide, then bleaching. When not removed, they can leave a dark spot in the fabric.

**Motion, laws of** *See Newton's law of motion.*

**Motionless mixer** *See static mixer.*

**Mottle** \ˈmä-tᵊl\ [prob. back-formation fr. *motley*] (1676) *n.* (1) An irregular distribution or mixture of colorants or colored materials giving a more or less distinct appearance of specks, spots, or streaks of color. Mottling is often deliberate although it may occur accidentally due to inadequate mixing. (2) Presence of irregularly shaped and randomly distributed areas of nonuniform appearance in color, gloss or sheen. Syn: blotching.

**Mouldrite** *n.* Urea, phenol, and melamine/formaldehyde resins manufactured by ICI, Great Britain.

**Mountain blue** *See azurite.*

**Mounting plate** *n.* In blow molding, the plate to which the mold is attached.
*See also clamping plate.*

**Movable platen** *n.* The large back plate of an injection molding machine to which the back half of the mold is secured during operation. This platen is moved either by a hydraulic ram or a toggle mechanism.

**Movil, Mowil** *n.* Poly(vinyl chloride), manufactured by Polymer Ind., Italy.

**Moviol** *n.* Poly(vinyl alcohol), manufactured by Hoechst, Germany.

**Mowilith** *n.* Poly(vinyl acetate), manufactured by Hoechst, Germany.

**MS** Abbreviation for mass spectrometry.

**Mucilage** \ˈmyü-s(ə)lij\ [ME *muscilage*, fr. LL *mucilago* mucus, musty juice, fr. L *mucus*] (15c) *n.* (1) Flocculant or slimy deposit which separates from unrefined vegetable oils on heating. (2) An adhesive prepared from a gum and water. Also in a more general sense, a liquid adhesive which has a low order of bonding strength.

**Mudcracking** *n.* Paint film defect characterized by a broken network of cracks in the film.

**Muff** *n.* A loose skein of textured yarn prepared for dyeing or bulking. In the bulking operation, the yarn contracts and the resulting skein resembles a muff.

**Muff dyeing** *See dyeing.*

**Mullen bursting strength** *n.* An instrumental test method that measures the ability of a fabric to resist rupture by pressure exerted by an inflated diaphragm.

**Muller** \ˈmə-lər\ [alter. of ME *molour*, prob. fr. *mullen* to grind] (1612) *n.* An instrument usually of glass used for dispersing pigments in varnish for test purposes. The two glass grinding surfaces are generally ground glass. Pigment and vehicle are placed between them and the two rubbed together, either by hand or by making power. Power driven automatic mullers have two circular glass grinding surfaces.

**Mullion** \ˈməl-yən\ [prob. alter. of *monial* mullion] (1567) *n.* Narrow dividers between windows or glass panels.

**Multicavity mold** (multiple-cavity mold, multiple-impression mold) *n.* A mold having several to hundreds of cavities so that many parts may be molded with each shot. In many cases, the parts are identical, but that need not be so. In a type of multicavity mold known as a family mold, some of the cavities may be identical while others are different, or they may all be different.

**Multicolor finish** *n.* A speckled coating containing flecks of small, individual colored particles different from the base color. *Also called speckled finish.*

**Multicomponent polymerization** *n.* A polymerization which in general involves the use of more than one co-monomer. The term is usually reserved for co-polymerization of three or more co-monomers. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Multifilament** *n.* A yarn consisting of many continuous filaments or strands, as opposed to monofilament which is one strand. Most textile filament yarns are multifilament.

**Multifilament yarn** *n.* A manufactured yarn composed of many fine continuous filaments or strands.

**Multifunctional concentrate** *n.* A plastic compound that contains high percentages of at least two of such additives as colorants, stabilizers, flame retardants, lubricants, antistatic agents, anti-blocking agents, blowing agents, fillers, etc, that will be diluted in base resin to provide a tailored compound with the desired final concentrations of the additives in the extruded or molded product.

**Multigated** *n.* Of an injection-mold cavity, having two or more gates. Multigating is common in molding large or complex parts that would be difficult to fill through one gate. Also, shrewd placement of the several gates can direct the weld lines to areas of the part where the stresses expected in service will be low.

**Multilayer fabric** *n.* A fabric for reinforced-plastic structures formed by braiding to and fro or overlapping in one direction. Layers may be biaxial or triaxial, fibers mixed, and braid angles varied.

**Multilayer film** *n.* A film comprised of layers of two or more different materials, all polymeric. The goal is to make a film that has a combination of properties not achievable with a single polymer. Most multilayer films are made by co-extrusion. The principal layers are usually joined by an adhesive resin compatible with both the adjacent principals and co-extruded with them.

**Multiple proportions, law of** *n.* If two elements form more than one compound, the weights of the first element which combine with a fixed weight of the second element are in the ratio of integers to each other.

**Multiple-regression analysis** *See regression analysis.*

**Multiple scattering** *See scattering multiple.*

**Munsell book notation** *n.* The Munsell color notation of a specimen obtained by visual or computational comparison with the Munsell hue, value, and chroma scales of the Munsell Book of Color.

*See Munsell renotation.*

**Munsell book of color** *n.* A collection of color chips, which illustrate the Munsell Color System, manufactured by the Munsell Color Co. (MD, USA) in both matte and glossy finishes. It consists of pages of constant hue at 2.5 hue step intervals, with darkest colors (of lowest value at the bottom) increasing in value upwards to the top and colors of lowest chroma in the center fold increasing to highest chroma at the outside edge of the page.

**Munsell chroma** *n.* The color term applied to the psychological sensation dimension of saturation. In Munsell notation, neutrals, white, graphs, etc., have a chroma of zero. Increasing deviation from gray to purest color in equally perceptible steps are given increasing numerical notations, with intermediate steps designated by decimals proportional to the perceptibility differences.

**Munsell value** *n.* (1) That portion of Munsell notation that corresponds to the sensation of lightness. It is described by a number from zero for a perfect black to ten for a perfect white and is calculated from the equation

$$Y_0 = 1.2219V - 0.23111V^2 + 0.23951V^3 - 0.021009V^4 + 0.0008404V^5.$$

(2) The daylight reflectance of a specimen expressed on a scale extending from 0 for ideal black to 10 for ideal white by steps of approximately equal visual importance. Achromatic or neutral colors are designated *N* followed by the value notation, thus: $N = 5.0$. McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Mu oil** *n.* Name sometimes given to tung oil obtained from *Aleurites Montana.*

**Mural painting** *n.* Usually, large picture which is painted on a wall, or fastened to a wall surface. Gair A (1996) Artist's manual. Chronicle Books LLC, San Francisco.

**Muscovite** \ˈməs-kə-ˌvīt\ [ML or NL *Muscovia*, *Moscovia* Moscow] (1535) *n.*

*See aluminum potassium silicate.*

**Muslin** \ˈməz-lən\ [F *mousseline*, fr. It *mussolina*, fr. Arabic *mawsilīy* of Mosul, fr. al-*Mawsil* Mosul, Iraq] (1609) *n.* A broad term describing a wide variety of plain-weave cotton or polyester/cotton fabrics ranging from lightweight seers to heavier shirting and sheeting.

**Muted colors** Colors whose chroma or saturation has been lessened or moderated by use of their complementary color or a neutral. *Also called grayed colors or tones*, which, on losing most of their character as a color, approach *Neutrals.*

**MVP** *n.* Abbreviation for moisture vapor permeability.

**MVT** *n.* Abbreviation for moisture vapor transmission.

*See specific permeability (of a film to moisture).*

**MVTR** *n.* Abbreviation for moisture–vapor-transmission rate.

*See water–vapor-transmission rate.*

**$M_w$** *n.* Symbol for weight-average molecular weight.

**MW** Abbreviation for molecular weight.

**Mycology** \mī-ˈkä-lə-jē\ [NL *mycologia*, fr. *myc-* + Latin *-logia* -logy] (1836) *n.* The science dealing with fungi.

**Mylar** \ˈmī-ˌlär\ *tradename* Polyester (film). DuPont's registered trade name for biaxially oriented film composed of polyethylene glycol terephthalate.

**Myristoyl peroxide** $(C_{13}H_{27}CO)O_2$. A soft, granular powder, used as a polymerization catalyst for vinyl monomers.

**$M_v$** *n.* Symbol for viscosity-average molecular weight.

# N

**n** \ˈen\ {*often capitalized, often attributive*} (before 12c) *n.* (1) SI abbreviation for nano-. (2) *n*-: In organic chemistry, abbreviation for normal, signifying a straight (unbranched) aliphatic chain. (3) A subscript denoting the last of a series of *n* ordered numbers or data.

**N** (1) Chemical symbol for the element nitrogen. (2) SI abbreviation for Newton. (3) N: In solution chemistry, following a numeral, abbreviation for normal or normality. *See normal solution.*

**Na** Chemical symbol for the element sodium.

**NACE** Abbreviation for National Association of Corrosion Engineers.

***N*-Acetyl ethanolamine** \-ˌe-thə-ˈnä-lə-ˌmēn, ˈnō-, *British also* ˌē-\ (hydroxyethyl acetamide) *n.* $CH_3CONHC_2H_4$–OH. A plasticizer for polyvinyl alcohol and cellulosic plastics.

**Nacreous** \ˈnā-kər\ [MF, fr. OIt *naccara* drum, nacre, fr. Arabic *naqqārah* drum] (1718) *n.* Pertaining to, or having the appearance of, mother-of-pearl. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

*See pearlescent pigment.*

**Nacreous pigment** *n.* Translucent pigment which, when added to transparent coating material, creates a deep lustrous and pearlescent finish. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

*See pearlescent pigment.*

**NAD** *See non-aqueous dispersion.*

**Nailhead rusting** *n.* Rust from iron nails that penetrates or bleeds through the coating and stains the surrounding area.

**Nainsook** \ˈnān-ˌsuk\ [Hindi *nainsukh*, fr. *nain* eye + *sukh* delight] (1790) *n.* A fine, lightweight, plain-weave fabric, usually of combed cotton. The fabric is often mercerized to produce luster and is finished soft. Nainsook is chiefly used for infants' wear, lingerie, and blouses.

***N*-β(Aminoethyl)-γ-aminopropyltri-methoxy silane** *n.* A silane coupling agent used in reinforced epoxy, phenolic, melamine and polypropylene resins.

**Nano-** {*combining form*} [ISV, fr/ Gk nanos dwarf]. The SI prefix meaning $\times 10^{-9}$ (one billionth).

**Nanometer (nm)** \ˈna-nə-ˌmē-tər\ [ISV] (1963) *n.* The usual unit of linear measurement with the electron microscope and of measuring ultraviolet and visible light wavelengths. ($1\,\text{nm} = 10^{-9}$m or about $4 \times 10^{-8}$in.) replaces the former name, "millimicron" (mμ). An SI unit of length equal to $10^{-9}$m, convenient for stating light wavelengths and superseding the older Angstrom unit and millimicron, both now deprecated.

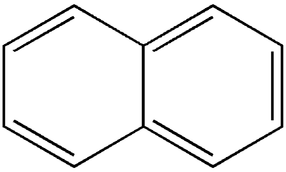
**Nanotechnology** *n.* The ultra-miniaturization of nanomaterial, nanodevices and nanoanalysis methods including nanorheology and molecular tribology. Bhushan B (ed) (2004) Springer handbook of nanotechnology. Springer-Verlag, New York.

**Nap** [ME *noppe*, fr. MD, flock of wool, nap] (15c) *n.* (1) The dense, soft, or fuzzy fabric attached to a cylindrical cover used on paint rollers. (2) A downy surface given to a cloth when part of the fiber is raised from the basic structure.

**Naphtha** \ˈnaf-thə\ [L, fr Gk, of Iranian origin, akin to Per *neft* naphtha] (1572) (solvent naphtha) *n.* Any of a family of petroleum and coal-tar distillates with 30°C boiling ranges within the interval 125–200°C.

They are useful as solvents for natural resins and rubber, and as paint thinners. Naphtha's contain substantial portions of paraffin and naphthalenes.

**Naphthalene** \ˈnaf-thə-ˌlēn\ [alter. of earlier *naphthaline*, irreg. fr. *naphtha*] (1821) *n.* A crystalline aromatic hydrocarbon usually obtained by distillation of coal tar (napthalin, tar camphor). An aromatic hydrocarbon, $C_{10}H_8$, derived from coal-tar oils or petroleum fractions and having the structure shown below (*See image*).



Once used as a moth repellent, it is now important as a reactant in the production of phthalic anhydride, which in turn is used for making plasticizers, alkyd resins, and polyester resins.

*See magdala red.*

**Naphthas** \ˈnaf-thəs\ [L, fr. Gk, of Iranian origin, akin to Persian *neft* naphtha] (1572) *n.* Aromatic hydrocarbons derived from coal tar, although the term "petroleum naphtha" is sometimes used for petroleum spirits of substantially aliphatic type. The coal tar naphthas are the distillation fractions, which contain a complex mixture of aromatic hydrocarbons, including xylenes. Generally refers to hydrocarbon solvents, both aromatic and aliphatic. Hi-flash naphtha is an example of the former and VM & P naphtha an example of the latter.

**Naphthenate** *n.* Salt of naphthenic acid. A drier used in paints; made with naphthenic acid and lead, cobalt, calcium, iron, zinc or manganese salts.

*See naphthenic acid.*

**Naphthenate driers** *n.* Compounds of naphthenic acid with metals, usually lead, cobalt, or manganese used to accelerate the oxidation of the ink film.

**Naphthenes** \ˈnaf-ˌthēns\ (1884) *n.* $C_nH_{2n}$. Found in certain types of crude petroleum. *Known also as cycloparaffins or hydrogenated benzenes.*

**Naphthenic acid** *n.* A carboxylic acid derived from petroleum refining and usually one of a mixture of similar compounds. The mixed acids and some of their soaps, e.g., cobalt naphthenate and calcium naphthenate, are useful as catalysts or accelerators in curing polyester resins and as drying agents in paints and varnishes. Commercial naphthenic acids are not pure compounds, but consist of a mixture of acids based on cyclopentane rings.

**Naphthenic solvent** *n.* Hydrocarbon solvents comprised wholly or partially of cycloparaffinic (naphthenic) hydrocarbon compounds. The only common commercial naphthenic solvent is cyclohexane.

**Naphthol** \ˈnaf-ˌthól\ [ISV] (1849) *n.* $C_{10}H_8O$. (1) Either of two isomeric derivatives of naphthalene used as an antiseptic and in the manufacture of dyes. (2) Any of various hydroxy derivatives of naphthalene that resemble the simpler phenols.

**NAPIM** The National Association of Printing Ink Manufacturers. NAPIM is a trade association whose purpose is to provide information and assistance to its members to better manage their businesses, and to represent the printing industry in the USA. NAPIM (www.napim.org) is located in 581 Main Street, Woodbridge, NJ.

**Naples yellow** *n.* A light yellow pigment; the true pigment is a basic antimonite of lead, but is imitated by mixtures. Syn: galliolino and antimony yellow.

**Napping** *n.* A finishing process that raises the surface fibers of a fabric by means of passage over rapidly revolving cylinders covered with metal points or teasel burrs. Outing, flannel, and wool broadcloth derive their downy appearance from this finishing process. Napping is also used for certain knit goods, blankets, and other fabrics with a raised surface.

**1,5-Napththalene diisocyanate (NDI)** *n.* $OCNC_{10}H_6NCO$. An isocyanate used in the production of urethane elastomers and foams.

**Narrow fabric** *n.* Any non-elastic woven fabric, 12 in. or less in width, having a selvage on either side, except ribbon and seam binding.

**National association of corrosion engineers (NACE)** *n.* Address: 1440 S Creek Dr., Houston, TX. A leading publisher of technical information on protection and performance of materials in corrosion environments. NACE also sponsors educational seminars on anticorrosion properties and applications of plastics in the chemical-process industries.

**National association of printing ink manufacturers (NAPIM)** 581 Main Street, Woodbridge, NJ. The NAPIM is a trade association whose purpose is to provide information and assistance to its members to better manage their businesses, and to represent the printing ink industry in the USA.

**Natta catalyst** \ˈnät-(ˌ)tä-\ *n.* Any of several catalysts used in the stereospecific polymerization of olefins, e.g., ethylene and propylene, particularly a catalyst made from titanium chloride and aluminum alkyl or similar materials by a special process including grinding the materials together to produce an active catalytic surface. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Natural fibers** *n.* A fiber of plant or animal origin such as cotton (nearly pure cellulose), flax, sisal, abaca, hemp, jute, etc., the wood of sheet and other animals, horsehair, and swine bristle. Cellulose from cotton linters and wood pump is the starting material for cellulosic plastics and is by far the most important natural fiber for the plastics industry.

**Natural finish** *n.* Any finish resulting from the application of a transparent substance (such as a varnish, water-repellent preservative, sealer, or oil) which does not affect significantly the original color or grain.

**Natural gums** *n.* Fossilized or animal gum resins. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Natural iron oxides** *n.* Natural mineral deposits consisting chiefly of ferric oxide. Color range of yellow, red, brown, and black, consisting chiefly of ferric oxide. *See iron oxides.*

**Natural pigments** *See earth pigment.*

**Natural polymers** *n.* A polymer that is produced by biosynthesis in nature, as opposed to human-controlled polymerized synthetic polymer.

**Natural red 4 (75470)** *See carmine lake.*

**Natural resin** *n.* A resin produced by nature, mostly by exudation from certain trees from cuts or tears in the bark. Lac resin is secreted by the lac insect and is refined to make shellac. Some of the tree resins are copal, rosin, and sandarac, at one time widely used in wood finishes. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

*See resin, natural.*

**Natural rubber** *n.* The rubber material obtained from the latex produced by certain plants and trees.

*See rubber, natural.*

**Natural yellow oxide** *See iron oxides, natural.*

**Naval stores** *n.* Chemically reactive oils, resins, tars, and pitches derived from the oleoresin contained in, exuded by, or extracted from, trees chiefly of the pine species *Genus Pinus*, or from the wood of such trees.

**Navy pitch** *See pitch, navy.*

**NBR** *n.* Elastomers from acrylonitrile and butadiene.

*See acrylonitrile-butadiene co-polymer.*

**Color difference equation** *n.* This expression was originally the National Bureau of Standards equation, now National Institute of Standards and Technology. Color difference equation devised by Judd and modified by Hunter. The total color difference, $\Delta$E, was called an NIST unit.

$$\Delta E = f_g\left\{\left[221\,Y_m^{1/4}\left(\Delta\alpha^2+\Delta\beta^2\right)^{1/2}\right]^2 + \left[k\,\Delta Y^{1/2}\right]^2\right\}^{1/2},$$

where

$$\alpha = \frac{2.4266x - 1.3631y - 0.3214}{1.0000x + 2.2633y + 1.1054},$$

$$\beta = \frac{0.5710x + 1.2447y - 0.5708}{1.000x + 2.2633y + 1.1054}$$

$$Y_m = \frac{Y_1 + Y_2}{2}, \quad \Delta\alpha = \alpha_1 - \alpha_2,$$
$$\Delta\beta = \beta_1 - \beta_2, \quad \Delta Y = Y_1 - Y_2,$$

and $k$ is the constant expressing the relative importance of lightness and chromaticness in a particular viewing arrangement; $k = 12$ for comparison made across a very narrow dividing line. With increasing separation of the two colors, the value $k$ decreases; $k = 10$ is frequently used. $f_g$ is the factor which takes into account the masking effect of gloss on the detection of color difference: for normal observation

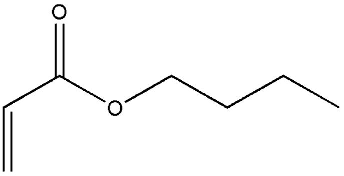
$$f_g = \frac{Y_m}{Y_m + 2.5}$$

($Y_m$ is measured with specular reflectance excluded). If $f_g$ is calculated in this way $f_g$ decreases very rapidly when $Y_m$ becomes less than 10%, where $f_g = 0.8$. At 1% $f_g = 0.287$, for example. For ease in calculation $k$ is frequently used as 10.000, especially where colors are not going to be used adjacently. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Syszecki G, Stiles WS (1967) Color science: concepts and methods, quantitative data and formulas. John Wiley and Sons Inc., New York. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**NIST total color difference** *n.* The total color difference, $\Delta E$, calculated by means of the NIST color difference equation, sometimes referred to as a Judd or a Judd unit. The term is frequently erroneously used to refer to the color difference calculated by other equations normalized to agree in magnitude on the average to an NBS unit, or to the $\Delta E$ measured on tristimulus colorimeters with electrical circuits designed to give an approximation of the NIST color difference equation, frequently one of the Hunter *L*, *a*, *b* equations. Such incorrect use of the term is to be discouraged. Description of the exact equation and method of measurement used will avoid confusion (NIST, www.nist.gov).

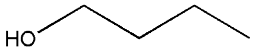
*See NIST color difference equation and Hunter color difference equation.*

**n-Butanol** \ˈen-ˈbyü-tᵊn-ˌól\ $CH_2{=}CHCOO$ $C_4H_9$. A colorless liquid that polymerizes readily on heating (*See image*).

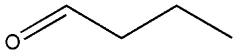


*See n-butyl alcohol n.*

**n-Butyl alcohol** (ca. 1871) (1-butanol) *n.* $CH_3(CH_2)_2CH_2OH$. A medium-boiling alcohol, liquid above 35°C, used as a solvent for cellulosic, phenolic, and urea–formaldehyde resins. It is also used as a diluent/reactant in the manufacture of urea–formaldehyde and phenol-formaldehyde resins, and as an intermediate in the production of butyl acetate, dibutyl phthalate, and dibutyl sebacate (*See image*).

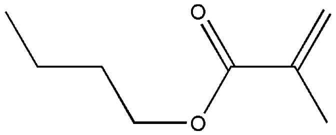


**n-Butyl aldehyde** *See butyaldehyde (See image).*



**n-Butyl lithium** (*n*-Bu-Li) *n.* An initiator for anionic polymerization; lithium alkyls are known to be highly associated in many solvents, and especially in non-polar solvents such as benzene and heptane.

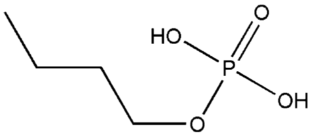
**n-Butyl methacrylate** \-ˌme-ˈtha-krə-ˌlāt\ *n.* $H_2C{=}CHCH_3COOC_4H_9$. A polymerizable monomer used in the production of acrylic resins and potting compounds (*See image*).

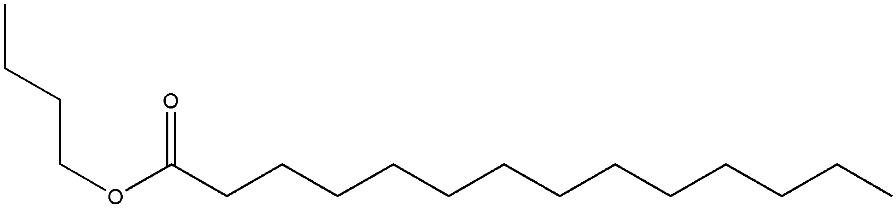


**n-Butyl myristate** *n.* $CH_3(CH_2)_{12}$ $COOC_4H_9$. The butyl ester of myristic acid, an oily liquid used as a plasticizer for cellulosic plastics (*See image*).

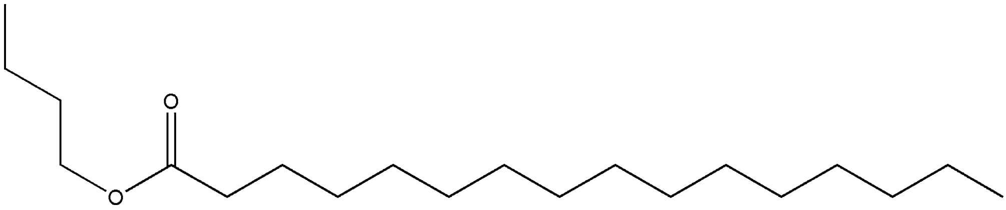
**n-Butyl palmitate** \-ˈpal-mə-ˌtāt\ *n.* $C_{15}H_{31}$ $COOC_4H_9$. A plasticizer for polystyrene and cellulosic plastics (*See image*).

**n-Butylphosphoric acid** *n.* $C_4H_9H_2$ $PO_4$. A reddish amber liquid used as a catalyst, e.g., in urea-resin production (*See image*).



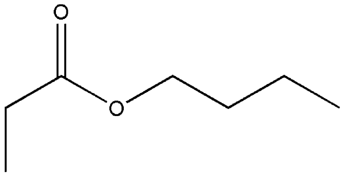


***n*-Butyl myristate**



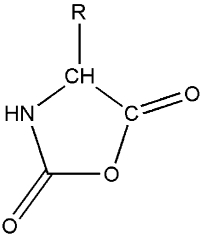
***n*-Butyl palmitate**

**n-Butyl propionate** \-ˈprō-pē-ə-ˌnāt\ *n.* $C_2H_5COOC_4H_9$. A colorless liquid with an apple-like odor, used as a solvent for nitrocellulose (*See image*).



**NC** *n.* (1) Abbreviation for numerical control. (2) *See cellulose nitrate.*

**N-Carboxyanhydrides** *n.* Alternative name for *N*-carboxy-α-amino acid anhydride (*See image*).



**NCCA** Abbreviation for National Coil Coaters Association.

**NCNS** *See triazine resin.*

**n-Decyl-n-octyl phthalate (NDOP)** *n. See n-octyl-n-decyl phthalate (See image).*

**N,N′-Dinitroso-N,N′-dimethylterephthal amide** *n.* A blowing agent that is a weak explosive in powder form and thus unsafe to handle, but is available in desensitized form by treatment with mineral oil (DuPont Nitrosan®). This blowing agent is unique in that its low decomposition temperature permits the expansion of vinyl plastisol prior to gelation (93°C). Subsequent fusion at 177°C produces open-cell vinyl foam. Closed-cell foam can be produced by heating to fusion in a closed mold, releasing the pressure and subsequently heating in an oven at 100°C.

**NDOP** *n.* Abbreviation for *n*-decyl-*n*-octyl phthalate.

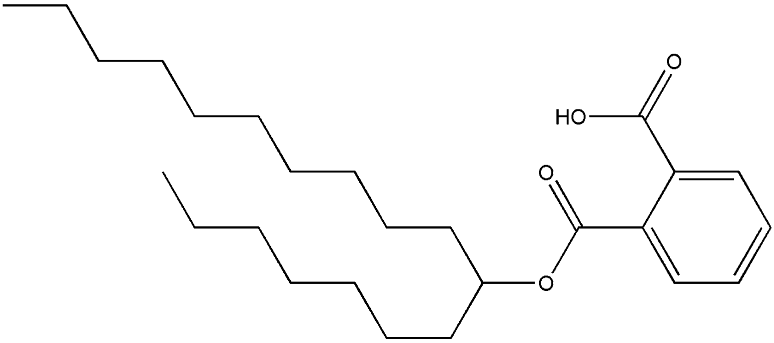
*See n-octyl-n-decyl phthalate.*

**NDPA** Abbreviation for National Decorating Products Association.

**Near-net-shape configuration** *n.* In reinforced plastics molding, designating a fibrous-preform shape very close to the shape the perform will take after resin impregnation and curing in the mold, such that no lay-up and little or no trimming after molding are required.

**Neat resin** *n.* Strictly, a resin containing nothing but the main identified polymer(s). Usually, the term means that, while there may be fractional percentages of stabilizers and other additives present, there are no fillers, reinforcements, or pigments. Sometimes called a “pure” resin, though, since all commercial polymers are mixtures of homologs of various molecular weights, “pure” has a looser meaning here.

**Neatsfoot oil** *See animal oil.*



**Neck-in** *n.* In extrusion of film, sheet and coatings, the difference between the width of the extrude web as it leaves the die and the final width of the chilled film, etc. (before any edge trimming is done).

**Necking** *n.* The localized reduction in cross-section that may occur in a ductile material under tensile stress (ASTM D 883). A similar phenomenon can occur during extrusion under certain conditions as the extrudate leaves the die. Necking can also occur during drawing of fibers at temperatures below their melting ranges. Fibers of crystalline and some non-crystalline thermoplastics, e.g., polyethylene, exhibit necking at a critical stress near the yield point. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Neck insert (finish insert)** *n.* In blow molding of bottles, a removable part of the mold that forms a specific neck finish of the bottle.

**Needle** \ˈnē-dəl\ [ME *nedle*, fr. OE *nîdl*; akin to OHGr *nādala* needle, *nājan* to sew, L *nere* to spin, Gk *nēn*] (before 12c) *n.* (1) A thin, metal device, usually with an eye at one end for inserting the thread, used in sewing to transport the thread. (2) The portion of a knitting machine used for intermeshing the loops. Several types of knitting needles are available. (3) In non-wovens manufacture, a barbed metal device used for punching the web's own fibers vertically through the web. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

*Also see spring needle and latch needle.*

**Needled** *n.* The product of the needle loom. Needled fabrics are used for rug pads, papermaker's felts, padding, linings, etc.

**Needle loom** *n.* A machine for bonding a non-woven web by mechanically orienting fibers through the web. The process is called needling, or needle punching. Barbed needles set into a board punch fiber into the batt and withdraw, leaving the fibers entangled. The needles are spaced in a non-aligned arrangement. By varying the strokes per minute, the advance rate of the batt, the degree of penetration of the needles, and the weight of the batt, a wide range of fabric densities can be made. For additional strength, the fiber web can be needled to a woven, knit, or bonded fabric. Bonding agents may also be used. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Negative catalyst** (inhibitor, retarder) *n.* An agent that slows a chemical reaction.

*See catalyst.*

**Negative crystals** *n.* A uniaxial crystal is optically negative if $\varepsilon < \omega$. A biaxial crystal is said to be optically negative if $\gamma - \beta < \beta - \alpha$.

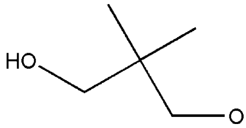
**Negatron** *n.* (1) A term used for electron when it is necessary to distinguish between (negative) electrons and positrons. (2) A four-element vacuum tube, which displays a negative resistance characteristic.

**NEMA** *n.* Acronymical abbreviation for National Electrical Manufacturers Association, an organization that has strongly influenced electrical applications of plastics.

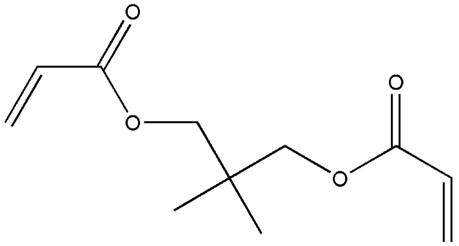
**Nematic** \ni-ˈma-tik\ [ISV *nemat-* + $^{1}$-*ic*] (1923) *adj. See liquid-crystal polymer.*

**Neo-** {*combining form*} [Gl, fr. *neos* new]. (1) Prefix meaning *new* and denoting a compound isomerically related to an older one whose name follows the prefix. (2) A prefix denoting a hydrocarbon in which at least one carbon atom is connected directly to four other carbon atoms, e.g., neopentane, $C(CH_3)_4$.

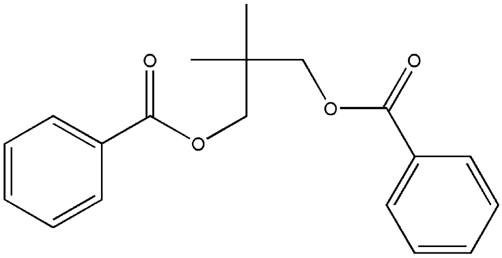
**Neopentyl glycol** (NPG, 2,2′-dimethyl-1,3-propanediol) *n.* An important intermediate for the production of alkyd and polyester resins, urethane foam and elastomers, and polyester plasticizers. Gel coats based on NPG for reinforced polyesters have improved flexibility, hardness, and resistance to abrasion and weathering (*See image*).



**Neopentyl glycol diacrylate (NPGDA)** *n.* A highly reactive cross-linking monomer used in photocurable coatings. It provides solvent and strain resistance as well as improved response to light (*See image*).



**Neopentyl glycol dibenzoate** *n.* A solid plasticizer for rigid PVC (*See image*).



**Neoprene** \ˈnē-ə-ˌprēn\ [*ne-* + chlor*oprene*] (1937) (Polychloroprene, poly-2-chloro-1-butadiene) *n.* Elastomers made from the monomer $CH_2{=}CHCCl{=}CH_2$. They are available as dry solids and lattices, and are vulcanizable to tough products with excellent resistance to oils, gasoline, solvents, heat, and weathering. The original neoprene, produced by DuPont under the trade name "Duprene", was America's first successful synthetic rubber, manufactured by DuPont.

**Neoprene paint** *n.* Paint based upon pigmented solutions of the proprietary synthetic rubber neoprene (polychloroprene rubber), a vulcanizing agent being added before use.

**Neou oil** *n.* Seed oil of the tree, *Parinarium macrophyllum*, which grows in several parts of West Africa. The main constituent acids of the oil are an isomer of α-elaeostearic acid and linoleic acid. The oil has an iodine value of 135 and a saponification value of 190.

**Nep** *n.* A small knot of entangled fibers that usually will not straighten to a parallel position during carding or drafting.

**Nepheline** \ˈne-fə-ˌlēn\ [F *néphéline*, fr. Gk *nephelē* cloud] (ca. 1814) *n.* A naturally occurring mineral composed mainly of feldspar and nephelite. As a filler in PVC compounds, it has the unique property of contributing almost no opacity, so that it can be used in nearly transparent compounds. It is also used as a filler in epoxy and polyester resins.

**Nepheline syenite** \-ˈsī-ə-ˌnīt\ *n.* A mineral aggregate consisting chiefly of albite, microline, and nephelite, each in significant amount.

**Nephelite** \ˈne-fə-ˌlīt\ [F *néphéline*, fr. Gk *nephelē* cloud] (ca. 1814) *n.*
*See nepheline.*

**Nernst effect** \ˈnern(t)st-\ [Walther Hermann *Nernst* 1864–1941] *n.* When heat flows across the lines of magnetic force, there is observed an electromotive force in the mutually perpendicular direction. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Nerve** \ˈnərv\ [L *nervus* sinew, nerve; akin to Gk *neuron* sinew, nerve, *nēn* to spin] (14c) *n.* A condition difficult to define fully, but commonly used to denote the qualities of firmness, strength and elasticity in crude rubber. In crude rubber, nerve is reduced or destroyed by milling or breakdown.

**Nesting** *n.* In reinforced plastics, the placing of plies of fabric so that the yarns of one ply lie in the valleys between the yarns of the adjacent ply.

**Nest plate** A retainer plate with depressed area for cavity blocks used in injection molding.

**Net** \ˈnet\ [ME *nett*, fr. OE, akin to OHGr *nezzi* net] (before 12c) *n.* An open fabric made by knotting the intersections of thread, cord, or wires to form meshes. Net can be made by hand or machine in a variety of mesh sizes and weights matched to varying end uses, i.e., veils, curtains, fishnets, and heavy cargo nets.

**Net equation** *n.* An equation, which shows only actual reactants at the left and only actual products at the right of the arrow.

**Net flow** *n.* The output of an extruder's metering section, being, to a first approximation, the algebraic sum of the drag flow, pressure flow and leakage flow. In most plastics extruders with solid feeds and screws having the conventional three sections – feed, transition, and metering – the net flow may be conservatively estimated from the equation

$$\dot{m} = 2.0D^2Nh\rho_o,$$

where $\dot{m}$ is in lb/h, $D$ the nominal screw diameter, in., $N$ the screw speed in rpm, $h$ the channel depth in the metering section, and $\rho_o$ is the plastic's room-temperature density, g/cm$^3$. If the rate is given in kg/h and the diameter and channel depth in cm, the equation becomes

$$\dot{m} = 0.055D^2Nh\rho_o.$$

Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc.

**Net rate** *n.* In a fiber production process the total throughput less waste and inferior or off-grade material.

**Netting** *n.* A crossing-strand sheet or tubular plastic structure, fused at the crossing points, produced by extrusion through (patented) oscillating dies. Plastic netting, in small pieces and baskets, is also made by injection molding.

**Netting analysis** *n.* The stress analysis of filament-wound structures that neglects the strength of the resin and assumes that the filaments carry only axial tensile loads and possess no bending or shearing stiffness.

**Network co-polymers** *n.* Three-dimensional polymers, polymer gels, multifunctional reactive polymers, and cross-linked polymers. Zaccaria VK, Utracki L (2003) Polymer blends. Springer-Verlag, New York. Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York.

**Network polymer** *n.* A polymer obtained by the polymerization of a monomer having two or more functional groups that become interconnected with sufficient interchain bonds to form a large three-dimensional network. The network can be formed during polymerization, or may be created by cross-linking the polymers after they have been formed. The vulcanization of rubber is an example of the formation of a network polymer from a preformed polymer. Copolymers of ethylene and propylene can be made into network polymers by cross-linking with ionizing radiation after reactive sites have been prepared by treating with heat or peroxides. Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York.

**Network structure** *n.* An atomic or molecular arrangement in which primary bonds form a three-dimensional network. Zaccaria VK, Utracki L (2003) Polymer blends. Springer-Verlag, New York. Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Allcock HR, Mark J, Lampe F (2003) Contemporary polymer chemistry. Prentice-Hall, New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Neuberg chalk** *n.* Aluminum silicate used to some extent as a filler or extender, but it has special properties as a constituent of metal polishes.

**Neutral** \ˈnü-trəl, ˈnyü-\ (15c) *n.* (1) Having no distinguishable hue; achromatic. (2) Not decided in color; nearly achromatic; of low saturation.

*See gray scale.*

**Neutral axis** *n.* In a beam or column subject to bending moments, the surface near the center of the beam and perpendicular to the applied loads upon which neither tensile nor compressive stress is acting. In homogeneous beams with depth-symmetrical cross-sections, the neutral axis is exactly at the center.

**Neutral gray** *n.* An achromatic gray representing a portion of the gray scale.

**Neutralization** \ˌnü-trə-lə-ˈzā-shən, ˌnyü-\ (1808) *n.* A chemical reaction in which the hydrogen ion of an acid and the hydroxyl ion of a base unite to form water and a salt.

**Neutralization equivalent or number** *See acid number.*

**Neutralization reaction** *n.* An acid–base reaction (Arrhenius).

**Neutralizing** (British) *n.* Spray finish deliberately applied to produce an uneven or mottled appearance.

**Neutral oil** *n.* A light gravity mineral oil derived from petroleum and used as a lubricant in rubbing finished work.

**Neutral solution** *n.* An aqueous solution in which the concentrations of hydrogen and hydroxide ions are equal. A solution of pH 7.0 at 25°C.

**Neutral toner** *n.* A stain of yellow-orange color used to blend colored wood streaks in wood finishing.

**Neutrino** \nü-ˈtrē-(ˌ)nō, nyü-\ [It, fr. *neutro* neutral, neuter, fr. L *neutr-*, neuter] (1935) *n.* An electrically neutral particle of very small (probably zero) rest mass and of spin quantum number 1/2. When the spin is oriented parallel to the linear momentum the particle is the antineutrino. When the spin is oriented anti-parallel to the linear momentum the particle is the neutrino. Postulated by Pauli in explaining the beta decay process. Whenever a beta (positron) particle is created in a radioactive decay so is an antineutrino (neutrino). The two particles and the parent nucleus share between them the available energy and momentum. Neutrinos and antineutrinos can penetrate amounts of matter measured in light years without appreciable attenuation. Detected by Reines and Cowan using antineutrinos from fission reactors and large scintillation detectors. Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York.

**Neutron** \ˈnü-ˌträn, ˈnyü-\ [prob. fr. *neutral*] (1932) *n.* A neutral elementary particle of mass number 1. It is believed to be a constituent particle of all nuclei of mass number greater than 1. It is unstable with respect to beta-decay, with half-life of about 12 min. It produces no detectable primary ionization in its passage through matter, but interacts with matter predominantly by collisions and, to a lesser extent, magnetically. Some properties of the neutron are: rest mass, 1.00894 atomic mass unit; charge, 0; spin quantum number, 1/2; magnetic moment, −1.9125 nuclear Bohr *magnetrons*. Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The CRC Press, Boca Raton, FL.

**Neutron-absorbing fiber** *n.* Polyethylene fiber modified with boron used in the nuclear industry for reducing neutron transmission.

**Neutron cross-section** *See cross-section.*

**Newel** \ˈnü-əl, ˈnyü\ [ME *nowell*, fr. MF *nouel* stone of a fruit, fr. LL *nucalis* like a nut, fr. L *nuc-*, *nux* nut] (14c) *n.* Large post at the termination of a stair rail used in coatings jargon.

**News inks** *n.* Printing inks designed to run on newsprint, consisting basically of carbon black or colored pigments dispersed in mineral oil vehicles, which dry by absorption. Recent developments utilize emulsion, oxidation, and heat set systems.

**Newsprint** \-ˌprint\ (1909) *n.* A generic term used to describe paper of the type generally used in the publication of newspapers.

**Newton** \ˈnü-tən, ˈnyü-\ [for Sir Isaac *Newton*] *n.* The SI unit of force that, when applied to a body having a mass of 1 kg and free to move, gives it an acceleration of one meter per square second ($1\,m/s^2$). Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL.

*See also force.*

**Newtonian flow** *n.* An isothermal, laminar flow characterized by a viscosity that is independent of the level of shear, so that the shear rate at all points in the flowing liquid is directly proportional to the shear stress and vice versa. Simple liquids such as water and mineral oil usually exhibit Newtonian flow, whereas polymer melts and solutions usually do not, but are *pseudoplastic*. Newtonian flow can occur, at least ideally, under the influence of an infinitesimally small force. It is said to be distinguished from plastic flow, which occurs only when a finite minimum force is exceeded. Oils, at sufficiently low rates of shear, exhibit Newtonian flow. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Van Wazer JR, Lyons JW, Kim KY, Colwell RE (1963) Viscosity and flow measurement. Interscience Publishers Inc., New York.

*See pseudoplastic fluid, non-Newtonian liquid.*

**Newtonian liquid** (Newtonian fluid) *n.* One is which the rate of shear is proportional to the shearing stress. The constant ratio of the shearing stress to the rate of shear is the viscosity of the liquid. If the ratio is not constant, the liquid is non-Newtonian. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York.

*See viscosity.*

**Newtonian viscosity** *n.* Another name for viscosity. Of polymer melts, the viscosity at very low shear rates ($<0.01\,s^{-1}$) in low-density polyethylene, for example) where viscosity is independent of shear rate and the melt is essentially Newtonian. In some models of pseudoplastic flow, a second limiting viscosity ($\mu_\infty$) approached as shear rate rises to extreme values and observed in some polymer solutions at high (but not infinite) shear rates. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. Patton TC (1964) Paint flow and pigment dispersion. Interscience Publishers Inc., New York.

**Newton's law of motion** *n.* Every body continues in its state of rest or of uniform motion in a straight line except in so far as it may be compelled to change that state by the action of some outside force. Change of motion is proportional to force applied and takes place in the direction of the line of action of the force. Also, to every action there is always an equal and opposite reaction.

**Newton's second law of motion** (Newton's law of momentum change) *n.*
*See force.*

**Newton's series** *n.* The sequence of interference colors observed when a quartz wedge is turned to the 45° position and observed between crossed polars. It is divided into "orders" by the red bands, which occur periodically as the thickness increases. It is identical with the interference colors from a thin isotropic film of gradually increasing thickness.

**Nextel®** *n.* 3M Corporation's trade name for their high-performance fiber containing 62% $Al_2O_3$, 24% $SiO_2$, and 14% $B_2O_3$. Grades range in properties: density 2.71–3.10 g/cm$^3$; modulus, 150–240 GPa; and tensile strength, 1.3–2.0 GPa.

**N'Gart oil** *n.* Oil obtained from *Plukenetia conophora*, which grows in the Cameroons. It polymerizes readily at normal stand-oil-making temperatures (300°C). Average reported constants for this oil are: iodine value, 200, Sp gr, 0.937/15°C; and saponification value, 191.

**N'Gore oil** *See isano oil.*

**NGR grain** *See non-grain-raising stain.*

**NHDP** *n.* Abbreviation for *n*-hexylethyl-*n*-decyl phthalate.
*See n-octyl-n-decyl phthalate.*

**Ni** *n.* Chemical symbol for the element nickel.

**Niax** *n.* Polyether from propylene and glycerine or 1,2,6-hexantriol, manufactured by Union Carbide, USA.

**Nibs** \ˈnib\ [prob. alter. of *neb*] (1585) *n.* Small piece of foreign material, pieces of skin, coagulated medium, etc., which project above the surface of an applied film, usually varnish or lacquer.
*See bitty.*

**Nickel** \ˈni-kəl\ [prob. fr. S *nickel*, fr. Gr *Kupfernickel* niccolite, prob. fr. *Kupfer* copper + *Nickel* goblin; fr. the deceptive copper color of niccolite] (1755) *n.* A silver-white hard malleable ductile metallic element capable of a high polish and resistant to corrosion that is used chiefly in alloys and as a catalyst.

**Nicol prism** *n* A polarizing element made of two pieces of calcite specially cut, ground, polished, and cemented. A transmitted beam splits into two polarized components, one of which is refracted into and absorbed by the asphalt mount. The remaining polarized beam is transmitted.

**Night vision** *See scotopic vision.*

**Nigrosines** *n.* Deep blue or black aniline dyes.

**Ninon** \ˈnē-ˌnän\ [prob. fr. F *Ninon*, nickname for *Anne*] (1911) n. A lightweight fabric of silk or manufactured fibers made in a plain weave with an open mesh. Used for curtains and evening wear. NIP: (1) The line or area of contact between two contiguous rollers. (2) A defect in yarn consisting of a thin place.

**NIOSH** *n.* Acronymical abbreviation for National Institute for Occupational Safety and Health, a division of the Center for Disease Control (Public Health Service, under the Department of Health, Education, and Welfare). This agency conducts investigations and research projects on industrial safety and makes recommendations for the guidance of OSHA. However, it does not enforce its own findings or OSHA regulations.

**Nip** \ˈnip\ [ME *nippen*; akin to ON *hnippa* to prod] (14c) *n.* (1) The curved, **V**-shaped gap between a pair of counter-rotating calender rolls, chills rolls, or rubber pull rolls where incoming material is "nipped" and drawn between the rolls. (2) In safety-management parlance, "nip" is broadened to include any convergent approach of two machine elements, such as meshing spur gears or a V-belt approaching its pulley.

**Nip creases** *n.* Creases occurring at regular intervals along a fabric selvage subsequent to a nipping operation such as calendering or padding. Such creases are caused by a loosely wound selvage or improper let-off tension, which allows the fabric to fold over or gather at the selvage prior to entering the nip of the rolls.

**Nip rolls** (pinch rolls) *n.* In film blowing, a pair of rolls situated at the top of the tower that pinch shut the blown-film tube, seal air inside it, and regulate the rate at which the film is pulled away from the extrusion die. One roll is usually covered with a resilient material, the other being of metal and internally cooled.

**NIST** *n.* National Institute of Standards and Technology, Gaithersburg, MD, www.nist.gov. NIST was established (formerly NBS or National Bureau of Standards founded in 1901) is a non-regulatory federal agency with USA Commerce Department's Technology Administration. The NIST (www.nist.gov) is to promote USA innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST carries out its mission in four cooperative programs: the NIST Laboratories, the Baldridge National Quality Program, the Manufacturing Extension Partnership and the Advanced Technology Program.

**Nitrate green** \ˈnī-ˌtrāt-\ *n.* Green pigment made from nitrate lead chrome and ferri-ferro cyanide.

**Nitration** \nī-ˈtrā-shən\ (1887) *n.* Process of chemically adding nitrogen in combination with oxygen to any material.

**Nitriding** (1928) *vt.* A type of case hardening in which a steel surface is reacted for hours or days with gaseous ammonia at temperatures from 480° and 540° to produce a surface hardness of about Rockwell C70 to a depth from 0.2 to 2 mm. The process is used with injection-mold cavities and extrusion screws, being less expensive and less durable with the latter than inlaid hard facing.

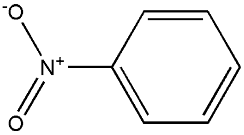
**Nitril** \ˈnī-trəl, ˌtrīl\ [ISV *nitr-* + *-il*, *-ile* (fr. L *–ilis* $^{1}$-ile] (1848) *n.* An organic cyanide containing the group CN which on hydrolysis yields an acid with elimination of ammonia.

**Nitrile barrier resins** (high-nitrile polymer) *n.* One of a family of polymers generally containing greater than 60% acrylonitrile, along with co-monomers such as acrylates, methacrylates, butadiene, and styrene. Both straight co-polymers and co-polymers grafted onto elastomeric spines are available. Their unique property is outstanding resistance to passage of gases and water vapor, making them useful in packaging applications.

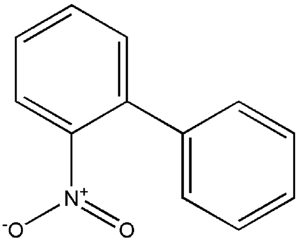
**Nitrile resins** *n.* Used principally in the packaging of foods other than beverages, and in non-food packaging in USA and abroad. The monomer used primarily is acrylonitrile, which provides a good gas barrier, chemical resistance, and taste- and odor-retention properties. Harper CA (2000) Modern plastics encyclopedia. McGraw-Hill Professional, New York.

**Nitrile rubber** *n.* A synthetic rubber obtained by the co-polymerization of acrylonitrile and butadiene, noted for its oil resistance. *See acrylonitrile-butadiene co-polymer.*

**Nitrobenzene** \ˌnī-trō-ˈben-ˌzēn, –ben-ˈ\ [ISV] (1868) *n.* $C_6H_5NO_2$. Mol wt, 123; bp, 210.85°C; mp 5.7°C; Sp gr, 1.1987; flp, 88°C (190°F). Syn: mirbane oil (*See image*).

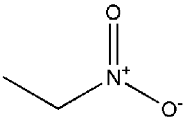


***o*-Nitrobiphenyl** \-(ˌ)bī-ˈfe-nᵊl\ (2-nitrobiphenyl, ONB) *n.* $O_2NC_6H_4–C_6H_5$. An involatile plasticizer for cellulose-ester polymers, and compatible with many others (*See image*).



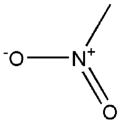
**Nitrocellulose** \-ˈsel-yə-ˌlōs, -ˌlōz\ [ISV] (1882) *n.* Another name for cellulose nitrate. The product obtained by treating cellulose with a mixture of nitric and sulfuric acids. It is primarily used in the coatings industry as a base for lacquers and as a film-forming material widely used in flexographic and gravure inks. *See dope cotton, and pyroxylin. See also lacquer.*

**Nitroethane** *n.* $CH_3CH_2NO_2$. A colorless liquid used as a solvent for cellulosic, vinyl, alkyd, and other resins. Bp, 114°C; flp, 41°C (106°F); mp, 16 mmHg per 20°C; Sp gr, 1.052 per 20°C (*See image*).



**Nitrogen** \ˈnī-trə-jən\ [F *nitrogène*, fr. *niter* + *-gène*, gen] (1794) *n.* Nitrogen gas is the most widely used blowing agent for injection-molded, structural foams. It is less expensive than most chemical blowing agents, leaves no residue, is environmentally harmless, and is easy to handle. Nitrogen is added to the polymer melt by pumping it directly into the barrel of the injection machine. Nitrogen is also used in the same way in foam extrusion.

**Nitromethane** \-ˈme-ˌthān, *British usually* -ˈmē-\ (1872) *n.* $CH_3NO_2$. A colorless liquid made by reacting methane with oxides of nitrogen or nitric acid under pressure, and used as a solvent for cellulosic, vinyl, alkyd, and other resins. Bp, 101°C; flp, 45°C (112°F); vp, 28 mmHg per 20°C (*See image*).

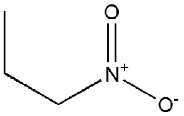


**Nitron** *n.* Cellulose nitrate, manufactured by Monsanto, USA.

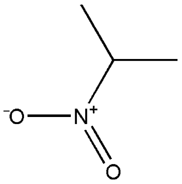
**Nitroparaffins** \-ˈpar-ə-fən\ [ISV] (1892) *n.* Nitrated hydrocarbons, e.g., nitroethane, nitromethane, etc.

**Nitropropane** \-ˈprō-ˌpān\ (1-nitropropane) *n.* $CH_3CH_2CH_2NO_2$. A colorless liquid boiling at 130°C, a good solvent for vinyl resins (*See image*).

Bp, 132°C; flp, 50°C; vp, 7.5 mmHg per 20°C; Sp gr, 1.003 per 20°C.



**2-Nitropropane** *n.* $CH_3CHNO_2CH_3$. Bp, 120°C; vp, 13 mmHg per 20°C; flp, 40°C; Sp gr, 0.992 per 20°C (*See image*).



**Nitroso rubber** *n.* A co-polymer of tetrafluoroethylene and trifluoronitrosomethane.

**nm** *n.* Abbreviation for nanometer.

*See Angstrom unit.*

**NMA** *n.* (1) Abbreviation for methyl nadic anhydride. (2) Abbreviation for *N*-methyl acetamide.

**NMR** *n.* A technique for characterization of organic molecules. Abbreviation for nuclear magnetic resonance.

**Noble gas** (1902) *n.* A member of group 0 in the periodic table. Any of a group of rare gases that include helium, neon, argon, krypton, xenon, and sometimes radon and that exhibit great stability and extremely low reaction rates.

*Also known as inert gas.*

**NODA** *n.* Abbreviation for *n*-octyl-*n*-decyl adipate.

**Nodal points** *n.* Two points on the axis of a lens such that a ray entering the lens in the direction of one, leaves as if from the other and parallel to the original direction. A *normal salt* is an ionic compound containing neither replaceable hydrogen nor hydroxyl ions. A *normal solution* contains 1 g molecular weight of the dissolved substance divided by the hydrogen equivalent of the substance (i.e., 1 g equivalent) per liter of solution. Moller KD (2003) Optics. Springer-Verlag, New York.

**Node** \ˈnōd\ [ME, fr. L *nodus* know, node; akin to MI *naidm* bond] (15c) *n.* (1) A characteristic of flax and hemp fibers, giving them a bamboo-like appearance under the microscope, seen in no other fiber. In flax, the nodes are fairly regularly spaced at intervals of about 0.5 mm. (2) In a vibrating body, a point, line, or surface, which is wholly or mostly free of vibration and appears to be at rest.

**NODP** *n.* Abbreviation for *n*-octyl-*n*-decyl phthalate.

**NODTM** Abbreviation for tri(*n*-octyl-*n*-decyl) trimellitate.

**Noil** \ˈnói(ə)l\ (ca. 1624) *n.* A short fiber that is rejected in the combing process of yarn manufacture.

**Nomenclature** \ˈnō-mən-ˌklā-chər\ [L *nomenclatura* assigning of names, from *nomen* + calatus, pp of *calare*] (1610) *n.* The names of chemical substances and the systems used for assigning them. Progress in polymer science and technology: 2002 IUPAC world polymer congress, Beijing, China, July 7–12, 2002. John Wiley and Sons, New York. IUPAC handbook, 2000–2001. International Union of Pure and Applied Chemistry, Oxford, England, 2000.

**Nomex** Polyamide from iosphthalic acid + *m*-phenylene diamine. Manufactured by DuPont, USA.

**Non-aqueous dispersion (NAD)** The solvent analog of a latex: the polymer is dispersed in a volatile organic liquid which is not a solvent for the polymer. NAD's have much higher solids than conventional high molecular weight solvent coatings. Like latices, the viscosity is independent of the molecular weight as opposed to solvent soluble resins.

**Non-break oil** See break free or non-break oil.

**Non-combustible** Incapable of being ignited and burned in air; fire-resistance; preferred to incombustible by fire authorities.

*See flammability.*

**Non-convertible coating** Film-former which, after being deposited from a solution, dries to give a film which can be redissolved in a solvent from which it was originally deposited.

*See also convertible coating.*

**Non-destructive test** (1) A test that yields information about failure under mechanical stress without actually stressing to failure. (2) More broadly, any test to evaluate a property of a material, part, or structure that does not significantly damage the part. Techniques used include ultrasound, magnetic inspection of metals and welds, X-ray inspection, infrared, nuclear magnetic resonance, and sonic analysis. Although an indentation-hardness test leaves a permanent mark, in many tests of parts it is non-destructive.

**Non-drying coating** Coating that does not dry in the course of a regular schedule.

*See grease paint.*

**Non-drying oils** Oil which does not of itself possess to a perceptible degree the power to take up oxygen from the air and lose its liquid characteristics.

*Also known as fixed oil.*

**Non-elastic woven tape** A woven narrow fabric, weighing less than 15 oz/yard$^2$, made principally of natural and/or manufactured fibers, including monofilaments, but not containing rubber or other similar elastic stands.

**Non-electrolyte** \ˌnän-ə-ˈlek-trə-ˌlīt\ (1891) *n.* A solute, which does not dissociate into ions in solution. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Non-flammable** \-ˈfla-mə-bəl\ (1915) *adj.* If combustible, burning without flame. Practically, whether or not a plastic material or part is "flammable" is a matter of its performance in a test – of which there are many – of flammability. Note that the word "inflammable" has been deprecated by fire-safety authorities because of the ambiguity of the prefix "in-", and has long been superseded by "flammable" and "non-flammable". Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997.

**Non-grain-rising stain** One of many liquid wood stains, based on alcohol or other solvent; almost totally free of water. Abbreviation is NGR.

**Non-ionic** \-(ˌ)ī-ˈä-nik\ (1929) *adj.* Pertaining to the material, atom, radical, or molecule that is incapable of being electrically charged.

*See also ionic.*

**Non-ionic surfactants** Those, which contain hydrophilic groups, which do not ionize appreciably in aqueous solutions. Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York. McCutcheon's emulsifiers and detergents (2000) North American edition, vol 1. McCutcheon Division of McCutcheon Publishing Co., NJ. Ash M, Ash I (2000) Industrial surfactants. Synapse Information Resources, New York.

**Non-isothermal** *See isothermal.*

**Non-metal** \-ˈme-tᵊl\ (ca. 1864) *n.* An element with generally low electrical and thermal conductivities, dull luster, and a high ionization energy, electron affinity and electronegativity.

**Non-metameric match** \-ˈme-tə-ˌmer-ik-\. A pair of colors, which appear to be identical to all observers under all conditions of illumination and viewing; an unconditional match. Popularly, the term is frequently used to apply to a pair of colors, which has identical spectrophotomeric reflectance or transmittance curves, as measured in a prescribed geometric configuration, thus ignoring the effects of any differences in geometric characteristics between the samples in the pair. In practice, the term may be used to describe a pair of samples, which does not appear to change in comparison to one another when viewed under several different light sources. McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See metamerism. Also known as a non-conditional match.*

**Non-Newtonian** Designating liquids whose viscosities are dependent on the rate of shear (as well as temperature and pressure), or the glow of such a liquid.

*See Newtonian liquid, pseudoplastic fluid, and viscosity.*

**Non-Newtonian liquid** Any liquid that exhibits a viscosity which varies with changing shear stress or shear rate; thus, any liquid which does not satisfy the requirements for a Newtonian liquid, i.e., that displays plastic, pseudoplastic, or dilatant flow characteristics. Most paints are non-Newtonian liquids.

**Non-Newtonian oil or fluid** A fluid that exhibits a viscosity, which varies with changing shear stress or shear rate.

**Non-penetrating stain** *See oil stain.*

**Non-polar** \ˌnän-ˈpō-lər\ (1892) *adj.* Having no concentrations of electrical charge on a molecular scale, thus incapable of significant dielectric loss. Examples of non-polar resins are polystyrene and polyethylene.

**Non-polar covalent bond** A covalent bond in which the bonding electron pair is shared equally between atoms of identical electronegativity.

**Non-polar molecule** A molecule in which the centers of positive and negative charge coincide.

**Non-polar solvents** The aromatic and petroleum hydro-carbon groups characterized by low dielectric constants are referred to as non-polar solvents.

**Non-rigid plastic** (as given by ASTM D 883). For the purpose of general classification, a plastic that has a modulus of elasticity either in flexure or tension of not over 70 MPa (10,000 psi) at 23°C and 50% relative humidity when tested in accordance with ASTM D 638, D 747, D 790, or D 882.

*See also rigid plastic.*

**Non-scratch inks** Inks, which have high abrasion and mar-resistance when dry.

**Non-skid paint** See anti-slip paint.

**Non-specular reflectance** Reflectance other than the "mirror" reflectance that occurs at the angle equal and opposite to the incident angle; diffused reflectance.

*See specular reflectance excluded, reflectance, diffuse, and fresnel reflection.*

**Non-toxic materials** The toxicity status of resins and additives used for food contact and packaging changes frequently, and in many cases percentages and conditions of end use are stipulated. Therefore, we do not attempt to list such materials here. The current statuses of resins, plasticizers, stabilizers, and other additives with respect to their permissible use in contact with food ("indirect additives") are spelled out in detail in the Code of Federal Regulations (CFR), Title 21 (Food and Drugs), Parts 173–184. The Code is reprinted annually in book form and updated weekly by the Federal Register, where one should check for the latest word on any particular substance.

**Non-volatile matter** Ingredients of a coating composition, which after drying, are left behind on the material to which it has been applied, and which constitute the dry film. The term also applies to coatings components such as varnishes, resins, solvents, thinners, and diluents, driers and additives, etc. Abbreviation is NVM.

*Known also as solids and total solids.*

**Non-woven fabric** An assembly of textile fibers held together by mechanical interlocking in a random web or mat, by fusing of the fibers (in the case of thermoplastic fibers), or by bonding with a cementing medium such as starch, glue, casein, rubber, latex, or one of the cellulose derivatives or synthetic resins. Initially, the fibers may be oriented in one direction or may be deposited in a random manner. This web or sheet of fibers is bonded together by one of the methods described above. Normally, crimped fibers that range in length from 0.75 to 4.5 in. are used. Non-woven fabrics are used for expendable items such as hospitable sheets, napkins, diapers, wiping, and cloths, as the base material for coated fabrics, and in a variety of other applications. They can also be used for semi-disposable items and for permanent items such as interlinings. Tortora PG, Merkel RS (2000) Fairchild's dictionary of textiles, 7th edn. Fairchield Publications, New York.

**Non-woven mat** A mat of glass fibers in random arrangement, lightly bonded so as to be able to be handled and cut, used in making reinforced-plastics structures.

**Non-woven scrim** An open-mesh glass fabric in which two or more layers of parallel yarns are bonded to each other by chemical or mechanical means, the yarns in adjacent layers lying at an angle to each other.

**Nor-** A prefix for organic compounds indicating the parent compound from which the subject compound may be derived, usually by removal of one or more carbon atoms and their attaché hydrogens. Example: *norcamphor* is camphor from which three $-CH_3$ groups have been removed.

**Norbornene-spiro-orthocarbonate** A compound that, when added in small concentrations to matrix resin of carbon composites, apparently strengthens the fiber-matrix interfacial bond, as evidenced by improved strength properties and lower water absorption of the composites.

**Norelac resins** Particular type of nylon resin in which the polymeric acids are those derived from drying oil fatty acids. These products differ from the true nylon resins in that they are much more soluble in solvents, and can be used as constituents of varnishes which possess air-drying properties.

**Normal boiling point** The boiling point of a substance at 1 atm pressure.

**Normal color vision** Vision of a normal observer who exhibits no symptoms of anomalous or defective color response.

**Normal covalent bond** A covalent bond in which one of the shared electrons appears to have been contributed by the first bonded atom, the other by the second. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Normal freezing point** The freezing point of a substance at 1 atm pressure.

**Normal hydrocarbon** A hydrocarbon whose skeletal carbon chain is unbranched.

**Normality (*N*)** [L *normalis*, fr. *norma*] (ca. 1696) *n.* A concentration unit: the number of equivalents of solute per liter of solution.

**Normal lead silico chromate** Normal lead chromate (medium shade) formed as a strongly adherent coating on a core of silica at a 50/50 weight ratio. Its major use is in traffic paints in which its lower density and lower cost are advantageous compared to pigmentations of pure lead chromate and extender. Density, 3.6 g/cm$^3$ (29.2 lb/gal); O.A., 14; particle size, 5 µm. Syn: normal lead chromate coated, silica cored pigment. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996. Gooch JW (1993) Lead based paint handbook. Plenum Press, New York.

**Normal salt** *n.* An ionic compound containing neither replaceable hydrogen nor hydroxyl groups.

**Normal solution** (1 N solution) *n.* A solution containing a mass of the dissolved substance per liter equal to 1 mol divided by the hydrogen equivalence of the substance, i.e., 1 g-equivalent per liter.

**Normal stress** *n.* (1) A stress directed at right angles to the area upon which it acts. (2) In a flowing viscoelastic liquid, tensile/compressive stresses at any point in the fluid in the principal coordinate directions, one of which will be the main direction of flow. Rheologists are usually concerned with *differences* between normal stresses acting in the flow direction and directions perpendicular to the flow.

**North light** (14c) *n.* Light from the north sky, generally through a window so located as to allow only light from the north to enter the room. Because such light is the more constant throughout the day than light from other directions, it was and is preferred by artists, colorists, etc. for viewing color. Artificial north light has been simulated with modern lamps and filters for the same purpose.

*See daylight.*

**North standard** *See NS.*

**Noryl®** *n.* Poly(phenylene oxide). Trade name for a family of blends of polyphenylene oxide (PPO) with much less costly styrenic polymers. These blends have the processability, low water absorption, and good dielectric properties associated with polystyrene, while the PPO contributes heat resistance. Glass-reinforced grades are available. Manufactured by General Electric, USA.

**Noryl resins** *n.* Blends of poly-(2,6-dimethyl-1,4-phenyl oxide) with polystyrene or with high impact polystyrene.

**Notch sensitivity** *n.* The extent to which a material's tendency to fracture under load, particularly an impact load, is increased by the presence of a surface in homogeneity such as a notch or sharp inside corner, a sudden change in section thickness, a crack, or a scratch. Low notch sensitivity is usually associated with ductility, while brittle materials exhibit higher notch sensitivity. Most engineers and physical testers consider the notched Izod and Charpy impact tests to be as much measures of notch sensitivity as they are of pure impact strength.

**Novacite** *See silica, microcrystalline.*

**Novaculite** \nō-ˈva-kyə-ˌlīt\ [L *novacula* razor] (1796) *n.* A very fine-grained type of quartz found in Arkansas, Georgia, Massachusetts, North Carolina, Oklahoma, and Tennessee. A variety known as *altered novaculite*, typically about 99.5% quartz, is a solid crystalline substance with the basic hardness of quartz but more easily reduced to very fine particles. At their surfaces, these particles have high concentrations of ruptured Si–O bonds that readily combine with water to create surface hydroxides called *silanols*. Such novaculites are useful as semi-reinforcing filers in silicone rubber, epoxy resins, urethane foams, and PVC.

**Novelty siding** *See drop siding.*

**Novelty yarn** A yarn produced for a special effect. Novelty yarns are usually uneven in size, varied in color, or modified in appearance by the presence of irregularities deliberately produced during their formation. In singles yarns, the irregularities may be caused by inclusion of knots, loops, curls, slubs, and the like. In plied yarns, the irregularities may be affected by variable delivery of one or more yarn components or by twisting together dissimilar singles yarns. Nub and slub are the examples of novelty yarns.

**Novodur** ABS polymer. Manufactured by Bayer, Germany.

**Novolac (novolak)** According to ASTM D 883, a novolac is a phenolic-aldehyde resin, which, unless a source of methylene groups is added, remains permanently thermoplastic. For a preferred definition, *see phenolic novolac*. However, the term is also used in connection with epoxies. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers Inc., New York.

*See epoxy-novolac resin.*

**Novolak** Phenol/formaldehyde condensate. Phenolic-aldehydic resin, which, unless a source of methylene groups is added, remains permanently thermoplastic. Manufactured by Dynamit Nobel, Germany.

*See also resinoid and thermoplastic.*

**Novoloid fiber** A phenolic fiber made by cross-linking a melt-spun novolac resin with formaldehyde. Novoloid fibers have good flame resistance, can serve at temperatures to about 220°C, and are used as reinforcement in a range of thermosetting matrices.

**Nozzle** \ˈnä-zəl\ [dimin. of *nose*] (1683) *n.* In injection or transfer molding, the orifice-containing fitment at the delivery end of the injection cylinder or transfer chamber that contacts the mold's sprue bushing and conducts the softened resin into the mold. The nozzle is shaped to form a seal under pressure against the sprue bushing. Its orifice is tapered and sometimes contains a check valve to prevent flow reversal, or an on/off valve to interrupt the flow at any desired point in the molding cycle.

**Nozzle manifold** A series of injection nozzles mounted on a common feed tube, each nozzle positioned so as to feed a single cavity in the mold. Such manifolds have been used to eliminate runners in molds when molding articles such as cups and when it is desired to gate the cavities at the centers of the cup bottoms.

**Nozzle, mold-gating** In injection molding, a nozzle whose tip is part of the mold cavity, thus feeding material directly into the cavity, eliminating the sprue and runner.

**NPCA** Abbreviation for National Paint and Coatings Association.

**NPIRI** Abbreviation for National Printing Ink Research Institute.

**NR** Abbreviation for natural rubber.

*See rubber, natural and polyisoprene.*

**$N_{Re}$** Symbol for Reynolds number.

**NS** Abbreviation for north standard, used as a dimension in the measurement of the fineness of dispersion (fineness of grind is deprecated).

*See fineness of dispersion.*

**Nsa-Sana oil** See essang oil.

**n-Type semiconductor** A semiconductor in which the charge carriers are weakly bound electrons.

**Nubs** \ˈnəb(s)\ [alter. of E dialect *knub*, prob. fr. LG *knubbe*] (1727) *n.* Size grading of natural resins, about the size of the end of a finger.

**Nub yarn** A novelty yarn containing slubs, beads, or lumps introduced intentionally.

**Nuclear atom** The atom of each element consists of a small dense nucleus, which includes most of the mass of the atom. The nucleus is made up of roughly equal numbers of neutrons and protons. The positive charges of the protons, enables the nucleus to surround itself with a set of negatively charged electrons which move around the nucleus in complicated orbits with well defined energies. The outermost electrons, which are least tightly bound to the nucleus play the dominant part in determining the physical and chemical properties of the atom. There are as many electrons in orbits as there are protons in the nucleus.

**Nuclear fusion** *See fusion.*

**Nuclear isomers** Isotopes of elements having the same mass number and atomic number but differing in radioactive properties such as half-life period.

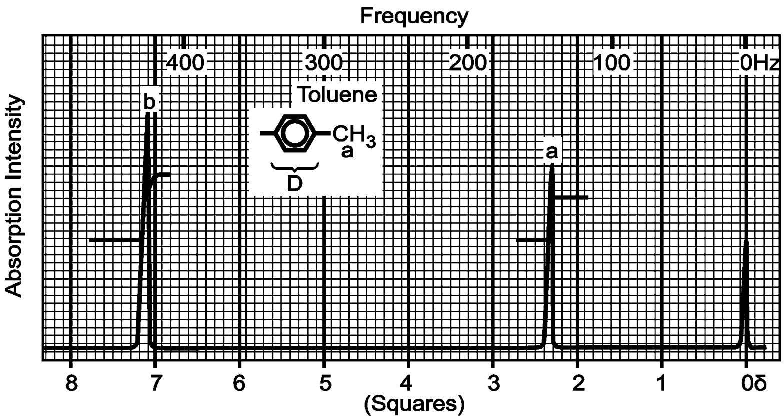
**Nuclear magnetic resonance (NMR)** (1942) *n.* The spinning motion of atomic nuclei imparted by an alternating, high-frequency magnetic field. The phenomenon is the basis for an analytical method enabling identification and quantification of isotopes. NMR spectroscopy has been used to study the distribution of hydrogen in substituent groups, and the molecular structure of polymers, such as tacticity and occurrence of infrequent branches. Proton and $^{13}$C NMR technologies have been developed for different purposes. An example of an $^{1}$H NMR spectrum of toluene is shown. Bovey FAA, Mirau PA (1996) NMR of polymers. Elsevier Science and Technology Books, New York.

**Nucleating agent** A chemical substance which, when incorporated in crystal-forming plastics, provide active centers (nuclei) for the growth of crystals as the melt is cooled through the melting range. In polypropylene, for example, a higher degree of crystallinity and more uniform crystalline structure is obtained by adding a nucleating agent such as adipic or benzoic acid or certain of their metal salts. Colloidal silicas are used as nucleating agents in nylon, seeding the polymer to produce more uniform growth of spherulites.

**Nucleation** \ˈnu-klē-ˌāt, ˈnyü-\ [LL *nucleates*, pp of *nucleare* to become stony, fr. L *nucleus*] (ca, 1864) *v.* The formation of short-range ordered polymer aggregates in a melt or solution, which acts as growth centers for crystallization.

**Nucleon** \ˈnu-klē-ˌān\ [ISV] (1923) *n.* A particle in the nucleus of an atom; a proton or a neutron.

**Nucleophile** \ˈnu-klē –ə-ˌfīl\ (1943) *n.* An electron-rich atom or group of atoms,



$^{1}$H-NMR spectrum of toluene

which seeks to share its electrons with a relatively positive atom.

**Nucleic acid** \nü-ˈklē-ik-\ [fr. their occurrence in cell nuclei] (1892) *n.* A family of macromolecules, of molecular masses ranging upward from 25,000, found in the chromosomes, nucleoli, mitochondria, and cytoplasm of all cells, and in viruses; in complexes with proteins, they are called nucleoproteins. On hydrolysis they yield purines, pyrimidines, phosphoric acid, and a pentose, either D-ribose or D-deoxyribose; from the last, the nucleic acid derive their more specific names, ribronucleic acid and deoxyribonucleic acid. Nuclear acids are liner (i.e., unbranched) chains of nucleotides in which the 5′-phosphoric group of each one is esterified with the 3′-hydroxyl of the adjoining nucleotide. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

**Nucleus** \ˈnü-klē-əs\ nulcei \-klē-ˌī\ [NL fr. L, kernal, dim. of *nuc*-, *nux* nut] *n, pl.* The dense central core of the atom, in which most of the mass and all of the positive charge is concentrated. The charge on the nucleus, an integral multiple of $Z$ of the electronic charge, is the essential factor, which distinguishes one element from another. $Z$ is called the atomic number and gives the number of protons in the nucleus, which includes a roughly equal number of neutrons. The mass number $A$ gives the total number of neutrons plus protons. *See isotopes and nuclear atom.*

**Nuclide** \ˈnü-ˌklīd\ [*nucl*eus + Gk *eidos* form, species] (1947) *n.* A species of atom distinguished by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, $Z$; number of neutrons, $N$; and energy content (or, by the atomic number, $Z$; mass number $A$ $(= N + Z)$ and atomic mass).

**Number-average molecular weight ($M_n$)** *n.* The sum of the molecular weights of all the individual molecules in a given polymer sample divided by the total number of molecules. The defining equation is

$$M_{\mathrm{n}} = \sum n_i M_i / \sum n_i = \sum w_i / \sum (w_i/M_i),$$

where $n_i$ is the number of molecules with molecular weight $M_i$, $w_i$ the weight fraction of material having molecular weight $M_i$; $\Sigma n$ is the total number of molecules and, Weight-average $M_{\mathrm{w}}$

$$M_{\mathrm{w}} = \sum w_i M_i / \sum w_i.$$

$Z$-average $M_z$

$$M_z = \sum wiM_i^2 / \sum w_i M_i.$$

Methods of determining molecular weight include osmotic pressure, light scattering, gel permeation chromatography, dilute solution viscosity, vapor pressure, freezing temperatures, and others. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York.

*See also molecular weight, molecular-weight distribution, and weight-average molecular weight.*

**Numerical aperture** *n.* The numerical aperture of a lens system (objective or condenser) is the sine of one-half the angular aperture times the refractive index of the medium (1.0 for air, 1.515 for Cargille immersion oil, etc.) between objective and specimen. The numerical aperture is a measure of the light gathering capacity of the lens system and determines its resolving power and depth of field.

**Nun's veiling** *n.* A soft, lightweight, plain-weave fabric that usually comes in black and white, nun's veiling is a rather flimsy, open fabric but always of high quality. It may be made from fine woolen yarn or yarns spun from manufactured fibers such as nylon, acrylic, or polyester.

**Nurnbert** *See mineral violet.*

**Nutshell flour** *n.* Ground peanut or walnut shells, dried by heating or solvent extraction, have been used as low-cost fillers in olyethylene. Physical properties are comparable to those of PE filled with wood flour.

**NV** *n.* Abbreviation for non-volatile matter.

**NVM** *n.* Abbreviation for non-volatile matter.

**Nylon** \ˈnī-ˌlän\ [coined word] (1938) (polyamide) *n.* Generic name for all long-chain polyamides that have recurring amide groups (–CONH–) as an integral part of the main polymer chain. Nylons are synthesized from intermediates such as dicarboxylic acids, diamins, amino acids and lactams, and are identified by dual numbers denoting the number of carbon atoms in the polymer chain derived from specific constituents, that of the diamine being given first. Use of a single numeral signifies that the monomer was a lactam, as in *nylon 6*. The second number, if used, denotes the number of carbons derived from a diacid. For example, in nylon 6/6 the two numbers are the numbers of carbon atoms in hexamethylene diamine and adipic acid, respectively. However, in the literature these numbers may otherwise appear as 66, 6.6, 6,6, or 6-6, and sometimes precede, rather than follow, the word "nylon". The convention used here – numbers following, divided by slash mark – is almost universally used today. Nylon molding powders can be converted to useful products by injection molding, extrusion, and blow molding. Nylons are crystalline polymers. In nylon 6/6, a wide range of crystallinity is possible, depending on how quickly the melt is chilled and the presence or absence of nucleating agents. Injection-molded items normally have low-crystallinity skins with higher-crystallinity interiors. Very thin sections may have as little as 10% crystalline material. Finely powdered forms of nylon are available for fluidized-bed coating, rotational molding, and other powder processes. A casting process employs molten caprolactam monomer to which catalysts are added, polymerization occurring in the mold after pouring without additional heat or pressure. Large solid castings and rotationally cast parts have been made by this method. In 1992, USA production of nylon plastics was about 270 Gg (300,000 tons). Polyamides are not commercially available in so many filled and reinforced varieties that *Modern Plastics Encyclopedia's* "Resins and Compounds" table for 1993 contained eight pages of polyamide listings, far more than for any other plastics family. Various types of nylons are described in the immediately following listings. Manufactured by DuPont, USA. Modern plastics encyclopedia. McGraw-Hill/Modern Plastics, New York, 1986-, 1990-, 1992-, and 1993-editions.

*See also interfacial polymerization and polycyclamide.*

**Nylon ("Zytel ST")** *n.* A DuPont rubber-toughened nylon, identified by the initials standing for *super-tough*, claimed to be the most rugged engineering resin then (1977) available. It is superior to polycarbonate in impact strength, with notched Izod = 9 J/cm ($17\ \text{ft-lb}_f/\text{in.}$).

**Nylon-3** (polypropiolactam) *n.* A type of nylon that has been prepared and explored experimentally, but has not become commercial.

**Nylon-4** (polypyrrolidinone) *n.* A polymer of 2-pyrrolidinone. Early attempts to commercialize nylon-4 failed because much of the material was of low molecular weight and decomposed at a relatively low temperature, making it unusable for melt spinning. Improved catalyst systems resulted in a polymer with a molecular weight ($M_n$) of about 400,000 and a melting point of 256°C. Today's nylon-4 has better heat stability than other nylons. Its moisture absorption is higher than that of nylon-6 and 6/6. It can be molded and extruded. Artificial leathers have been made from slurries of nylon-4 fibers.

**Nylon-4/6** (polytetramethylenediamineadipamide) *n.* A condensation polymer of diaminobutane and adipic acid that melts higher than nylon 6/6 so it can be used at somewhat higher temperatures than the latter.

**Nylon-5** *n.* A blend of aliphatic-, cycloaliphatic-, and aromatic-based polyamides. The material is clear in thick cross-sections, has low water absorption, good dimensional stability and solvent resistance, and can be processed economically in injection molding or extrusion.

**Nylon-6** (polycaprolactam) *n.* A type of nylon made by the polycondensation of caprolactam, the second-most widely used polyamide in the USA. Melting at about 228°C, it is used for fibers, including tire cord, and as a thermoplastic molding powder. Nylon-6 is as structurally sound as type 6/6 at room temperature, but it picks up moisture more rapidly and loses strength more rapidly as humidity and temperature increase. It is available in many grades, including glass–fiber-filled, and in a broad range of molecular weights, suitable for injection molding, extrusion, blow molding, and rotational molding. Parts can be machined, welded, and adhesive-bonded.

**Nylon-6/6** (polyhexamthyleneadipamide) *n.* A type of nylon made by condensing hexamethylenediamine with adipic acid, first prepared by W. H. Carothers of DuPont in 1936. It is the leading commercial polyamide, being used extensively for staple fibers and monofilaments, and is the most widely used type in other applications. The bulk polymer is a tough, white, translucent, crystalline material that melts rather sharply near 269°C. Nylon 6/6 is the strongest of the nylons over the widest range of temperature and humidity, but absorbs up to 2% water from air in the normal range of climatic humidity. Water acts as a plasticizer, reducing moduli but improving impact resistance and flex life in humid environments, with opposite effects in arid ones. During molding and extrusion, moisture content must be less than 0.1%.

**Nylon-6/6 salt** (hexamethylenediammonium adipate) *n.* An intermediate in the manufacture of nylon-6/6, formed from one molecule each of adipic acid and hexamethylene diamine.

**Nylon-6/T** *n.* Terephthalic acid + hexamethylene diamine (polyhexamethyleneterephthalamide). A major member of an aliphatic-aromatic family of polyamides, none of which have gained commercial importance because they are difficult to prepare and to process. Manufactured by Celanese, USA.

**Nylon-6, thermal degradation of** *n.* When exposed to elevated temperatures, unmodified nylons undergo molecular weight degradation, which results in loss of mechanical properties. The degradation process is highly time–temperature dependent.

**Nylon 6/10** (polyhexamethylenesebacamide) *n.* The product of condensation of Hexamethylenediamine with sebacic acid, used for brush bristles and monofilaments. It has lower water absorption and lower melting point than nylon 6 or 6/6. When a small amount of an alkyl-substituted hexamethylenediamine is added to the condensation mixture, a more elastic polymer known as *elastic nylon* is obtained.

**Nylon-6/12** (polyhexamethylenedodecanamide) *n.* A nylon introduced by DuPont in 1970, made from hexamethylenediamine and a carbon-12 dibasic acid. Nylon-6/12 is characterized by retention of physical and electrical properties over a wide humidity range, good dimensional stability, and low moisture absorption.

**Nylon-7** (polyenantholactam, polyheptanamide) *n.* A type of nylon known commercially in Russia as "Enant", but not yet commercial in the USA. Its properties are similar to those of nylon-6.

**Nylon-8** (polycapryllactam, polyoctanamide) *n.* A nylon made by condensation polymerization from capryllactam. Its low melting temperature (200°C) and high cost of starting materials have limited the utilization of this polymer. It should not be confused with a type of nylon long marketed as "Type-8", which is actually a chemically modified nylon-6/6.

**Nylon-9** (polypelargonamide, polynonanamide) *n.* A type of nylon made by melt condensation of aminopelargonic acid (9-aminononanoic acid). Nylon-9 has tensile yield and flexural strengths approaching those of nylon-6, having low water absorption like those of nylons 11 and 12. It is, however, in limited use.

**Nylon-10** *n.* An experimental polymer prepared, with difficulty, from aminodecanoic acid.

**Nylon-11** (polyundecanamide) *n.* A type of nylon produced by polycondensation of the monomer 11-aminoundecanoic acid, a derivative of castor oil. It is available in the form of fine powders for rotational molding and other powder processes; and in pellet form for extrusion or molding. Like nylon-12, nylon-11 has properties intermediate between those of nylon-6 and polyethylene: good impact strength, hardness, and abrasion resistance, but other mechanical properties are lower than those of most other nylons. However, due to its exceptionally low water absorption, the dimensional stability of nylon-11 is high. A modified nylon-11 trade named Rilsan N is flexible, transparent, and self-extinguishing.

**Nylon 12** (polylauryllactam, polydodecanamide) *n.* A nylon made by the polymerization of lauric lactam (dodecanoic lactam) or cyclododecalactam, with 11 methylene groups between the linking –CONH– groups in the polymer chain. Its mechanical properties are intermediate between those of conventional nylons and polyethylene, and it is the lowest in water absorption (1.5%) and density (1.01 g/cm$^3$) of all the nylons.

**Nylon fiber** *n.* Generic name for a manufactured fiber in which the fiber-forming substance is any long-chain synthetic polyamide having recurring amide groups (–CONH–) as an integral part of the polymer chain, with less than 85% of the amide groups bonded directly to aromatic rings (if more than 85%, it's considered to be a polyamide). Nylon was the first fiber of major commercial importance to be made of wholly synthetic material. Carothers' pioneering research in 1929 culminated in DuPont's introduction of nylon hosiery in 1940. Characteristics: although the properties of the nylons described above vary in some respects, they all exhibit excellent strength, flexibility, toughness, elasticity, abrasion resistance, washability, ease of drying, and resistance to attack by insects and microorganisms. End uses: nylon is used for apparel such as stockings, lingerie, dresses, bathing suits, foundation garments, and wash-and-wear linings; for floor coverings; for tire cord and industrial fabrics; and in-home furnishings such as upholstery fabrics.

**Nylon monofilament** *n.* Single strands much larger in diameter than those of staple fiber, used for fishing leaders and lines, brush bristles, racket strings, surgical sutures, and ropes.

**Nylon MXD/6** (poly-*m*-xylyleneadipamide) *n.* A type of nylon with lower elongation at break than nylon-6 or 6/6, but capable of attaining their properties by reinforcement with glass fibers. The resin has low melt viscosity, good flexural strength and modulus, and resists alkalies and hydrolytic degradation.

**Nylon, nucleated** *n.* A nylon polymerized in the presence of a nucleating agent, e.g., about 0.1% of finely dispersed silica, which promotes the growth of spherulites and controls their number, type, and size. Nucleated nylons have higher tensile strength, flexural modulus, abrasion, resistance, and hardness, but lower impact strength and elongation than their unnucleated counterparts.

**Nylon resins** *n.* Polyamide resins made from the interaction of diamines and dicarboxylic acids. Hexamethylene diamine and adipic acid are typical reactants. These resins are composed principally of a long-chain synthetic polymeric amide, which has recurring amide groups as an integral part of the main polymer chain.

**Nylons** *n.* Nylons are one of the most common polymers used as a fiber. Nylons are also called polyamides, because of the characteristic amide groups in the backbone chain. Nylon is a DuPont trade mark.

**Nylon salt** *n.* Any of the intermediates in nylon synthesis formed by the combination of one molecule of diamine and one of diacid, such as nylon-6/6 salt.

**Nylon, transparent** *n.* Any of several nylon polymers based on aromatic ring units. The first such nylon, introduced in the early 1970s by Dynamit Nobel under the trade name Trogamid T, was made by polycondensation of terephthalic acid with 2,2,4-trimethylhexamethylenediamine. This crystal-clear, amorphous polyamide has excellent resistance to stress cracking and a glass-transition temperature comparable to those of polycarbonates.

**Nylsuisse** *n.* Adipic acid + hexamethylene diamine, manufactured by Viscose-Suisse, Switzerland.

**Nytril fiber** *n.* A manufactured fiber containing at least 85% by weight of a long chain polymer of vinylidene dinitrile [$-CH_2-C(CN)_2-$] and having the vinylidene dinitrile group in no less than every other unit in the polymer chain (FTC definition). Nytril fibers have a low softening point so they are most commonly used in articles that do not require pressing such as sweaters and pile fabrics. They are also blended with wool to improve shrink resistance and shape retention.

# O

**o-** \ˈō\ *n.* Abbreviation for prefix *ortho-* and ignored in alphabetizing compound names.

**O** Chemical symbol for the element oxygen.

**O.A** Abbreviation for oil absorption.

**Oak varnish** Short oil type of varnish for interiors use, normally based on natural copals.

**Oatmeal** \ˈōt-ˌmēl\ *n.* A heavy, soft linen fabric with a pebbled or crepe effect.

**Object color** *n.* Color of light reflected by an object as normally observed, as contrasted to other types of observed color. Saleh BEA, Teich MC(1991) Fundamentals of photonics. John Wiley and Sons, New York.

*See object mode of appearance.*

**Object mode of appearance** *n.* Mode of perceiving the appearance of tangible objects as located at a particular place; object mode includes two of the five recognized modes of appearance, that of surfaces and of bulk volume.

*See modes of appearance.*

**Objet d'art** \ˌób-ˌzhā-ˈdär\ [F, literally, art object] (1865) *n.* Any object of artistic merit. A curio. Gair A(1996) Artist's manual. Chronicle Books LLC, San Francisco.

**Obliterating power** *See opacity.*

**OBP** Abbreviation for octyl benzyl phthalate.

**Observation angle** *n.* (1) The angle between the incident ray measured relative to the perpendicular or normal and the viewing angle, also measured relative to the normal; therefore, the total subtended angle between incident and viewing. It is the same as "bend angle" in the literature relating to projection screens, and as "divergence angle" in some federal and military specifications. (2) It is synonymous with viewing angle.

**Observer** \əb-ˈzər-vər\ (ca. 1550) *n.* The human viewer who receives a stimulus and experiences a sensation from it. In vision, the stimulus is a visual one and the sensation is an appearance.

**Observer, standard** *n.* The spectral response characteristics of the average observer defined by the CIE. Two such sets of data are defined, the 1931 data for the 2° visual field (distance viewing) and the 1964 data for the annular 10° visual field (approximately arm's length viewing). By custom, the assumption is made that if the observer is not specified the tristimulus data has been calculated for the 1931, or 2° field observer. The use of the 1964 data should be specified.

**OBSH** *n.* Abbreviation for 4,4′-oxybis(benzenesulfonyl-hydr-azide).

**Obtuse bisectrix ($Bx_o$)** *n.* The angle supplementary to the acute optic axial angle of a biaxial crystal is obtuse and is bisected by the obtuse bisectrix, which may be either α or γ. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. CRC Press, Boca Raton, FL.

**OCCA** *n.* Abbreviation for Oil and Colour Chemists' Association (British).

**Occupational safety and health act (OSHA)** *n.* According to this Act of 1970, inspectors may at any time or when requested by an employee, examine any company for violations of occupational safety and health standards set by the act.

**Ocher, ochre (yellow, golden, and red)** \ˈō-kər\ [ME *oker* fr. MF *ocre*, fr. L *ochra*, fr. Gk *ōchra*, fr. feminine of *ōchros* yellow] (14c) *n.* There are two types of ocher: (1) Synthetic. (2) Natural (a naturally occurring yellow-brown hydrated iron oxide). Synthetic ocher possesses little advantage over the natural earth pigments, the difference being the method of manufacture. Natural

ocher is found in France, Italy, Spain, Africa, Great Britain, and USA.
*See iron oxide.*

**OCR inks** n. *See optical character recognition inks.*

**Octabis(2-hydroxypropyl) sucrose** A viscous, straw-colored liquid used as a cross-linking agent for urethane foams and as a plasticizer for cellulosics.

**Octahedral hole** \ˌäk-tə-ˈhē-drəl-\ *n.* A space in a close-packed structure which is bounded by six spheres located at the corners of an octahedron.

**Octahedrite** A term sometimes used for the anatase form of titanium dioxide.

**1-Octene** *n.* $C_6H_{13}CH{=}CH_2$. A co-monomer, made from ethylene, and polymerized with ethylene to make linear, low-density polyethylene (*See image*).

**Octet** \äk-ˈtet\ (1879) *n.* A filled shell of eight (8) electrons surrounding an element. Morrison RT, Boyd RN(1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

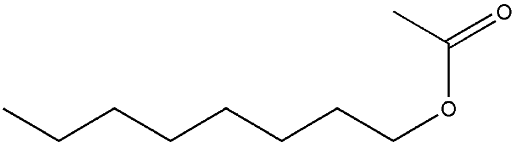
**Octet rule** *n.* A rule which states that a (valence-shell) $ns^2np^6$ configuration in an atom is an especially stable one.

**Octoates** *n.* (1) Salts of octoic, or 2-ethyl hexoic acid. (2) Driers used in paints; made with the lead, cobalt, manganese, calcium, zinc or iron salts of 2-ethyl hexoic acid.

**Octobromodiphenyl** \oct-ˈbrō-(ˌ)mō-(ˌ)dī-ˌfe-nᵊl\ [ISV] (octabromodi-phenyl) *n.* $(C_6H_2Br_4)_2$. A very dense involatile liquid useful as a fire-retardant additive.

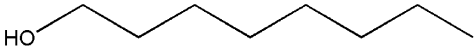
**Octyl-** *nj.* The general term for all saturated, carbon-8 aliphatic radicals having the formula, $C_8H_{17}$–, often used imprecisely for the actual radical 2-ethylhexyl.

**Octyl acetate** *n.* High-boiling solvent. Bp, 199°C; Sp gr, 0.873/20°C; flp, 83°C (180°F); vp, 0.3 mmHg per 20°C (*See image*).



Syn: 2-ethyl hexyl ethanoate.

**Octyl alcohol** *n.* High-boiling solvent used for controlling flow and for coupling with hydrocarbon solvents to reduce high viscosities. Bp, 194°C; Sp gr, 0.834/20°C; flp, 81°C (178°F); vp, 0.3 mmHg per 20°C. It is also used as an etherifying agent for urea–formaldehyde resins to confer drying oil and aliphatic hydrocarbon compatibility (*See image*).

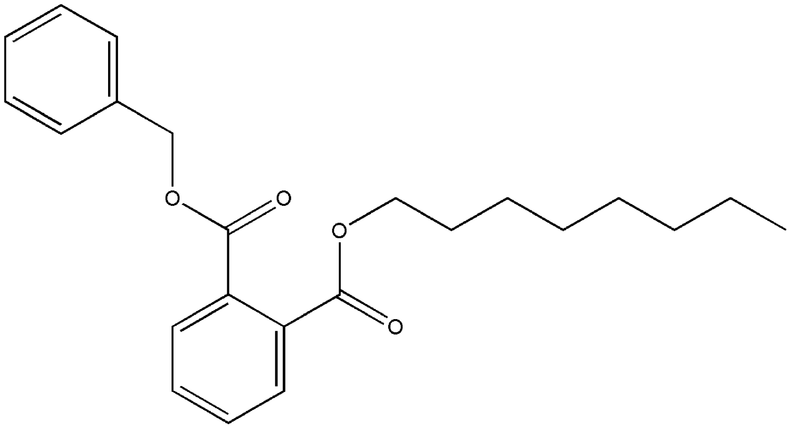


**Octyl benzyl phthalate (OBP)** *n.* A plasticizer for PVC, cellulosics, polystyrene, and polyvinyl butyral. It is similar to butyl benzyl phthalate but has lower volatility. It resists oil extraction (*See image*).

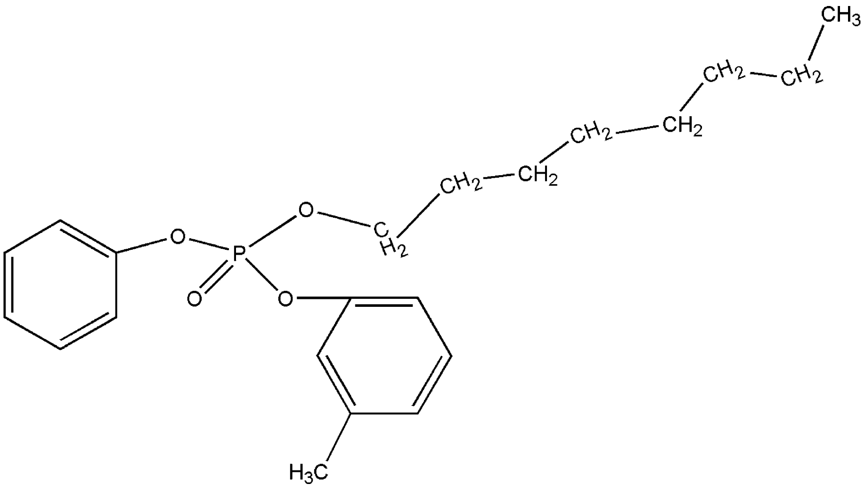
**Octyl biphenyl phosphate** *n.* A plasticizer for vinyl and other resins with good permanence and low-temperature properties. It imparts flame resistance and is approved by FDA and use in food packaging (*See image*).

**Octyl epoxy tallate** *n.* A monomeric plasticizer and heat and light stabilizer for vinyls and cellulosics. It imparts good low-temperature flexibility, has low volatility, and is used primarily in coated fabrics, garden hose, film and sheeting, and slush-molded parts.

**Octyl isodecyl phthalate** *See ethylhexyl isodecyl phthalate.*

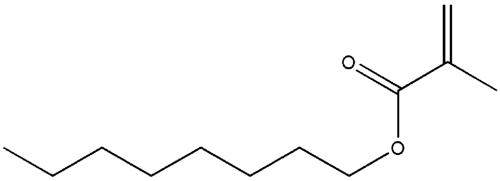


**Octyl benzyl phthalate (OBP)**



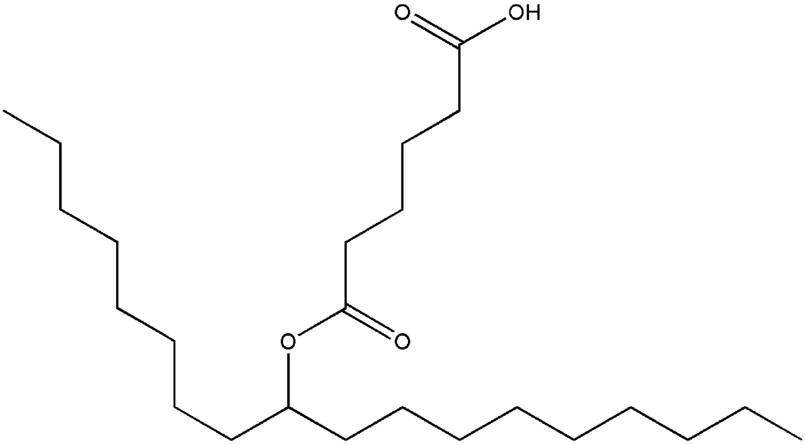
**Octyl biphenyl phosphate**

**n-Octyl methacrylate** A co-monomer for acrylic resins (*See image*).

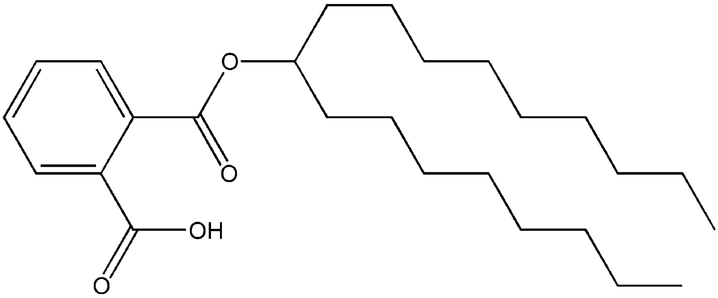


**n-Octyl-n-decyl adipate (NODA, octyl decyl adipate, isooctyl isodecyl adipate)** *n.* A plasticizer for cellulosics, synthetic rubbers, and vinyl resins. It imparts good low-temperature flexibility and resistance to extraction by water. NODA is also useful at low concentrations in polypropylene as a processing aid (*See image*).

**n-Octyl-n-decyl phthalate (NODP, Ethyl-hexyl decyl phthalate, and octyl decyl phthalate)** *n.* One of an important family of phthalate-ester plasticizers derived from $C_6$ to $C_{10}$ alcohols. These plasticizers may be used interchangeably in PVC compositions, to which they impart somewhat better drape, flexibility, and low-temperature resistance than does dioctyl phthalate. They are also compatible with vinyl chloride-acetate copolymers, cellulose nitrate, ethyl cellulose, cellulose acetate butyrate, polystyrene, acrylic



***n*-Octyl-*n*-decyl adipate**

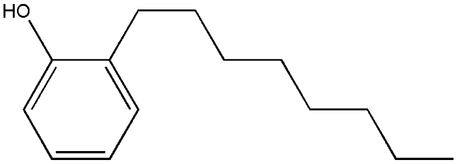


***n*-Octyl-*n*-decyl pthalate**

and butadiene-acrylonitrile resins, neoprene and chlorinated rubber (*See image*).

***n*-Octyl-*n*-didecyl trimellitate** *n.* $C_8H_{17}OOCC_6H_3(COOC_{10}H_{21})_2$. An ester of trimellitic acid (1,2,4-benzene tricarboxylic acid), used as a plasticizer for vinyl chloride polymers and copolymers. The trimellitate plasticizers are used especially for non-fogging applications, and in adhesives or laminates where low migration is important.

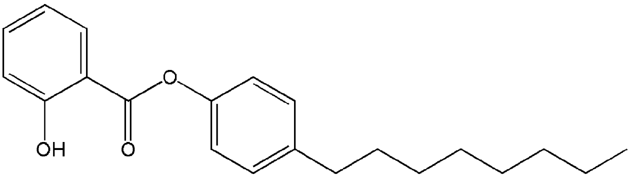
**Octyl phenol (tertiary)** Phenol used as an alternative to tertiary butyl phenol in the manufacture of pure oil-reactive phenolic resins (*See image*).



***p*-Octylphenyl salicylate** *n.* A white, crystalline powder, used as an ultraviolet absorber in polyolefins and cellulosics. It is reported to have increased the outdoor weathering life of polyethylene by 400% (*See image*).

**Octyl phosphate** *See trioctyl phosphate.*

**OD** Abbreviation for outside diameter (of an annulus or spherical shell).



**Odor** \ˈō-dər\ [ME *odour,* fr. MF, fr. L *odor;* akin to L *olēre* to smell, Gk *ozein* to smell, *osmē* smell, odor] (13c) *n.* A reaction that is manifested by a physiological sensation due to physical contact with odorant agent molecules and the human olfactory nervous system.

**Odor intensity level** (odor threshold number) *n.* A test to determine the intensity of an odorant, or the number of dilutions required for an odorant (gas, vapor, or liquid) in order to become odorless or barely detectable as evaluated by a panel of humans sniffing samples. Also the character of the odorant sample may be evaluated (e.g., sweet, sour, ethereal, and putrid) (ASTM D1292-86, Standard Test Methods for Odor in Water; and ASTM Publication DS 61, Atlas of Odor Character Profiles).

**Odorless mineral spirits** *See odorless solvent.*

**Odorless paint** *n.* A paint such as a water-base latex paint or an oil- or alkyd-base paint which contains an odorless mineral spirit as a thinner; produces a minimum amount of odor during application.

**Odorless solvent** *n.* Solvents generally of the mineral spirits type, that are synthesized by the aklylation process and refined to remove odorous aromatics and sulfur compounds.

**Oenanthal** *n.* Aldehyde decomposition product derived during the dehydration of castor oil.

*Also known as enanthaldehyde.*

**Oersted** \ˈər-stəd\ [Hans Christian *Oerstead*] (1930) *n.* cgs emu of magnetic intensity exists at a point where a force of 1 dyne acts upon a unit magnetic pole at that point, i.e., the intensity of 1 cm from a unit magnetic pole.

**Oeschle'** *n.* A method of measuring density of liquids named for its Swiss inventor. The Oeschle' scale is related to specific gravity (SG) by: Oeschle' = (SG − 1) × 1000 (*See www.monashscientific.com, Oeschle'*).

**Off-clip** *See scalloped selvage.*

**Off color** *n.* Unacceptable color difference. Non-matching at different shade.

**Offset** \ˈóf-ˌset\ (ca. 1555) *n.* An indirect form of printing in which the ink is transferred from the printing plate to a rubber blanket and subsequently to the sheet.

*See lithography.*

**Offset adapter** *n.* In extrusion, a short, angled connector between extruder and die that orients the die axis on an axis different from, but sometimes parallel to that of the extruder axis.

**Offset, custom decorating** *n.* A printing process in which the image to be printed is first applied to an intermediate carrier such as a rubber roll or plate then is transferred (in reverse) to the surface to be printed.

**Offset molding** *See jet molding.*

**Offset paper** *n.* A variety of printing paper especially sized for offset lithography; it is non-curing and absorptive.

**Offset printing** *n.* A printing process in which the image to be printed is first applied to an intermediate carrier such as a rubber roll or plate, then is transferred (in reverse) to the surface to be printed.

**Offsetting of inks** *See set off of ink.*

**Offset yield strength** *n.* The stress at which the strain exceeds by a specified amount (the offset) an extension of the initial proportional portion of the stress-strain curve. It is expressed in force per unit area, usually psi or MPa (ASTM D 638).

**Off-square** *n.* (1) A term to describe the difference between the percentage of warp crimp and the percentage of filling crimp. (2) A term referring to a fabric in which the number of ends and the number of picks per inch are not equal.

**Off-white** (1927) *n.* Color which is obviously not white, but which is not sufficiently far removed from white to enable it to be called by a definite color name.

**–OH** *n.* The hydroxyl radical, the characterizing group of inorganic basses, aliphatic alcohols, and phenols.

**Ohm** \ˈōm,\ [Georg Simon *Ohn*] (1867) (Ω) *n.* The SI unit of electrical resistance, equal to 1 V divided by 1 A. The SI definition for 1 Ω is the resistance between two points of a conductor when a constant difference of potential of 1 V, applied between these two points, produce in this conductor a current of 1 A, this conductor not being the source of any electromotive force.

**Ohm's law** \ˈōmz-\ (1863) *n.* Current in terms of electromotive force $E$ and resistance $R$.

$$I = \frac{E}{R}.$$

The current is given in ampere when $E$ is in volt and $R$ in ohm. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**OIDP** *n.* Abbreviation for octyl isodecyl phthalate.

*See ethylhexyl isodecyl phthalate.*

**Oil** \ˈói(ə)l\ [ME *oile*, fr. OF, fr. L *oleum* olive oil, fr. Gk *elaion*, fr. *elaia* olive] (13c) *n.* Any of numerous mineral, vegetable and synthetic substances, and animal or vegetable fats that are generally unctuous, slippery, combustible, viscous, liquid, or liquefiable at room temperatures, soluble in various organic solvents, but not in water.

*See drying oil, non-drying oil and semi-drying oil.*

**Oil absorption** *n.* The percentage increase in weight of a specimen after immersion in oil for a specified time. This property is important with respect to fillers used in plasticized thermoplastics, which can absorb plasticizer from a resin in a compound.

**Oil absorption (value)** *n.* Quantity of oil required to wet completely a definite weight of pigment to form a stiff paste when mechanically mixed. The oil absorption number or value of a pigment is the number of milliliters or grams of oil, usually acid refined linseed oil, used to bind together 100 g of pigment under specified conditions of test. The unit used should be stated. The figure is not absolute, but depends on the operator as well as on the method of determination. *Note*—The term "oil absorption" is frequently used as a measure of plastic viscosity. As such it can lead to unpredictable results, since oil absorption as measured bears little relation to finished mill-ground pigment dispersion. Oil absorption has meaning of a qualitative sort, however, in relation to a preliminary mixer operation.

*See also binder demand.*

**Oil, blown** *See blown oil.*

**Oil-bound** *n.* Description of a water paint, the medium of which contains a proportion of drying oil in the binder.

**Oil-bound distemper** *n.* A distemper which contains a drying oil.

**Oil cake** (1743) *n.* A cake or mass of linseed, cottonseed, etc., from which the oil has been expressed.

**Oil can** *n.* In the coil coating industry, metal irregularities of an otherwise flat looking metal sheet when viewed at near grazing angle.

**Oil canning** *n.* (1) A problem of distortion or buckling encountered in extrusion of rigid-vinyl sheet and shapes, usually attributed to uneven cooling of the extrudate. (2) A similar problem with dark-colored, rigid-vinyl house siding caused by solar heating and cured by adding the extrusion compound a heat-resistant resin that elevates the glass-transition and heat-deflection temperatures of the siding.

**Oil cloth** *n.* Any fabric treated with linseed-oil varnish to make it waterproof. It comes in plain colors and printed designs and is most commonly used for table covers or shelf covering. It has now been widely replaced by plastic coated fabrics.

**Oil color** (1539) *n.* Oil paint containing a high concentration of colored pigment, commonly used for tinting paint. Syn: oil paste.

**Oil content** *See oil length.*

**Oil, debloomed** *n.* Mineral oils which show a decided blue or purple cast when examined in a test tube or when spread in a thin film over a dark colored surface, are said to possess a bloom. When oil has been treated as to remove this color effect, it is said to be debloomed. Debloomed rubbing oil gives a clearer, sharper, rubbed surface than that which shows a bloom.
*See bloom.*

**Oil-drying** *n.* Any unsaturated oil which will react with oxygen from the air and dry to a relatively hard, tough, elastic substance when spread out in a thin film.

**Oil, fixed** *See non-drying oil.*

**Oil green** *See chromium oxide green.*

**Oil, heat-bodied** *n.* Drying or semi-drying oil which has been heated to an elevated temperature and held at this temperature for the time required to produce a specific increase in viscosity, as distinct from oil polymerized by a process involving oxidation.

**Oil length** *n.* Ratio of oil to resin in a medium. For an oleoresinous varnish, the oil length may be expressed in terms of parts by weight of oil to one part by weight of resin or, in American practice, in terms of USA gallons of oil per 100 lb of resin. Thus, a 25 gal varnish would mean, in American usage, a varnish composed of 25 USA gallons of oil to 100 lb of resin. For alkyd resins, the oil length is expressed as the percentage of oil they weight in the resin. Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York.
*See long oil, medium oil varnish, and short oil varnish.*

**Oil, long** *See long oil.*

**Oil melt** *n.* Solution of resin in oil, obtained by heating.

**Oil-modified alkyd** *See alkyds.*

**Oil, non-drying** (1905) *n. See non-drying oil.*

**Oil of lemon** *n.* Volatile oil expressed from fresh peel of *Citrus limonum.* It contains limonene, terpinene, phellandrene, and pinene.

**Oil of Mirbane** *See nitrobenzene.*

**Oil of pine tar** *n.* Certain heavier fractions of the volatile oil recovered by distilling pine-tar oil to convert it into pine tar.

**Oil of turpentine** *n.* Pharmaceutical name for spirits of turpentine which conforms to the requirements of the National Formulary.

**Oil paint** (1790) *n.* (1) Paint that contains drying oil as the sole film-forming ingredient. (2) A paint that contains drying oil, oil varnish, or oil-modified resin as the basic vehicle ingredient. (3) Commonly (but technically incorrect), any paint soluble in organic solvents (deprecated).

**Oil pastes** *n.* Very concentrated mixtures of pigment and oil, which are of paste-like consistency. They may be used for tinting purposes, or for preparation of oil paints by the simple addition of more vehicle and/or thinners, with the necessary driers.
*These are also known as colors in oil.*

**Oil polish** *n.* Finished surface produced on wood by successive thin coats of linseed oil, accompanied by rubbing motion at the time of application. Also refers to any polishing material containing oil as one of the essential ingredients.

**Oil proof** *n.* A term describing fabrics that are impervious to oil.

**Oil-reactive phenolic resins** *n.* Phenol-formaldehyde resins which react with drying oils on heating to yield products with special properties.

**Oil-repellent** *n.* A term applied to fabrics that have been treated with finishes to make them resistant to oil stains.

**Oil resistance** *n.* The ability of a material to withstand contact with an oil without deterioration of physical properties, or geometric change.

**Oil rubbing** Process *n* of rubbing the dried film of a finished material with oil and pumice or some other suitable abrasive. Linseed oil thinned with naphtha or turpentine is sometimes used, as are also light mineral oils, such as neutral oil, straw oil, and paraffin oil.

**Oil, semi-drying** *See semi-drying oil.*

**Oil shale** (1873) *n.* A rock from which oil can be recovered by distillation.

**Oil soluble** *n.* Materials capable of being dissolved in vegetable or mineral oils.

**Oil-soluble resin** *n.* A resin that is capable of dissolving in or reacting with drying oils at moderate temperatures. Such resins are used for producing homogeneous coatings with modified characteristics.

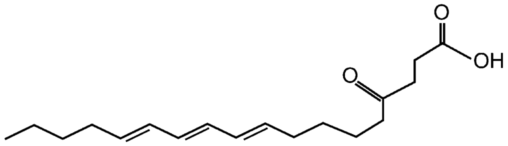
**Oil stain** *n.* Solution of dyes and/or pigment dispersions blended with oil or varnish and reduced with hydrocarbon solvents. Those that are absorbed into the surface of the substrate are called penetrating stains, while non-penetrating stains contain higher levels of non-volatile vehicle and/or pigments. *See stain.*

**Oil, stand** *See stand oil.*

**Oil varnish** *See oleoresinous vehicle.*

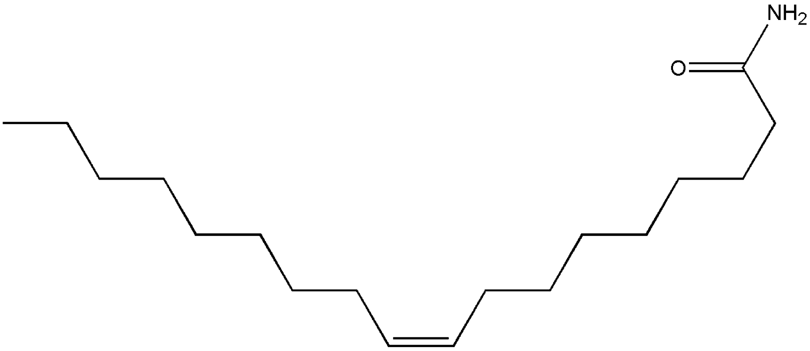
**Oil, vegetable** *See vegetable oil.*

**Oiticica oil** \ˌói-tə-ˈsē-kə-\ [Portuguese, fr. Tupi] (1901) *n.* Obtained from the nuts of *Licania rigida*, a tree native to Brazil. It is unique by reason of the fact that its main constituent acid is licanic acid shown below. This acid is highly unsaturated because of its three conjugated double bonds and it also contains a ketonic group. Oiticica oil is similar to tung oil in that it has a high specific gravity, high refractive index, polymerizes rapidly on heating, dries quickly and possesses good water resistance. Like tung oil, it webs, frosts, and wrinkles unless adequately processed. It is used as a partial substitute for tung oil and special care is necessary when making varnished from it. Sp gr. 0.982 per 20°C; iodine value, 145, saponification value, 190 (*See image*).



**Oleamide** *n.* *cis*-$CH_3(CH_2)_7CH{=}CH(CH_2)_7CONH_2$. An ivory-colored powder used in low percentages as a slip agent for film-grade polyethylenes, as is its *trans*- isomer, Elaidamide (*See image*).

**Olefin** \ˈō-lə-fən\ [ISV, fr. F (*gaz*) *oléfiant* ethylene, fr. L *oleum*] (1860) *n.* (1) Any of the class of monounsaturated, aliphatic hydrocarbons of the general formula $C_nH_{2n}$, and named after the corresponding paraffins by changing their –*ane* endings to –*ene* or –*ylene*. Examples are ethylene (ethene), propylene, and butanes. The class of polymers of olefins is called *polyolefins* or *olefin plastics*. (2) The term is sometimes taken to include aliphatics containing more than one double bond in the molecule such as a diolefin or diene. *Butadiene* is a typical member and an important comonomer for plastics. (3) A



**Oleamide**

general name for fibers from at least 85% other olefins, excluding rubber. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Olefin fiber** *n.* A manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of ethylene, propylene, or other olefin units. Olefin fibers combine lightweight with high strength and abrasion resistance, and are currently being used in rope, indoor–outdoor carpets, and lawn furniture upholstery.

*Also see polyethylene fiber and polypropylene fiber.*

**Olefinic** *n.* A reaction between two molecules, both containing carbon–carbon double bonds.

**Olefin plastic** *See polyolefin.*

**Oleic acid** \ˈō-lē-ik-\ (1819) *n.* $CH_3(CH_2)_7CH{=}{=}CH(CH_2)_7COOH$ (*cis*-9-octadecenoic acid). Fatty acid found in most vegetable oils, whether drying or non-drying. Used to some extent in non-drying and non-yellowing alkyd resins. Mp, 140°C; acid value, 199; iodine value, 90.1 a commercial grade is known as red oil. AS Registry Number: 112-80-1, CAS Name: (*Z*)-9-octadecenoic acid. Molecular formula: $C_{18}H_{34}O_2$. Molecular weight: 282.46. Percent composition: C 76.54%, H 12.13%, and O 11.33%. Obtained by the hydrolysis of various animal and vegetable fats and oils. Preparation from olive oil: Biochem Prepn 2:100 (1952). Separation from olive oil by double fractionation via urea adducts: Paisley R (1962). Biochem Prepn 9:113. Stereochemistry: Thieme G (1905). Ann 343:354. Synthesis: Robinson R (1925). J Chem Soc 127:175. $^{13}$C-NMR studies: Stoffel W et al (1972). Z Physiol Chem 353:1962; Batchelor JG et al (1974). J Org Chem 39:1698. Toxicity data: Orö L, Wretlind A (1961). Acta Pharmacol Toxicol 18:141. Exceptional use of $^{131}$I-labeled oleic acid in myocardial imaging: Bonte FJ et al (1973). Radiology 108:195. Review of diagnostic use of $^{3}$H-oleic acid in pancreatic function: Pedersen NT (1987). Digestion 37(Suppl 1):25–34. Properties: Pure oleic acid is a colorless or nearly colorless liquid (above 5°C–7°C). $d_{25}^{25}$ ~0.895. Solidifies to crystal mass, mp 4°C. $bp_{100}$ 286°C. At atmospheric pressure it declines when heated at 80°C–100°C. $^{n}D^{18}$ 1.463; $^{n}D^{26}$ 1.4585. Iodine no. 89.9; acid value 198.6. On exposure to air, especially when impure, it oxidizes and acquires a yellow to brown color and rancid odor. Practically insoluble in water. Soluble in alcohol, benzene, chloroform, ether, fixed and volatile oils, and keep well closed, protected from light. From Merck Index: $LD_{50}$ i.v. in mice:

230 ± 18 mg/kg. Several grades of the acid are available in commerce, varying in color from pale yellow to red-brown and, depending on the amount of saturated acid present, becoming turbid at 8°C–16°C. The acid of commerce usually contains 7–12% saturated acids, e.g., stearic, palmitic; also some linoleic, etc., unsaturated acids. Melting point: mp 4°C. Boiling point: bp$_{100}$ 286°C. Index of refraction: $^{n}D^{18}$ 1.463; $^{n}D^{26}$ 1.4585. Density: $d_{25}^{25}$ ~(0.895. Toxicity data: LD$_{50}$ i.v. in mice: 230 ± 18 mg/kg. Merck index, 13th edn. Merck and Company Inc., Whitehouse Station, New Jersey, 2001. (*See image.*)

**Oleo chemical** *n.* A fatty acid, ester, amide, or a mixture of those compounded into thermoplastic resins, usually in fractional percentages, to enhance their release from injection molds and, in films, to reduce surface friction and stickiness.

**Oleophobic** *n.* A term describing a substance that has a strong affinity for oil.

**Oleoresin** \ˌō-lē-ō-ˈre-zᵊn\ [ISV] (ca. 1846) *n.* Pine gum, the non-aqueous secretion of resin acids dissolved in a terpene hydrocarbon oil, which is: (1) Produced or exuded from the intercellular resin ducts of a living tree. (2) Accumulated, together with oxidation products, in the dead wood of weathered limbs and stumps. *Note*—The term "oleoresinous", however, is not restricted to products of pine gum.
*See oleoresinous vehicle.*

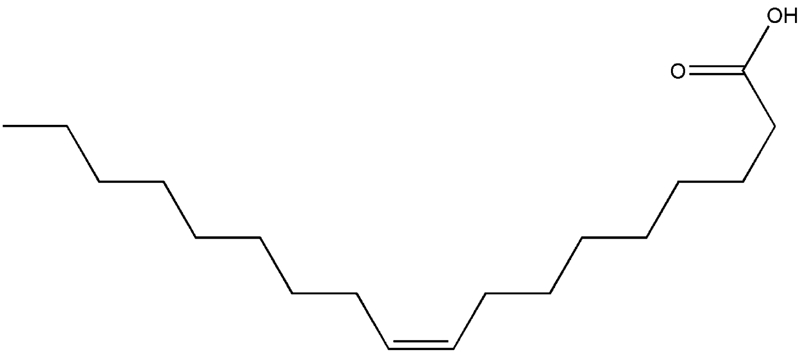
**Oleoresinous** *adj.* Indicating a material, which has been made by the combination of an oil and a resin.

**Oleoresinous vehicle** *n.* A vehicle prepared by the addition of a resin to a drying oil. These two components may or may not be further processed to obtain specified properties. Alkyd resins are sometimes, but not generally, included in this category.
*See varnish.*

**Olibanum** *See gum thus.*

**Oligomer** \ə-ˈli-gə-mər\ (1952) *n.* A substance composed of only a few monomeric units repetitively linked to each other, such as a dimmer, trimer, tetramer, etc., or their mixtures (ASTM D 883). Other definitions in the literature place the upper limit of repeating units in an oligomer at about ten. The term *telomere* is sometimes used synonymously with oligomer.

**Ombré** \ˈäm-ˌbrā\ [F, pp of *ombrer* to shade, fr. It *ombrare*, fr. *ombra* shade, fr. L *umbra*] (ca. 1896) *adj.* A color effect in which the shade is changeable from light to dark, generally produced by using warp yarns of different tones. Ombré effects may also be produced by printing.



**Oleic acid**

**Omega vibration direction ($\omega$)** *n.* Any vibration direction in the plane of an axis for uniaxial crystals.

**OMR inks** *See optical mark recognition inks.*

**ONB** *n.* Abbreviation for *o*-nitrobisphenyl.

**Ondule** *n.* A general term for plain-weave fabrics of silk, cotton, or manufactured fiber having a wavy effect produced by weaving the warp or filling, but usually the filling, in a wavy line. An ondule reed is generally used to produce this effect, often in a leno weave to emphasize the wave. Ondule is used for dress fabrics.

**One-compartment coating** *n.* Cross-linking systems, which can be stored in a single compartment, as opposed to a two-compartment coating.

*Also called one-pot coating. See also two-compartment coating.*

**One-pot coating** *See one-compartment coating.*

**One-shot molding** *n.* A process for molding polyurethane foam in which the reactants, usually an isocyanate, a polyol, and a catalyst, are fed in separate streams to a mixing head from which the mixed reactants are discharged into a mold. The polyol and catalyst are sometimes combined along with other additives prior to mixing, but the isocyanate is always fed separately to the mixing head.

**Onguka oil** *See isano oil.*

**On–off control** *n.* A simple type of process control in which an instrument is connected or disconnected from electrical power or other process parameter such as flow of fluid.

**On-stream** *n.* The state of having been brought into production. The term is usually used for chemical and metallurgical plants or processes.

**OP** Abbreviation for over proof.

**Opacity** \ō-ˈpa-sə-tē\ [F *opacité* shadiness, fr. L *opacitat-*, *opacitas*, fr. *opacus* shaded, dark] (ca. 1611) *n.* A general term to describe the degree to which a material obscures a substrate, as opposed to transparency, which is the degree to which a material does not obscure a substrate. Opacity is sometimes described in terms of the contrast ratio. Opacity is the quality or state of a body that makes it impervious to rays of light. The resistance to transmission of radiant energy, usually visible light, in terms of percent opacity where 100% opacity is non-light transmitting and 0% opacity is completely light transmitting. Section 08 of ASTM Standards contains some nine tests dealing with optical properties of plastics (ASTM, www.astm.org) is a method for determining the opacity of papers, some of which are used as backings for plastic sheets. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

*See contrast ratio and hiding power.*

**Opalescence** \ˌō-pə-ˈle-sᵊnt\ (ca. 1813) *adj.* (1) The limited clarity of vision through a sheet of transparent plastic at any angle, because of diffusion within or on the surface of the plastic. (2) Of a plastic material, the quality of having inner, tiny colored lights resembling those of opals. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Opaque** \ō-ˈpāk\ [L *opacus*] (1641) *adj.* (1) Impervious to light or not translucent. (2) Adjective to describe complete opacity. (3) Opaque to transmitted light, that is, 100% absorbing throughout the visible light range.

**Opaque ink** *n.* An ink that does not allow the light to pass through it and has good hiding power. It does not permit the paper or previous printing to show through.

**Opaqueness** *See opaque and opacity.*

**Opaque stains** *n.* All stains that are not classified as semi-transparent stains.

**Open assembly time** *See time, assembly.*

**Open-cell foamed plastic** *n.* A cellular plastic in which most of the cells are interconnected in a manner such that gases can flow freely from one cell to another.

**Open-cell foams** *n.* Foams are a very useful class of materials used as thermal and acoustic insulators, furniture, flotation devices and others. Foams could be of the closed or open cell type. Both types are characterized by a significant fraction of the material being voids (gas). When these voids are connected to one another it is called an open-cell structure. If the voids are individually surrounded by the plastic matrix such polyurethane, then it is a closed-cell structure.

**Open coat** *n.* In coated abrasives, when the individual abrasive grains are spaced at pre-determined distance from one another the open coat covers about 50–70% of the coated surface with abrasive. Open coat has greater flexibility and resistance to filling or clogging than closed coat.

**Open grain** *n.* Common classification for woods with large pores such as oak, chestnut, and walnut.

*Also known as coarse textured.*

**Opening** *n.* (1) A preliminary operation in the processing of staple fiber. Opening separates the compressed masses of staple into loose tufts and removes the heavier impurities. (2) An operation in the processing of tow that substantially increases the bulk of the tow by separating the filaments and deregistering the crimp.

**Open-mold process** *n.* Any technique for fabricating reinforced plastics in which a one-sided male or female mold is used, with no or low pressure being required.

*See hand lay-up, spray-up, and bag molding.*

**Oppanol B** *n.* Poly(isobutylene), manufactured by BASF, Germany.

**Oppanol C** *n.* Poly(vinylisobutyl ether), manufactured by BASF, Germany.

**Oppanol O** *n.* Copolymer from 90% isobutene and 10% styrene, manufactured by BASF, Germany.

**Optical brightener** *n.* (1) A colorless compound that, when applied to fabric, absorbs the ultraviolet radiation in light but emits radiation in the visible spectrum. (2) Fluorescent materials added to polymer in manufactured fiber production that emit light in the visible spectrum, usually with a blue cast.

*See brightener, optical, and brightening agents.*

**Optical character recognition inks (or OCR inks)** *n.* Inks composed of lowest reflectance pigments, such as carbon black, which can be read by optical scanners (OCR readers). Non-readable inks, though visible to the human eye, cannot be read by OCR readers, because they present no reflectance contrast to the machine. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 1976.

**Optical composite** *n.* A composite that is transparent or nearly so. Making one requires that the refractive indices of the resin and reinforcing fiber, themselves transparent, be closely equal. This might be feasible with polymethyl methacrylate and a carefully chosen glass, since the refractive index of PMMA ($^{n}D^{20}$) is 1.49, that of fused quartz is 1.458, and most common glasses are above 1.51. Some fairly clear composites have been made with glass-reinforced polyurethanes.

**Optical density** *n.* The degree of opacity of any translucent medium, sometimes expressed as the logarithm of the opacity.

**Optical dispersion** *n.* Of a transparent material, the difference between the refractive indices of the material for two different wavelengths of light: in particular, the wavelengths of red and violet lights (ca. 650 and 410 nm, respectively). Dispersion is an important property in the design of compound lenses.

**Optical distortion** *n.* Any apparent alteration of the geometric shape of an object as seen either through a transparent material or as a reflection from mirror surface.

**Optical fibers** (1962) *n.* Optical fibers are made from both glass and plastic and are being used increasingly to replace copper wire for carrying computer date and electronic signals because of their high speed and expansion capabilities over conventional wiring.

**Optical filter** *See filter, optical.*

**Optical isomer** *n.* An isomer which will rotate the plane of polarized light.

**Optically active polymers** *n.* Examples of these materials are organic polymers, metallorganic optical materials, and biomolecular optical materials. These materials may be used for various non-linear optical and electroptical applications, principally in communications, information processing, memory/storage, and optical limiting.

**Optical mark recognition inks (or OMR inks)** *n.* Similar to OCR inks. Optical scanners (OMR readers) detect the presence of bar marks rather than data characters. Thus, OMR is generally less demanding in print quality than OCR, but more demanding in positional accuracy and space. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 1976.

**Optical properties** *n.* A general term used to refer to the relations of yarn or fibers with light. It includes such parameters as birefringence, refractive index, reflectance, optical density, etc.

**Optic axial angle** *n.* The actual angle between two optic axes of a biaxial crystal in the plane of $\alpha$ and $\gamma$. It is constant for and characteristic of any particular substance.

**Optic axial plane** *n.* The plane containing the optic axes as well as $\alpha$ and $\gamma$.

**Optic axis** (1664) *n.* In crystallography, the direction through an anisotropic crystal along which unpolarized light travels without suffering double refraction. Uniaxial crystals have one optic axis; biaxial crystals have two optic axes.

**Optic sign** *n.* For uniaxial materials, by definition, the sign is positive if the value $\varepsilon - \omega$ is positive and negative if $\varepsilon - \omega$ is negative. For biaxial materials, the sign is positive if $\gamma$ is the acute bisectrix, and negative if $\alpha$ is the acute bisectrix or positive if $\gamma - \beta > \beta - \alpha$ and negative if $\gamma - \beta > \beta - \alpha$.

**Optimum twist** *n.* In spun yarns, a term to describe the amount of twist that gives the maximum breaking strength or the maximum bulk at strength levels acceptable for weaving or knitting.

**Oral lethal dose** ($LD_{50}$) *n.* The amount of a substance taken by mouth that would kill within 14 days half (50%) of those test animals exposed. The dose is measured in milligrams per kilogram of body weight of the test animal.

*See* $LD_{50}$ *test.*

**Orange chrome** *See chrome orange, light, and deep.*

**Orange lead** *n.* Lead oxide pigment similar to red lead but containing less litharge and more lead peroxide. It is used as a base for lakes and to some extent as a pigment.
*See red lead and red lead (non-setting).*

**Orange mineral** Lead oxide pigment, which is finer and of a brighter color than red lead. Made by roasting white lead carbonate or sublimed litharge.
*Also known as mineral orange. See red lead.*

**Orange peel** (ca. 1909) *n.* (1) Surface condition characterized by an irregular waviness of the enamel, resembling an orange skin texture; sometimes considered a defect. The condition is often caused by uneven wear of the mold surface due to overpolishing, overheating, or overcarburizing of the mold cavity. It may also be caused by overspraying with mold releases. (2) A type of mottle that occurs in flexographic, gravure and tin printing.
*See pockmarking and spray mottle.*

**Orange shellac** *n.* A refined lac which is soluble in alcohol; contains some wax and resin; used as a coating on floors and other wood surfaces.
*See shellac.*

**Orbital** \ˈór-bə-tᵊl\ [*orbital, adj*] (1932) *n.* A discrete electronic energy level; also, the spatial distribution of the electron probability density, $\psi^2$, for such a level.

**Orbital pad sander** *n.* A portable sanding machine consisting of a backup pad that moves in small circles, at high speed. Used for sanding metal, the end grain of wood, plastics, and the undercoats for paint and lacquer finishes.
*See straight-line pad sander.*

**Organdy** \ˈór-gən-dē\ [F *organdi*] (1835) *n.* A very thin, transparent, stiff, wiry, muslin fabric used for dresses, neckwear, trimmings, and curtains. Swiss organdy is chemically treated and keeps its crisp, transparent finish through many launderings. Organdy without chemical treatment loses its crispness in laundering and has to be restarched. Organdy crushes or musses but is easily pressed. Shadow organdy has a faint printed design in self-color.

**Organic** \ór-ˈga-nik\ (1517) *adj.* (1) Designation of any chemical compound containing carbon (some of the simple compounds of carbon, such as carbon dioxide, are frequently classified as inorganic compounds). To date, nearly one million organic compounds have been synthesized or isolated. Many occur in nature; others are produced by chemical synthesis. *Refer to carbonaceous.* (2) In medicine, producing or involving alteration in the structure of an organ; opposed to functional.

**Organic chemistry** *n.* The chemistry of carbon compounds, usually containing hydrogen, and many containing oxygen, nitrogen, halogens, sulfur, phosphorus, and, occasionally, other elements. The term arose because such compounds were first obtained from living organisms. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Organic peroxides** *n.* Peroxides used in the plastics industry are thermally decomposable compounds analogous to hydrogen peroxide in which one or both of the hydrogen atoms are replaced by an organic radical. As they decompose, they form free radicals, which can initiate polymerization reactions and affect cross-linking.
*See peroxide.*

**Organic pigments** *n.* Any pigment derived from naturally occurring or synthetic organic substances, characterized by good brightness and brilliance and (usually) transparency. They are generally more resistant to chemicals than inorganic pigments, but are less resistant to that, light, and solvents. Example: lithol rubine.

**Organic yellow** *See hansa yellow.*

**Organize yarn** Two or more threads twisted in the singles and then plied in the reverse direction. The number of turns per inch in the singles and in the ply is usually in the range of 10–20 turns. Organize yarn is generally used in the warp.

**Organometallic compound** \-mə-ˈta-lik-\ *n.* Any compound containing carbon, hydrogen and a metal, excluding ordinary metallic carbonates such as sodium bicarbonate and also excluding metallic salts of common organic acids. Many organometallic compounds are used as polymerization catalysts and stabilizes, most notably the organotin stabilizers.

**Organopolysiloxane** *See silicone.*

**Organosol** *n.* A suspension of a finely divided resin in a plasticizer together with a volatile organic liquid (ASTM D 883). A somewhat tighter definition requires that the volatile liquid comprise at least 5% of the total weight of the suspension. The resin used is most frequently PVC, but the term applies to such suspensions of any resin. An organosols can be prepared from a *plastisol* merely by adding a volatile diluent or solvent that serves to lower viscosity and evaporates when the compound is heated.

**Organotin stabilizer** *n.* Any of an important class of stabilizers for PVC, notable for their high efficiency, compatibility, and imparting of clarity. The family includes sulfides and oxides of tin-alkyls or -aryls, organotins salts of carboxylic acids, organotins mercaptides, and trialkyl or triaryl tin alcoholates. Certain dioctyltin mercaptides and maleate compounds have been approved for food contact use. *See also di-n-octyltin maleate polymer and di-n-octyltin-S,S′ bis(isooctyl mercaptoacetate).*

**Organza** \ór-ˈgan-zə\ [prob. alter. of *Lorganza*, a trademark] (1820) *n.* A stiff, thin, plain weave fabric made of silk, nylon, acrylic, or polyester, organza is used primarily in evening and wedding attire for women.

**Oriental blue** *n.* Synthetic ultramarine blue. *See ultramarine blue.*

**Orientation** \ˌōr-ē-ən-ˈtā-shən\ (1839) *n.* The process of stretching a hot plastic article to align the molecular chains in the direction(s) of stretching, thus improving modulus and strength in those direction(s). When the stretching is applied to one direction or two perpendicular directions, the process is called *uniaxial* or *biaxial orientation*, respectively. Upon reheating, an oriented film will shrink in the direction(s) of orientation. This property is useful in applications such as shrink packaging, and for improving the strength of formed or extruded articles such as lids of dairy-product tubs, pipe, filaments, film, and sheet. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Chung DD (1994) Carbon fiber compositors.Elsevier Science and Technology Books, New York.

**Orientation equipment** *n.* Equipment which draws and strains a film or fiber in one direction as it is extruded from a die.

**Orientation-release stress** *n.* The internal stress remaining in a plastic sheet after orientation, which can be relieved by reheating the sheet to a temperature above that which it was oriented. This stress is measured by heating the sheet and determining the force per unit cross-sectional area exerted by the sheet as it attempts to revert to its pre-orientation dimensions.

**Oriented film extruders** *n.* Screw type extruders with film dies and drawing equipment which strain or orient the film as it taken-up on a reel.

**Orifice** \ˈór-ə-fəs, ˈär-\ [ME, fr. MF, fr. LL *orificium*, fr. L *or-*, *os* mouth + *facere* to make, do] (15c) *n.* (1) A small, usually cylindrical passage in a die, as in a strand die or an orifice-type rheometer. (2) A beveled, sharp-edged, usually circular hold in a thin metal plate that is inserted between flanges in a pipeline. By measuring the fluid pressure up- and downstream near the plate, one can calculate the rate of flow of the fluid. The method has long been used with simple gasses and liquids and is useful for dilute polymer solutions, but not for melts.

**Orlon** \ˈór-ˌlän\. Poly(acrylonitrile). Manufactured by DuPont, USA.

**Ormolu varnish** \ˈór-mə-ˌlü-\ *n.* A varnish having the appearance of gold or gilded bronze.

**Orpiment** \ˈór-pə-mənt\ [ME, fr. MF, fr. L *auripigmentum*, fr. *aurum* + *pigmentum* pigment] (14c) *n.* $As_2S_3$. Used to a small extent as a pigment, but is also used in shellac to mask its natural color. *Refer to realgar.*

*Known also as King's yellow.*

**Orr's white** *n.* Syn: lithopone.

**Ortho** \ˈór-(ˌ)thō\. (1) Short for orthogonal weave. (2) (*ortho-*) The relation of two adjacent carbon atoms in the benzene ring, abbreviated *o-* and ignored in alphabetizing lists of compounds.

**Ortho-chlor-para nitraniline** *n.* Pigment Red 4 (12085). This pigment has general properties similar to those of para red, although it is slightly superior in tint lightfastness to para red. Syn: ortho chlor.

*See chlorinated para reds.*

**Orthogonal weave** *n.* (1) A type of reinforcing cloth in which fibers are equally distributed in three principal directions (0°, 60°, and 120°) to make a sheet whose properties are nearly equal in all planar directions. (2) A type of three-dimensional reinforcement weave in which fibers are distributed equally in all three principal directions to generate a preform that is then impregnated with resin and cured.

**Orthophthalate plasticizer** (phthalate-ester plasticizer) *n.* Any of a family of plasticizers derived by reacting phthalic anhydride with an alcohol. They include the widely used DOP, DIDP, and DTDP.

**Orthorhombic** \ˌór-thə-ˈräm-bik\ [ISV] (ca. 1859) *adj.* One of the six crystal systems, in which the three principal axes are mutually perpendicular but the atomic spacings are different on all three.

**Orthoscopic observation** *n.* The normal way of viewing an object microscopically (cf., conoscopic observation). With Köhler illumination the field diaphragm and the ocular front focal plane as well as the specimen will be in focus.

**Orthotropic** *n.* Having three mutually perpendicular planes of elastic symmetry, as in composites having fibers running in two perpendicular directions, or biaxially oriented sheet. If the fibers or orientation are unidirectional, the material is still orthotropic but also isotropic in the two directions perpendicular to the fibers or oriented polymer chains. Complete textile glossary. Celanese Corporation, New York. Brandrup J, Immergut EH (eds) (1989) Polymer handbook, 3rd edn. Wiley-Interscience, New York.

**Oscillating die** *n.* (1) A blown-film die that slowly rotates about its axis in one direction about 90°, then reverses to rotate as far in the opposite direction. The effect of the rotation is to distribute evenly over the width of the rolled-up film any slight differences in film thickness at different points around the die. (2) Flat or cylindrical strand dies in which the one die lip moves to and fro so as to cross the flow channels and produce non-woven, knotless netting.

**OSHA** *n.* See (1) Abbreviation for Occupational Safety and Health Administration, the Federal Agency established by the Department of Labor, Bureau of Labor Standards, to enforce occupational safety and health standards. The standards are known as Part 1910 of amended Chapter XVII of Title 29 of the Code of Federal Regulations established on April 13, 1971 (36 F R 7006) and as amended thereafter. (2) Abbreviation for Occupational Safety and Health Act.

**OSHRC** *n.* Abbreviation for Occupational Safety and Health Review Commission.

**Osmometer** \äz-ˈmä-mə-tər, äs-\ [*osmo*sis + -*meter*] (1854) *n.* An instrument for measuring osmotic pressure (OP). The essential elements are a membrane, which is permeable to solvents but impermeable to polymer molecules of a specific size range, reservoirs on each side of the membrane containing respectively the polymer solution and pure solvent, means for holding the temperature of the reservoirs constant, and means for measuring the differential osmotic pressure between the solution and the solvent. Osmotic pressure is proportional to the *number* of molecules per unit volume of the solution. From the mass per unit volume and the molar concentration estimated from the OP, one finds the value of the number-average molecular weight. The useful range of the method is for $M_n$ from 20,000 to 1,000,000. Membrane materials include cellophane, cellulose acetate, polyvinyl alcohol, and polychlorotrifluoroethylene.

**Osmometry** \ˌäz-mə-ˈme-tri\ [*osmo*sis + -*meter*] (1854) *adj.* Measurement of molecular weight of polymers based on osmotic pressure. A plot of reduced osmotic pressure,

$$\Pi/c \text{ versus } c$$

and extrapolation to $c = 0$, then $1/M_n$ condition exists. Collins EA, Bares J, Billmeyer FW Jr (1973) Experiments in polymer science. Wiley-Interscience, New York.
*See osmotic pressure.*

**Osmometry, membrane** *n.* A semi-permeable membrane used in an osmo-meter to allow solvent to penetrate, but not polymer.

**Osmosis** \äz-ˈmō-səs, äs-\ [NL, short for *endosmosis*] (1867) *n.* The passage of solvent molecules through a semi-permeable membrane from a solution of higher solvent concentration (lower solute concentration) to one of lower solvent concentration (higher solute concentration).

**Osmotic coefficient** *n.* Quantity characterizing the deviation of the solvent from ideal behavior referenced to Raoult's law. The osmotic coefficient on an amount fraction basis is given by

$$\varphi = (\mu_A^* - \mu_A)/RT \ln x_A,$$

where $\mu_A{}^*$ and $\mu_A$ are the chemical potentials of the solvent as a pure substance and in solution, respectively. $x_A$ is the amount fraction. $R$ the gas constant and $T$ is the temperature.

**Osmotic pressure** (1888) *n.* The osmotic pressure developed between any dilute solution and its solvent will shown to be a colligative property; it is therefore dependent only on the concentration of the solution and on the properties of the solvent; a semipermeable membrane separates the solvent from solution, and allows the solvent to flow to the solution; Van't Hoff's equation is:

$$II = RTc/M_n,$$

where $I$ is the osmotic pressure, mmHg, $M_n$ the number average molecular weight, $c$ the concentration of small molecules (g/100 ml), $R$ the gas constant, and $T$ is the absolute temperature. And where the solute is many hundreds of times larger than the solvent, the equation becomes

$$II/c = (RT/M_n) + B_c,$$

where $B = RTA_2$ and $A_2$ is the second virial coefficient, $II/(RTc)_c = 0 = 1/M_n$. Collins EA, Bares J, Billmeyer FW Jr (1973) Experiments in polymer science. Wiley-Interscience, New York.

**Osnaburg** *n.* A coarse cotton or polyester/cotton fabric, often partly of waste fiber, in a plain weave, medium to heavy in weight, that looks like crash. Unbleached osnaburg is used for grain and cement sacks, and higher grades are used as apparel and household fabrics.

**Ostwald color system** *n.* System of classifying and designating colors in terms of their full color content, their white content, and their black content. The system was devised by Wilhelm Ostwald, based on additive color mixture, by means of spinning a Maxwell Disc and was used as the basic principle in making the color harmony manual.

**Ostwald-de Waele model** *See power law.*

**Ostwald–Fenske viscometer** A capillary viscometer for measuring time *v*, flow time a liquid or solution; viscosity molecular weight of a polymer can be derived.
*See dilute-solution viscosity.*

**Ostwald ripening** *n.* The process in an oil-in-water emulsion by which oil diffuses from the smaller droplets, across the aqueous phase, and into the larger droplets. The driving force for diffusion is the minimization of interfacial free energy by accumulating oil in larger droplets. Ostwald ripening can be mitigated by the addition of a co-stabilizer. The concentration of the co-stabilizer caused by monomer diffusion counters the reduction in interfacial area, causing an equilibrium condition.

**Ostwald U-tube** *n.* Viscometer in the form of a "U", in which the liquid flows from a bulb at a higher level on one side of the "U", through a capillary, to a receiving bulb on the other side. The time is measured for a given volume of liquid to pass from one side to the other.

**Otsu-ye** (Japanese) *n.* A rough broadsheet painting, of small size on paper: the precursor of the print.
*Also spelled "Otsue".*

**Ottoman** \ˈä-tə-mən\ (1605) *n.* Heavy, large, filling rib yarns, often of cotton, wool, or waste yarn, covered in their entirety by silk or manufactured fiber warp yarns, characterized this fabric used for women's wear and coats.

**Ouricuri wax** *n.* Hard wax obtained from the leaves of the Bahia palm, and used as a substitute for carnauba wax.
*Also spelled "Ouricury".*

**Ouropardo wax** *n.* Unusual hard wax of exceptionally high Sp gr (1.23), and possessing the property of resinifying on heating, without melting.

**Outflow quench** *n.* Air for cooling extruded polymer that is directed radically outward from a central dispersion device around which the filaments descend.

**Outgassing** *n.* A term used in the vacuum-metallizing industry for the evaporation under vacuum of a volatile substance such as moisture, solvent, or plasticizer, from plastic articles to be coated with metal. Outgassing can cause pressure increase (loss of vacuum), also darkening and poor adhesion of the metal coating.

**Outsert molding** *n.* A term coined to distinguish the process of molding small plastic parts in a large metal plate from the "insert molding", in which small metallic parts are incorporated into a larger plastic molding. The place is indexed in the injection mold by a pre-and-hole system, with the plastic parts injected through blanks pre-punched in the metal plate. The process makes it feasible to use plastics-metal combinations where economics formerly directed all-metal components.

**Outside finish** *n.* The surface treatment or decorative trim on the exterior of a building.

**Ovaloid** *n.* A surface of revolution symmetrical about the polar axis that forms the end closure for a filament-wound cylinder.

**Oven-dry weight** *n.* The constant weight of a specimen obtained by drying in an oven under prescribed conditions of temperature and humidity.

**Overall conductance** (overall heat-transfer coefficient) *n.* In heat-transfer engineering, the reciprocal of the total thermal resistance, for heat flow through plane walls or tube walls. It is defined by the equation: $U = q/A\,\Delta T$, where $q$ is the rate of heat flow through (and normal to) the surface of area $A$, and $\Delta T$ is the fall in temperature through the layer in the direction of $q$. This is a modification of Fourier's law, invented to deal conveniently with heat flow through stagnant fluid films adjacent to walls, films whose thicknesses are difficult or impossible to measure. For curved surfaces such as pipes, $U$ must be referred to either the inside or outside area, usually the later $(U_o)$. The SI unit for overall conductance is $\mathrm{W/m^2K}$.

**Overbaking** *n.* An exposure of the coating to a temperature moderately higher or for a longer period of time, or both, than recommended by the manufacturer of the coating for normal curing. This condition is in contrast to "heat resistance" which is a parameter relating to the service life of a coating.

**Overcoating** *n.* In extrusion coating, the practice of extruding a web beyond the edges of the substrate web.

**Overcure** *n* Caused by an aftercure or by being subjected to too high a temperature or too long a period at a proper temperature and resulting in a product less resistance to aging.

**Overcut** *n.* A staple fiber that is longer than nominal length. Usually, the length is a multiple of 2, 3, or more times the nominal length. An overcut is caused by the failure of filaments to be cut to the desired length during staple manufacture.

**Overflow groove** *n.* A small groove used in molds to allow material to escape freely to prevent flash and low part density, and to dispose of excess material.

**Overlap** *See lap.*

**Overlapping seam** *n.* Method of hanging wallpaper in which only one selvage is trimmed.

**Overlay sheet** (top sheet, surfacing mat) *n.* A non-woven fibrous mat of glass or synthetic fiber used as the surfacing sheet in decorative laminates. Its function is to provide a smoother finish, hide the fibrous pattern of the laminate, and/or to provide a decorative motif when printed on the underside.

**Overlength** *See overcut.*

**Overprint** *n.* The printing of one impression over another.

**Overprint varnish** *n.* A clear varnish applied over a printed job to improve its gloss and/or mar resistance, etc.

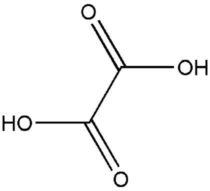
**Overproof** *n.* Containing a greater proportion of alcohol than proof spirit, especially, containing more than 50% alcohol by volume. Abbreviation is OP.

**Overspray** *n.* The roughness of a film of paint or lacquer due to dry particles deposited on, but not melded into a previously sprayed, semidried film. Overspray is encountered particularly with surfaces in more than one plane, such as auto bodies, television cabinets, etc. The remedy for overspray is a well-balanced solvent system containing enough high boiler to prevent the drying out of spray droplets before they land on an overshot surface.

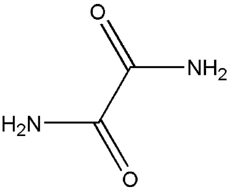
**Over-the-counter** (1921) *adj.* A term that usually refers to direct sales to a retail customer in a store, as opposed to wholesale marketing.

**Overtone** *See mass color.*

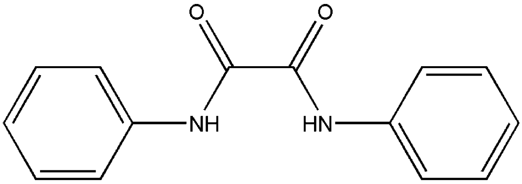
**Oxalic acid** \(ˌ)äk-ˈsa-lik-\ [F (*acide*) *oxalique*, fr. L *oxalis*] (1791) *n.* $(COOH)_2{\cdot}2H_2O$. Dicarboxylic acid, used as a bleaching agent. Mp, 99°C; Sp gr, 1.65; mol wt. 126.07 (*See image*).



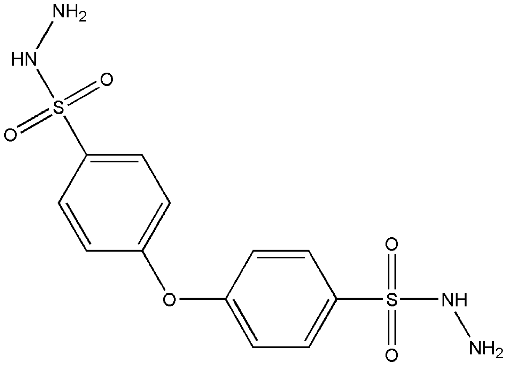
**Oxamide** *n.* $H_2NCOCONH_2$. A white powder, used as a stabilizer for cellulose nitrate CAS Registry Number: 471-46-5, CAS Name: Ethanediamide. Additional Names: oxalamide; oxalic acid diamide; ethanedioic acid diamide. Molecular formula: $C_2H_4N_2O_2$. Molecular weight: 88.07. Percent composition: C 27.28%, H 4.58%, N 31.81%, and O 36.33%. Line formula: $H_2NCOCONH_2$. Literature references: Prepared from formamide by glow-discharge electrolysis: Brown et al (1962). J Org Chem 27: 3698. Crystal structure: DeWith G, Harkema S (1977). Acta Crystallogr 33B:2367. Metabolized in body to form oxalic acid. Properties: Triclinic needles, declined at 350°. $d_4^{20}$ 1.667. Sparingly sol in hot water, alcohol. Density: $d_4^{20}$ 1.667 (*See image*).



**Oxanilide** *n.* $C_6H_5NHCOCONHC_6H_5$. A plasticizer with bp, 320°C; mol wt, 240.11; mp. 245°C. Syn: *N*,*N*-diphenyl-oxamide and oxalic acid dianilide. *Known also as camphol* (*See image*).



**4,4′-Oxybis(benzenesulfonylhydrazide) (OBSH)** *n.* The most important of the sulfonyl hydrazide family of blowing agents, a white crystalline solid melting at 164°C and yielding nitrogen upon decomposition. It is used widely in rubber-resin blends due to its ability to simultaneously foam the blends and act as a cross-linking agent, but it is also used in polyethylene, PVC, phenolics, and epoxy resins. Favorable properties are low odor, non-toxicity, and freedom from discoloration (*See image*).



**Oxford cloth** *n.* A soft but stout shirting fabric in a modified basket weave with a large filling yarn having no twist woven under and over two single, twisted warp yarns. The fabric is usually made from cotton or polyester/cotton blends and is frequently given a silk like luster finish.

**Oxidation** \\ˌäk-sə-ˈdā-shən\\ [F, fr. *oxider, oxyder* to oxidize, fr. *oxide*] (1791) *n.* (1) The formation of an oxide or, more generally, any increase in valence of an element. (2) In coatings, the introduction of oxygen into a molecule thereby producing a cured film. Rapid oxidation accompanied by flame is called *burning*. Oxidation is always exothermic.

**Oxidation inhibitor** *See anti-oxidant.*

**Oxidation number (oxidation state)** (1926) *n.* A somewhat arbitrary but useful way of indicating the approximate electrical characteristic of an atom.

**Oxidation potential** *n.* A measure of the tendency of an oxidation half-reaction to occur; expressed as the voltage produced by a cell employing the half-reaction at its anode and using the standard hydrogen electrode as its cathode.

**Oxidation–reduction** (1909) *n.* A chemical reaction in which one or more electrons are transferred from one atom or molecule to another.

**Oxidation–reduction reaction** *n.* An electron-transfer reaction.

**Oxidative aging, elastomers** *n.* Breaking down of an elastomer through the action of oxygen on the polymer itself or on other ingredients of the compound. The process may be signaled by change of color, visible deterioration of the part surface, or lowered performance in service.

**Oxidative coupling** *n.* A process defined as a reaction of oxygen with active hydrogen atoms from different molecules, producing water and a dimerized molecule. If the hydrogen-yielding substance has two active hydrogen atoms polymerization results. This process is used in the polymerization of phenols, particular polyphenylene oxide.

**Oxidative degradation** *n.* Breaking down of a polymer or plastic product through the action of oxygen on the polymer itself or on other ingredients of the compound. The process may be signaled by change of color, visible deterioration of the part surface, or lowered performance in service.

**Oxidative dehydrogenation** *n.* A chemical process used in making monomers such as styrene, butadiene, and vinyl chloride. Such "oxydehydro" processes involve either removal of hydrogen, from a hydrocarbon by oxygen, forming water; or removal of hydrogen from a hydrocarbon by a halogen to form the hydrogen halide, then regeneration of the halogen with oxygen.

**Oxide of chromium** *See chromium oxide green.*

**Oxidized asphalt** *See blown bitumen.*

**Oxidized bitumen** *See blown bitumen.*

**Oxidized rosin** *n.* Resin of much higher melting point than ordinary rosin and characterized by good solubility in industrial alcohol.

**Oxidized rubber** *n.* Rubber which has been subjected to oxidation by air, in the presence of catalysts. Oxidized rubber differs considerably from the parent rubber in that it is a dark reddish-brown color, and is much more compatible with solvents, drying oils, etc. It has good heat resisting properties and yields useful films on baking.

**Oxidized turpentine** *n.* Turpentine which has been thickened by blowing or oxidation with air.
*Also called fat turpentine.*

**Oxidizing agent** *n.* A substance or species, which gains electrons in a reaction. An electron acceptor.

**Oxime** \ˈäk-ˌsēm\ [ISV *ox-* + *-ime* (from *imide*)] (ca. 1890) *n.* Compound of the general type characterized by the grouping C=NOH. Butyraldoxime and methyl ethyl ketoxime are used as antiskinning agents and as anti-oxidants for dip-tank stability, etc.

**Oxirane** *n.* $C_2H_4O$. (1) Epoxide. Describing the oxygen atom of the epoxides ring. (2) Ethylene oxide. Syn: ethylene oxide.

**Oxirane group** Syn: epoxy group.

**Oxirane value** (oxirane oxygen) *n.* The percent of oxygen absorbed by an unsaturated raw material during epoxidation; a measure of the amount of epoxidized double bond in a material. The oxirane value and the iodine value are used in evaluating epoxy plasticizers. A high oxirane value and low iodine value are considered to be essential for good performance, but these are not the only criteria.

**Oxonium ion** *n.* Hydronium ion; $H_3O^+$.

**Oxo process** *n.* A chemical process utilizing a reaction known as *oxonation* or *hydroformylation*, in which hydrogen and carbon monoxide are added across an olefinic bond to produce an aldehyde containing one more carbon atom than the olefin. The aldehydes produced by this process can be reduced to alcohols, which are used for making many ester-type plasticizers.

**Oxy-** A prefix denoting the –O– radical or (primarily in Europe) the –OH radical.

***p*-Oxybenzoyl copolyester** *n.* Any of a family of readily moldable polyester copolymers consisting of mixtures of *p*-oxybenzoÿl with units from aromatic carboxylic acids and aromatic diphenols.

***p*-Oxybenzoyl polymer** *n.* A polymer based on *p*-hydroxybenzoic acid (derived from phenol and carbon dioxide). Technically a thermoplastic, the polymer retains good stiffness at temperatures up to 315°C and, at temperatures around 425°C, undergoes a second-order transition and becomes malleable so that it can be forged like ductile metals. Some other properties are high dielectric strength, elastic modulus, thermal conductivity, resistance to wear and solvents, self-lubricity, and good machinability. It has also been blended with metals to form alloys. Copolymers (see preceding entry) sacrifice some of the high-temperature performance to gain moldability.

**Oxygen-index flammability test** *See flammability, ASTM D 2863*, www.astm.org.

**Oxygen-transmission rate** *See permeability.*

**Oxymethylene** *n.* (1) Syn: formaldehyde. (2) (oxane) The group ($–OCH_2–$) the chain unit of acetal resins.

**Oxyns** *n.* Name given to the oxidation products of drying oils, which are obtained by the addition of oxygen to the double bonds of the unsaturated fatty acids.

**Ozokerite** \ˌō-zō-ˈkir-ˌīt\ [Gr *Ozokerit*, fr. Gk *ozein* to small + *kēros* was] (ca. 1837) *n.* Natural mineral wax of variable properties, found in Germany, America, South Africa, and Austria. Its mp varies from 59 to 90°C and its Sp gr from 0.900 to 0.960.

**Ozonation** \ˌō-(ˌ)zō-ˈnā-shən\ (1854) *n.* Chemical reaction with ozone.

**Ozone** \ˈō-ˌzōn\ [Gr *Ozon*, fr. Gk *ozōn*, pp of *ozein* to smell] (ca. 1840) *n.* An allotropic form of oxygen, $O_3$, a faintly blue, irritating gas and a powerful oxidant.

**Ozone fading** *n.* The fading of a dyed textile material, especially those in blue shades, caused by atmospheric ozone ($O_3$).

**Ozone resistance** *n.* The ability of a plastic or elastomer to withstand, without diminution of useful properties, the chemical action (strong oxidation) of ozone.

**Ozonolysis** *n.* Oxidation of an organic material by means of ozone.

# P

**p** \ˈpē\ *n.* (1) Abbreviation for SI prefix pico-. (2) *p*-Abbreviation for para-.

**P** *n.* (1) Chemical symbol for the element phosphorus. (2) Abbreviation for SI prefix peta-. (3) Symbol for pressure or permeability.

**Pa** *n.* SI abbreviation for pascal.

**PA** *n.* (1) Abbreviation for polyamide. (2) Abbreviation for phthalic anhydride. *See nylon.*

**PAA** *n.* Abbreviation for polyarylic acid.

**PABM** *See polyaminobismaleimide resin.*

**PAC** *n.* Poly(acrylonitrile) fiber.

**Pack** \ˈpak\ {*often attributive*} [ME, pf LGr or D origin; akin to MLGr & MD *pak* pack] (13c) *n.* (1) The complete assembly of filters and spinneret through which polymer flows during extrusion. (2) A unit of weight for wool, 240lb. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.

**Package build** *n.* A general term that applies to the shape, angles, tension, etc., of a yarn package during winding. Package build affects performance during subsequent processing.

**Package dyeing** *See dyeing, yarn dyeing.*

**Package stability** *n.* The ability of a liquid such as paint or varnish, to retain its original quality after prolonged storage.

**Packing braid** *n.* A braid of reinforcing fiber having a fully filled, square cross-section.

**Pack life** *n.* The time during which a pack assembly can remain in use and produce good quality yarn.

**Padding** *n.* The application of a liquor or paste to textiles either by passing the material through a bath and subsequently through squeeze rollers, or by passing it between squeeze rollers, the bottom one of which carries the liquor or paste.

**Paddle agitator** *n.* One of the simple types of mixing equipment for plastics in the form of dispersions, pastes, and doughs. The most common form comprises a set of rotating blades driven by a vertical shaft and intermeshing with a set of fixed blades.

**Paddle dyeing machine** *n.* A machine used for dyeing garments, hosiery, and other small pieces that are packaged loosely in mesh bags. The unit consists of an open tank and revolving paddles that circulate the bags in the dyebath.

**PAI** Abbreviation of polyamide-imide resin.

**Paint** \ˈpānt\ (1) *v.* To apply a thin layer of a coating to a substrate by brush, spray, roller, immersion, or any other suitable means. (2, *n*) Any pigment liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer, which is converted to an opaque solid film after application. Used for protection, decoration or identification, or to serve some functional purpose such as the filing or concealing, of surface irregularities, the modification of light and heat radiation characteristics, etc. (3) The dispersion of pigment in a liquid vehicle that may be applied to surfaces to form a thin adherent protective or decorative coating. The liquid vehicle usually consists of a film-forming resin dissolved in a solvent, or resin latex. Resins most frequently used in paints are phenolics, polyesters, urea's, melamine's, cellulosics, acrylics, vinyls, alkyds, and epoxies. (ASTM Special Technical Publication No. 500), American Society for Testing and Materials, Philadelphia, PA, 1972. Tatton WH, Drew EW (1964) Industrial paint application. Hart Publishing Co., New York. Tatton WH, Drew EW (1964) Industrial paint application. Van Nostrand Co. Inc., Princeton, NJ. Taubes F (1971) Painter's dictionary of materials and methods. The Watson–Guptill Publications, New York. Sward GG (ed) Paint and Coating Testing Manual (Gardner-Sward Handbook) (1995) MNL 17, 14th edn. ASTM, Conshohocken, PA.

*See also lacquer and enamel*

**Paint and varnish remover** *n.* Liquid, principally solvents, sometimes with wax or thickeners, which is applied to a coated surface in order to soften the old coating and bring it to such a condition that it can be easily removed.

*Also called stripper.*

**Paint base** *n.* The vehicle into which pigment is mixed to form a paint; commonly alkyd, latex, and acrylic. Talen HW (1962) Some consideration on the formation of films. J Oil Colour Chem Assoc 45(6): 387-415.

**Painter's mitt** *n.* A glove-like device that slips over the hand. Used for coating areas inaccessible with a brush or roller such as fences and walls behind radiators.

**Painter's naphtha** *See VM & P naphtha.*

**Painter's putty** *See putty.*

**Paint harling** *n.* Process of throwing paint-coated granite chips on to a sticky paint film previously applied to a surface, to give a roughcast effect. This gives a thick durable finish which had been used, e.g., on steel clad houses.

**Painting of plastics** *n.* Plastic articles are painted not only to enhance their appearance, but also to provide desired surface properties lacking in the unpainted articles. For example, electrical properties and resistance to water, solvents, chemicals, and abrasion resistance may be improved by painting. Adhesion of paints to plastics is achieved by intermolecular attraction, solvent etching, or a combination of both. In the case of plastics of low surface energy, e.g. polyethylene, an oxidative pretreatment is mandatory for good coating adhesion. The methods used to apply paints to plastics are spraying (with or without masks) dip coating, flow coating, roller coating, screen printing, and spray-and-wipe painting.

**Paint mitt** *See painter's mitt.*

**Paint remover** *See paint and varnish remover.*

**Paint research institute (PRI)** *n.* Fundamental research-granting agency of the coatings industry; supported mainly by the Federation of Societies for Coatings Technology (FSCT), and by donations from individuals, corporations, and many associations within the coatings industry.

**Paint roller** *n.* A cylindrical tube which is coated on the outside with Non-woven fibers such as nylon, mohair, and lamb's wool, and mounted on a roller with a handle; used for application of paint or varnish.

**Paint system** *See coat.*

**Paint thinner** *See thinner.*

**Paisley** \ˈpāz-lē\ {*often capitalized*} [Paisley, Scotland] (1824) *adj.* A drop-shaped pattern that is extremely popular for men's ties and women's wear.

**PAK** *n.* Abbreviation for polyester alkyd resin.

*See alkyd resin.*

**Pale boiled oil** *n.* Lightly blown linseed oil containing a small amount of driers, such as lead and manganese.

**Pale crepe** Light, unsmoked natural rubber.

**Palette** \ˈpa-lət\ [F, fr. MF, dim. of *pale* spade, fr. L *pala*; prob. akin to L *pangere* to fix] (1622) *n.* (1) Surface in which an artist sets out, and mixes his pigments and range of colors which he uses. (2) The typical color range of a school or group. (3) The gamut of colors possible when mixing a prescribed group of colorants. Gair A (1996) Artist's manual. Chronicle Books LLC, San Francisco.

**Palette knife** (1759) *n.* A spatula, usually smaller and slightly more flexible than the kind used for domestic and laboratory purposes, which serves to mix the artist's paint.

**Palmitic acid** \(ˌ)pal-ˈmi-tik-\ [ISV, fr. *palmitin*] (1857) *n.* $CH_3(CH_2)_{14}COOH$. Bp, 278°C; mp, 62°C; Sp gr, 0.846/8°C; acid value, 218.8 (*See image*).

**Palm oil pitch** *See fatty acid pitches.*

**Pan** \ˈpan\ [ME *panne*, fr. OE (akin to OHGr *phanna* pan), fr. L *patina*, fr. Gk *patanē*] (before 12c) *n.* In coil coating, the open container at the coater which holds the paint, and also the place where the pickup roller revolves in the paint.

**PAN** *n.* Abbreviation for poly(acrylonitrile).

**Panel decoration** *n.* A type of wallpaper which flourished in the second half of the 18th century, related to the wood-paneled walls then in use. Wallpaper panels of the present day are thought of more as "spot" decorations.

**Paneling** *n.* Distortion of a filled or partly full plastic container occurring during aging or storage, due to outward diffusion of solvent that causes reduced pressure inside the container.

**Panels (hosiery)** *n.* Knitted panels used for testing purposes.

**Panné satin** *n.* A satin fabric with an unusually high luster because of the application of very heavy roll pressure in finishing. Panné satin is made of silk or one of the manufactured fibers.

**Pantone printing** *n.* Planographic printing proves using plates having mercury- or amalgam-coated non-printing areas.

**PAPA** Abbreviation for polyazelaic polyanhydride.

**Paper, building** *See building paper.*

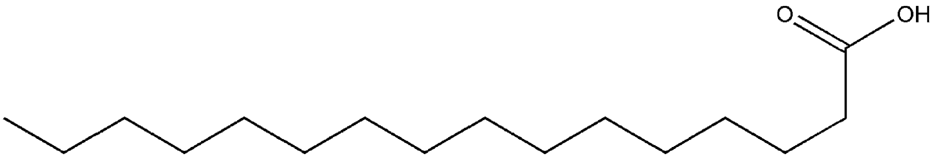
**Paper chromatography** \-ˌkrō-mə-ˈtä-grə-fē\ (1948) *n.* The original chromatography.

**Papermarker's felt** *n.* Formerly, a heavy, wide, coarse, worsted, or woolen fabric that was threaded between the rolls of the papermaking machine to form an endless conveyer belt for pulp or wet paper in its passage through the machine. These products are now also made of various constructions, woven, and non-woven, of manufactured fibers and monofilaments.

**PAPI (PMPPI)** Abbreviation for polymethylenepolyphenylene isocyanate. *See diisocyanate.*

**Papier-mâché** \ˌpā-pər-mə-ˈshā\ [F, literally, chewed paper] (1753) *n.* Paper which is wet, molded, and hardened into forms used for decorative purposes.

**Para-** \ˈpär-ə\ [ME, fr. MF, fr. L, fr. Gk fr. *para*; akin to Gk *pro* before] *n.* (1) A chemical prefix from the Greek word meaning beside or beyond, denoting a relation "alongside" another compound such as a higher hydrated form of an acid or a polymeric form, as in paraldehyde. (2) (italicized, *p*-) Denoting the relation of opposite carbon atoms in the benzene ring, the 4-position in a singly substituted benzene.



**Palmitic acid**

In this use, the prefix is ignored in alphabetizing compounds.

**Para brown** *n.* Bright brown pigment of good staining power, made by treating para red with copper salts.

**Parachlor nitraniline red** *See parachlor red.*

**Para-chlor-ortho-nitraniline** *n.* Pigment red 6 (12090). The parachlor variety of chlorinated para red is redder (less yellow) in shade and more transparent compared to the ortho-chlor but much superior in lightfastness. It is superior in tint lightfastness to toluidine red. Special precautions are required in drier addition to parachlor red paints since it discolors (dark and dull) with cobalt and/or iron driers. Syn: parachlor red.

**Parachlor red** *See para-chlor-ortho-nitraniline.*

**Paracoumarone-indene resins** *n.* Resin obtained from coumarone by polymerization with sulfuric acid.

*See coumarone-indene resins.*

**Paraffin** \ˈpar-ə-fən\ [Gr, fr. L *parum* too little (akin to Gk *pauros* little, *paid-*, *pais* child) + *affinis* bordering on] (1838) *n.* (1) A Syn: alkane. (2) A colorless, translucent wax obtained from petroleum-refining residues, a mixture of most saturated, straight-chain hydrocarbons melting between 49 and 63°C. (3) In Britain and its former possessions, kerosene.

**Paraffin oil** *n.* An oil either pressed or dry-distilled from paraffin distillate.

**Paraffin wax** *n.* Inert hydrocarbon wax derivative of crude petroleum. Paraffin waxes are distinguished by their melting points. Their main uses include the conferring of water resistance, slip, or solvent retention in special types of compositions.

**Paraformaldehyde** \ˌpar-ə-fór-ˈmal-də-ˌhīd\ (1894) *n.* A low-molecular-weight, linear polymer of formaldehyde $HOCH_2$-$(OCH_2)_nOCH_2OH$, a white solid that is easily depolymerized by mild heating to yield anhydrous formaldehyde gas. It is therefore a convenient form in which to handle and ship formaldehyde for industrial processes such as the manufacture of acetal resins, it high-molecular-weight, stable homologs.

*See also 1,3,5-trioxane.*

**Paralac** Polyester resin, manufactured by ICI, Great Britain.

**Paralleling** *n.* The process of aligning fibers to produce a more uniform, smoother, stronger yarn.

**Parallel laminated** \ˈpar-ə-ˌləl ˈla-mə-ˌnāt-\ *n.* Pertaining to a laminate in which all layers of reinforcement are oriented approximately parallel with respect to the length or the direction of applied tensile stress.

*See laminated, parallel.*

**Parallel-plate viscometer** *n.* (1) An instrument consisting of two circular parallel plates, the lower one stationary, the upper one rotatable, the disk-shaped specimen being confined between the plates. An example of this type of viscometer is the Mooney viscometer.

**Parallels** *n.* (1) Spacers placed between the steam plate and press platen to prevent the middle section of a compression mold from bending under pressure. (2) Pressure pads or spacers between the steam plates of a mold when the land area is too small. The pads control the height when the mold is closed and thus prevent crushing parts of the mold.

**Paramagnetic materials** \ˌpar-ə-mag-ˈne-tik-\ *n.* Those within which an applied magnetic field is slightly increased by the alignment of electron orbits. The slight diamagnetic effect in materials having magnetic dipole moments is overshadowed by this paramagnetic alignment. As the temperature increases this paramagnetism disappears leaving only diamagnetism. The permeability of paramagnetic materials is slightly greater than that of empty space. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. CRC Press, Boca Raton, FL.

**Paramagnetism** *n.* A weak attraction into a magnetic field, a result of the presence of unpaired electrons in a substance.

**Parameter** \pə-ˈram-ə-tər\ [NL, fr. *para-* + Gk *metron* measure] (1656) *n.* (1) Loosely, a system factor or variable that may take on a range of values as decided by the observer or operator of the system. Example: hydraulic-line pressure and cylinder temperature are parameters in injection molding. (2) A defining constant of a statistical distribution, such as the mean or standard deviation of a normal distribution, and distinct from estimates of same calculated from sample measurements. (3) An independent variable through whose functions relations between other factors may conveniently be expressed.

**Parameter of specular gloss** *n.* A measurement of specular gloss dependent on glossmeter geometry.

**Para nitraniline red** *See para reds.*

**Paraphthalate plasticizer** *n.* Any of a family of plasticizers derived by reacting terephthalic acid with an alcohol. They are similar in plasticizing capacity to the orthophthalate plasticizers while offering improved performance in areas such as volatility, low temperature flexibility, electrical, and lacquer-marring. With the exception of dioctyl terephthalate (DOTP), a liquid plasticizer suitable for plastisols, most paraphthalates are solids when prepared from alcohols having an average chain length over six carbon atoms.

**Para red** *n.* Pigment red 1 (12070). Series of red pigments made by coupling reactions involving diazotized *p*-nitroaniline and alkaline *β*-naphthol. Adjustments in shade are made by substituting part of the *β*-naphthol.

**Para toner** *See para reds.*

**Paraxylylene** *See parylene.*

**Parfocal objectives** \ˌpär-ˈfō-kəl-əb-ˈjek-tiv\ *n.* Objectives which are mounted so that only small adjustment of the bodytube and stage is necessary to focus after changing from one objective to any of the others. They are mounted in such a way that the second conjugate plane is in the same position on the optical axis of the microscope for each objective. Objectives used on a rotating nosepiece are usually parfocal. Eyepieces are also parfocal within any given manufacturer's series.

**Parison** *n.* The hollow tube or other preformed shape of molten thermoplastic that is inflated inside the mold in the process of blow molding. Most commonly, the parison is extruded immediately before blowing, but parisons are also injection molded and may also be chilled and stored, to be reheated before blowing. In the earliest application of blow molding, a pair of calendered sheets joined along the edges was used as the parison.

**Parkerized** *adj.* Descriptive of iron or steel which has received a rust-proofing treatment by being dipped in a boiling solution of manganese dihydrogen phosphate; this protective coating also improves the bonding of paints and lacquers.

**Parkesine** *n.* The name given to the historic first (commercially unsuccessful) thermoplastic, made by plasticizing cellulose nitrate. The polymer was dissolved in a solvent, castor oil was mixed in, and the solvent was evaporated. The product was developed by Alexander Parkes and was the forerunner of Celluloid, which was perfected in 1870 by John Wesley Hyatt, who used camphor as the plasticizer.

**Parlon** *n.* Chlorinated rubber, manufactured by Hercules Powder, USA.

**Parquet** \ˈpär-ˌkā\ [F, fr. MF, small enclosure, fr. *parc* park] (1818) *n.* A wood floor inlaid with geometric patterns. A type of decoration dating from 17th century France.

**Parqueting** (1678) *vt.* Method of reinforcing the backs of wood panels with battens to prevent them from warping.

**Parquetry** \ˈpär-kə-trē\ (ca. 1842) *n.* Patterned wood inlay, especially for floors.

**Partial aromatic solvents** *See aromatic solvents.*

**Partially oriented staple** *n.* Staple fibers cut from tow that has been drawn less than normal so that only partial longitudinal orientation of the polymer molecules exists.

**Partially oriented yarns (poly)** *n.* Filament yarns in which the draw ratio is less than normal resulting in only partial longitudinal orientation of the polymer molecules.

**Partial molar quantities** *n.* The partial molar quantity of the substance A in a mixture of *n* components is the change in a thermodynamic property of such mixture per mole of component A. The partial molar quantities show the contribution of component A to the total thermodynamic properties of the mixture.

**Partial pressure** *n.* The pressure which a gas in a mixture would exert on the walls of a container if no other gases were present.
*See Raoult's law.*

**Particle board** *n.* A panel material composed of small discrete pieces of wood or other lignocellulosic materials that are bonded together in the presence of heat and pressure by a synthetic resin adhesive. Particle boards are further defined by the method of pressing. When the pressure is applied in the direction perpendicular to the faces, as in a conventional multiplaten hot press, they are defined as flatplaten pressed, and when the applied pressure is parallel to the faces, they are defined as extruded. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.
*Also called flake board.*

**Particle size (Rayleigh, Mie, and Frankhoffer)** *n.* (1) Solid particles of matter and their dimensions (usually average diameter) which industrial materials are composed; carbon black, clays, etc., the fundamental theories for studying the scattering of light by the Tyndel effect produced by increasing sizes of particles from "molecular to colloid to visible" are Rayleigh, Mie and Frankhoffer, respectively. (2) In paints, the diameter of a pigment or latex particle; usually expressed in mils or micrometer. Provder T (ed) (1991) Particle size distribution II: assessment and characterization. Oxford University Press, New York.

**Particle size distribution** *n.* The relative percentage by weight or number of each of the different size fractions of particulate matter.

**Particulate** \pär-ˈti-kyə-lət *also* -ˌlāt\ (1871) *n.* (1, *adj*) Existing as minute, separate particles. (2, *n*, plural) A particulate substance, a powder.

**Particulate composite** *n.* A plastic filled with solid particles of one or more substances that do not melt during processing.
*See filler.*

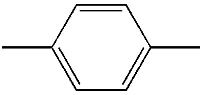
**Particulates** *n.* Finely divided solid or liquid particles in the air or in an emission. Particulates include dust, smoke, fumes, mist, spray, and fog.

**Parting agent** (release agent, mold lubricant, and mold release) *n.* A lubricant, often wax, silicone oil, or fluorocarbon fluid or solid, used to coat a mold cavity to prevent the molded piece from sticking to it, and thus to facilitate its removal from the mold. Parting agents are often packaged in aerosol cans for convenience in application.

**Parting line** (flash line) *n.* (1) A line marked on a three-dimensional model from which a mold is to be prepared, to indicate where the mold is to be split into two halves or several components. (2) The mark on a molded or cast article caused by slight flow of material into the crevices between mold parts. If the amount of material is sufficient that it must be removed, it is called flash.

**Partition** \par-ˈti-shən\ (15c) *n.* (1) Any building component that divides space such as a wall, door, window, roof, or floor-ceiling assembly; or a combination of components such as a wall containing a door and a window. (2) A solvent system in which the solute is divided between two components of the liquid phase, the ratio of their concentration (partition coefficient) being constant for a given substance.

**Parylene** (poly-*p*-xylylene) *n.* Generic name for a group of film-forming thermoplastics introduced in 1965 by Union Carbide. The basic member, trade named Parylene N, is a polymer of *p*-xylylene, which has the structure shown below. Parylenes C and D contain one and two chlorine atoms on the benzene ring, and other types have recently become available. The polymer is formed on a receiving surface by pyrolyzing the dimmer of *p*-xylylene, a white powder, in vacuum (0.13 Pa abs) to its monomer vapor, which then flows to the room-temperature deposition chamber and forms a polymeric film with the structure $(-C_6H_4-CH_2CH_2-)_n$. Objects to be coated are usually mounted on rotatable racks to improve the uniformity of coating thickness. The films are tough, have excellent chemical resistance, low permeability, high thermal stability, and dielectric strength, and have been used to protect electronic assemblies and other critical parts from atmospheric oxygen and moisture. Very thin films – down to 25 nm (1 µm) – can be formed without pinholes, and thickness uniformity is good even on irregular surfaces. The rather high cost of the material and processing still limits use (*See image*).



**Parylen C** *n.* Poly(monochyloro-*p*-xylylene), manufactured by Union Carbide, USA.

**Parylen N** *n.* Poly(*p*-xylylene), manufactured by Union Carbide, USA.

**Pascal** \pas-ˈkal\ [Blaise *Pascal*] (1956) (Pa) *n.* The SI unit of pressure and stress, equal to 1 Newton per square meter ($N/m^2$). The pascal and its multiples are intended to supersede all other units of force per unit area such as pounds per square inch, atmosphere, torr, etc (1 psi = 6.894,757 kPa, 1 atm = 101.3250 kPa, and 1 torr = 133.322 Pa).

**Pascal second** (pascal-second, Pa·s) *n.* The SI unit of dynamic (absolute) viscosity, equal to 1 $Ns/m^2$. Some conversions of older viscosity units (of which there is a bewildering plethora) to Pa·s are given in the appendix. When shear stress $\tau$ assumes its alternate identify, momentum flux, the pascal-second is interpreted as 1 kg/m s).

**Pascal's law** *np.* Externally applied pressure on a confined fluid is transmitted equally in all directions.

**Pass** *n.* Motion of spray gun in one direction only.

**Passivation** \ˌpa-si-ˈvā-shən\ (1913) *n.* Act of making inert or unreactive.

**Paste** \ˈpāst\ [ME, fr. MF, fr. LL *pasta* dough, paste] (14c) *n.* An adhesive composition having a characteristic plastic-type consistency, that is, a high order or yield value, such as that of a paste prepared by heating a mixture of starch and water and subsequently cooling the hydrolyzed product.

*See also adhesive, glue, mucilage, and sizing.*

**Paste blue** *See iron blue.*

**Paste driers** *n.* Driers made by grinding or mixing suitable inorganic drying compounds of lead or manganese into drying oil, together with some cheap filler to provide bulk. The resultant product is a stiff paste. Rarely made today.

*Known also as patent driers.*

**Paste filler** *See filler.*

**Pastel** \pa-ˈstel\ (1884) *adj.* (1) Light tint; masstone to which white has been added. (2) Soft delicate hue. (3) In art, a picture made with a crayon of pigment with some binding medium such as gum.

**Pastel painting** *See pastel.*

**Paste, pigment** *n.* Pigment dispersion concentrate to permit substantial reduction (let down) with solvent, water, or vehicle.

**Paste, PVC** A term sometimes used for plastisol.

**Paste resin** A term sometimes used for PVC resins used in making vinyl dispersions such as plastisols.

*See dispersion resin.*

**Pasteurizing varnishes** \ˈpas-chə-ˌrīz-eŋ ˈvär-nish\ *n.* Varnishes for food containers which are capable of withstanding immersion in water at pasteurizing temperature for half an hour or more. Pasteurizing temperature is about 70°C, but food canners often require varnishes to withstand immersion in boiling water, or water boiling under pressure, without softening.

**Paste water emulsion wax** *n.* Similar to liquid water emulsion wax except furnished in paste form. Must be polished for luster. Occasionally pigmented. May contain some solvent.

**Pastiche** \pas-ˈtēsh\ [F, fr. It *pasticcio*] (1878) *n.* Work of art composed in the style of another person.

**PAT** Abbreviation for polyaminotriazole.

**Patent driers** *See paste driers.*

**Patent vermillion** *See mercuric sulfide.*

**Pathogenicity** \pa-jə-ˈni-sə-tē\ [ISV] (1852) *n.* The state or condition of producing disease or capable of doing so.

**Pathogen, pathogene** \ˈpa-thə-jən\ [ISV] (1880) *n.* A parasite or virus capable of causing disease.

**Patina** \pə-ˈtē-nə\ [It, fr. L, shallow dish] (1748) *n.* (1) The film (usually greenish) which forms on copper or copper alloys through chemical action. (2) The gloss on wooden and other surfaces. (3) The softening of color that develops with age.

**Pat-out** *See tap-out.*

**Pattern** \ˈpa-tərn\ [ME *patron*, fr. MF, fr. ML *patronus*] (14c) *n.* (1) An arrangement of form; a design or decoration such as the design of woven or printed fabrics. (2) A model, guide, or plan used in making things, such as a garment pattern.

**Pattern staining** *n.* Patterns on surfaces caused by deposits of dust, the amount of which varies according to the relative thermal conductivity of different pats of the structural background. The more highly conductive (colder) areas collect more dust that those of poor conductivity, thus the pattern of the underlying structure shows. The dust is often carried toward the surface by convection currents.

**Pattern wheel** *n.* In a circular-knitting machine, a slotted device for controlling individual needles so that patterns can be knit in the fabric.

**Pb** *n.* Chemical symbol for the element lead (Latin: *plumbum*).

**PB** *n.* Abbreviation for poly-1-butene.

*See polybutylene resin.*

**PBAN** *n.* Abbreviation of polybutadiene-acrylonitrile co-polymer.

*See NBR and acrylonitrile-butadiene co-polymer.*

**PBI** *n.* Abbreviation for polybenzimidazole, manufactured by Celanese, USA.

**PBMA** *n.* Abbreviation for poly-*n*-butyl methacrylate.

**PBS** *n.* Abbreviation for polybutadiene-styrene co-polymer.

*See styrene-butadiene thermoplastic.*

**PBTP** *n.* Abbreviation for polybutylene terephthalate.

**PC** *n.* Abbreviation for polycarbonate resin.

**PCB** *n.* Poly(acrylonitrile) fibers (EEC abbreviation).

*See chlorinated diphenyls.*

**PCF** *n.* Poly(trifluorochloroethylene) fiber.

**PCL** *n.* Abbreviation for polycarproylactone.

**PCT** *See polycyclohexylene dimethylene terephthalate.*

**PCTFE** *n.* Poly(trifluorochloroethylene) fiber.

*See polychlorotri-fluoroethylene.*

**PCTFE fluoroplastics** [$CF_2CFCl$] *n.* Common name for ethane, chlorotrifluoro-, homopolymer. It is also commonly known as Halocarbon oil. PCTFE is prepared by free radical polymerization in aqueous solution. It is used in seals, gaskets and in certain electrical applications.

**PDAP** *n.* Abbreviation for poly(diallyl phthalate). The abbreviation DAP is widely used for both the monomeric and polymeric foams of diallyl phthalate.

**PDCA** *n.* Abbreviation for painting and decorating contractors of America.

**PDMS** *n.* Abbreviation for polydimethyl siloxane.

**PE** *n.* (1) Polyester fiber (EEC abbreviation). (2) Abbreviation for poly-ethylene, polyethene. (3) Abbreviation for pentaerythritol.

**Peacock blue** (1881) *n.* Lake of aid glaucine blue dye on alumina hydrate. Structurally, the dye is alpha, alpha-bis [*N*-ethyl-*N*-(4-sulfobenzyl) amino phenyl] – alpha-hydroxy-ortho toluenesulfonic acid sodium salt.

**Peanut-hull flour** *See nutshell flour.*

**Peanut oil** (1882) *n.* A fixed oil that is yellow to greenish yellow. It is a typical non-drying oil of olive oil type. It is soluble in ether, petroleum ether, carbon disulfide and chloroform; insoluble in alkalies, but saponified by alkali hydroxides with formation of soaps; insoluble in water; slightly soluble in alcohol. It is principally glycerides of oleic and linoleic acids, with lesser amounts of the glycerides of palmitic, stearic, archidic, behenic, and lignoceric acids. Peanut oil is made by pressing ground peanut meats or by extraction with hot or cold solvents. Constants: Sp gr, 0.912–0.920 (25°C); solidifying point, −5 to +3°C; saponification value, 186–194; iodine value, 99–98; refractive index, 1.4625–1.4645 (40°C). Shahidi F, Bailey AE (eds) (2005) Bailey's industrial oil and fat products. John Wiley and Sons, New York. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Philadelphia, PA, 2001.

*Also known as archis oil and groundnut oil.*

**Pearl** \ˈpər(-ə)l\ *n. See purl* (2).

**Pearlescent** \ˌpər-ˈle-sᵊnt\ (1936) *adj.* An appearance resembling that of natural pearls or mother-of-pearl; it results from the specular reflectance of alternating thin layers of differing refractive index; similar to nacreous, interference color; the pigment particles are transparent, thin platelets of high refractive index which partially reflect and partially transmit incident light; simultaneous reflection from many layers of oriented platelets creates a sense of depth that is characteristic of nacreous luster. Syn: nacreous. Leher LR, Salzman M (1985) Color pigments. Applied Polymer Science, American Chemical Society, Washington, DC. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

*See interference color.*

**Pearlescent pigment (pearl-essence pigment, nacreous pigment)** *n.* A pigment with crystalline, transparent particles in the form of parallel platelets that impart an appearance of mother-of-pearl to plastics. The thin platelets have a high refractive index. Each crystal reflects only a portion of incident light reaching it, transmitting the remaining light to the crystal below. The simultaneous reflection of light from many parallel layers produces the characteristic pearly luster, the brilliance of which depends on the uniformity and parallelism of the crystals. Natural pearlescent pigments are composed primarily of guanine crystals derived from fish scales. They are expensive but non-toxic. The synthetic pearlescents are based on crystallized lead or bismuth compounds or platelets of mica coated with a dye or pigment. Leher LR, Salzman M (1985) Color pigments. Applied Polymer Science, American Chemical Society, Washington, DC. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing, PA.

*See nacreous pigment, interference pigments.*

**Pearl essence** (ca. 1909) *n.* Extract from fish scales used for obtaining the mother-of-pearl effect.

**Pearlite** \ˈpər(-ə)-ˌlīt\ [F *perlite*, fr. *perle* pearl] (1888) *n.* The lamellar mixture of ferrite and cementite in slowly cooled iron–carbon alloys occurring normally as a principal constituent of both steel and cast iron. Same as perlite.

**Pearl lacquer** *See pearlescent.*

**Pearl moss** *See carrageen.*

**Pearl polymerization** *See granular polymerization and suspension and bead polymerization.*

**Pearlstone** *See perlite, expanded.*

**Pear oil** *See amyl acetate.*

**Peat wax** *n.* Wax, resembling molten wax, obtained by the solvent extraction of pet. Mp, 70–100°C.

**Peau de soie** *n.* A heavyweight, soft satin of silk or manufactured fiber with a fine cross rib and a dull luster. The term is French for "skin of silk".

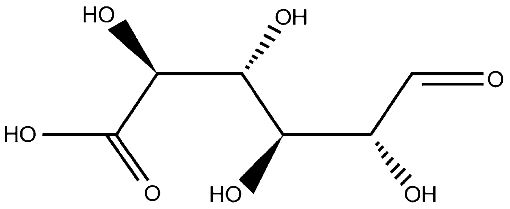
**Pebble mill** *n.* A rotating porcelain, buhrstone (or other non-metallic lined) cylinder containing pebbles or porcelain balls or rods as the grinding media. In the manufacture of pigments or paints it is used to grind and/or disperse.

*See ball mill.*

**Pebble-weave fabric** *n* A fabric with an irregular or rough surface texture formed by either a special weave or by the use of highly twisted yarns that shrink when they are wet.

**PE CE** *n.* Post-chlorinated vinyl chloride polymer. The post-chlorination process increases chlorine content form 57 to 64%. The resulting polymer is soluble in acetone and can be wet spun. Manufactured by BASF, Germany.

**Pectin** \ˈpek-tən\ [F *pectine*, fr. *pectique*] (1838) *n.* A water-soluble plant polysaccharide, mainly *D*-galacturonic acid, but also containing other sugar units. CAS registry number: 685-73-4. Molecular formula: $C_6H_{10}O_7$. Molecular weight: 194.14. Percent composition: C 37.12%, H 5.19%, and O 57.69%. Literature references: Obtained by hydrolysis of pectin where it is present as polygalacturonic acid: Ehrlich G (1917). Chem Ztg 41:197; Ehrlich G (1933). Biochem Z 259:100; Ber 66:220; Niemann L (1932). J Biol Chem 95:203; 104, 743 (1934); Morell L (1933). Ibid 100:385; Anderson K. J Chem Soc 1961: 5333. Isoln from mustard seeds: Goering, USA 2987448 (1961 to oil seed production). Derivative type: α-form. Properties: monohydrate, needles, mp 159°C. Soluble in water; slightly soluble in hot alcohol. Practically insoluble in ether. Melting point: mp 159°C. Optical rotation: $[\alpha]_D^{20} + 98.0^\circ C \rightarrow + 50.9^\circ C$ (water). Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001. (*See image*).



**Pedion** *n.* In crystallography, a single face having no equivalent.

**PEEK** *n.* Abbreviation for polyetheretherketone.

**Peel adhesion** *n.* The force required to delaminate a structure or to separate the surface layer from a substrate. Peel adhesion is the usual measure of the strength of the bond between fiber reinforcements and rubber in tires and other mechanical rubber goods.

**Peeler** *n.* (1) A machine for slitting large rolls or blocks of foamed plastics into thin sheets, by rotating the blocks into a horizontally mounted band saw blade. Sheets as thin as 1.5 mm may be produced by this method. (2) In beaming, a defect caused by a portion of an end sticking or remaining on the beam, causing the filament to strip back or peel until it is broken. Although they are often associated with ringers, peelers are not necessarily defects that will circle the beams.

**Peeling** *n.* Spontaneous removal in ribbons or sheets of a paint, varnish, or lacquer film from a surface due to loss of adhesion.

**Peel ply** *n.* The outside layer of a laminate that is removed or sacrificed to achieve improved bonding of additional layers.

**Peel test** *n. See "scotch-tape" test.*

**PEG** *n.* Abbreviation for polyethylene glycol.

**PEI** *n.* Abbreviation for polyetherimide.

**PEK** *n.* Abbreviation for polyetherketone.

**Pelerine** \ˌpe-lə-ˈrēn\ [obs. F, neckerchief, fr. F *pèlerine*, feminine of *pèlerin* pilgrim, fr. LL *pelegrinus*] (1744) *n.* A device for transferring stitches from the cylinder to the dial or vice versa on a circular-knitting machine.

**Pelletier's green** *See hydrated chromium oxide.*

**Pelletization** \ˌpe-lə-tə-ˈzā-shən\ (1942) *n.* Processing of pigments or other chemical products into very small, free-flowing beads, which eliminates the dust nuisance.

**Pelletizers** *n.* Equipment which forms pellets for plastic molding or other.

**Pellets** \ˈpe-lət\ [ME *pelote*, fr. MF, fr. (assumed) VL *pilota*, dimin. of L *pila* ball]

(14c) (molding powder) *n.* Granules or tablets of uniform size, consisting of resins or mixtures of resins with compounding additives, that have been prepared for molding and extrusion by shaping in a pelletizing machine or by extrusion into strands that are cut while hot or after solidifying in a water bath.

**Peltier effect** \ˈpel-tē-ər, ˌpel-tē-ˈā\ *n.* The physical phenomenon occurring at the junctions, in electric circuits, of dissimilar metals that is the inverse of the Hall effect (*see thermocouple*). When a current flows through the junction of two unlike metals it causes an absorption or liberation of heat, depending on the direction of flow and the metals. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Pencil hardness** *n.* A measure of coating hardness based on the scratching of the film with pencil leads of known hardness. The result is reported as the hardest lead, which will not scratch or cut through the film to the substrate. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Pencilling** *n.* Painting mortar joints of brickwork with white paint to bring out the contrast between the joints and the brickwork. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Pendulum** \ˈpen-jə-ləm\ [NL, fr. L, neuter of *pendulus*] (1660) *n.* For a simple pendulum of length $l$, for a small amplitude, the complete period

$$T = 2\pi\sqrt{\frac{l}{g}} \quad \text{or} \quad g = 4\pi^2\frac{l}{T^2},$$

where $T$ will be given in second if $l$ is in cm and $g$ in cm/s$^2$. For a sphere suspended by a wire of negligible mass where $d$ is the distance from the knife edge to the center of the sphere whose radius is $r$, the length of the equivalent simple pendulum,

$$l = d + \frac{2r^2}{5d}.$$

If the period is $P$ for an arc $\theta$, the time of vibration in an infinitely small arc is approximately

$$T = \frac{P}{1 + \left({}^1\!/_4 \sin^2 {}^\theta\!/_4\right)}.$$

For a compound pendulum, if a body of mass $m$ be suspended from a point about which its moment of inertia is $I$ with its center of gravity a distance $h$ below the point of suspension, the period.

$$T = 2\pi\frac{I}{mgh}.$$

Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Penetrating finish** *n.* A low-viscosity oil or varnish which penetrates wood, leaving a very thin film at the surface.

**Penetration** \ˌpe-nə-ˈtrā-shən\ (1605) *n.* The entering of an adhesive into an adherend. This property of a system is measured by the depth of penetration of the adhesive into the adherend. It is also the ability of a liquid (ink, varnish, or solvent) to be absorbed into the paper or other printing substrate. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

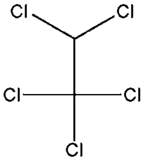
**Penetration number** *n.* Figure used, chiefly for bituminous type products, as a measure of their softness. It is obtained by allowing a weighted needle of specified dimensions to penetrate into the material under test, at a definite temperature. The penetration figure is usually recorded as the number of units of depth, which the needle penetrates in a given time. Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York.

**Penetrometer** \ˌpe-nə-ˈträ-mə-tər\ [L *penetrare* + ISV *-meter*] (1905) *n.* Apparatus for measuring penetration number of a solid (ASTM, www.astm.org).

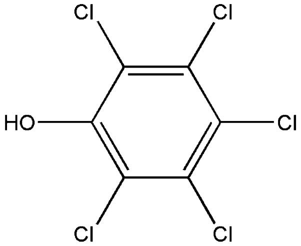
**Penné velvet** *n.* Velvet of silk or a manufactured fiber, with a finish in which the pile is flattened and laid in one direction. Panné velvet is a lustrous, lightweight fabric. Humphries M (2000) Fabric glossary. Prentice-Hall, Upper-Saddle River, NJ.

**Pensky–Martens closed flash tester** *n.* A device used in determining the flash point of liquids which have a viscosity of 45 SUS or more at 37.8°C (100°F), or contain suspended solids and require stirring to obtain uniform distribution of heat, or have a tendency to form a surface film under test conditions.

**Pentachloroethane** \ˌpen-tə-ˌklōr-ˈe-ˌthān \ *n.* $CHCl_2CCl$. Non-flammable solvent. Bp, 161°C; vp, 5 mmHg per 20°C; Sp gr, 1.685. CAS registry number: 76-01-7. Additional names: Pentalin. Molecular formula: $C_2HCl_5$. Molecular weight: 202.30. Percent composition: C 11.87%, H 0.50%, and Cl 87.62%. Line formula: $CCl_3CHCl_2$. Literature references: Toxicity data: Barsoum GS, Saad K (1934). Quart J Pharm Pharmacol 7:205. Properties: liquid; chloroform-like odor. $d_4^{25}$ 1.6712; bp 161–162°. mp −29°. $n_D^{15}$ 1.5054. Insoluble in water. Miscible with alcohol, ether. MLD (mg/kg) in dogs: 1750 orally; 100 i.v.; in rabbits: 700 s.c. (Barsoum, Saad). Melting point: mp −29°. Boiling point: bp 161–162°. Index of refraction: $n_D^{15}$ 1.5054. Density: d425 1.6712. Toxicity data: MLD (mg/kg) in dogs: 1750 orally; 100 i.v.; in rabbits: 700 s.c. (Barsoum, Saad). Caution: potential symptoms of overexposure in exceptional animals are irritation of eyes, skin; weakness, restlessness, irregular respiration, muscle incoordination; liver, kidney, and lung changes. Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001. (*See image*).



**Pentachlorophenol** \ˌpen-tə-ˌklōr-ə-ˈfē-ˌnōl\ (1879) *n.* $C_6HCl_5O$. A toxic, oil-soluble chemical; widely used as a wood preservative for protection against decay and insects. CAS registry number: 87-86-5, Additional names: Penta; PCP; penchlorol. Trademarks: Santophen 20 (Monsanto). Molecular formula: $C_6HCl_5O$. Molecular weight: 266.34. Percent composition: C 27.06%, H 0.38%, Cl 66.56%, and O 6.01%. Literature references: prepared by the chlorination of phenol in the presence of a catalyst. Toxicity study: Gaines TB (1969) Toxicol Appl Pharmacol 14:515. Properties: needle-like crystals, mp 190–191°; bp ~309–310° (dec). $d_4^{22}$ 1.978. Very pungent odor only when hot. Sublimes in needles. Almost insoluble in water (8 mg in 100 ml). Freely soluble in alcohol, ether; soluble in benzene; slightly soluble in cold petrol ether. $LD_{50}$ in male, female rats (mg/kg): 146, 175 orally (Gaines). Melting point: mp 190–191°. Boiling point: bp ~309–310° (dec). Density: $d_4^{22}$ 1.978. Toxicity data: $LD_{50}$ in male, female rats (mg/kg): 146, 175 orally (Gaines). Derivative type: sodium salt. Additional names: sodium Pentachlorophenate; sodium pentachlorophenoxide. Trademarks: santobrite (Monsanto); Dowicide G (Dow). Properties: soluble in water. Caution: potential symptoms of overexposure are irritation of eyes, nose, throat, sneezing, cough, weakness, anorexia, weight loss, sweating, headache, dizziness, nausea, vomiting, dyspnea, chest pain, and high fever. Direct contact may cause dermatitis. (DHHS/NIOSH 97-140, 1997) p. 242. Use: insecticide for termite control; pre-harvest defoliant; general herbicide. Antimicrobial preservative and fungicide for wood, wood products, starches, textiles, paints, adhesives, leather, pulp, paper, industrial waste systems, and building materials. Surface disinfectant. (*See image*).

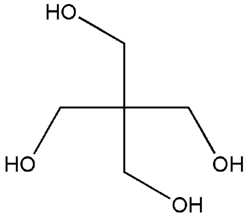


Clayton GD, Clayton FE (eds) (1994) Patty's industrial hygiene and toxicology, vol 2B. Wiley-Interscience, New York, pp. 1603–1613. Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001.

*See NIOSH pocket guide to chemical hazards.*

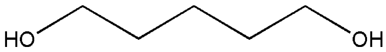
**Pentacite** An alkyd resin formed by using pentaerythritol as the polyhydric alcohol.

**Pentaerythritol** (tetramethylol methane). 2,2-bis-hydroxymethyl)-1,3-propanediol. A white crystalline powder derived by reacting acetaldehyde with an excess of formaldehyde in an alkaline medium. It is used in the production of alkyd resins and chlorinated polyethers. It is used in the manufacture of alkyds, copal ester, rosin esters, synthetic resins, and lubricants. Bp, 276°C; mp, 262°C; Sp gr, 1.399. Abbreviation: PE (*See image*).



**1,5-Pentanediol** (pentamethylene glycol) $HOCH_2(CH_2)_3CH_2OH$. A colorless liquid used in the production of polyester and urethane resins. CAS registry number: 111-29-5, Additional names: pentamethylene glycol; 1,5-dihydroxypentane. Molecular formula: $C_5H_{12}O_2$. Molecular weight: 104.15. Percent composition: C 57.66%, H 11.61%, and O 30.72%. Line formula: $HOCH_2(CH_2)_3CH_2OH$. Literature references: prepared by hydrogenolysis of tetrahydrofurfuryl alcohol in the presence of copper chromite: Properties: viscous, oily liquid. Bitter taste. $d^{20}$ 0.9941. mp −18°C. $bp_{760}$ 239°C, $bp_{3.0}$ 120°C. $n_D^{20}$ 1.4499. Flash pt 125°C (275°F). Miscible with water, methanol, alcohol, acetone, and ethyl acetate. Soluble in ether (25°C): 11% w/w. Limited solubility in benzene, trichloroethylene, methylene chloride, petrol ether, and heptane. $LD_{50}$ orally in rats: 5.89 g/kg (Smyth). Melting point: mp −18°C Boiling point: $bp_{760}$ 239°C; $bp_{3.0}$ 120°C. Flash point: Flash pt 125°C (275°F). Index of refraction: $n_D^{20}$ 1.4499.

Density: $d^{20}$ 0.9941. Toxicity data: $LD_{50}$ orally in rats: 5.89 g/kg . Use: as plasticizer in cellulose products and adhesives, in brake fluid compositions. Forms esters and polyesters which can be used as plasticizers, emulsifying agents and resin intermediates. Connor A (1932) J Am Chem Soc 54: 4678. Kaufman D, Reeve W (1955) Org Syn Coll 3: 693. Smyth HF et al. (1962) Toxicity study. Am Ind Hyg Assoc J 23: 95. Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York. Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001. (*See image*)



**Penta resin** *n.* Ester gum made from rosin and pentaerythritol.

**Penton®** *n.* Poly(2,2-dichloromethyl trimethylene oxide. Trade name for chlorinated polyether. Manufactured by Hercules Powder, USA.

**Penultimate unit** \pi-ˈnəl-tə-mət-\ *n.* The unit adjacent to the radical endgroup (next to last unit) on a growing co-polymer chain; pre-penultimate is second to last unit, antepenulti-mate unit. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**PEO** *n.* Abbreviation for polyethylene oxide.

**Peppery** *See bitty.*

**Peptization** *n.* Process of bringing a solid into a colloidal solution. Becher P (1989) Dictionary of colloid and surface science. Marcel Dekker, New York.

**Peptizing agents** *n.* (1) Materials which, when added in relatively small amounts, are capable of causing substantial reduction in viscosity, as the result of depolymerization, or dispersion. Peptization can occur in aqueous media, such as when agents are added to prevent flocculation or aggregation of particles. (2) Substances that act as a chemical plasticizer for natural and synthetic rubbers. They act as catalysts for oxidation breakdown of rubber during the milling or mastication period. Additional plasticization can be accomplished without further milling by heating the rubber containing the peptizing agent, thus reducing power consumption in breakdown. Becher P (1989) Dictionary of colloid and surface science. Marcel Dekker, New York.

**Peracetylated rubber** *n.* Product prepared from raw rubber by treatment with acetic acid and hydrogen peroxide. Improved compatibility is obtained.

**Perbunan C** *n.* Poly(chloroprene), manufactured by Bayer, Germany.

**Perbunan N** *n.* Butadiene/acrylonitrile co-polymer, manufactured by Bayer, Germany.

**Percale** \(ˌ)pər-ˈkā(ə)l\ [Persian *pargālah*] (1840) *n.* A closely woven, plain-weave, spun fabric used for dress goods and sheeting, generally 80 × 80 threads/in. or better.

**Percentage elongation** *n.* 100 × elongation.

**Percent by mass (mass percent)** *n.* A concentration unit: 100 times the mass of one component divided by the total mass of the solution.

**Perceptible** \pər-ˈsep-tə-bəl\ (1603) *adj.* Capable of being perceived; discernible.

**Perception** \pər-ˈsep-shən\ [L *perception-, perceptio* act of perceiving, fr. *percipere*] (14c) *n.* The process of mental functions that includes the combination of different sensations and the utilization of past observations in recognizing the objects and "facts" from which the stimulation arises. This is the phenomenon of "experience" that serves the engineer, scientist, and researcher for performing competent work.

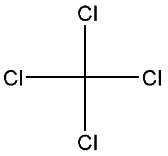
In other words, there is no substitute for experience.

**Perceptual** *n.* Adjective pertaining to or involving perception.

**Perching** Inspection of cloth for defects while it is run over a roller.technician and

**Perchloroethylene** \(ˌ)pər-ˌklōr-ō-ˈe-thə-ˌlēn \ (1873) *n.* Used for vapor degreasing and dry cleaning. Bp, 121°C; vp, 15 mmHg per 20°C.

**Perchloromethane** *See carbon tetrachloride* (*See image*).



**Perchloropentacyclodecane** *n.* $C_{10}Cl_{12}$. A bridged bicyclic, saturated compound, a solid filler used as a flame retardant in epoxy resins, often in conjunction with antimony trioxide.

**Perduren** *n.* Thioplasts, manufactured by Hoechst, Germany.

**Perfect diffuser** *n.* Theoretical ideal white substance which reflects 100% of the incident light in a perfectly diffuse way; official CIE reference white to which colors being measured are compared; a Lambert surface, following the Lambert cosine law perfectly.

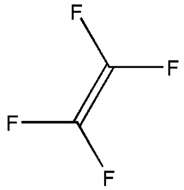
*See Lambert's law of reflection.*

**Perfecting press** Any printing press that prints both sides of paper in one operation. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Perfluoroalkoxy resin (PFA)** *n.* A class of melt-processable fluoroplastics in which perfluoroalkyl side chains are connected to the fluorocarbon backbone of the polymer through flexible oxygen linkages. PFA resins have the desirable properties associated with fluoroplastics plus superior creep resistance, and are more easily processed by extrusion and injection molding.

**Perfluoroelastomer** (tetrafluoro-perfluoromethyl vinyl ether co-polymer) *n.* Introduced by DuPont in 1977 as Kalrez®, this elastomer combines the properties of a conventional fluoroelastomer, such as vinylidene fluoride-hexafluoropropylene co-polymer, with those of a fluorocarbon resin such as polytetrafluoroethylene. It has found application for O-rings and seals that must withstand strong chemicals and solvents at high temperatures.

**Perfluoroethylene** *n.* Syn: tetrafluoroethylene (*See image*).



**Perforating** *n.* Any process by which plastic film, sheet, or tubing is provided with holes ranging from relatively large diameters for decorative effects (by means of punching or clicking) to very small, even invisible sizes. The latter are achieved by passing the material between rollers or plates, of which one of the pair is equipped with loosely spaced, fine needles; or by spark erosion.

**Preform** *n.* (1) The "test tube" shape that is used to form the final blown product in injection blow molding. (2) A compressed tablet or biscuit of plastic composition used for efficiency in handling and accuracy in weighing materials, particularly thermosets. (3) Foamed perform. (4) A pre-shaped fibrous reinforcement formed by the distribution of chopped fibers or cloth by air, water flotation, or vacuum over the surface of a perforated screen to the approximate contour and thickness desired in the finished part. (5) A pre-shaped fibrous reinforcement of mat or cloth formed to the desired shape on a mandrel or mock-up before being placed in a mold press.

**Perilla oil** \pə-ˈri-lə\ (1917) *n.* A drying oil obtained from the seed of the perilla plants, *Perilla ocymoides* and *Perilla nankinensis*, natives of the Orient. Its main constituent acids are linoleic and linolenic, and it has the highest iodine value of all known vegetable oils except chia. It is superior to linseed oil, both from the point of view of drying rate, especially in the form of stand oil, and also of polymerization rate. Sp gr, 0.933–0.937 per 15°C; iodine value, 194, saponification value, 192. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Philadelphia, PA, 2001.

**Period** *n.* (1) A horizontal series (row) of elements in the periodic table. (2) In uniform circular motion is the time of one complete revolution. In any oscillatory motion it is the time of a complete oscillation. Dimension – [T].

**Periodic law** (1872) *n.* Elements when arranged in the order of their atomic weights or atomic numbers show regular variations in most of their physical and chemical properties. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Perishing** *n.* Degradation of a film with age, resulting in loss of film strength, flexibility, adhesion, etc., and which may be shown by the development of chalking, checking, cracking, and flaking, etc. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Periston** *n.* Poly(vinyl pyrrolidone), manufactured by Bayer, Germany.

**Perlenka** *n.* Poly(caprolactam), manufactured by AKU, The Netherlands.

**Perlite** \ˈpər-ˌlīt\ [F, fr. *perle* pearl] (1833) *n.* A siliceous lava which, when heated to 720–1090°C, expands to 10–20 times its original volume, forming tiny, hollow, spherical bubbles. Perlite is much used as an ingredient of lightweight concrete and as a density-lowering filler for plastics.

*See also microspheres.*

**Perlite, expanded** *n.* $1Na_2O \cdot 1K_2O \cdot 2.5 Al_2O_3 \cdot 19.5SiO_2$. A unique form of siliceous lava that is characterized by many spherical and convoluted cracks. The interior or internal structure causes it to leak up into small spheres or "pebbles". Perlite expands when heated at a range of 720 (1500°F) to 1090°C (2000°F) to 10–20 times its initial volume. Used as insulation and filler, also extender. Density, 2.2 g/cm$^3$ (1.87 lb/gal); particle size, 44 µm. Syn: pearlstone, ground perlite, and pearlite.

**Perlon** *n.* Generic name for polyamides from caprolactam (nylon-6).

**Perlon U** *n.* Polyurethane, manufactured by Bayer, Germany.

**Perm** *n.* (1) A unit of measurement of water vapor transmission or permeance; a metric perm, 1 g/24 h/m$^2$/mmHg or USA unit, 1 grain/h ft$^2$ in. Hg; used to express the resistance of a material to the penetration of moisture. (2) A process involving ammoniacal chemicals and, usually, heat, by which straight strands of keratinous fiber are rendered into circular, spiral, and wavelike forms.

**Permachor** *n.* A concept of M. Salame (1961), who discovered that the permeation rates of many (though not all) organic liquids through polyethylene (PE) films could be estimated with the equation:

$$\log \mathrm{Pf} = 16.55 - 3700/T - 0.22\pi,$$

in which Pf is the "permeability factor", $T$ absolute temperature (K), and $\pi$ is the *permachor* calculated for the permeating compound from a table of empirically determined, additive, atomic, and structural contributions. Pf was measured by sealing the test liquid in a PE bag and measuring the loss of weight over a period of days, and was computed as (rate of weight loss, g/day)·(film thickness, mil)/(film area, 100 in.$^2$), so has the units gmil/(day·100 in.$^2$), not the same as permeability defined below. The concept worked well for some other film materials, too. Later (1967), Salame extended it to polymer permeation by oxygen, nitrogen, and carbon dioxide, this time computing the permachor for the polymer rather than the permeant. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

P

**Permanence** \ˈpər-mə-nən(t)s\ (15c) *n.* The resistance of any material to change with regard to its properties and performance with age or exposure to deleterious conditions such natural weathering. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Permanent deformation** *n.* The change in length of a sample after removal of an applied tensile stress and after the removal of any internal strain (e.g., by boiling off the sample and allowing it to dry without tension). The permanent deformation is expressed as a percentage of the original sample length.

**Permanent fast violet** *See mineral violet.*

**Permanent finish** *n.* A term for various finishing treatments, chemical and/or mechanical, applied to fabric so that it will retain certain properties, such as glaze of chintz, crispness of organdy, smoothness of cotton table damask, and crease, crush, and shrinkage resistance of many apparel fabrics during the normal period of wear and laundering,

**Permanent inks** *n.* Inks that do not readily fade or change color when exposed to light and weather. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Permanent set** *n.* The deformation remaining after a specimen has been stressed in tension, compression, or shear for a specified time period and released for a specified time period. Syn: hysteresis loss. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. *See secondary creep.*

**Permanent violets** *n.* (1) A light resistant, tungstated or molybdated methyl violet pigment used in printing inks. (2) Carbazole violet.

**Permanent white** *See barium sulfate, natural.*

**Permanent yellow FGL** *n.* Pigment yellow 97 (USA Patent 2,644,814). A monoazo pigment that has gained significant use in trade sales finishes. It is very similar in color to dalamar yellow and somewhat more bleed-resistant.

**Permeability** \ˌpər-mē-ə-ˈbi-lə-tē\ (1759) (polymeric mateials) *n.* The ease with which a gas or vapor passes through a membrane, e.g., a plastic sheet or film. It has been proved that permeability is equal to the product of *diffusivity* times the *solubility* of the gas or vapor in the plastic. *Coefficient of permeability* (*permeability coefficient*) = the rate of permeation of a gas or vapor per unit cross-sectional area of the film, divided by the concentration gradient through the film. Because of the wide choice that has existed for units of permeation rate, film area, and concentration, many different "convenient" sets of units have been used. ASTM (www.astm.org) defines permeability as the product of permeance times the thickness of a film. Permeabilities of polymeric films to atmospheric gases and carbon dioxide vary from about 0.009 to 2.5 pmol/m s Pa.

**Permeance** *n.* The ratio of the gas-transmission rate to the difference in partial pressure of the gas on two sides of a sheet or film. The SI unit is mol/$m^2$ s Pa, but much smaller submultiples are convenient. The test conditions must be stated.

*See ASTM D 1434* (Section 15.09), *also permeability* (1).

**Permeation** \ˌpər-mē-ˈā-shən\ (ca. 1623) *n.* The passage of gas, vapor, or liquid molecules through a film or membrane, usually without physically or chemically changing it, except that permeation involves solubility of the vapor in the film.

*See permeability. See ASTM, www.astm.org.*

**Permittivity** \ˌpər-ˌmi-ˈti-və-tē\ [$^{1}$*permit* + -*ivity* (as in *selectivity*)] (1887) *n.*

*See dielectric constant.*

**Permselective membrane** *n.* A thin film that will preferentially permit gases of different kinds to pass through the film at different rates. For common gases such as hydrogen, oxygen nitrogen, and carbon dioxide, silicon rubber is the most permeable polymer.

**Peroxide** \pə-ˈräk-ˌsīd\ [ISV] (1804) *n.* A polymerization *initiator* containing at least one pair of oxygen atoms bonded by a single covalent bond. Organic peroxides, analogous to $H_2O_2$ in which either or both of the H atoms have been replaced by organic radicals, are thermally unstable and are widely used as initiators in polymerizations. As they decompose, they form free two free radicals that can initiate polymerization reactions and effect cross-linking. A hydroperoxide provides only one free radical available for initiation. The rate of decomposition can be controlled by means of promoters or accelerators or by inhibitors when it is desired to slow the rate. Peroxides are used to cure thermosetting resins. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA. (*See image*).

**Peroxyester (perester, *t*-alkyl peroxyester)** *n.* Any of a family of liquid initiators used for cross-linking of polyethylene, polymerization of vinyls, high-temperature cross-linking of diallyl phthalate-modified polyesters, curing of styrene-modified polyesters, and styrenation of alkyd paints. They are aliphatic, not prone to yellowing and bleaching, and have good solubility and compatibility characteristics. One example of the numerous compounds in the family is *t*-butyl peroxypentanoate.

**Persorption** *n.* The adsorption of a substance in pores only slightly wider than the diameter of adsorbed molecules of the substance.

**Perspex** Poly(methyl methacrylate). Manufactured by ICI, Great Britain.

**Persulfonium ion** \-ˌsəl-ˈfō-nē-əm-\ *n.* The ionic mechanism (*initiator*) proposed for sulfur vulcanization involves the reaction of a highly polarized sulfur bond R–S$^+$–S–R, present in either elemental sulfur or an organic polysulfide with a double bond to form an intermediate persulfonium ion; an initiator for sulfur vulcanization. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Perylene pigments** *n.* A group of vat pigments, nearly all of which are N,N′–substituted peryzene-3,4,9,10-tetracarboxylic diimides. Scarlet and vermilion varieties, resistant to bleeding, light, heat, and chemicals are used in plastics.

**PES** *n.* Polyester fiber. Abbreviation for polyethersulfone.

**PET (PETP)** *n.* Abbreviation for polyethylene terephthalate.

**Peta-(P)** The SI prefix meaning $\times 10^{15}$.

**PETP (PET)** *n.* Abbreviation for polyethylene terephthalate.

**Petrifying liquid** *n.* Usually a dilute emulsion of drying oil and/or resin in water, used as a sealing coat before applying an oil-bound water paint to a porous surface. It may also be used in place of water to thin the first coat of water paint before application to a porous surface.

**Petrochemical** \ˌpe-trō-ˈke-mi-kəl\ (1942) *n.* Any chemical derived directly or indirectly from petroleum or natural gas.

**Petrolatum** \ˌpe-trə-ˈlā-təm, ˈlä-\ [NL, fr. ML *petroleum*] (1887) *n.* Purified mixture of semisolid hydrocarbons with unctuous nature derived from petroleum. Syn: petroleum jelly.

**Petroleum bitumens** \pə-ˈtrō-lē-əm bə-ˈtyü-mən\ *n.* Distillation residues derived from crude petroleum.

**Petroleum ethers** *n.* Low boiling aliphatic fractions derived from crude petroleum by fractional distillation. The boiling ranges are fairly restricted, and products known as 40–60°C and 60–80°C petroleum ethers are common. The low boiling ranges and exceptionally high evaporation rates restrict the use of the solvents in the paint trade considerably. The petroleum ethers bear no resemblance chemically to the true ethers. The only resemblance is the high evaporation rate.

**Petroleum hydrocarbons** *n.* Hydrocarbons of aliphatic type obtained from crude petroleum and including VM&P naphtha, mineral spirits, and paraffins.

**Petroleum jelly** (1897) *n. See petrolatum.*

**Petroleum naphtha** \-ˈnaf-thə\ *n.* A generic term applied to refined, partly refined, or unrefined petroleum products and liquid products of natural gas, not less than 10% of which distills below 175°C (347°F) and not less than 95% of which distills below 240°C (464°F), when subjected to distillation in accordance with AST Method D 86, test for distillation of petroleum products.

**Petroleum resin** *See hydrocarbon plastics.*

**Petroleum spirits** *See mineral spirits.*

**PF** *n.* Abbreviation for phenol-formaldehyde resin.

**PFA** *See perfluoroalkoxy resin.*

**PFA fluoroplastic resins** *See perfluoroalkoxy resin.*

**PFEP** *n.* Co-polymer from tetrafluoroethylene and hexafluoropropylene.

**PF resins** *See phenolic resins.*

**Pfund hardness** *n.* A method of measuring indentation hardness of paints and related coatings in which a small hemispherical indenter made of quartz or sapphire is pressed into the coating (*see ASTM, www.astm.org*).

**Pfund hardness number** *n.* The indentation hardness determined with a Pfund indenter and calculated as follows:

$$\mathrm{PHN} = \frac{L}{A} = \frac{4L}{\pi d^2} = 1.27\frac{L}{d^2},$$

where $L$ is the load in kilogram applied to the indenter, $A$ the area of projected indentation in square millimeter, and $d$ is the diameter of projected indentation in millimeter. Abbreviation: PHN. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**Pfund indenter** *n.* A hemispherical quartz or sapphire indenter of prescribed dimensions used for testing indentation hardness of organic coatings. Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York.

**pH** *n.* A measure of the acidity or alkalinity of an aqueous solution or mixture, defined as the logarithm to base 10 of the reciprocal of the effective hydrogen-ion concentration ($H^+$) in gram-equivalents per liter, moles per liter (m/l). The equation for calculating pH is

$$\mathrm{pH} = -\log[\mathrm{H}^+] = \log\frac{1}{\mathrm{H}^+}.$$

Pure water has a pH of 7 and is neutral. A one-unit drop in pH corresponds to a tenfold rise in $H^+$.

**Phase** \ˈfāz\ [NL *phasis*, fr. Gk, appearance of a star, phase of the moon, fr. *phainein* to show (middle voice, to appear)] (1812) *n.* A physical distinct region with a uniform set of properties throughout.

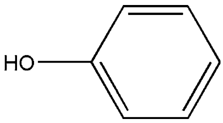
**Phase angle** *n.* In many cyclic processes, particularly ones at high frequency, there is usually a time lag between the impulses driving the processes and the responses to those impulses. The lag time divided by the cycle period and multiplied by 2π is the phase angle (radians). This occurs in oscillatory rheometry, where the shear applied to the rotating element results in a lagging torque, which has two components, an elastic part, in phase with the displacement, and the viscous, out-of-phase component. The same situation exists in fatigue testing of plastics.

**Phase of oscillatory motion** *n.* The fraction of a whole period which has elapsed since the moving particle last passed through its middle position in a positive direction.

**Phases beam** *n.* A beam on which each of the ends is wound from the same depth of each of the bobbins on the creel. Phased beams are prepared when yarn properties vary from the inside to the outside of the bobbins in order to prevent warp streakiness in the finished fabric. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Phase separation** *n.* Separation of two or more phases due to temperature changes.

**Phenol** \ˈfē-ˌnōl\ [ISV *phen-* + $^3$-*ol*] (ca. 1852) (carbolic acid) *n.* $C_6H_5OH$. A corrosive poisonous crystalline acid compound present in coal tar and wood tar that in dilute solution is used as a disinfectant. The simplest phenol. Used for the preparation of phenol-formaldehyde resins. Bp, 182°C; mp, 42°C. Phenols are a class of aromatic compounds containing –OH groups attached directly to the benzene ring and which are used in the manufacture of epoxy resins, phenol-formaldehyde resins, plasticizes, plastics and wood preservatives. The specific name for $C_6H_5OH$ (carbolic acid, phenylic acid, and hydroxybenzene). Phenol was first derived from coal tar but today is most commonly synthesized from benzene or toluene. (*See image*). Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.



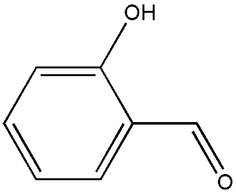
**Phenol-aldehyde polymers** *n.* Common name for phenol, polymer with formaldehyde. It is also commonly known as phenol-aldehyde resin.

*See phenolic resins.*

**Phenol-aldehyde resins** *See phenolic resins.*

**Phenol-aralkyl resin** *n.* Any of several thermosetting resins produced by the condensation of aralkyl ethers and phenols.

**Phenol-formaldehyde** *n.* A condensation product of reaction of phenol and formaldehyde. If the reaction is carried under acidic conditions, the product formed is Novolac. Under alkaline conditions, with an excess formaldehyde, an C-stage resin is formed. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Raton, FL. (*See image*)



**Phenol-formaldehyde resin** (PF resin, phenolic resin) *n* .The most important of the phenolic resins. Made by condensing phenol with formaldehyde, these were the first synthetic thermosetting resins to be developed (Baekeland, 1907) and were marketed under the trade name Bakelite. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL.

**Phenol-furfural resin** A type of furan resin.

**Phenolic** \fi-ˈnō-lik\ *n.* (1) Any of several types of thermoset plastics obtained by the condensation of phenol or substituted phenols with aldehydes such as formaldehyde and furfural. (2) *adj* Containing or pertaining to phenol.

**Phenolic novolac** (novolac, novolak) *n.* Thermoplastic, water-soluble resins obtained by reacting a phenol with an aldehyde, usually form-aldehyde, in the proportion of less than 1 mol of the phenol with 1 mol of aldehyde, in the presence of an acid catalyst. When a source of methylene groups is added, linkage between the methylenes and the phenolic rings occurs and the resins can react with diamines or diacids (e.g., hexamethylenetetramine) to form thermosetting, insoluble resins. Absent a source of methylene groups, the resin remains permanently thermoplastic. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL.

*See also resinoid and epoxy-novolac resin.*

**Phenolic plastics** *n.* Plastics based on resins made by the condensation of phenols, such as phenol and cresol, with aldehydes.

**Phenolic resin** *n.* Any of a wide range of thermosetting resins made by reacting a phenol with an aldehyde, followed by curing and cross-linking.

*Known also as phenol-formaldehyde or PR resins.*

**Phenol red** (1916) *n.* $C_{19}H_{14}O_5S$. A red crystalline compound used as an acid–base indicator.

**Phenoplast** *n.* Another name for phenol-formaldehyde resin.

**Phenoxide** \fi-ˈnäk-ˌsīd\ (1888) *n.* A salt of a phenol in its capacity as a weak acid.

**Phenoxy** *n.* Co-polymer from bisphenol A + epichlorohydrin, manufactured by Union Carbide, USA.

**Phenoxy resin** (polyhdroxyether) *n.* Any linear thermoplastic resin made by reacting an exact equivalent of epichlorohydrin with bisphenol A and sodium hydroxide in dimethyl sulfoxide.

**Phenyl benzoate** *n.* $C_6H_5COOC_6H_5$. A plasticizer. Bp, 314°C. Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York.

**Phenylethylene** Syn: styrene.

**Phenylformic acid** *n.* Syn: benzoic acid.

**Phenyl group (phenyl radical)** *n.* The group $C_6H_5-$, existing only in combination.

**Phenylsilane resin** *n.* Any thermosetting copolymer or silicone and phenolic resins, available in solution form.

**Phosphate** \ˈfäs-ˌfāt\ [F, fr. *acide phosphorique* phosphoric acid] (1795) *n.* (1) A salt or ester of a phosphoric acid. (2) The trivalent anion $PO_4^{3-}$ derived from phosphoric acid $H_3PO_4$. (3) An organic compound of phosphoric acid in which the acid group is bound to nitrogen or a carboxyl group in a way that permits useful energy to be released.

**Phosphate plasticizer** *n.* Any of a group of plasticizers derived from phosphoric acid and aliphatic alcohols and phenols, and used in conjunction with others to impart flame resistance. Troitzsch J (2004) Plastics flammability handbook: principle, regulations, testing and approval. Hanser–Gardner Publications, New York. Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York.

**Phosphating** *n.* Pre-treatment of steel or certain other metal surfaces by chemical solutions containing metal phosphates and phosphoric acid as the main ingredients, to form a thin, inert, adherent, corrosion-inhibiting phosphate layer which serves as a good base for subsequent paint coats.

**Phosphatize (phosphate) coat** *See phosphating.*

**Phosphazene polymer** *n.* Any of a family of experimental resins built on long chains of alternating phosphorus and nitrogen atoms. The general structure is $(-PX_2{=}N-)_n$, where $X$ may be a halogen or organic radical. They have been used in fuel hoses that remain flexible in subzero, arctic climates, prosthetics for reconstruction surgery, and fabric waterproofing. In solution these polymers can be reacted with various nucleophilic agents to form a range of thermoplastics and elastomers. An important potential use may be as flame retardants for textiles. They can also be foamed.

**Phosphomolybdic pigments** *n.* A series of colored pigments derived from the interaction of basic dyes and complex acids such as phosphomolybdic, phosphotungstic, and tungstomolybdic. They are characterized by good resistance to alkali, heat, light, and water.

**Phosphorescence** \-ˈre-sᵊn(t)s\ (1796) *n.* The ability of certain substances to continue to emit light long after the source of excitation energy has been removed.

**Phosphorescent paint** *See luminous paint.*

**Phosphorescent pigment** *n.* One of a family of pigments, generally an inorganic sulfide crystal of fairly large and controlled size, which absorbs the energy of incident light then slowly re-emits it as radiation of a color specific to each pigment. The phosphorescence gradually dims in darkness, to be renewed by the next light restimulation.

**Phosphoric acid** (1791) *n.* An inorganic acid having the formula ($H_3PO_4$).

**Photochemical catalysis** *n.* Chemical reaction stimulated by action of light. Fouassier

J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York.

**Photochemically reactive organic material** *n.* Any organic material which will react with oxygen, excited oxygen, ozone and/or other free radicals generated by the action of sunlight on components in the atmosphere, giving rise to secondary contaminants and reaction intermediates in the atmosphere which can have detrimental effects. Hare CH (2001) Paint film degradation – mechanisms and control. Steel Structures Paint Council, Pittsburgh, PA. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Photochemically reactive solvent** *n.* Any solvent with an aggregate of more than 20% of its total volume composed of the chemical compounds classified below or which exceeds any of the following individual percentage composition limitations, referred to the total volume of solvent: (1) A combination of hydrocarbons, alcohols, aldehydes, esters, ethers or ketones having an olefinic or cycloolefinic type of unsaturation: 5%. (2) A combination of aromatic compounds with eight or more carbon atoms to the molecule except ethylbenzene: 8%. (3) A combination of ethylbenzene, ketones having branched hydrocarbon structures, trichloroethylene or toluene: 20% (as defined by Rule 66). Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Photochemical oxidants** *n.* Secondary pollutants formed by the action of sunlight on the oxides of nitrogen and hydrocarbons in the air. They are the primary contributors to photochemical smog.

**Photochromatic** *n.* Materials exhibiting the phenomenon of photochromatism. Fox AM (2001) Optical properties of solids. Oxford University Press, UK. Meeten GH (1986) Optical properties of polymers. Springer-Verlag, New York.

**Photochromatism** *n.* Phenomenon of reversible change exhibited by some materials when exposed to light.

**Photochromic** \ˌfō-tə-ˈkrō-mik\ [*phot-* + *chrom-* + $^{1}$*-ic*] (1953) *adj.* Capable of changing color on exposure to radiant energy (as light). Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Photoconductive** \-kən-ˈkək-tiv\ (1929) *adj.* Becoming electrically conductive when irradiated by light or ultraviolet light. Emerson JA, Torkelson JM (eds) (1991) Optical and electrical properties of polymers: materials research society symposium proceedings, vol 24. Materials Research Society, Warrendale, PA.

*See poly(n-vinylcarbazole).*

**Photocurable coating** *n.* A polymerizable mixture that can be applied as a thin film to a substrate and polymerized at a rapid rate by exposure to actinic light. Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York.

**Photodegradation** (1971) *adj.* Breakdown of plastics due to the action of visible or ultraviolet light. Most polymers tend to absorb high-energy radiation in the ultraviolet portion of the spectrum, which elevates their electrons to higher reactivity and causes oxidation, chain cleavage, and other destructive reactions. Delay of photodegradatioin may be accomplished by incorporation of UV light absorbers. The two most common methods of promoting degradation by UV light are incorporation of additives that act as photoinitiators or photosensitizers, and co-polymerization for deliberatly incorporating weak links with the polymer chain. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

*See also ultraviolet stabilizer and stabilizer.*

**Photoelasticity** *n.* Changes in optical properties of isotropic, transparent materials when subjected to stress. Mainly, they become birefringent, a property that has been widely used to detect frozen-in stresses in sheets and other products. Meeten GH (1986) Optical properties of polymers. Springer-Verlag, New York.

**Photoengraving** (1872) *n.* A process for producing an alpha-numeric script or graphical image on a sensitized metal plate by placing a transparent negative (i.e., light sensitive emulsion) between the plate and a source of light. The areas not rendered water-insoluble by light exposure are washed and etched with acid solutions. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1976.

**Photogenic property** \ˌfō-tə-ˈje-nik-\ *n.* The tendency of a pigment to darken on exposure to sunlight and to be rebleached on being placed in the dark.

**Photographic density** The density $D$ of silver deposit on a photographic plate or film is defined by the relation

$$D = \log\ O,$$

where $O$ is the opacity. If $I_0$ and $I$ are the incident and transmitted intensities respectively the opacity is given by $I_0/I$. The transparency is the reciprocal of the opacity or $I/I_0$. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1976.

**Photographic printing** *See printing.*

**Photographing** *n.* Brush marks or other irregularities in the previous coat or substrate that show through the dried topcoat.

*Also called telegraphing or show-through.*

**Photogravure** \ˌfō-tə-grə-ˈvyúr\ [F, fr. *phot-* + *gravure*] (1879) *n.* Process for making prints from photomechanically prepared intaglio plates. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1976.

**Photoinitiation** *n.* Initiation of a free radical polymerization by irradiation with ultraviolet light (or other frequency of light), causing photopolymerization. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Photoinitiator** *n.* (1) A substance which, by absorbing light, becomes energized into forming free radicals which promote secondary radical reactions. (2) Initiators which create initiating species for polymerization reactions when exposed to light; cationic free radical, etc. Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York.

**Photolithography** \-li-ˈthä-grə-fē\ [ISV] (1856) *n.* Process utilizing surfaces which, under the selective action of light, are transformed from a water-receptive to a water-repellant and ink-receptive nature. Belfield KD, Crivello JV (eds) (2003) Photoinitiated polymerization. American Chemical Society Publications, Washington, DC.

**Photometer** \fō-ˈtä-mə-tər\ [NL *photometrum*, fr. *phot-* + *-metrum* –meter] (1778) *n.*

An instrument for the measurement of the intensity of emitted, reflected, or transmitted light. For the measurement of luminous intensity, a visual receptor element (the eye), may be used in the measuring device or a physical receptor element may be used which can be related to the calculated response of a standard observer. Harris DC (2002) Quantitative chemical analysis. W. H. Freeman Co., New York. Krause A, Lange A, Ezrin M (1988) Plastics analysis guide: chemical and instrumental methods. Oxford University Press, UK.

**Photometric** \ˌfō-tə-ˈme-trik\ (ca. 1828) *adj.* Pertaining to the measurement of the intensity of light. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Photomicrograph** \ˌfō-tə-ˈmī-krə-ˌgraf\ (1858) *n.* A large photograph of a small object as through a microscope, the image of which is enlarged or magnified. Loveland RP (1981) Photomicrograsphy. Krieger Publishing Co., New York.

**Photon** \ˈfō-ˌtän\ [*phot-* + $^{2}$*-on*] (1916) *n.* A photon (or $\gamma$-ray) is a quantum of electromagnetic radiation which has zero rest mass and an energy of $h$ (Planck's constant) times the frequency of the radiation. Photons are generated in collisions between nuclei or electrons and in any other process in which an electrically charged particle changes its momentum. Conversely photons can be absorbed (i.e., annihilated) by any charged particle. A quantum of electromagnetic energy: $E_{\text{photon}} = h\nu$. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Photopic** \fōt-ˈō-pik\ [NL *photopia*, fr. *phot-* + *-opia*] (1915) *adj.* An adjective used to describe vision mediated by the cone receptors in the retina of the eye, which give rise to the sensation of color occurring at high and medium levels of luminance. Stedman's medical dictionary, 27th edn. Lippincott Williams and Wilkins, New York, 2000.

**Photopolymer** \ˌfō-tō-ˈpä-lə-mər\ (1932) *n.* A plastic compound containing an agent that undergoes a change, proportional to light intensity, upon exposure to light, so that images can be formed on its surface by a photographic process. Photopolymers play an important role in the manufacture of semiconductors.

**Photopolymerization** *n.* An addition reaction brought about by exposure of the monomer or mixture of monomers to natural or artificial light, with or without a catalyst. Methyl methacrylate, styrene, and vinyl chloride are examples of monomers that can be photopolymerized. Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York.

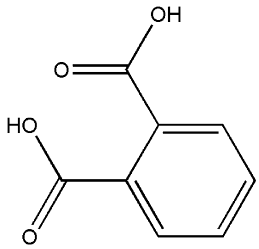
**Photopolymers** These are photoinitiated and photo-cross-linked polymers; e.g., photoresists, printing inks, can coatings, etc. Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

**Photosensitizers** \-ˈsen(t)-sə-ˌtīz-\ (ca. 1923) *n.* A substance which, by absorbing light, passes its energy to another substance which then reacts. Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York.

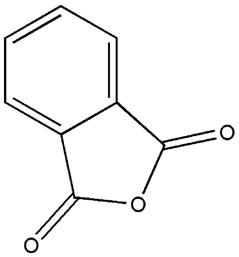
**Phr** *n.* Abbreviation for *parts* per *hundred* parts of *resin*, a fractional measure of composition, simpler than weight percentage that facilitates making up multicomponent compounds. For example, as used in plastics formulations, 5 phr means that 5 kg of an ingredient would be combined with 100 kg of resin.

**Phthalate ester** \ˈtha-ˌlāt ˈes-tər\ (*o*-phthalic ester) *n.* Any of a large class of plasticizers produced by the direct action of alcohol on phthalic anhydride. They are the most widely used of all plasticizers and are generally characterized by moderate cost, good stability, and good all-round properties.

**Phthalic acid** \ˈtha-lik ˈa-səd\ *n.* *o*-Benzenedicarboxylic acid. $C_8H_6O_4$; mol wt, 166.13, crystals; mp, about 230°C when heated, forming phthalic anhydride and water (*See image*).



**Phthalic anhydride** (phthalic-acid anhydride) *n.* $C_6H_4(CO)_2O$. A white, odorless, crystalline compound derived by oxidation of naphthalene or *o*-xylene, shipped in flake or molten form. It major use is in the production of phthalate esters for plasticizing vinyl and cellulosic resins. It is also an important intermediate in the manufacture of alkyd and unsaturated polyester resins, and is a curing agent for epoxy resins. Bp, 284°C; mp, 130°C; Sp gr, 1.53; acid value, 758.0 (*See image*).



**Phthalic anhydride test** *n.* Phthalic anhydride reacts with primary alcohols when the mixture is refluxed in benzene. Secondary alcohols react less readily, usually requiring a reaction temperature of 100–200°C, whereas the tertiary alcohols do not react.

**Phthalocyanine** \ˌtha-lō-ˈsī-ə-ˌnēn\ [ISV *phthalic* acid + -*o*- + cyanine] (1933) (cyan) *n.* Blue and green ink pigments characterized by extreme light fastness and resistance to solvents, acid and alkali. The blue is now widely used in process inks.

**Phthalocyanine pigments** *n.* Series of organic pigments having as a structural unit four isoindole groups $(C_6H_4)C_2N$, linked by four nitrogen atoms so as to form a conjugated chain. There are four commercially important modifications, including the basic compound: (1) Phthalocyanine (metal free) $(C_6H_4C_2N)_4\ N_4$, blue–green. (2) Copper phthalocyanine, in which a copper atom is held by secondary valences of the isoindole nitrogen atoms; Sp gr, 1.59. (3) Chlorinated copper phthalocyanine, green, in which 15–16 hydrogen atoms are replaced by chlorine. (4) Sulfonated copper phthalocyanine, water-soluble, green in which two hydrogen atoms are replaced by sulfonic acid, $HSO_4$, groups. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York.

**Phycocolloid** *n.* Any of several polysaccharide hydrocolloids from brown to red seaweeds. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.
*See gum, natural.*

**Physical catalyst** *n.* Radiant energy capable of promoting or modifying a chemical reaction, as in photopolymerization.

**Physical change** *n.* A change in which no new substances are formed.

**Physical property** A property which can be described without referring to a chemical reaction.

**PI** *n.* Abbreviation for the *trans*-1,4- type of polyisoprene.

**PIA** *n.* Abbreviation for plastics institute of America Inc., headquartered at 333 Aiken Street, Lowell, MA 01854-3686. PIA sponsors seminars in plastics technology and supports graduate research in plastics engineering and undergraduate scholarships.

**PIB** *n.* Abbreviation for poly(isobutylene). *See polybutene.*

**pi (π) Bond** *n.* A covalent bond in which the electron charge cloud of the shared pair of electrons is located in two regions on opposite sides of the bond axis.

**Pick** *n.* A single filling thread carried by one trip of the weft-insertion device across the loom. The picks interlace with the warp ends to form a woven fabric.
*See picking. Also see filling.*

**Pick count** *n.* The number of filling yarns per inch or per centimeter of fabric.

**Pick counter** *n.* (1) A mechanical device that counts the picks as they are inserted during weaving. (2) A mechanical device equipped with a magnifying glass used for counting picks (and/or ends) in finished fabrics.

**Picker** *n.* (1) A machine that opens staple fiber and forms a lap for the carding process used in the production of spun yarns. (2) It is the part of the picking mechanism of the loom that actually strikes the shuttle.

**Picker lap** *n.* A continuous, considerably compressed sheet of staple that is delivered by the picker and wound into a cylindrical package. It is used to feed the card.

**Picker sticks** *n.* The two sticks that throw the shuttles from box to box at each end of the faceplate of the loom.

**Picking** *n.* (1) The adherence of a sheet of paper to the plate due to the tack of the ink. (2) The removal of the surface of the paper during printing. It occurs when the pulling force (tack) of the ink is greater than the surface strength of the paper whether coated or uncoated.

**Picking up** *n.* (1) The blending of a coat of freshly applied paint with another over which it is applied. (2) The joining up of a wet edge.
*See pulling up.*

**Pickled pine** *n.* A gray finish which duplicates the effect formerly produced by actually pickling the wood with nitric acid but now obtained by using a gray stain.

**Pickling** *n.* (1) Treatment for the removal of rust and mill scale from steel by immersion in an acid solution containing an inhibitor. Pickling should be followed by thorough washing and drying before painting. (2) The process of removing paint and varnish with an alkaline preparation or strong solvents.

**Pick out mark** *n.* A filling wise band or bar characterized by a chafed or fuzzy appearance due to pulled-out picks.

**Pick-up groove** *See hold-down groove.*

**Pick-up roll** *n.* (1) In the coil coating industry, the roll which revolves within the pan and is partially immersed in the paint. This roll picks up paint from the pan and applies it to the transfer or applicator roll. (2) Spreading device where the roll for picking up the adhesive runs in a reservoir of adhesive.

**Pico-** (p). The SI prefix meaning $\times 10^{-12}$.

**Picot** \ˈpē-(ˌ)kō, pē-ˈ\ [F, literally, small point, fr. MF, fr. *pic* prick, fr. *piquer* to pick] (ca. 1882) *n.* (1) A small loop woven on the edge of ribbon, or a purl on lace. A picot edge may also be produced by a hemstitching machine. (2) A run-resistant loop usually found at the top of hosiery.

**PIC test** *n.* Abbreviation for pseudoisochromatic test for defective color vision.

*See pseudoisochromatic plate test.*

**Piece** \ˈpēs\ [ME, fr. OF, fr. (assumed) VL *pettia*, of Gaulish origin, akin to Welsh *peth* thing] (13c) *n.* A standard length of a fabric, such as 40, 60, 80, or 100 yards.

**Piece dyeing** (1920) *vt. See dyeing.*

**Piecing** The joining of two or more ends of sliver, roving, yarn, etc.

**Piezo-electric effect** *n.* The phenomenon exhibited by certain crystals of expansion along one axis and contraction along another when subjected to an electric field. Conversely, compression of certain crystals, generate an electrostatic voltage across the crystal. Piezoelectricity is only possible in crystal classes, which do not possess a center of symmetry. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Piggyback** (1823) *adj.* A word used to designate a system of two extruders in which one discharges to the other. Such an arrangement has occasionally been used to separate the melt-generating (plasticating) function from the pressure-developing and shaping function of the standard extruder thus gaining more precise control over both functions and eliminating a main cause of surging at the die. For general extrusion this method of accomplishing that separation has been superseded by the cheaper and more compact combination of extruder with gear pump.

*Also see extruder, tandem for a special application of the piggyback concept.*

**Pigment** \ˈpig-mənt\ [L *pigmentum*, fr. *pingere* to paint] (14c) *n.* Finely ground, natural or synthetic, inorganic or organic, insoluble dispersed particles (powder) which, when dispersed in a liquid vehicle to make paint, may provide, in addition to color, many of the essential properties of a paint – opacity, hardness, durability, and corrosion resistance. The color index is a method of classifying pigments established under the joint partnership of the American Association of Textile Chemists and Colorist in USA and the Society of Dyes and Colorist in UK. An example is shown in the following figure. (*See image*)

| C. I. Pigment | White | 6 | 77891 |
|---|---|---|---|
| (General Category) | (Hue) | (Consecutive Number) | (Chemical Class) |

Titanium Dioxide, Rutile. $TiO_2$. Pigment.

The term “pigment” is used to include extenders, as well as white or color pigments. The distinction between powders which are pigments and those which are dyes is generally considered on the basis of solubility – pigments being insoluble and dispersed in the material, dyes being soluble or in solution as used. Leher LR, Salzman M (1985) Color pigments. Applied Polymer Science, American Chemical Society, Washington, DC. Annual book of ASTM standards, Pt. 28: pigments, resins, and polymers. American Society for Testing and Materials, Philadelphia, PA, 1978.

Bentley KW (1960) Natural pigments. The Interscience Publishers Inc., New York. *Pigments* (In English and French), International Organization for Standardization (ISO), Geneva, Switzerland, 1963. Fuller WR, Love CH (1968) Inorganic color pigments, unit 8 of the federation series on coatings technology. Federation of Societies for Coatings Technology, Philadelphia, PA. Patton TC (1964) Paint flow and pigment dispersion. Interscience Publishers Inc., New York. Synonyms for pigment names. Pamphlet of the British Standards Institution, London, 1957.

*See also colorant.*

**Pigment/binder ratio** *n.* Ratio (generally, by weight in USA; by volume in Britain) of total pigment to binder solids in paint.

*Also called binder ratio.*

**Pig wrack** *See carrageen.*

**Pilaster** \pi-ˈlas-tər\ [MF *pilastre*, fr. It *pilastro*] (1575) *n.* Flat vertical projection from a wall, with the proportions, capital shaft, and base of a column.

**Pile** \ˈpī(ə)l\ [ME, fr. L *pilus* hair] (15c) *n.* (1) A fabric effect formed by introducing tufts, loops, or other erect yarns on all or part of the fabric surface. Types are warp, filling, and knotted pile, or loops produced by weaving an extra set of yarns over wires that are then drawn out of the fabric. Plain wires leave uncut loops; wires with a razor-like blade produce a cut-pile surface. Pile fabric can also be made by producing a double-cloth structure woven face to face, with an extra set of yarn interlacing with each cloth alternately. The two fabrics are cut apart by a traversing knife, producing two fabrics with a cut-pile face. Pile should not be confused with nap. Corduroys are another type of pile fabric, where long filling floats on the surface are slit, causing the pile to stand erect. (2) In carpets, pile refers to the face yarn, as opposed to backing or support yarn. Pile carpets are produced by either tufting or weaving. Complete textile glossary. Celanese Corporation, New York, 2000.

*Also see cut pile and loop pile.*

**Pile burning** *See bin cure.*

**Pile crush** *n.* The bending of upholstery or carpet pile that results from heavy use or the pressure of furniture.

**Pile weave** *n.* A weave in which an additional set of yarns, either warp or filling, floats on the surface and is cut to form the pile. Turkish toweling is a pile weave fabric with uncut loops on one or both sides.

**Pile wire** *n.* A metal rod over which yarn is woven to generate a pile fabric.

**Pill** n. A small accumulation of fibers on the surface of a fabric. Pills, which can develop during wear, are held to the fabric by an entanglement with surface fibers of the material, and are usually composed of the same fibers from which the fabric is made. A term sometimes used for preform.

**Pilling** *n.* (1) Behavior of a very quick-drying paint which, during application by brush, becomes so sticky that the resulting film is thick and uneven. (2) The buildup of ink on rollers, plate or blanket.

*Also see caking.*

**Pilot** \ˌpī-lət\ [ME *pilote*, fr. It *pilota*, alter. of *pedota*, fr. (assumed) MGk *pēdōtēs*, fr. Gk *pēda* steering oars, plural of *pēdon* oar, prob. akin to Gk *pod-*, *pous* foot] (1530) *n.* A woolen cloth generally made in navy blue and used for seamen's coats. It is usually a heavily milled 2/2 twill with a raised, brushed finish.

**Pimelic ketone** *n.* A Syn: cyclohexanone.

**Pimple** \ˈpim-pəl\ [ME *pinple*] (14c) *n.* Small, conical protrusion on the surface. It also may refer to small surface blister.

**Pin** *n.* Another name for mandrel (2).

**Pinacold** *n.* Two parallel faces of a crystal having no equivalents.

**Pinacolone** *n.* $CH_3COC(CH_3)_3$. Methyl tert butylketone. Medium-boiling ketonic solvent. Bp, 106°C.

*Also known as pinacolin.*

**Pinched coating** *n.* In coated fabrics, a ridge or a wrinkle in the coating.

**Pinch effect** *n.* When an electric current, either direct or alternating, passes through a liquid conductor, that conductor tends to contract in cross-section, due to *electromagnetic* forces.

**Pinch-off** *n.* (1) In blow molding, a raised edge around the cavity in the mold that seals off the part and separates the excess material as the mold closes around the parison. (2) In making tubular film, the paired rollers (pinch rolls) at the top of the tower that flatten the tube and confine the air in the bubble.

**Pinch-off blades** *n.* In blow molding, the mating parts of the mold at the bottom that come together first, to pinch off the parison at the bottom and serve the tail, then, to help form the bottom of the part as the parison is inflated.

**Pinch-off land** *n.* The width of the pinch-off blade that effects the sealing of the parison.

**Pinch-off tail** *n.* In blow molding, the bottom tip of the parison that is pinched off and severed as the mold closes.

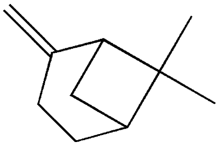
*See the three preceding entries.*

**Pin drafting** *n.* Any system of drafting in which the orientation of the fibers relative to one another in the sliver is controlled by pins.

**Pineholes** *n.* Film defect characterized by small pore-like flaws in a coating, which extend entirely through the applied film and have the general appearance of pin pricks when viewed by reflected light. The term is rather generally applied to holes caused by solvent bubbling, moisture, other volatile products, or the presence of extraneous particles in the applied film.

*See pores.*

**Pinene** \ˈpī-ˌnēn\ [ISV, fr. L *pinus*] (1885) *n.* $C_{10}H_{16}$. A bicyclic terpene hydrocarbon, the principal constituent of all turpentines, and existing therein in two isomeric forms, alpha- and beta-piene. The latter is found in appreciable quantity only in gum spirits and sulfate wood turpentine. Pinene not otherwise described usually means alpha-pinene. Alpha-pinene: Bp, 155°C; Sp gr, 0.858 per 20°C; refractive index, 1.466. Beta-piene: Bp, 163°C; Sp gr, 0.869 per 20°C; refractive index, 1,476 (*See image*).



**Pine needle oil** *n.* Essential oil of typical fragrance obtained by steam distillation of the leaves (needles) of certain species of pine or other coniferous trees.

**Pinene resin** *See polyterpene resin.*

**Pine oil** *n.* Colorless to amber colored volatile oil with characteristic pinaceous odor, consisting principally of isomeric tertiary and secondary cyclic terpene alcohols, with variable quantities of terpene hydrocarbons, ethers, ketones, phenols and phenolic ethers, the amount and character of which depend on the source and method of manufacture. The four commercial kinds of pine oil are: (1) *Steam distilled pine oil.* Obtained from pine wood by steam distillation or by solvent extraction followed by such distillation. (2) *Destructively distilled pine oil.* Obtained from the lighter distillate from the destructive distillation (carbonization) of pine wood. (3) *Synthetic* *pine oil.* Obtained by chemical hydration of terpene hydrocarbons to form the terpene alcohols, or by dehydration of terpin hydrate. (4) *Sulfate pine oil.* A high boiling fraction obtained in the refining and fractional distillation of the condensed vapors released during the ingestion of wood by the sulfate processes.

**Pine pitch** *n.* Dark-colored to black solidified material, somewhat pliant and tenacious, obtained by distilling off practically all the volatile oil from a retort pine tar; the genuine contains no added free rosin.

**Pine tar, kiln burned** *n.* Heavy, oily liquid resulting from controlled carbonization (slow burning) of pine knots and stumpwood to charcoal in earth-covered piles or "kilns", with introduction of insufficient air to permit complete combustion; contains under composed resin acids along with the decomposition products. This product is sometimes called "country tar".

**Pine tar oil** *n.* Oil obtained by condensing the vapors from the retorts in which resinous pine wood is destructively distilled (carbonized).

**Pine tar, retort** *n.* Tar produced by removal of volatile oils from pine tar oil by stream distillation. Several grades are marketed, namely; thin, medium, heavy and extra heavy, so classified on the basis of viscosity, and depending upon the quantity of volatile oils removed.

**Pine tar, Stockholm** *n.* Kiln-burned pine tar produced in Scandinavian countries from wood of the Northern European pine, *Pinus sylvestris.*

**Pinhead** (1593) *n.* A small pinhead-sized opening usually found about 10–12 in. from a selvage. Pinheads usually run in a fairly straight line along the warp and are formed by the shuttle pinching the filling, causing small kinks that show up as small holes in transmitted light.

**Pinholing** *n.* (1) Failure of a printed ink to form a completely continuous film. Visible in the form of small holes or voids in the printed area. (2) The appearance of fine, pimply elevations or tiny holes on a coating.

**Pinion barré** \ˈpin-yən ˈbär\ *n.* A fine, filling wise fabric defect appearing as one or two pick bars in an even repeat. It is caused by a faulty loom pinion.

**Pink staining** *n.* A pink-colored stain that sometimes appears on vinyl-coated fabrics of white and pastel colors when they have lain on earth for a long time. It has been attributed to growth of fungi of the genus *Penicillium*, and to the bacterium. *Streptomyces rubrireticuli.* It can be prevented by treating the fabric with a fungicide, e.g., *N*-(trichloromethylthio) phthalimide or an arsenic compound.

**Pin mark** *See clip mark.*

**Pinning** *See pin drafting.*

**Pinolin** *See rosin spirit.*

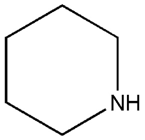
**Pinpoint gate (pin gate)** *n.* In injection molding, a very small orifice, generally 0.75 mm (30 mils) or less in diameter (or maximum lateral dimension), connecting the runner and mold cavity, and through which molten plastic flows into and fills the cavity. Such a gate leaves a small, easily removed mark on the part, but due to the tendency of the melt to freeze early in the pinpoint gate as flow slows, its use is limited to small parts and to resins with good fluidity. In multicavity molds, the dimensions of pinpoint gates must be held within very tight tolerances in order to fill all cavities at the same time and to avoid differences in dimensions among the parts extracted from the several cavities. *See also balanced gating, gate, and restricted gate.*

**Pinsonic® thermal joining machine** *n.* A rapid, efficient quilting machine that uses ultrasonic energy rather than conventional stitching techniques to join layers of thermoplastic materials. The ultrasonic vibrations generate localized heat by causing one piece of material to vibrate against the other at extremely high speed, resulting in a series of welds that fuse the materials together.

**Pipe clay** *See aluminum silicate* (*clay*).

**Pipe die** *n.* An extrusion die whose lands form a circular annulus used in extrusion of plastic pipe or tubing. The outer shell of the die is usually called the *die*, the core is called the *mandrel*. Pipe dies may be side-fed or end-fed, and the mandrel may be supported by a trio of legs called a *spider*, or it may be supported from the rear of a side-fed die. It is easier to achieve circumferential uniformity of wall thickness with a spider die, but the splitting of the melt stream at the legs has sometimes caused weak welds because of insufficient knitting time before the pipe emerges and is chilled.

**Piperidine** \pi-ˈper-ə-ˌdēn\ [ISV *piper*ine + -*idine*] (1854) *n.* A heterocyclic, secondary amine with a six-membered ring. $C_5H_{10}NH$, a slow-acting curing agent for thick-section epoxy castings or laminates, where faster curing would cause exotherm problems such as bubbling, distortion, or cracking (*See image*).



**Pipe train** *n.* A term used in pipe extrusion that denotes the entire equipment assembly, i.e., extruder, die, external sizing means, cooling bath, haul-off, and coiler or cutter.

**Piqué** \pi-ˈkā\ [F *piqué*, fr. pp of *piquer* to pick, quilt] (1852) *n.* (1) A medium weight to heavyweight fabric with raised cords in the warp direction. (2) A double-knit fabric construction knit on multifeed circular machines.

**PIR** Abbreviation for polyisocyanurate.

**Pirn** \ˈpərn, *2 is also* ˈpirn\ [ME] (15c) *n.* (1) A wood, paper, or plastic support, cylindrical or slightly tapered, with or without a conical base, on which yarn is wound. (2) The double-tapered take-up yarn package from drawtwisting of nylon, polyester, and other melt spun yarns.

**Pirn barré** A fabric defect consisting of crosswise bars caused by unequal shrinkage of the filling yarn from different points on the original yarn package.

**Piston** \ˈpis-tən\ [f, fr. It *pistone*, fr. *pistare* to pound, fr. OIt, fr. ML, fr. L *pistus*, pp of *pinsere* to crush] (1704) *n.*
*See force plug.*

**Pit** [ME, fr. OE *pytt* (akin to OHGr *pfuzzi* well), fr. L *puteus* well, pit] (before 12c) *n.* An imperfection, a small crater in the surface of the plastic, with its width of about the same size as the depth.
*See pockmarking.*

**Pitch** *n.* (1) Of an extruder screw, the axial distance from a point on a screw flight to the corresponding point on the next flight. In a single-flight (single-start) screw, the pitch and lead are equal. In a screw having *n* parallel multiple flights, pitch = lead/*n*. In certain solids-draining screws with two flights, the lead of one flight is slightly larger than that of the other. In such a screw, pitch varies continuously along the two-flighted section. (2) Any of various black or dark semi-solid to solid materials obtained as residues from the distillation of tars, and sometimes including natural bitumen.

**Pitch** *n.* Psychological response of the ear, primarily dependent upon the frequency of vibration of the air. The intensity of the sound also has a certain effect on the pitch. Pitch of a screw is the axial distance between adjacent turns of a single threat on the screw.

**Pitch, Archangel** *n.* Originally a genuine pine pitch made from pine tar in the Archangel district of Russia; in this country a similar product is made from residues of pine origin, blended with various oils to make a pitch for caulking boats. Its acidity is due mainly to rosin acids.

**Pitch, Brewer's** *n.* Type of pitch made by blending certain oils, waxes or other ingredients with rosin for the coating of beer barrels.

**Pitch, burgundy** *n.* Originally the solidified resin obtained by heating and straining the air-dried oleoresin exuded by the Norway spruce (*Picea excelsa*) and European silver fir (*Abies petinata*); now denotes an artificial mixture made by heating rosin with certain fixed oils, the combination being used for adhesive plasters.

**Pitch, navy** *n.* Pitch obtained by melting rosin with pine tar, with or without rosin distillation residues.

**Pitch oil** *See creosote.*

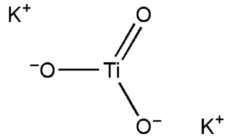
**Pitch pocket** *n.* An opening between the growth rings containing resin in certain softwoods. Syn: resin pocket, pitch streak.

**Pitch streak** *See pitch pocket.*

**Pitting** *n.* Formation of holes or pits in the surface of a metal, by corrosion, or in the surface of a coating while it cures often because of the escape of gas or solvent.

**p*K*** *n.* The negative logarithm of the dissociation constant $K$ or $-\log K$ that serves as a convenient measure of an acid [$K$ for acetic acid is 0.000018 or $1.8 \times 10^{-5}$ from which p$K$ is $(5-0.25)$ or 4.75].

**PKT** *See potassium titanate* (*See image*).



**PL** *n.* Poly(ethylene) (EEC abbreviation).

**Plain-knit fabric** *See flat-knit fabric.*

**Plain weave** *n.* One of the three fundamental weaves: plain, satin, and twill. Each filling yarn passes successively over and under each warp yarn, alternating each row.

**Plaiting** *See braiding.*

**Planar helix winding** *n.* A winding in which the filament path on each dome lies on a plane that intersects the dome, while a helical path over the cylindrical section is connected to the dome paths.

**Planar winding** *n.* A winding in which the filament lies on a plane that intersects the winding surface.

**Planckian radiator** *n.* A body which absorbs all radiation falling on it and reflects none. At each temperature to which it is heated, it radiates a precise magnitude per area of its surface at each wavelength throughout the spectrum, thus, a family of spectral curves is formed for the family of temperatures. The chromaticity coordinates of the integration of these individual curves trace a curve on a CIE chromaticity diagram which is called the Planckian locus and is the chromaticity reference for designating color temperature and correlated color temperature. The temperatures are expressed in the Kelvin (absolute) scale. *See correlated color temperature.*

**Planck's constant** \ˈpläŋk-\ (*h*) (Max Plank, 1858–1947) *np.* A universal constant of nature which relates the energy of a quantum of radiation to the frequency of the oscillator, which emitted it. It has the dimensions of action (energy × time). Classically expressed by

$$E = h\nu,$$

where $E$ is the energy of the quantum and $\nu$ (or sometimes $f$) is its frequency and $h$ is Planck's constant. Its numerical value is $(6.6517 \pm 0.00023) \times 10^{-27}$ ergs or $(10^{-34}\,\mathrm{J\,s})$ where $\nu$ is the frequency, $\lambda$ the wavelength (m), $c$ is the velocity of light $(3 \times 10^{8}\,\mathrm{m/s})$, it is calculated by

$$\nu = \frac{c}{\lambda}.$$

Russell JB (1980) General chemistry. McGraw-Hill, New York.

**Planetary-screw extruder** *See extruder, planetary-screw.*

**Planishing** \ˈpla-nish-shən\ *n. See press polishing.*

**Planography** \plā-ˈnä-grə-fē\ (1909) *n.* Printing processes which are dependent upon the fact that an oily ink will not adhere to water-moistened, non-design areas of a level plate but will wet design areas treated with a greasy ink or varnish.

**Plaskon** *n.* Urea–formaldehyde resin, manufactured by Allied Chemicals, USA.

**Plasma etching** *n.* A process in which a plastic surface to be metal-plated is exposed to a gas plasma in a vacuum, producing chemical and physical changes that yield bondability and wettability equivalent to those produced in the past by stringent and hazardous chemical pre-treatments. Although a variety of gases may be used, bottled oxygen has been found to be best. A radio-frequency source inside the high-vacuum chamber generates the plasma (an ionized gas consisting of an equal number of positive ions and electrons). The process has been effective on nylons, acrylonitrile-butadiene-styrene resins, and plastics based on phenylene oxide.

**Plasma flame** *See flame spray.*

**Plasma polymerization** *n.* The process of polymerizing a gaseous monomer (e.g., tetrafluorethylene) in a radio-frequency (rf) field in a low vacuum whereby the monomer absorbs electromagnetic energy sufficiently to excite the π-bond thereby producing free radicals to initiate polymerization. The polymer adheres to the surfaces within the vacuum chamber (usually falls due to gravity on a surface). Poly(ethylene tetrafluoride) and other films can be deposited on metals, etc., using this process that would be difficult to deposit otherwise. Biederman H (2004) Plasma polymer films. Imperial College Press, London. D'Agostino R, Fracassi F (eds) (1997) Plasma processing of polymers. Kluwer Academic Publishers, New York.

**Plasma-spray coating** *n.* A spray-coating process developed to apply sinterable plastics such as polytetrafluoroethylene to metals and ceramics. A special spray gun produces a rotating jet of hot, ionized gas particles (plasma) with laminar-flow characteristics. Plastic powder supplied to the gun is channeled within the gun so that it emerges as a layer on the periphery of the plasma jet where temperatures are lower than those in the center of the jet. The process is capable of producing coatings as thin as 2.5 μm on unprinted but clean substrates, without after-baking. Substrates must be capable of withstanding the sintering temperature of the polymer.

**Plaster** \ˈplas-tər\ [ME, fr. OE, fr. L *emplastrum*, fr. Gk *emplastronomer*, fr. *emplassein* to plaster on, fr. *en-* + *plassein* to mold, plaster, perhaps akin to L *planus* level, flat] (before 12c) *n.* A paste-like material, usually a mixture of Portland cement, lime or gypsum with water and sand; fiber or hair may be added as a binder; applied to surfaces such as walls or ceilings in the plastic state; later it sets to form a hard surface.

**Plasterboard** *See gypsum wallboard.*

**Plaster of Paris** \-ˈpar-əs\ {*often capitalized 2d P*} [*Paris*, France] (15c). A group of cements which consist essentially of calcium sulfate and are produced by a partial dehydration of gypsum to the hemihydrate $2CaSO_4{\cdot}H_2O$. They usually contain additives of various sorts.

*Also known as gypsum cement.*

**Plaster primer** *n.* Primers with a degree of resistance to alkali, which are used for priming plasters and cements of varying degrees of alkalinity. The primers must not only resist saponification but must insulate succeeding coats of paint from attack.

**Plastic** \ˈplas-tik\ [L *plasticus* of molding, from Gr *plastikos*, fr *plassein* to mold, form] (1632) *adj.* (1) *adj* Originally, the term was used as an adjective to indicate a material was capable of being "molded or shaped". Indicating that the noun modified is made of or pertains to a plastic or plastics. The singular form is customarily used when the noun obviously refers to a particular, single plastic, as in "a plastic hose", and the plural form is often used when the noun could refer to several types of plastics, as in "the plastics industry". However, there has been a trend in Europe to use the plural form exclusively even when it results in ungrammatical phrases such as "a plastics hose". The intent of the ungrammatical pluralization is to distinguish between the synthetic polymers used in the plastics industry and other materials sometimes referred to as "plastic", such as hot glass, modeling wax, and clay in the wet, unfired state. The preference of most authors is to use the singular form when it is evident from context that the noun refers to a single material. (2) *adj* Capable of being deformed continuously and permanently without rupture at a stress above the yield value. (3) *n* A material that contains as an essential ingredient one or more high polymers, is solid in its finished state and, at some stage in its manufacture or processing into finished articles, can be shaped by flow. However, this definition is supplemented by notes explaining that materials such as rubbers, textiles, adhesives, and paints, which may in some cases meet this definition, are not considered to be plastics. The terms *plastic, resin,* and *polymer* are somewhat synonymous, but resin and polymer most often denote the basic materials as polymerized, while the term *plastic* or *plastics* encompasses compounds containing plasticizers, stabilizers, fillers, and other additives. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004. James F Carley (eds) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA.

*See also elastomer.*

**Plasticate (plastificate)** *v.* To render a thermoplastic more flexible, even molten, by means of both heat and mechanical working. Sometimes used imprecisely for plastify and incorrectly for plasticize.

**Plasticating capacity** *n.* Of an extruder or injection molder, the maximum rate at which the machine can melt room-temperature feedstock and raise it to the temperature suitable for extrusion or molding. This rate is determined mainly by the quotient of the available screw power, divided by the means specific heat of the plastic of interest and the rise in temperature of the plastic from feed to die; and to lesser degrees by extruder length, screw design, and die design.

**Plastication** *n.* In a screw extruder, plastication means that one starts with a solid feed (pellet form), which is brought to a melt state, so that plastication extrusion can proceed.

**Plastic-bonded wallpapers** *n.* Papers made with a protein size with a plastic added. They are washable, but subject to staining by certain liquids.

**Plastic-coated wallpapers** *n.* Papers that are more washable and stain-resistant. A thick plastic coating increases the resistance and permits vigorous washing.

**Plastic deformation** *n.* (1) A change in dimensions of an object under load that is not recovered when the load is removed. For example, squeezing a chunk of putty results in plastic deformation. The opposite of plastic deformation is *elastic deformation*, in which the dimensions return instantly to the original values when the load is removed, e.g., as when a rubber band is stretched and released. (2) In tough plastics, deformation beyond the yield point, appearing on the stress–strain diagram as a large extension with little or no rise in stress. A part of the plastic deformation may be recovered when the stress is released; the remainder is plastic flow.

**Plastic flow** Irreversible flow above the yield point. The flow of molten or liquid plastics during processing. Deformation without change of stress. A liquid displays plastic flow when a yield stress must be overcome or exceeded before flow will take place. Plastic viscosity, $U$, is expressed as:

$$U = \frac{\text{shear stress} - \text{yield stress}}{\text{shear rate}}.$$

Liquids which display plastic flow are called Bingham liquids. Patton TC (1964) Paint flow and pigment dispersion. Interscience Publishers Inc., New York.

**Plastic foam** (1943) *n.* Syn: cellular plastic.

**Plasticity** \pla-ˈsti-sə-tē\ (ca. 1783) *n.* The complex property of a material involving a combination of the properties of mobility and of yield value, enabling it to be continuously deformed without rupture when acted on by a force sufficient to case flow and allowing it to retain its shape after the applied force has been removed.

**Plasticize** \ˈplas-tə-ˌsīz\ (1919) *vt.* To render a material softer, more flexible and/or more moldable by the addition and intimate blending in of a plasticizer. Should not be confused with plasticate and plastify.

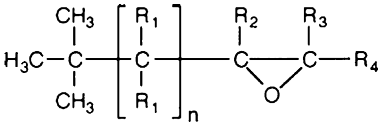
**Plasticizer** *n.* (1) An additive in a paint formulation to soften the film, thus giving it better flexibility, chip resistance, and formability. (2) A substance of low or even negligible volatility incorporated into a material (usually a plastic or an elastomer) to increase its flexibility, workability, or extensibility, while reducing elastic moduli. A plasticizer may also reduce melt viscosity and lower the glass-transition temperature. Most plasticizers are non-volatile organic liquids or low-melting solids that function by reducing the normal intermolecular forces in a resin, thus permitting the macromolecules to slip past one another more freely. Some are polymeric. Plasticizers are classified in several ways according to: their compatibility (*see primary and secondary plasticizers*); their general structure (monomeric or polymeric); their functions [(flame-retardant, high-temperature, low-temperature, non-toxic (*see non-toxic material*), stabilizing, cross-linking, etc.]; and their chemical nature (*see adipate plasticizer, chlorinated paraffin,* *epoxy plasticizer, phosphate plasticizer, and phthalate ester*). Many thousands of compounds have been developed as plasticizers, or which perhaps less than 200 are in widespread use today. The main facts about over 3509 plasticizers are tabulated in the "Plasticizers" data table of the *Modern Plastics Encyclopedia* for 1993 (and earlier years). About two-thirds of all plasticizers produced are used in vinyl compounds, in which field the three "workhorse" plasticizers are dioctyl phthalate, diisooctyl phthalate, and diisodecyl phthalate.

**Plasticizer-adhesive** *n.* An additive, partly replacing plasticizers, that improves the adhesion of plastics coatings to substrates. For example, polymersable monomers such as diallyl phthalate or triallyl cyanurate are added to PVC plastisols to improve their adhesion to metals, but these compounds also contribute to the plasticizing function.

**Plasticizer efficiency** *n.* (1) The parts by weight of plasticizer per 100 parts of resin (phr) required to produce a plasticized PVC resin of a particular hardness on the Durometer A scale. (2) Taking dioctyl phthalate as the industry standard of comparison, one may express the efficiency (in %) of another plasticizer as 100 ($n_0/n_1$), where $n_0$ is the phr of DOP required to achieve a particular Durometer value (or other desired property) and $n_1$ is the phr of the alternate plasticizer required to reach that same value.

**Plasticizer migration** *See migration of plasticizer.*

**Plasticizer, polymerizable (reactive plasticizer)** *n.* (1) A special type of plasticizer, unique in that it functions as a plasticizer only before and during the processing step consisting of a monomer added to a plastisol to increase its fluidity, which monomer cures in the presence of catalysts to become rigid in the fused plastisol article. Among such monomers are polyglycol dimethacrylates, dimethacrylates of 1,3-butylene glycol and trimethylolpropane, and some trade named monomers whose compositions are proprietary. These polymerizable plasticizers enable one to liquid-cast very rigid articles that would otherwise have to be made, with very low plasticizer levels by injection molding. Monomeric styrene, not ordinarily thought of as a plasticizer, performs in much the same way in polyester laminating formulations, lowering viscosity during wetting-out and the initial moments of pressure molding, then polymerizing to form cross-links of the strong, stiff finished product. (2) Any of a new class of epoxy resins having the general structure in which the R groups may be H, methyl, or ethyl, and $n = 1–10$. These are very miscible with epoxy resins, they provide non-migrating internal plasticization after curing, and they are useful in coatings, adhesives, and sealants. (*See image*)



**Plasticizer, solid** *n.* A plasticizer that is solid at room temperature but melts during processing to improve processability of the polymer in which it is incorporated. Upon cooling it resolidifies and thus does not soften the finished article. Solid plasticizers are used in rigid PVC, one of the most common being diphenyl phthalate (mp = 75°C).

**Plastic memory** *See memory.*

**Plasticorder (plastograph)** *n. See barbender plastograph.*

**Plastic paint** *n.* A heavy-bodied, thixotropic paint which can be worked after application, by stripping or by paint rollers having a textured pattern, to produce various textured or pattern surfaces.

*Also called textured paint and texture-finished paint.*

**Plastic paper (synthetic paper)** *n.* Paper-like products in which the skeletal structure is composed of synthetic resin. Three main types are *spunbonded sheet, film paper,* and *synthetic pump* (synpulp). Film papers are similar to thin films of oriented polystyrene or polyolefins but they are treated to obtain opacity and ink receptivity. Synpulps are papermaking pumps made usually from polyolefins by processes that produce fibrous pulps without the use of conventional spinning methods.

**Plastic, rigid** *See rigid plastic.*

**Plastic, semi-rigid** *See semi-rigid plastic.*

**Plastics, recycling** *n.* A term embracing systems by which plastics materials that would otherwise immediately become solid wastes are collected, separated, or otherwise processed and returned to the economic mainstream in the form of useful raw materials or products.

**Plastic solid** *n.* Solid that deforms continuously and permanently when subjected to a shearing stress in excess of its yield value.

**Plastic strain** *n.* Plastic flow above the yield stress expressed as a fraction or percent of the original dimension before applying stress.

**Plastic tooling** *n.* A term designating structures composed of plastics that are used as tools in the fabrication of metals or other materials including plastics. While they are usually made of reinforced and/or filled thermosets, flexible silicone or polyurethane tools are often used for casting plastics. Common applications of rigid plastics tooling are sheet-metal-forming dies, models for duplicators, drill fixtures, spotting racks molds for thermoforming thermoplastics, and injection molds for short runs. The tools are formed by the usual processes used for thermosetting resins, such as laminating, cating, and spray-up.

**Plastic viscosity** *n.* A term describing a flow property of a printing ink. The flow curve is a graph of shearing force versus rate of shear.

*See viscosity, plastic.*

**Plastic viscosity** *n.* For a Bingham plastic, the difference between the shear stress and the yield stress, divided by the shear rate.

**Plastic welding** *See welding.*

**Plastic wood** *n.* A paste of wood flour, plasticizer, resins and/or other materials dispersed in nitrocellulose or other binders and volatile solvents, used for repairing or filling holes in wood, etc.

**Plastify** *adj.* To soften a thermoplastic resin or compound by means of heat alone, as in sheet thermoforming. Should not be confused with plasticize or plasticate.

**Plastigel** *n.* A vinyl compound similar to a plastisol, but containing sufficient gelling agent and/or filler to provide a putty-like consistency. It may be molded to a shape-retaining form at room temperature, then heated and cooled to impart permanency.

**Plastisol** \ˈplas-tə-ˌsäl\ [*plastic* + $^{4}$*sol*] (1946) *n.* A suspension of a finely divided vinyl chloride polymer or co-polymer in a liquid plasticizer which has little or no tendency to dissolve the resin at ambient temperature but which becomes a solvent for the resin when heated. At room temperature the suspension is very fluid and suitable for casting. At the proper temperature, the resin is completely dissolved in the plasticizer, forming a homogeneous plastic mass, which upon cooling is a more or less flexible solid. Additives such as fillers, stabilizes, and colorants are also usually present. A plastisol modified with volatile solvents or diluents that evaporate upon heating is known as an organosol. When gelling or thickening agents are added to produce a putty-like consistency at room temperature, the dispersion is called a plastigel. The coined term *ridigsol* is used to denote a plastisol modified with polymerizable or cross-linking monomers so that the fused product is rigid rather than flexible. Products are made from plastisols by rotational casting, slush casting, dipping, spraying, film casting, and coating.

**Plastograph** *See barbender plastograph.*

**Plastomer** *n.* (1) (Solprene®) Any of a family of thermoplastic-elastomeric, styrene-butadiene co-polymers whose molecules have a radial or star structure in which several polybutadiene chains extend from a central hub, with a polystyrene block at the outward end of each segment. They are used in making footwear components, in adhesives and sealants, and are also blended with other resins to upgrade performance. (2) Late in 1992 this term was adopted as generic by Exxon Chemical and Dow Chemical for grades of very-low-density polyethylene, produced with so-called "exact" metallocene catalysts and offering the flexibility of rubber with the strength and processability of linear low-density polyethylene. Densities range from 0.880 to 0.905 g/cm$^3$.

**Plastometer** *n.* An instrument for determining the flow properties of plastic materials. The term "plastometer" is not actually necessary, for a plastometer is essentially any viscometer capable of measuring the flow properties of a material exhibiting yield value.

*See rheometer and viscometer.*

**Plate cylinder** *n.* That roller of an offset printing press which bears the printing plate.

**Plated** (14c) *vt.* (1) A term to describe a fabric that is produced from two yarns of different colors, characters, or qualities, one of which appears on the face and the other on the back. (2) A term to describe a yarn covered by another yarn.

**Plate die** *n.* An inexpensive and easily modified die for extruding a plastic profile, into which a orifice of the desired shape has been machined typically by electrical-discharge machining. The plate is bolted to the front of a universal die body.

**Plate dispersion plug** *n.* Two small, perforated, parallel disks joined by a central connecting rod. Such assemblies were sometimes inserted in the nozzles of ram-type injection-molding machines to improve the distribution of colorants in the resin as it flows through the nozzle.

**Plateless engraving** *n.* A typographic printing process in which densely pigmented ink on printed sheets is dusted with a powdered resin of low melting point. After surplus powder has been blown from the paper, heat is applied to fuse the resin and yield characters, which are raised above the paper.

**Plate mark** *n.* Any imperfection in a pressed plastic sheet resulting from the surface of the pressing plate (ASTM D 883).

**Platen** \ˈpla-tᵊn\ [MF *plateine*, fr. *plate*] (1541) *n.* (1) A flat plate in a printing press, which presses the paper against the inked type, thus securing an impression. (2) A plate of metal, especially one that exerts or receives pressure, as in a press used for gluing plywood. (3) Either of the sturdy mounting plates of a press, usually a pair, to which the entire mold assembly is bolted. Syn: caul.

**Platen press** *n.* A press which prints a single sheet by pressing the latter against an entire frame or chase of type at the same moment.

**Plate-out** *n.* An objectionable coating gradually formed on metal surfaces of molds and calendering and embossing rolls during processing of plastics, and caused by extraction and deposition of some ingredients such as a pigment, lubricant, stabilizer, or plasticizer. In the case of vinyls, which are especially prone to this condition, plate-out can be reduced by using highly compatible stabilizers such as barium phenolates and cadmium ethylhexoate, or by incorporating silica in the formulation. Resins can play a role in the plate-out problem, although the degree and mechanisms of resin contributions to plate-out are controversial.

**Platform blowing** *n.* A special technique for blow molding large parts. To prevent excessive sag of the massive parison, the machine employs a table that after rising to meet the parison at the die, descends with the parison, but a little more slowly than the parison, so as to support its weight, yet not cause buckling.

**Plating** *See electroplating on plastics.*

**Pleat** \ˈplēt\ [ME *plete*] (15c) *n.* Three layers of fabric involving twofolds or reversals of direction; the back fold may be replaced by a seam.

**Pleochroism** \plē-ˈä-krə-ˌwi-zəm\ [ISV *pleochroic*, fr. *pleio-* + Gk *chrōs* skin, color] (1857) *n.* Property of crystals or minerals of giving different absorption colors for different directions of vibration of light within the crystal; in optical mineralogy this property is observed in crystals under a polarizing microscope with the lower nicol only and rotating the stage.
*See dichroism.*

**Plessy's green** *n.* $CrPO_4 \cdot nH_2O$. A bluish green pigment consisting essentially of hydrated chromium phosphate.

**Plexidur** *n.* Poly(methyl methacrylate). Manufactured by Roehm and Haas, USA.

**Plexiglas®** *n.* Poly(methyl methacrylate) Famous trade name for acrylic resins and cast polymethyl methacrylate sheet. Manufactured by Röhm & Haas, Germany.

**Plexol** *n.* Oil-soluble methacrylate copolymer (viscosity improver). Manufactured by Röhm & Haas, Germany.

**Plied yarn** *n.* A yarn formed by twisting together two or more singles yarns in one operation.

**Plied yarn duck** *See duck.*

**Pliofilm** *n.* Rubber hydrochloride, manufactured by Goodyear, USA.

**Pliolite NR** Cyclo rubber. Manufactured by Goodyear, USA.

**Plissé** \pil-ˈsā\ [F *plissé*, fr. pp of *plisser* to pleat, fr. MF, fr. *pli* fold, fr. *plier* to fold] (1873) *n.* A cotton, rayon, or acetate fabric with a crinkled or pleated effect. The effect is produced by treating the fabric, in a striped or spotted motif, with a caustic-soda solution which shrinks parts of the goods.

**Plochere color system** *n.* A color order system based on subtractive colorant mixture developed by mixing a limited number of pigments in systematically varied proportions.

**Plucking** *n.* A condition found at the feed roll and lickerin section of the card when larger than normal clusters of fiber are pulled from the lap by the lickerin. This situation is normally caused by uneven laps or the inability of the feed rolls to hold the lap sheet while small clusters of fibers are being pulled from the lap by the lickerin. Plucking inevitably produces flaky webs.

**Plug-and-ring forming** *n.* A technique of sheet thermoforming in which a plug, functioning as a male mold, is forced into a heat-softened sheet held in place by a clamping ring.

**Plug-assist forming** (vacuum forming with plug assist) *n.* A sheet thermoforming process in which a convex mold half presses the softened sheet into the concave half, accomplishing most of the draw, after which vacuum is applied, drawing the sheet onto the concave surface. The method provides more nearly equal bottom and side thicknesses than straight vacuum forming and permits deeper draws.

**Plug flow** *n.* Movement of a material as a unit without shearing within the mass. This is an extreme seldom realized in practice, but can occur over the center of a Bingham-plastic stream or in a system where the fluid does not wet the bounding walls. As compared with Newtonian flow, the more pseudoplastic the plastic melt, the more nearly sluggish is its flow.

**Plugging value** *n.* In the manufacture of acetate fibers, a measure of filterability. It is the weight of solids in an acetate dope that can be passed through a fixed area of filter before the filter becomes plugged. It is expressed as weight of solids per square unit of filter area, e.g., $g/cm^2$.

**Plumbago** \ˌpləm-ˈbā-(ˌ)gō\ [L *plumbagin-*, *plumbago* galena, fr. *plumbum*] (1747) *n.* Another name for graphite.

**Plunger** \ˈplən-jər\ (1611) *n.* The part of a transfer-press or old-style injection machine that applies pressure on the unmelted plastic material to push it into the chamber, which in turn displaces the plastic melt in front of it, forcing it through the nozzle and into the mold.

*See also ram, force plug, and pot plunger.*

**Plunger molding** *n.* A variation of transfer molding in which an auxiliary hydraulic ram is employed to assist the main ram. The auxiliary ram rapidly forces the material through a small orifice, thereby generating high frictional heat. The higher temperature speeds the cure of the material, which when transferred into the mold by the main ram, cures very soon after the mold is filled.

**Pluronics** *n.* Ethylene oxide/propylene oxide co-polymer, manufactured by Wyandotte Chemical, USA.

**Plush** \ˈpləsh\ [MF *peluche*] (1594) *n.* A term describing a cut-pile carpet in which the pile yarns are only slightly twisted, dense, and very evenly sheared. A plush carpet has the look of a solid, flat velvet surface. Similar pile constructions are also used in upholstery fabric.

**Plutonium** \plü-ˈtō-nē-əm\ [NL, fr. *Pluton-*, *Pluto*, the planet Pluto] (1942) *n.* A fissile element, artificially produced in the pile by neutron bombardment of $U^{238}$.

**Ply** \ˈplī\ [ME *plien* to fold, fr. MF *plier*, from L *plicare*; akin to OHGr *flehtan* to braid, Latin *plectere*, Gk *plekein*] (ca. 1909) *n.* (1) The number of single yarns twisted together to form a plied yarn, or the number of plied yarns twisted together to form cord. (2) An individual yarn in a plied yarn or cord. (3) One of a number of layers of fabric (ASTM). (4) The number of layers of fabric, as in a shirt collar, or of cord in a tire.

**Plyfil®** *n.* A proprietary system of making twofold long-and-short staple yarns by using ultrahigh drafting. The slightly twisted ends produced are not useable yarns but are well suited for subsequent processing, i.e., twisting.

**Plying** *n.* Twisting together two or more single yarns or ply yarns to form, respectively, ply yarn or cord.

**Ply twisting** *See plying.*

**Plywood** \ˈplī-ˌwúd\ (1907) *n.* A cross-bonded assembly made of layers of veneer or veneer in combination with a lumber core or plies joined with an adhesive. Two types of plywood are recognized, namely *veneer plywood* and *lumber core plywood. Note*—Generally the grain of one or more plies is approximately at right angles to the other plies, and almost always an odd number of plies are used.

**PMA** *n.* (1) An abbreviation for phosphomolybdic acid. (2) Applied to pigments which have been precipitated with phosphomolybdic acid to give it permanence and insolubility.

**PMAC** *n.* Abbreviation for polymethoxy acetal.

**PMAN** *n.* Abbreviation for polymethacrylonitrile.

**PMA pigment** *See precipitated basic dye blues.*

**PMC** *n.* Abbreviation for polymer–matrix composite.

**PMCA** *n.* Abbreviation for poly(methyl-α-chloroacrylate), a member of the acrylic-resin family.

**PMDA** *n.* Abbreviation for pyromellitic dianhydride.

**PMMA** *n.* Abbreviation for poly(methyl methacrylate).

**PMP** *n.* Abbreviation for poly(4-methylpentene-1).

**Pnicogen** *n.* A member of group VA in the periodic table.

**PO** *n.* Phenoxy resin.

**Pock mark** *n.* An imperfection on the surface of a blow-molded article, an irregular indentation caused by inadequate contact of the blown parison with the mold surface. Contributory factors are insufficient blowing pressure, air entrapment, and condensation of moisture on the mold surface.

*See also pit for an ASTM-approved definition for synonymous term that is not specific to blow molding.*

**Pockmarking** *n.* Film defect in the shape of irregular and unsightly depressions formed during the drying of a paint or varnish film.

*See orange peel. Also called pitting.*

**Point bonding** *See bonding* (2).

**Pointillism** \ˈpwaⁿ(n)-tē-ˌyi-zəm\ {*often capatilized*} [F *pointillisme*, fr. *pointiller* to stipple, fr. *point* spot] (1901) *n.* From the French, pointiller, meaning to dot, stipple. A system of late impressionist painting developed by Georges Surant (1859–1991) and Paul Signac (1863–1935). Contrary to the practice of color mixing on the palette, pointillism consists of applying separated spots or dots of pre-color, side by side on the canvas, e.g., red and yellow for orange, red and blue for mauve, etc. Theoretically, at the right distance, the spectator's eye automatically mixes the colors.

**Pointing** *n.* Treatment of joins in masonry by filling with mortar to improve appearance or protect against weather.

**Point source** *n.* Any discernible, confined and discrete conveyance from which pollutants are or may be discharged.

**Poise** \ˈpóiz\ [F, fr. Jean Louis Marie *Poiseuille* † 1869 French physician and anatomist] (1913) *n.* A fundamental and absolute unit of viscosity measurement. A substance is said to have a viscosity of 1 poise when a force of 1 dyne is required to move a surface of 1 cm$^2$ at a speed of 1 cm/s relative to another plane surface separated from it by a layer 1 cm thick.

$$1\ \mathrm{poise} = 1\ \mathrm{dyn\ s/cm^2} = 1\ \mathrm{g/cm\,s}.$$

**Poiseuille equation** *See Hagen–Poiseuille equation.*

**Poiseuille flow** *n.* Laminar flow in a pipe or tube of circular cross-section under a constant pressure gradient. If the flowing fluid is Newtonian, the flow rate will be given by the Hagen–Poiseuille equation.

**Poison** \ˈpói-zᵊn\ [ME, fr. MF, drink, poisonous drink, poison, fr. L *potion-*, *potio* drink] (13c) *n.* (1) Any substance that is harmful to living tissues when applied in relatively small doses. (2) A substance that reduces or destroys the activity of a catalyst.

**Poisson ratio** *n.* The proportion of lateral strain to longitudinal strain under conditions of uniform longitudinal stress within the proportional or elastic limit. When the material's deformation is within the elastic range its results in lateral to longitudinal strains will also be constant. Elias HG (1977) Macromolecule, Plenum Press, New York.

**Poisson ratio distribution** *n.* The constant relating the changes in dimensions which occur when a material is stretched. It is obtained by dividing the change in width per unit length by the change in length per unit length.

**Polar** \ˈpō-lər\ [NL *polaris*, fr. L *polus* pole] (1551) *adj.* Molecule or radical that has, or is capable of developing, electrical charges. Thus, polar molecules ionize in solution and impart electrical conductivity. Water, alcohol, and sulfuric acid are polar in nature; most hydrocarbon liquids are not. Carboxyl and hydroxyl often exhibit an electrical charge. The formation of emulsions and the action of detergents are dependent on this behavior.

**Polar covalent bond** *n.* A covalent bond in which the bonding electron pair is not shared equally but is drawn closer to the more electronegative atom.

**Polarizability** \ˌpō-lə-ˌrī-zə-ˈbi-lə-tē\ [F *polariser*, fr. NL *polaris* polar] (1811) *n.* The ease by which the particles of a substance may be distorted or oriented by an electric field.

**Polarization** \ˌpō-lə-rə-ˈzā-shən\ (1812) *n.* (1, dielectric) The slight shifting of molecular electric charges when a polymer is placed in a strong electric field, creating local electric dipoles. The shifting of charge takes finite time and generates friction. In a high-frequency field, the rapid shifting causes considerable dissipation of energy, which is the basis for dielectric heating of plastics. (2, light) Of the three types possible, the most useful and common is *plane polarization*. This occurs when ordinary, unpolarized light having wave motions in all directions perpendicular to the ray, passes through nicol prisms or polarizing filters that deliver an exit ray whose vibrations lie in one plane.

**Polarized light** *n.* A bundle of light rays with a single propagation direction and a single vibration direction. The vibration direction is always perpendicular to the propagation direction. It is produced from ordinary light by reflection, by double refraction in a suitable crystal or by absorption with a suitable pleochroic substance. Specific rotation is the power of liquids to rotate the plane of polarization, it is stated in terms of specific rotation or the rotation in degrees per decimeter per unit density.

**Polarizer** *n.* A polarizing element which is placed below the preparation with its vibration direction preferable set in an E–W direction.

**Polarizing microscope** *n.* An optical microscope fitted above and below the specimen-holding stage with nicol prisms or polarizing filters. The lower filter (*polarizer*) imparts plane polarization to the incoming light. The upper one (*analyzer*) is rotatable, but is usually set so that its plane of vibrations is at 90° to that of the lower one. With isotropic specimens, all light is blocked at the analyzer and the observer sees only darkness. With a birefringent specimen, if the original light source is white, the observer sees bands of colors related to the crystal structure and the specimen's refractive indices.

**Polar molecule** *n.* A molecule in which the centers of positive and negative charge do not coincide; a dipole.

**Polars** *n.* Two identical polarizing elements in a polarizing microscope. The polar placed between the light source and substage condenser is called the polarizer; the polar placed between the objective and ocular is called the analyzer. The vibration directions of the two polars may be crossed 90° to achieve "crossed polars"; slightly uncrossing one polar gives "slightly uncrossed polars"; removing the analyzer results in "plane-polarized light".

**Polar solvents** *n.* Solvents with oxygen in their molecule. Water, alcohols, esters, and ketones are examples. All possess a degree of conductivity that inhibits static build-up characteristic of non-polar solvents such as tolvol, xylol, and naphthas.

**Polar winding** *n.* In filament winding, a winding in which the filament path passes tangent to the polar opening at one end of a chamber and tangent to the opposite side of the polar opening at the other end.

**Polepiece** *n.* In reinforced plastics, the supporting part of the mandrel used in filament winding, usually on one of the axes of rotation.

**Polimerisado oil** *n.* A bodied liquid oiticica oil.

**Polish** \ˈpä-lish\ [ME *polisshen*, fr. MF *poliss*-, stem of *polir*, fr. L *polire*] (14c). (1, *v*). (2, *n*) A solid powder or a liquid or semi-liquid mixture that imparts smoothness, surface protection or a decorative finish.

*See burnish.*

**Polishing** *n.* (1) Smoothing and imparting luster to a surface by rubbing with successively finer abrasive-containing compounds or by filling the minute low areas of the surface with a wax or polymeric finish. (2) Smoothing rough edges by applying a jet of hot gas (to plastics) or a flame (to glasses). Flame polishing of plastics is generally not recommended because of the likelihood of degrading the surface and/or leaving residual stresses, either of which can cause crazing.

**Polishing roll** *n.* A roll, usually one of a set that has a highly polished, chrome-plated surface that is mirrored on all sheet or film extruded onto the roll or calendered through it (them).

**Polishing varnish** *n.* Very hard-drying, short oil varnish used for interior woodwork, furniture, etc., and capable of being rubbed with abrasive and mineral oil lubricants to a very smooth surface for a desired degree of gloss. Syn: rubbing varnish.

*See also flatting varnish.*

**Pollopas** *n.* Urea–formaldehyde resin. Manufactured by Dynamit Nobel, Germany.

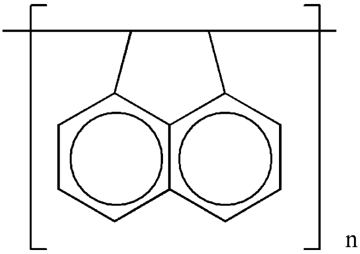
**Pollution** \pə-ˈlü-shən\ (14c) *n.* The presence of matter or energy whose nature, location, or quantity produces undesired environmental effects.

**Pollution abatement** *n.* Ending pollution. Distinguished from pollution control, which may only reduce pollution, and penalties, which principally punish violations.

**Pollution control** *n.* Reducing pollution. Distinguished from pollution abatement, which means ending pollution, and penalties, which principally punish violations.

**Poly-** A prefix meaning many. Thus, the term *polymer* literally means *many mer*, a mer being the repeating unit of any high polymer.

**Polyacenaphthalene** (*See image*).

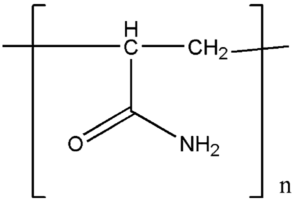


**Polyacetal** *n.* A polymer in which the repeated structural unit in the chain is of the acetal type.

*See also acetal resin and polyoxymethylene.*

**Polyacetylene** *n.* A polymer of acetylene, made with Ziegler–Natta catalysts and usually dark-colored, with the unusual property (for a polymer) of high electrical conductivity, achieved by doping the polymer with about 1% of ionic dopant such as iodine. It may become a useful solar-cell material because its absorption spectrum closely matches the solar spectrum, but mechanical properties and stability are poor. Also, practical processing methods have yet to be developed.

**Polyacrylamide** \ˌpä-lē-ə-ˈkri-lə-ˌmīd\ (1944) *n.* Poly(2-Propenamide) A non-ionic, water-soluble polymer prepared by the addition polymerization of acrylamide ($CH_2{=}CHCONH_2$). The white polymer is readily soluble in cold water but insoluble in most organic solvents. It is used as a thickener, suspending agent, and as an ingredient in adhesives (*See image*).

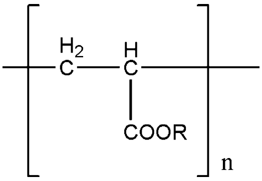


**Polyacrylate** A polymer of an ester of acrylic acid or of esters of acrylic acid homologues or substituted derivatives.

*See acrylic resin.*

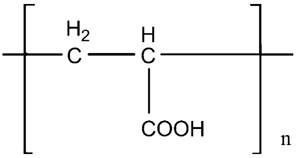
**Polyacrylates** A thermoplastic resin made by the polymerization of acrylic ester such as methyl methacrylate (*See image*).

*See acrylic resin.*

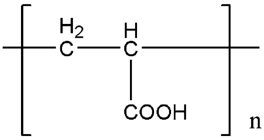


**Polyacrylic acid (PAA)** A polymer of acrylic acid, used as a textile size.

**Poly(acrylic acid)** A polymer of acrylic acid used as a sizing agent in the manufacture of nylon and other synthetic textiles (*See image*).



**Poly(acrylic-acid-co-styrene)** Poly(2-propenoic acid-co-ethenyl benzene) (*See image*).



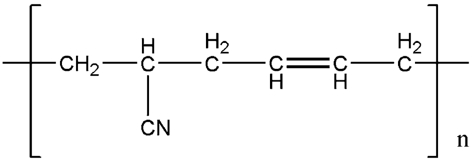
**Polyacrylic plastics** Plastics based on polymers in which the repeated structural units in the chains are essentially all of the acrylic type.

*See acrylic plastics.*

**Polyacrylonitrile** \ˌpä-lē-ˌa-krə-lō-ˈnī-trəl\ (1935) (PAN) *n.* Made by free-radial polymerization of acrylonitrile ($CH_2{=}CHCN$)

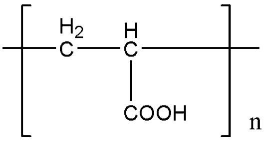
in solution or suspension, this highly polar polymer is the basis of large-volume acrylic and modacrylic fibers.

**Poly(acrylonitrile-co-butadiene)** Common name for 2-propenenitrile, polymer with 1,3 butadiene. It is also commonly known as acrylonitrile-butadiene polymer (*See image*).



$$-\left[CH_2-CH(CN)-CH_2-CH{=}CH-CH_2\right]_n-$$

**Poly(acrylonitrile-co-styrene)** (*See image*).



$$-\left[CH_2-CH(COOH)\right]_n-$$

**Polyaddition** *See addition polymerization.*

**Polyadipamide** A polymer formed by the reaction of adipic acid with a diamine, nylon 6/6 being the most important example.

**Polyalcohol** \ˌpä-lē-ˈal-kə-ˌhól\ (1900) *n.* Alcoholic or hydroxy compound, containing more than one hydroxyl group. Typical polyalcohols are ethylene glycol with two hydroxyl groups, glycerol with three, and pentaerythritol with four hydroxyl groups. Polyalcohols are sometimes known as polyhydric alcohols. Syn: polyol.

**Polyalkenamer** *n.* A chlorine-containing elastomer developed by Goodyear, with properties similar to but somewhat better than those of neoprene rubber. It is a co-polymer of the addition–reaction product of hexachlorocyclo-pentadiene or 1,5-cyclooctadiene and an olefin such as cyclopentane.

**Polyalkylene amide** *See amino resin.*

**Polyalkylene terephthalate** *n.* Any of a family of thermoplastic polyesters that are polycondensates derived from terephthalic acid, whose diol components may be any within a wide range. The principal members of the family are polyethylene terephthalate and polybutylene terephthalate.

**Polyallomer** *n.* A crystalline block co-polymer produced from two or more different monomers, usually ethylene and propylene, by alternately polymerizing the monomers in the presence of anionic, coordination catalysts, resulting in chains containing polymerized segments of both monomers. The polymer chains exhibit degrees of crystallinity normally found only in stereoregular homopolymers of propylene and ethylene, and the co-polymers possess properties different from those of either blends of the homopolymers or co-polymers prepared by conventional polymerization processes. Among such properties are high impact strength, low density, and flexural-fatigue resistance. The name "polyallomer" is derived from *allomerism*, meaning a similarity of crystalline form with a difference in chemical composition.

**Polyalloys** *n.* Alloys that are combinations of two or more plastics which are mechanically blended; they do not depend on chemical bonds but often require special compatibilizers.

**Polyallyl diglycol carbonate** *n.* A high-impact, transparent thermoplastic with excellent abrasion resistance, made from Pittsburg Plate Glass Industries' CR-39 monomer (and hence sometimes called CR-39). It is widely used in eyeglasses.

**Polyamic acid** [(from *poly(amide-acid)*]. A polymer containing both amide and acid groups. The aromatic varieties are precursors of polyimides.

**Polyamide** \ˌpä-lē-ˈa-ˌmīd\ [ISV] (1929) *n.* A synthetic polymer and the fibers made from it in which the simple chemical compounds used for its production are linked together by amide linkages (–NH–CO–). *Also see nylon fiber.*

**Polyamide-imide resin (PAI)** *n.* Any of a family of polymers based on the combination of trimellite anhydride with aromatic diamines. In the uncured form (*ortho*-amic acid) the polymers are soluble in polar organic solvents. The imide linkage is formed by heating, producing an infusible resin with thermal stability up to 290°C. These resins are used for laminating, prepregs, and electrical components. Molding resins that behave as thermoplastics can be produced by thermally curing and modifying amide-imide polymers. These molding resins can be processed by compression molding, extrusion, and injection molding.

**Polyamide-imide resins** *n.* Engineered thermoplastics characterized by excellent dimensional stability, high strength at high temperatures, and good impact resistance.

**Polyamide plastic (polyamide)** *n.*
*See nylon and other listings following same.*

**Polyamide resins** *n.* Condensation resins of an amine and an amine and an acid, the repeated structural unit in the chain being of the amide type.

**Polyamides** Polymers in which the monomer units are linked together by the amide group –CONH–.

**Polyamine** \ˈpä-lē-ə-ˌmēn\ (1861) *n.* Any of a family of compounds containing multiple amines – primary, secondary, or tertiary – or mixtures of these, useful as hardening agents for epoxy resins.

**Polyamine–methylene resin** *n.* A light-amber-colored resin derived from diphenylol and formaldehyde, used as an ion-exchange resin.

**Polyamine sulfone** *n.* A water-soluble copolymer of diallylamine monomer and sulfur dioxide, used as a paint additive, antistatic agent, synthetic-fiber modifier, and polishing agent for metal platings.

**Polyaminobismaleimide resin (PABM)** *n.* Any thermosetting resin of dark-brown color obtained by the addition reaction of an aromatic diamine and a bismaleimide. Typical pre-polymers accept high percentages of fillers and can be cast and compression or transfer molded. PABMs have flow properties comparable to common thermosetting resins and thermomechanical properties exceeding those of some light alloys. They possess excellent dimensional stability and are flame- and radiation-resistant. They can be adapted to aircraft, electrical and electronic fabrication, ablation applications, and to chemical-process equipment where resistance to aromatic solvents, refrigerants, and acids is required.

**Polyaminotriazole (PAT)** *n.* A family of fiber-forming polymers made from sebacic acid and hydrazine with small amounts of acetamide.

**Polyary** (–O–) in the chain. Sometimes used as generic for poly-2,6-dimethyl-1,4-phenylene oxide, several markers' brands are manufactured.

**Polyarylamide resins** *n.* Synthesized by melt polymerization of *m*-xylenediamoine with adipic acid. It is used as a high stiffness, high softening point engineering plastic. Polyarylamide resins have higher modules and yield stress values than nylon 66, however, its water sensitivity has precluded a wider usage.

**Polyarylate** *n.* A polyester made by the condensation of an aromatic diacid with a dihydroxy aromatic compound. Commercial resins are co-polymers of iso- and terephthalic acid with bisphenol A, with properties comparable to those of polycarbonate and polyethersulfone.

**Polyarylate resins** *n.* Often defined as copolyesters involving bisphenol-A and a mixture of terephthalic acid and iosphthalic acid, resulting in two distinct repeat units.

**Polyarylene sulfide** *n.* Any of a polymer family prepared by polymerization and reaction of polyhalogenated aromatics with sodium sulfide in a polar solvent at high temperature. The best known (and only commercial) resin is polyphenylene sulfide.

**Polyaryl ether** *n.* A polymer having both aromatic rings and either links (–O–) in the chain. Sometimes used as generic for poly-2,6-dimethyl-1,4-phenylene oxide, of which several markers' brands are available.

**Polyarylethersulfone resin** *See polyethersulfone.*

**Polyaryloxysilane** *n.* A family of polymers, resistant to high temperatures, made up of silicon atoms, oxygen atoms, and thermally stable aromatic rings, part organic and part inorganic in nature, like the silicones.

**Poly(aryl sulfone)** *n.* An aromatic polymer consisting of benzene rings linked by both sulfone (–$SO_2$–) groups and ether oxygen atoms. Poly(aryl sulfones) can be synthesized by solution polymerization in a polar solvent. Several commercial products of this type have been developed as reasonably high temperature resistant engineering plastics.

*Also called polyether-sulfone.*

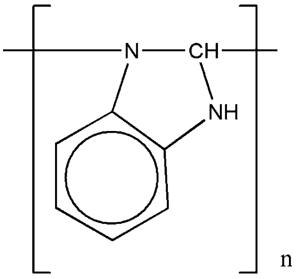
**Polyarylsulfone resins** *n.* Consists mainly of phenyl and biphenyl groups linked by thermally stable either and sulfone groups.

**Polyazelaic polyanhydride (PAPA)** *n.* A carboxyl-terminated, low polymer of approximately 2300 molecular weight, used as a flexibilizing curing agent for epoxy resins.

**Polybasic acid** *n.* Acid containing more than one reactive hydrogen atom. With water-soluble ionizable acids which are polybasic, two or more hydrogen ions are made available, per molecule.

**Polybenzamide (poly-*p*-benzamide)** A fiber-forming polymer made from *p*-aminobenzoÿl chlorine by self-condensation polymerization. Fibers retain high modulus to high temperatures and have been used for composite reinforcement.

**Polybenzimidazole (PBI)** *n.* A family of high-molecular-weight, strong, and stable polymers containing recurring aromatic units with alternating double bonds. PBIs are produced mainly by the condensation of 3,3′,4,4′-tetraaminobiphenyl (3,3′-diaminobenzidine) and diphenyl isophthalate. The polymers are brown, amorphous powders, exhibiting a high degree of thermal and chemical stability. They are used to make fibers and films with excellent resistance to high temperatures and flame. Principal applications have been in the aerospace field, as protective coatings on missiles, radar antennas, and supersonic aircraft; and in reinforced laminates for critical applications. In 1992, Hoechst Celanese (NC, USA) and KMI Inc. (OH, USA) announced a joint venture to injection-mold bearings and other parts from PBI, heretofore considered not to be melt-processable using proprietary technology (*See image*).



**Polybenzimidazole fiber (PBI)** *n.* A manufactured fiber in which the fiber-forming substance is a long chain aromatic polymer having recurrent imidazole groups as an integral part of the polymer chain (FTC definition). The polymer is made from tetraaminobiphenyl and diphenyl isophthalate and is dry spun from a dope with dimethylacetamide as a solvent. Characteristics: a high-performance fiber with high chemical resistance that does not burn in air. It has no melting point and does not drip when exposed to flame. The fiber and fabrics from PBI retain their flexibility, dimensional stability, and significant strength without embrittlement even when exposed to flame or extreme heat. The fiber emits little smoke in extreme conditions. It processes well on conventional textile equipment, having processing characteristics similar to polyester. It can be used in 100% form or blended with other fibers. It has a high moisture regain and low modulus with comfort properties similar to cotton. The natural color of PBI is a gold-khaki shade, but it can be dyed to almost any medium to dark shade with conventional basic dyes. End uses: with excellent thermal, flame, and chemical resistance, combined with good comfort properties, PBI is a good fiber for many critical uses including: firefighter's protective apparel, aluminized proximity gear, industrial apparel such as pants, shirts and underwear, protective gloves, welder's apparel, aircraft fire-blocking layers, aircraft wall fabrics, rocket motor insulation, race car driver's apparel, and braided packings among others.

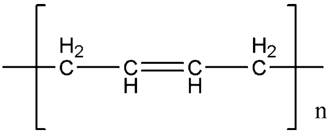
P

**Polybenzothiazole (PBT)** *n.* A family of resins, one type of which has been made by cooking a toluidine with sulfur, or by reaction of, e.g., 3,3′-mercaptobenzidine with diphenyl phthalate. These polymers have outstanding thermal stability: glass-reinforced PBT composites have withstood 350°C for over 10 days. Although they are technically thermoplastics, they are not melt-processable. Applications are in coatings for high-temperature service and laminating.

**Polybiphenylsulfone** *n.* An engineering thermoplastic (Union Carbide's Radel®) with a deflection temperature of 205°C and notched-Izod impact strength approaching 8 J/cm (15 ft-lb$_f$/in), this resin is conventionally melt-processable.

**Polyblend** *n.* A colloquial term – shortened from *poly*mer *blend* – used for physical mixtures of two or more polymers, for example, polystyrene and rubber or PVC and nitrile rubber. Such blends usually yield products with favorable properties of both components, sometimes opening markets not available to either of the neat resins. The term *alloy* is sometimes used for blends.

**Polybutadiene** \-ˌbyü-tə-ˈdī-ˌēn\ (1939) *n.* A synthetic rubber made from 1,3-butadiene ($H_2C{=}CH{-}CH{=}CH_2$). The *cis* type has superior abrasion resistance and resilience, while the *trans* type is similar to natural rubber (*See image*).



**Polybutadiene-carylic acid co-polymer** *n.* A binder used in solid propellants.

**Polybutadiene resins (PB, poly-1-butene)** *n.* Any of a family of polymers consisting of isotactic, stereoregular, highly crystalline polymers based on 1-butene. Properties are similar to those of polypropylene and linear polyethylene, with superior toughness, creep resistance, and flexibility. FB has been used in pipe, wire coating, gaskets, and industrial packaging. PB pipe carries the highest design-stress rating of all flexible, thermoplastic piping materials, serving to temperatures of 90°C.

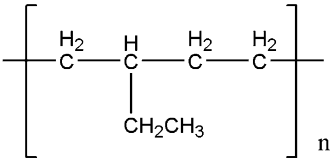
**Polybutadiene-type resins** *n.* Unsaturated, thermosetting hydrocarbons cured by a peroxide-catalyzed, vinyl-type polymerization reaction, or by sodium-catalyzed polymerization of butadiene or blends of butadiene and styrene. Liquid systems, curable in the presence of monomers, are used for casting, encapsulation, and potting of electrical components, and in making laminates. Molding compounds, often containing fillers and modified with other resins or rubbers, may be compression or transfer molded. Syndiotactic 1,2-butadiene, introduced in 1974 in Japan, is thermoplastic, with semicrystalline nature, with good transparency and flexibility without plasticization. In the presence of a photosensitizer such as *p,p′*-tetramethyl diaminobenzophenone, this polymer can readily be cured by ultraviolet radiation. Transparent films of the non-toxic polymer are used for packaging, and cellular forms for shoe soles. It is biodegradable.

**Polybutanediol terephthalate (PBTP, PBT)** *n.* A crystalline polymer formed by the polycondensation of 1,4-butanediol and dimethylterephthalate (*See image*).

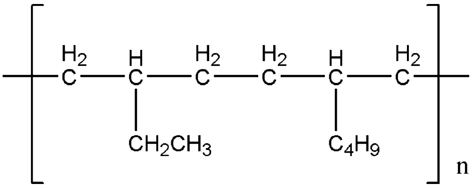
**Poly(1-butene)** Produced commercially in isotactic for by Ziegler–Natta polymerization of butene-1.

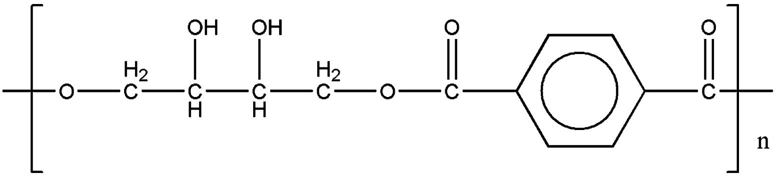
*See polybutylene.*

**Poly(1-butene co ethylene)** *n.* Alternative name for ethylene–butene-co-polymer (*See image*).



**Poly(1-butene co ethylene co 1-hexene)** *n.* A co-polymer produced commercially by the Phillips process and containing up to 5% butene-1. It is similar to high-density polyethylene but has a slightly lower density and better resistance to creep (*See image*).

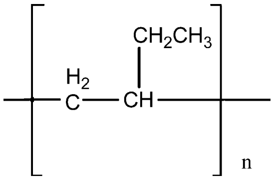




**Polybutanediol terephthalate**

**Polybutylene** *n.* Any of a family of low-molecular-weight polymers of mixed 1-butene, *cis*-2-butene, *trans*-2-butene, and isobutene. Depending on molecular weight, these polymers range from oils through tacky waxes, crystalline waxes, and rubbery solids. Poly(1-butene) shown below (*See image*).

*See also butyl rubber and polybutylene resin.*



**Polybutylene adipate glycol (PBAG)** *n.* A polymeric diol used in the production of urethane elastomers.

**Polybutylene resin (PB, poly-1-butene)** *n.* Any of a family of polymers consisting of isotactic, stereoregular, highly crystalline polymers based on 1-butene. Properties are similar to those of polypropylene and linear polyethylene, with superior toughness, creep resistance, and flexibility. PB has been used in pipe, wire coating, gaskets, and industrial packaging. PB pipe carries the highest design-stress rating of all flexible, thermoplastic piping materials, serving to temperatures of 90°C.

P

**Polybutylene terephthalate (PBTP, PBT, and polytetramethylene terephthalate)** *n.* A member of the polyalkylene terephthalate family, similar to polyethylene terephthalate in that it is derived from a polycondensate of terephthalic acid, but with butanediol rather than glycol. PBTP can be modified easily to overcome its relatively low-operating-temperature limit, making it equivalent to plastics used in construction and appliances. Grades are available for injection and blow molding, extrusion, and thermoforming. Properties include high tensile and impact strength, dimensional stability, low moisture absorption, and good electrials; also resistant to fire and chemicals when suitably modified.

**Polycaprolactam** *n.* A cyclic amide type compound, containing six carbon atoms.

*See nylon-6.*

**Polycaprolactone (PCL)** *n.* A low-melting (62°C) polyester resin with the linear structure $(\text{-}CH_2CH_2CH_2CH_2CH_2COO\text{-})_n$, made by polymerizing ε-caprolactone. PCL is compatible with most thermosetting and thermoplastic resins and elastomers. It increases impact resistance and aids mold release of thermosets, and acts as a polymeric plasticizer with PVC. It is biodegradable, useful in containers for growing and transplanting trees and other plants. Unmodified PCL is completely consumed by soil microbes but the rate of degradation can be slowed by incorporating a non-biodegradable polymer. PCL is also useful in the production of polyurethane elastomers and foams, to which it imparts good-low-temperature properties and water resistance.

**Polycarbonate** \-ˈkär-bə-ˌnāt\ (1930) *n.* A polymer that comprises the repeated structural unit in the chain is of the carbonate type [–O–CO–O–].

**Polycarbonate resin (PC)** *n.* Any of a family of special polyesters in which groups of dihydric phenols are joined through carbonate linkages. They can be produced by a variety of methods, of which the most commercially important are (1) Phosogeneration of dihydric alcohols, usually bisphenol A. (2) Ester interchange between diamyl carbonates and dihydric phenols, usually between diphenyl carbonate and bisphenol A. (3) Interfacial polycondensation of bisphenol A and phosgene. Bisphenol A polycarbonates with molecular weights close to 33,000 can be processed by injection molding, extrusion, thermoforming, and blow molding. Melt-casting and solution-casting processes are also employed. Such polycarbonates have high impact strength (to 8 J/cm of notched width), good heat resistance, low water absorption, good electrical properties, and no toxicity. They are vulnerable to some common organic solvents. Crystal-clear grades have been developed for safety glazing, including multilayer glass-and-PC, bullet-proof structures. Other applications include dentures, food packages, electrical components, precision parts for instruments and household appliances and – a current large-volume use – compact disk (CD) records and data disks.

**Polycarbonates** *See polycarbonate.*

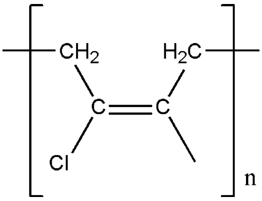
**Polycarboranesiloxane (SiB)** *n.* A polymer whose chain consists of alternating carbonane and siloxane groups. Commercial resins contain active end groups that may be vulcanized with peroxides to yield rubbers resistant to high temperatures (260°C in air).

**Polycarboxane** *n.* Syn: acetal resin.

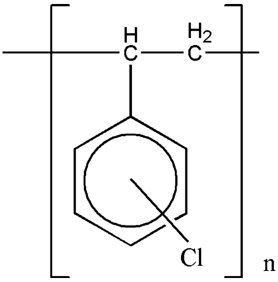
**Polychlal fiber** *n.* A manufactured, bicomponent fiber of polyvinyl alcohol and polyvinyl chloride. Some vinyl chloride is grafted to the polyvinyl alcohol (Japanese Chemical Fibers Association definition). The fiber is emulsion spun into tow and staple. Characteristics: polychlal fibers have a soft, lamb's wool-like hand and moderate moisture regain. The fibers are also characterized by high flame resistance and high abrasion resistance. End uses: polychlal fibers are suitable for end uses such as children's sleepwear, blankets, carpets, curtains, bedding, upholstery, non-wovens, and papermaking.

**Polychloroether** *n.* Syn: chlorinated polyether.

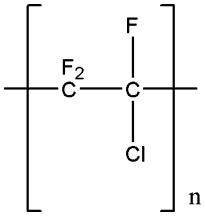
**Polychloroprene** *n.* Polychloroprene is usually sold under the trade name Neoprene. It is especially resistant to oil. It was the first synthetic elastomer, or rubber to be a hit commercially. Polychloroprene is made from the monomer chloroprene. Syn: neoprene (*See image*).



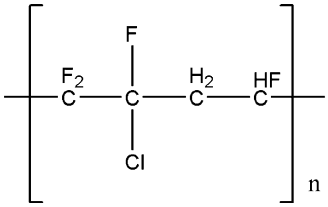
**Polychlorostyrenes** *n.* A polymer produced by the polymerization of one of the isomers of chlorostyrene or of a mixture of isomers. Polymerization conditions are similar to those use for styrene, but polymerization occurs more rapidly. These polymers have higher flame resistance than styrenes (*See image*).



**Polychlorotrifluoroethylene (CTFE, PCTFE)** *n.* A family of polymers made by polymerizing the gas $ClFC{=}CF_2$ by mass, emulsion, or suspension polymerization. The polymers range from oils, greases, and waxes of low molecular weight to the tough, rigid thermoplastics most commonly used in industry. Unlike polytetrafluoroethylene, PCTFE may be processed by conventional thermoplastic methods. It is also available as dispersions in xylene or ketones for application by dipping or spraying. The polymers are non-toxic, resistant to heat, chemically inert, and have outstanding electrical properties (*See image*).

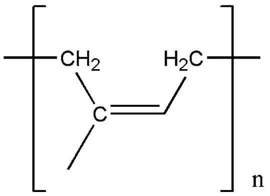


**Poly(chlorotrifluoroethylene-co-vinyl fluoride)** *n.* Common name for ethene, chlorotrifluoro-, polymer, with 1,1-difluoroethene (*See image*).



**Polychromatic finish** *n.* (1) A multicolored paint finish. (2) A paint containing reflecting metallic flake and fine transparent pigments which appears as a variety of colors when viewed from different angles.

**Poly(*cis*-1,4-isoprene)** Poly(2-methyl-1,3-butadiene) (*See image*).



**Polycondensate** *n.* Product of a condensation polymerization.

**Polycondensation** \-ˌkän-ˌden-ˈsā-shən\ [ISV] (1936) *n.* *See condensation and condensation polymerization.*

**Polycoummarone resins** *See coumarone-indene resins.*

**Polycyclamide** (1) A polyamide containing a cycloalkane ring. (2) Any linear, high-molecular-weight polyamide formed by condensing cyclohexane-1,4-bis(methylamine) with one or more dicarboxylic acids. These polymers have high melting points, but are sufficiently stable to permit melt processing at temperatures above 300°C without thermal decomposition. Their excellent physical and chemical properties indicate their usefulness as fibers, films, and moldings. *See also nylon.*

**Polycyclic** \ˌpä-lē-ˈsī-klik\ [ISV] (1869) *n, adj.* Of an organic compound, containing two or more rings, often with pairs of rings sharing two carbon atoms, as in the hydrocarbon anthracene ($C_{14}H_{10}$).

**Polycyclization** *n.* Cyclization in which more than one internal ring formation occurs.

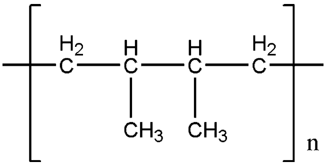
**Polycyclohexylendeimethylene terephthalate** [PCT, poly(cyclohexane-1,4-dimethylene terephthalate)] *n.* The newest member of the commercial thermoplastic-polyester family, PCT is produced by reacting 1,4-cyclohexane dimethanol with dimethyl terephthalate. It is superior to its siblings (PET and PBT) in that it can serve at higher temperatures, with 1.8 MPa deflection temperatures to 260°C with 30% glass–fiber content. Moisture absorption is lower, too, and it has excellent chemical resistance. It is being used in automotive parts and dual-ovenable cookware. It can be compounded for high flame resistance.

**Polydentate ligand** *n.* A polyatomic ligand with more than one lone pair of electrons which can simultaneously bond to the central ion in a complex.

**Poly(dichloro-*p*-xylylene) (Parylene D)** *n.* *See parylene.*

**Polydicyclopentadiene resins** *n.* Friable, thermoplastic, unsaturated aromatic resins derived from petroleum hydrocarbons whose principal component is dicyclopentadiene. Softening points from 10 to 140°C (50–285°F); Sp gr, 0.99–1.11; iodine value, 170–200. Soluble in aliphatic, aromatic, chlorinated solvents; insoluble in water, alcohols, and glycols.

**Poly(2,3-dimethyl butadiene)** *n.* A very elastic synthetic rubber, the monomer being made by conversion of acetone via pinacol to 2,3-dimethyl-butadiene (*See image*).

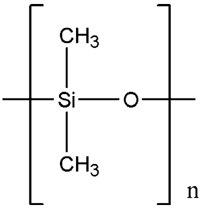


$$\left[-\mathrm{CH_2}-\mathrm{CH}(\mathrm{CH_3})-\mathrm{CH}(\mathrm{CH_3})-\mathrm{CH_2}-\right]_n$$

**Poly-2,6-dimethyl-1,4-phenylene oxide** *See polyphenylene oxide.*

**Polydimethylsiloxane (dimethyl silicone)** *n.* Any of a family of silicones of the composition $[\text{-}(\mathrm{CH_3})_2\mathrm{SiO}\text{-}]_n$. Those of low molecular weight – several hundreds to 10,000 – are oils, some of which are widely used in aerosol mold releases for plastics that are not to be painted or printed. Polymers in the molecular-weight range near 105 are rubbers that are flexible at cryogenic temperatures but crystalline above −60°C. *See also silicone.*

**Poly(dimethyl siloxane)** *n.* Basis of most technical silicone oils, greases, rubbers and resins. The polymer is formed by the hydrolysis of dimethyldichlorosilane with water.



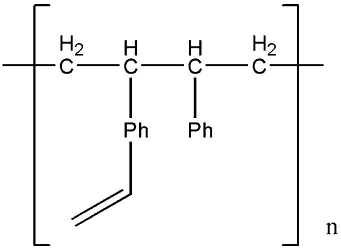
$$\left[-\mathrm{Si}(\mathrm{CH_3})_2-\mathrm{O}-\right]_n$$

**Polydisperse** \-dis-ˈpərs\ [*poly-* + L *dispersus* dispersed, fr. pp of *dispergere* to disperse] (1915) *adj.* Of a polymer, having a range of molecular weights as opposed to a single molecular weight (monodisperse) the usual state among commercial polymers. The broader the distribution relative to its center, the greater is its polydispersity.

**Polydispersity** *n.* The breadth of the molecular-weight distribution of a polymer. Two measures of polydispersity are in common use: (1) the ratio of the weight-average and number-average molecular weights $M_w/M_n$, and (2) the *g*-index.

**Polydispersity index** *n.* Same value as polydispersity.

**Poly(divinyl benzene co styrene)** (*See image*).



**Polyelectrolyte** \ˌpä-lē-ə-ˈlek-trə-ˌlīt\ (ca. 1947) (polyion, ionomer) *n.* (1) Any of several classes of polymers having fixed ionizable groups, such as polyacids (e.g., polyacrylic acid), polybases (e.g., polyvinyl trimethylammonium chloride), and sodium- or potassium-salt complexes of such polymers as polyethylene oxide. They are much more electrically conductive than ordinary plastics, their conductivities generally rising with temperature. Some are finding use in battery separators, photoelectrochemical cells, and humidity sensors. An allied class is described under ionomer. (2) The presence of ionized groups on a polymer chain superimposes the effects of electrostatic interactions on the properties of the un-ionized polymer; e.g., poly(acrylic acid), sodium polyacrylate; useful for increasing viscosity in solvents including water, and water treatment. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Polyester** \ˈpä-lē-ˌes-tər\ [ISV] (1929) (alkyd) *n.* A general term encompassing all polymers in which the main polymer backbones are formed by the esterification condensation of polyfunctional alcohols and acids. The coined term *alkyd* (*see alkyd resin*) is synonymous, chemically, with polyester. However, as more commonly used in the plastics industry, alkyd refers to polyesters modified with oils or fatty acids that are cross-linkable (*see alkyd molding compound*). The term polyester is explained further under polyester, saturated and polyester, unsaturated.

**Polyester, aromatic** *See poly-p-hydroxybenzoic acid.*

**Polyester carbonates** *n.* A synthetic thermoplastic resin, a linear polymer of carbonic acid.

**Polyester fiber** *n.* Generic name for a manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of at least 85% by weight of an ester of a dihydric alcohol and terephthalic acid (Federal Trade Commission). The polyester fiber in widest use throughout the world is derived from polyethylene terephthalate. Polyester filaments are produced by forcing the molten polymer at a temperature of about 290°C through spinneret holes about 0.23 mm (9 mils) in diameter, followed by air cooling, combining the single filaments into yarns, and drawing. The major end use of polyester fibers is in blends with cotton or wood to enhance crease retention and reduce wrinkling of garment fabrics. It is also used in carpeting and tire cords.

**Polyester imide** *n.* A polymer containing both ester and imide groups in the polymer chain.

**Polyester plasticizer** *n.* Any of a broad class of plasticizers characterized by having many ester groups in each molecule. They are synthesized from three components: (1) A dibasic acid such as adipic, azelaic, lauric, or sebacic acid. (2) A glycol (dihydric alcohol). (3) A monofunctional chain terminator such as a monobasic acid. Molecular weights are low – from 500 to 5,000. Polyester plasticizers are noted for their permanence and resistance to extraction.

**Polyester resins** *n.* Group of synthetic resins which are polycondensation products of dicarboxylic acids with dihydroxyl alcohols. They are therefore a special type of alkyd resin. Oil-free alkyds are a class by themselves. Often these resins are dispersed in a suitable monomer.

**Polyesters** A polymer in which the monomer units are linked together by the group

–COO– and are usually formed by polymerizing a polyhydric alcohol with a polybasic acid.

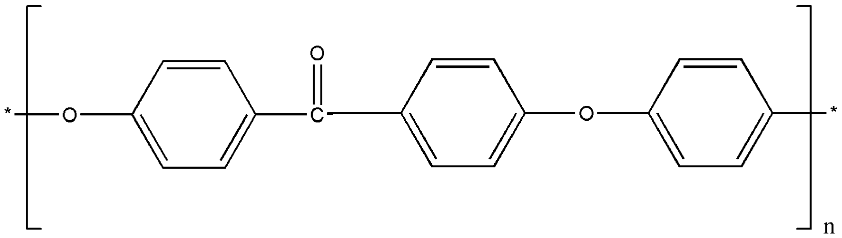
**Polyester, saturated** *n.* Any polyester in which the polyester backbone has no double bonds. The class includes low-molecular-weight liquids used as plasticizers and as reactants in forming urethane polymers; and linear, high-molecular-weight thermoplastics such as polyethylene terephthalate. Usual reactants for the saturated polyesters are: (1) a glycol such as ethylene-, propylene-, diethylene-, dipropylene-, or butylene glycol; (2) An acid or anhydride such as adipic, azelaic, or terephthalic acid or phthalic anhydride. Some saturated, branched polyesters are used in high-temperature varnishes and adhesives.

**Polyester, unsaturated** *n.* A polyester family characterized by ethenic unsaturation in the polyester backbone that enables subsequent hardening or curing by co-polymerization with a reactive monomer in which the polyester constituent has been dissolved. Unsaturated polyesters are made by agitating in a heated kettle a mixture of glycols, e.g., propylene- or diethylene glycol; unsaturated dibasic acids or anhydrides, e.g., fumaric acid or maleic anhydride; and, sometimes in order to control the reaction and modify properties, a saturated dibasic acid, or anhydride, e.g., iosphthalic acid or phthalic anhydride. After removal of water and cooling, the fluid polyester may be dissolved in a reactive monomer in the same kettle, or it may be shipped to users who add the monomer and catalyst in their plants. Styrene is most widely used as the reactive monomer. Others sometimes used as diallyl phthalate, diallyl isophthalate, and triallyl cyanurate. A peroxide catalyst is generally used for the final co-polymerization. These unsaturated polyesters are thermosetting and are most widely used in reinforced plastics for making boat hulls, trays containers, and panels, and in potting of electrical assemblies. *See also water-extended polyester.*

**Polyether** *n.* (1) Any polymer having the general structure $(–R–O–)_n$, where R may be simple or more elaborate [technically, polyoxymethylene $(–CH_2–O–)_n$, is a polyether, though known as an acetal resin in the industry]. Polyphenylene oxide is a well-known polyether. (2) A low-molecular-weight polymer containing hydroxyl end groups, used as a reactant in the production of polyurethane foams. One type of polyether, widely used for rigid foams, is obtained by reacting propylene oxide with a polyol initiator such as a glycol glycoside in the presence of potassium hydroxide as a catalyst.

**Polyether, chlorinated** *See chlorinated polyether.*

**Polyetheretherketone (PEEK)** *n.* An "advanced" polymer chain it has excellent



temperature resistance among processable thermoplastics, with a melting temperature of 334°C, deflection temperature at 1.8 MPa of 160°C, and tensile yield strength of 91 MPa. Reinforcement with 30% glass–fiber elevates the deflection temperature to about 300°C and almost doubles the yield strength (*See image*).

**Polyetheretheretherketone fiber (PEEK)** *n.* A manufactured fiber from polyetheretherketone polymer with high temperature and chemical resistance used in composites as a matrix material and in other industrial applications.

**Polyether foam** *n.* A type of polyurethane foam that has been made by reacting isocyanate with a polyether rather than a polyester or other resin component. For rigid foams, polyethers often used as the propylene oxide adducts of materials such as sorbitol, sucrose, aromatics, diamines, pentaerythritol, and methyl glucoside. These range in hydroxyl numbers from 350 to 600. For flexible foams, polyethers with hydroxyl numbers ranging from 40 to 160 are used. Examples are condensates of polyhydric alcohols such as glycerine, sometimes containing small amounts of ethylene oxide to increase reactivity.

**Polyether glycol** *See polyethylene glycol.*

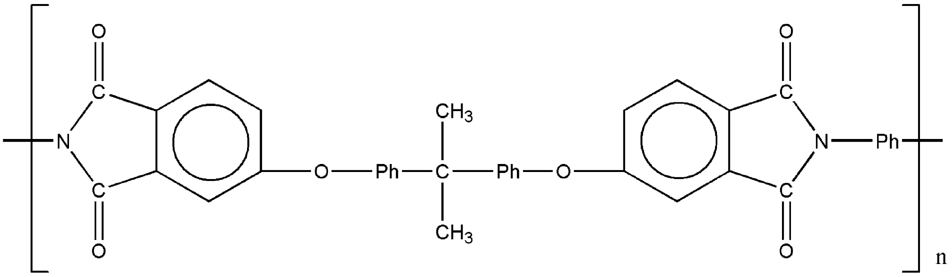
**Polyetherimide** *n.* One of the "advanced" thermoplastics, having both ether links and imide groups in its chain, as shown below. (*See image*) Deflection temperature at 1.8 MPa is 199°C, tensile modulus is 3.0 GPa, strength is 96 MPa, and the resin has good fire resistance.

**Polyether imide** *n.* A polymer containing both ester and imide groups in the polymer chain. They are usually synthesized by polycondensation between a dianhydride containing aromatic ester links and a diamine. Their main use is as high temperature resistant wire (*See image*).

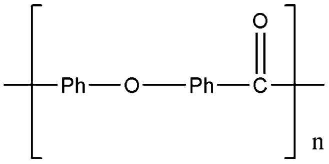
**Polyetherimide fiber (PEI)** *n.* A manufactured fiber spun from polyetherimide polymer having high temperature resistance, excellent processability, and toughness. Used for matrix materials in composites and in other industrial applications.

**Polyetherimide resins** *n.* An amorphous engineering TP characterized by high heat resistance, high strength and a high modulus, excellent electrical properties that remain stable over a wide range of temperatures and frequencies, and very good processability.

**Polyetherketone** *n.* An "advanced" thermoplastic resin having both ether and ketone linkages in its chains, a close relative of polyetheretherketone, above, and having the peek structure with the leftmost phenyl and ether oxygen deleted. This melt-processable polymer melts near 365°C, is



fire-resistant, has good resistance to chemicals, and can be used at temperatures comparable to those for peek (*See image*).



$[-\mathrm{Ph}-\mathrm{O}-\mathrm{Ph}-\mathrm{C}(=\mathrm{O})-]_n$

**Polyetherketoneketone** *n.* A polyetherketone which contains two ketone links between benzene rings to each link. It has the highest glass transition and melting temperatures of all the commercial aromatic polyether ketones.

**Polyether resins** *n.* Polymers in which the repeating unit contains a carbon–oxygen bond derived from aldehydes or epoxides or similar materials.

**Polyethers** *n.* A polymer of general structure $[R–O]_n$, where R may be a simple alkene group.

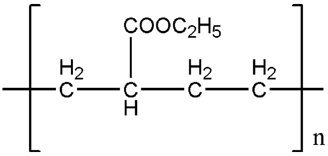
**Polyethers resins** *n.* Polymers in which the repeating unit contains a carbon–oxygen bond derived from aldehydes or epoxides or similar materials.

**Polyethersulfone** *n.* An "advanced" thermoplastic consisting of repeating phenyl groups ($\phi$) linked by thermally stable either and sulfone ($–SO_2–$) groups, its structure being like that of peek, stated above, but with the right hand $–O–\phi–CO–$ section replaced by sulfone. The resin has good transparency and flame resistance, and has one of the lowest smoke-emission ratings among plastics. Both neat and reinforced grades are available in granule form for extrusion and molding. Unreinforced grades are used in high-temperature electrical applications, bakery-oven windows and medical components. Reinforced grades are used for radomes, structural aircraft and aerospace components, and corrosion-resisting applications in packaging and chemical-plant hardware.

**Polyethersulfone fiber (PES)** *n.* High molecular weight fibers from polymers containing sulfone ($–SO_2–$) groups and aromatic nuclei. They demonstrate high thermal stability and chemical inertness.

**Polyethersulfone resins** *n.* PES is a high temperature engineering TP in the polysulfone family.

**Poly(ethyl acrylate co ethylene)** *n.* *See image.*

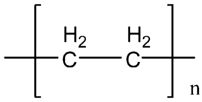


$[-CH_2-CH(COOC_2H_5)-CH_2-CH_2-]_n$

**Polyethylene** \-ˈe-thə-ˌēn\ (ca. 1862) (Pe, polyethene; *in Britain*, polythene) *n.* A huge family of resins obtained by polymerizing ethylene gas, $H_2C{=}CH_2$ and by far the largest-volume commercial polymer. Almost 10 Tg ($11 \times 10^6$ tons) was sold in USA in 1992, about one-third of all USA resin sales. By varying the catalyst and methods of polymerization, properties such as density, melt-flow index, crystallinity, degree of branching and cross-linking, molecular weight and polydispersity can be regulated over wide ranges. Further modifications are created by co-polymerization, chlorination, and compounding additives. Low-molecular-weight polymers of ethylene are fluids used as lubricants; medium-weight polymers are waxes miscible with paraffin; and the polymers with molecular weights over 10,000 (to which the above sales figure applies) are the familiar tough and strong resins, flexible or stiff, to make a myriad of products, both consumer and industrial. Polymers with densities ranging from about 0.910 to 0.925 g/cm3 are called *low-density* polyethylene; those with densities from 0.926 to 0.940 are called *medium-density*; and those with densities from 0.941 to 0.965 and over are called *high-density* polyethylene. The low-density resins are polymerized at very high pressures and temperatures, and the high-density ones at lower pressures and temperatures, using special catalysts. Two newer types are *extra-high-molecular-weight* (EHMWPE) materials in the MW range from 150,000 to 1,500,000, and *ultra-high-molecular-weight* (UHMWPE) materials in the 1,500,000–3,000,000 range. Because UHMWPE does not melt and flow, it is processed by powder-molding and sintering techniques developed decades ago for polytetrafluoroethylene. Under carefully controlled conditions some EHMWPEs can be extruded, blow molded, and thermoformed on standard equipment. When fully cross-linked by irradiation or by the use of chemical additives polyethylene is no longer a thermoplastic, and has superior strength, impact resistance, and electrical properties. A still newer member of the family, much used in grocery bags, is linear low-density polyethylene. Another new subfamily are the very-low-density polyethylenes.

**Poly(ethylene-chlorotrifluoroethylene) (PE-CTFE, ECTFE co-polymer)** *n.* A high-molecular-weight, 1:1 alternating co-polymer of ethylene and chlorotrifluoroethylene. Available in pellet and powder form, PE-CTFE can be extruded, injection, transfer, and compression molded, rotocast and powder coated. It is a strong, highly impact-resistant material that retains useful properties over a wide temperature range. Good electrical properties and chemical resistance make it useful in electrical and chemical ware and in packaging applications requiring corrosion resistance.

**Polyethylene fiber** *n.* A manufactured fiber made of polyethylene, often in monofilament form as well as continuous filament yarns and staple. Ethylene is polymerized at high pressures and the resulting polymer is melt spun and cold drawn. It may also be dry-spun from xylene solution. Characteristics: polyethylene fibers have a low specific gravity, extremely low moisture regain, the same tensile strength wet and dry, and are resistant to attack by mildew and insects. These qualities have made polyethylene fiber suitable for industrial applications, geotextiles, outdoor furniture, and similar applications. Polyethylene fiber does not dye, and in most cases, it is colored by the addition of pigments and dyes to the material prior to spinning. It has a low melting point, a property that has restricted its use in apparel (*See image*).



**Polyethylene foam** *n.* Low-density-PE foam, with foam densities as low as 0.03 g/cm$^3$, is made by thoroughly mixing a blowing agent with hot, molten polymer under pressure, then releasing the pressure and cooling. Foams are also made by extrusion, using pellets containing a heat-triggered foaming agent. Cross-linked PE foam is made by blending a peroxide cross-linking agent with the molten compound, then subsequently vulcanizing the molded shapes in a press. The denser foams have found application in packaging of electronic equipment.

**Polyethylene glycol** *n.* Any of several condensation polymers of ethylene glycol. These glycols general formula: $HOCH_2$-$(CH_2OCH_2)_\eta CH_2OH$ or $H(OCH_2CH_2)_\eta$-OH. Average molecular weights range from about 200 to 8000, ranging from water-clear liquids to hard, waxy solids. They are used as plasticizers for polyvinyl alcohol, as intermediates, and in printing inks and mold releases. Syn: polyether glycol and polyoxyethylene glycol.

**Polyethylene glycol (200) dibenzoate** *n.* $C_6H_5CO(OCH_2CH_2)_4OCO$–$C_6H_5$. A plasticizer compatible with cellulose acetate butyrate, ethyl cellulose, polymethyl methacrylate, polystyrene, and vinyl resins. Its major application is with phenol-formaldehyde resins in laminating applications, to improve flexibility without loss of electrical properties and high-temperature capability.

**Polyethylene glycol (600) dibenzoate** *n.* A plasticizer similar to the preceding one but with 13 $-OCH_2CH_2-$ groups, and with only partial compatibility with the resins listed for that one.

**Polyethylene glycol di-2-ethylhexoate** *n.* A plasticizer for most cellulosic plastics, polymethyl methacrylate, polystyrene, and vinyls.

**Polyethylene glycol (400) dilaurate** *n.* A plasticizer for cellulose nitrate, PVC, and vinyl co-polymers.

**Polyethylene glycol terephthalate** *n.* A longer name for poly ethylene terephthalate.

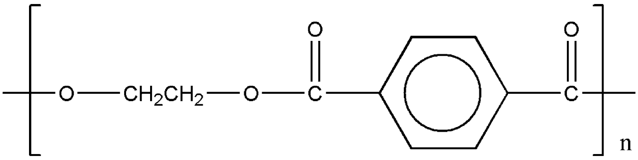
**Polyethylene, high M.W** *n.* Density = 0.97.

**Polyethylene, low M.W. (branched)** *n.* Density = 0.95.

**Polyethylene oxide (PEO)** *n.* Low-molecular-weight polymers of ethylene oxide are viscous liquids or waxes. Those of high molecular weight are tough, highly crystalline, ductile thermoplastics that can be processed by molding, extrusion, etc. All PEO resins are soluble in water, and thus are used in the form of packaging film for powdered detergents, insecticides, and other household, industrial and agricultural products that are dissolved in water prior to use. The film is heat-sealable and permeable to gases.

**Polyethylene–propylene adipate glycol (PEPAG)** *n.* A polymeric diol used in the production of urethane elastomers (Witco Corp., CT, USA, Formrez F 10-91).

**Polyethylene terephthalate (PET, polyethylene glycol terephthalate)** *n.* A saturated, thermoplastic polyester resin made by condensing ethylene glycol, and terephthalic acid, used for textile fibers, water-clear, biaxially oriented film (e.g., Mylar®) and, more recently, for extruded, thermoformable sheet (TV-dinner trays), injection-molded parts, and large, blow-molded, soft-drink bottles. It is extremely hard, wear- and chemical-resistant, dimensionally stable, and has good dielectric properties. *See also polyester, saturated and crystallized polyethylene terephthalate* (*See image*).

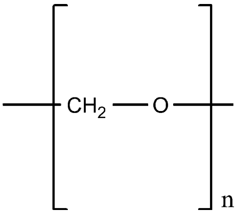


**Poly(ethylene-tetrafluoroethylene) (PE-TFE)** *n.* A crystalline resin in which the proportion of ethylene to tetrafluoroethylene (E/TFE) may range, for the best combination of properties, between 2:3 and 3:2, modified with a vinyl co-polymer for better toughness. It is stronger than either low-density polyethylene or polytetrafluoroethylene, has good electrical properties, high Izod-impact strength, and plastic memory that makes it useful for heat-shrinkable packaging.

**Polyethylene, ultra-high MW** density = 0.99.

**Polyformaldehyde** *n.*

*See acetal resin, paraformaldehyde and polyoxymethylene* (*See image*).



**Polyglycerols** *n.* Compounds of either-alcohol type derived from the interaction of two or more molecules of glycerol. Thus, for example, two molecules of glycerol react to give diglycerol. The polyglycerols have some applications in alkyd and ester resin manufacture.

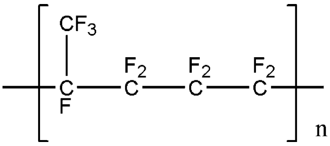
**Polyglycidyl polyepichlorohydrin resin** Any of a family of epoxy resins derived from epichlorohydrin and hydroxyl compounds, possessing flexibility and flame-retarding characteristics. They may be cured by themselves, or mixed with conventional epoxy resins to impart their favorable characteristics to laminates.

**Polyglycol** *n.* A polyhydric alcohol of the monomeric glycol, of uncertain composition. Bp 230–250°C.

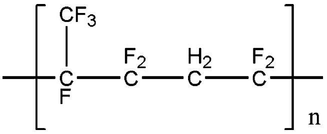
**Polyglycol distearate** (polyethylene glycol distearate) *n.* The di(stearic acid) ester of polyglycol, used as a plasticizer.

**Polyhexafluoropropylene** *n.* A fully fluorinated polymer based on the gas $CF_3CF{=}CF_2$, not commercial. However, the co-polymers of hexafluoropropylene and tetrafluoroethylene make up the family of fluorinated ethylene-propylene resins.

**Poly(hexafluoropropylene-co-tetrafluoroethylene)** *n.* 1,1,2,3,3,3-hexafluoro 1-propene-co-1,1,2,2-tetrafluoroethene (*See image*).



**Poly(hexafluoropropylene-co-vinylidene fluoride)** *n.* 1,1,2,3,3,3-hexafluoro-1-propene-co-1,1-difluoroethene a fully fluorinated polymer based on gas $CF_3$ $CF{=}CF_2$, not commercial. However, the co-polymers of hexafluoropropylene and tetrafluoroethylene make up the family of fluorinated ethylene propylene resins (*See image*).



**Poly(hexamethylene adipamide)** *n.* Explicit Syn: nylon-6/6.

**Polyhexamethylenesebacamide** *n.* Explicit name for nylon-6/10.

**Polyhexamethyleneterephthalamide** *n.* Explicit name for nylon-6/T.

**Polyhydric alcohol** Syn: polyol.

**Polyhexamethylenesebacamide** *n.* Explicit name for nylon-6/10.

**Polyhexamethyleneterephthalamide** *n.* Explicit name for nylon-6/T.

**Polyhydric alcohol** *n.* Syn: polyol.

**Polyhydroxyether resin** *See phenoxy resin.*

**Polyimidazopyrrolone** (ladder pyrrone, polypyrrolone) *n.* An aromatic, heterocyclic polymer that results from the reaction of an aromatic dianhydride with a tetramine. Due to the double-chain or ladder-like structure, these polymers have outstanding resistance to radiation, chemicals, and heat (no weight loss to 550°C). However, this structure also makes them difficult to process. To overcome this difficulty pyrrone pre-polymers in the form of solutions and salt-like powders have been made available. The powders can be molded under conditions that complete the cyclization or conversion of the ladder-like molecular structure during the molding cycle. The cyclization reaction generates water, which must be removed from the part.

**Polyimide** *n.* A polymer formed by the condensation of an organic anhydride or dianhydride with a diamine, in some cases followed by thermal dehydration (curing). The early polyimides from pyromellitic anhydride and aromatic diamines, when fully cured, had extremely high thermal stability but were unmeltable and required special processing. Later, addition-type polyimides based on reacting maleic anhydride and 4,4′-methylenedianiline were developed. These are processable by conventional thermoset molding, film casting, and solution-fiber techniques. Molding compounds filled with lubricating fillers or fibers produce parts with self-lubricating wear surfaces. Thermoplastic polyimide reinforced with glass, boron, or graphic fibers can be molded into high-strength structural components. Polyimide solutions are used as laminating varnishes to produce radomes, printed-circuit boards, and other components requiring fire resistance, good electrical properties, and strength at high temperatures. Printed-circuit boards of polyimide-glass laminate handily endure high-temperature soldering. Recently, the introduction of thermoplastic polyimides containing aromatic rings in the polymer backbone and trifluoromethyl side group has opened these materials, to a wider field of applications because of improved processability. Film has been used as insulation in electric motors, magnet wire and missile wiring, and in dielectric applications.

**Polyimide fiber** *n.* A manufactured fiber formed from the condensation polymer of an aromatic dianhydride and an aromatic diisocyanate. The fiber is produced by dry spinning. It is a high-shrinkage fiber used in the formation of mechanically stable non-woven fabrics. These fabrics are made without binders or resins; bonding apparently results from the local temperature and pressure that develop during shrinkage.

**Polyimide foam** *n.* A family of polyimide-precursor powders enables the production of flexible and rigid polyimide-foam structures. These powders are poured into molds and heated until sufficient integrity for removal is attained, then, they are subsequently cured at 300°C.

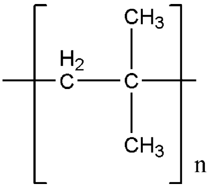
**Polyimide resin** *n.* Aromatic polyimides made by reacting pyromellitic dianhydride with aromatic diamines. Characterized by high resistance to thermal stress.

**Polyindene resins** *See coumarone-indene resins.*

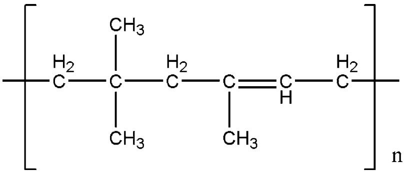
**Polyisobutene** *See polybutene.*

**Polyisobutylene** *n.* Poly(2-methyl-1-propene) Any of a family of polymers of isobutylene $(CH_3)_2C{=}CH_2$, for which the IUPAC name is 2-*methylpropene.*

Depending on molecular weight, they range from oily liquids to elastomeric solids. The higher-molecular-weight polymers are used as impact-resistance improvers in polyethylene and other plastics. The liquid polymers are used as tackifying agents in adhesives. A rubbery polymer of isobutylene which yields viscous solutions in aliphatic and aromatic hydrocarbons. Films of great elasticity can be obtained and the product is characterized by excellent chemical and light resistance, and absorbs very little. It is used chiefly in the manufacture of synthetic rubber (*See image*).



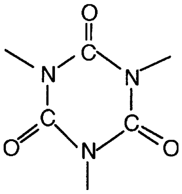
**Poly(isobutylene co-isoprene)** *n.* Poly(2-methyl-1-propene-co-2-methyl-1,3-butadiene).



**Polyisobutylvinyl ether (polyvinyliosbutyl ether)** *n.* Any polymer of isobutylvinyl ether. Some are liquids, others are solid and crystalline. They are used as adhesives, surface coatings, laminating agents, and filling compounds in electrical cables.

**Polyisocyanate** *See isocyanate.*

**Polyisocyanurate (PIR)** *n.* A polymer containing isocyanurate rings, i.e., isocyanate trimer, and forming foams that have better fire resistance than rigid polyurethanes, but are more brittle, so are often used in mixtures with the latter (*See image*).



**Polyisoprene** *n.* A polymer of isoprene. The *cis*-1,4- type of polyisoprene occurs naturally as the major polymer in natural rubber and is also produced synthetically. The *trans*-1,4- type resembles Gutta–Percha and has in the past been used in golf-ball covers and shoe soles.

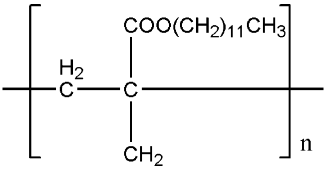
*See poly*(*cis-1,4-isoprene*).

**Polyisoprene, deutero** *n.* A polyisoprene in which heavy hydrogen (deuterium) atoms have replaced the ordinary hydrogen atoms. The *cis*-1,4-deuteropolyisoprene is more elastic than natural rubber.

**Polyketone resins** *n.* A new and unique family of aliphatic polymers composed of carbon monoxide, ethylene and minor amounts of other alpha olefins. This family of semi-crystalline resins exhibits many of the properties of engineering resins while processing similarly to polyolefins.

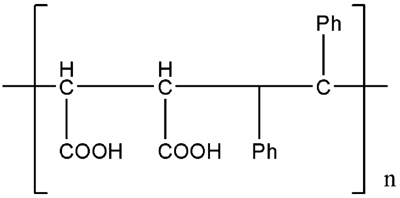
**Polylauryllactam** *See nylon-12.*

**Poly(lauryl methacrylate)** *n.* Poly(propanoic acid, 2-methyl-, and dodecal ester).



**Polyliner** *n.* A perforated, longitudinally ribbed sleeve that fitted snugly inside the cylinder of a ram-type injection-molding machine, replacing the conventional torpedo. It improved the heat transfer, plastifying rate, and uniformity of melt temperature at the nozzle.

**Poly(maleic anhydride co stilbene)** *n.* Poly-(2-butenedioic acid-co-1,1′-(1,2-ethediyl)-bis-(*E*)-benzene (*See image*).



**Polymer** \pä-lə-mər\ [ISV, back-formation fr. *polymeric*, fr. Gk *polymerēs* having many parts, fr. *poly-*+ *meros* part] (1866) {*d* polymer *n*, *f* polymere, *s* polimero *m.*} *n.* (1) A chemical compound, or mixture of compounds, formed by a polymerization reaction and consisting essentially of repeating structural units. (2) A compound of high molecular weight derived either by the addition of many smaller molecules, as polyethylene, or by the condensation of many smaller molecules with the elimination of water, alcohol, or the like, as nylon. (3) A compound formed from two or more polymeric compounds. (4) A product of polymerization. (5) Macromolecules.

**Polymeric** \ˌpä-lə-ˈmer-ik\, **polymerism** \ pä-ˈli-mə-ˌri-zəm\ *n, adj.* (1) Substance, the molecules of which consist of one or more structural units repeated any number of times; vinyl resins are examples of true polymers. The name is also frequently applied to large molecules produced by any chemical process, e.g., condensation in which water or other products are produced; alkyd resins are examples of these. *Homopolymer* – Polymer of which the molecules consist of one kind of structural unit repeated any number of times; polyvinyl chloride and polyvinyl acetate are examples. *Co-polymer* – Polymer of which the molecule consists of more than one kind of structural unit derived from more than one monomer; polyvinyl chloride-acetate, or polyvinyl acetate-acrylic copolymers are examples. (2) A substance consisting of molecules characterized by the repetition (neglecting ends, branch junctions, and other minor irregularities) of one or more types of monomeric units (IUPAC).

*See high polymer. Also known as high polymer and macromolecule.*

**Polymer blend** *n.* A physical mixture of two or more polymers and possible additives, achieved by kneading or by high-intensity mixing of fine powders. Because hot working can cause chain scission in some polymers, some grafting of the component polymers is likely to occur during such operations. Blends are made to take advantage of synergistic gains in properties, some of which may be better than the same properties of the blend components alone. Often, costly resins of outstanding properties are blended with cheaper, compatible ones to achieve blends of intermediate properties at a cost lower than that of the more expensive member. Melt viscosities of blends may lie, at a given shear rate and temperature, between those of the separate components, or above or below both of them.

**Polymer concrete** *n.* A composite material consisting of graded aggregates with an organic binder or mixed organic and inorganic binders. Epoxy and other resins have been used, in contents between 8 and 20%. Compressive and flexural strengths are several times those of Portland-cement concretes, they are impervious to liquids, and can be made to look like granite or marble. However, cost is about five times that of

Portland concrete, so polymer concretes, so far, have been limited to special uses.

**Polymer gels** *n.* Similar to liquid emulsion polymer coatings, except furnished in paste form. Must be polished for luster. May contain some solvent.

**Polymeric modifier** *n.* A term applied to any polymer that is blended with the principal polymer to alter the latter's characteristics. *See also elasticizer, impact modifier, and polymeric plasticizer.*

**Polymeric plasticizer** *n.* The term refers to plasticizers with molecules containing repeating mers and much larger than those of monomeric plasticizers that comprise virtually all other classifications of plasticizers. The two main types of polymeric plasticizers are the epoxidized oils of high molecular weight and polyester plasticizers. Polymeric plasticizers are noted for their permanence, which is due to the reduced tendency of the larger molecules to migrate and evaporate. However, the viscosity rises and the low-temperature properties of polymeric plasticizers decrease as their molecular weights increase. In cold weather, the high-molecular-weight polymerics may be difficult to handle and pump.

**Polymeric polyisocyanate** *n.* A generic term for a family of isocyanates derived from aniline-formaldehyde condensation products, used as reactants in the production of polyurethane foams.

**Polymeric sulfur nitride** *See sulfur nitride polymer.*

**Polymerizable plasticizer** *See plasticizer, polymerizable.*

**1,2-Polymerization** *n.* Polymerization of a butadiene by 1,2 addition.

**1,4-Polymerization** *n.* Polymerization of a butadiene by 1,4 addition.

**Polymerization** *n.* Polymerization is the reaction in which two or more small molecules (*monomers*) that combine to form large molecules (polymers, macromolecules) that contain repeating structural units of the original molecules and have the same percentage composition as the small molecules if the small ones were of the same kind. There are two basic types of polymerizations, both with many variations: *addition* polymerization, which occurs when reactive, unsaturated monomers unit without forming any other products; and *condensation* polymerization, which occurs by combining of reactive

Addition polymerization
Alternating co-polymer
Autoacceleration
Bead polymerization
Block co-polymer
Branching
Bulk polymerization
Chain-transfer agent
Condensation polymerization
Cross-linking
Emulsion polymerization
Free-radical polymerization
Gas-phase polymerization
Graft co-polymer
Interfacial polymerization
Ionic polymerization
Isotactic

Network polymer
Oxidative coupling
Photopolymerization
Precipitation polymerization
Radiation polymerization
Random co-polymer
Redox
Solid-state polymerization
Solution polymerization
Stereoblock polymer
Stereograft polymer
Stereoregular polymer
Stereospecific
Suspension polymerization
Syndiotactic
Thermal polymerization

end groups, accompanied by the elimination of a simple molecule such as water. Examples of condensation polymers are nylons and phenolic resins. Polymers polymerized via photoinitiators (free radical or chain polymerized) are photopolymerized. The majority of thermoplastics, aside from polyamides and polyesters, and a few thermosets, are made by addition polymerization, in which a pair of shared electrons in each monomer molecule is utilized to link the separate molecules into long chains. Polymerization processes and related terms are defined under the following heading. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York. James F Carley (eds) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA.

**Polymerize** *adj.* The process of undergoing polymerization. The reaction of molecules that result in forming relatively long-chain molecules.

**Polymerized fatty acid** *n.* Polycarboxylic acids produced by polymerizing acids from animal or vegetable fats and oils, in either an ester or free acid state, by means of heat alone or catalytically.

*See dimer acids.*

**Polymer melts** *n.* Polymer that has been heated until it has reached a molten condition.

**Polymer, natural** *n.* A substance of high molecular weight occurring naturally, consisting of molecules that are, at least approximately, multiples of simple units. Natural polymers are often regarded as organic, but many inorganic minerals, such as quartz, feldspar, and asbestos are considered to be entirely or substantially polymeric. Examples of natural organic polymers are cellulose, natural rubber, lac, proteins such as collagen and keratin, and many natural fibers.

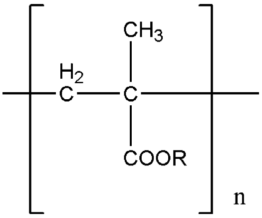
**Polymerography (resinography)** *n.* The use of microscopic and metallographic techniques in the study of polymers.

**Polymer structure** *n.* (1) A general term referring to the relative positions, arrangements in space, freedom of motion of atoms in a polymer molecule, and orientation of chains. Such structural details have important effects on polymer properties such as the second-order-transition temperature, flexibility, and tensile strength. (2) The microstructure of a polymer, as observed by light- or electro-microscopic techniques, and including crystalline structure, birefringence, distribution of sizes of filler particles and spherulites, and distribution of reinforcement directions. These, too, have important influences on macroscopic properties and behavior.

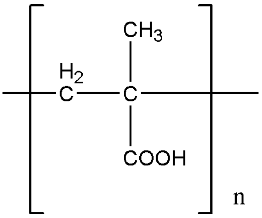
**Polymer, synthetic** *n.* The product of a polymerization reaction whose starting materials are one or more *monomers*. When a single monomer is used, the product is called a *homopolymer*, *monopolymer*, or simply a polymer. When two monomers are polymerized simultaneously one obtains a *co-polymer*. The term *terpolymer* is used for the polymerization product of three monomers. However, the term *heteropolymer* is also used for terpolymers as well as for products of more than three monomers. When no monomer is used, the product is known as a *nonomer*. The terms *polymer, resin, high polymer, macromolecular material*, and *plastic* are often used interchangeably, although *plastic* also refers to compounds containing major additives. *Note*—The definition approved

by IUPAC and ISO for polymer is “a substance composed of molecules characterized by the multiple repetition of one or more species of atoms or groups of atoms (constitutional units) linked to each other in amounts sufficient to provide a set of properties that do not vary markedly with the addition or removal of one or a few constitutional units”. A polymer may be amorphous or may contain crystalline structures up to and exceeding half its specific volume, In a given polymer, the crystalline regions are always more dense than the amorphous ones; thus, percent crystallinity can be estimated from density.
*See polymerization.*

**Polymethacrylates** *n.* A polymer of a methacrylic ester, polymethyl methacrylate being the most important and useful member of the class.



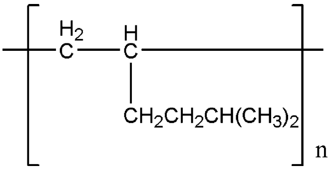
**Poly(methacrylic acid)** *n.* Poly(2-methyl-2-propenoic acid).



**Polymethacrylonitrile (PMAN)** *n.* Poly(2-methyl-2-propenenitrile). A thermoplastic obtained by the polymerization of Methacrylonitrile, a vinyl monomer containing the nitrile group. The homopolymer has good mechanical strength and high resistance to solvents, acids, and alkalis, but discolors at molding temperatures (*See image*).

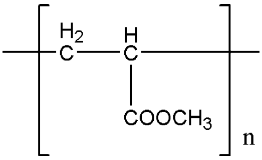
**Polymethoxy acetal (PMAC)** *n.* Any oligomer of methoxyl dimethyl acetal with degree of polymerization in the range 3–10. These oligomers are high-boiling, yellowish liquids used as modifiers for phenolic resins, and as solvents and plasticizers.

**Poly(5-methyl-hexene-1)** *n.*

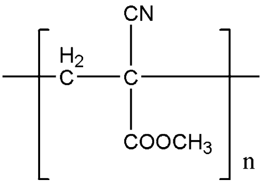


**Polymethyl acrylate** *n.* A polymer of methyl acrylate, having a glass-transition at 10°C, a leathery, tough material used in textile and leather finishing.

**Poly(methyl acrylate)** *n.* Poly(2-methyl-2-propenoic acid).

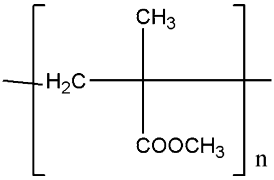


**Poly(methyl cyanoacrylate)** *n.* Poly(2-propenoic acid, 2-cyano-, methyl ester) (*See image*).



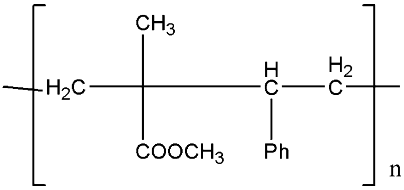
**Polymethylene** *n.* A polymer first made by polymerizing diazomethane (also called *azomethylene*) ($CH_2N_2$), with evolution of nitrogen gas. While this polymer has the same formula as polyethylene, it contains no side chains, so provides a standard with which branched ethylene polymers may be compared. Although long known in the laboratory, it is not a commercial resin.

**Poly(methyl methacrylate) (PMMA)** \ˈpä-lē-ˌme-thəl-\ (1936) *n.* Poly(2-propenoic acid, 2-cyano-, methyl ester). Belongs to the group of acrylic resins. It is a rigid amorphous polymer. A polymer of methyl methacrylate. The most important member of the family of acrylic resins, made by addition polymerization of the monomer, methyl methacrylate [$CH_2{=}C(CH_3)COOCH_3$]. Two outstanding characteristics of PMMA are its optical clarity (92% light transmission) and unsurpassed resistance to weathering. It also has good electrical properties, the ability to "pipe" light around bends, and is tasteless, odorless, and non-toxic. PMMA molding powders can be injection molded, extruded, and compression molded. The liquid monomer can be cast into rods, sheets, optical lenses, etc. Cast and extruded PMMA sheets are fabricated and thermoformed into many products such as aircraft canopies, skylights, lighting fixtures, and outdoor signs. *See also acrylic resin* (*See image*).



$$\left[ -H_2C-\overset{CH_3}{\underset{COOCH_3}{|}}- \right]_n$$

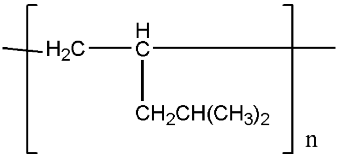
**Poly(methyl methacrylate co styrene)** *n.* Poly(2-propenoic acid, 2-cyano-, methyl ester-co-ethenyl benzene) (*See image*).



$$\left[ -H_2C-\overset{CH_3}{\underset{COOCH_3}{|}}-\underset{Ph}{\overset{H}{C}}-\overset{H_2}{C}- \right]_n$$

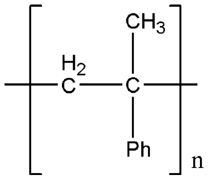
**Poly(methyl methacrylate) plastics** *n.* Plastics based on polymers made with methyl methacrylate as essentially the sole monomer.

**Poly(4-methylpentene-1) (PMP)** *n.* A polyolefin first introduced commercially in 1966 by Imperial Chemical Industries but now produced only by Mitsui Plastics ("TPX") and Phillips 66 C ("Crystalor"). The monomer, 4-methylpentene-1, is produced by dimerization of propylene. Polymerization is conducted with a Ziegler-type catalyst. The polymers are supplied as free-flowing powders or as compounded granules, suitable for the usual thermoplastics processes. Properties of the resins are high light transmission (93%, better than many glasses), melting range near 240°C, rigidity and tensile properties similar to those of polypropylene, good electricals, high chemical resistance, and the lowest density of all commercial solid resins, $0.834\,g/cm^3$. It is approved for food contact. These properties account for its use in laboratory volumeware, slight glasses, high-frequency electrical components, coffee funnels, wire coatings, and microwave-safe cookware.



$$\left[ -H_2C-\underset{CH_2CH(CH_3)_2}{\overset{H}{C}}- \right]_n$$

**Poly(α-methyl styrene)** *n.*



**Polymin** *n.* Poly(ethylene imine), manufactured by BASF, Germany.

**Poly(monochloro-*p*-xylylene)** (parylene C) *n.*
*See parylene.*

**Polymorphism** \ˌpä-lē-ˈmór-ˌfi-zəm\ (1839) *n.* The ability of a substance to crystallize with different internal lattices thereby giving correspondingly different external crystal morphology and internal physical properties, Most, and probably all, elements and compounds exhibit polymorphism. The crystal systems of the two (or more) modifications (forms) of the compound are usually but not always, different.

**Poly-*m*-xylyleneadipamide** *n.* Syn: nylon mxd/6.

**Poly-*n*-butyl methacrylate (PBMA)** A rubbery polymer that enjoys some use as an adhesive and textile finish.

**Polynosic fiber** *n.* A high-wet-modulus rayon staple having a microfibular structure of fibers. The molecular chain length of the cellulose forming the fiber is about twice as long as in conventional rayon.

**Polyoctanoamide** *n.* Syn: nylon-8.

**Polyol** (polyhydric alcohol, polyalcohol) *n.* An organic compound having more than one hydroxyl (–OH) group per molecule, In the cellular plastics industry, the term includes monomeric and polymeric compounds containing alcoholic hydroxyl groups such as polyethers, glycols, glycerol, and polyesters, used as reactants in polyurethane foam.
*See polyalcohol.*

**Polyolefin** \ˌpä-lē-ˈō-lə-fən\ (1930) *n.* Any of the largest genus of thermoplastics, polymers of simple olefins such as ethylene, propylene, butanes, isoprenes, and pentenes, and co-polymers and modifications thereof. The two most important are polyethylene and polypropylene, which, together, accounted for just under half of all USA resin sales in 1992. Polyolefin plastics are most usually processed into end products by extrusion, injection molding, blow molding, and rotational molding. Thermoforming, calendering, and compression molding are used to a lesser degree. An inherent characteristic common to all polyolefins is a non-polar, nonporous, low-energy surface that is not receptive to inks, lacquers, etc., without special oxidative pre-treatment.
*See the following*:

*Ethylene-propylene rubber*
*Ethylene-vinyl acetate co-polymer*
*Ionomer resin*
*Polyallometer*
*Polyethylene polyisoprene*
*Poly(4-methylpentene-1)*
*Polypropylene*

**Polyolefin fiber** *n.* A fiber produced from a polymerized olefin, such as polypropylene or polyethylene.

**Polyolefin plastics** *n.* Plastics based on polymers made with an olefin (or olefins) as essentially the sole monomer (or monomers).

**Polyorganophosphazene** *n.* A polymer obtained by reaction of phosphorus pentachloride and ammonium chloride. A cyclic trimer $(NPCl_2)_3$, or tetramer $(NPCl_2)_4$, is formed which can be converted to polyorganophosphazenes $(–N{=}PR_2–)_n$ where

R represents an organic side group. The polymers have found some use in hose, gaskets, and seals in aviation-fuel-handling equipment. They have better solvent resistance and low-temperature elasticity than siloxane-carborane polymers, and are less costly.

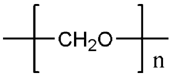
**Polyox** *n.* High-molecular-weight poly(ethylene oxide, manufactured by Union Carbide, USA.

**Polyoxamide** Generic name for nylon-type materials made from oxalic acid and diamines. Their extremely high melting temperatures have kept them out of commerce.

**Polyoxetane** *See chlorinated polyether.*

**Polyoxyamide fiber** *n.* Co-polymeric fiber with good comfort properties, particularly high moisture absorption and transfer, and intrinsic softness.

**Polyoxymethylene (POM)** *n.* Linear polymers of formaldehyde or oxymethylene glycol with the formula $(–OCH_2–)_n$, in which $n$ is above 100. Those in the range of $100 < n < 300$ are brittle solids used as intermediates. Those in the range $500 < n < 5000$ are acetal resins. *Note*—Polyoxymethylene is theoretically the simplest member of the generic class of polyacetals.



$$\left[ CH_2O \right]_n$$

**Polyoxyethylene glycol** *See polyethylene glycol.*

**Polyoxypropylene glycol** *n.* Any low-molecular-weight polymer with the structure $H[–OCH(CH_3)CH_2–]_nOH$, derived from propylene oxide and used in the production of polyurethane foams.

***Trans*-polypentenamer** *n.* An elastomer obtained by the polymerization of cyclopentane, using complex catalysts. Its structure is highly linear and the molecular weight has a wide range. Its properties are similar to those of natural rubber and *cis*-polybutadiene.

**Polypeptide** \ˌpä-lē-ˈpep-ˌtīd\ [ISV] (1903) *n.* Low molecular weight plastics of amino acids.

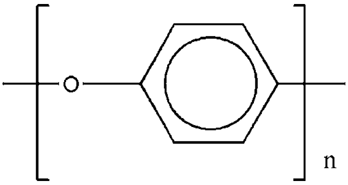
**Polyphenone** *n.* A phenolic-like material developed in the early 1970s by Union Carbide, but still not commercial. Unlike phenolic, it was to be available in a range of light colors, with good moldability and electrical and physical properties equal to those of mineral-filled phenolics.

**Polyphenylene benzobisthiazole (PBT, PBZ)** *n.* A liquid-crystalline polymer from which very strong and heat-resistant fibers are made.

**Poly-1,3-phenylenediamine isophthalate** *n.* A high-temperature fiber, trade named Nomex® by DuPont. This fiber resists common flame temperatures around 500°C for a short time and thus is suitable for fire-protective clothing and insulation of motors and transformers.

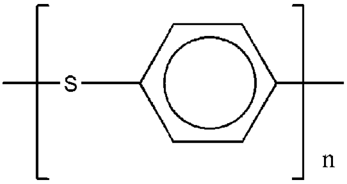
**Polyphenylene glycol** *See polyethylene glycol.*

**Polyphenylene oxide (PPO)** *n.* A thermoplastic, linear, non-crystalline polyether obtained by the oxidative polycondensation on 2,6-dimethylphenol in the presence of a copper-amine complex catalyst. The resin has a wide useful temperature range, from below −170 to +190°C, with intermittent use to 205°C possible. It has excellent electrical properties, unusual resistance to acids and bases, and is processable on conventional extrusion and injection-molding equipment. Because of its high coat PPO is also marketed in the form of polystyrene blends (*see Noryl®*) that are lower-softening ($T_g$ of PS is about 100°C vs 208°C for PPO), and have working properties intermediate between those of the two resins.



**Poly(phenylene oxide)** *n.* Poly(phenylene oxide), or PPO, is a high-performance polymer. Its biggest strength is its resistance to high temperatures. It has a very high glass transition temperature, 210°C. PPO is often made into blends with high-impact polystyrene (HIPS for short) due to its high resistance to heat. Blending PPO with HIPS makes the PPO easier to process, plus it gives PPO some resilience. Structurally, PPO is made of phenylene rings linked together by ether linkages in the 1,4 or para- positions, with a methyl group attached to carbon atoms in the 2 and 6 positions. PPO is made by what we call oxidative coupling polymerization of the monomer 2,6-dimethylphenol.

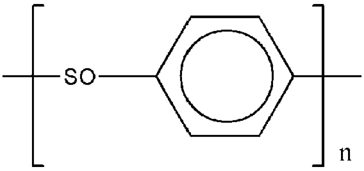
**Poly(phenylene sulfide)** *n.* Poly(phenylene sulfide), or PPS, is a high-performance plastic that is very strong and can resist very high temperatures up to 300°C. To produce PPS you have to react paradichlorobenzene and sodium sulfide in a polar solvent like *N*-methyl pyrrolidone (*See image*).



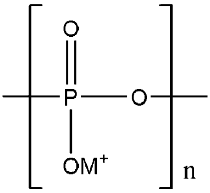
**Polyphenylene sulfide (PPS)** *n.* A crystalline polymer having a symmetrical, rigid backbone chain consisting of recurring *p*-substituted benzene rings and sulfur atoms. A variety of grades suitable for slurry coating, fluidized-bed coating, electrostatic spraying, as well as injection and compression molding are offered (Phillips 66 Co.'s Ryton® and others). The polymers exhibit outstanding chemical resistance, thermal stability, and fire resistance. Their extreme inertness toward organic solvents, and inorganic salts and bases make for outstanding performance as a corrosion-resistant coating suitable for contact with foods. Doping with arsenic pentrafluoride infuses the resin with usefully high electrical conductivity.

**Polyphenylquinoxaline (PPQ)** *n.* Any of a family of high-performance thermoplastics that have potential for use as functional and structural resins in applications demanding high chemical and thermal stability. The most attractive synthesis is by co-polycondensation of an aromatic bis(*o*-diamine) powder and a stirred solution or slurry of bis(1,2-dicarbonyl) monomer in an appropriate solvent such as a mixture of *m*-cresol and xylene. In solution form, the polymers can be used directly for prepreg and adhesive-tape formulations, film casting, etc. If desired, the polymer can be isolated from solution and compression molded. It is convertible to a thermoset form by rigidizing the linear polymer backbone with reactive latent groups and by cross-linking.

**Polypheylsulfone** *n.*



**Polyphosphates** *n.*



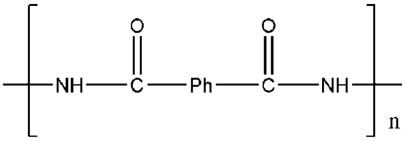
$$\left[ -\underset{\underset{OM^+}{|}}{\overset{\overset{O}{\|}}{P}}-O- \right]_n$$

**Polyphosphazene** *n.* A family of inorganic-base polymers having phosphorus-nitrogen backbones joined with fluorine or chlorine. Depending on which organic side groups are linked to the backbones, a wide variety of polymers can be made with properties ranging from rigid and flexible thermoplastics and elastomers to glass-like thermosets. Some grades outperform silicones in biomedical uses.

*See also phosphazene polymer.*

**Polyphosphazene fluoroelastomer** *n.* Any of a family of elastomers developed primarily for fuel tanks to be used in the Arctic, having the typical chain-unit configuration $(CF_3CH_2O)_2PN(CH_2C_3F_6\text{-}CH_2O)_2PN$. These elastomers are inert to aviation fuel and remain flexible to −60°C, lower than other elastomers previously used in this application.

**Polyphthalamide (PPA)** *n.* Poly(1,2-benzene-dicarboxamide). A polyamide in which the residues of terephthalic or iosphthalic (or mixed) acid components are part of the mer unit of the chain. PPA is an advanced engineering polymer first commercially offered in 1991 by Amoco Chemical Co. (MS, USA) under the trade name Amodel®.

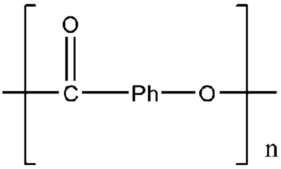


$$\left[ -NH-\overset{\overset{O}{\|}}{C}-Ph-\overset{\overset{O}{\|}}{C}-NH- \right]_n$$

**Poly-*p*-hydroxybenzoic acid** *n.* A homopolyester of repeating *p*-oxyenzoyl units with a high degree of crystallinity. It does not melt below its decomposition temperature, 550°C, but can be fabricated at 300–360°C by compression sintering and plasma-spray processes. Co-polymers with aromatic dicarboxylic acids and aromatic bisphenols are processable by normal means. Applications include electrical connectors, valve seats, high-performance-aircraft parts, and automotive parts.

**Polypinvalotactone** *n.* A crystalline thermoplastic polymerized by ring opening from the cyclic monomer, $(CH_3)_2\underline{CCOOCH_2}$. It is useful for making high-strength fibers, also as a high-crystallinity (75%) matrix resin with carbon fibers.

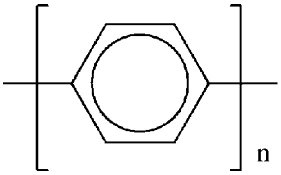
**Poly(*p*-oxybenzoate)** *n.* Poly(4-hydroxy-benzoic acid).



$$\left[ -\overset{\overset{O}{\|}}{C}-Ph-O- \right]_n$$

**Poly-*p*-oxybenzoÿl** *See poly-p-hydroxybenzoic acid.*

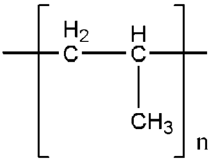
**Poly(*p*-phenylene)** (*See image*).



**Poly(*p*-phenylene sulfone) (PPSU)** *n.* Chemically similar to the polysulfones, this high-performance polymer has better impact resistance. It also has excellent heat resistance, low creep and good electrical properties. It is difficult to process, however, which has limited its commercial acceptance.

**Polypropylene** \ˌpä-lē-ˈprō-pə-ˌlēn\ (1935) (PP, polypropene) *n.* Any of several types of a large family of thermoplastics resins made by polymerizing propylene with suitable catalysts, generally solutions of aluminum alkyl and titanium tetrachloride. Its density (approximately 0.905 g/cm$^3$) is among the lowest of all plastics. PP and co-polymers enjoyed the third largest sales in USA in 1992, 3.8 Tg ($4.2 \times 10^6$ tons), about 13% of all USA resins sales. As with the polyethylenes, properties of the polymers vary widely according to molecular weight, method of production, and co-polymers involved. The grades used for molding have molecular weights of 40,000 or more, are 90–95% isotactic with about 50% crystallinity. They have good resistance to heat, chemicals, and solvents, and good electrical properties. Properties can be improved by compounding with fillers, e.g., mica or glass fibers, by blending with synthetic elastomers, e.g., polyisobutylene; and by co-polymerizing with small amounts of other monomers. Fibers are the single largest use of polypropylene.
*See split-film fiber.*

**Polypropylene** *n.* Poly(1-propene) A plastic polymer of propylene $(C_3H_5)_n$. Similar to polyethylene, but each unit of the chain has a methyl group attached. It is translucent, autoclavable, and has no known solvent at room temperature. A polymer of propylene (propene). Abbreviation: PP.
*also called polypropene.*



$$\left[ -CH_2-CH(CH_3)- \right]_n$$

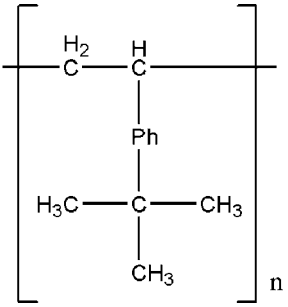
**Polypropylene adipate (polypropylene glycol adipate)** *n.* A polymeric plasticizer for vinyl chloride polymers and co-polymers formed by reacting propylene glycol and adipic acid.

**Polypropylene fiber** *n.* A manufactured, olefin fiber made from polymers or co-polymers of propylene. Polypropylene fiber is produced by melt spinning the molten polymer, followed by stretching to orient the fiber molecules. Characteristics: polypropylene fibers have a number of advantages over polyethylene fibers in the field of textile applications. The degree of crystallinity, 72–75%, results in a fiber that is strong and resilient, and does not fibrillate like high-density polyethylene. Polypropylene has a high work of rupture, which indicates a tough fiber, and may be made with tenacities as high as 8.0–8.5 g/denier. The melting point of polypropylene is 165°C, which is low by comparison with nylon or polyester, but is high enough to make it suitable for most textile applications. So light that it actually floats, polypropylene fiber provides greater coverage per pound than any other fiber. It is highly resistant to mechanical abuse and chemical attack. End uses: polypropylene fibers are widely used in industrial, carpet, and geotextile applications. They have found important uses in fishing gear, in ropes, and for filter cloths, laundry bags and dye bags. The excellent chemical resistance of polypropylene fiber is of advantage in the filtration and protective clothing fields. Fibrillated polypropylene yarns are widely used in indoor–outdoor carpets. Staple fiber finds application in blankets, pile fabrics, underwear, and industrial fabrics; it is being developed for carpets, candlewicks, knitted outerwear, hand-knitting yarns, and upholstery.

**Polypropylene glycol (PPG, polypropylene oxide)** *n.* A family of non-volatile liquids with the general formula $HOCH(CH_3)\text{-}[-CH_2CH-(CH_3)O-]_nCH_2OH$. They are similar to the polyethylene glycols, but are more oil-soluble and less water-soluble. They are polyols used in producing polyurethane foams, adhesives, coatings, and elastomers.

**Polyprotic acid** *n.* An acid which has more than one available $H^+$, or can donate more than one proton.

**Poly(*p*-*tert*-butyl styrene)** *n.* Poly(1-(1,1-dimethylethyl)-4-ethenyl-benzene).



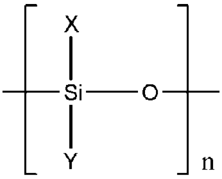
**Poly-*p*-xylylene** (parylene N) *n.* *See parylene.*

**Polypyromellitimide (PPM)** *n.* The original polyimide family of polymers, having enhanced heat resistance and formed from polyamide carboxylic acids derived by reacting pyromellitic dianhydride with 4,4′-diaminophenyl ether. Grades of the polymer are used for forming films, paint components, and are processable as thermoplastics under special conditions. More easily processed co-polymers have enjoyed greater commercial success.

**Polysar butyl** *n.* Isobutylene/isoprene co-polymer, manufactured by Sarnia, Canada.

**Polysilane** *n.* A polymer whose backbone is composed of covalently linked silicon atoms with organic side groups that may be aliphatic, aromatic, or mixed, and not to be confused with *polysiloxanes* (*see silicone*). Polysilanes have been used as lithographic resists.

**Polysiloxane** *n.* Polysiloxane is the proper name for silicones. (*See image*)

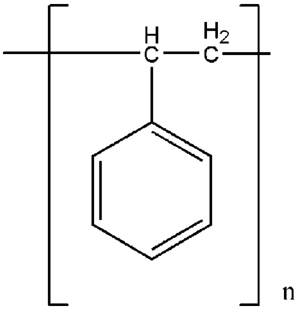


X and Y can be an alkyl groups.

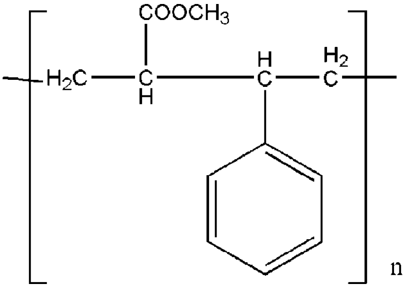
**Poly(siloxanes)** *n. See polysiloxanes and poly* (*p*-*tert*-butyl styrene) above.

**Polystyrene** \ˌpä-lē-ˈstī-ˌrēn\ (1927) *n.* An important family of workhorse plastics, the polymer of styrene (vinyl benzene), which has been commercially available for more than half of a century. In 1992 polystyrene, neat and modified, accounted for about 10% of USA resins sales, i.e., 3.0 Tg ($3.2 \times 10^6$ tons). The homopolymer is water-white, has excellent clarity and sparkle, outstanding electrical properties, good thermal and dimensional stability, is hard, stiff, and resistant to staining, and is inexpensive ($1/kg in 12/92). However, it is somewhat brittle, and is often modified by blending or co-polymerization to a desired mix of properties. High impact grades (HIPS) are produced by adding rubber or butadiene co-polymers. Heat resistance is improved by including some α-methyl styrene as a comonomer. Co-polymerizations with methyl methacrylate improve light stability, and co-polymerization with acrylonitrile raises resistance to chemicals.

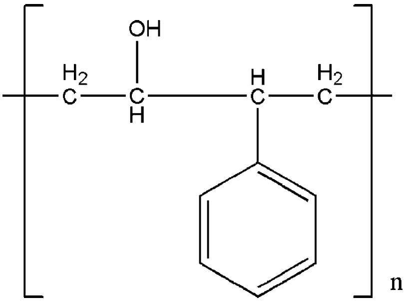
Styrene polymers and co-polymers possess good flow properties at temperatures safely below degradation ranges, and can easily be extruded, injection molded, or compression molded. Abbreviation: PS (*See image*).



**Poly(styrene co vinyl acetate)** *n.* Poly (ethenyl benzene-co-acetic acid ester).



**Poly(styrene-co-vinyl alcohol)** *n.* Poly (ethenyl benzene -co- 1 hydroxyethylene).



**Polystyrene foam (expanded polystyrene, EPS)** *n.* A low-density, cellular plastic made from polystyrene by either of two methods. Extruded foam is made in tandem extruders, the first for plasticating the resin, the second to homogenize the blowing agent, which may be a gas or volatile liquid, such as nitrogen or pentane, and reduce the temperature of the melt before it reaches the die. As it emerges from the die the large drop in pressure frees the blowing agent and the mass expands to form a low-density "log" conveyed through a long cooling tunnel. The cooled slab is usually sliced into a large range of shapes marketed through building-materials dealers. In the other basic method, a volatile blowing agent, e.g., isopentane, is incorporated into the tiny PS beads as they are polymerized, or afterward. The beads are first pre-expanded, allowed to "rest" for about a day, then molded in a closed, steam-heated mold, and finally cooled with water in the mold members. This method, which generally produces closed-cell foams, is used to mold finished products such as coffee cups, packaging components, and life-preserver rings. Beads are also used to generate very large, thick slabs ($6 \times 1.2 \times 0.6\,m^3$) by blowing live steam into an expanded, low-pressure mold charged with measured weight of beads. After cooling, these slabs are sliced with multiple hot-wire cutters to produce foam "lumber", as with the extruded foam.

**Polystyrene resins** *n.* Synthetic resins formed by polymerization of styrene.

**Polystyrenes** Polymers that contain the styrene monomer. Styrenes can be used as high impact grades, or heat resistance substances, or light stable substance or chemically stable polymer by simply blending the styrene homopolymer or creating a styrene co-polymer.

**Polystyrol** *n.* A rarely used term for polystyrene.

**Polystyrylpyridine (PSP)** *n.* A thermosetting resin, resistant to high temperatures, formed by condensation of 2,4,6-trimethylpyridine and 1,4-benzyldialdehyde, and a useful matrix for carbon-fiber composites.

**Polysulfide** \-ˈsəl-ˌfīd\ [ISV] (1849) *n.* A family of sulfur-containing polymers prepared by condensing organic polyhalides with sodium polysulfides in aqueous suspension. They range from liquids to solid elastomers.

**Polysulfide rubber (T)** *n.* A family of sulfur-containing polymers prepared by condensing organic polyhalides with sodium polysulfides in aqueous suspension. They range from liquids to solids elastomers. The first commercial polysulfide was Thiokol® A, polyethylene tetrasulfide, made from sodium tetrasulfide and ethyl dichloride. This elastomer had outstanding solvent resistance, but its poor mechanical properties and unpleasant odor limited its use to plasticizing acid-resistant cements. Modern T materials have the general structure $(–R–S_m–)_n$ where $m$ is usually 2–4 and R is $(CH_2)_2$ or an ether group. These elastomers are used in hose, printing rolls, gaskets, and gas meter diaphragms. Polysulfide products have excellent resistance to oils, solvents, oxygen, ozone, light, and weathering, and low permeability to gases and vapors.

**Polysulfonate co-polymer** (sulfonate-carboxylate co-polymer) *n.* A family of transparent, thermoplastic polyesters, moldable at 250–300°C, and formed by reaction of a diphenol, generally bisphenol A, with an aromatic disulfonyl chloride and an aliphatic disulfonyl chloride or carboxylic acid chloride. These co-polymers have good electrical and mechanical properties, and excellent resistance to hydrolysis and aminolysis.

**Polysulfone (PSU, PPSU)** *n.* A family of sulfur-containing thermoplastics, closely akin to polyethersulfone made by reacting bisphenol A and 4,4′-dichlorodiphenyl sulfone with potassium hydroxide in dimethyl sulfoxide at 130–140°C. The structure of the polymer is benzene rings or phenylene units linked by one or more of three different chemical groups – a sulfone group, an ether link, and an isopropylidene group. Each of these three linking components acts as an internal stabilizer. Polysulfones are characterized by high strength, very high service-temperature limits, low creep, good electrical characteristics, transparency, self-extinguishing ability, and resistance to greases, many solvents, and chemicals. They may be processed by extrusion, injection molding, and blow molding.

**Polysulfonate co-polymer** (sulfonate–carboxylate co-polymer) *n.* A family of transparent, thermoplastic polyesters, moldable at 250–300°C, and formed by reaction of a diphenol, generally bisphenol A, with an aromatic disulfonyl chloride and an aliphatic disulfonyl chloride or carboxylic acid chloride. These co-polymers have good electrical and mechanical properties, and excellent resistance to hydrolysis and aminolysis.

**Polysulfone** *n.* Co-polymer from bisphenol A + *p,p*′-dichlorodiphenyl sulfone. Manufactured by Shell, The Netherlands.

**Polysulfones (PSU, PPSU)** *n.* A family of sulfur-containing thermoplastics, closely akin to polyethersulfone made by reacting bisphenol A and 4,4′-dichlorodiphenyl

Sulfone with potassium hydroxide in dimethyl sulfoxide at 130–140°C. The structure of the polymer is benzene rings or phenylene units linked by one or more of three different chemical groups – a sulfone group, an ether link, and an isopropylidene group. Each of these three linking components acts as an internal stabilizer. Polysulfones are characterized by high strength, very high service-temperature limits, low creep, good electrical characteristics, transparency, self-extinguishing ability, and resistance to greases, many solvents, and chemicals. They may be processed by extrusion, injection molding, and blow molding.

**Polyterephthalate** *See polyester, saturated, and terephthalate polyester.*

**Polyterpene resins** *n.* Friable, thermoplastic saturated cyclic resins produced by the catalytic polymerization of monomeric alpha- beta- pinene which are principal constituents of turpentine, with softening points, 10–135°C, Gardner color, 3–6; Sp gr, 0.93–0.97; iodine no., 48. Soluble in aliphatic, aromatic, chlorinated solvents, insoluble in alcohols, glycols, or water. The amber-colored resins, ranging from viscous liquids to solids, are used as tackifiers, wetting agents, and modifiers in the manufacture of adhesives, paints and varnishes, and caulking and sealing compounds. They are compatible with natural and synthetic rubbers, polyolefins, alkyd resins, other hydrocarbon resins, and waxes.

*See hydrocarbon plastics and terpene resins.*

**Polytetrafluoroethylene (PTFE)** *n.* The oldest of the fluorocarbon-resin family discovered in 1938 by R. J. Plunkett, developed by DuPont and marketed under the trade name Teflon®. It is made by polymerizing tetrafluoroethylene, $F_2C{=}CF_2$, and is available in powder and aqueous-dispersion forms. PTFE inert to virtually all chemicals, has a crystalline melting point of 327°C, though it does not truly liquefy. Molecular weighs of commercial PTFE powders are very high, on the order of 106. It has a very low coefficient of friction on most surfaces, resists adhesion to almost any material unless strenuously pre-treated, and has excellent electrical properties. Its non-stick character has long been evidenced by its everyday use as an interior coating in cooking utensils. Its inability to form a true melt long ago forced the development of special extrusion, molding, and calendering processes in which the PTFE powder is pressed, then, sintered with heat. PTFE tape and film are made by skiving pressed (or extruded) and sintered rods. Continuous extrusion is accomplished by alternating strokes of two ram extruders feeding a single die block. PTFE's low modulus and tendency to creep under load can be substantially improved by addition in inorganic fillers or chopped glass–fiber.

*See also fluorocarbon resins.*

**Polytetrafluoroethylene fiber (PTFE)** *n.* Fluorine-containing manufactured fibers characterized by high chemical stability, relative inertness, and high melting point. Polytetrafluoroethylene Fiber is made my emulsion spinning, a process that essentially results in fusion of fibrils by passing an emulsion through a capillary, then drawing the resulting fiber. The fiber has a moderate tensile strength and is particularly resistant to the effect of high temperatures and corrosive chemicals. Having very low frictional coefficients, it has a slippery hand. Its principal uses are in packaging and filtration media.

**Polytetrahydrofuran (polytetramethylene ether, PTHF)** *n.* A type of polycol made from tetrahydrofuran by ring opening, have the mer $[-CH_2(CH_2)_3-O-]$ and $-OH$ end groups, with low to moderate molecular weights. These polymers have long been used as pre-polymers for polyurethane elastomers.

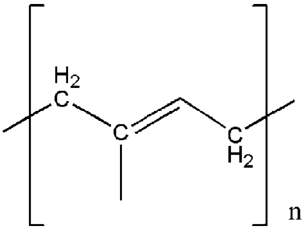
**Polytetramethyleneadipamide** *n.* Syn: nylon-4/6.

**Poly(tetramethylene terephthalate)** Syn: polybutylene tere-phthalate.

**Polythene** \ˈpä-lə-ˌthēn\ [by contraction] (1939) *n.* Poly(ethylene) (high pressure), manufactured by DuPont, USA. The British name for polyethylene.

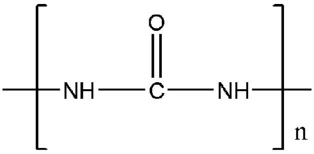
**Polythiazyl** *See sulfur nitride polymer.*

**Poly(trans-1,4-isoprene)** *n.*



**Polytrifluorostyrene** *n.* A clear, thermoplastic material introduced in 1965 and said to combine the oxidation resistance of polytetrafluoroethylene with the mechanical and electrical properties and ease of processing of polystyrene, but still not commercially available in 1992.

**Polyureas** *n. See image.*



**Polyurethane** \ˌpä-lē-ˈyúr-ə-ˌthān\ [ISV] (1944) *n. Type-I,* one-package, pre-reacted-urethane coatings characterized by the absence of any significant quantity of free isocyanate groups. They are usually the reaction product of a polyisocyanate and a polyhydric alcohol ester of vegetable oil acids and are hardened with the aid of metallic soap driers. *Type-II,* one-package, moisture-cured urethane coatings characterized by the presence of free isocyanate groups and capable of conversion to useful films by the reaction of these isocyanate groups with ambient moisture. *Type-III,* one-package, heat-cured urethane coatings that dry or cure by thermal release of blocking agents and regeneration of active isocyanate groups that subsequently react with substances containing active hydrogen groups. *Type-IV,* two-package catalyst-urethane coatings that comprise systems wherein one package contains a pre-polymers or adduct having free isocyanate groups capable of forming useful films by combining with a relatively small quantity of catalyst, accelerator or cross-linking agent such as a monomeric polyol or polyamine contained in a second package. This type has limited pot life after the two components are mixed. *Type-V,* two-package poly-urethane coatings that comprise systems wherein one package contains a pre-polymers or adduct or other polyisocyanate capable of forming useful films by combining with a substantial quantity of a second package containing a resin having active hydrogen groups, with or without the benefit of catalyst. This type has limited pot life after the two components are mixed. *Type-VI,* one-package, non-reactive lacquer-urethane solution coatings characterized by the absence of any significant quantity of free isocyanate or other functional groups. Such coatings convert to solid films primarily by solvent evaporation (*See image*).

*See urethane coatings and isocyanate resins.*

$$\left[\!-\mathrm{O}-\mathrm{CONH}-\mathrm{R}-\mathrm{NHCO}-\mathrm{O}-\!\right]_n$$

**Polyurethane elastomer (PU)** *n.* Any condensation polymer made by reacting an aromatic diisocyanate with a polyol that has an average molecular weight greater than about 750. The aromatic diisocyanates usually employed are toluene diisocyanate (TDI) and diphenylmethane diisocyanate (MDI). the polyol component is either a polyester or polyether. In the "one-shot" system the elastomer is prepared directly in the mold that shapes the final product. The diisocyanate, polyol, and catalyst are rapidly and intimately mixed, then immediately poured or pumped into the mold. Pre-polymers, in the form of liquids or low-melting solids, are used when a longer working time is desired. The pre-polymers are mixed with catalysts, heated when necessary, degassed, and poured into the molds. Also available are millable guns and pellets containing all components, which have been reacted to a degree that permits further processing by methods used for rubber, including injection molding, compression molding, and transfer molding. The polyurethane elastomers most widely used are harder than natural rubber, and possess excellent resistance to flexural fatigue, abrasion, impact, oils and greases, oxygen, ozone, and radiation, but are susceptible to hydrolysis.

**Polyurethane fiber** *See spandex fiber.*

**Polyurethane finish** *n.* An exceptionally hard and wear-resistant paint or varnish made by the reaction of polyols with a multifunctional isocyanate.

*See polyurethanes.*

**Polyurethane foam** (urethane foam, isocyanate foam) *n.* This family of foams differs from other cellular plastics in that the chemical reactions causing foaming occur simultaneously with the polymer-forming reactions. As in the case of polyurethane resins the polymeric constituent of urethane foams is made by reacting a polyol with an isocyanate. The polyol may be of the polyester or polyether type. When the isocyanate is in excess of the amount that will react with the polyol, and when water is present, the excess isocyanate will react with water to produce carbon dioxide which expands the mixture. The hardness of the cured foam is governed by the molecular weight of the polyol used. Low-molecular-weight polyols (approximately 700) produce rigid foams, and high-molecular-weight polyols (3000–4000) produce flexible foams. Polyols with molecular weights around 6000 are used for the so-called "cold-cure", highly resilient foams. They are usually capped with ethylene oxide to provide terminal primary hydroxyl groups that increase the polyols' reactivity about threefold. Cross-linked foams are rigid or semirigid. Auxiliary blowing agents are often used, especially in rigid foams where they improve the insulation values. Other ingredients often incorporated in urethane foams are catalysts to control the speed of reaction, and a surfactant to stabilize the rising foam and control cell size. Three basic processes are used for making urethane foams: the pre-polymers technique, the semi-prepolymer technique, and the one-shot process. In the pre-polymers technique, a polyol and an isocyanate are reacted to produce a compound that may be stored and subsequently mixed with water, catalyst, and, in some cases, a foam stabilizer. In the semi-prepolymer process about 20% of the polyol is pre-reacted with all of the isocyanate, then, this product is later reacted with a masterbatch containing the remainder of the ingredients.

*See also one-shot molding, isocyanate, polyol, polyether foam, reticulated polyurethane foam, and integral-skin molding.*

**Polyurethane/imide modified foam** *n.* A polyaryl polyisocyanate (PAPI) is reacted with a 3,3′,4′-benzophenone tetracarboxylic dianhydride (BTDA) to form an isocyanate pre-polymer. This pre-polymer can be compounded with a polyol, a blowing agent, a catalyst, and a cell stabilizer to form the modified foam. Such a foam containing 5% BTDA in the pre-polymer has better thermal properties than conventional polyurethane foams.

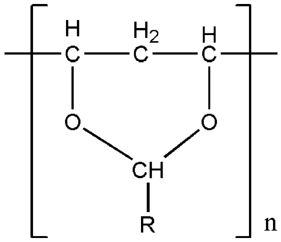
**Polyurethane resin** (isocyanate resin) *n.* A family of resins produced by reacting diisocyanates with organic compounds containing two or more active hydrogen atoms to form polymers having free isocyanate groups. These groups, under the influence of heat or certain catalysts, will react with each other, or with water, glycols, etc., to form a thermosetting material.

**Polyurethanes** *n.* Polyurethanes are the most well-known polymers used to make foams. Polyurethanes can be elastomers, paints, fibers, or adhesives. Polyurethanes are called polyurethanes because in their backbones they have a urethane linkage. Polyurethane can be any polymer containing the urethane linkage in its backbone chain. Polyurethanes are made by reacting diisocyanates with di-alcohols.

**Polyurethane, thermoset resins** *n.* A family of resins produced by reacting diisocyanates with organic compounds containing two or more active hydrogen atoms to form an polymers having free isocyanate groups. These groups, under the presence of heat or certain catalysts, will react with each other, or water, glycols, etc., to form a thermosetting material.

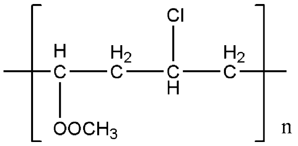
**Polyvinyl** \ˌpä-lē-ˈvī-nᵊl\ [ISV] (1927) *adj.* Of, relating to, or being a polymerized vinyl compound, resin, or plastic.

**Polyvinyl acetal** *n.* (1) Generically, a class of polymers derived from polyvinyl esters in which some or all of the acid groups have been replaced by hydroxyl groups and some or all of these hydroxyl groups have been reacted with aldehydes to form acetal groups. (2) Specifically, polyvinyl acetal made by the reaction of the hydroxyl group with acetaldehyde. (3) A vinyl plastic produced from the condensation of polyvinyl alcohol with an aldehyde. There are three main groups: polyvinyl acetal, polyvinyl butyral, and polyvinyl formal; used in lacquers and adhesives. Polyvinyl acetal resins are thermoplastics, which can be processed by casting (*See image*).



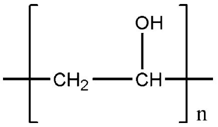
**Polyvinyl acetate** *n.* A colorless, odorless, non-toxic, transparent, thermoplastic, water-insoluble, and resinous high polymer derived from the polymerization of vinyl acetate with a catalyst; used as a latex binder in certain paints and as an intermediate in the synthesis of polyvinyl acetal and polyvinyl alcohol. The major use is in water-based latex paints, adhesives, fabric finishes, and lacquers. In the plastics industry, the *co-polymers* of vinyl acetate, particularly with vinyl chloride, are of most interest. Abbreviation for PVA and PVAc.

**Poly(vinyl acetate co vinyl chloride)** *n.* Poly (1 acetoxy ethylene -co- chloro-ethene) (*See image*).



$$\left[ -\underset{OOCH_3}{\overset{H}{C}} - \overset{H_2}{C} - \underset{H}{\overset{Cl}{C}} - \overset{H_2}{C} - \right]_n$$

**Polyvinyl alcohol (PVA)** *n.* Poly(vinyl alcohol), Poly(1-hydroxy-ethylene). (1) A colorless, water-soluble, thermoplastic polymer prepared by partial or complete hydrolysis of polyvinyl acetate with methanol or water. Although it can be extruded and molded, its principal uses are in packaging films, fabric sizes, adhesives, emulsifying agents, etc. The packaging films are impervious to oils, fats, and waxes, and have very low transmission rates of oxygen, nitrogen, and helium. Thus, they are often used as barrier coatings on other thermoplastics or coextruded with them. The water solubility of polyvinyl alcohol films can be regulated to some degree. The "standard" type, made from higher-molecular-weight polymers and plasticized with glycerine, is only weakly soluble in cold water. The other type, known as CWS (cold-water-soluble), is made from internally plasticized or lower-molecular-weight resins. It is used in synthetic resins. (2) Oil resistant plastic.



$$\left[ -CH_2 - \overset{OH}{CH} - \right]_n$$

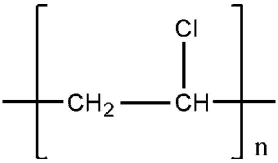
**Polyvinyl alcohol resins** *n.* A water-soluble thermoplastic prepared by partial or complete hydrolysis of polyvinyl acetate with methanol or water. These resins are mainly used as packing films since they are impervious to oils, fats, and waxes, and have very low transmission rates of oxygen, nitrogen, and helium.

**Polyvinyl butyral (PVB, polyvinyl butyral acetal)** *n.* A member of the polyvinyl acetal family, made by reacting polyvinyl alcohol with Butyraldehyde, with some unreacted PVAL groups retained in the polymer. It is a tough, sticky, colorless, flexible solid, used primarily as the interlayer in automotive safety glass. Other applications include adhesive formulations; base resins for coatings, toners and inks, solutions of rendering fabrics resistant to water, staining and abrasion; and cross-linking with resins such as urea's, phenolics, epoxies, isocyanate, and melamine's to improve coating uniformity and adhesion, increase toughness, and minimize cratering.

**Polyvinyl butyral resins** *n.* A member of the polyvinyl acetal family. Resins formed by reacting polyvinyl alcohol with butyraldehyde. It is a rough, sticky, colorless, flexible solid, used primarily as the interlayer in automotive safety glass. Other applications include adhesive formulations, base resin for coatings, solutions for rendering fabrics resistant to water, staining, and abrasion.

**Poly(*N*-vinylcarbazole) (PVK)** *n.* A thermoplastic resin, brown, obtained by reacting acetylene with carbazole. It has excellent electrical properties and good heat and chemical resistance, and is used as an impregnate for paper capacitors. It is photoconductive, a property that has found use in xerography.

**Polyvinyl chloride (PVC)** (1933) *n.* Poly (vinyl chloride), poly(1-chloro-ethylene). A vinyl polymer which is similar to polyethylene, but on every other carbon in the backbone chain, one of the hydrogen atoms is replaced with a chlorine atom. It is produced by the free radical polymerization of vinyl chloride. A white, water-insoluble, thermoplastic resin, derived by the polymerization of vinyl chloride. A hard and tough plastic solid. Stabilizers are necessary to prevent discoloration from exposure to light and heat. Used for plastics and coatings. Commonly known as vinyl. Abbreviation is PVC (*See image*).



**Polyvinyl chloride acetate (PVAc)** *n.* An important co-polymer family of vinyl chloride and vinyl acetate, usually containing 85–97% vinyl chloride. These co-polymers are more flexible and more soluble in solvents than PVC, and are used in solution coatings as well as in most of the processes and applications employing PVC.

**Polyvinyl chloride-co-vinyl acetate** *n.* A co-polymer of vinyl chloride and vinyl acetate. Abbreviation: PVC/VAC.

**Polyvinyl dichloride** *See chlorinated polyvinyl chloride.*

**Poly(vinylmethyl ether) [PVME, PVM poly (methylvinyl ether)]** *n.* A family of polymers polymerized from Vinylmethyl ether, $H_2C{=}CHO{-}CH_3$. The range from viscous liquids to stiff rubbers. The liquids, soluble in cold water but not in hot water, are used in pressure-sensitive and hot-melt adhesives for paper and polyethylene, and as a tackifier in rubbers. PVM also designates co-polymers of vinyl chloride and vinylmethyl ether.

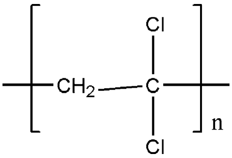
**Polyvinyl fiber** *n.* A manufactured textile fiber developed in Japan. It is made by dissolving polyvinyl alcohol in hot water and extruding this solution through a spinneret into a sodium sulfate coagulating bath. In Japan, the fiber is used in apparel, household, and industrial fabrics.

**Polyvinyl fluoride** *n.* $(–H_2CCHF–)_n$. The polymer of vinyl fluoride (fluoroethylene). The fluorine atom forms a strong bond along the hydrocarbon chain, accounting for properties such as high melting point, chemical inertness, and resistance to ultraviolet light. In the form of film, PVF is used for packaging, glazing, and electrical applications. Laminates of PVF film with wood, metal, and polyester panels are being used in building construction. Although it cannot be dissolved in ordinary solvents at room temperature, coating solutions can be made by dissolving PVF in hot "latent solvents" such as dimethyl acetamide and the lower-boiling phthalate, glycolate, and isobutyrate esters. Such solutions are used to protectively coat the insides of rigid metal containers for chemicals and industrial compounds. Abbreviation is PVF.

**Polyvinyl formal (PVFO, PVFM)** *n.* A member of the polyvinyl acetal family, made by condensing formaldehyde in the presence of polyvinyl alcohol or by the simultaneous hydrolysis and acetylation of polyvinyl acetate. It is used mainly in combination with cresylic phenolics for wire coatings, and impregnating, but can also be molded, extruded, or cast. It is resistant to greases and oils and to moderately high temperatures.

**Polyvinyl halide** *n.* A term sometimes used (almost exclusively in patents) for polymers and co-polymers of vinyl chloride. Aside from polyvinyl fluoride, which is more similar structurally to polyethylene, and brominated butyl rubber, which has enjoyed some use in the automobile-tire industry, no polymers containing the other halogens (bromine, iodine, and astatine) exist in commerce.

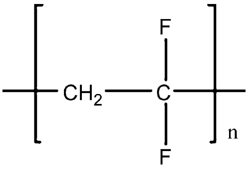
**Polyvinylidene chloride** *n.* Poly(1,1-dichloroethylene) poly(vinylidene chloride) is a vinyl polymer and is made from the monomer vinylidene chloride, using free radical vinyl polymerization. Co-polymers with vinyl chloride (15% or more) are widely used as packaging and food-wrapping films under the name Saran. Abbreviation is PVDC.



**Poly(vinylidene chloride)** *See polyvinylidene chloride.*

**Polyvinylidene fluoride** *n.* $(–H_2CCF_2–)_n$. Thermoplastic fluorocarbon polymer derived from vinylidene fluoride. It is a fluoropolymer with alternating $CH_2$ and $CF_2$ groups. PVDF is an opaque white resin. Extremely pure, it is superior for non-contaminating applications. In film form it is characterized by superior weather and UV resistance. Abbreviation is PVDF.

**Poly(vinylidene fluoride)** *n.* Poly(1,1-difluoroethylene) poly(vinylidene fluoride) is made by free radical vinyl polymerization of the monomer vinylidene fluoride poly (vinylidene fluoride) of PVDF has a has very high electrical resistance, PVDF resists ultraviolet and is often blended with poly (methyl methacrylate) (PMMA) to make it more resistant to UV light. It is a piezoelectric material and when placed in an electric field will change its shape.



**Polyvinylisobutyl ether** *See polyisobutylvinyl ether.*

**Poly(vinyl isobutyl ether)** *n.* 1-(ethoxy)-2 propane. Any polymer of isobutylvinyl ether. Some are liquids, others are solid and crystalline. They are used as adhesives, surface coatings, laminating agents, and filling compounds.

**Poly(4-vinyl pyridine)** *n.* 4-ethenyl pyridine.

**Polyvinyl pyrollidone** *n.* $(C_6H_9NO)_n$. White free-flowing amorphous polymer. It is soluble in water and organic solvents, and is compatible with a wide range of hydrophilic and hydrophobic resins. Abbreviation: PVP.

**Poly(1-vinylpyrrolidone) [PVP, poly(*N*-vinyl-2-pyrrolidone)]** *n.* A highly water-soluble polymer prepared by the addition polymerization of 1-vinyl-2-pyrrolidone (for structure). Molecular weights range from 10,000 to 360,000. Solutions of the polymer are used as protective colloids and emulsion stabilizers, and it has been used as a substitute for human blood plasma. PVP films are clear and hard, but can be plasticized.

**Polyvinyl stearate** *n.* A wax-like polymer of vinyl stearate, of limited use in the plastics industry. However, the monomer is copolymerized with vinyl chloride, acting as an internal lubricant.

**Polywater** \ˈpä-lē-ˌwó-tər\ [*poly*meric *water*] (1969) *n.* In late 1960s, it was reported that the Soviet physicist, Boris Derjaguin, had discovered a polymeric form of water, formed by condensing ordinary water on the inside quartz capillary tubing of very fine bore. Properties of the polymer, dubbed *polywater*, were said to be thermal stability up to 50°C, density equal to 1.4 g/cm$^3$, i.e., 40% greater than that of ordinary water, and solidification to a glass-like state at −40°C. There were subsequent reports that USA scientists had confirmed the existence of polywater. Later, however, the discoverer of "polywater" admitted that the substance he had created was actually impurities dissolved from the quartz tubes used in the experiment.

**POM** *n.* Abbreviation for poly(oxymethylene).

*Also see acetal resin.*

**Pompey red** *n.* Another name for ferric oxide.

*See iron oxides, natural.*

**Pongee** \ˌpän-ˈjē\ {*often attributive*} [Chinese (Beijing) *běnjī*, fr. *běn* own + *jī* loom] (1711) *n.* (1) A thin, naturally tan-colored silk fabric with a knotty, rough weave. (2) A cotton fabric made from yarns spun from fine-combed staple and finished with a high luster. This fabric is used for underwear. (3) Fabrics like cotton pongee made from manufactured fibers.

**Pontianak** \ˌpän-tē-ˈä-ˌnäk\. Manila type of semifossil copal obtained from Borneo. By reason of its alcohol solubility, it is used in spirit varnishes, but after running it becomes oil-soluble and is sometimes used in oleoresinous varnishes.

**Pony mixer** *See change-can mixer.*

**Popcorn** \ˈpäp-ˌkórn\ *n.* A name for non-useful, hard, tough, insoluble polymer, resembling popcorn, formed by polymerization in the manufacture of synthetic rubbers.

**Popcorn polymerization** *n.* Polymerization reaction in which the material's molecular matrix has been penetrated due to vapor pressure by uninhibited monomer.

**Poplin** \ˈpä-plən\ [F *papeline*] (1710) *n.* A plain-weave fabric of various fibers characterized by a rib effect in the filling direction.

**Popping** (1) Eruptions in a film of paint or varnish after it has become partially set so that craters remain in the film. (2) Of plaster. A mild form of blowing. (3) In the coil coating industry, a film defect manifested as a pinhole completely through the film.

**Poppyseed oil** (14c) *n.* Oil with only fair drying properties, obtained from the seeds of *Papaver somniferum*, which grows in India, Russia, and France. Its main constituent acid is linoleic, which is present to approximately 62%. The oil is little used in the trade, its main applications being for artistic purposes. Sp gr, 0.925 per 15°C; iodine value, 134, saponification value, 192.

**POR** Elastomer from propylene oxide and allyl glycidyl ether.

**Porcelain enamel** *See vitreous enamel.*

**Porch paint** *See deck paint.*

**Pores** \ˈpōr, ˈpór\ [ME, fr. MF, fr. L *porus*, fr. Gk *poros* passage, pore] (14c) *n.* Minute openings (holes) in surface of cured goods. May refer to minute bubbles within the article.

*See pinholes.*

**Pore size** *n.* The size of the openings of filters or screens, usually expressed in micrometers.

**Poromeric** (from micro*poro*us and poly*meric*) *n.* A material that has the ability to transmit moisture vapor to some degree while remaining essentially waterproof. The first plastic material of this type was DuPont's "Corfam", introduced in 1963 and vigorously marketed as a leather substitute in the uppers, at which task, it enjoyed only mediocre success. It was a composite of urethane polymers and polyester fibers. The most successful poromerics are the fabrics known as Gore-Tex®, developed by W L Gore Associates, and applied widely to raincoats sport garments, and camping gear.

**Poromerics** *n.* The microporosity, air permeability and abrasion resistance of natural and synthetic leather.

**Porosity** \pə-ˈrä-sə-tē\ (14c) *n.* The ratio of the volume of voids contained within a sample of material to the total volume, solid matter plus voids, expressed as a fraction, void fraction or percentage of voids. *See absorbency.*

**Porous mold** *n.* A mold that is made up of bonded or sintered aggregates (powdered metal, pellets, etc.) in such a manner that the resulting mass contains numerous connected interstices or regular or irregular shape and size through which air may escape as the mold is filled.

**Portland cement** *n.* A hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates and usually containing one or more of the forms of calcium sulfate as an interground addition.

**Portland cement paint** *See cement paint.*

**Positive crystals** *n.* A unlaxial crystal is optically positive if $\varepsilon > \omega$. A bilaxial crystal is said to be optically positive if $\gamma - \beta > \beta - \alpha$.

**Positive mold** *n.* A compression mold in which the pressure is applied wholly on the material, and which is designed to prevent the escape of any molding material.

**Positron** \ˈpä-zə-ˌträn\ [*posi*tive + *-tron* (as in electron)] (1933) *n.* A particle with the same mass $M_e$, as an electron. It has a positive electrical charge of exactly the same amount as that of an ordinary electron (which is sometimes called negatron). Positrons are created either by the radioactive decay of certain unstable nuclei or, together with a negatron, in a collision between an energetic (more than 1 MeV) photon and an electrically charged particle (or another photon). A positron does not decay spontaneously but on passing through matter it sooner or later collides with an ordinary electron and in this collision the positron–negatron pair is annihilated. The rest energy of the two particles, which is given by Einstein's relation $E = mc^2$ and amounts to 1.0216 MeV altogether, is converted into electromagnetic radiation in the form of one or more photons. Freir GD (1965) University physics. Appleton-Century-Crofts, New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Post-cure** *n.* A treatment (normally involving heat) applied to an adhesive assembly following the initial cure, to modify specific properties. To expose an adhesive assembly to an additional cure, following the initial cure, for the purpose of modifying specific properties.

**Post-curing** *n.* Completing the cure of a thermosetting casting or molding after removal from the mold in which a partial cure has been accomplished. Post-curing usually involves heating, for example, in a circulating-air oven.

**Poster color** *n.* Opaque water color (gouache) obtainable in pots or tubes; often used by poster designers.

*Also called tempera (a misnomer) and show card colors; these are water paints with a gum binder.*

**Post-forming** (1) The heating and reshaping of a fully or partially cured laminate, On cooling, the formed laminate retains the contours and shape to which it has been post-formed. (2) Operations applied to still warm extrudates, particularly some types of profile extrusions, in which limbs of the extrudate pass through fixtures that bend or curl them into their final shapes.

**Pot** (1) *n.* A chamber to hold and heat molding material for a transfer mold. (2) *v.* *See potting.*

**Potash** \ˈpät-ˌash\ [singular of *pot ashes*] (ca. 1648) *n.* A common name for potassium or potassium compounds. Potash is generally used to mean potassium carbonate.

**Potash blue** *See iron blue.*

**Potassium** \pə-ˈta-sē-əm\ {*often attributive*} [NL, fr. *potassa* potash, fr. E *potash*] (ca. 1807) *n.* A silver-white soft light low-melting univalent metallic element of the alkali metal group that occurs abundantly in nature especially combined in minerals.

**Potassium bromide** \-ˈbrō-ˌmīd\ (1873) *n.* A crystalline salt KBr with a saline taste that is used as a sedative and in photography.

**Potassium carbonate** (1885) *n.* $K_2CO_3$. A white salt that forms a strongly alkaline solution and is used in making glass and soap.

**Potassium chlorate** (1885) *n.* $KClO_3$. A crystalline salt that is used as an oxidizing agent in matches, fireworks, and explosives.

**Potassium dichromate** \-(ˌ)dī-ˈkrō-ˌmāt\ (1885) *n.* $K_2Cr_2O_7$. A soluble salt forming large orange-red crystals used ion dyeing, in photography, and as an oxidizing agent.

**Potassium hydroxide** \-hī-ˈdräk-ˌsīd\ (1885) *n.* A white deliquescent solid KOH that dissolves in water with much heat to form a strongly alkaline and caustic liquid and is used chiefly in making soap and as a reagent.

**Potassium permanganate** \-(ˌ)pər-ˈmaŋ-gə-ˌnāt\ (1869) *n.* $KMnO_4$. A dark purple salt used as an oxidizer and disinfectant.

**Potassium titanate** \-ˈtī-tᵊn-ˌāt\ *n.* $(K_2O)_{1/x}(TiO_2)_4$. The value of $x$ in the formula is greater than 1.0 because the commercial pigment has the crystal structure of a leached tetratitanate. It is an acicular white hiding pigment that has high scattering power, and its ultraviolet reflection is significantly higher than that of commercial titanium dioxide. It has been used in the paper industry and in vinyl plastics. Density, 3.3 g/cm$^3$ (27.5 lb/gal); O.A., approximately 80; particle size, diameter, 0.2 μm, length, 8–10 μm. Abbreviation: PKT.

**Potassium titanate fiber $K_2O(TiO_2)$** *n.* in wherein $n = 4$–7. Highly refined, single crystals, approximately 6 μm long by 0.1 μm in thickness, used as reinforcing fibers in thermoplastic composites. The fibers melt at 1370°C; density is 3.2 g/cm$^3$. They also act as white pigments.

**Potential (electric)** *n.* At any point is measured by the work necessary to bring unit positive charge from an infinite distance. Difference of potential between two points is measured by the work necessary to carry unit positive charge from one to the other. If the work involved is 1 erg then there is the electrostatic unit of potential. The potential at a point due to charge $q$ at a distance $r$ in a medium whose dielectric constant is $e$ is,

$$V = \frac{q}{er}.$$

Freir GD (1965) University physics. Appleton-Century-Crofts, New York.

**Potential energy** *n.* Energy associated with the position or configuration of an object.

**Pot life** (working life) *n.* (1) The period after mixing the ingredients of an active compound during which the viscosity remains low enough to permit normal processing. Dissatisfied with the vagueness of this definition, Breitigam and Ulrich (August, 19990) cautiously defend pot life or their epoxy compounds as the time, at room temperature, for the viscosity to reach double its initial value. (2) The length of time a paint material is useful after its original package is opened, or after catalyst or other ingredients are added.

*Also called usable life, spreadable life. See working time.*

**Pot plunger** *n.* A plunger used to force softened molding material from the pot into the closed cavity of a transfer mold.

**Pot retainer** *n.* A plate channeled for passage of a heat-transfer medium (e.g., hot oil) and used to hold the pot of a transfer mold.

**Pot spinning** *n.* A method formerly used for making viscose rayon. The newly spun yarn was delivered into the center of a rapidly rotating, centrifugal pot, where it received twist and centrifugal force caused it to go to the wall of the pot. The yarn package so formed was called a cake.

**Potting** *n.* (1) The process of encasing an article or assembly in a resinous mass, performed by placing the articles in a container that serves as a disposable mold, pouring a liquid resin into the mold to completely submerge the article, then curing the resin. The container remains attached to the potted article. The main difference between potting and encapsulation is that in the latter the mold is removed from the encapsulated article and reused. These processes are widely used in the electronics industry. (2) *v* The act of potting or "potting an article".

**Potting syrup** *See casting syrup.*

**Pounce** \ˈpaún(t)s\ *n.* (1) Design on paper which has been formed by pricking it out with a sharp pointed instrument. The design is transferred to the surface on which it is to be painted, by laying the paper on the latter and shaking on it to a dry powdered pigment through a linen bag called a pounce bag. Some of the pigment passes through the pinholes in the paper and forms a replica of the design on the surface where it can then be rendered in paint. (2) *v* To transfer the outlines of a drawing by applying a dry powder through small perforations made in the outline.

**Poundal** \ˈpaún-dᵊl\ [$^{1}$*pound* + *-al* (as in *quintal*)] (1879) *n.* An obsolete, but still occasionally seen, unit of force (the force required to accelerate a 1 lb mass 1 ft/s$^2$), analogous to the dyne in the cgs system, both created many years ago to perpetuate the illusion that Newton's law of momentum change needs no proportionality constant.

*See force.*

**Pour point** *n.* Temperature at which materials posses a defined degree of fluidity. One particular method of determining pour point involves recording the times of efflux of a specified volume of the molten product through an orifice of standard dimensions. From the figures thus obtained it is possible to arrive at a temperature which permits a standard volume of product to flow through the orifice in a specified time. This temperature is the pour point.

**Powder blend** *See dry blend.*

**Powder bonded non-woven** *n* A manufactured product in which a carded web is produced and treated with a thermoplastic powder that has a melting point less than that of the fiber in the web. The powder is heated to its melting point by through-air and infrared heating or by hot-calendering to effect bonding.

**Powder coatings** *n.* (1) A 100% solids coating applied as a dry powder and subsequently formed into a film with heat. (2) A coatings application method which utilizes a solid binder and pigment. The solid binder melts upon heating, binds the pigment and results in a pigment coating upon cooling.

*See also fluidized bed coating.*

**Powder compact** *n.* A molding material in the form of dry, friable pellets prepared by compacting dry-blended mixtures of resin (typically PVC) with plasticizers and other compounding ingredients. The powder compacts are about as easy to handle and process by extrusion as pellets and offer the advantages of lower heat history and somewhat lower cost than equivalent materials in the form of fused pellets.

*See also dry blend.*

**Powder density** *See bulk density.*

**Powdered distemper** *See calcimine.*

**Powdered plastic** *n.* A resin or plastic compound in the form of extremely fine particles, for use in fluidized-bed coating, rotational molding, and various sintering techniques.

**Powdered quartz** *See silica, crystalline.*

**Powdering** *See chalking.*

**Powdering of paints** *See chalking.*

**Powdering (of polishes)** The partial or total disintegration of the polish film resulting in a fine, light-colored material.

**Powder metallurgy** (1933) *n.* A branch of science or an art concerned with the production of a powdered metals or of metallic objects by compressing a powdered metal or alloy with or without other materials and heating without thoroughly melting to solidify and strengthen.

**Powder molding** *n.* A general term encompassing rotational molding, slouch molding, compression molding, and centrifugal molding of dry, sinterable powders such as polyethylene, nylon, PVC, polytetrafluoroethylene and ultra-high-molecular-weight polyethylene. The powders are charged into molds that are heated, and manipulated or pressed, according to the process being used. These actions cause the powders to sinter or fuse into a uniform layer or molding against the mold surfaces, which are then cooled.

*See also fluidized-bed coating, rotational molding, centrifugal molding, slush molding, and sinter molding.*

**Powell–Eyring model (Eyring–Powell model)** *n.* A complex rheological equation containing three parameters that must be evaluated by fitting experimental flow data. It has the form:

$$\tau_{xz} = C\left(\frac{\mathrm{d}v_z}{\mathrm{d}x}\right) + \frac{1}{B}\sinh^{-1}\left[\frac{1}{A}\left(\frac{\mathrm{d}v_z}{\mathrm{d}x}\right)\right],$$

where $\tau_{xz}$ is the $z$-directed shear stress perpendicular to $x$, $v_z$ is the velocity in the $z$-direction, $\mathrm{d}v_z/\mathrm{d}x$ is the shear rate at $x$, and $A$, $B$, and $C$ are temperature-dependent constants characteristic of the flowing medium. The model calls for Newtonian-flow regions at both very low and very high shear rates, a type of behavior seen in a few polymer solutions but rarely in melts. The limiting viscosity at low heat rate is given by $C + 1/AB$, while the high-shear limiting viscosity is $C$. Applying this model to even simple flow geometries is cumbersome, especially when it is to be used to find shear rates, velocities, and flow rates from known stresses, so it has not seen much use. *Compare eyring model.* James F Carley (eds) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA.

**Power** \ˈpaú(-ə)r\ [ME, fr. OF *poeir*, fr. *poeir* to be able, fr, (assumed) VL *potēre*, alter. of L *posse*] (13c) *n.* The rate at which work is being done or energy expended. The SI unit is the watt (W), equal to 1 joule/s (J/s). Some conversions of other units are given in the appendix. In purely resistive, direct-current electric circuits, power is given by the product of voltage drop times current ($\Delta e \times i$) and the watt is equal to 1 volt-ampere (V-A). In sinusoidally alternating circuits, power is given by $\Delta ei \cos\phi$, in which $\phi$ is the phase angle between the current and the voltage.

**Power cleaning** *See blast cleaning.*

**Power developed by a direct current** *n.* The power in watts developed by an electric current flowing in a conductor, where $E$ is the difference of potential at its terminals in volt, $R$ its resistance in ohms, and $I$ the current in ampere,

$$P = EI = RI^2.$$

The work done in joules in a time $t$ (s) is

$$W = EIt = RI^2 t.$$

Giambattista A, Richardson R, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Power factor** *n.* The ratio of actual power (wattage) being used in an alternating circuit to product of voltage drop ($\Delta e$) times current ($i$), usually expressed as a percentage. When the load in the AC circuit is purely resistive, as with ovens and incandescent lamps, the wattage equal $\Delta ei$ and the power factor is 100%. When the load includes inductive elements such as motors and transformers, the current lags the voltage by the phase angle $\phi$, which can range from 0 for a purely resistive load to 90° for a load that is wholly inductive, and the power factor is referred to as a *lagging* power factor. When the load in the AC circuit contains capacitive elements, the current *leads* the voltage by the phase angle and the term *leading* power factor is used. In a circuit containing all three types of elements, the net effect will generally be current lagging or leading, but with a relatively smaller phase angle. The difference between actual power and $\Delta ei$ is called *reactive power*, which increases as the power factor decreases. Reactive power does no useful work but costs the same as actual power used. Thus, low power factors increase power costs, cause overloading of motors and transformers, and reduce load-handling capacity of plant electrical systems. (2) In testing the behavior of plastics as dielectrics, power factor is the cosine of the phase angle when the voltage across the capacitor varies sinusoidally. In a perfect dielectric (pure capacitance), the current would lead the voltage and the phase angle ($\phi$) would be 90°, it cosine 0. When loss occurs, the phase angle is $90-\delta$, where $\delta$ is the *loss* *angle*, hence $\cos\phi = \sin\delta$. In the literature, $\tan\delta$ is often called the power factor. In capacitor application, $\delta$ is usually very small, so the difference between sine and tangent is negligible. This might not be so in dielectric heating, say, or phenolics or vinyls, where power factors are higher. Dielectric loss depends on frequency. Because it is generated by oscillatory movement of molecular and atomic dipoles within the material, the loss spectrum over the frequency range of many decades will usually show one or more maxima and minima. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Power** (in watts for alternating current) *n.* $P = EI\cos\phi$, where $E$ and $I$ are the effective values of the electromotive force and current in volt and ampere, respectively, and $\phi$ the phase angle between the current and the impressed electromotive force. The ratio

$$\frac{P}{EI} = \cos\phi$$

is called the power factor.

**Power law (Ostwald-deWaele model)** *n.* The simplest representation of pseudoplastic flow, and characteristic of most polymer melts over several decades of shear rate. One versatile form of the model is

$$\tau_{xz\infty-m}\left|\frac{dv_z}{dx}\right|^{n-1}\left(\frac{dv_z}{dx}\right),$$

where $\tau_{xz}$ is the $z$-directed shear stress perpendicular to $x$, $v_z$ the velocity in the $z$-direction, $dv_z/dx$ the shear rate at $x$, and $m$ and $n$ are the constants peculiar to the liquid. $n$ is called the *flow-behavior index* and has a value between 0.25 and 0.9 for most polymer melts. The quantity $m$ is analogous to viscosity and is temperature-dependent. For $n = 1$, the power law reduces to Newton's law of flow and $m = \mu$, the Newtonian viscosity. Over the limited range of shear rates occurring in a given process, the power law can often provide a sufficiently accurate approximation to the actual flow behavior. Chemical engineers often cast the power law into the simpler form:

$$\frac{\Delta PD}{4L} = K\left(\frac{8V}{D}\right)_n,$$

in which the left-hand side is the shear stress at the wall of a pipe of diameter $D$ and length $L$, $\Delta P$ is the pressure drop over that length of pipe, $K$ is a viscosity-like property (temperature-dependent), $V$ the average liquid velocity, and $n$ is the flow-behavior index of the liquid. The quantity $(8V/D)$ is the apparent Newtonian shear rate at the tube wall. Patton TC (1964) Paint flow and pigment dispersion. Interscience Publishers Inc., New York. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, Cambridge, UK.

**Power ratio** *n.* In telephone engineering are measured in *decibels*. The gain or loss of power expressed in decibels is ten times the logarithm of the power ratio. By reference to an arbitrarily chosen "power level" the actual power may be expressed in decibels. The numerical values thus used will not be proportional to the actual power level but roughly to the sensation on the ear produced when the electrical power supply to a telephone receiver produces approximately the smallest change in volume of sound, which a normal ear can detect.

Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**POY** *See partially oriented yarns.*

**Po-yok oil** *n.* An oil derived from *Afrolicania elaeosperma* and *Parinarium sherbroense*, which occur in West Africa. It is a drying oil since its main constituent acids are licanic and elaeostearic, but it has never become available in quantity. It bodies rapidly on heating and behaves generally something like a mixture of oiticica and tung oils. Sp gr, 0.9612 per 15°C; iodine value, 150; saponification value, 188; refractive index, 1.5082. *Also spelled "po-yoak" oil.*

**PP** *n.* Abbreviation for poly(propylene).

**ppb** *n.* Abbreviation for parts per billion.

**PPG** *n.* Abbreviation for polyoxypropylene glycol.

**PPI** *n.* Abbreviation for parts per million.

**PPMI** *n.* Abbreviation for polypyromellitimide.

**PPO** *n.* Poly(2,6-dimethyl phenylene oxide. Manufactured by General Electric, USA. *n.* Abbreviation for poly(phenylene oxide).

**PPOX** *n.* Abbreviation for polypropylene oxide. *See polypropylene glycol.*

**PPS** *n.* Abbreviation for polyphenylene sulfide.

**PPSU** *n.* Abbreviation for poly(*p*-phenylene sulfone).

**PRA** *n.* Abbreviation for Paint Research Association (British).

**Prandtl number (Pr, $N\mathrm{p_r}$)** *n.* A dimensionless group important in the analysis of convection heat transfer, defined as (in consistent units) $C_\mathrm{p}\mu/k$, where $C_\mathrm{p}$ is the specific heat of a fluid at constant pressures, $\mu$ the viscosity, and $k$ is the thermal conductivity. The Prandtl number is also the ratio of the kinematic viscosity to the thermal diffusivity (*see both entries*).

**Prebond treatment** *n. See surface preparation.*

**Precipitate** \pri-ˈsi-pə-ˌtət\ NL *praecipitatum*, fr. L, neuter of *praecipitatus* (1594) *n.* Substances separated from a solution in solid form by application of cold or heat or by a chemical reaction.

**Precipitated barium sulfate** *See barium sulfate.*

**Precipitated basic dye blues** *n.* The more commonly used pigments of this group are the so-called PTA, PMA, and PTMA pigments. They are so designated because they comprise the precipitated products of the reaction between basic dyes (e.g., Victoria Blue B) and complex inorganic acids such as phosphotungstic and phosphomolybdic acids or their mixture. These pigments as a group are nearly black in masstone, accordingly, they are used chiefly for tinting purposes. In spite of certain deficiencies (e.g., poor bleed resistance and poor lightfastness on outdoor exposure), the brilliance and high tinting strength of these pigments make them suitable for various interior paints of more-or-less special character (e.g., foil lacquers, poster paints and some toy enamels). In general, PTA pigments are more lightfast than corresponding PMA pigments, although the latter are somewhat superior in tinting strength.

**Precipitated basic dye violets** *n.* The general properties of the phosphotungstic or molybdic acid violet pigments in paint are essentially the same as those discussed under precipitated basic dye blue in the section not adequate for exterior exposure. About its only application in paint would be lead-free finishes for interior use.

**Precipitated calcium carbonate** *See calcium carbonate, synthetic.*

**Precipitated driers** *n.* Metallic soaps derived from the interaction of aqueous solutions of the alkali soaps of the drier acids, and of the metallic salts. The drying soaps are obtained as precipitates, and are usually characterized by much paler colors than those made by the fusion method.

**Precipitation** \pri-ˌsi-pə-ˈtā-shən\ (1502) *n.* The formation of a condensed phase (solid or liquid) during a reaction.

**Precipitation number** *n.* Measure of the amount of solid matter precipitated from oil in a test. The number of milliliters of solid matter formed in a certain amount of mixture of oil and solvent.

**Precipitation polymerization** *n.* A polymerization reaction in which the polymer being formed is insoluble in its own monomer or in a particular monomer-solvent combination and thus precipitates as it is formed.

**Precision** \pri-ˈsi-zhən \ (1740) (as distinguished from accuracy) *n.* The degree of mutual agreement between individual measurements, namely repeatability and reproducibility.

**Pre-conditioning** *n.* Bringing a sample or specimen of textile material to a relatively low moisture content (approximate equilibrium in an atmosphere between 5 and 25% relative humidity) prior to conditioning in a controlled atmosphere of higher humidity for testing (while pre-conditioning is frequently translated as pre-drying, specimens should not be brought to the overdry state).

**Precure** *n.* A partial or full state of cure existing in an elastomer or thermosetting resin prior to its use as an adhesive or in a forming operation.

**Precursor** \pri-ˈkər-sər\ [ME *precursoure*, fr. L *praecursor*, fr. *praecurrere* to run before, fr. *prae*- pre- + *currere* to run] (15c) *n.* One who or that which precedes and suggests the course of future events. A compound or polymer that is later transformed into another material or polymer by chemical reaction.

**Pre-drying** *n.* The drying of a resin or molding compound prior to its introduction into an extruder, a mold, or molding machine. Many resins and plastics compounds are hygroscopic and require this treatment, to prevent formation of bubbles in the product, particularly after exposure to a humid atmosphere. Pre-drying for extrusion or injection molding is usually accomplished by passing heated, bone-dry air up through the bed of pellets in an enclosed feed hopper. This has a bonus of reducing the heat input required from the extruder drive and a boost extruder output. The exit, moistened air is recycled through a dryer packed with silica gel or other drying agent.

**Pre-fabrication primer** *n.* Quick-drying material applied as a thin film to a metal surface after cleaning. e.g., by a blast cleaning process, to give protection during the period before and during fabrication. Pre-fabrication primers should not interfere seriously with conventional welding operations or give off toxic fumes during such operations. Syn: shop primer.

**Preform** \ˈprē-ˌfórm\ [L *praeformare*, fr. *prae*- + *formare* to form, fr. *forma* form] (1601) *vt.* (1) The "test tube" shape that is used to form the final blown product in injection blow molding. (2) A compressed tablet or biscuit of plastic composition used for efficiency in handling and accuracy in weighting materials, particularly thermosets. (3) Formed perform. (4) A pre-shaped fibrous reinforcement formed by the distribution of chopped fibers or cloth by air, water flotation, or vacuum over the surface of a perforated screen to the approximate contour and thickness desired in the finished part. (5) A pre-shaped fibrous reinforcement of mat or cloth formed to the desired shape on a mandrel or mock-up before being placed in a mold press.

**Preform** *n.* (1) A compressed, shaped mass of plastic material or fibrous reinforcing material or a combination of both, prepared in advance of a molding operation for convenience in handling or for accuracy of loading by weighing the mass. The term also applies to tablets and biscuits of thermoplastic and thermosetting compounds. (2) In the reinforced-plastics industry, a preform is a mat of chopped strands boned together by a resin in approximately the shape of the end product, for use in processes such as matched-die molding, Or it may be a complex shape made by two- or three-dimensional weaving or braiding that, when wet out with resin and cured, will become the finished product.

*See near-net-shape configuration.*

**Preform** *v.* (1) To make plastic molding powders into pellets, tablets, or biscuits of known mass that facilitate accuracy in compression molding. (2) To prepare by hand cutting of reinforcing cloth or mat, or by blowing chopped fibers onto a contoured screen, the reinforcement for a fiber-reinforced molded object. The reinforcement, which has a shape close to that of the final molded object, is placed into or onto the mold along with the required amount of resin, then wet out and cured.

**Preform binder** *n.* A light application of resin applied to a mat or screened preform that provides enough shape stability to permit handling the preform into the mold without tearing the mat or shifting the fiber distribution.

**Preform molding** *See matched-metal-die molding.*

**Pregel** *n.* An unintentional, prematurely cured, or partially cured layer of resin on part of the surface of reinforced plastic prior to molding. Should not be confused with gel coat.

**Pregl method** *See combustion analysis.*

**Pre-heating** *n.* Heating of feedstock or material to be processed prior to the main processing step. In extrusion of coated wire, the wire is resistively heated just before entering the die to ease melt flow through the die and maintain coating quality at high wire speeds (*compare pre-heat roll*). In compression molding with preforms, the preforms are commonly preheated electronically before being loaded into the mold, thus improving the flow, reducing curing time in the mold, and shortening the cycle, In some extrusion and injection-molding operations, pellet feedstocks are dried in the hopper with hot air, this pre-drying of the feed not only precludes splay marks, bubbles, etc., caused by moisture in the melt, but significantly reduces the amount of energy per unit mass of plastic that must be furnished by screw action, permitting higher throughputs with lower screw-energy input per unit of product delivered. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Pre-heating hopper** *See hopper dryer.*

**Pre-heat roll** *n.* In extrusion coating, a heated roll installed between the pressure roll and unwind roll, the purpose of which is to heat the substrate before it is coated, thereby providing better adhesion of the coating and permitting lower melt temperature and, possibly, a higher production rate.

**Pre-historic art** *n.* Painting and sculpture produced by artists of the old, middle, and new stone ages. The earliest known piece of pre-historic sculpture is the famous “Venus of Willendorf” (Natural History Museum, Vienna), a small fertility image of Paleolithic origin dating around 11,000 BC.

*See cave painting.*

**Pre-impregnation** *n.* A method of preparing fiber-reinforced molding material by forcing thermoplastic resin, or thermosetting resin advanced only to the B-stage, into mats or cloths of fiber reinforcement. The product, called a prepreg is ready for molding, but storable for periods up to several months and is shippable.

**Pre-mature vulcanization** *n.* Uncontrolled curing or setting up of material before final cure.

*See bin cure.*

**Premix** ("gunk") *n.* A term originally applied to mixtures of polyester resin with sisal or glass–fiber reinforcement and fillers, usually prepared by molders shortly before use. The ASTM definition (D 883) specifies that the premix should not be in web or filamentous form. The term premix is now often used by molding compounds of any thermosetting resin mixed with fillers, reinforcements, and catalysts. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Premix molding** ("gunk" molding) *n.* A variation of matched-die molding in which the ingredients, usually chopped roving, resin, pigment, filler, and catalyst, are premixed and divided into accurately weighted charges for molding.

**Pre-oxidized fiber** *n.* In carbon fiber production, a fiber that results from a relatively low temperature (200–500°C) heat treatment in the presence of oxygen, which converts the precursor fiber, PAN or rayon, to an infusible fiber that is stable to further processing.

**Prepared linseed oil** *n.* In the printing ink industry, linseed oil which has been treated with litharge and other chemicals.

**Prepasted** *n.* Adhesive applied to the back of wallcovering by the manufacture. Dipping in water before hanging activates the paste.

**Pre-plasticization** *n.* In plunger-type injection molding, the technique of pre-melting molding powders in a separate chamber, then transferring the melt to the injection cylinder. The technique shortened molding cycles and provided a more homogeneous melt entering the mold. With the widespread adoption of screw-injection machines, the need for separate pre-plasticization has fallen sharply to a few special circumstances.

**Pre-polymer** *n.* A polymer of relatively low molecular weight, usually intermediate between those of the monomer or monomers and the final polymer or resin that may be mixed with compounding additives, and that is capable of being hardened by further polymerization during or after a forming process.

**Pre-polymer molding** *n.* In the polyurethane-foam industry, a system whereby a portion of the polyol is pre-reacted with the isocyanate to form a liquid pre-polymer with a viscosity suitable for pumping or metering. This component is supplied to end-uses with a second pre-mixed blend of additional polyol catalyst, blowing agent, etc. When the two components are vigorously mixed, foaming and cross-linking occurs. For a contrasting method,

*See one-shot molding.*

**Prepreg** \ˌprē-ˈpreg\ [*pre-* + im*preg*nated] (1954) *n.* In the reinforced-plastics industry, a mat or shaped mass of reinforcing fibers, typically glass strands, impregnated with a thermosetting resin advanced in cure only through the B-stage. Such prepregs may be stored until needed for a molding or laminating operation.

A prepreg containing a chemical thickening agent is called a mold-mat. The term "prepreg" also includes fabrics such as jute coconut fiber, or rayon yarn impregnated with a thermoplastic resin, e.g., vinyl, acrylonitrile-butadiene-styrene, or acrylic. For sheet forms, the term "prepreg" is being displaced by the more specifically descriptive "sheet-molding compound (SMC)".

**Prepreg molding** *n.* A type of matched-metal-die molding in which the fibrous mat is pre-impregnated with a partially cured, thermosetting resin.

**Pre-printing** *n.* In sheet thermoforming, the inversely distorted printing of sheets before they are formed. During forming, the stretching of the sheet brings the print into its proper size and spacing.

**Pre-production test** *n.* A test or series of tests conducted by (1) An adhesive manufacturer to determine conformity of an adhesive batch to established production standards. (2) A fabricator to determine the quality of an adhesive before parts are produced. (3) An adhesive specification custodian to determine conformance of an adhesive to the requirements of a specification not requiring qualification tests.

**Pre-sensitized plate** *n.* In photomechanics, a metal or paper plate that has been precoated with a light-sensitive coating, e.g. pre-sensitized lithographic plate.

**Preservative** \pri-ˈzər-və-tiv\ (14c) *adj.* A chemical incorporated in a material to prevent deterioration, mainly by living organisms, but more generally, also by heat, oxidation or weather.

*See also antioxidant, fungicide, and stabilizer.*

**Press cake** *n.* A pigment dispersed in water (obtained directly from a filter press) in which a water-insoluble resin is emulsified. A solvent-based dispersion is made by breaking this emulsion and removing the water.

**Pressley index** A measure of the strength of fiber bundles determined under prescribed conditions and expressed in an arbitrary unit, pounds per milligram.

**Press polishing (plainshine)** *n.* A finishing process used to impart high gloss and improved clarity and mechanical properties to sheets of vinyl, cellulosic, and other thermoplastics. The sheets are hot-pressed against thin, highly polished metal plates.

**Pressure** \ˈpre-shər\ [ME, fr. LL *pressura*, fr. L, action of pressing, pressure, fr. *pressus*, pp of *premere*] (14c) *n.* Force exerted over an area, expressed as force per unit area,. The SI unit is the pascal (Pa), equal to $1\,N/m^2$, the same as the unit of stress. Since our pervading atmosphere keeps us all under a pressure of about 101 kPa, many pressure-sensing devices detect and indicate the "difference" between a process of pressure and atmospheric, called "gauge" (or gage) pressure. Pressure referred to total vacuum is "absolute pressure". When exerted by solid contact, as by a ram on an elastic surface, pressure may vary over the contact area. Pressures of confined gases at rest are equal, everywhere within the container while liquid pressures can depend significantly on depth because of density and gravity.

**Pressure bag molding** *See bag molding.*

**Pressure break** *n.* As applied to a defect in a laminated plastic, a break apparent in one or more outer sheets of the paper, fabric, or other base visible through the surface layer of resin that covers it.

**Pressure drop** *n.* (1) A decrease in pressure that is caused by friction between a flowing liquid and a constricting container. The pressure drop is increased by a reduction in diameter of the container. (2) The change in pressure across a filter.

**Pressure dyeing** *See dyeing.*

**Pressure flow** *n.* (1) In general, any flow that is driven by a pressure gradient along a flow path, including any vertical component due to gravity's action on the fluid density. Flows through orifice-type rheometers and extrusion dies are pressure flows. (2) Specifically, in the metering section of an extruder screw, the rearward flow ("back flow") that would occur *if* the screw were not rotating and the pressure gradient were unaltered. In the rotating screw, pressure flow opposes the productive drag flow, reducing net output, but can never exceed it. In Newtonian flow equations for extruders the pressure flow is subtracted from the drag flow to obtain the net flow (throughput). In the actual plastics extruder, the non-Newtonian character of the melt invalidates the algebraic summing, yet because pressure flow is usually a third or less of the drag flow in a well designed system, the errors of this algebraic summing are seldom serious. If the simplified flow equation overstates the actual output, the difference is more likely to be due to insufficient feeding or poor plasticating action than the equation errors. On the other hand, there have been instances, with screws of high compression ratio, where the pressure of the melt entering the metering section was as high or higher than that at the die. In that case, there may be little or no pressure flow or even *positive* (forward) pressure flow. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

*See also drag flow, leakage flow, and net flow.*

**Pressure forming** *n.* A variant of sheet thermoforming in which pressure above atmospheric is used to push the heat-softened sheet against the mold surface, as opposed to using only a vacuum to suck the sheet against the mold. The cycle may be shortened. Pressure forming has been effectively used to form container lids form biaxially oriented polystyrene sheet without losing the orientation and good strength properties accruing therefrom.

*See trapped-sheet forming.*

**Pressure mark** *See finger mark.*

**Pressure marking** *n.* Glossy or dull spots which become apparent as a strip is uncoiled. This is usually due to an undercured or soft film. Also can be caused by improper plasticizer balance.

**Pressure motting** *n.* The film distortion or uneven pattern that causes a change of gloss and a non-uniform appearance in the coated surface, as opposed to blocking.

*See pressure marking.*

**Pressure pad** *n.* A reinforcement of hardened steel, several of which may be distributed around the dead area in the faces of a mold to help the land absorb the final pressure of closing without collapsing.

**Pressure roll** In extrusion coating, a roll that presses the coating and substrate together to form a strong bond, continuous over the entire interface.

**Pressure-sensitive adhesive (PSA)** *n.* An adhesive that develops a strong bond to most surfaces by applying only a moderate pressure.

*See adhesive, pressure-sensitive.*

**Pressure transducer** *n.* An instrument that converts a sensed fluid pressure into an electrical signal that in turn can be converted to a pressure reading and recorded. Transducers for extruders presented a difficult problem of temperature compensation and need for extreme ruggedness in service, and were pioneered by Dynisco in the 1950s. Several reliable makes are not available.

**Pre-tension** \ˌprē-ˈten(t)-shən\ [*pre-* + ²*tension*] (1937) *vt.* The relatively low tension applied to remove kinks and crimp when mounting a specimen preparatory to making a test or to a textile processing operation, etc.

**Pre-treatment** *n.* Usually restricted to mean the chemical treatment of unpainted metal surfaces before painting.

**Pre-treatment primer** *See wash primer.*

**Pre-trimmed papers** Rolls of wallpaper form which selvage has been trimmed at factory.

**PRI** Abbreviation for Plastics and Rubber Institute (UK).

**Primary** \ˈprī-ˌmer-ē\ [ME, fr. LL *primarius* basic, primary, fr. LL, principal, fr. *primus*] (15c) *adj.* In chemistry, a functional group at the end of a molecule's chain (or branch) in which only one of the hydrogen atoms has been replaced by some other link, as a primary alcohol, –CH$_2$OH, or primary amine, –NH$_2$. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

*See secondary and tertiary.*

**Primary amine value** *n.* The number of milligrams of potassium hydroxide equivalent to the primary amine basicity in 1 g of sample.

**Primary backing** *n.* The material, usually woven or non-woven polypropylene or jute, into which a carpet is tufted. The primary backing allows the positioning of each tuft and holds the tufts in position during processing, after which a secondary backing (q.v.) is applied to provide dimensional stability.

**Primary colors** (1612) *n.* In theory, those colors from which all other colors and white may be made. The primary colors in visible light are red, green, and blue. The so-called pigment primaries, each absorbing a light primary, would then be blue green cyan (minus red), magenta (minus green), and yellow (minus blue). Because of deficiencies in the available cyan and magenta colorants, confusion developed, so that red, yellow, and blue are now often referred to as the pigment primaries. Syszecki G, Stiles WS (1967) Color science: concepts and methods, quantitative data and formulas. John Wiley and Sons Inc., New York. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

*See primary colors, additive; primary colors, cie; and primary colors subtractive.*

**Primary colors, additive** *n.* Three colored lights from which all other colors can be matched by additive mixture. The three must be selected so that no one of them can be matched by mixture of the other two. Generally, a red, a green, and a blue are used. Additive primaries are the complements of the subtractive primaries.

**Primary colors, CIE** *n.* Red, green, and blue (violet) primaries defined by the CIE in terms of spectral distribution curves. They are imaginary primary lights so selected that all possible real colors can be matched by computation with positive amounts, to avoid the use of negative amounts, which are required to match all colors when using real colored lights. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Primary colors, subtractive** *n.* Colors of three colorants or colored materials which, when mixed together subtractively, result in black or a very dark neutral color. Subtractive primaries are generally cyan, magenta, and yellow, the three basic colorants used in printing, for example.

**Primary creep** *n.* The recoverable component of creep.

*Also see delayed deformation.*

**Primary high polymer** *n.* One which is produced directly from small molecules, without chemical alteration subsequent to the polymerization.

*See derived high polymer.*

**Primary plasticizer** *n.* A plasticizer that, within reasonable compatibility limits, may be used as the sole plasticizer, is completely compatible with the resin, and is sufficiently permanent to produce a composition that will retain its desired properties under normal service conditions throughout the expected life of the article.

*See also plasticizer and secondary plasticizer.*

**Prime pigments** *n.* Pigments which possess colorant value and hiding power. The refractive index of these pigments is 2.0 or higher in contrast to extended pigments.

**Primer** \ˈprī-mər\ (1819) *n.* First complete coat of paint of a painting system applied to a surface. Such paints are designed to provide adequate adhesion to new surfaces and are formulated to meet the special requirements of the surfaces. The type of primer varies with the surface, it condition, and the total painting system to be used. Thus, primers for new wood and certain other surfaces must provide for exceptional absorption of the medium. Primers for steelwork contain special anti-corrosive pigments, such as red lead, zinc chromate, zinc powder, etc. A coating applied to a surface, prior to the application of an adhesive, to improve the performance of the bond. Martens CR (1964) Emulsion and water-soluble paints and coatings. Reinhold Publishing Co., New York. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

*See metal primer and plaster primer.*

**Primer surfacer** *See surfacer.*

**Priming** *n.* The application of a primer.

**Priming paints** *See primer.*

**Primitive cell** *n.* A unit cell which has entities (atoms, molecules, and ions) only at the corners of the cell.

**Primrose chrome** *n.* Complex, primrose-colored chromates to with the formula $PbCrO_4 \cdot 4PbSO_4 \cdot Al_2(OH)_6$ has been given.

*See chrome-yellow pigment.*

**Primrose yellow** *See chrome-yellow pigment.*

**Principal focus** *n.* In a lens or spherical mirror, the point of convergence of light coming from a source at an infinite distance.

**Principal quantum number (*n*)** *n.* A quantum number which specifies a shell for an electron in an atom.

**Print** [ME *preinte*, fr. MF, fr. *preint*, pp of *preindre* to press, fr. L *premere*] (14c) *n.* (1) Name for etching, lithograph, woodcut, etc. (2) A fabric with designs applied by means of dyes or pigments used on engraved rollers, blocks, or screens.

*Also see printing.*

**Printability** *n.* A collective term used to describe the properties required of all components in a printing process.

**Print bonding** *See bonding* (2).

**Print cloth** *n.* A medium weight, plain-weave fabric made of carded yarns, usually cotton or polyester/cotton blends, with counts from 28 to 42s. Millions of yards of print cloth are printed annually and other millions are finished as white goods. Large amounts of the goods are also used in the greige for bags, containers, and base fabric for coated materials.

**Printing** *n.* (1) The process, art, or business of producing printed material by means of inked type and a printing press or similar means. (2) Forming a permanent impression in a semi-hardened paint film as a result of pressure from an object placed on it. (3) A process for producing a pattern on yarns, warp, fabric, or carpet by any of a large number of printing methods. The color or other treating material, usually in the form of a paste, is deposited onto the fabric which is then usually treated with steam, heat, or chemicals for fixation. Various types of printing follows.

*Also see dyeing.*

1. Methods of producing printed fabrics:

*Block printing* – The printing of fabric by hand, using carved wooden or linoleum blocks, as distinguished from printing by screens or roller.

*Blotch printing* – A process wherein the background color of a design is printed rather than dyed.

*Burn-out printing* – A method of printing to obtain a raised design on a sheer ground. The design is applied with a special chemical onto a fabric woven of pairs of threads of different fibers. One of the fibers is then destroyed locally by chemical action. Burn-out printing is often used on velvet. The product of this operation is known as a burnt-out print.

*Direct printing* – A process wherein the colors for the desired designs are applied directly to the white or dyed cloth, as distinguished from discharge printing and resist printing.

*Discharge printing* – In "white" discharge printing, the fabric is piece dyed, then printed with a paste containing a chemical that reduces the dye and hence removes the color where the white designs are desired. In "colored" discharge printing, a color is added to the discharge paste in order to replace the discharged color with another shade.

*Duplex printing* – A method of printing a pattern on the face and the back of a fabric with equal clarity.

*Etching – See printing, burn-out printing.*

*Extract printings – See printing, discharge printing.*

*Heat transfer printing* – A method of printing fabric of polyester or other thermoplastic fibers with disperse dyes. The design is transferred from pre-printed paper onto the fabric by contact heat which causes the dye to sublime. Having no affinity for paper, the dyes are taken up by the fabric. The method is capable of producing well-defined, clear prints.

*Ink-jet printing* – Non-contact printing that uses electrostatic acceleration and deflection of ink particles released by small nozzles to form the pattern.

*Photographic printing* – A method of printing from photoengraved rollers. The resultant design looks like a photograph. The designs may also be photographed on a silk screen which is used in screen printing.

*Pigment printing* – Printing by the use of pigments instead of dyes. The pigments do not penetrate the fiber but are affixed to the surface of the fabric by means of synthetic resins which are cured after application to make them insoluble. The pigments are insoluble, and application is in the form of water-in-oil or oil-in-water emulsions of pigment pastes and resins. The colors produced are bright and generally fat except to crocking.

*Resist printing* – A printing method in which the design can be produced: (1) by applying a resist agent in the desired design, then dyeing the fabric, in which case, the design remains white although the rest of the fabric is dyed. (2) by including a resist agent and a dye in the paste which is applied for the design, in which case, the color of the design is not affected by subsequent dyeing of the fabric background.

*Roller printing* – The application of designs to fabric, using a machine containing a series of engraved metal rollers positioned around a large padded cylinder. Print paste is fed to the rollers and a doctor blade scrapes the paste from the unengraved portion of the roller. Each roller supplies one color to the finished design, and as the fabric passes between the roller and the padded cylinder, each color in the design is applied. Most machines are equipped with eight rollers, although some have sixteen rollers.

*Rotary screen printing* – A combination of roller and screen printing in which a perforated cylindrical screen is used to apply color. Color is forced from the interior of the screen onto the cloth.

*Screen printing* – A method of printing similar to using a stencil. The areas of the screen through which the coloring matter is not to pass are filled with a waterproof material. The printing paste which contains the dye is then forced through the untreated portions of the screen onto the fabric below.

*Warp printing* – The printing of a design on the sheet of warp yarns before weaving. The filling is either white or a neutral color, and a grayed effect is produced in the areas of the design.

2. Methods of producing printed carpets:

*Millitron® process* – A computer-controlled, non-contact spray printing process that allows the production of intricate multicolored designs. Although this process was developed for carpets by Milliken & Co. (ME, USA) it can also be used for upholstery, pile fabrics, and other textiles.

*Mitter printing machine* – A rotary carpet printing machine with up to eight stainless-steel mesh screens, and with cylindrical squeegees of moderately large diameter in each rotary screen. The unit has a streaming zone for dye fixation.

*Stalwart printing machine* – A carpet printing machine in which color is applied to the carpet with a neoprene sponge laminated to the pattern. The pattern is cut in a rubber base attached to a wooden roll. It is very similar to relief printing. Used primarily for overprinting random patterns on dyed carpets. Suitable for shags and plush carpets as well as level loop and needletuft types.

*Zimmer flatbed printing machine* (*Peter Zimmer*) – A carpet printing machine that uses flat screens and dual, metal-roll squeegees. The squeegees are operated by electromagnets to control the pressure applied. The unit also has a steamer for dye fixation. The Zimmer flatbed machine is normally used for carpets of low to medium pile heights. Very precise designs are possible, but speeds are slower than with rotary screen printers.

*Zimmer rotary printing machine* (*Johannes Zimmer*) – A three-step, rotary carpet printing machine consisting of: (a) Rotary screens with small diameter steel-roll squeegees inside, with pressure adjusted electromagnetically for initial dyestuff application. (b) Infrared heating units to fix dyes on the tips of the tufts. (c) Application of low-viscosity print paste, followed by steaming for complete penetration of dyes into tufts.

*Zimmer rotary printing machine* (*Peter Zimmer*) – A rotary carpet printing machine in which each rotary screen has a slotted squeegee inside to feed print pastes through the screens to the carpet. Pressure of the print paste is adjusted by hydrostatic head adjustments.

Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York. Tortora PG, Merkel RS (2000) Fairchild's dictionary of textiles, 7th edn. Fairchild Publications, New York. Complete textile glossary. Celanese Corporation, New York, 2000. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Printing ink** *n.* Any fluid or viscous composition of materials, used in printing, impressing, stamping, or transferring on paper or paper-like substances, wood, fabrics, plastics, films or metals, by the recognized mechanical reproductive processes employed in printing, publishing and related services. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1976.

**Printing on plastics** *n.* Many methods commonly used on paper and other materials are also used for printing on plastics, with slight modifications such as the use of special links. Such processes are letterpress, offset, silk screen, electrostatic, and photographic methods. Polyolefins are normally oxidatively treated before printing so as to make them receptive to inks. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1976.

*See casing, corona-discharge treatment, flame treating, and ultraviolet printing. See also electrostatic printing, flexographic printing, gravure printing, hot stamping, spanishing, and valley printing.*

**Printing plate** *n.* A surface carrying a design by which the ink is ultimately transferred to the material to be printed.

**Printing press** *n.* A mechanical device to apply ink to a surface, reproducing the pattern or design on the printing plate.

**Printing strength** *n.* A relative value indicating how much ink is required to given an equal depth of tint to a definite amount of white ink as compared with the same amount of a standard ink of the same consistency.

**Print paste** *n.* The mixture of gum or thickener, dye, and appropriate chemicals used in printing fabrics. Viscosity varies according to the types of printing equipment, the type of cloth, the degree of penetration desired, etc.

**Print resistance** *n.* The ability of a coating to resist taking on the imprint of another surface placed against it.

*See printing* (2).

**Print test** *See print resistance.*

**Prism (prismatic)** \ˈpri-zəm\ [LL *prismat*-, *prisma*, fr. Gk, literally, anything sawn, fr. *priein* to saw] (1570) *n.* Crystals made up of three, four, six, eight or twelve similar faces all parallel to a single axis.

**Probability density, $\psi^2$** (1939) *n.* The probability of finding an electron in a small element of volume; the square of the wave function for an electron; the density of the electronic charge cloud.

**Probability density function** (1957) *n.* (1) Probability function. (2) A function of a continuous random variable whose integral over an interval gives the probability that its value will fall within the interval.

**Probability function** (1906) *n.* A function of a discrete random variable that gives the probability that a specified value will occur.

**Probit** \ˈprä-bət\ [*prob*ability un*it*] (1934) *n.* A translation of origin of the scale of standard normal deviates (not a contradiction) to avoid the inconveniences of negative signs. For a given percentage point of the standard normal distribution, the probit = the corresponding standard normal deviate + 5, i.e., $z + 5$. There is available normal probability paper that has a probit sale alongside the probability scale. The device is useful in plotting and discussing the results of testing by the up-and-down method.

**Processability** \ˈprä-ˌse-sə-ˈbi-lə-tē\ (1954) *n.* The ease with which a polymer, elastomer, or plastic compound can be converted to high-quality, useful products with standard melt-processing techniques and equipment. Some quantitative tests of processability have been devised; for example, *see molding index and thermoformability.*

**Processing aid** *n.* A substance added to a compound to improve its behavior during processing. Many processing aids have been tried with rigid PVC because the neat resin is heat-sensitive, decomposing autocatalytically with evolution of toxic hydrogen chloride gas (HCl) at temperatures near 215°C. Processing aids may include heat stabilizers, lubricants, and other resins, even plasticizers.

**Process inks** *n.* Used in reproducing illustrations by the halftone color separation process. The colors used base yellow, magenta (red) and cyan (blue); they are used with or without black.

**Process variation** *n.* The degree to which measurements of the same process parameter, or characteristic or dimension of successive parts or products are different. *See standard deviation and range.*

**Producer-colored** *See dyeing, mass-colored.*

**Producer's risk** *n.* In quality control and acceptance sampling, the probability, under a given sampling plan, of making a type-I error, that is, of reflecting a lot whose true quality is at the desired acceptable level.

**Producer-textured yarns** *n.* Continuous filament yarns that have been bulked during manufacturing by the fiber producer. *Also see texturing.*

**Producer twist** *n.* Small amounts of twist, usually 0.5 turn/in. or less, applied to yarns by the manufacturer to provide cohesion of filaments for further processing.

**Product** \ˈprä-(ˌ)dəkt\ [in sense 1, fr. ME, fr. ML *productum*, fr. L, something produced, fr. neuter of *productus*, pp of *producere*; in other senses, fr. L *productum*] (15c) *n.* A substance formed in a chemical reaction.

**Profile** \ˈprō-ˌfīl\ [It *profilo*, fr. *profilare* to draw in outline, fr. *pro-* forward (fr. L) + *filare* to spin, fr. LL] (ca. 1656) *n.* (1) Any extruded product but those of the simplest cross-sections, such as film, sheet, rod stock, pipe, and coated substrates. Examples of profiles are angle-stock and channels; square, triangular, and trapezoidal solids and annuli; house siding and refrigerator-door baskets. (2) The lineal variation of the smoothness/roughness of a finished surface. (3) The pattern of variation of some process parameter over time, or more usually, distance. Examples are the channel-depth profile of an extruder screw and the temperature profile along an extruder cylinder.

*See profilograph.*

**Profile angle** *n.* An angle, not necessarily an interfacial angle, used to describe a crystal. This angle is observed when the crystal is lying on a face. For example, a cube shows 90°; an octahedron 60° or 120°.

**Profile depth** *n.* Average distance between top of peaks and bottom of valleys on the surface of a coating.

**Profile die** *n.* A die used to form an extruded profile. Two basic types are used: *plate* dies and *streamlined* dies. The former are cheaper to make and alter; the latter are essential when extruding rigid PVC and other heat-sensitive plastics, and are apt, with *any* compound, to permit higher extrusion rates of good product.

**Profilograph (profilometer)** *n.* An instrument that measures the roughness of a surface, usually expressed as the local root-mean-square average in nm (or μm). The profile taken in any direction can be magnified and displayed graphically. Reason RE (1970) The measurement of surface texture, modern workshop technology, Part 2. The Macmillan Co., New York.

**Progressive aging** *n.* In a heat-aging test, stepwise raising of the temperature at preset time intervals.

**Progressive bonding** *n.* A method of curing thermosetting-resin adhesives in laminates or plywood slabs that are larger in area than the press platens in which they are being bonded. A partial area, say, a quarter of the laminate, is cured by application of heat and pressure. The press is then opened, and a different quarter of the laminate is moved between the platens and cured, and so on, until the entire laminate has been cured.

**Progressive proofs (or progs)** *n.* In color separation, a series of proofs of a color process reproduction pulled in each color, and in combinations of two, three, and four colors. Used to indicate color quality and as a guide for printing.

**Projected area** *n.* In molding, the area of a cavity, or all the cavities, or cavities and runners, perpendicular to the direction of mold closing force and parallel to the parting plane. In injection molding and blow molding, this area must be safely less than the quotient of the force applied to hold the mold closed divided by the maximum melt pressure or blowing pressure within the mold. In transfer molding, it must also be about 15% less than the cross-sectional area of the pot.

**Projectile loom** *n.* A shuttleless loom that uses small, bullet-like projectiles to carry the filling yarn through the shed. Fill is inserted from the same side of the loom for each pick. A tucked selvage is formed.

*Also see weft insertion.*

**Projectiles** *n.* For bodies projected with velocity $v$ at an angle $a$ above the horizontal, the time to highest point of flight,

$$t = \frac{v \sin a}{g}.$$

Total time of flight to reach the original horizontal plane is

$$= \frac{2v \sin a}{g}.$$

Maximum height

$$h = \frac{v^2 \sin^2 a}{2g}.$$

Horizontal range,

$$R = \frac{v^2 \sin^2 2a}{g}.$$

In the above equations the resistance of the air is neglected. $a$ is the acceleration due to gravity. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Promoter** \-ˈmō-tər\ (14c) (promotor) *n.* A chemical substance that, in very small concentrating, increases the activity of a catalyst. The promotor may itself be a weak catalyst. Examples in the curing of polyester resins are cobalt octoate used as the promoter with methyl ethyl ketone peroxide, and *N*-alkyl anilines used with benzoÿl peroxide.

**Proof** \ˈprüf\ [ME, alter. of *preove*, fr. OF *preuve*, fr. LL *proba*, fr. L *probare* to prove] (13c) *n.* A test photographic print or total impression in a printing process taken for correction or examination.

**Proof, apparent** *n.* The proof of a liquid as calculated from its specific gravity at 60°F. It is equivalent to the proof of a solution of pure alcohol and water having the same specific gravity at 60/60°F and the mixture in question. Since materials other than alcohol and water, such as denaturants or other soluble ingredients, affect the specific gravity of the solution, the apparent proof is not necessarily the true "alcohol proof" of the solution. Russell JB (1980) General chemistry. McGraw-Hill, New York.

**Proof gallon, USA** *n.* The amount of alcohol present in one wine gallon of 50% by volume of alcohol at 60°F. Proof gallons are calculated by multiplying the number of wine gallons at 60°F by the proof and dividing by 100. For example, one wine gallon of 190 proof alcohol contains 1.9 proof gallons.

*See wine gallon.*

**Proofing** *n.* The process of rubberizing fabrics, to render them impervious to water. It is an operation most commonly done by spreading a rubber cement of high viscosity or dough on the fabric, allowing the solvent to evaporate and curing in dry heat ovens or with sulfur chloride.

**Proof resilience** (energy to break) *n.* The work required to stretch an elastomeric test specimen from no elongation to its breaking point, expressed in J/cm$^3$ of specimen volume.

**Proof spirit** (1790) (British) *n.* This corresponds with a definite mixture of absolute alcohol in water, and actually contains 49.24% by weight of alcohol. Sixty-four overproof (O.P.) industrial alcohol is commonly used for spirit varnish manufacture, containing approximately 90% of alcohol by weight.

**Propagation** \ˌprä-pə-ˈgā-shən\ (15c) *n.* Chain propagation is the middle phase of any polymerization process during which monomers are extending polymer chain lengths by addition or condensation reactions. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Propanol** *See propyl alcohol.*

**2-Propanone** *See acetone.*

**Propeller mixer** *n.* A device comprising a rotating shaft with a propeller at its end, used for mixing relatively low-viscosity dispersions and holding contents of tanks in suspension. The propellers, of which there may be two or three on a single shaft, resemble boat propellers, having two to four broad, curved lobes.

*See also paddle agitator.*

**Propenal** *n.* Syn: acrolein.

**Propeneitrile** *n.* Syn: acrylonitrile.

**Propenoic acid** *See acrylic acid.*

**Propiofan** *n.* Poly(vinyl propionate), manufactured by BASF, Germany.

**Proportional control** *n.* A method of controlling processes in which control action taken is proportional to the difference (process error) between the sensed state variable of a process and the desired target level of that variable.

*See on-off control.*

**Proportional limit** *n.* The greatest stress a material is capable of sustaining without deviating from direct proportionality (linearity) between stress and strain (Hooke's law).

*See also elastic limit and yield point.*

**Proprietary alcohol** *n.* Denatured ethyl alcohol.

**Proprietary solvents** *n.* Based on ethyl alcohol. Solvents containing more than 25% alcohol by volume which are manufactured from specially denatured alcohol, in accordance with authorized formulas. No permit is required to purchase proprietary solvents in USA.

**Propyl** \ˈprō-pəl\ {*often attributive*} [ISV *prop-* + *-yl*] (1850) *n.* $C_3H_7$. Either of two isomeric alkyl groups derived from propane.

**Propyl acetate** *n.* $C_3H_7COOCH_3$. Medium-boiling solvent used for nitrocellose. Bp, 102°C; Sp gr, 0.897; flp, 12°C (53°F).

***n*-Propyl acetate** (propyl acetate) *n.* $C_3H_7OOCCH_3$. A clear, colorless liquid with a pleasant odor, used as a solvent for cellulosics, vinyls, acrylics, polystyrene, alkyds, and coumarone-indene resins.

**Propyl alcohol** *n.* $CH_3CH_2CH_2OH$. Used as a solvent and as a diluent for nitrocellulose lacquers. Bp, 97°C; Sp gr, 0.804 per 20°C; flp, 25°C (67°F).

*Also known as n-propanol.*

**Propyl benzoate** *n.* $C_6H_5COOC_3H_7$. Semipermanent plasticizer. Bp, 231°C.

**Propyl butyrate** *n.* $CH_3CH_2CH_2COOC_3H_7$. Medium-boiling solvent. Bp, 143°C.

**Propyl carbinol** *See N-butyl alcohol.*

**Propylene** \ˈprō-pə-ˌlēn\ (1850) *n.* $H_2C{=}CHCH_3$. 1-propene a flammable gas obtained from petroleum oils during the refining of baseline. Used in the polymerized form as polypropylene plastic. Syn: propene, methylethylene, and methylethene.

**Propylene dichloride** *n.* $C_3H_6Cl_2$. Chlorinated hydrocarbon. Bp, 96°C; flp, 21°C (70°F); vp, 38 mmHg per 20°C.

**Propylene glycol** (1885) *n.* $CH_3CHOH\text{-}CH_2OH$. Dihydric alcohol used as an esterifying agent. Also used as a wet-edge additive. Bp, 187°C; Sp gr, 1.038 per 20°C; flp 99°C (210°F); vp, 0.1 mmHg per 20°C.

*Also known as 1,2 propanediol.*

**1,2-Propylene glycol monolaurate** *n.* $C_{11}H_{23}COOCH_2CH(OH)CH_3$. A plasticizer for cellulosics, polystyrene, and vinyl resins.

**1,2-Propylene glycol monoöleate** *n.* $C_{17}H_{33}COOCH_2CH(OH)CH_3$. A plasticizer for cellulose nitrate and ethyl cellulose.

**Propylene oxide** *n.* $CH_3CH(O)CH_2$ (1,2 – propylene oxide, 1,2 epoxypropane). A low boiling, liquid epoxide compound derived from the intermediate propylene chlorohydrin, which is itself produced by reacting propylene with chlorine and water. Propylene oxide is an important intermediate for the manufacture of polyglycols used for polyurethane foams and resins, and polyester resins.

**Propylene plastic** *See polypropylene.*

**Propylene-vinyl chloride co-polymer** *n.* Any of a family of co-polymers ranging from 2 to 10% by weight of propylene, that provides the application-properties advantages of PVC homopolymers plus the processing advantages attributable to the introduction of stable hydrocarbon structures as end groups, The co-polymers are easy to mold and extrude, and have high thermal stability and low melt viscosity.

***n*-Propyl oleate** *n.* $C_{17}H_{33}COOC_3H_7$. A monounsaturated fatty ester, and a plasticizer for ethyl cellulose, polystyrene, and, with limited compatibility, some vinyl and acrylic resins.

**Propyl propionate** *n.* $CH_3CH_2COOC_3H_7$. Medium-boiling ester solvent. Bp, 122°C; Sp gr, 0.883; mp, −76°C.

**Propyl ricinoleate** *n.* $CH_3(CH_2)_5CHOH\text{-}CH_2CH{=}CH(CH_2)_7COOC_3H_7$. Permanent plasticizer. Bp, 268°C per 13 mm; Sp gr, 9.908.

**Protective coatings** A thin layer of metal or organic material, as paint applied to a surface, primarily to protect it from oxidation, weathering, and corrosion.

**Protective colloids** *n.* Materials such as gums, starches and proteins, polyacrylates and cellulose and cellulose derivatives, which are effective agents for protecting charged colloidal particles in aqueous media against flocculation.

**Protective factor (of an antioxidant)** *n.* The proportion of millimoles of peroxide per kilogram in untreated oil to that in the oil containing an antioxidant.

**Protein** \ˈprō-ˌtēn *also* ˈprō-tē-ən\ {*often attributive*} [F *protéine*, fr. LGk *prōteios* primary, fr. Gk *prōtos* first] (ca. 1844) *n.* Any of a group of complex nitrogenous organic compounds of high molecular weight that contain amino acids as their base structural units and that occur in all living matter and are essential for the growth of animal tissue. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.
*See casein.*

**Protein–aldehyde resins** *n.* Plastic derived from casein and formaldehyde.

**Protein resin** A generic term for resins derived from proteins, constituting casein plastics and zein.

**Protium** \ˈprō-tē-əm\ [NL, fr. Gk *prōtos* first] (1933) *n.* Ordinary hydrogen $^{1}_{1}H$.

**Proton** \ˈprō-ˌtän\ [Gk *prōton*, neuter of *prōtos* first] (1920) *n.* A nuclear particle that used to be considered elementary, having a positive charge equal to the negative charge of an electron but possessing a mass approximately 1837 times that of an electron at rest, and slightly less than that of a neutron. The proton is in effect a hydrogen-atom nucleus.

**Protonic acids** *See acids.*

**Prototype mold** *n.* A temporary or experimental mold used to make a few samples to test product design or obtain market reactions. Such a mold is often made from a low-melting metal-casting alloy or from a filled and reinforced epoxy resin.

**Protrusion** \prō-ˈtrü-zhən\ [L *protrudere*] (1646) *n.* Any raisded area on a molded or painted surface, such as a blister, bump, or ridge. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Prussian blue** \ˈpre-shən-\ [*Prussia*, Germany] (1724) *n.* Brilliant deep blue pigment of excellent staining power, good lightfastness, but unstable in the presence of alkalis. It is usually obtained as a very fine powder. Its oil absorption is about 90. Syn: Erlangen blue, gas blue.

*See iron blue.*

**Prussian brown** *n.* Brown-colored, iron oxide pigment, obtained as a decomposition product of Prussian blue subjected to heat.

**Prussiate of iron** *See iron blue.*

**PS** Abbreviation for poly(styrene).

**PSB** *n.* Co-polymer from styrene and butadiene.

**Pseudoisochromatic plate test** *n.* General term applied to a type of test plates sued to determine defective or anomalous color vision. A PIC plate is a chromatic figure formed by dots on a background of different chromatic dots, varying sometimes in lightness and size. The figure is either an Arabic numeral or some other identifiable pattern. The simplest version is a dichotomous test, which involves the perception of chromatic dot patterns on backgrounds of different chromatic dots, used to test for red–green confusion. More complex tests are double number types (color defectives see one number, normals a different number), special camouflage type (Ishihara), those designed to detect qualitatively type and degree of defect, and quantitative diagnostic types (Hardy–Rand–Rittler PIC plate test). Abbreviation: PIC test.

**Pseudomonas** \-ˈmō-nəs\ [NL, fr. *pseud-* + *monad-*, *monas* monad] (1903) *n.* A generic class of aerobic, mesophilic bacterium capable of releasing a variety of enzymes, including cellulose-decomposing "cellulose" enzymes; these enzymes are a factor in viscosity reduction of latex paints modified with cellulosic thickener, and may contribute to biodeterioration of paint films, enhancing their nutrient value for fungus (*mildew*) growth. Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York.

**Pseudoplastic flow** *n.* Type of flow characterized by a consistency curve which shows no yield value (starts at the origin) and where the rate of flow increases faster than linearly with the shearing stress.

*See viscosity.*

**Pseudoplastic fluid** *n.* A solution or melt whose apparent viscosity decreases instantaneously and reversibly with increasing shear rate and stress without a yield stress (stress to initiate shearing). Most polymer solutions and melts are pseudoplastic. Pseudoplastic behavior is often confused with, and mistakenly labeled as thixotropy. Most dispersions are pseudoplastic but with a yield stress or yield value, and this term is not to be confused with true pseudoplastic fluids. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. Patton TC (1964) Paint flow and pigment dispersion. Interscience Publishers Inc., New York. Coussot P (2005) Rheometry of pastes, suspensions and grannular materials: applications in industry and environment. John Wiley and Sons, New York.

*See also Power law and Ellis model.*

**Pseudoplasticity** *n.* Time-independent shear thinning with no yield stress.

**PSP** *n.* Abbreviation for polystyrylpyridine.

**PST** *n.* Poly(styrene) fiber.

**PS-TSG** *n.* Injection-molding foam poly (styrene).

**PSU** *n.* Abbreviation for polysulfone.

**Psychophysical** \ˌsī-kō-ˈfi-zi-kəl\ (1847) *adj.* Adjective used to describe the sector of color science which deals with the relationship between physical description or specification of stimuli and the sensory perception arising from them.

**Psychrometer** \sī-ˈkrä-mə-tər\ [ISV] (1838) *n.* A wet-and-dry bulb type of hygrometer. Used for the determination of relative humidity.

**PTA** *n.* (1) Abbreviation for phosphotungstic acid. (2) Applied also to toners and pigments which have been precipitated with phosphotungstic acid to give it permanence and insolubility.

**PTA pigment** *See precipitated basic dye blues.*

**PTB** *See polybenzothiazole and polybutylene terephthalate.*

***p-t*-Butyl phenol** *n.* $(CH_3)_3CC_6H_4OH$. A white crystalline solid used as a plasticizer for cellulose acetate.

***p-t*-Butylphenyl salicylate** *n.* A plasticizer approved by FDA for contact with foods, also used as a light-absorbing agent.

***p-tert*-Amyl phenol** *n.* $(CH_3)_2C_2H_5C$-$C_6H_4OH$. A white crystalline material made by alkylating phenol with amyl chlorides or amylenes, then separating by distillation. Resins made by reacting *p-tert*-amyl phenol with formaldehyde or paraformaldehyde are used in varnishes for wood, wire coating and coil insulation. They are also used as plasticizers and/or stabilizers in hot-melt adhesives based on ethyl cellulose.

**PTF** *n.* Poly(tetrafluoroethylene) fiber.

**PTFE** Abbreviation for poly(tetrafluoroethylene).

**PTFE fluoroplastic** *n.* Polytetrafluoroethylene is prepared by free radical polymerization of tetrafluoroethylene in aqueous systems with persulfate or peroxide initiators to give granular or dispersion polymers. The polymers have exceptionally high thermal and thermo-oxidative stability and are completely solvent resistant. PTFEs are tough, relatively flexible materials which have outstandingly good electrical insulation properties as well as unusually low coefficients of friction.

**PTHF** *n.* Abbreviation for polytetrahydrofuran.

**PTM** *n.* Abbreviation for paint testing manual.

**PTMA pigment** *See precipitated basic dye blues.*

**PTMT** *See poly(tetramethylene terephthalate).*

***p*-Type semiconductor** *n.* A semiconductor in which the charged carriers are weakly localized holes (missing electrons).

**PU** *n.* Polyurethane fiber. Abbreviation sometimes used in Europe for polyurethane.

**PUA** Polyurea fiber.

**Pucker** \ˈpə-kər\ [prob. irregular from [1]*poke*] (1750) *n.* Uneven surface caused by differential shrinkage of the yarns in a fabric or differential shrinkage of the fabric and sewing thread. A pucker may be desirable and planned, or undesirable. Complete textile glossary. Celanese Corporation, New York, 2000.

**PUE** *n.* Segmented polyurethane fiber.

**Pug mill** *n.* Mill used for the preliminary mixing of pigments into oils or media to form stiff pastes prior to grinding. This process of mixing is sometimes known as *pugging.*

**Pulforming** *n.* A modified pultrusion process developed to produce a changing volume/shape.

*See pultrusion.*

**Pulldown** *See drawdown.*

**Pulled-in filling** *n.* An extra thread dragged into the shed with the regular pick and extending only a part of the way across the fabric.

**Pulled surface** *n.* Imperfections in the surface of a laminated plastic, ranging from a slight breaking or lifting of its surface in spots to pronounced separation of its surface from its body (ASTM D 883).

**Puller** *n.* Any device used to pull an extrudate away from the extruder and through the cooling tank, playing a role in determining the dimensions of the product's cross-section.

*See caterpillar for a description of the kind most used.*

**Pulling** *n.* Resistance to the movement of a brush during the application of a material due to the viscous nature of the medium. Such a material is sometimes referred to as being sticky under the brush.

*See drag.*

**Pulling over** *n.* Process of leveling a cellulose lacquer film, usually on wood, by rubbing it with a soft cloth pad soaked in a mixture of organic solvents which is only a partial solvent for the lacquer film.

**Pulling (under the brush)** *See drag.*

**Pulling up** *n.* Action of a coat or paint or varnish, which softens a previous coat to such an extent as to make brush application difficult and, in extreme cases, causes an objectionable intermingling of the two coats.

**Pull-out strength** *n.* Of threaded inserts in plastics moldings, the force required to pull the insert out of the molding, It may be expressed as the force per unit area of the engaged outside surface.

**Pull strength** *n.* The bond strength of an adhesive joint, obtained by pulling in a direction perpendicular to the plane of the bond. This is an uncommon mode of test for adhesive bonds; the usual mode is to pull apart the ends of lap-joined specimens, thus testing the joint in shear.

*See tensile-shear strength.*

**Pulp** \ˈpəlp\ [ME *pulpe*, fr. MF *poulpe*, fr. L *pulpa* flesh, pulp] (14c) *n.* Press cake that has been further processed to yield a homogeneous paste of controlled solids content or controlled tinting strength for commercial sale.

**Pulsed positive/negative-ion chemical mass spectrometry** *See mass spectrometry.*

**Pultrusion** *n.* A reinforced-plastics technique for continuously producing profiles of constant cross-section, both solid and annular. Strands of reinforcing material are conveyed through a tank of resin – usually polyester but silicone and epoxy are also used – from which they are pulled through a long, heated steel die shaped to impart the desired profile. Both gelling and curing of the resin are sometimes accomplished entirely within the die length. Pre-heating of the resin-wet reinforcement is effected by dielectric energy prior to its entering the die, or heating may be continued in an oven after emergence from the die. In the past, the pultrusion process has mainly yielded continuous lengths of material with high unidirectional strengths, used for building siding, fishing rods, golf-club shafts, etc., but recent advancements in the technique permit multidirectional reinforcement and strengths. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Pulverulent** \ˌpəl-ˈver-yə-lənt\ [L *pulverulentus* dusty, fr. *pulver-*, *pulvis*] (ca. 1656) *adj.* Consisting of, or reducible to, a fine powder. Dusty, friable, and crumbly.

**Pumacite** *See pumice.*

**Pumice** \ˈpə-məs\ [ME *pomis*, fr. MF, fr. L *pumic-*, *pumex*] (15c) *n.* A highly vesicular (frothy), glassy, volcanic lava, usually rhyolitic (granitic) in composition; composed of complex aluminum, calcium, magnesium, iron, sodium, and potassium silicates. Pumacite is the name for volcanic ash found in Kansas and Nebraska. Pumice is used as an abrasive, filler for plastics, polishing compounds and non-slip compounds. Density, 2.2 g/cm$^3$ (18.5 lb/gal). Syn: pumacite, pumice stone.

**Pumicing** *n.* A finishing method for molded plastics parts, consisting of the rubbing off of traces of tool marks and surfaces irregularities by means of wet pumice stones.

**Pump molding** *n.* A process by which a resin-impregnated pulp material is preformed by application of a vacuum and subsequently oven cured or molded. The pulp is first mixed with water and pumped into a tank wherein a mold, usually of wire mesh shaped like the finished article, is positioned. Air is evacuated from the mold to attract the pulp fibers, forming a preformed layer in contact with the screen. The mold is then removed from the vacuum tank, the pulp deposit is stripped off and dried, then, the preform is molded to final form by fluid pressure or conventional compression methods.

**Pump ratio** *n.* In single-screw extrusion with two-stage screws (as in vented operation), the ratio of the drag-flow capacity of the forward (final) pumping section to that of the rear (first) pumping section. This ratio is approximately equal to (but slightly less than) the ratio of the two pump depths, providing the lead angle is constant throughout, and is usually in the vicinity of 1.5.

**Punching** *n.* A method of producing components, particularly electrical parts, from flat sheets of rigid or laminated plastics by cutting out shapes with a matched punch and die in a punch press.

**Puncture resistance** *n.* The ability of a plastic film or sheet to resist being penetrated by pointed objects. The most nearly relevant ASTM tests are two in which a specimen of films or sheets are punctured by not very pointy objects. One is D 1709, the free-falling dart method, in which a variably weighted dart having a hemispherical nose is dropped on a clamped specimen, a new specimen being used with each weight change and drop. By one of two testing techniques, the mean weight required for penetration is determined. In the other, more sophisticated test, D 3763, an instrumented plunger, also round-nosed, is forced at high speed through the clamped film or sheet specimen and load versus displacement trace is developed. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**PUR** *n.* The preferred (in USA) abbreviation for polyurethane.

**Pure black iron oxide** *See black iron oxide.*

**Purging** *n.* In extrusion or injection molding, the cleaning of one color or type of material from the machine by forcing it out with the new color or material to be used in subsequent production, or with another compatible purging material. The operation goes faster when the purg*er* is more viscous than the purg*ee*.

*See also dry purge and purging compound.*

**Purging compounds** *n.* A plastic compound especially designed to quickly purge most other plastics from an extruder or molder. It may contain organic fibers that help to scour the cylinder, and some purging compounds contain percentages of ultra-high-molecular-weight polyethylene, which because it does not actually melt in the extrusion, also tends to be an efficient purger.

**Purified stand oil** *See tekaol.*

**Purity, colorimetric** *n.* Ratio of the luminance of the spectrum light, in mixture with the specified achromatic light required to match the light being described, to the luminance of the color itself. It is distinguished from excitation purity by the abbreviation $P_c$.

**Purity, excitation** *n.* Ratio of the straight line distance on a CIE chromaticity diagram between the chromaticity point of the sample and the achromatic or illuminant point on the diagram, to the linear distance between the point of intersection of this line with the spectrum locus and the illuminant point, It is properly designated as $P_e$, but is frequently abbreviation simply as $P$. The excitation purity, then, describes the relative distance from the neutral point and roughly corresponds in concept to the psychological description of saturation or chroma.

**Purkinje effect** \(ˌ)pər-ˈkin-jē-\. A phenomenon associated with the human eye, making it more sensitive to blue light when the illumination is poor (less than about $0.1\,\mathrm{lm/ft^2}$) and to yellow light when the illumination is good.

**Purl** \ˈpər(-ə)l\ [ME] (1526) *n.* (1) A knitting stitch that results in horizontal ridges across the fabric. It is made by drawing alternate courses through each side of the fabric. (2) A picot or small loop that edges needlework, lace, or ribbon. Sometimes spelled pearl (*also see picot*). (3) Coiled gold or silver thread used for embroidery. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Purple brown** *n.* Artificial red oxide pigment obtained by high-temperature treatment.

**Purree** *See indian yellow.*

**Pushback pin** *See return pin.*

**Pushing flight** *n.* Syn: leading flight face.

**Push–pull molding** *n.* An injection-molding technique that uses twin injection units to fill a mold through well separated gates. By oscillating the advance and retraction of the injection screws or rams, the material in the mold is sheared and oriented, breaking up weld lines. It is particularly suited to molding of liquid-crystalline polymers.

*See also multi-live-fed molding.*

**Pushup** *n.* In the packaging industry, a container bottom with sufficient concavity to prevent rocking of the container when it is filled and placed on a flat surface.

**Putty** \ˈpə-tē\ [F *potée* potter's glaze, literally, potful, fr. OF, fr. *pot* pot] (ca. 1706) *n.* (1) A heavy paste composed of pigment, such as whiting, mixed with linseed oil; used to fill holes and cracks in wood prior to painting, to secure and seal panes of glass in window frames. (2) In plastering, a fine cement consisting of lump lime slaked with water; lime putty.

*Also called painter's putty, glazing compound.*

**Putty chaser** *See edge runner mill.*

**PVA** *n.* Poly(vinyl ether). Abbreviation for either polyvinyl alcohol or poly(vinyl acetate).

**PVAC** *n.* Abbreviation for poly(vinyl acetate).

**PVAL** *n.* Abbreviation for poly(vinyl alcohol).

**PVB** *n.* Abbreviation for poly(vinyl butyral).

**PVC** *n.* (1) In the paint industry, abbreviation for pigment volume concentration. (2) Abbreviation for poly(vinyl chloride).

**PVCA** *n.* An abbreviation for co-polymers of vinyl chloride and vinyl acetate.

**PVD** *n.* A rarely used abbreviation for polyvinyl dichloride.
*See chlorinated polyvinyl chloride.*

**PVDC** *n.* Poly(vinylidene chloride).

**PVDF** *n.* Abbreviation for poly(vinylidene fluoride).

**PVF** *n.* Abbreviation for poly(vinyl fluoride). The possibility of confusion exists because this abbreviation has been used in some literature for polyvinyl formal, for which the alternative abbreviations PVFM and PVFP have been employed.

**PVFM, PVFO** *n.* Abbreviation for poly(vinyl formal).

**PVI** *n.* Abbreviation for polyisobutylvinyl ether.

**PVID** *n.* Poly(vinylidene cyanide).

**PVK** *n.* Co-polymer from vinyl ethers and vinyl chloride. Abbreviation for poly(*N*-vinylcarbazole).

**PVM, PVME** *n.* Abbreviation for poly(vinylmethyl ether).

**PVOH** *n.* Abbreviation for polyvinyl alcohol. The abbreviation PVA is more commonly used.

**PVP** *n.* Abbreviation for polyvinyl pyrollidone.

**PX** *n.* Abbreviation for *p*-xylylene.

**Pycnometer** \pik-ˈnä-mə-tər\ [Gk *pyknos* + ISV –*meter*] (1858) *n.* A container whose volume is precisely known, used to determine the density of a liquid by filling the container with liquid and then weighing it. The same instrument may be used to measure the density of particular matter, such as plastic pellets, by immersing it in a liquid that is inert to, and significantly less dense than the solid matter. A dilatometer is a special pycnometer equipped with instruments to study specific volume as a function of temperature.
*See weight-per-gallon cup.*

**Pyramid (pyramidal)** \ˈpir-ə-ˌmid\ [L *pyramid*, *pyramis*, fr. Gk] (1549) *n.* A group of three, four, six, eight, or twelve similar faces intersecting in a point or parallel to faces that would intersect in a point.

**Pyranyl foam** *n.* A type of rigid, pour-in-place, thermosetting foam similar to a polyurethane foam, but with superior resistance to high temperatures, it is formed in the same manner as polyurethane foams, using as the monomer a pyranyl (radical) derived from polypropylene by heating and oxidation to form an Acrolein dimmer, which ultimately forms the pyranyl.

**Pyrazolone red** *n.* $C_{36}H_{28}N_8O_6Cl_2$. Pigment red 38 (21120). A metal-free diazo pigment based on a pyrazolone. A red powder used in the rubber, plastics, and flour products industries. Density, 1.35–1.58 g/cm$^3$ (11.3–13.2 lb/gal); O.A., 41–70.

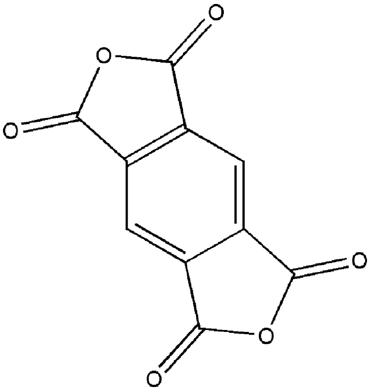
**Pyroabietic acids** *n.* Acidic products obtained from the abietic acid of rosin by heating.

**Pyrogenic silica** *n. See fumed silica.*

**Pyrogram** *n.* A chromatogram (*see chromatography*) obtained from the pyrolysis products of a sample.

**Pyrolysis** \pī-ˈrä-lə-səs\ [NL] (ca. 1890) *n.* Heating of a plastic or other material to temperature which cause decomposition and production of by-products; the process is temperature dependent.

**Pyromellitic dianhydride** (PMDA, 1,2,4,5-benzenetetracarboxlic anhydride) *n.* A triple-ring heterocyclic with the structure shown below, PMDA is a curing agent for epoxies giving cured products of high deflection temperatures. It is the least costly starting material, reacted with diamines, for producing polyimides and related high-temperature-resistant polymers (*See image*).



**Pyrometer** \pī-ˈrä-mə-tər\ [ISV] (1796) *n.* (1) Instrument for measuring temperatures beyond the upper limit of the usual liquid thermometer. They may operate on the differential expansion of two metallic strips joined together, the measurement of changes of resistance, and the measurement of current flowing through two joined pieces of metal. In addition, radiation pyrometers are based on the measurement of heat radiated from a hot body, and optical pyrometers on the measurement of the intensity of light emitted from a hot body. (2) An infrared pyrometer.

**Pyrophoric** \ˌpī-rə-ˈfór-ik\ *adj* [NL *pyrophorus*, fr. Gk *pyrophoros* fire-bearing, fr. *pyr-* + *-phoros* carrying] (1836) Igniting spontaneously in air.

**Pyroxylin** \pī-ˈräk-sə-lən\ [ISV *pyr-* + Gk *xylon* wood] (ca. 1847) *n.* Name given to the more soluble types of cellulose nitrate, and confined roughly to those containing less than 12.4% nitrogen.

*See nitrocellulose.*

**Pyrrone** *See polyimidazopyrrolone.*

# Q

**Q** \ˈkyü\ *n* {*often capitalized, often attributive*}. Symbol, in electronics, for the ratio of the reactance to the resistance of an oscillatory circuit, and then often called the *quality factor* of the circuit. $Q/2\pi$ is the ratio of energy stored to energy dissipated per cycle. A closely analogous measure applies to mechanical oscillating systems and, when the system is oscillating at or near its resonant frequency, $Q$ is proportional to that frequency. Giambattista A, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**QA** Abbreviation for quality assurance.

**QC** Abbreviation for quality control.

**QCT** *See Cleveland condensing humidity cabinet.*

**Q–E scheme** The Q–E scheme is used for quantitatively correlating relative monomer reactivities in co-polymerization reactions, introduced by Alfrey T, Price CC, J. Polymer Sci. 2, 101 (1947) for the purpose of defining an equation for each cross-propagation rate constant ($k_{12}$ or $k_{21}$), in a co-polymerization reaction in terms of three constants characteristic of $P$ is considered to be a function of the structures of the monomer: $P$, $Q$, and $e$.

$$k = P_1 Q_2 \exp(-e_1 e_2).$$

The constant $P$ is considered to be a function of the reactivity of the radical only, and the constant $Q$ is considered to be a function of the reactivity of the monomer only (both are determined by resonance effects), and the constant $e$ is considered to be a reflection of the polar characteristics of both the radical and monomer. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. , Plenum Press, New York. Tanford C (1961) Physical chemistry of macromolecules. John Wiley and Sons Inc., New York.

**Qiana** /kē-än-ˈə/ (Trade name for silk like fiber material). Fiber from *trans*-diamino dicyclohexyl methane + dodecane dicarboxylic acid, manufactured by DuPont, USA. New fibers should help the synthetics to capture an even bigger piece of the total. One of them is Qiana, introduced, after 20 years of experimentation, by E. I. Du Pont de Nemours and Company, the largest producer of synthetic fibers in USA. The new fiber has the appearance and feel of silk but has wrinkle-resistant and wash-and-wear properties that are as good or better than other synthetics. Qiana has a polyamide structure and thus is related to nylon fibers, but it is produced from different chemical ingredients and by different processes than previous nylons, according to Du Pont. The use of Qiana is expected to be limited to high-fashion women's apparel at first. Hounshell DA, Smith Jr JK (1988) Science and corporate strategy. DuPont R&D (1902—1980), New York. DuPont heritage: innovation and technological development, www.heritage.dupont.com.

**Q2** Polyamide from 1,4-*bis*(aminomethyl) cyclohexane + suberic acid. Manufactured from Eastman, USA.

**Quadripolymer (tetrapolymer)** A rarely used term for the product of simultaneous polymerization of four monomers. Complete textile glossary. Celanese Corporation, New York.

**Quadrupole spectrometer** \ˈkwä-drə-ˌpōl spek-ˈträ-mə-tər\ *n.* A type of mass spectrometer with two dipoles that provides better separation of ionic masses than can a single dipole. Carrying the idea even further are modern triple-quadrupole spectrometers.

*See mass spectrometry.*

**Qualification test** *n.* A series of tests conducted by the procuring activity, or an agent thereof, to determine conformance of materials, or materials system, to the requirements of a specification which normally results in a qualified products list under the specification. *Note*—Generally, qualification under a specification requires conformance to all tests in the specification, or it may be limited to the conformance to a specific type or class, or both, under the specification.

**Quality** \ˈkwä-lə-tē\ [ME *qualite* fr. OF *qualité*, fr. L *qualitat-*, *qualitas*, fr. *qualis* of what kind; akin to L *qui* who] (14c) *n.* For acoustical purposes, the quality or timbre of a sound depends on the coexistence with the fundamental of other vibrations of various frequencies and amplitudes.

*See seconds and yarn quality.*

**Quality assurance** (1982) (QA) *n.* A system of activities whose purpose is to provide assurance, with documentation, that the overall quality-control function for any product, operation, service, or entire organization is in fact being accomplished.

**Quality characteristic** Any dimension, property, aspect of appearance, surface finish, or performance specification that helps to determine the acceptability of a product or its ability to perform particular design functions. Most quality characteristics are measurable and therefore objective, but some, such as odor or texture, may be subjective and may be determined by the judgment of an expert or a panel of potential consumers of the product.

**Quality control** (1935) (QC) *n.* The techniques, measurements, and other activities that monitor and maintain product–quality characteristics within stated limits. These means require sampling of the product, measurement of important quality characteristics, statistical analysis, continuous presentation of the data (typically by means of *control charts*), and taking of decisions on whether lots are to be accepted, reworked, or scrapped.

**Quantitative analysis** \ˈkwän-tə-ˌtā-tiv-\ (ca. 1847) *n.* A branch of chemistry, encompassing very many methods and techniques, whose scope is to determine the amounts of the different elements in substances or the percentages of molecular entities in a mixture of gases, liquids, or solids. Harris DC (2002) Quantitative chemical analysis. W. H. Freeman Co., New York. DeLevie R (1996) Principles of quantitative analysis. McGraw-Hill Higher Education, New York.

**Quantitative differential thermal analysis** Differential thermal analysis in which the equipment used is designed to produce quantitative results in terms of energy and/or other physical parameters (ISO). Kemp RB (1999) Handbook of thermal analysis and calorimetry. Elsevier Science and Technology Books, New York.

**Quantity of electricity or charge** The electrostatic unit of charge, the quantity which when concentrated at a point and placed at unit distance from an equal and similarly concentrated quantity, is repelled with unit force. If the distance is 1 cm and force of repulsion 1 dyne and the surrounding medium a vacuum, we have the electrostatic unity of quantity. The electrostatic unit of quantity may be defined as that transferred by electrostatic unit current in unit time. The quantity transferred by 1 A in 1 s is the coulomb, the practical unit. The faraday is the electrical charge carried by 1 g equivalent. The coulomb = 3 × 109 esu. Dimensions

$$[\varepsilon^{1/2}\,M^{1/2}\,L^{3/2}\,T^{-1}], \quad [\mu^{1/2}\,M^{1/2}\,L^{1/2}].$$

Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Quantization of energy** The restriction of the energy of a system to certain specific, discrete amounts.

**Quantum** \ˈkwän-təm\ [L, neuter of *quantus*] (1567) *n.* Unit quantity of energy postulated in the quantum theory. The *photon* is a quantum of the electromagnetic field, and in nuclear field theories, the *meson* is considered to be the quantum of the nuclear field.

**Quantum mechanics** {*plural but singular or plural in construction*} (1922) *n.* The branch of physics, which describes the behavior of small particles by assigning wavelike properties to them.

*Also known as wave mechanics.*

**Quantum number** (1902) *n.* A number used to describe the state of an electron. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Quarry tile** Unglazed tile, usually six square inch or more in surface area and 0.5–0.75 in. (1.3–1.0 cm) in thickness made by the extrusion process from natural clay or shales.

**Quartz** \ˈkwórts\ [Gr *Quarz*] (ca 1631) *n.* The most common of minerals, of the rhombohedric crystal habit, occurring in a myriad of minerals and colors, but in its purest form, silicon dioxide ($SiO_2$), colorless, clear, very hard and transparent to both visible and ultraviolet light. The crystallized silica, when reduced to powder, is used as an extender. The term is also used for synthetically produced, amorphous fused quartz or vitrified silica. McGraw-Hill dictionary of geology and mineralogy. McGraw-Hill, New York, 2002. Nesse WD (2003) Introduction to optical mineralogy. Oxford University Press, New York. Callister WD (2002) Materials science and engineering. John Wiley and Sons, New York.

*See silica, crystalline.*

**Quartz fiber** Fiber produced from natural quartz crystals of high purity (99.95% $SiO_2$). Quartz melts at 1610°C and is immune to thermal shock. Quartz- and silica-fiber reinforced composites are used in jet aircraft, rocket nozzles, and reentry nose cones. Quartz whiskers are also in use where their high cost is justified. They are among the strongest and stiffest of all fibers, comparable with graphite whiskers, with strength of 21 GPa and modulus of 700 GPa. Density is 2.65 g/cm$^3$. Callister WD (2002) Materials science and engineering. John Wiley and Sons, New York. McGraw-Hill dictionary of geology and mineralogy. McGraw-Hill, New York, 2002.

**Quaternary ammonium compound** (ca. 1934) *n.* Any of numerous strong bases and their salts derived from ammonium by replacement of the hydrogen atoms with organic radicals and important especially a surface-active agents.

**Quaterpolymer** The IUPAC term for a copolymer derived from four species of monomers.

**Quench** \ˈkwench\ [ME, fr. OE –*cwencan*; akin to OE –*cwincan* to vanish, Old Frisian *quinka*] (12c) *v.* (1) A box filled with water into which fabric is run after singeing to prevent sparks or fires. (2) *See cabinet. Also see quenching.*

**Quench bath** The cooling medium used in quenching.

**Quenching** A process of shock cooling thermoplastic materials from the molten state, usually done experimentally with thin films of crystal-forming polymers in order to minimize the crystalline content and to study the nearly amorphous material.

**Quench spacer** The "quiet" zone below the spinneret in which there is no quench airflow. Quench spacer distance is important in controlling fiber orientation and birefringence.

**Quench-tank extrusion** An extrusion process wherein the extrudate is conducted through a water bath for rapid cooling.

**Quercitron** \ˈkwər-ˌsi-trən, ˌkwər-ˈ\ [blend of NL *Quercus* and ISV *citron*] (1794) *n.* $C_{15}H_{10}O_7C_{21}H_{20}O_{12}$. (1) The inner part of a North American black oak tree (*Quercus velutina*), containing tannin and used in tanning and dyeing. (2) A yellow dye made from this bark. (3) Natural yellow matter obtained from the bark of *Quercus nigra* (oak) or *Quercus tinctorial*, and it is used primarily for the production of yellow lake pigments. The principal constituents are quercitrin and quercetin. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Quetsch** The nip rollers of a padding machine. Complete textile glossary. Celanese Corporation, New York.

**Quick-burst pressure** (of a pipe, tube, or pressure vessel).
*See hydrostatic strength.*

**Quick-hardening lime** A hydraulic lime.

**Quicklime** \ˈkwik-ˌlīm\ (14c) *n.*
*See calcium oxide.*

**Quickpeek** A simple piece of equipment by means of which reproducible offset or letterpress ink films can be obtained. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 1976.

**Quill** \ˈkwil\ [ME *quil*; akin to MHGr *kil*] (15c) *n.* A light, tapered tube of wood, metal, paper, or plastic on which the filling yarn is wound for use in the shuttle during weaving. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York. Joseph ML (1986) Textile science, 5th edn. CBS College Publishing, New York.

**Quilling** (1783) *vt.* The process of winding filling yarns onto filling bobbins, or quills, in preparation for use in the shuttle for weaving. Complete textile glossary. Celanese Corporation, New York.

**Quilting** (1609) *n.* (1) A fabric construction consisting of a layer of padding, frequently down or fiberfill, sandwiched between two layers of material and held in place by stitching or sealing in a regular pattern across the body of the composite (*also see Pinsonic® thermal joining machine*). (2) The process of stitch bonding a batting or composite. Complete textile glossary. Celanese Corporation, New York.

**Quinacridone reds and magentas** Pigments of outstanding light-fastness and other resistance properties.

**Quinacridone golds** These are very transparent, red-shade yellows of particular interest in formulating the best quality metallic finishes; often in blends with transparent iron oxides and or other, less transparent, organic pigments. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.
*See quinacridone pigments.*

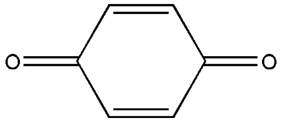
**Quinacridone pigments** A family of organic pigments based on substituted and unsubstituted forms of linear *trans*-quinacridones. Colors available include several shades of red, violet, gold, orange, magenta, and maroon. These pigments have good light-fastness, intensity of hue, resistance to bleeding and chemical attack, good transparency, and heat resistance. Quinacridones are unique pigments that are utilized in many diverse applications. Their outstanding light-fastness, excellent bleed and heat resistance in combination with bright tones, good tinting value and working properties permit them as a right candidate in color formulation in the coatings, plastic, textile and ink industries to achieve the highest degree of quality performance. These pigments most closely parallel the phthalocyanines in properties. Quinacridone pigments are non-bleeding, heat and chemical resistant, and give outstanding exterior durability, even in light shades. However, their cost is high. Depending on substitution and crystal form, a variety of orange, maroon, scarlet, magenta and violet colors are available. Large particle size grades are used when opaque pigments are needed, and fine particle size grades for use in metallic automotive top coats. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (1993) Printing ink manual, 5th edn. Blueprint, New York. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York. Herbst W, Hunger K (2004) Industrial organic pigments. John Wiley and Sons Inc., New York.

**Quinacridone violet** A versatile member of the quinacridone pigment family. It is used as a toning pigment; used to neutralize yellow tones in whites. Various shades from yellowish red to bright violet, resistant to most environmental conditions, very lightfast and used where superb properties are required, but very expensive in comparison to other pigments of the same hue. It is also used in blends with molybdate orange to obtain relatively low-coat, durable, non-bleeding, bright reds. Its high level of transparency is also very desirable for styling automotive metallized finishes. For maximum saturation when toning phthalocyanine blues to redder hues, the quinacridone reds or magentas may be preferred to the violet. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (1993) Printing ink manual, 5th edn. Blueprint, New York. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978.

**Quinol** \ˈkwi-nᵊl\. *See hydroquinone.*

**Quinone** \kwi-ˈnōn, ˈkwi-\ [ISV *quinine* + -*one*] (1853) *n.*

*See p-benzoquinone* (*See image*).



# R

**r** \ˈär\. Symbol for radius of a circle or sphere, or radial co-ordinate in cylindrical and spherical co-ordinate systems, or product–moment correlation coefficient in statistics. Witte RSS, Witte JS, Smith GS (2003) Statistics. John Wiley and Sons, New York. Box GE, Hunter WG, Hunter JS (2005) Statistics for experimenters: innovation, and discovery, 2nd edn. John Wiley and Sons, New York.

**R** In organic chemistry, symbol for a general attached group or radical, frequently an aliphatic or aromatic hydrocarbon group, that may take on any of various specific identities. Abbreviation for Roentgen. Abbreviation for generalized of multiple correlation coefficient, the square root of the coefficient of determination. °R, Abbreviation for degree of Rankine. Symbol for electrical resistance.

*See Rankine temperature.*

**Rabinowitsch correction** *n.* The correction factor derived by Rabinowitsch (1929) applied to the Newtonian shear rate at the wall of a circular tube (including capillary) through which a non-Newtonian liquid is flowing, gives the true shear rate at the wall. For pseudoplastic liquids such as paints and some polymer melts the correction is always an increase. If the fluid obeys the *power law* it reduces to a simple correction factor $(3n+1)/4n$, where $n$ is the flow-behavior index of the liquid. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York. Patton TC (1964) Paint flow and pigment dispersion. Interscience Publishers Inc., New York.

**Racemic** \rā-ˈsē-mik\ (1892) *adj.* Of, relating to, or constituting a compound or mixture that is composed of equal amounts of dextrorotatory (D-) and levorotatory (L-) forms of the same compound and is not optically active. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Rack** *n.* A warp-knitting measure consisting of 480 courses. Tricot fabric quality is judged by the number of inches per rack.

**Racked stitch** *n.* A knitting stitch that produces a herringbone effect with a ribbed back. It is employed in sweaters for decorative purposes or to form the edge of garments. The racked stitch is a variation of the half-cardigan stitch; it is created when one set of needles is displaced in relation to the other set.

**Racking** *n.* A term referring to the side-to-side movement of the needles of the needle bed of a knitting machine. Racking results in inclined stitches and reduced elasticity.

**Rad** \ˈrad\ [*r*adiation *a*bsorbed *d*ose] (1918) *n.* (1) A deprecated, but still widely used, unit of energy absorbed by a material, including living matter, from exposure to ionizing radiation (1 rad = 0.01 gray (Gy) = 0.01 J/kg). (2, rad). The abbreviation for the SI unit of plane angular measure, the *radian*, the angle intercepting a circular arc of length equal to its radius ($=360°/2\pi = 57.3°$). CRC Handbook of Chemistry and Physics. Lide DR (ed) CRC Press, Boca Raton, FL, 2004 Version. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

*Also see Roentgen.*

**Radiance** \ˈrā-dē-ən(t)s\ (1601) *n.* Quotient of the radiant intensity in a given direction of an infinitesimal surface element containing the point under consideration divided by the area of the orthogonal projection of this surface element on a plane perpendicular to the given direction. Holst GC (2006) Electro-optical imaging system performance, SPIE-International Society for Optical Engineering, Bellingham, Washington. J. C. D. Publishing, FL. Klocek P (ed) (1991) Handbook of infrared optical materials. Marcel Dekker, New York.

**Radiant energy** (ca. 1890) *n.* That form of energy consisting of the electromagnetic spectrum, which travels at 115.890 km (186,500 mile/s) through a vacuum, reducing this speed in denser media (air, water, glass, etc.). The nature of radiant energy is described by its wavelength or frequency although it also behaves as distinct quanta ("corpuscular theory"). The various types of energy may be transformed into other forms of energy (electrical, chemical, mechanical, atomic, thermal, and radiant) but the energy itself cannot be destroyed. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Radiant flux** (1917) *n.* Radiant power; radiant energy emitted from, transferred to, or received through a surface per time internal.

**Radiant heat** (1794) *n.* Heat transmitted by radiation as contrasted with that transmitted by conduction or convection.

**Radiant heat baking** *n.* Curing treatment in which heat is transferred to the paint surface mainly by radiation from a hot surface, e.g., electric lamps or gas heated panels. This is also known as infrared drying or infrared baking.

**Radiant heat drying** *See radiant heat baking.*

**Radiant heating** (1794) *n.* The net transfer of heat from a hotter body to a cooler one by (usually infrared) radiation. Radiant transfer is one of the three basic mechanisms of heat transfer requiring no contact or fluid between the bodies. The net rate is proportional to the differences between the fourth powers of the absolute temperatures of the hotter and cooler bodies ($T_1{}^4 - T_2{}^4$), and depends also on the thermal "color" of the bodies (their emissivities), their geometries, and their positioning relative to each other. The principal use of radiant heating in the plastics industry is in sheet thermoforming. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

*See infrared drying.*

**Radiation** \ˌrā-dē-ˈā-shən\ (15c) *n.* (1) Emission or transfer of energy in the form of electromagnetic waves or particles. (2) The electromagnetic waves or particles. *Note*—In general, nuclear radiations and radio waves are not considered in this vocabulary, only optical radiations, that is, electromagnetic radiations (photons) of wavelengths between the region of transmission to X-ray (1 nm) and the region of transition to radio waves (1 mm). Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Weast RC (ed) (1978) CRC handbook of chemistry and physics, CRC, 59th edn. CRC Press, Boca Raton, FL.

**Radiation degradation** *n.* Breakdown of a plastic caused by too long exposure to radiation, or to radiation of too high energy levels, or both. The radiation may be X-ray, electron, gamma, or neutron beams. The mechanism is ionization and chain scission. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York. Zaiko GE (ed) (1995) Degradation and stabilization of polymers.

Nova Science Publishers Inc., New York. Dissado LA, Fothergill CJ (eds) (1992) Electrical degradation and breakdown of polymers. Institution of Electrical Engineering (IEE), London.

**Radiation compatibility** *n.* The ability of a plastic to maintain its properties when exposed to X-ray, gamma, electron, or other ionizing radiation.

**Radiation cross-linking** *n.* The formation of chemical links between polymer chains through the action of high-energy radiation, commonly gamma radiation from a cobalt-60 source of electrons from an electron gun. The treatment has improved the modulus and raised the use temperature of polyethylene wire coatings and some polymer films. Exposure must be accurately controlled if the cross-linking is to be achieved without degrading the resin. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Radiation formula, Planck's** *n.* The emissive power of a black body at wavelength $\lambda$ may be written

$$E\lambda = \frac{c_1\lambda^{-5}}{e^{c_2/\lambda T} - 1},$$

where $c_1$ and $c_2$ are constants with $c_1$ being $3.7403 \times 10^{10}\,\mu W\,\mu^4/cm^2$ or $3.7403 \times 10^{-12}$ $W\,cm^2$, $c_2$ being $14{,}384\,\mu^\circ$ and $T$ the absolute temperature. Giambattista A, Richardson R, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York. Freir GD (1965) University physics. Appleton-Century-Crofts, New York.

**Radiation polymerization** *n.* A polymerization reaction initiated by exposure to radiation such as ultraviolet or gamma rays rather than by means of a chemical initiator. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers Inc., New York.

**Radical** \\ˈra-di-kəl\\ [ME, fr. LL *radicalis*, fr. L *radic-*, radix root] (1641) *n.* A group of atoms, normally part of a molecule that may replace a single atom (frequently H in organic compounds) and remain unchanged during reactions of the compound. Some examples are the *ethyl* radical, $–C_2H–$, the *acetate* radical, $CH_3COO–$, and the *phenyl* radical, $–C_6H_5$. Many chemical-reaction mechanisms postulate the transitory existence of unattached ("free") radicals as intermediates, which, because of their charge, are extremely reactive. Free radicals play important roles in addition polymerizations. A few free radicals are known that are sufficiently stable to permit their identification and quantitative determination as chemical entities. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Radical polymerization** *n.* A complex mechanism of initiation, propagation, and termination of which the propagation and termination steps are typically very fast. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. *Also called free-radical polymerization.*

**Radioactive nuclides** *n.* Atoms that disintegrate by emission of corpuscular or electromagnetic radiations. The rays most commonly emitted are alpha or beta or gamma rays. The three classes are: *primary*, which have half-life times exceeding $10^8$ years. These may be alpha-emitters or beta-emitters. *Secondary*, which are formed in radioactive transformations starting with $U^{238}$, $U^{235}$, or $TH^{232}$. *Induced*, having geologically short lifetimes and formed by induced nuclear reactions occurring in nature. All these reactions result in transmutation. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Radioactive tracer** *n.* A chemical compound or other material in which one or more of the ordinary atoms have been replaced by their radioactive isotopes. Carbon-14, tritium (hydrogen-3), and iodine-131 are among the isotopes that have been used in this way. The tracer isotopes have been useful in elucidating chemical-reaction mechanisms and in tracking human and animal metabolisms.

**Radioactivity** \ˈrā-dē-ˌō-ak-ˈti-və-tē\ [ISV] (1899) *n.* The decay or decomposition of nuclei of atoms. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Radio frequency** (1915) (RF) *n.* A frequency of electromagnetic radiation within the broad range of radio and radar transmission, e.g., from about 300 kHz to 20 GHz. Serway RA, Faugh JS, Bennett CV (2005) College physics. Thomas, New York.

**Radio-frequency drying** *n.* Use of radio-frequency electromagnetic radiation for drying textiles. The application of RF to wet goods results in the selective heating of the water, which has a partial polarity, because the molecule must do work to align in the RF field causing heat generation within the water droplets. Non-polar materials, i.e., fabrics, are unaffected. RF drying is very uniform and energy efficient when airflow patterns through the dryer are properly designed and controlled.

**Radio-frequency heating** *See dielectric heating.*

**Radio-frequency pre-heating** (RF pre-heating) *n.* A method of pre-heating used for thermosetting molding materials to facilitate the molding operation or shorten the molding cycle. The frequencies most commonly used are near 20 or 40 MHz.

**Radio-frequency welding** (dielectric welding, high-frequency welding) *n.*
*See dielectric heat sealing.*

**Radius of gyration** *n.* The radial distance from a given axis at which the mass of a body could be concentrated without altering the rotational inertia of the body about that axis. For a polymer molecule, a parameter characterizing the size of a polymer random coil. It is defined as

$$R_G^2 = \sum m s_i^2 / \sum m = \sum s_i^2 / n,$$

where the polymer chain consists of $n$ segments, each of mass $m$, located at distance $s$ from the center of gravity of the coil. The radius of gyration is the second moment of mass distribution. The mean square value of the unperturbed radius of gyration, $\langle R_G^2 \rangle_0$, is related to the unperturbed end-to-end distance, $\langle r^2 \rangle_0$, by the following equation.

$$\langle R_G^2 \rangle_0 = \langle r^2 \rangle_0 / 6.$$

If the polymer is in contact with a solvent other than a theta solvent, the mean square value of the radius of gyration is given by the following equation

$$\langle R_G^2 \rangle = \alpha_R \langle R_G^2 \rangle_0.$$

Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York. Mark JE (ed) (1996) Physical properties of polymers handbook.

Springer-Verlag, New York. Elias HG (1977) Macromolecules, vols 1–2. , Plenum Press, New York. Miller ML (1966) Structure of polymers. The Reinhold Publishing Co., New York.

**Rafaelite** *n.* Hard, natural asphaltum mined in the Argentine. It is characterized by a high melting point, and good opacity, but limited solubility in drying oils. Special heating treatment is necessary to obtain stable solutions. Usmani AM (1997) Asphalt Science and Technology. Marcel Dekker, New York.

**Rag rolled finish** *See rag rolling.*

**Rag rolling** *n.* (1) Process of forming in a scumble or glaze over a painted ground, a textured or variegated pattern by rolling a rag or washleather over the surface. (2) Printing a pattern on a dry painted surface by means of a rag or washleather or special paint roller charged with color. The rag is crumpled or screwed up in the form of a rough roller to produce the pattern.

**Railroading** *n.* The horizontal, rather than vertical, application of a wall covering or the use, horizontally, of an upholstery fabric. Complete textile glossary. Celanese Corporation, New York, 2000.

**Railroad tracks** *n.* In coated fabric, depressions in surface of a definite pattern as indicated by the name. Complete textile glossary. Celanese Corporation, New York, 2000.

**Rails** \ˈrā(ə)l\ [ME *raile*, fr. MF *reille* ruler, bar, fr. L *regula* ruler, fr. *regere* to keep straight, direct, rule] (14c) *n.* The metal bars on which the spindles of a downtwister are mounted. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Rain spotting** *n.* Particular case of weather spotting caused by rain.

**Raised grain** *n.* Condition of wood surfaces where fibers from the wood structure have become prominent due to wetting with water or materials containing water. Prominence of the harder portions of the grain of wood when the softer portions have suffered shrinkage. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA, 1978. Laurie AP (1967) Painter's methods and materials. The Dover Publications Inc., New York. Gross WF (1970) Application manual for paint and protective coatings. MGraw-Hill Book Co., New York.

**Raising** *See lifting and napping.*

**RAL** *n.* Abbreviation for Reichsnormen Ausschuss for Lieferbedingungen, issues of German colors (Farbregisters RAL 840).

**Ram** \ˈram\ [ME, fr. OE *ramm*; akin to OHGr *ram*] (before 12c) *n.* In compression and matched-die molding, the press member that enters the cavity block and exerts pressure on the molding compound, designated by its position in the assembly as the top force or bottom force. In older injection machines predating the development of screw injection, the plunger that forced the feed pellets through the annulus between cylinder and torpedo, and that also accomplished, in most such machines, the injection of melt into the mold. The piston of a melt accumulator such as may be used in blow molding large objects, or in special injection-molding techniques.

**RAM** (1957) *n.* Acronymic abbreviation for random-access memory, computer memory for storing and working with programs and data, and erasable by the operator. Compare ROM. Microsoft computer dictionary. Microsoft Press, Washington, 2002. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Raman spectroscopy** (Raman effect, and normal Raman scattering). When light is scattered from a molecule most photons are elastically scattered. The scattered photons have the same energy (frequency) and, therefore, wavelength, as the incident photons. However, a small fraction of light (approximately 1 in 107 photons) is scattered at optical frequencies different from, and usually lower than, the frequency of the incident photons. The process leading to this inelastic scatter is termed the Raman effect. Raman scattering can occur with a change in vibrational, rotational, or electronic energy of a molecule. Chemists are concerned primarily with the vibrational Raman effect. We will use the term Raman effect to mean vibrational Raman effect only. The difference in energy between the incident photon and the Raman scattered photon is equal to the energy of a vibration of the scattering molecule. Raman spectroscopy determines the maximum theoretical extents to which, plastics may be drawn when high tensile modulus fibers are made. Smith E, Dent G (2004) Modern Raman spectroscopy. John Wiley and Sons, New York.

**Ramie** \ˈrā-mē, ˈra-\ [Malay *rami*] (1832) *n.* A natural vegetable fiber obtained from the stems of the hemp *Boehmeria nivea*, used as a reinforcement.

**Ramped temperature** *n.* The programmed heating of a sample at a closely controlled linear rate.

**Ramsden circle (Ramsden disc, eyepoint)** *n.* The circular spot of light formed at that distance above the eyepiece where the chief image forming rays cross the back focal plane of the eyepiece. The objective back focal plane is in conjugate focus in this same plane. In visual microscopy, the point where the lens of the eye is placed.

**Ram travel** *n.* The distance the injection ram (or screw) moves in filling the mold in injection or transfer molding.

**Random chain, coil, flight, walk** *n.* Simple model that relates the average size of the molecule's cloud changes with molecular weight. It states that the average square distance traveled by a molecule ($r_0{}^2$), increases linearly with the number ($n$) of links, and $r_0^2 = n_a^2$, where $a$ is the length of the link. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Random co-polymers** *n.* A co-polymer consisting of alternating segments of two different monomeric units of random lengths, including single molecules. A random co-polymer usually results from the co-polymerization of two monomers in the presence of a free-radical initiator, for example the so-produced rubbery co-polymer of ethylene and propylene.

**Random-sheared carpet** *n.* A pile carpet with a textured face produced by shearing some of the loops and leaving others intact. Complete textile glossary. Celanese Corporation, New York.

**Range** \ˈrānj\ {*often attributive*} [ME, row of persons, fr. MF *renge*, fr. OF *rengier* to range] (14c) (*R*) *n.* In sampling of product dimensions and properties, the difference between the largest and smallest values in the sample. Range charts for small samples have long been used in quality-control work. The range is simple to calculate and is almost as efficient as the standard deviation in samples of 2–5 items.

**Rankine scale of temperature** \ˈraŋ-kən\ [William J. M. *Rankine* † 1872 Scottish engineer & physicist] (ca. 1926). The absolute Fahrenheit scale,

$$°F + 459.69 = ° R;\ \text{thus } 0°F \text{ Rankin} = 459.69°F.$$

Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Rankine temperature** *n.* The absolute temperature scale, now deprecated, derived from the Fahrenheit scale, having its zero at −459.67°F. To convert Rankine to SI's Kelvin (K), multiply by 5/9.

**Raoult's law** *n.* The quantitative relationship between vapor–pressure lowering and concentration in an ideal solution is stated in Raoult's law: the partial vapor pressure of a component in solution is equal to the mole fraction of that component times its vapor pressure when pure at a temperature;

$$P_1 = X_1 P_1^{\mathrm{o}},$$

where $P_1$ and $P_1^{\mathrm{o}}$ are the vapor pressure of the solution and the pure solvent, respectively, $X_1$ is the mole fraction of solvent, $X_1 = 1 - X_2$ and $P_1 = (X_1 - X_2)P_1^{\mathrm{o}}$, and,

$$X_2 = \frac{P_1^{\mathrm{o}} - P_1}{P_1^{\mathrm{o}}}.$$

This means that the fractional vapor–pressure lowering is equal to the mole fraction of the solute; also, the total pressure of the system is equal to the sum of the partial pressures,

$$P_s = P_1 + P_2 + \cdots + P_n.$$

Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York.

**Rapier looms** *n.* Looms in which either a double or single rapier (thin metallic shaft with a yarn gripping device) carries the filament through the shed. In a single rapier machine, the yarn is carried completely across the fabric by the rapier. In the double machine, the yarn is passed from one rapier to the other in the middle of the shed. Complete Textile Glossary. Celanese Corporation, New York.

*Also see weft insertion.*

**Rapseed oil** (1816) *n.* Obtained from the seeds of the species, *Brassica.* It is a non-drying oil, the main constituent acid being erucic acid, with smaller amounts of oleic and linoleic acids. Sp gr, 0.915/15°C; iodine value, 92; saponification value, 173. *Known also as colza oil.*

**RAPRA** *n.* Rubber and Plastics Research Association, since 1985 renamed RAPRA Technology Ltd. (Shropshire, UK) consultants for the plastics and rubber industry and an industry-supported organization headquartered at Shawbury, England, www.rapra.com. RAPRA offers a wide range of consultancy services for a whole spectrum of clients within the plastics and rubber industry and works alongside the client offering guidance and support as an integral part of the product design and development process. RAPRA boasts the necessary skills and experience to undertake entire product design and development programs and using knowledge built up over many years within the industry, has an understanding of how polymer materials perform in service.

**Raschel knitting** *See knitting* (1).

**Rate constants** *n.* The constant of the reaction rate of a reaction. This constant is a function of temperature that follows the Arrhenius equation.

**Rate of shear** In rheology, rate of shear is often used interchangeably with velocity gradient.

*See shear rate.*

**Rate-process theory** *n.* A general theory, derived from statistical mechanics, applicable to both chemical reactions and creep phenomena in plastics. For the latter, the theory relates time-to-rupture to stress and the reciprocal of the absolute temperature.

An equation recommended for a pipe in ASTM D 2837 is,

$$\log t = A_0 + A_i/T + (A_2/T)\log S,$$

where the $A_i$ are empirical coefficients, different for each plastic, $t$ is the time to failure under sustained hoop stress $S$, and $T$ is the absolute temperature. James F, Carley (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., USA.

**Rate law** The dependence of the rate of a reaction upon the concentrations of reactants. Levenspiel O (1998) Chemical reaction engineering. John Wiley and Sons, New York.

**Rate of polymerization** In chain polymerization, the rate at which the monomer (M), of concentration [M], is converted to polymer, $-\mathrm{d}[\mathrm{M}]/\mathrm{d}t$. Since the rate of propagation occurs hundreds of times more frequently than initiation, rates of polymerization and propagation are the same and the symbol $R_\mathrm{p}$ is used for both. For a steady state chain polymerization reaction, $R_\mathrm{p}$ is defined by the following equation

$$R_\mathrm{p}{=}k_\mathrm{p}[\mathrm{M}](R_i/2k_\mathrm{t})^{1/2},$$

where $k_\mathrm{p}$ is the rate constant, $R_i$ the rate of initiation, and $k_\mathrm{t}$ is the termination rate constant. In free radical polymerization initiated by thermal decomposition of initiator $I$ with rate constant $k_\mathrm{d}$, and initiator efficiency $f$, the rate of polymerization is given by

$$R_\mathrm{p} = k_\mathrm{p}[\mathrm{M}](fk_\mathrm{d}[I]/2k_\mathrm{t})^{1/2}.$$

Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Connors KA (1990) Chemial kinetics. John Wiley and Sons, New York. Solomon DH (1969) Kinetics and mechanisms of polymerization series, vol 2 – Ring opening and vol 3 – Step growth. Marcel Dekker Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers Inc., New York.

**Rate-determining step** *n.* The slowest step in a chemical reaction. Russell JB (1980) General chemistry. McGraw-Hill, New York.

**Ratine** \ˌra-tə-ˈnā\ [F *ratiné*] (ca. 1914) *n.* (1) A plain-weave, loosely constructed fabric having a rough, spongy texture, which is imparted by the use of nubby plied yarns. It is made from worsted, cotton, or other yarns. (2) A variant of spiral yarns in which the outer yarn is fed more freely to form loops that kink back on themselves and are held in place by a third binder yarn that is added in a second twisting operation. Complete textile glossary. Celanese Corporation, New York.

**Ravel** \ˈra-vəl\ [D *rafelen*, fr. *rafel* loose thread] (1582) *n.* A type of comb or rail with projecting teeth for separating and guiding warp ends.

**Raveling** (1658) *n.* The process of undoing or separating the weave or knit of a fabric.

**Raw fiber** *n.* A textile fiber in its natural state, such as silk "in the gum" and cotton as it comes from the bale.

**Raw sienna** \-sē-ˈe-nə\ [I *terra di Siena*, literally, Siena earth, fr. *Siena*, Italy] (1787) *n.* Naturally occurring iron oxide, limonite type ore. Color range, yellow to light brown, 40–70% $Fe_2O_3$. Somewhat translucent when dispersed in oil. General uses, tinting colors, artists' colors, and stains. *See iron oxides, natural.*

**Raw umber** *See umber.*

**Rayleigh ratio** \ˈrā-lē\ [John Welsh S. *Rayleigh*] *n.* $R_\partial = \kappa c M_2$ as $c \to 0$ where $\kappa$ is the optical constant, $c$ the dilute concentration factor for a mixture of a homologous series of polymers of different molecular weights $M_2$ corresponds to weight-average molecular weight $\overline{M_w}$; other derivations of the equation $\overline{R_\vartheta} = \kappa c\overline{Mw}$ are used to determine the molecular weights of co-polymers. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York. Pecora R (1985) Dynamic scattering: applications of photon correlation spectroscopy. Kluwer Academic Publishers, New York.

**Rayleigh scattering** (1937) *n.* Scattering of light by small or molecular size particles to render the effect selective so that different colors are deflected through different angles, scattering $= 1/\lambda^4$, where $\lambda$ is the wavelength of light. This relationship explains why earth's sky is blue as viewed in direct sunlight because blue has a lower wavelength compared to other wavelengths of the visible spectrum. Flory PJ (1953) Principles of polymer science. The Cornell University Press, Ithaca, NY. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Raymond roller mill** *n.* A type of mill used for the dry-grinding of pigments or similar materials. The pre-crushed crudes or solids are fed into a circular grinding chamber in the base of the mill and by mechanical means are forced between rolls and a ring. Grinding of the pigment crude is obtained by the centrifugal force and pressure of the revolving roll exerted against the ring. A stream of compressed air passes through the mill and carries out the pigment particles, which are fine enough to "float" on it; the larger particles drop back into the mill grinding chamber for further grinding.

**Rayon** \ˈrā-ˌän\ [irreg. from $^{2}$*ray*] (1924) *n.* The definition established by the Federal Commission in 1951 is: "Generic name for a manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated cellulose in which constituents have replaced not more than 15% of the hydrogens of the hydroxyl groups". Prior to that date, going back to 1924 when the name rayon was first used (inspired by its sheen invoking the brilliance of a ray of sunlight), the term was used for all man-made fibers derived from cellulose, including cellulose acetate, and cellulose triacetate. Rayon is the oldest of the synthetic fibers, having been produced commercially since 1855. All methods of producing rayon are based on treating fibrous forms of cellulose to make them soluble, extruding the solution through the tiny orifices of a spinneret then converting the filaments into solid cellulose. Most rayon fibers are produced from the intermediate Viscose.

*See also cuprammonium rayon.*

**Rayon acetate** *n.* Generic name for the regenerated manmade fibers of cellulose from cellulose acetate.

**Rayon fiber** *n.* A manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated cellulose in which substituents have replaced not more than 15% of the hydrogens of the hydroxyl groups (FTC definition). Rayon fibers include yarns and fibers made by the viscose process, the cuprammonium process, and the now obsolete nitrocellulose and saponified acetate processes. Generally, in the manufacture of rayon, cellulose derived from wood pulp, cotton linters, or other vegetable matter is dissolved into a viscose spinning solution. The solution is extruded into an acid-salt coagulating bath and drawn into continuous filaments. Groups of these filaments may be made in the form of yarns or cut into staple. Characteristics: rayon yarns are made in a wide range of types in regard to size, physical characteristics, strength, elongation, luster, handle, suppleness, etc. They may be white or solution dyed. Strength is regulated by the process itself and the structure of the yarn. Luster is reduced by including delustering materials, such as titanium dioxide pigments, in the fiber when it is extruded. The suppleness of the yarn is controlled by the number of filaments in the yarn, the denier or gauge of the individual filaments or fibers, and the fiber cross-section. End uses: rayon is used in draperies, bedspreads, upholstery, blanket, dish towels, curtains, throw rugs, tire cord, industrial products, sport shirts, slacks, suitings, dress goods, and linings and in blends with other fibers to enhance functional and aesthetic qualities, e.g., with polyester in permanent-press fabrics. (*Also see polynosic fiber*).

**Re** ($N_{Re}$). An alternate, older symbol for *Reynolds number.*

**Reactant** \rē-ˈakt-tənt\ (ca. 1920) *n.* A substance consumed in a chemical reaction.

**Reaction injection molding (RIM)** *n.* This term is usually applied to the process of injection molding of urethane reactants in which the two primary constituents, isocyanate and polyol, are pumped by a metering device into a mixing head from which the intimately mixed reactants are quickly injected into a closed mold. The injection pressure is much lower than in conventional injection molding of molten plastics, enabling the use of inexpensive, lightweight molds. However, the mixing head is a high-pressure impingement mixer in which pressures may reach 14–21 MPa. One mixing head may be used to feed up to ten separate molding presses. One of the largest-volume applications of RIM is the production of exterior automotive parts such as body panels and bumpers. Furniture is another big use. The term liquid injection molding (LIM) is usually applied to the similar process of molding other thermosetting resins such as polyesters, epoxies, silicones, alkyds, and diallyl phthalate resins. The terms liquid reaction molding (LRM) and high-pressure injection molding (HPIM) have sometimes been used for either or both processes. If reinforcing fibers are included in the reaction mix, the process is called reinforced reaction injection molding (RRIM). Structural reaction injection molding (SRIM) is a variation in which there is some foaming of the polyurethane in the core of the molding, with a solid skin on the outside. This technique reduces part weight with little loss of stiffness or strength and is widely used in the commodity-furniture industry.

**Reaction order** *n.* The exponent on a concentration term in a simple rate law (order with respect to one component); or the sum of all such exponents (overall order).

**Reaction rate** *n.* The time rate of change of concentration (or, sometimes, quantity) of a reactant or product in a reaction.

**Reaction spinning** *See spinning* (2).

**Reactive pigments** *n.* Those pigments which react with the vehicle, as in the formation of zinc and lead soaps with drying oils; also, pigments such as red lead which react with acids formed at metal surface to prevent rust.

**Reactive plasticizer** *See plasticizer, polymerizable.*

**Reactive processing** *n.* A molding or extrusion operation in which chemical reactions are carried out. Extruders, mainly specialized twin-screw machines, have successfully carried out partial and complete polymerizations on a large scale. Transfer and compression molding of thermosets have always been reactive processes, but see reaction injection molding.

**Reactive resins** *n.* (1) Resins of phenol-formaldehyde type which are believed to react with drying oils on heating, more particularly those of conjugated types. (2) Resins capable of cross-linking with themselves or other resins. (3) Resins with a high acid number.

**Ready-mixed aluminum paint** *See aluminum mixing varnish.*

**Reagent resistance** (chemical resistance) *n.* The ability of a plastic to withstand exposure to acids, alkalis, oxidants, and solvents.

**Realgar** \rē-ˈal-ˌgär, -gər\ [ME, fr. ML, fr. Catalan, fr. Arabic *rahj al-ghār* powder of the mine] (15c) *n.* As$_2$S$_2$. Arsenic disulfide mineral, which was used as a pigment under the name, "arsenic orange". Its chemical and physical properties are similar to those of orpiment. In modern times, it is not used as a pigment because of its toxicity.

**Ream** \ˈrēm\ [ME *reme*, fr. MF *raime*, fr. Arabic *rizmah*, literally, bundle] (14c) *n.* (1) Layers of inhomogeneous material parallel to the surface in a transparent or translucent plastic article. (2) A quantity of paper, 472–500 sheets, depending on the type of paper.

**Reaming** *n.* Further plying of a two-ply yarn with a singles yarn. Reaming is not the same as plying three singles yarns in one operation.

**Reciprocating-screw injection molding** *n.* In this process the screw serves to both plasticate the feedstock and inject the melt into the mold. During part of the cycle, the screw rotates rapidly, moving backward as it accumulates a charge (shot) of melt in the forward and of the cylinder. A limit switch stops the rotation and two hydraulic rams, one on either side, push the screw forward, forcing the melt into the mold and holding melt pressure unit the gates freeze. The rams are withdrawn, screw rotation recommences, the mold opens to eject the parts, the mold closes, and a new cycle begins. Most new injection machines sold today are of this type.

**Reciprocating-screw molding machines** *n.* A combination plasticating and injection unit in which an extrusion device with a reciprocating screw is used to plasticate the plastic.

**Reclaim** \ri-ˈklām\ [ME *reclamen*, fr. MF *reclamer* to call back, fr. L *reclamare* to cry out against, fr. *re-* + clamare to cry out] (14c) (recycle) *vt.* To salvage plastics from discarded products such as milk and soda bottles, automobiles, and packaging films.

**Reclaiming or recycling** *n.* The recovery, recycling, and reuse of scrap materials.

**Reconstituted fibers** *n.* Fibers made from recovered waste polymer or blends of virgin polymer and recovered waste polymer.

**Reconstituted oils** *n.* Drying oils which are made by the re-esterification of selected fatty acids, previously derived from a natural drying oil.

**Recovery** *See elastic recovery.*

**Recreational surfaces** *n.* Manufactured surfaces providing consistent properties, durability, and special characteristics as needed for the specific application. Included are artificial turf, pool decks, indoor–outdoor carpeting, tennis court surfaces, etc. Most types of constructions (knit, woven, tufted, and non-woven), and most polymer types find use in this market. The polyolefins are particularly prominent in these applications.

**Recycle** \(ˌ)rē-ˈsī-kəl\ (1926) *n, v.* (1) (regrind) In a processing plant, to recover trim scrap and faulty parts by granulating them and blending the ground material with virgin feed. (2) To reclaim.

**Recycled plastic** (reclaimed plastic) *n.* A plastic prepared from discarded articles that have been cleaned and ground (ISO). This material may or may not be reformulated by the addition of stabilizers, plasticizers, fillers, pigment, etc.

**Recycling** *n.* (1) (regrind) In a processing plant, to recover trim scrap and faulty parts by granulating them and blending the ground material with virgin feed. (2) To reclaim.

**Red (magenta) inks** The calcium salt of an azo pigment, it has generally good transparency; good resistance to bleeding and baking; fair lightfastness and alkali resistance.

**Red cinnabar** *See mercuric sulfide.*

**Red iron oxide** *See iron oxides, synthetic.*

**Red lake C** *n.* Family of organic acid azo pigments prepared by coupling the diazonium salt of ortho-chloro-meta-toluidine-para-sulfonic acid with $\beta$-naphthol.

**Red lake C pigments** *n.* Family of organic acid azo pigments prepared by coupling the diazonium salt of ortho-chloro-meta-toluidine-para-sulfonic acid with $\beta$-naphthol.

**Red lake D** *n.* Strong red lake, sensitive to cobalt driers, and made by coupling diazotized anthranilic acid with $\beta$-naphthol.

R

**Red lake P** *n.* Made by coupling diazotized p-nitro aniline-*o*-sulfonic acid with $\beta$-naphthol.

**Red lead** (15c) *n.* $Pb_3O_4$. Pigment red 105 (77578). Bright red to orange-red tetroxide; excellent opacity with good properties as a primary constituent of anti-corrosive primers for iron and steel. Density, 8.9 g/cm$^3$ (74.2 lb/gal); O.A., 7–9.

*Also known as minium. See orange mineral.*

**Red lead (non-setting)** *n.* Special type of red lead containing a minimum amount of free or reactive litharge and a high content of lead peroxide. The non-setting types are used when it is desired to prevent undue thickening of oil mixtures or paints.

**Red ocher** (1572) *n.* A mixture of hematites; any of a number of natural earths used as red pigments.

*See iron oxides, natural.*

**Red oil** Commercial grade of oleic acid.

**Red oxide** *See iron oxides, natural.*

**Redox, initiation** \ˈrē-ˌdäks-\ [*red*uction + *ox*idation] (1928) *adj.* Oxidation or reduction of a compound to generate ionic species for initiation of polymer reactions. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Redox polymers** *n.* Polymers which are formed when a redox catalyst enters into an oxidation–reduction reaction.

**Redox reaction** *n.* An oxidation–reduction, or electron transfer, reaction. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

**Redtone ink blue** *See iron blue.*

**Reduce** \ri-ˈdüs, -ˈdyüs\ [ME, to lead back, fr. L *reducere*, fr. *re-* + *ducere* to lead] (14c) *v.* To add a solvent or thinner to a coating, varnish, resin, latex, or emulsion for the purpose of lowering its viscosity and/or non-volatile content.

**Reduced viscosity** *n.* (1) (IUPAC: viscosity number) Reduced viscosity is the fluid viscosity increase per unit of polymer solute concentration. Mathematically, it is defined by the following equation:

$$\eta_{\text{reduced}} = \eta_{\text{specific}}/c,$$

where $\eta_{\text{reduced}}$ is the reduced viscosity, $\eta_{\text{specific}}$ the specific viscosity, and $c$ is the concentration of the polymer in solution. Reduced viscosity is a measure of the specific capacity of the polymer to elevate viscosity. (2) The viscosity of a coating or vehicle when thinned (reduced) to a specified percent of solids with specified solvents. Often used as a portion of the specifications between buyer and seller. Collins EA, Bares J, Billmeyer FW Jr (1973) Experiments in polymer science. Wiley-Interscience, New York.

*See dilute-solution viscosity.*

**Reducer** *n.* A volatile compound, which is employed to bring coatings to the proper consistency.

*Also called thinner.*

**Reducers** *n.* Varnishes, solvents, oils, or waxy, or greasy compounds that are employed to reduce tack or consistency of the ink for use on a press.

*See thinner.*

**Reducing agent** (1885) *n.* A species or substance, which loses electrons in a reaction.

**Reducing power** *n.* The strength of a white pigment, i.e., the degree to which it is able to produce a very pale tint when mixed with a defined proportion of colored pigment. The paler the tint produced, the greater the reducing power.

**Reduction** \ri-ˈdək-shən\ [ME *reduccion* restoration, fr. MF *reduction*, fr. LL & L *reduction-*, *reductio* reduction (in a syllogism), fr. L, restoration, from *reducere*] (1546) *n.* (1) Any chemical process that increases the proportion of hydrogen or base-forming elements or radicals in a compound. (2) The gaining of electrons by an atom, ion, or element, thereby reducing the positive valence of that which gained the electron(s). The reverse of oxidation. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Reduction clearing** *n.* The removal of unabsorbed disperse dye from the surface of polyester at the end of the dyeing or printing process by treatment in a sodium hydroxide/sodium hydrosulfite bath. A surface-active agent may be employed in the process.

**Reduction potential** *n.* A measure of the tendency of a reduction half-reaction to occur, expressed as the voltage produced by a cell employing the half-reaction at its cathode and using the standard hydrogen electrode as its anode.

**Reed** \ˈrēd\ [ME *rede*, fr. OE *hrēod*; akin to OHGr *hriot* reed] (before 12c) *n.* A comb-like device on a loom that separates the warp yarns and also beats each succeeding filling thread against that already woven. The reed usually consists of a top and bottom rib of wood into which metal strips or wires are set. The space between two adjacent wires is called a dent (or split) and the warp is drawn through the dents. The fineness of the reed is calculated by the number of dents per inch.

**Reed marks** *n.* A fabric defect consisting of warpwise light and heavy streaks in a woven fabric, caused by bent, unevenly packed, or weak reed wires.

**Reel** \rē(ə)l\ [ME, fr. OE *hrēol*; akin to ON *hrœll* weaver's reed, Gk *krekein* to weave] (before 12c) *n.* (1) A revolving frame on which yarn is wound to form hanks orskeins. (2) The frame on which silk is wound from the cocoon. (3) A linen yarn measure of 72,000 yards. (4) The large wheel in a horizontal warper onto which the warp sections are wound in the indirect system of warping. (5) A spool of large capacity used to wind yarn or wire.

**Reeling** *n.* In silk fiber production, the process of unwinding the cocoon.

**Reentrant mold** *n.* A mold containing an undercut that tends to impede withdrawal of the molded product. If the undercut is more than slight, the mold will probably be designed with a side draw that retracts from the undercut region as the mold opens and relieves the undercut.

**Reference material** (reference standard) *n.* In analytical chemistry, a gas mixture, pure liquid, solution, pure solid, or alloy whose composition is certified with a stated, high degree of accuracy. Reference materials are used to calibrate analytical procedures and instruments. They are available from private companies, also from the National Institute of Standards and Technology (the former National Bureau of Standards).

**Reference standard** *n.* The standard to which a measurement is compared.

**Refiner** *n.* A machine similar to a two-roll mixing mill, operated with rolls very close together to crush undispersed ingredients and hold them in the bite of the rolls for removal and discarding when the mass has passed through. Refiner rolls are shorter and have a much greater diameter than mixing rolls, and are operated at a higher surface speed ratio to provide more grinding effect and classification.

**Reflectance** \ri-ˈflek-tən(t)s\ (1926) *n.* The ratio of the intensity of reflected radiant flux to that of the incident flux. In popular usage, it is considered as the ratio of the intensity of reflected radiant energy to that reflected from a defined reference standard. *See light reflectance.*

**Reflectance, absolute** *See absolute reflectance.*

**Reflectance, diffuse** *n.* Reflectance over a wide range of angles. In popular usage, the diffuse reflectance is all of the reflected radiant energy except that of the specular angle.

*See perfect diffuser and specular reflectance excluded.*

**Reflectance, directional** *n.* Measurement of radiant flux reflected for specified directions of illumination and viewing, generally measured relative to that from a perfect diffuse reflector similarly illuminated and viewed. In practice, a reference white, which approaches a perfect diffuser, or a secondary calibrated reference standard, may be used.

**Reflectance factor** *n.* Radiance measured relative to the perfect diffuser rather than to the irradiance.

**Reflectance, Fresnel** *n.* Reflectance of radiant energy at the surface separating media of different refractive indices. The magnitude of the light reflected may be calculated from Fresnel's law.

**Reflectance, hemispherical** *n.* Ratio of radiant flux reflected into a hemispherical collector to the incident flux. Normally, the portion reflected backward from a material is measured, although the portion reflected in the forward direction may be measured on translucent materials.

**Reflectance, luminous** *n.* Reflectance derived from radiant flux by evaluating the radiant energy reflected according to its action upon a selective receptor (such as the eye), whose spectral sensitivity is defined by a standard relative luminous efficiency function. In popular usage, the term is used to describe the Y tristimulus value in the CIE system.

**Reflectance, non-specular** *n.* Reflectance of radiant flux from a surface at angles other than that of the specular angle, i.e., diffuse reflectance.

*See reflectance, diffuse.*

**Reflectance, specular** *n.* Reflectance of a beam of radiant energy at an angle equal but opposite to the incident angle; the mirror-like reflectance. The magnitude of the specular reflectance on glossy materials depends on the angle and on the difference in refractive indices between two media at a surface and may be calculated from the Fresnel law.

*See reflectance, Fresnel.*

**Reflectance, total** *n.* Reflectance of radiant flux reflected at all angles from the surface, thus including both diffuse and specular reflectances.

**Reflection** \ri-ˈflek-shən\ [ME, alter. of *reflexion*, fr. LL *reflexion-*, *reflexio* act of bending back, fr. L *reflectere*] (14c) *n.* Process or phenomenon of the return of radiant energy from a surface.

**Reflection–absorption spectroscopy** *n.* Spectroscopic technique that investigates the vibration of molecules on surfaces. Reflection–absorption spectroscopy uses IR light to excite the molecules on the surface. These molecules will absorb only certain fixed frequencies. Hence, the spectrum will show the absorption peaks characteristic of the molecule as well as its method of bonding to the surface.

**Reflection coefficient or reflectivity** *n.* The ratio of the light reflected from a surface to the total incident light. The coefficient may refer to diffuse or to specular reflection. In general it varies with the angle of incidence and with the wavelength of the light.

**Reflection of light by a transparent medium in air** (Fresnel's formulae) *n.* If $i$ is the angle of incidence, $r$ the angle of refraction, $n_1$ the index of refraction for air (nearly equal to unity), and $n_2$ is the index of refraction for a medium, then the ratio of the reflected light to the incident light is

$$R = \frac{1}{2}\left(\frac{\sin^2(i-r)}{\sin^2(i+r)} + \frac{\tan^2(i-r)}{\tan^2(i+r)}\right).$$

If $I = 0$ (normal incidence), and $n_1 = 1$ (approximate for air),

$$R = \left(\frac{n_2 - 1}{n_2 + 1}\right)^2.$$

Weast RC (ed) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Reflectivity (R∞)** \ˌrē-ˌflek-ˈti-və-tē\ *n.* (1) Reflectance which would be attained if a material were completely opaque; reflectance of a layer of material of such thickness that an increase in thickness will not change its reflectance. (2) The reflectance of a film so thick that a further increase in thickness does not change the reflectance.

**Reflectometer** \ˌrē-ˌflek-ˈtä-mə-ter, ri-\ (1891) *n.* An instrument that measures the total luminous flux from a surface and reports it as a percentage of the incident flux on the surface.

**Reflectorization** *n.* Incorporation of ballotini in, for example, road signs or markings to give selective reflection in the general direction of the light source.

**Reflex blue** *See alkali blue.*

**Reflex reflector** *n.* A reflecting material so designed that a beam of radiant energy returns, or is reflected back, along the line of incidence. Such reflectors are of importance for automobiles, traffic signals and signs.

*See also retroreflective.*

**Refract** \ri-ˈfrakt\ [L *refractus*, pp. of *refringere* to break open, break up, fr. re- + *frangere* to break] (1612) *vt.* To subject (as a ray of light) to refraction.

**Refraction** \ri-ˈfrak-shən\ (1603) *n.* Deflection of radiant energy from a straight path in one medium to a different path in another medium of different index of refraction.

**Refraction at a spherical surface** *n.* If $u$ be the distance of a point source, $v$ the distance of the point image or the intersection of the refracted ray with the axis, $n_1$ and $n_2$ the indices of refraction of the first and second medium, and $r$ the radius of curvature of the separating surface

$$\frac{n_2}{v}+\frac{n_1}{u}=\frac{n_2-n_1}{r}.$$

If the first medium is air, the equation becomes

$$\frac{n}{v}+\frac{1}{u}=\frac{n-1}{r}.$$

**Refractive index** (1839) *n.* The index of refraction of a material is the ratio of the velocity of the light in a vacuum to that of the specimen; it is expressed as a ratio of the sine of the angle of incidence to the sine of the angle of refraction; it is used as a measure of purity, identification and optical design (ASTM D 542).

*See index of refraction.*

**Refractivity** \ˌrē-ˌfrak-ˈti-və-tē\ (1673) *n.* The index of refraction −1. Specific refractivity is given by the expression $(n-1)/d$, where $n$ is the index of refraction and $d$ is the density of the material.

**Refractometer** \ˌrē-ˌfrak-ˈta-mə-tər\ [ISV] (ca. 1859) *n.* An instrument used to measure the index of refraction of transparent materials, both solid and liquid. Refractive indices are often taken as a guide to the purity of raw materials, such as drying oils. The Abbé design is convenient and is used worldwide.

*See index of refraction, differential refractometer, and Abbé re-fractometer.*

**Refractory** \ri-ˈfrak-t(ə-)rē\ [alter. of *refractary*, fr. L *refractarius*, irreg. fr. *refragari* to oppose, fr. *re-* + *fragari* (as in *suffragari* to support with one's vote)] (1606) *adj.* Having a very high melting point.

**Refractory fiber** *n.* Oxide or non-oxide, amorphous or crystalline, manufactured fiber generally used for applications at temperatures greater than 1063°C in both oxidizing and non-oxidizing atmospheres, i.e., $Al_2O_3$, $ZrO_2$, and $Al_2O_3SiO_2$.

**Regain standard** *See standard moisture regain.*

**Regenerated cellulose** *n.* A transparent cellulosic plastic made by mixing cellulose expatiate with a dilute sodium hydroxide solution to form a viscose extruding the viscose into film, sheeting, or fiber form, then treating the extrudate with acid to effect regeneration. In fiber form, the material is called rayon. The term cellophane is used for films and sheets.

**Register** (14c) *v.* When a design or form is printed in parts, as in multiple colors, it is a requirement that all parts match exactly. When they do, they are "in register"; otherwise they are "out of register".

**Regression analysis** (method of least squares) *n.* A family of statistical techniques for fitting equations to data based on the principle that the best-fitting parameters are those that minimize the sum of squares of the differences between the original observations and the corresponding equation values. A simple case is fitting a straight line to a set of data $(x_i, y_i)$ to obtain the equation $\hat{y} = a + bx$. Multiple linear regression includes the application of the least-squares principle to any form of relationship between a dependent variable $y$ and several "independent" Factors $x_{1i}$, $x_{2i}$ … $x_{ki}$, or explicit functions of the $x_{ji}$, that is "linear with respect to the constants to be fitted". Non-linear regression, which requires one or another iterative-search method, deals with relationships that are not linear in the constants sought. Powerful programs for all these techniques are now available for personal computers. Regression equations provide the vehicle for estimating the outcomes of future experiments in the systems investigated, with known errors of estimate. They have been a powerful tool in polymer science, plastics processing, compound development, and in estimating future performances of plastics products in service.

**Regrind** *n.* Thermoplastic waste material such as sprues, runners, excess parison material, sheet trimmings, and rejected parts from molding, extrusion, and thermoforming operations that has been reclaimed by shredding or granulating. Regrind is usually mixed with virgin compound at a pre-determined percentage for remolding, etc.

**Regular block** *n.* In the chemical structure of polymers, a block that can be described by only one species of mer in a single sequential arrangement (IUPAC, slightly modified).

**Regular polymer** *n.* A polymer whose molecules can be described by only one species of mer in a single sequential arrangement (IUPAC).

**Regulator** In polymerization reactions, a chain-transfer agent used at low concentration to limit the molecular weight of the polymer.

**Reichert–Meissl value** *n.* The number of ml of *N*/10 potassium hydroxide solution required to neutralize the free volatile and soluble fatty acids in 5g of the sample under test.

**Reinforced molding compound** *n.* A compound containing reinforcing fibers and supplied by the raw-material producer in the form of ready-to-use material, as distinguished from premix.

**Reinforced plastic (RP)** *n.* A plastic composition in which are embedded fibers that are much stronger and typically much stiffer than the matrix resin. The reinforcements are usually fibers, rovings, fabrics, or mats, or mixed forms of glass, carbon, asbestos, metals, ceramics, paper, sisal, cotton, or nylon. Resins most commonly used are polyesters, phenolics, aminos, silicones, epoxies, and various thermoplastics. The term reinforced plastic includes some forms of laminate and molded parts in which the reinforcements are not in layered form. When the resin is thermoplastic, the term reinforced thermoplastic is often used. Methods of forming reinforced-plastics articles from thermosetting resins are defined under the entries listed below.

Axial winding
Bag molding
Centrifugal casting
Ceraplast
Contact-pressure molding
Fiberfill molding
Filament winding
Furan prepreg impregnation
Laminate
Lap winding
Lay-up molding
Low-pressure laminate
Matched-metal-die molding
Perform
Premix
Prepreg
Prepreg molding
Pulforming
Pulp molding
Pultrusion
Reaction injection molding
Resin-transfer molding
Reverse helical winding
Sheet-molding compound
Slurry performing
Spray-up

Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH. James F, Carley (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., USA.

**Reinforced thermoplastic (RTP)** *n.* A reinforced structure in which the bonding resin is a thermoplastic rather than a thermoset. Over the past two decades, applications for RTP have grown rapidly, mainly based on nylons, polycarbonates, acetal resins, polystyrene, polypropylene, and advanced resins. The tensile strength and modulus of a thermoplastic can be at least doubled by the addition of glass reinforcement, and creep under load is greatly decreased. Because thermoplastics are remeltable, RTPs are most commonly produced as palletized molding compounds for injection molding.

**Reinforcement** *n.* A strong, inert, fibrous material incorporated in a plastic mass to improve mechanical properties. Typical reinforcements are asbestos, boron fiber, carbon fiber, ceramic fiber, flock, glass–fiber reinforcement, graphite, jute, mica, sisal, and whiskers. Others sometimes used are chopped paper, macerated fabrics, synthetic fibers, and metal wires. To be effective, a reinforcement must form a strong adhesive bond with the matrix resin, to which end adhesion, promoting substances known as coupling agents are often pre-applied to the fibers. Reinforcements differ from fillers in that they markedly improve modulus and strength, whereas filler do not.

**Reinforcement fabrics** *See geotextiles.*

**Reinforcing pigment** *n.* A pigment that also serves to improve the strength of the finished product. An example is carbon black.

**Related shades** *n.* Colors of similar tone in the same or different depths.

**Relative** \ˈre-lə-tiv\ (15c) *adj.* Comparative; specifically applied to measurements made relative to a reference standard, which values are dependent on the method of measurement used, as opposed to absolute measurements made in fundamental units and obtainable by different methods.

**Relative density** Syn: specific gravity.

**Relative dry hiding power** *n.* Of a paint is the ability of that paint to reduce the contrast of a black and white surface to which it is applied and allowed to dry, It is quantitatively expressed in terms of the proportional spreading rate of paint required to produce the same contrast reduction as obtained with the paint chosen as standard.

**Relative humidity (1820) (RH)** *n.* The ratio, always expressed in percent, of the quantity of water vapor present in the ambient atmosphere to the quantity that would saturate it at the prevailing temperature. It is also the ratio of the partial pressure of water vapor present to the vapor pressure of water at the prevailing temperature. High relative humidity, which occurs in summer in many manufacturing-plant atmospheres, can cause condensation of water on chilled surfaces such as injection molds, with attendant mold defects. It can also cause blushing problems in the painting of plastics and metals.

*See also humidity and humidity, relative.*

**Relative leveling** *n.* A measure of the ability of a coating to flow out after application so as to obliterate any surface irregularities, such as brush marks or orange peel or peaks and craters, which have been produced by the mechanical process of applying the coating. The term is used with the "0"–"10" scale of leveling ratings of ASTM Method D 2801. Leveling Characteristics of paints by Draw-down method.

**Relative standard deviation** (1894) *n. See coefficient of variation.*

**Relative viscosity** *n.* The ratio of the kinematic viscosity of a specified solution of the polymer to the kinematic viscosity of the pure solvent. This can also be written as the ratio of the viscosities of pure solvent ($\eta_{\mathrm{solv}}$) and a solute in solution ($\eta_{\mathrm{sol}}$) at a concentration according to the method of calculating the Staudinder idex [$\eta$]:

$$\eta_{\mathrm{sol}}/\eta_{\mathrm{solv}} = \eta_{\mathrm{rel}}.$$

Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Pethrick RA, Pethrick RA (eds) (1999) Modern techniques for polymer characterization. John Wiley and Sons, New York. Staudinger H, Heuer WA (1930) Relationship between the viscosity and the molecular weight of polystyrene. *Ber* 63B:222-234 (German). Collins EA, Bares J, Billmeyer FW Jr (1973) Experiments in polymer science. Wiley-Interscience, New York.

*See also dilute-solution viscosity.*

**Relaxation** \ˌrē-ˌlak-ˈsā-shən, ri-ˌlak-, *esp British* ˌre-lək-\ (1548) *n.* A gradual decrease in stress in a structure under sustained constant strain.

*See stress relaxation.*

**Relaxation-map analysis (RMA)** *n.* A technique used on the results of a series of thermally stimulated current experiments in which the TSC data are transformed into relaxation times and plotted versus reciprocal absolute temperature to estimate enthalpy and entropy of activation for the molecular relaxations.

**Relaxation time** *n.* Of a viscoelastic material under constant strain (specifically, one behaving as a Maxwell element), the time required for the stress to diminish to $1/e$ (=0.368) of its initial value. Compare retardation time.

**Relaxed yarn** *n.* A yarn treated to reduce tension and produce more uniform shrinkage or torque. Relaxation produces more uniform dyeing characteristics in regular filament yarns of nylon or polyester.

**Release agent** *See mold wash and parting agent.*

**Release paper** *n.* A layer of paper which can be readily separated from the surface of a plastic article to which it has been applied or against which the plastic article has been formed. The term applies to papers used to protect the surfaces of plastic sheets, to temporary backings for pressure-sensitive adhesives, and to papers used as temporary carriers in film- and foam-casting processes.

*See also transfer coating.*

**Releasing liquid** *n.* A base for receiving printed matter, which base later can be removed by treatment with a solvent, e.g., water or alcohol.

**Relief** \ri-ˈlēf\ [ME, fr. MF, fr. OF, fr. *relever* to relieve] (14c) *n.* Decoration in which the design is given prominence by cutting away the background.

**Relief angle** In an injection or blow mold, the relief angle is the angle between the narrow pinch-off land and the cutaway portion adjacent to the pinch-off land.

**Relief offset** *n.* Process using a relief plate on an offset press.

**Relief printing** (1875) *n.* Process utilizing those portions of the matrix which are in relief for taking ink from a supply roller and transferring it to the surface to be printed.

**Relset® process** *n.* A process of Richen Inc., for continuous heat-setting of carpet or other heavy yarns. Individual ends are continuously fed into a heat-setting chamber and withdrawn into take-up cans or fed to winders.

**Reluctance** \ri-ˈlək-tən(t)s (1710) *n.* That property of a magnetic circuit which determines the total magnetic flux in the circuit when a given magnetomotive force is applied. Unit, the reluctance of 1 cm length and 1 cm$^2$ cross-section of space taken in a vacuum. Dimensions $\left[E\,L\,T^{-2}\right]$, $[\mu\,L^{-1}]$.

**Reluctivity** *n.* Reluctivity or specific reluctance is the reciprocal of magnetic permeability. The reluctivity of empty space is taken as unity. Dimensions $\left[E\,L\,T^{-2}\right]$, $[\mu\,L^{-1}]$.

**Remover** *See paint and varnish remover.*

**Render** \ˈren-dər\ ME *rendren*, fr. MF *rendre* to give back, yield, fr. (assumed) Vulgar L *rendere*, alter. of L *reddere*, partly fr. *re-* +

*dare* to give & partly fr. *re-* + *-dere* to put] (14c) *v.* To cover (brick, wood, or stone) with a first coat of plaster.

**Rennet casein** *n.* A type of casein precipitated from milk to means of rennet, the dried extract of stomach secretions from calves or other ruminants containing the enzyme rennin.

*See also casein and casein plastic.*

**Repact order** *n.* (1) An order requiring special packaging, as for export. (2) A small order for a number of items requiring a breakdown of large case.

**Repainting** *n.* Cleaning and recoating (with similar materials) of extensive areas which are being redecorated or on which the existing coatings have deteriorated, or otherwise do not provide adequate protection.

**Repeat** (15c) *n.* (1) The printing length of a plate cylinder as determined by one revolution of the plate cylinder gear. (2) The distance covered by a single unit of a pattern that is duplicated over and over, measured along the length of a fabric.

**Repellency** \ri-ˈpe-lən(t)sē\ (1747) *n.* The ability to resist wetting and staining by oils, water, soils, and other materials.

**Representative element** *n.* A member of one of the main, or a, groups in the periodic table.

**Reprocessed plastic** *n.* Thermoplastic material that has been left over from molding, extrusion, or thermoforming, such as sprues and runners, sheet, trim, trim between thermoformed parts, and rejected parts, then molded, extruded, or thermoformed again into useful articles by other than the original processors.

*See also recycled plastic.*

**Reprography** \ri-prä-grə-fē\ [*repro*duction + *-graphy*] (1956) *n.* A term coined in 1963 to cover the arts and sciences involved in the copying and duplicating of information by photographic, mechanical or reprinting in quantities below the commercial printing level. The American heritage dictionary. Houghton Mifflin Co., New York, 1996–2004.

**Rescue orange** *n.* Special color used for lifebelts and life rafts, etc., to improve visibility at sea.

**Resene, *β*** *n.* Dammar is a mixture, and one of its constituents is *β* resene, sometimes known as dammar wax. It is this material which is removed in the so-called dewaxing process, which is an essential operation to make the dammar suitable for use in nitrocellulose lacquers.

**Resenes** *n.* (1) Alkali-resistant constituents of certain natural resins, e.g., dammar, and characterized by the presence of oxygen. The resenes are not, however, acids, aldehydes, esters, ketones, or lactones. (2) As applied to naval stores, those constituents of rosin which cannot be saponified with alcoholic alkali, but which contain carbon, hydrogen, and oxygen in the molecule.

**Reserve dyeing** *See dyeing.*

**Residual monomer** *n.* The unpolymerized monomer that remains incorporated in a polymer after the polymerization reaction has been completed. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Harris DC (2002) Quantitative chemical analysis. W. H. Freeman Co., New York.

**Residual shrinkage** *n.* A term describing the amount of shrinkage remaining in a fabric after finishing, expressed as a percentage of the dimensions before finishing.

**Residual solvent** *n.* Solvent, usually polymerization solvent, remaining in an unfinished resin, or a pelletized resin ready for market, or solvent remaining in a solvent-cast film after drying. Either is usually expressed as a weight percent.

**Residual strain** *n.* Strain remaining in a part that has been chilled while undergoing plastic deformation or immediately thereafter. Often, if the part is reheated, some or nearly all of the strain may be recovered. Usually associated with residual stress.

**Residual stress** (frozen-in stress) *n.* Stress remaining in a part that has been chilled quickly during or after molding, extrusion, or forming. It remains because there was too little time for the stress to relax while the material was soft. Over time, high residual stress can cause parts to warp and shrink. It can be relieved and rendered harmless by annealing residually stressed parts while restraining them in fixtures.

**Residual tack** *n.* Tackiness remaining in a film which, although set, does not reach the really tack-free stage.

*See tack.*

**Resilience** \ri-ˈzil-yən(t)s\ (1824) *n.* (1) The degree to which a body can quickly resume its original shape after removal of a deforming stress. When the body is a standard test specimen, the resilience, expressed as the percentage recovery from a stated maximum strain, may be attributed to the material from which the specimen was made. ASTM tests D 926 and D 945 (Section 09.01) describes compression and shear tests for resilience of rubber and foam rubber. (2) The fractional return, to an impacting body, of the energy with which it strikes a resilient test specimen. ASTM D 1054 details a pendulum-rebound test, while D 2632 and D 3574 describe drop-weight-rebound tests, all employing this principle and all in Section 09.01.

**Resiliency** \-yən(t)-sē\ (ca. 1836) *n.* Ability of a fiber or fabric to spring back when crushed or wrinkled.

**Resin** \ˈre-zᵊn\ [ME, fr. MF *resine*, fr. L *resina*; akin to Gk *rhētinē* pine resin] (14c) *n.* The term *resin* is defined by ASTM D 883 as a solid or pseudosolid material, often of high molecular weight, that exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. A note appended to this definition explains that in a broad sense, the term is used to designate any polymer that is a basic material for plastics. However, common uses of the term in the plastics industry do not always conform to this definition. The term is also used foruncured fluid thermosetting materials, some chemically modified natural resins, and often synonymously with the terms *plastic* and *polymer.* Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001. Flick EW (1991) Industrial synthetic resins handbook. Williams Andrews Publishing/Noyes, New York.

**Resinamines** *n.* Resinous basic products obtained from low temperature tar.

**Resin applicator** In filament winding, a device that deposits the liquid resin onto the reinforcement band.

**Resinates, metallic** *n.* Rosin in which part or all of the rosin aids have been chemically reacted with those metals, which give soaps or salts, which are water insoluble. Limed rosin, zinc-treated rosin, and the resinates of lead, cobalt, copper, and manganese, are of the greatest importance.

**Resin content** The percentage, by weight or volume, or resin in a laminate or filled or reinforced thermoplastic molding.

**Resin emulsion paint** *n.* A water paint consisting of a water emulsion of an oil-modified alkyd or other resin; when dry, leaves a tough film of resin.

**Resin, natural** *n.* When certain trees and other plants are wounded, either by natural accident or by tapping, they exude liquids that harden or partially harden upon exposure to air to form resinous or balsam-like products. Deposits of such secretions undergo chemical changes – oxidation and polymerization – when buried for long periods, forming solid or semi-solid products that are soluble in oils and organic liquids but insoluble in water. Such water-insoluble resins are generally known as the natural resins, sometimes called *varnish resins.* Those that are water-soluble are known as gums or essential oils. Examples of natural resins are accroides (acaroid resin), amber, Canada balsam, Congo copal, dammar, elemi, Kauri copal, and sandarac. They are used in varnishes and lacquers, also as modifiers for plastics. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

**Resinography** *See polymerography.*

**Resinoid** \ˈre-zᵊn-ˌóid\ (1880) *n.* Any of the class of thermosetting synthetic resins, either in their initial temporarily fusible state or in their final infusible state.

*See also Novolak and thermosetting.*

**Resin oil** *See tall oil.*

**Resinous timber** *n.* Wood from certain trees, which contain resinous material in the cells. The resins have high solvent power for many paints and paint media. This resin frequently exudes through paint films applied to such wood, especially in sunny positions.

**Resin picket** *See pitch pocket.*

**Resin pocket** *n.* An apparent accumulation of excess resin in a small localized area between laminations in a laminated-plastic article, visible on a cut edge or a molded surface.

**Resin-rich area** *n.* A region in a reinforced-plastic article in which there is an objectionable excess of resin.

**Resin-starved area** (dry spot) *n.* An area of a reinforced-plastic article that has an insufficient amount of resin to wet out the reinforcement completely, evidenced by low gloss, dry spots, or exposure of fiber. The condition may be caused by improper wetting or impregnation, or by excessive molding pressure.

**Resin streak** *n.* A long, narrow surface imperfection on the surface of a laminated plastic caused by local excess of resin.

**Resin, synthetic** (synthetic polymer). A Resin that has been produced from simple materials, or intermediates made from such chemicals, by either addition or condensation polymerization. Of the commercial plastics, all but the cellulosics are based on synthetic resins. Among commercial elastomers, only natural rubber, or refined from the sap of the *Hevea* tree, is natural.

**Resin, synthetic** *n.* Originally, a member of a group of synthetic substances which resemble and share some of the properties of natural resins, but now used for materials which bear little resemblance to natural resins. The term is generally understood to mean a member of the heterogeneous group of compounds produced from simpler compounds by condensation and/or polymerization. Chemically modified natural polymers, such as cellulose acetate and hardened casein, are not considered to be synthetic resins. Flick EW (1991) Industrial synthetic resins handbook. Williams Andrews Publishing/Noyes, New York.

*See polymer and resin, natural.*

**Resin transfer** *n.* Resin transfer molding is a variation of matched-metal-die molding in which, after placing the preformed reinforcement in the heated mold, premixed, quick-curing resin is injected while the mold is closing or after it has closed.

**Resin transfer molding (RTM)** *n.* A variation of matched-metal-die molding in which, after placing the preformed reinforcement in the heated mold, premixed, quick-curing resin is injected while the mold is closing or after it has closed. The technique has been used to make body parts for specialty cars and aircraft components.

**Resin treated** *n.* Usually a term descriptive of a textile material that has received an external resin application for stiffening or an internal fiber treatment (especially of cellulosics) to give wrinkle resistance or permanent press characteristics.

**Resist** \ri-ˈzist\ (1836) *n.* (1) In preparing zinc printing plates, a material, such as wax, that covers the areas of the plate that are not to be etched by acid (*acid resist*); or, in electroplating, a material that covers areas that are not to be plated. (2) In photolithography and microlithography, widely used in making solid-state electronic devices and printed circuits, a thin film, applied over a substrate, whose solubility in a developer solvent is reduced (negative resist) or enhanced (positive resist) by exposure to UV or other radiation. In polymeric resists, the mechanism of solubility reduction is cross-linking and of solubility enhancement, chemical reaction or chain scission. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (1993) Printing ink manual, 5th edn. Blueprint, New York. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 1976.

**Resistance** \ri-ˈzis-tən(t)s\ (14c) *n.* A property of conductors depending on their dimensions, material and temperature, which determines the current produced by a given difference of potential. The practical unit of resistance, the *ohm* is that resistance through which a difference of potential of 1 V will produce a current of 1 A. The *international ohm* is the resistance offered to an unvarying current by a column of mercury at 0°C, 14.4521 g in mass, of constant cross-sectional area and 106.300 cm in length, sometimes called the legal ohm. Dimensions $[\varepsilon^{-1}\,L^{-1}\,T]$, $[\mu\,L\,L^{-1}]$.

**Resistance heating** *n.* Heating by means of dissipation of electrical energy in resistive circuit elements. The rate of heating (W) is given by the quotient of the square of the voltage drop across the heater ($V^2$) divided by its at-temperature resistance ($\Omega$), also by the product of the voltage drop and the current (VA).

**Resistance of a conductor** *n.* At 0°C, of length *l*, cross-section *s* and specific resistance $\rho$,

$$R_0 = \rho \frac{1}{s}.$$

The resistivity may be expressed as ohm-cm when *R* is in ohm, *l* in cm and *s* in cm$^2$, $R_t = R_0(1 + \rho l)$. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York, New York.

**Resistance of conductors in series and parallel** *n.* The total resistance of any number of resistances joined in series is the sum of the separate resistances. The total resistance of conductors in parallel whose separate resistances are $r_1, r_2, r_3, \ldots, r_n$ is given by the formula

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \cdots + \frac{1}{r_n} c,$$

where *R* is the total resistance. For two terms, this becomes

$$R = \frac{r_1 r_2}{r_1 + r_2}.$$

Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York, New York.

**Resistance, specific (resistivity)** A proportionality factor characteristic of different substances equal to the *resistance* that a centimeter cube of the substance offers to the passage of electricity, the current being perpendicular to two parallel faces. It is defined by the expression:

$$R = \rho \frac{l}{A},$$

where $R$ is the resistance of a uniform conductor, $l$ is its length, $A$ is its cross-sectional area, and $\rho$ is its resistivity. Resistivity is usually expressed in ohm-cm. Giambattista A, Richardson R, Richardson B (2003) College physics. McGraw-Hill Science, New York, New York.

**Resistance thermometer** *n.* A temperature-measuring device consisting of an encapsulated, fine coil of platinum wire whose resistance increases substantially and nearly linearly with rising temperature. The change in resistance is sensed and converted to a temperature reading. Resistance thermometers have found considerable use in plastics processing.

*See thermistor.*

**Resistance welding** *See thermoband welding.*

**Resist dyeing** *See dyeing, reserve dyeing.*

**Resistivity** \ri-ˌzis-ˈti-və-tē\ (1885) (specific resistance) *n.* (1) When this word stands alone, it usually means volume resistivity. (2) The electrical resistance of a body of unit length and unit cross-sectional area or unit weight. Reciprocal of conductivity.

*But also see surface resistivity.*

**Resist printing** *See printing.*

**Resist technique** *n.* Taping a fine line effect over a surface, and then blocking out the rest of the area and spraying into the opening left by the tape.

**Resite** *n.* A phenol-formaldehyde resin in the final state of the curing process. In this stage it is insoluble in alcohol and acetone, and infusible. Alternate term for C-stage.

*See C-stage; also called resitol and resol.*

**Resitol** *n.* A phenol-formaldehyde resin in the transition state of the curing process. Under heating it softens to rubber-like consistency but without melting. It swells when it is immersed in alcohol or acetone, but does not dissolve. Alternate term for B-stage.

*See B-stage, resite, resol, and resolite.*

**Resol** *n.* A flusible, soluble, and phenolic resin containing sufficient reactive methylol groups to enable the resin to become infusible on further reaction. Alternate term for A-stage.

*See Novolak.*

**Resolite** Syn: a resin at its B-stage.

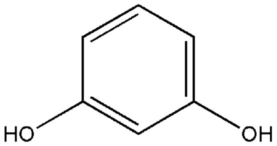
**Resolving power** *n.* The resolving power of a telescope or microscope is indicated by the minimum separation of two objects for which they appear distinct and separate when viewed through the instrument.

**Resonance** \ˈre-zən-ən(t)s, ˈrəz-nən(t)s\ (15c) *n.* In chemistry, the periodic cycling of electrons from one atom of a molecule or ion to another atom of the same molecule or ion. Thus, given atoms remain in a fixed spatial arrangement with their electrons oscillating between atoms so as to satisfy two (or more) possible structural formulas. Resonance was first conceived to account for the outstanding stability of the benzene ring and it took almost a century for researchers to prove its reality. A large-amplitude vibration of a mechanical or electrical system caused by a relatively small periodic stimulus applied at the natural frequency of the system. It is a phenomenon to be avoided in most structures. That is done by designing the natural frequency and the first few harmonics to be very different from the loading frequencies expected during use. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

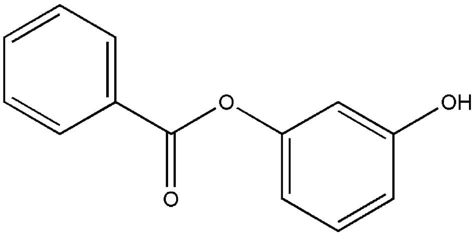
**Resonance (chemical)** *n.* The moving of electrons from one atom of a molecule or ion to another atom of that molecule or ion. It is simply the oriented movement of the bonds between atoms. Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Resonance hybrid** *n.* A structure which cannot be represented by a single valence-bond Lewis structure but rather is shown as a combination, or average, of two or more structures.

**Resorcinol** \-ˌól, -ˌōl\ (1881) (resorcin, *m*-dihydroxybenzene, 3-hydroxyphenol) *n.* $C_6H_6O_2$. A white, needlelike, water-soluble solid, a benzene derivative (1,3-substituted with two hydroxy groups) originally obtained from certain resins, now usually synthesized. When reacted with formaldehyde, produces resins suitable for cold-setting adhesives (*See image*).



**Resorcinol monobenzoate** *n.* A white, crystalline solid used as an ultraviolet screener in plastics. It is particularly useful in applications requiring a high degree of transparency, and can be used with cellulosics, vinyls, and certain polyesters (*See image*).



**Resorcinol test** Used to detect the presence of phthalic acid in phthalate plasticizers or alkyd resins. It involves heating the product under test with concentrated sulfuric acid and resorcinol, and pouring the resulting mixture into excess of an alkaline solution. If phthalic acid is present, the fluorescein produced yields its characteristic yellow-green color.

**Resox** *n.* A contraction (and reversal) of the term "exudation–reduction". A *redox catalyst* is one entering into an oxidation–reduction reaction. A polymerization initiator comprising a mixture of a peroxide and a reducing agent is called a *redox initiator.* Polymers formed by such reactions are sometimes called *redox polymers.*

**Restitution, coefficient of** *n.* For two bodies on impact. The ratio of the difference in velocity, after impact to the difference before impact.

**Restraint systems** *n.* An end use for textile fibers; restraint systems are devices such as air bags, seat belts, and shoulder harnesses for passenger protection in automobile, trucks, airplanes, etc.

**Restricted gate** *n.* A small orifice between runner and cavity in an injection or transfer mold. Such a gate freezes (or cures) quickly when the cavity has filled and flow stops, preventing packing of the region near the gate in the cavity. When the piece is ejected, this gate breaks cleanly, simplifying separation of the runner from the molded item. It may be so small (*see pinpoint gate*) that its tiny stub need not be removed from the piece.

**Restrictor bar** Syn: choker bar.

**Restrictor ring** *n.* A ring-shaped part protruding from the torpedo surface within the cylinder of a plunger-type injection machine. It was claimed that the ring provided higher injection pressure on the melt, higher rate of filling the cavities, and improved weld strength.

**Retainer plate** *n.* In injection molding, a plate that reinforces the cavity block against the injection pressure, and also serves as an anchor for the cavities, ejector pins, guide pins, and bushings. The retainer plate is usually cored for circulating water or steam.

**Retaining pin** *n.* A pin in an injection or transfer mold on which an insert is placed and located prior to molding. The term is sometimes used to mean *guide pin* or *dowel pin*.

R

**Retardation** \ˌrē-ˌtär-ˈdā-shən, ri-\ *n.* (1) To reduce the rate at which a polymer is formed. Retardation occurs as a result of a reaction between the chain-initiating species and the inhibitor or retarder. (2) The actual distance of one of the doubly refracted rays behind the other as they emerge from an anisotropic particle. It depends on the difference in the two refractive indices, $n_2 - n_1$, and the thickness.

**Retardation time** *n.* Of a stressed viscoelastic material (specifically, one behaving like a Voigt element), the time required after release of stress for the strain to decrease to $1/e$ (=0.368) of its original value.

**Retarder** (1) Generally, a component added to a composition to slow down a chemical or physical change. A slowly evaporating solvent may be added to a paint, varnish or lacquer to delay the set of the film after application and so improve the application properties, or to give a better film, e.g., one with improved flow, or a retarder may be added to plaster to retard its setting. (2) In flexography, gravure and heatset printing, high boiling solvent added to ink to slow the evaporation rate. (3) In letterpress and offset. (4) A material which in small amount added to a rubber compound retards vulcanization or slows down the activity of the accelerator. Specifically, phthalic anhydride and salicylic acid are retarders. The most valuable retarder is one which slows the vulcanization at processing and early curing temperatures, but does not affect or may even activate the rate of cure at full curing temperatures. Syn: inhibitor. (5) A chemical that, when added to the dyebath, decreases the rate of dyeing but does not affect the final exhaustion. Kirk–Othmer encyclopedia of chemical technology. Wiley-Interscience, New York, 1998. Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL. James F, Carley (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., USA.

*See antioxidant.*

**Retarders** *n.* (1) In flexography, gravure and heatset printing high boiling solvents added to ink to slow the evaporation rate. (2) In letterpress and offset.

*See antioxidant.*

**Reticulated polyurethane foam** *n.* A urethane foam of extremely low density, characterized by a three-dimensional skeletal structure of strands with dew or no membranes between the strands, and containing up to 97 + % of void space. Such foams are made by treating an open cell foam structure with a dilute aqueous sodium hydroxide solution under controlled conditions so that the thin membranes are dissolved, leaving the strands substantially unaffected. Ultrasonic vibrating is sometimes used to assist the solution process. These foams are used in filters for air conditioners, automobile carburetors, and air-cleaning systems; and in acoustical panels, humidifiers, and various household products.

**Reticulation** \ri-ˌti-kyə-ˈlā-shən\ (1671) *n.* The crepe-like appearance of the surface of the colloid on collotype plates.

**Retina** \ˈre-tᵊn-ə, ˈret-nə\ [ME *rethina*, fr. ML *retina*, prob. fr. L *rete* net] (14c) *n.* The light-sensitive layer and highly organized neuron structure within the choroids, and lining the posterior two thirds of the eyeball. This is the part of the human eye that is responsible for detecting color.

**Retinal** \ˈre-tᵊn-əl, ˈret-nəl\ (1838) *adj.* Of or pertaining to the retina.

**Retort pine tar** *See pine tar, retort.*

**Retouching** *See spotting in.*

**Retrogradation** (ca. 1545) *n.* (a) A change of starch pastes from low to high consistency on aging.

**Retroreflective** (ca. 1965) *n.* A retroreflective surface or device is one which reflects in incident ray of light back along the direction of incidence with only limited spread, without requiring the incident ray to be normal to the surface. Such a surface or device differs from both a perfect diffuser and a perfect mirror. It may utilize small triple-reflection cube corners, small transparent spheroids, multiple hemispheric indentations, a multiple lens sheet backed by a reflective surface, or some simple derive.
*See reflex reflector.*

**Return pin** *n.* In injection molding, any of the set of pins that return the ejector mechanism to its molding position.

**Reverse-flighted screw** *n.* A short section of a screw in a twin-screw extruder in which the flights have a helical direction opposite to that of the main screw sections, thus opposing the forward flow of the heat-softened plastic. The purpose is to improve mixing and dispersion of compound ingredients such as pigments, and sometimes to heat the melt just before it enters a vacuum-extraction zone. Reverse-flight sections have rarely been used in single-screw machines.

**Reverse helical winding** *n.* In filament winding, a pattern in which a continuous helix is laid down, reversing direction at each of the polar ends. It differs from biaxial compact, or sequential winding in that the fibers cross each other at definite equators, the number depending on the helical lead, with the minimum number of crossovers being three.

**Reverse impact test** *n.* A test for sheet material in which one side of the specimen is struck by a pendulum or falling object and the reverse side is inspected for damage.
*See impact test.*

**Reverse printing** *n.* (1) Printing on the underside of a transparent film. (2) Design in which the copy is "dropped out" and the background is printed.

**Reverse-roll coating** *n.* A method of coating wherein the coating material is premetered between two rolls, one of which deposits the coating on a substrate. The thickness of the coating is controlled by the gap between the rollers and also by the speed of rotation of the coating roll.

**Reversible bonded fabric** *n.* A bonded structure in which two face fabrics are bonded together so that the two sides may be used interchangeably. There are limitations to the fabrics that may be used because of increased fabric stiffness resulting from bonding.

**Reversible colloid** *n. See colloid, reversible.*

**Reversible reaction** *n.* One which can be caused to proceed in either direction by suitable variation in the conditions of temperature, volume, pressure or of the quantities of reacting substances.

**Reversion** *n.* A reduction in the modulus and tensile strength of a rubber vulcanizate as a result of prolonged thermal ageing. It occurs in sulfur vulcanized rubbers containing polysulphide cross-links that have been over cured or during exposures to temperatures above 150°C. Reversion is due to a breakdown in the network structure, probably as a result of cross-link forming cyclic structures. Reversion can be also defined as the recombination of the hydrolysis products of polysaccharides. The softening of vulcanized rubber (usually natural but sometimes synthetic rubber) when heated too long or at too high a temperature. Reversion is evidenced by increase in extensibility, decrease in tensile strength, and lowering of the stress to produce a given elongation. Extreme reversion usually results in tackiness. Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York.

**Revolving spinning ring** *n.* A driven ring that rotates in the direction of the traveler on a ring spinning frame. Since both the ring and the yarn package turn when this ring system is used, productivity is increased.

**Rewind** *n.* In the coil coating industry, the apparatus used to recoil the strip after it is coated.

**Reworked material** *n.* A thermoplastic from a processor's own production that has been reground, pelletized, or solvated, after having been previously processed by molding, extrusion, etc. *Note*—In many specifications the use of reworked material is limited to clean plastic that meets the requirements specified for the virgin material, and yields a product essentially equal in quality to one made from only virgin material (ASTM D 883).
*See also regrind.*

**Reynolds number (*Re*, $N_{Re}$)** \ˈre-nᵊldz-\ [Osborne *Reynolds* † 1912 English physicist] (1910) *n.* The Reynolds number *Re* is the ratio of kinetic energy to viscous energy; the equation is

$$Re = 2rds/\nu_d = 2rs/\nu_k,$$

where $s$ is the speed of the fluid, cm/s, $r$ the radius of tube, cm, $d$ the fluid density, $\nu_d$ the dynamic viscosity, Poise (dyn-s/cm$^2$), $\nu_k$ the kinetic viscosity in Stokes ($\nu_d/d$), $Re$ is the Reynolds number; small $Re$ means that the fluid's viscosity is dominant, large $Re$ (10,000) means viscosity is negligible and the kinetic or inertia effects rule; when $Re$ is high, turbulent, cavitations and chaos describe the flow, when $Re$ is low, laminar flow dominates. (2) A dimensionless ratio that relates to frictional pressure drop in fluid flow in pipes, defined by $DV\rho/\mu$ for gasses and Newtonian liquids, where $D$ is the inside pipe diameter, $V$ the average velocity of the fluid (=flow rate/cross-section), $\rho$ the fluid density, and $\mu$ is the mass-based viscosity (Pa = kg/ms in SI units). When $N_{Re}$ = 2100–4000, the character of the flow ranges from streamline (laminar) to turbulent. For non-Newtonian liquids the criterion for flow transition by the Reynolds number is redefined. For a power-law liquid it becomes $D^n V^{2-n}\rho/g_c K 8^{n-1}$, where $n$ is the flow-behavior index of the liquid, $K$ the temperature-dependent consistency index, and $g_c$ is the proportionality constant in Newton's law of momentum change. The Reynolds number is also applicable to other flow geometries, such as packed beds, with appropriate modifications.Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York. *See power law.*

**R-factor** *n. See thermal resistance.*

**RF curing** *n.* Hastening the final cross-linking of thermosetting compounds and laminates by application of radio-frequency energy.

**RF heating** Syn: dielectric heating.

**RF shielding** *n.* Enclosing equipment that generates radio-frequency radiation in a conductive housing that prevents the radiation from being broadcast and causing interference in nearby electronic devices that operate in the same frequency range. Required by law for all RF-heating equipment except that operating at 27.12 MHz, the frequency band reserved for industrial use.

**RH** *n.* Abbreviation for relative humidity.

**Rhe** *n.* In the now deprecated cgs system, the rhe was the unit of fluidity, equal to 1 P$^{-1}$ [10 (Pa s)$^{-1}$]. (2) The cgs unit of measurement of fluidity. A material has a fluidity of 1 rhe when a shearing force of 1 dyne/cm$^2$ induces a rate of shear of 1 cm/s.

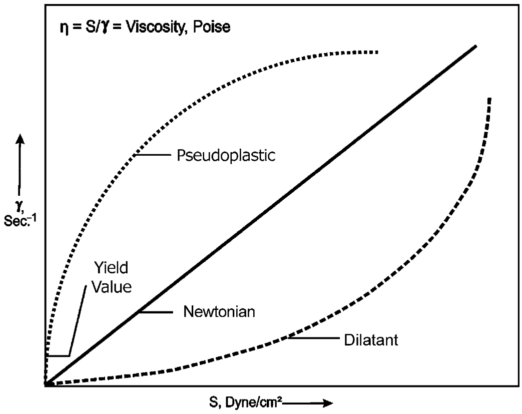
**Rheogoniometer** *See Weissenberg rheogoniometer.*

**Rheological** \re-ˈä-lə-jē-\ [ISV] (1929) *n.* Refers to rheology.

**Rheological properties** *n.* The properties of viscous substances including polymers that deal with deformation and flow. Includes viscosity and flow rate measurements.

**Rheology** \re-ˈä-lə-jē\ [ISV] (1929) *n.* Viscosity refer to how thick a liquid is or how easily it flows. A viscometer measures the resistance to flow of a rotating probe in a liquid in units of dyne cm/s. Viscosity is the study of deformation and flow of matter. Rheology, derived from the Greek *rheos* meaning "something flowing", was proposed by Bingham in 1929 for the rapidly growing science of flow and deformation properties of materials, including liquids, solids, and even powders, in terms of stress, strain rates, and time. The following plot demonstrates the behavior of pure liquids (usually Newtonian), dispersions (pseudoplastic and dilatant). Gooch JW (1997) Analysis and deformulation of polymeric materials. Plenum Press, New York. ASTM, D 5165-93 (2004). Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York.

*See dilatancy, Newtonian, non-Newtonian, thixotropy, rheopectic, viscoelasticity, viscosity and Bingham body, and yield value.*



Rheology curves of liquids and dispersions.

**Rheomalaxis** Some fluids demonstrate shear-thinning due to a break-down or "degradation of structure", and this phenomenon is known as *rheomalaxis* and an example is the shearing of gypsum paste, whereas an example of thixiotropic phenomenon is shearing of paint. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK. Patton TC (1979) Paint flow and pigment dispersion. John Wiley and Sons, New York. Mercurio A

(1964) Rheology of acrylic paint resins. Canadian Paint and Varnish, ON.

**Rheometer** \rē-ˈa-mə-tər\ [ISV] (ca. 1859) (plastometer) *n.* An instrument for measuring the flow behavior of high-viscosity materials such as molten thermoplastics, rubbers, pastes, and cements. The most widely used principle is that of the capillary rheometer of which a variety of makes and models are in daily use. Instruments for measuring the flow properties of less viscous fluids, e.g., dilute polymer solutions, are called viscometers but the terms *rheometer* and *viscometer* are often used interchangeably. Currently, computerized, on-line capillary rheometers linked to a single control station can simultaneously monitor melt viscosity in ten or more extruders in a resin-finishing plant.

**Rheometer, foam** *n.* A special type of capillary rheometer developed by W. Kostyrzewski to measure the density and viscosity of foaming polyurethane immediately after mixing. Creaming time is also measured. It consists of a three-section vertical acrylic tube, adapted at the bottom to a reaction–injection-molding mixer (RIM machine). The bottom chamber is large enough to contain the mix charge delivered by the RIM machine, and the mixture rises through an instrumented and temperature-controlled "capillary" as the foam forms and expands. The instruments are connected to an analog-to-digital converter and computer. The foam passes up through the capillary into a larger-diameter collection chamber and raises a floating disk that can be weighted to adjust the pressure on the foam as it rises. Flow rate is inferred from foam density; rate of change of density, and shear rate at the capillary wall are computed from flow rate. Shear stress is inferred from the pressure-transducer readings.

**Rheopexy** *n.* (1) The inverse of thixotropy. The viscosity of a rheopectic material increases with time under an applied constant stress, approaching a constant value. When the stress is removed or reduced, the viscosity diminishes toward its original value. (2) A special form of thixotropic gel, which possesses the property of solidifying more rapidly when sheared (stirred) very slowly than when at complete rest. It should not be confused with dilatancy. The equilibrium state of the former is a solid gel, while the latter is a liquid.

**Rhodamine** \ˈrō-də-ˌmēn\ [ISV] (1888) *n.* Any of a class of organic dyes that exhibit bright orange to red fluorescent colors when viewed under ultraviolet light. An interesting characteristic is that in vinyl compound, the color shade is dependent on the degree of fusion. Thus, they can be used as indicators of fusion completeness.

**Rhodamine B** *n.* Pigment violet 10 (45170). Brilliant, strong dyestuff made by condensing diethyl-*m*-amino-phenol and phthalic anhydride together, in the presence of zinc chloride.

**Rhodamine reds** *n.* A class of clean, blue shade organic reds possessing good lightfastness; often called magenta in process printing.

**Rhodamine 6G** Pigment red 81 (45160). Xanthene type dyestuff made by condensing monoethyl-*m*-amino-phenol with phthalic anhydride and converting the product into the ethyl ester.

**Rhodester** *n.* Cellulose acetate. Manufactured by Society of Rhone Poulane, France.

**Rhodia** *n.* Cellulose 2½ acetate. Manufactured by Society of Rhodiaceta, France.

**Rhodiaceta-nylon** *n.* Nylon-66. Society of Rhodiaceta, France.

**Rhoduline blue 66** *n.* A bright, greenish blue pigment dyestuff, made by condensing *o*-chlorobenzaldehyde with dimethylaniline, which is then oxidized.

*Also known as setoglaucine or permanent peacock blue.*

**Rhoduline heliotrope** *n.* Aniline dye used in colored lacquers. Soluble in lacquer solvents, fast to light, and is not affected by exposure to air.

**Rhombohedron** \ˌräm-bō-ˈhē-drən\ [NL] (1836) *n.* A crystal having six faces each of which is a rhombus.

**Rhovil** *n.* Poly(vinyl chloride). Manufactured by Society of Rhovil, France.

***Rhus vernicifera*** *n.* $C_{22}H_{31}O_3$. Chinese tree which delivers a milky type of liquid. When the water is removed, a dark oily liquid is obtained, which yields a tough flexible film on atmospheric oxidation. The chief constituent of the film-forming material is an unsaturated phenol-acid-urushiol. The liquid is used for the preparation of Japanese lacquer.

**Ribbing** *n.* In the coil coating industry, longitudinal streaks that do not flow out on painted strip.

**Ribbon** \ˈri-bən\ [ME *riban*, fr. MF *riban, ruban*] (14c) *n.* Narrow fabric made in several widths and a variety of weaves and used as a trimming.

**Ribbon blender** *n.* A type of low-intensity mixer comprising helical, ribbon-shaped blades supported by spokes from the horizontal shaft, with the blade edges fitting fairly closely to the lower half of the U-shaped shell of the mixer. The shell is usually jacketed for temperature control and the shaft, spokes and blades may also be cored for circulation of heat-transfer liquid (usually water). They are used in the plastics industry mostly for cooling dry blends such as PVC extrusion and calendering compounds discharged from high-intensity mixers before storage and/or shipment.

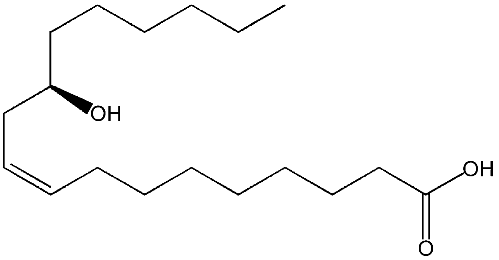
**Ribbon straw** *n.* Cellulose $2^{1}/_{2}$ acetate (artificial straw). Manufactured by British Celanese, Great Britain.

**Rib knit** *n.* A double-knit fabric in which the wales or vertical rows of stitches intermesh alternately on the face and the back. In other words, odd wales intermesh on one side of the cloth and even wales on the other. Ribknit fabrics of this type have good elasticity, especially in the width.

**Ribs** Raised ridge in the finish caused by heavy brush marks, which were not sanded or rubbed from underneath coats before finishing coats were applied.

**Ricinoleic acid** \ˌrī-sən-ō-ˈlē-ik-\ [L *ricin*us + E *oleic acid*] (1848) *n.* Chief acid of castor oil, almost unique by reason of the presence of a hydroxyl group in the fatty acid chain. To exhibit drying properties, the ester must be dehydrated. Bp, 250°C per 15 mmHg; mp, 17°C; Sp gr, 0.945.

*See DCO* (*See image*).



**Ricinus oil** Syn: castor oil.

**Rickrack** \ˈrik-ˌrak\ [reduplication of $^4$*rack*] (1884) *n.* Flat braid in zigzag formation. It is produced by applying different tensions to individual threads during manufacture.

**Ridge forming** *n.* A variation of sheet thermoforming.

**Ridgy beam** *n.* A beam of yarn on which the ends are not evenly distributed across the barrel, causing a profile of peaks (ridges) and valleys. A ridgy beam can give poor removal characteristics.

**Ridgy cloth** *See baggy cloth.*

**Rigidity** \rə-ˈji-də-tē\ (1624) *n.* The ability of a structure to resist deformation under load. It is a function of both the material's modulus of elasticity and, often more critically, of the geometry of the structure. In a loaded beam, whatever the load distribution or type of beam supports, the maximum deflection is inversely proportional to the product, *EI*, of the material's elastic modulus and the moment of inertia of the beam's cross-section about its neutral axis. The term *rigidity* is often applied loosely to materials themselves without reference to a particular structure when what the speaker actually has in mind is the elastic modulus. *See also section modulus.*

**Rigidity, modulus of** *n.* The slope of the linear portion of the stress–strain graph of a specimen tested in shear.
*See shear modulus.*

**Rigid plastic** *n.* For the purposes of general classification, a plastic that has a modulus of elasticity either in flexure or in tension greater than 700 MPa (100 kpsi) at 23°C and 50% relative humidity when tested in accordance with ASTM methods D 747, D 790, D 638, or D 882 (ASTM D 883). This simple ASTM criterion has not always been adequate, especially with respect to vinyls whose impact strengths and other properties can vary widely while elastic modulus remains fairly constant. Vinyls are classified as rigid if their moduli are 1.4 GPa or higher, semi-rigid from 0.4 to 1.4 GPa, and flexible below 0.4 GPa.

**Rigid PVC** *n. See rigid plastic and polyvinyl chloride.*

**Rigidsol** *n.* A coined term for a plastisol that forms an article of very high Durometer hardness. Such hardness is obtained by means of compounding techniques that permit the use of relatively small amounts of plasticizer, and/or by the incorporation of monomers that serve as diluents at room temperature but cross-link or polymerize upon heating.

**Rilsan** *n.* Nylon-11. Manufactured by Acquitaine-Organico, France.

**RIM** Abbreviation for reaction injection molding.

**RIM molders** *n.* Molders for reaction injection molding (RIM). These types of molders are lightly constructed machines and consists of preformer, clamp, metering unit and mixhead. The preformer types include thermoforming, fiber-directed, knitting, braiding, or a combination of two or more. Herman F Mark (2003) Encyclopedia of Polymer Science and Technology, John Wiley and Sons, New York.

**Ring** *n.* (1) A narrow band around hosiery appearing different from the rest of the hose. Principal causes: variations in yarn size, dye, absorption, or luster. (2) The device that carries the traveler up and down the package in ring spinning.
*Also see ring spinning and revolving ring spinning.*

**Ring** [ME, fr. OE *hring*; akin to OHGr *hring* ring] (before 12c) *n.* A polymeric structure resulting from the reaction of one end of a molecule with the other end, forming a ring structure that may be likened to a snake biting its own tail. The stability of ring molecules formed from carbon–carbon chains is generally greatest in 5- to 6-membered rings, and least in 9- to 11-membered rings. The probability of ring formation decreases rapidly as the length of the molecule increases. Thus the presence of a few small rings in the polymer is usually insignificant.

**Ring and ball method** *See ball and ring method.*

**Ringer** *n.* On a section beam, ringer is a term used for one or more filaments that have left the parent end; as the beam revolves, the filaments continue to unwind, wrapping around the beam (hence the word "ringer"). The severity of a ringer is dependent upon the number of filaments contained therein at the time the filaments break. In slashing, the term ringer is often used when an end breaks on the slasher can, adheres to the can, and continues to wrap around it. This condition should not be confused with ringers on the section beam. Complete textile glossary. Celanese Corporation, New York, 2000.

**Ring gate** *n.* A gate for molding tubular objects in which the top of the cavity is encircled by a thick runner connected to the cavity through a thin web (the ring gate) along its entire circumference. This promotes filling the mold without objectionable weld lines.

**Ring-opening polymerization** *n.* Ring-opening polymerization, or olefin metathesis reaction, proceeds by the facile cleavage and reformation of the double bond.

**Ring-opening reactivity** *n.* A polymerization in which cyclic monomer is converted into a polymer which does not contain rings. The monomer rings are opened up and stretched out in the polymer chain.

**Ring-spinning** *n.* A system of spinning using a ring-and-traveler take-up wherein the drafting of the roving and twisting and winding of the yarn onto the bobbin proceed simultaneously and continuously. Ring frames are suitable for spinning all counts up to 150s, and they usually give a stronger yarn and are more productive than mule spinning frames. The latest innovation in ring spinning involves the use of a revolving ring to increase productivity. Ring spinning equipment is also widely used to take-up manufactured filament yarns and insert producer-twist at extrusion.

(*Also see revolving spinning ring*)

**Ring spinning frame** *See spinning frame.*

**Ring strain** *n.* The extra strain associated with the cyclic structure of a compound, as compared with a similar acyclic compound.

**Ring tensile test** *See split-disk method.*

**Rinmann's green** *See cobalt green.*

**Ripening** *n.* Hydrolysis of cellulose acetate after acetylation to obtain the desired acetyl value. This is generally accomplished by heat and agitation of the acid cellulose acetate solution under controlled conditions of time, temperature, and acidity. Rapid ripening is accomplished by using increased temperature for the reaction.

**Rip out** *See pick-out mark.*

**Ripped selvage** *See cut selvage.*

**Ripple finish** *n.* An intentional, uniformly wrinkled finish which is obtained usually by baking. Syn: crinkle finish, shrivel finish, wrinkle finish, and suede finish.

**Riser** *n.* In textile fabric designing, a colored or darkened square on the design paper which indicates that the warp end is over the filling pick at that point. The opposite of riser is sinker.

**Riveling, rivelling** *See wrinkling.*

**RMA** *n.* Abbreviation for relaxation-map analysis.

**Rocker** *n.* A colloquial term for a blown container that is defective by reason of a bulged or deformed bottom causing the container to rock when placed upright on a flat surface.

**Rocker hardness tester** *n.* An instrument made up of two circular stainless runners connected through traverse bars spaced 25 mm apart. Rocking frequency is calibrated by weights on a glass standard. It works on the principle that a "soft" surface dampens the oscillations of a rocking wheel more than a “hard” one. Reference ASTM D 2134.

**Rock salt moss** *See carrageen.*

**Rockwell hardness** *n.* The Rockwell hardness test method consists of indenting the test material with a diamond cone or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load $F_0$, usually 10 kgf. When equilibrium has been reached, an indicating device, which follows the movements of the indenter and so responds to changes in depth of penetration of the indenter is set to a datum position. While the preliminary minor load is still applied an additional major load is applied with resulting increase in penetration. When equilibrium has again been reached, the additional major load is removed but the preliminary minor load is still maintained. Removal of the additional major load allows a partial recovery, so reducing the depth of penetration. The permanent increase in depth of penetration, resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number.

$$\mathrm{HR} = E - e.$$

The deprecated unit kilogram-force (kgf) or kilopond (kp) is defined as the force exerted by 1 kg of mass in standard Earth gravity. Although the gravitational pull of the Earth varies as a function of position on earth, it is here defined as exactly 9.80665 m/s$^2$. So 1 kg-force is by definition equal to 9.80665 N. The kilogram-force has never been a part of the International System of Units (SI), which was introduced in 1960. The SI unit of force is the Newton. Typical scales for calculating Rockwell hardness are listed

**Rockwell hardness scales**

| Scale | Indenter | Minor load $F_0$ (kgf) | Major load $F_1$ (kgf) | Total load $F$ (kgf) | Value of $E$ |
|---|---|---|---|---|---|
| A | Diamond cone | 10 | 50 | 60 | 100 |
| B | 1/16″ steel ball | 10 | 90 | 100 | 130 |
| C | Diamond cone | 10 | 140 | 150 | 100 |
| D | Diamond cone | 10 | 90 | 100 | 100 |
| E | 1/8″ steel ball | 10 | 90 | 100 | 130 |
| F | 1/16″ steel ball | 10 | 50 | 60 | 130 |
| G | 1/16″ steel ball | 10 | 140 | 150 | 130 |
| H | 1/8″ steel ball | 10 | 50 | 60 | 130 |
| K | 1/8″ steel ball | 10 | 140 | 150 | 130 |
| L | 1/4″ steel ball | 10 | 50 | 60 | 130 |
| M | 1/4″ steel ball | 10 | 90 | 100 | 130 |
| P | 1/4″ steel ball | 10 | 140 | 150 | 130 |
| R | 1/2″ steel ball | 10 | 50 | 60 | 130 |
| S | 1/2″ steel ball | 10 | 90 | 100 | 130 |
| V | 1/2″ steel ball | 10 | 140 | 150 | 130 |

$F_0$ is the preliminary minor load in kgf, $F_1$ the additional major load in kgf, $F$ the total load in kgf, $e$ the permanent increase in depth of penetration due to major load $F_1$ measured in units of 0.002 mm, $E$ a constant depending on form of indenter: 100 units for diamond indenter, 130 units for steel ball indenter, $D$ the diameter of steel ball, HR is the Rockwell hardness number.

in the following table. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. w.ww.gordonengland.co.uk/hardness/rockwell.ht.

**Rococo** \rə-ˈkō-(ˌ)kō, rō-kə-ˈkō\ (1840) *n.* Extremely ornate 18th century style featuring scrolls, shells, and fanciful forms. This term is often used in connection with furniture and fashionable fabric materials.

**Rodent resistance** *n.* The ability of a plastic to withstand or repel attacks by rodents. Some plastics require additives to prevent rodents from chewing objects such as cable insulation. One such additive is tetramethyl-thiuram disulfide.

**Rod mill** *n.* A grinding machine consisting of a cylindrical, horizontal shell containing a number of free steel rods and rotated about its axis at a speed such that each rod is lifted almost to the top of the cylinder before it falls to impact the charge of material being ground. *Compare ball mill.*

**Roentgen** \ˈrent-gən, ˈrənt-, -jən, -shən\ [ISV, fr. Wilhelm *Röntgen*] (1896) (R) *adj.* The former international unit, now being phased out, of quantity or dose of X-rays or gamma rays, a measure of the ionization induced by these rays, equal to $2.58 \times 10^{-4}$ coulomb per kilogram (C/kg).

**Roll bending** *n.* In calendering of sheet, the practice of applying a bending moment to the ends of the calender rolls that opposes the bending caused by the pressure forces as the plastic is squeezed between the rolls. The object is to produce sheet whose thickness varies minimally across its width,
*See also crown and roll crossing.*

**Roll crossing** *n.* In calendering, a method of compensating for the slight, but significant, bending apart of the rolls that occur under working pressure, in which the roll axes are set slightly askew of each other. The effect is to make the thickness of the calendered sheet more nearly uniform across the sheet's width.

**Rolled ends** *n.* (1) On a section beam, rolled ends are adjacent ends that do not unwind parallel to each other. Rolled ends can be caused by such factors as uneven tension, ridgy beams, and static. (2) The ends can also roll behind the hook reed in slashing and can tangle with each other, resulting in broken ends and ends doubling.

**Rolled selvage** *n.* A curled selvage.

**Roller** (13c) *n.* Cylinder covered with lamb's wood, felt, foamed plastics or other materials, used for applying paint.
*See paint roller.*

**Roller application** *See roller coating.*

**Roller card** Generally, any type of card in which rollers do the carding. Usually this refers to a woolen card with a main cylinder and four to seven stripper rolls and worker rolls working in pairs.

**Roller cleaner** *See brush or roller cleaner.*

**Roller coating** *n.* Process by which a film is applied mechanically to sheet metal. The machine consists of a series of horizontal cylindrical rollers. The coating is picked up by one of the first rollers rotating in a trough containing the coating, is transferred to subsequent rollers until evenly distributed over the last roller, and thence to the flat surface of mild steel, tinned iron or other suitable sheets. Application of paint by means of a hand-operated roller to wall surfaces, etc. The process of coating substrates with liquid resins, solutions, or dispersions by contacting the substrate with a roller on which the fluid material has been spread. The process is often used to apply a contrasting color or raised lettering or markings. Printing ink handbook. National Association of Printing Ink Manufacturers Inc., 1976.
*See also gravure coating, kiss-roll coating, and reverse-roll coating.*

**Roller coating enamel** *n.* Special type of enamel, designed for application by a roller coating machine.

*See roller coating.*

**Roller mill** *n.* Mill involving one or more rolls; three and five rolls are commonly used. The rolls, which revolve at different speeds, are adjustable as to clearance between the milling surfaces, making it possible to obtain various fineness of pigment dispersion.

**Roller printing** *See printing.*

**Rollformer** In the coil coating industry, a machine that bends continuous strip into various shapes by a series of revolving metal wheels or discs.

**Roll forming** *See cold forming.*

**Roll goods** *n.* Fabric rolled up on a core after it has been produced. It is described in terms of weight and width of the roll and length of the material on the roll.

**Rolling up** *n.* The application of ink to a plate by means of a roller.

**Roll lapping** *n.* A condition in which groups of fibers attach themselves to the drafting rolls instead of following the normal path through the drafting system. These fibers cause the trailing fibers to wind around the rolls and to bread the end down completely. Cleaning of the rolls is required to remove the accumulated fiber.

**Roll-leaf stamping** *See hot stamping.*

**Roll mill** *n.* An apparatus for mixing a plastic material with compounding ingredients, comprising two horizontal rolls placed close together. The rolls turn at speeds that differ by about 10% to produce a shearing action in the material being compounded. Mixing plows and slitting knives are sometimes used to work the stock across the rolls, thus improving the uniformity of additive distribution in the compound.

*See also refiner.*

**Roll of wall covering** *n.* A bolt, consisting of 36 $ft^2$ of wall covering, of which 30 $ft^2$ are estimated as usable. Bolts come in single, double, and triple rolls.

**Roll-out** Ink spread for test or sampling purposes by use of a hand roller.

**ROM** \ˈräm\ (1966) *n.* Acronymic abbreviation for read-only memory, the permanent part of computer memory not alterable by the user. Microsoft computer dictionary. Microsoft Press, 2002. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004.

**Roof** \ˈrüf\ [ME, fr. OE *hrōf*, akin to ON *hrōf* roof of a boathouse and perhaps to Old Church Slavonic *stropŭ* roof] (before 12c) *n.* The cover of a building, including the roofing and all other material and construction (such as supporting members) necessary to carry and maintain it on the walls or uprights.

**Roof cladding** *See roofing.*

**Roofing** *n.* (1) Any material used as a roof covering (such as shingles, slate, sheet metal, or tile) to make it wind- and waterproof, and often provide thermal insulation. (2) A roof.

*Also called roof cladding.*

**Room temperature** *n.* A temperature in the range of 20–30°C (68–85°F).

**Room temperature setting/adhesive setting** *n.* A resin obtained as a residue in the distillation of crude turpentine from the sap of the pine tree (gum rosin) or from an extract of the stumps and other parts of the tree (wood rosin).

*See adhesive, room temperature settings.*

**Root diameter** *n.* The smaller (*minor*) diameter of an extruder screw at any point along its length. In most industrial extruder screws, the increase in root diameter from the feed section to the metering section is the most important factor creating the compression ratio.

**ROP colors** *n.* An abbreviation for run of press colors; a term used to describe the colored inks generally accepted as "standard" colors for newspaper printing.

**Rope** \ˈrōp\ [ME, fr. OE *rāp*; akin to OHGr *reif* hoop] (before 12c) *n.* A heavy, strong cord, made from either natural or manufactured fibers or from wire, in a wide range of diameters. Yarns are twisted together to form strands. These strands are then twisted together in the opposite direction to form the rope. The fact that the twist directions alternate at different stages of rope assembly assures that the rope will be twist-stable and will not kink during use, also called "cord". A fabric in a process without weft tension, thus having the appearance of a thick rope. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Rope mark** *n.* A fabric defect consisting of long, irregular, longitudinal markings on dyed or finished goods. A principal cause is abrasion while wet processing the fabric in rope form. Rope marks are often related to overloading of the fabric during wet processing. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Ropiness** *See ropy finish.*

**Ropy finish** *n.* Finish in which the brush marks have not flowed out, this being the normal appearance of a paint or varnish having poor leveling properties. A similar appearance may also be produced in a paint, which normally has good leveling properties, by continuing to brush the paint after the film has begun to set.

**Rosin** \ˈrä-zᵊn, ˈró-, *dial* ˈró-zəm\ [ME, mod. of MF *resine* resin] (13c) *n.* An important "natural" resin, obtained from pine trees of several species by collection of exudates from cuts through the bark or by extraction from stumps, referred to as wood rosin. Rosin is brittle and friable, and is used mostly for sizing paper. Modified rosins are used in printing inks, pressure-sensitive adhesives, and chewing gum. Two general kinds of rosin are commercially available: gum rosin obtained from living trees, and wood rosin obtained from dead wood, such as stumps and knots. Tall oil rosin, a by-product of the paper industry, is a chemically similar material, also known a colophonium and colophony. Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, 2004. Flick EW (1991) Industrial synthetic resins handbook. Williams Andrew Publishing/Noyes, New York.

**Rosin acids** *n.* Predominately monocarboxylic acids with the empirical formula $C_{19}H_{29}COOH$. They are classified into two groups: the abietic type and the pimaric type. Both types and their derivatives are found in wood, gum, and tall oil rosins.

**Rosin-bonded laminate** *See laminate and reinforced plastic.*

**Rosin essence** *n.* That portion of rosin distilled below 360°C.

**Rosin esters** A large family of resins produced from rosin aids and polyols.

*See ester gum.*

**Rosin, limed or zinc-treated** *n.* Rosin, which has been chemically reacted with a calcium or zinc compound, or both, to form a product containing a metallic salt of the rosin acids, along with unreacted rosin. The amount of calcium or zinc contained in the finished products of this category may vary over a wide range.

*See resinates, metallic.*

**Rosin, modified** *n.* Rosin that has been treated with heat or catalysts, or both, with or without added chemical substances, so as to cause substantial change in the structure of the rosin acids, as isomerization, hydrogenation, dehydrogenation or polymerization, without substantial effect on the carboxyl group.

**Rosin oil** *n.* Relatively viscous oily portion of the condensate obtained when rosin is subjected to dry destructive distillation: also used to describe specially compounded oils having a rosin oil base.

*See bloom oils.*

**Rosin pitch** *n.* Dark, acidic residue obtained from the destructive distillation of rosin.

**Rosin, reclaimed** *n.* Rosin that has been recovered or reclaimed by any means from waste or deteriorated material, provided that the concentration of rosin acids is not below that normal for rosin, and any residual or contaminating component from the waste material itself or from any article used in the recovery process is not in sufficient quantity to cause the physical or chemical properties of the reclaimed product to differ materially from those of rosin.

**Rosin size** *n.* Soda rosin soap containing varying amounts of free rosin; used for sizing paper.

**Rosin spirit** *n.* Relatively light, volatile portion of the condensate obtained in the first stages when rosin is subjected to dry destructive distillation. Syn: pinolin.

**Rosin standards** *n.* The Color Standards for USA Naval Stores Rosin Scale consists of color standards specified in ASTM D 509. The USA Naval Stores Rosin scales are in the form of colored glasses mounted in metal cubes for direct comparison with the rosin samples. Rosin darker in color than the standard for grade D or FF is graded B. The designation Opaque with the grade letters OP is used to describe rosin which, because of a turbid, cloudy, or non-transparent condition due to occluded moisture, excessive crystallization, or presence of foreign matter other than dirt cannot be accurately graded by comparison with any of the rosin grade standards. The recognized official standards are those developed and issued by USA. Department of Agriculture, or similar standards made of Lovibond glass (Lovibond, Salisburg, and England, www.tintometer.com). Lovibond PFX195 Automatic Colorimeters are designed to automatically measure color tint. The most widely used method for assessing the color quality of rosins consists of 15 color standards varying in color from yellow to reddish orange, each assigned letters – XC (lightest), XB, XA, X, WW, WG, N, M, K, I, H, G, F, E, and D (darkest). FF is a special additional grade used for dark wood resins.

**Rosin test (qualitative)** *n. See Halphen–Hicks test and Lieberman–Storch method.*

**Rosin type (sample)** *n.* Sample of rosin, or a mold of thermosetting plastic material, used as an unofficial standard in grading rosin. Such sample shall be so selected, sized and surface-finished that it will have the form of an approximate 7/8 in. cube with at least two opposite faces having smooth parallel surfaces and shall have a color when viewed through these faces which matches within rather narrow tolerances the color of the corresponding official government standard.

**Rossi–Peakes tester** *n.* An instrument for measuring the temperature at which a given amount of a molding powder will flow through a standard orifice in a prescribed period of time and pressure (ASTM Test D 569). The instrument tests a peculiar combination of properties of a thermoplastic molding compound that may relate to its moldability.

**Rot** \ˈrät\ [ME *roten*, fr. OE *rotian*; akin to OHGr *rōzzēn* to rot] (before 12c) *v.* Decomposition in wood by fungi and other microorganisms; reduces its strength, density, and hardness.

**Rotameter** \ˈrō-tə-ˌmē-tər, ro-ˈta-mə-tər\ [L *rota* + English –*meter*] (1907) *n.* A simple flow-measuring device for gases and low-viscosity liquids consisting of a vertical glass tube whose internal diameter increases gradually from bottom to top, graduated on the outside, and consisting a float that reaches an equilibrium position that rises in proportion to the flow rate. By calculation or calibration, the flow rate can be derived from the float position and the pressure and temperature of the fluid at the discharge end. Floats of small rotameters may be simple spheres interchangeable with others of different density to expand the instrument's range.

**Rotary joint** *n.* A plumbing fixture used with cored extruder screws and chilled rolls that permits circulation of liquid within the screw or roll, without leakage at the point of connection of the inlet and return lines.

**Rotary molding** *n.* A term sometimes used to denote a type of injection, transfer, compression, or blow molding utilizing several mold cavities mounted on a rotating table or dial. Not to be confused with rotational molding.

**Rotary press** *n.* High-speed press which passes continuously running webs of paper between an impression cylinder and the curved form on the plate cylinder.

**Rotary screen printing** *See printing.*

**Rotary-vane feeder** *n.* A device for conveying and metering dry materials, comprising a cylindrical housing containing a concentric shaft with blades or flutes attached, rotating at a rate selected to feed the material at a desired rate.

**Rotating die** *See oscillating die.*

**Rotating spreader** *n.* A type of torpedo used in plunger-type injection machines that consisted of a finned torpedo rotated by a shaft extending through the cored injection ram behind it. This was soon superseded by the screw-injection machine.

**Rotational casting** *n.* The process of forming hollow articles from liquid materials by rotating a mold containing a charge of the material about one or more axes at relatively low speeds until the charge is distributed on the inner walls of the mold by gravity and hardened by heating, cooling, or curing. Rotation about one axis is suitable for cylindrical objects. Rotation about two axes and/or rocking motions are employed for completely closed articles. The process of rotational casting of plastisols comprises placing a measured charge of plastisol in the bottom half of an opened mold, closing the mold, rotating the mold about one or more axes while applying heat until the charge has been distributed and fused against the mold walls, cooling the mold until the deposit has gained strength, opening the mold, and removing the article.

*See also centrifugal casting and rotational molding.*

**Rotational injection molding** *n.* A modified injection-molding process applicable to hollow, axisymmetrical articles such as cups and beakers, in which the male half of the mold is rotated during the molding cycle until the material has hardened to a pre-chosen degree. The rotation produces orientation and increased crystallinity of some polymers, resulting in improved toughness and stress-craze resistance.

**Rotational molding (rotomolding)** *n.* The preferred term for a variation of rotational casting utilizing dry, finely divided, sinterable powders, such as polyethylene, rather than liquid slurries. The powders are first distributed, then sintered against the heated mold walls, the mold is cooled, and the product stripped from the mold.

**Rotational rheometer** *n.* An instrument for measuring the viscosity of molten polymers (any many other fluid types) in which the sample is held at a controlled temperature between a stator and a rotor. From the torque on either element and the relative rotational speed, the viscosity can be inferred. The most satisfactory type for melts is the *cone-and-plate* geometry, in which the vertex of the cone almost touches the plate and the specimen is situated between the two elements. This provides a uniform shear rate throughout the specimen. It may be operated in steady rotation or in an oscillatory mode.

**Rotational viscometer** *n.* An instrument for measuring the viscosity of pourable liquids, slurries, plastisols, and solutions. Most are of the *bob-and-cup* type. In these, the bob is a polished, accurate cylinder that is immersed in the liquid contained in the cup. Either the bob or cup is rotated and the torque on one or the other is measured, as is the rotational velocity. From these and the dimensions, the viscosity can be inferred, either directly by calculation from principles or indirectly by calibration with standards of known viscosity. An instrument widely used in the plastics industry is the Brookfield viscometer.

**Rotatory power** *n.* The power of rotating the plane of polarized light, given in general by $\theta/l$ where $\theta$ is the total rotation which occurs in a distance $l$. The *molecular* or *atomic rotary power* is the product of the specific rotatory power by the molecular or atomic weight. Magnetic rotatory power is given by

$$\theta/eH\cos\alpha,$$

where $H$ is the intensity of the magnetic field, and $\alpha$ is the angle between the field and the direction of the light.

**Roto-dipping** *n.* Patented method of pretreating and priming motor bodies in which the body is mounted on a longitudinal axle and is caused to pass through a series of spray zones and dip tanks. At appropriate stages in the process the body is revolved on the axle.

**Roto-flex** *n.* A fatigue or endurance test developed by Goodyear for industrial yarns or cords.

**Roto-gravure** \ˌrō-tə-grə-ˈvyür\ [G *Rotogravur*, blend of L *rota* wheel and Gr *Photogravur* photogravure] (1913) *n.*

*See gravure.*

**Roto-molding** *n.* A contraction of the term *rotational molding*, sometimes used indiscriminately for both the processes of rotational casting and rotational molding.

**Rotor spinning** *See open-end spinning.*

**Rot resistance** *n.* The ability of textile materials to resist physical deterioration resulting from the action of bacteria and other destructive agents such as sunlight or sea water.

**Rottenstone** \ˈrä-tᵊn-ˌstōn\ (1677) *n.* Brown, amorphous, siliceous limestone, similar in nature to pumice stone, but softer in texture. Principal uses are as an abrasive and filter medium.

*Also known as tripoli and terra cariosa.*

**Rouge** \ˈrüzh, *esp Southern* ˈrüj\ [F, fr. MF, fr. *rouge* red, fr. L *rubeus* reddish] (1753) *n.*

*See iron oxides, synthetic.*

**Rough** *n.* A fabric condition in which the surface resembles sandpaper. Principal causes are the shuttle rebounding in the box, jerky

or loose shuttle tension, an incorrectly timed harness, and wild twist in the filling.
*See loopy selvage.*

**Roughing pump** *n.* In high-vacuum work, e.g., vacuum metallizing, a mechanical pump that removes most of the air from the chamber, leaving the remainder to a secondary pump, usually a diffusion pump, capable of reducing the pressure to about 0.13 Pa absolute.

**Roughness** *See finish.*

**Round (round color)** *n.* Description of a full-bodied paint, i.e., one which gives good build.

**Rovicella** *n.* Cellulose (viscose), manufactured by Feldmühle Rorsch., Switzerland.

**Roving** [$^4$*rove*] (1802) *n.* (1) A form of fibrous glass comprising from 8 to 120 single filaments or strands gathered together in a bundle. When the strands are twisted together, the term *spun roving* is used. Roving is used in continuous lengths for filament winding, chopped into short lengths for use in reinforced-plastic molding compounds and in spray-up, and woven into skeins or mats for use in laminates. (2) In spun yarn production, an intermediate state between sliver and yarn. Roving is a condensed sliver that has been drafted, twisted, doubled, and redoubled. The product of the first roving operation is sometimes called slubbing. (3) The operation of producing roving (*see 0*). (4) In the manufacture of composites, continuous strands of parallel filaments.
*See reinforcement.*

**Roving frame** *n.* A general name for all the machines used to produce roving, different types of which are called slubber, intermediate, fine, and jack. Roving frames draft the stock by means of drafting rolls, twist it by means of a flyer, and wind it into a bobbin.

**Rows** *n.* In pile floor covering, the average number of tufts or loops per inch in the warpwise direction.

**Royalene** *n.* Poly(ethylene) or poly (propylene), manufactured by USA Rubber Company, USA.

**RP** *n.* Abbreviation for reinforced plastic.

**rpm** *n.* Abbreviation for revolutions per minute, a convenient industrial unit of rotational speed. One rpm equals 0.10472 rad/s.

**RRIM** *n.* Abbreviation for reinforced reaction injection molding.
*See reaction injection molding.*

**RTM** Abbreviation for resin-transfer molding.

**RTP** *n.* Abbreviation for reinforced thermoplastic.

**RT 700** *n.* Cellulose (viscose). Manufactured by Glanzstoff, Germany.

**RTV** *n.* Abbreviation for room-temperature vulcanizing, a characteristic of some elastomers that do not require heating to cure.

**RTV elastomers** *n.* Room-temperature vulcanizing (RTV) elastomer is an elastomer that does not require heating to cure.

**Ru** *n.* Measure for surface roughness, 0.025 μm ($10^{-6}$ in.) BSS 1134.

**Rub** *See abrasion mark.*

**Rubazote** *n.* Natural rubber. Manufactured by Expanded Rubber, Great Britain.

**Rubber** \ˈrə-bər\ (1536) *n.* (1) A highly resilient material, capable of recovering from large deformations quickly; manufactured from the juice of rubber trees as well as other trees and plants. (2) Any of various synthetically produced materials having similar properties; an elastomer.

**Rubber cement** (1886) *n. See cement, rubber.*

**Rubber-emulsion paint** *See latex paint.*

**Rubber filament** A filament extruded from natural or synthetic rubber and used as the core of some elastic threads.

**Rubber hydrochloride** *n.* A non-flammable thermoplastic material containing about one-third chlorine, obtained by treating a solution of rubber with anhydrous hydrogen chloride (HCl) under pressure at low temperature. The packaging film Pliofilm® is a representative product.

**Rubber latex** *n.* Colloidal aqueous emulsion of an elastomer.

**Rubber materials** *See elastomers.*

**Rubber, natural** (India rubber, Caoutchouc) *n.* An amorphous polymer consisting essentially of *cis*-1,4-polyisoprene, obtained from the sap (latex) of certain trees and plants, mainly the *Hevea brasiliensis* tree. The material is shipped from tropical plantations in one of two primary forms: latex, usually stabilized and preserved with ammonia and centrifuged to remove part of the water; or sheets made by milling the coagulum from the latex. Natural rubber has very high molecular weight and is usually masticated to reduce the molecular weight and improve processability. A major use is sidewalls of automotive tires.

**Rubber-plate printing** *n.* A marking method sometimes employed for intricate parts such as molded terminal blocks. Numbers, instructions, etc., are stamped with conventional rubber stamps or printing plates.

**Rubber-plunger molding** *n.* A variation of matched-die molding that employs a deformable rubber plunger and a heated metal concave mold. The process enables the use of high fiber loadings.

**Rubber-seed oil** *n.* Oil obtained from the seeds of *Hevea brasiliensis.* Sp gr, 0.927/15°C; saponification value, 190, iodine value, 138.

**Rubber, synthetic** *See elastomer.*

**Rubber, synthetic natural** An awkward term sometimes used for synthetic elastomers having the composition of natural rubber, *cis*-1,4-polyisoprene.

**Rubber toughening** *n.* The practice of compounding into a brittle plastic 5–20% of a rubber in the form of spherical particles, in order to improve the plastic's resistance to impact. The process has been used with both thermoplastics and thermosets, e.g., polystyrene and epoxies. Some users of this term include toughening achieved by co-polymerization with elastomer-forming monomers.

**Rubber transition** (rubbery transition, gamma transition) *n.*

*See glass transition.*

**Rubbing** *n.* Process of leveling and flatting a dried coating film by rubbing it, either wet or dry and usually with a suitable abrasive, to remove nibs and other irregularities and to provide a surface with a suitable key for a subsequent coating.

*Also called flatting down. See sanding.*

**Rubbing flat** *n.* Process of flatting a coating means to subject it to abrasive action of remove nibs and other irregularities and to provide a surface with a suitable key for a subsequent coating.

**Rubbing oil** *n.* Neutral, medium-heavy mineral oil used as a lubricant for pumice stone in rubbing varnish or lacquer.

**Rubbing test** *n.* A procedure for testing the ease with which a lacquer or enamel can be rubbed to a smooth high-gloss finish. Federal Standard 141a Method 6332.

**Rubbing varnish** *n. See polishing varnish and flatting varnish.*

**Rubine** *n.* Pertaining to blue shade red, probably derived from the Latin word "rubia" for the madder plant from which madder lake (Alizarin Red), a blue shade red, was originally made. The name of the bluish red colored gem, the ruby, would appear to be similarly derived.

**Rubine reds** *n. See permanent red 2B.*

**Rub-of** *n.* Ink on printed sheets which, after sufficient drying time, smears or comes off on the fingers when handled.

**Rubometer (or rub tester)** *n.* An instrument used for the measurement of rub or scuff resistance of a printed design.

**Rule of mixtures** *See law of mixtures.*

**Rule 66** *n.* The original air quality control regulation enacted by Los Angeles County in California for the purpose of eliminating smog caused by the photochemical degradation of some organic solvents. The Federal Environmental Protection Agency (EPA) has used Rule 66 as a basis for minimum Federal guidelines on which the various states could pattern their mandated local regulations.

*See photochemically reactive solvent.*

**Rumbling** *See tumbling.*

**Run** *n.* (1) In experimental or test work, performance of the experiment or test at one set of experimental factors. (2) Resin flow down the vertical or sloping surface of a sprayed-up or laid-up reinforced-plastic fabrication before it can be cured (usually unwanted). (3) Narrow downward movement of a paint or varnish film; may be caused by the collection of excess quantities of paint at irregularities in the surface, e.g., cracks, holds, etc., the excess material continuing to flow after the surrounding surface has set. Sometimes called tear. (4)

*See running.*

**Runner** *n.* In an injection or transfer mold, the feed channel, often branched to serve multiple cavities, and usually of semicircular or trapezoidal cross-section, that connects the sprue with the cavity gates. The term is also used for the plastic piece formed in this channel.

**Runner length** *n.* In knitting, the number of inches of yarn from a warp to make one rack of fabric.

**Runnerless injection molding** *n.* (1) In molding thermoplastics, a process in which the runners are insulated from the cavities and kept hot, so that the molded parts are ejected with only small gates attached. (2) In thermoset molding, the same as cold-runner injection molding.

*See also hotrunner mold.*

**Runner system** *n.* This term is sometimes used for the entire mold feeding system, including sprue, runners, and gates, in injection or transfer molding.

**Running** *v.* Process by which solubility of a resin in an oil is achieved. Fossil resins such as Congo are "run" by heating the resin alone to elevated temperatures in incremental steps, thereby distilling off unwanted volatile components and altering the resin so that it becomes compatible with additions of oil. Resin so treated are said to have been "run".

**Run-of-the-mill** *n. See mill run.*

**Run-proof** A knitted construction in which the loops are locked to prevent runs.

**Run-resistant** *n.* A type of knitting stitch that reduces runs.

**Rupture** \ˈrəp(t)-shər\ [ME *ruptur*, fr. MF or L; MF *rupture*, fr. L *ruptura* fracture, fr. *ruptus*, pp of *rumpere* to break] (15c) (fracture) *n.* Failure by cracking or tearing of, or in, a test specimen or working part.

**Rupture disk** *n.* A thin metal disk, contained in a *rupture-disk fitting*, that, when subjected to a known high fluid pressure, will tear, permitting outflow of fluid and rapid relief of pressure. Rupture disks are now used routinely on extruders and gear pumps to protect both personnel and equipment against the dangers of excessive melt pressure.

**Rust** \ˈrəst\ [ME, fr. OE *rūst*; akin to OE *rēad* red] (before 12c) *n.* The reddish, brittle coating formed on iron or its alloys resulting from exposure to humid atmosphere or chemical attach. *Note*—Not to be confused with white rust. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX. Uhlig HH (1948, 1971, 2000) Corrosion and corrosion control. John Wiley and Sons Inc., New York.

**Rust grade scale** *n.* In evaluating the resistance to rusting, the linear, numerical rust grade scale is an exponential function of the area of rust so that slight amounts of first rusting have the greatest effect on lowering the rust grade. There is also a European rust scale and an ISO rust scale (*ISO 4624*).

**Rustic siding** *See drop siding.*

**Rusting** (13c) *v.* Corrosion on the surface of iron or ferrous metals resulting in the formation of products consisting largely of hydrous ferric oxide.

**Rust-inhibiting paint** Hare CH (2001) Paint film degradation – mechanisms and control. Steel Structures Paint Council, Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX. Weismantal GF (1981) Paint handbook. McGraw-Hill Corp. Inc., New York. Keane JD (1970) Surface preparation: new trends in anti-corrosion coatings. International congress,. Milan, Italy, October 1970.

*See anti-corrosion paint.*

**Rust-inhibitive washes** *See chemical conversion coating.*

**Rust resistance** *n.* The ability of a coating to protect the substrate of iron or its alloys from rusting.

*See rust.*

**Rutile** \ˈrü-ˌtēl\ [Gr *Rutil*, fr. L *rutilus*] (1803) *n.* One of the crystalline forms of titanium dioxide. Used to designate a crystal structure of titanium dioxide with a Sp gr of 4.2 and a refractive index of 2.69. The rutile type is characterized by higher opacity, greater density and greater inertness as compared to the anatase type. McGraw-Hill dictionary of geology and mineralogy. McGraw-Hill, New York, 2002. Hurlbut CS Jr (1966) Mineralogy. John Wiley and Sons, New York.

**Ruvea** *n.* Nylon 66 (artificial straw). Manufactured by DuPont, USA.

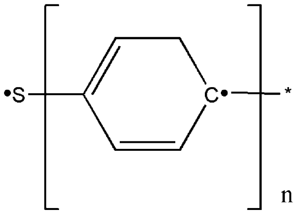
***R*-value** *See thermal resistance.*

**Rydberg formula** *n.* A formula, similar to that of Balmer, for expressing the wavenumbers ($\nu$) of the lines in a spectral series:

$$\nu = R\frac{1}{(n+a)^2} - \frac{1}{(m+b)^2},$$

where $n$ and $m$ are integers and $m > n$, $a$, and $b$ are constants for a particular series, and $R$ is the *Rydberg constant*, 109,667.8 $\mathrm{cm}^{-1}$ for hydrogen.

**Ryton** *n.* Poly(thio-1,4-phenylene), manufactured by Phillips Petroleum, USA.



# S

**s** \ˈes\ *n.* (1) Abbreviation for SI's basic time unit, the second. (2) Symbol for sample standard deviation.

**S** *n.* (1) Abbreviation for the SI unit of conductance, the Siemens. (2) Chemical symbol for the element sulfur. (3) Symbol for entropy.

**Sa** (0.1,2,-1/2,3). Grades of cleanliness of blasted steel, Swedish Standard SIS 05 50 00, ASTM D-2200.

**$\sigma$** *n.* Symbol for standard deviation (2).

**Sable pencil** \ˌsā-bəl ˈpen(t)-səl\ *n.* Fine pointed brushes of sable hair, set in quills, varying in size from lark's, through crow's, to duck's and goose's, or set in a metal ferrule. Used for decorative detail. Because of the high cost of sable, squirrel hair may be used instead.

**Sable writer** \-ˈrī-tər\ *n.* A brush-like a sable pencil, but longer, with a flat edge or a point, used for sign writing.

**SABRA** *n.* Abbreviation or surface activation beneath reactive adhesives, a method of bonding plastics, such as polyolefins and polytetrafluoroethylene, that are normally unreceptive to adhesives without pretreatment. The method consists of mechanical abrasion of the surfaces to be joined to roughen their outer layers scission of bonds with creation of free radicals, and further reaction with primers in the liquid, vapor, or gaseous phase. An adhesive such as an epoxy is then applied.

**SACMA** *n.* Acronymic abbreviation for suppliers of advanced composite materials association.

**Sacrificial protection** \ˌsa-krə-ˈfi-shəl prə-ˈtek-shən\ *n.* (1) The use of a metallic coating, such as a zinc-rich paint, to protect steel. In the presence of an electrolyte, such as salt water, a galvanic cell is set up and the metallic coating corrodes instead of the steel. (2) Zinc or aluminum anode.

**SAE** *n.* Abbreviation for society of automotive engineers.

**Safety factor** \ˈsāf-tē\ *n. See factor of safety.*

**Safety inks** Printing inks which will change color or bleed when ink eradicator or water is applied to prints. Also inks which will erase easily. Usually, mixtures of a drying-oil ink with an aqueous solution of a water-soluble color.

**Safflower oil** \ˈsa-ˌflaú(-ə)r-\ (ca. 1857) *n.* Semidrying to drying oil, obtained from *Carthamus tinctorius*, a native of India. It is now available from seed grown in USA. Its main constituent acid is linoleic, with a small quantity of linolenic acid. It dries and bodies more slowly than linseed oil. Sp gr, 0.925/15°C; iodine value, 139; saponification value, 189. Its drying characteristics lie between those of linseed and soybean oils. One of its main advantages for paint and varnishes is its extremely low after-yellowing due to its very low linolenic acid content.

**Saflex** *n.* Poly(vinyl acetal), manufactured by Monsanto, USA.

**Sag** \ˈsag\ [ME *saggen*, prob. of Scand origin; akin to Sw *sacka* to sag] (14c) *v.* (1) In blow molding, the local reduction in parison diameter, or *necking down*, caused by gravity. It is usually greatest on the portion nearest the die, and increases as the parison grows longer. (2) In thermoforming, sag is the downward bulge in the heat-softened sheet.

*See sagging.*

**Sagging** *n.* Downward movement of a paint film between the times of application and setting, resulting in an uneven coating having a thick lower edge. The resulting sag is usually restricted to a local area of a vertical surface and may have the characteristic appearance of a draped curtain, hence the synonymous term, “curtaining”.

**SAIB** Abbreviation for sucrose acetate isobutyrate.

**Sailcloth** \ˈsā(ə)l-ˌklóth\ (13c) *n.* Any heavy, strongly made woven canvas of cotton, linen, jute, polyester, nylon, aramid, etc., that is used for sails. Laminated fabrics are also finding use in this market. Sailcloth is used for apparel, particularly sportswear.

**Salicylic acid** \ˌsa-lə-ˈsi-lik-\ [ISV, fr. *salicyl* (the group $HOC_6H_4CO$)] (1840) *n.* $C_7H_6O_3$. A crystalline phenolic acid used especially in the form of salts and other derivatives as an analgesic and antipyretic.

**Salloped selvage** *n.* A fabric defect consisting of an abrupt, narrow place along the selvage. Principal cause is the failure of the clip on the tenter frame to engage or hold the fabric.

**Salt** \ˈsólt\ [ME, fr. OE *sealt*; akin to OHGr *salz* salt, Lithuanian *saldus* sweet, L *sal* salt, Gk *hals* salt, sea] (before 12c) *n.* (1) In inorganic chemistry, an ionic substance formed by the reaction of an acid with a base. Polybasic acids can form acid salts and, when dissolved in water, generally yield acidic solutions, i.e., their pH is less than 7. Similarly, polyacidic bases can form basic salt whose solutions are generally basic. (2) By analogy with the above, some organic reaction products of diacids and diamines that have ionic character are called salts. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry, Brookes/Cole, New York.

**Salt spray test** *n.* A test applied to metal finishes to determine their anti-corrosive properties, involving the spraying of common salt (sodium chloride) solution on the surface of a coated steel panel.

**Sample mean** *See arithmetic mean.*

**SAN** *n.* Co-polymer from styrene and acrylonitrile. Abbreviation for styrene acrylonitrile polymer.

**Sand** \ˈsand\ *n.* Used as a filter medium in fiber manufacture, particularly used in spinning packs for nylon or polyester production.

**Sandarac** \ˈsan-də-ˌrak\ [L *sandaraca* red coloring, fr. Gk *sandarakē* realgar, red pigment fr. realgar] (1543) *n.* Natural resin which exudes from *Callitris quadrivalvis*, found in North Africa.

**Sandblast** \-ˌblast\ (1871) *n.* To use sand, flint or similar abrasive propelled by an air blast, or metal, masonry, concrete, etc., to remove dirt, rust, or paint, or to decorate the surface with a rough texture.

**Sand-dry** *n.* Descriptive of a stage in drying of a paint film at which sand will not adhere to the surface.

**Sanderson–Milner zeta space color difference equation** *n.* A color difference equation designed to fit the spacing of the Munsell system and based on Munsell value functions as described in the Adams chromatic value color difference equation:

$$\Delta E = [(\Delta\xi_1)^2 + (\Delta\xi_2)^2 + (\Delta\xi_3)^2]^{1/2},$$

where $\xi_1 = (V_X - V_Y)(9.37 + 0.79 \cos\theta)$, $\xi_2 = kV_Y$, $\xi_3 = (V_Y - V_Y)(3.33 + 0.87 \sin\theta)$, $\theta$ is the angle calculated from $\tan\theta = \frac{0.4(V_Z - V_Y)}{V_X - V_Y}$, $k$ is the constant ranging from 1 to 5 depending on observation conditions such as fineness of line dividing the two colors being compared. Using a constant $k$ of 2, the average magnitude of $\Delta E$ is one-sixth that of an NIST unit. Johnson SF (2001) History of light and colour measurement: a science in the shadows. Taylor and Francis, UK. McDonald R (1997) Colour physics for industry, 2nd edn. Society of

Dyers and Colourists, West Yorkshire, England. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Sand finish** *n.* Rough finish plaster wall.

**Sand grinder** *n.* A type of pigment dispersing equipment consisting of pumping pigment/vehicle slurry (the mill base) through a cylindrical bank of sand which is being subjected to intense agitation. During passage upward through the agitated sand zone, the mill base is caught and dispersed between the sand particles; a strong shearing action, which effects the dispersion of the pigment into the vehicle results. On emerging from the active sand zone, the dispersed mill base overflows through an exit screen sized to permit a free flow-through of the pigment dispersion while holding back the sand particles.

**Sand grinding** *n.* Process of dispersing pigments in the sand grinder.

**Sanding** *n.* A finishing process employing abrasive belts or disks, sometimes used on thermosetting-resin parts to remove heavy flash or projections, or to produce radii or bevels that cannot be formed during molding.

**Sanding sealer** *n.* Specially hard first coat that has the property of sealing or filling, but not obscuring, the grain of wood. The surface is then suitable for sanding before the application of subsequent coats.

**Sanding surfacer** *n.* A heavily pigmented finishing material used for building the surface to a smooth condition. It is sanded after drying.

**Sand mill** *n.* An apparatus used for preparing pigment dispersions, consisting of a vertical cylinder with a centrally mounted agitator shaft on which are mounted several flat, annular disk impellers. The mill is charged with coarse natural sand or high-silica ceramic beads as the grinding medium. The pigment slurry is pumped into the bottom of the mill and becomes mixed with the grinding medium. As the mixture is forced upward through the mill, it passes through several zones of agitation and finally flows through a screen at the top that retains the sand or beads but allows the much smaller pigment particles to pass.

**Sandpaper** \-ˈpā-pər\ (1825) *n.* (1) A tough paper which is coated with an abrasive material such as silica, garnet, silicon carbide, or aluminum oxide; used for smoothing and polishing; graded by a grit numbering system according to which the highest grit numbers (360–600) are used for fine polishing, and the lowest grit numbers (16–40) are used for coarse smoothing. Alternatively, sandpaper may be designated by the “0 grade” system, according to which “very fine” includes grades from 10/0 to 6/0, “fine” from 5/0 to 3/0, “medium”, 2/0, 1/0, ½; “coarse”, 1, 1½, and 2; “very coarse”, 2½, 3, and 3½, and 4. (2) *See coated abrasive.* The general term of the Coated Abrasives Manufacturer’s Institute for materials of this type.

**Sandwich blend** \-ˈwich-\ *n.* A method of preparing fiber mixtures by layering them horizontally in alternating layers with all elements in the proper proportion.

**Sandwich heating** (two-sided heating) *n.* A method of heating a plastic sheet for thermoforming in which the sheet is positioned between two radiant heaters.

**Sandwich structure** *n.* A term often employed for a laminate comprising at least three layers; for example, a cellular-plastic or honeycomb core sandwiched between two layers of glass-reinforced laminate. *See also laminate.*

**Sanforized®** \ˈsan-fə-ˌrīzd\ {*trademark*}. A trademark of Cluett, Peabody & Co. Inc. (MN, USA) denoting a controlled standard of shrinkage performance. Fabrics bearing this trademark will not shrink more than 1% because they have been subjected to a method of compressive shrinkage involving feeding the fabric between a stretched blanket and a heated shoe. When the blanket is allowed to retract, the cloth is physically forced to comply.

**Sanfor-set®** {*trademark*}. A trademark of Cluett, Peabody & Co. Inc., denoting a controlled standard of shrinkage performance originally developed for denims. Fabrics bearing this trademark will not shrink under home-wash, tumble-dry conditions because they have been subjected to a liquid ammonia treatment and compressive shrinkage.

**Saponification** \sə-ˈpä-nə-ˌfī\ [F *saponifier*, fr. L *sapon*-, *sapo*] (1821) *v.* (1) Alkaline hydrolysis of fats whereby a soap is formed; more generally, the hydrolysis of an ester by an alkali with the formation of an alcohol and a salt of the acid portion. (2) The decomposition of the medium of a paint or varnish film by alkali and moisture in a substrate, e.g., new concrete or fresh plaster. Saponified paint may become sticky and discolored. In severe cases, the film may be completely liquefied by saponification. Loss of adhesion may occur as a saponified layer develops next to the substrate. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Saponification value** *n.* A measure of the alkali reactive groups in oils and fatty acids which is expressed as the number of milligrams of potassium hydroxide that react with 1 g of sample (*see ASTM, www.astm.org*).

*Also known as Koettstorfer number.*

**Sapwood** \-ˌwúd\ (1791) *n.* The layers of wood next to the bark, usually lighter in color than the heartwood and 0.5–3 in. or more wide. It is relatively involved in the life processes of the tree. Under most conditions, sapwood is more susceptible to decay than heartwood.

**Saran** \sə-ˈran\ [fr. *Saran*, a trademark] (1940) *n.* (1) Generic name for thermoplastics consisting of polymers of vinylidene chloride (PVDC) or co-polymers of same with lesser amounts of other unsaturated compounds. (2) Saran® is also Dow Chemical's trade name for its copolymer films. PVDC's very low permeability to gases and vapors makes it an excellent barrier material for packaging and food wrapping. (3) Generic name for fibers from polymers with not less than 80% vinylidene chloride. Strong AB (2000) Plastics: materials and processing. Prentice-Hall, New York. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Saran fiber** *n.* Generic name for a manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of at least 80% by weight of vinylidene chloride units ($-CH_2CCl_2-$) (Federal Trade Commission).

**Sardine oils** \sär-ˈdēn \ *n.* Fish, oils, mainly of Japanese or American origin, which, when adequately refined, are useful drying oils. Sp gr, 0.930/15°C; iodine value, 187; saponification value, 190.

**SASE** *n.* Acronym for stress at specified elongation; the stress experienced by a yarn or cord at a given elongation.

**Sash** \ˈsash\ {plural sash *also* sashes} [prob. mod. of F *châssis* chassis (taken as plural] (1681) *n.* Any framework of a window; may be movable or fixed; may slide in a vertical plane (as in a double-hung window) or may be pivoted as in a casement window; a pivoted sash is also called a ventilator.

*Also known as window sash.*

**Sash tool** *n.* A round brush made in various sizes, bound with metal or string and used for painting sashes, frames and other small areas.

**Sateen** \sa-ˈtēn, sə-\ [alter. of *satin*] (ca. 1878) *n.* A cotton fabric made in a satin weave.

**Satin finish** \ˈsa-tᵊn-\ *n.* A finish having gloss in the general range overlapping eggshell and semi-gloss, depending on manufacturer's or customer's specifications.

*See gloss.* Syn: silk.

**Satin weave** (ca. 1883) *n.* One of the basic weaves, plain, satin, and twill. The face of the fabric consists almost completely of warp or filling floats produced in the repeat of the weave. The points of intersection are distributed evenly and widely separated as possible. Satin-weave fabric has a characteristic smooth, lustrous surface and has a considerably greater number of yarns in the set of threads, either warp or filling, that forms the face than in the other set.

**Satin white** *n.* Filler made by precipitating together a mixture of calcium sulfate and aluminate. The ingredients used for its preparation are calcium hydroxide and basic aluminum sulfate. It is used chiefly in aqueous pigmented coatings for paper, and also as a base for lake pigments.

**Saturated compound** *n.* A compound in which all of the valences of the elements are satisfied; in organic chemistry, having no double or triple bonds, i.e., incapable of absorbing substances by addition, such as hydrogen or iodine. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Saturated hydrocarbon** *n.* A hydrocarbon containing no multiple bonds. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Saturated polyester** *See polyester, saturated.* Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Saturated solution** A solution which is or can be at equilibrium with excess solute. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Saturation** *n.* (1) The attribute of color perception that expresses the degree of departure from the gray of the same lightness. All grays have zero saturation. (2) The maximum intensity or purity of a color. If the color is as brilliant as possible, it is at saturation; if the color is subdued or grayed, it is dull, weak, and low in intensity. (3) The upper limit concentration of a solute in a solvent, i.e., no more solute can be dissolved at a fixed temperature and pressure. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Saturation bonding** *See bonding* (2).

**Saturation value** *n.* The maximum amount of dye that can be absorbed by a textile fiber under defined conditions. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Saturator** *n.* A machine designed to impregnate paper, fabrics, and the like with resins. The web to be saturated is conveyed by rollers through a pan containing a solution of the resin, then through metering devices such as squeeze rolls, scraper blades, or suction elements that control the amount of resin retained.

**Saunderson correction** *n.* Equation for calculating a correction for the Fresnel reflectances at the surface of a dielectric material for both the incident light ($k_1$) and exiting light ($k_2$). It is related to the internal reflectance, $R_\mathrm{i}$, and to the total reflectance. $R_\mathrm{T}$, by the following equation:

$$R_\mathrm{T} = k_1 + \frac{(1-k_1)(1-k_2)R_i}{1-k_2R_i}.$$

(The equation was popularized by Saunderson in his work on computer color matching but actually dates back many years, at least to Walsh in the 1920s.) Moller KD (2003) Optics. Springer-Verlag, New York.

**Saxony** \ˈsak-s(ə-)nē\ {*plural* -nies, *often capitalized*} [*Saxony*, Germany] (1842) *n.* (1) A high-grade fabric for coats, made from Saxony Merino wool. (2) A soft woolen with fancy yarn effects, used in sportcoat fabric. (3) A highly twisted worsted knitting yarn. (4) A term describing a cut-pile carpet having highly twisted, evenly sheared, medium-length pile yarns.

**SAXS** Abbreviation for small-angle X-ray scattering.

S

**Saybolt universal viscosity** *n.* Efflux time in seconds for 60 ml or fluid to flow through a calibrated orifice under specified conditions.

**Saybolt viscosity** (SSU or second Saybolt universal) *n.* The time in second required to fill at 60-cm$^3$ flask with an oil specimen pre-heated to 38, 54, or 99°C and draining through a standard orifice. The measurement is convertible to kinematic viscosity by the equation: $v = 0.00222t - 1.83/t$, where $v$ is the kinematic viscosity, cm$^2$/s and $t$ is the Saybolt second. Several ASTM tests (www.astm.org) make use of the Saybolt viscometer. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Sb** *n.* Chemical symbol for the element antimony (Latin: stibnium).

**SB** Abbreviation for co-polymers of styrene and butadiene.

**SBP** Special boiling point spirits. A range of solvent obtained from petroleum.

**SBR** Elastomer from styrene and butadiene. Abbreviation for styrene butadiene rubber.

**SBS** Abbreviation for styrene-butadiene-styrene block terpolymer.

**Scale** \ˈskā(ə)l\ [ME, fr. MF *escale*, of Gr origin; akin to OE *scealu* shell, husk] (14c) *n.* (1) An adherent oxide coating that is thicker than the superficial film referred to as tarnish. (2) A deposit formed from solution directly in place upon a confining surface. *Note* — Scale is a deposit that usually will retain its physical shape when mechanical means are used to remove it from the surface on which it is deposited. Scale which may or may not adhere to the underlying surface is usually crystalline and dense, frequently laminated, and occasionally columnar in structure. (3) The oxide formed on the surface of the metal during heating. (4) Rust occurring in thin layers.

**Scale of segregation** In mixing, the average distance between regions of the same component.

*See also intensity of segregation.*

**Scaler** (1568) *n.* A hand-cleaning chisel.

**Scaling** (1) Process of forming scale with or without acid fumes; sometimes refers to the spontaneous detachment of scale. (2) *See flaking.*

**Scaling resistance** *See flaking resistance.*

**Scanning electron microscope (SEM)** (1953) *n.* An electron microscope that uses electrons reflected from the sample surface to form images. The surface must first be made opaque and reflective, usually by sputtering onto it a very thin layer of gold. The microscope has more depth of field than the transmission-type instrument and can produce very sharp and insightful pictures.

*See electron micrograph.*

**Scarf joint** \ˈskärf ˈjóint\ {*plural* scarfs} [ME *skarf*, prob. of Scand origin; akin to ON *skarfr* scarf] (15c) *n.* A joint made by cutting away congruent acute-angular segments on two pieces to be joined, then bonding the cut surfaces to make the adherents coplanar.

*See also butt joint, lap joint, and joint scarf.*

**Scarlet chrome** \ˈskär-lət ˈkrōm\. Mixed pigment containing lead chromate, molybdate and sulfate.

*See molybdate orange.*

**Scarlet lake** $C_{18}H_{14}N_2O_7S_2Ba$. Lake, acid red 26 (16150). Pigment made by precipitating Scarlet 2R, which is the product of coupling diazotized *m*-xylidine with 2-naphthol-3,6disulfonic acid, on gloss white or hydrate of alumina.

**Scatter, coefficient of** The rate of increase of reflectance with thickness (weight per area) at infinitesimal thickness of material over an ideally black backing, $S = (dR_0/dX)x \rightarrow 0$.

**Scattering** Diffusion or redirection of radiant energy encountering particles of different refractive index; scattering occurs at any such interface, at the surface, or inside a medium containing particles.

**Scattering coefficient, Kubelka–Munk** Multiple (diffuse) scattering coefficient for a unit thickness and concentration of scattering material in a medium of different refractive index as used in the Kubelka–Munk equation. It is the rate of increase of reflectance of a layer over black as thickness is increased. Hence, the assumption is made that all of the scattering is in the backward or reverse direction from that of the incident diffuse light.

**Scattering coefficient, Mie** Single scattering coefficient of a particle in a medium of different refractive index, expressed as the ratio between scattering cross-section and geometric cross-section of the particle. It should properly be called scattering efficiency, but in popular usage, the term "scattering coefficient" is common.  Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

*See Mie theory.*

**Scattering loss** That part of transmitted energy lost due to roughness of reflecting surface.

**Scattering, multiple** Diffusion or redirection of radiant energy, which results from the observation of the reflected energy after multiple reflections from one particle to others, as opposed to the observation of single scattering.

*See Kubelka–Munk theory.*

**Scattering, single** Diffusion or redirection of radiant energy by a single particle spaced sufficiently distant from any other particle that the observed reflected energy from each particle has not impinged on any other particle. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

*See Mie theory.*

**SCE** *See specular reflectance excluded.*

**Schaffer's acid** Acid used in the manufacture of dyestuffs. Chemically, it is 2-naphthol-6-sulfonic acid.

**Schappe** A yarn from partly degummed silk waste.

**Scheiber** One of the original dehydrated castor oils.

S

**Schiff base** \ˈshifs-\. A reaction intermediate compound characteristic of reactions involving amines in general; formula is $\mathrm{RNH{-}CO{-}N{=}CH_2}$; often used in formation of ureaformaldehyde polymers. Mith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York.

**Schlieren optics** \ˈshlir-ən ˈäp-tiks\. An optical system used in an ultracentrifuge for the determination of the solute concentration gradient at any point in the cell. A parallel beam of light from a slit passes through the cell and an image of the slit is obtained which is deflected by different amounts along its length by radically directed refractive index gradient in the cell. The image is focused on a suitable phase plate. An image of this is photograph to give a two-dimensional plot in which the abscissa corresponds to the distance from the end of the cell and the ordinate is proportional to the refractive index gradient and hence to the concentration.

**Schnitzer's green** *See chromium oxide green.*

**Schotten–Baumann reaction** Consists of reactions diamines or dials with acid chlorides of difunctional carboxylic or sulfonic acids to yield high polymers in which degrees of polymerization of well over 100 are easily attainable; e.g., step-growth polymerization in the condensation polymerization of terephthaloyl chloride with ethylene glycol to form poly(ethylene terephthalate). Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Schweinfurt green** \ˈshvīn-ˌfúrt\. Another name for Paris green. Chemically, cupric acetoarsenite.

*Also known as emerald green.*

**SCI** *See specular reflectance included.*

**Scintillometer** \ˌsin-tᵊl-ˈä-mə-tər\ [L *scintilla* + ISV -*o*- + -*meter*] (1877) (scintillation counter) *n.* An instrument used to detect the presence of and measure the concentration of beta-emitting radioactive isotopes. When the emitted beta particle is intercepted by a molecule of the scintillant material in solution, a tiny flash of light is given off. By counting the flashes over a period of hours one obtains an estimate of concentration of the known beta emitter.

**Scleroscope** An instrument for measuring impact resilience by dropping a ram with a flattened-cone tip from a specified height onto the specimen, then noting the height of rebound.

**Scorching** A term denoting pre-mature vulcanization of a rubber compound, occurring during the mixing operation when the compound is calendered or extruded. Scorch is often controlled or prevented by selection of proper accelerators or by use of retarders. Scorched or burnt stock is generally not processible.

*Also known as burning.*

**Score** \ˈskōr, ˈskór\ (14c) *v.* To mark a line on a flat surface using a sharp-pointed instrument (*scriber*) and a straightedge. With a brittle material, the scoring may be deepened by repeated strokes, sometimes on both sides of the sheet, making it possible to cleanly break the sheet along the line of scoring. The same can be accomplished with brittle tubing with a triangular file, scoring only the outside surface.

**Scotchcast** Epoxide resin. Manufactured by Minnesota Mining & Manufacturing, USA.

**"Scotch-tape" test** A method of evaluating the adhesion of a lacquer, paint, or printed label to a plastic substrate. Pressure-sensitive adhesive tape is applied to an area of the painted plastic article, which may first be cross-hatched with scored lines. Adhesion is considered to be adequate if no paint adheres to the tape when it is peeled off.

**Scotopic vision** \skə-ˈtō-pik ˈvi-zhən\. The vision mediated by rods alone at very low levels of luminance; night vision.

**Scouring** (1) A wet process of cleaning by chemical and/or mechanical means. (2) An operation to remove the sizing and tint used on the warp yarn in weaving and, in general, to clean the fabric prior to dyeing.

**SCR** Abbreviation for either saturable-core reactor or silicon-controlled rectifier. (*See saturable reactor*) (*see SCR drive*).

**Scrap** \ˈskrap\ {*often attributive*} [ME, fr. ON *skrap* scraps; akin to ON *skrapa* to scrape] (14c) *n.* All products of a processing operation that are not present in the primary finished articles. This includes flash, runners, sprues, excess parison, and rejected articles. Scrap from thermosetting molding is generally not reusable. That from most thermoplastic operations can usually be reclaimed for reuse in the molder's own plant or can be sold to a commercial reclaimer.

**Scraper** Tool for scraping off paint or other adherent matter.

**Scrap grinder** *See granulator.*

**Scrapless thermoforming** *See sheet thermoforming.*

**Scratch coat** In three-coat plastering, the first coat of plaster, which is then scratched to provide a bond for the second (brown) coat.

**Scratch hardness** The resistance of a material to scratching by another material. The test most often employed with plastics is the Bierbaum test, in which he specimen is moved laterally on the stage of a microscope under a loaded diamond point. The standard load is 0.0294 N. The width of the scratch is measured with a micrometer eyepiece and the hardness value is expressed as the quotient of the load divided by the scratch width.

*See also Mohs hardness.*

**SCR drive** A variable-speed motor drive widely used today on new extruders in which a silicon-controlled rectifier (SCR) converts alternating current to run a direct-current motor. Unlike AC motors, DC motors have good torque characteristics over a wide speed range.

**Screen** \ˈskrēn\ [ME *screne*, fr. MF *escren*, fr. MD *scherm*; akin to OHGr *skirm* shield; prob. akin to Sanskirt *carman* skin, *krnāti* he injures] (14c) *n.* (1) A hollow, cylindrical, coarse-mesh wire device used in pickers and certain openers to form the loose staple stock into a sheet, or lap. The screen is mounted horizontally on a shaft on which it revolves freely. (2) A stencil used in screen printing. It is made of fine cloth, usually of silk or nylon, finely perforated in areas to form a design and mounted on a frame. The paste containing the dye is forced through the perforations onto the fabric, leaving the design. A series of screens, one for each color, is used for multicolored designs.

*Also see printing.*

**Screen analysis or test** *See sieve analysis.*

**Screen changer** A device bolted to the head end of an extruder, between extruder and die adapter, that allows the operator to quickly replace a dirty screen pack with a clean one, usually without having to rethread the downstream line.

**Screening** *See sieving.*

**Screen pack** *See extruder screen pack.*

**Screen painting** *See silk-screening.*

**Screen print** *See silk-screening.*

**Screen printing** (silk-screen printing). A printing process widely used on plastic bottles and other articles, employing as a stencil a taut woven fabric secured in a frame, the fabric being coated in selected areas with a masking material that is not penetrated by the ink being used. The stencil fabric is commonly called a "silk screen" even though silk is rarely used today. Nylon is most often used, and screens of copper, stainless steel and many other materials are suitable. The screen is placed above the part to be decorated, and a flexible squeegee forces ink through the openings in the screen onto the surface of the plastic article. Multicolor work requires multiple screens and impressions. Printing ink handbook, 5th edn. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1999.

*See printing.*

**Screen process printing** *See silk screen printing.*

**Screw** In extrusion, the shaft provided with a helical channel that coveys the material from the feed hopper through the barrel, working it vigorously and causing it to melt, then developing pressure through pumping action to force the molten plastic through the die.

*See extruder screw* for more details.

**Screw characteristic** The relationship between volumetric flow rate in a melt-metering extrusion screw and the head pressure. For a melt screw operating isothermally, it is given by the equation:

$$Q = \alpha N - \beta\,\Delta P/\eta L,$$

where $N$ is the screw rotational speed, $\Delta P$ the rise in pressure along the screw, equal to the head pressure, $L$ the axial length of the screw, $\eta$ the melt viscosity based on temperature and shear rate in the screw channel, and $\alpha$, $\beta$ are the constants related to the screw dimensions. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Rosato DV (ed) (1992) Rosato's plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York.

*See also die characteristics.*

**Screw conveyor** A device for moving and metering the flow of solid particles at a fairly well controlled rate, consisting of a trough or sometimes a closed tube within which rotates a deep-flighted screw. Unlike an extruder screw, a conveyor screw normally operates only partly full and is a low-friction, low-torque device. A conveyor can be jacketed for heating or cooling. Screw conveyors are sometimes used as feeders for extruders and injection machines when it is desired to operate them in the starved mode.

**Screw dislocation** A dislocation in which layers of particles in a crystal are warped around a screw axis.

**Screw extruder** *See extruder.*

**Screw feeds** Feed systems in which the action of the screw generates pressure that causes flow. The system usually consists of a container with a closely fitting screw unit.

**Screw injection molding** *See injection molding.*

**Screw lead** *See second lead.*

**Screw melter** (1) Screw extruder in which frictional forces between the screw and the heated barrel contribute to rapid melting of solid polymer. This configuration is capable of high throughput. (2) System in which a screw feed is used to feed polymer to a melt grid and to maintain a constant pressure at the grid.

**Screw-piston injection molding** *See injection molding.*

**Screw pitch** *See pitch* (1).

**Screw-plasticating injection molding** *See injection molding.*

**Scrim** \ˈskrim\ [origin unknown] (1792) *n.* (1) A lightweight, open-weave, coarse fabric;

the best qualities are made with two-ply yarns. Cotton scrim usually comes in white, cream, or ecru and is used for window curtains and as backing for carpets. (2) Fabric with open construction used as base fabric in the production of coated or laminated fabrics.

**Scroop** The sound of rustle or crunch that is characteristic of silk. Scroop is a natural property of silk, but may be induced in other fabrics to a degree by various treatments.

**Scrub board** *See baseboard.*

**Scrub resistance** *n.* The ability of a coating to resist being worn away or to maintain its original appearance when rubbed with a brush, sponge, or cloth, and an abrasive soap. For test method, refer to ASTM D 2486.

*Also known as wet abrasion resistance.*

**Scrumbling** *n.* In painting, the operation of lightly rubbing a brush containing a small quantity of opaque or semi-opaque color over a surface to soften and blend tints that are too bright, or to produce a special effect; the coat may be so thin as to be semi-transparent.

**Sculptured wall covering** Products molded of solid (usually synthetic) material in which the texture and shadows are real.

**Scumble glaze** \ˈskəm-bəl ˈglāz\ *n.* Transparent preparation used in the scumbling process.

**Scumble stain** *n.* Semitransparent stain for application over an opaque groundwork of paint. Brush, stipple or sponge may be used for manipulating the scrumble, or it may be combed, so that various effects, i.e., wood graining and other more formal patterns, are possible. In this, the non-flowing property of the scrumble greatly assists.

**Scumming** *See greasing.*

**Sealant** \ˈsē-lənt\ (1944) *n.* A liquid, paste, or coating, or tape that fills small gaps between mating parts, e.g., pipe-thread sealant, or plugs small holds, stopping fluid leaks.

**Seal coat, sealing coat** *See sealer.*

**Sealer** *n.* (1) A liquid coat which seals wood, plaster, etc., and prevents the surface from absorbing paint or varnish; may be transparent; may at as a primer for a following coat or as a finish for the surface. (2) A coat, applied in liquid form, which is laid over a tar-like substance to prevent its bleeding through an applied paint film. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

*See size and floor sealer. Also known as seal coat or sealing coat.*

**Sealing** *See heat sealing.*

**Sealing coat** *See sealer.*

**Sealing wax** (14c) *n.* A resinous composition that is plastic when warm and is used for sealing.

**Seaming** *n.* Joining the overlap of two pieces of fabric, usually near their edges.

**Seamless** *n.* A term that describes a tubular knit fabric without seams, e.g., seamless hosiery.

**Seamless flooring** *n.* Fluid or trowel-applied flooring without aggregates. Syn: monolithic flooring.

**Seam mark** *n.* A particular type of pressure mark in the finished fabric. It is produced during finishing operations by the thickness of the seam used to join pieces for processing.

**Seams** *n.* In hanging wall coverings, there are three methods of joining seams. All three are satisfactory, but the "but" method produces the smoother finished job and is most often preferred. (1) In a "butt" the seam edges are fitted tightly together without any overlap. If the wall covering comes untrimmed, selvages must be cut off at both sides of the roll. This leaves a flat, invisible seam, with no double thickness. (2) In the "lap" method, one strip is lapped over the selvage of another. Wall coverings are usually hung from left to right. In moving from left to right, the selvage is left intact on the right and trimmed on the left. The clean edge overlaps and covers the selvage edge. This procedure would be reversed in hanging from right to left. (3) The "wire-edge" method is a version of the "butt" technique, but will overlap about one-sixteenth of an inch (1.5 mm) into the pattern, so that no wall shows through in case the butting is not prefect. Here, also, both selvages must be removed. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Seam slippage** *n.* A defect consisting of separated yarns occurring when sewn fabrics pull apart at the seams. Seam slippage is more prone to occur in smooth-yarn fabrics produced from manufactured filament yarns.

**Seam welding** *n.* Any stitchless procedure for joining fabrics based on the use of thermoplastic resins or the direct welding of thermoplastic materials. Seam welding is an alternative to conventional needle-and-thread seaming operations that is extremely popular in the non-woven field.

**Sebacic acid** \si-ˈba-sik\ [ISV, fr. L *sebaceus*] (1790) *n.* (1) (sebacylic acid, decanedioic acid). $HOOC(CH_2)_8COOH$. White leaflets derived from butadiene or castor oil, used as an intermediate in the production of plasticizers, alkyd resins, and certain nylons. (2) $(CH_2)_8(COOH)_2$. Used for the preparation of sebacate plasticizers and ass a stabilizer for alkyds. Mp, 133°C; bp, 295°C per 100 mmHg.

**SEBS** *n.* Abbreviations for block terpolymer styrene-ethylene/butene-styrene.

**Secant modulus** \ˈsē-ˌkant ˈmä-jə-ləs\ *n.* The ratio of stress to corresponding strain at any specific point on a stress–strain curve. It is expressed in force per unit area, MPa or kpsi. This definition of modulus is useful for many plastics whose stress–strain relationships are non-linear even at very low strains, exhibiting little or no Hooke's-law range. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

***sec*-Butyl acetate** \ˈsek ˈbyü-tᵊl ˈa-sə-ˌtāt] (2-butyl acetate) *n.* $CH_3COOCH(CH_3)C_2H_5$. A solvent for nitrocellulose, ethyl cellulose, PVC, acrylics, polystyrene, phenolics, and alkyd resins.

**Second** \ˈse-kənd *also* –kənt, esp *before a consonant* –kən, -kəŋ\ [ME *secunde*, fr. ML *secunda*, fr. L, fem. of secundus second; from its being the second sexagesimal division of a unit, as a minute is the first] (14c) *n.* (1) (s) The SI basic unit of elapsed time, the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom. All other measures of time intervals are defined in terms of the second. (2) A finished product containing slight imperfections but without serious functional faults and therefore usable, but usually sold at a discount. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Secondary** (1, *adj*) In organic chemistry, a functional group in which two of its hydrogen atoms have been replaced by other groups as a secondary alcohol, >CHOH, or a secondary amine, >NH. Examples are isopropyl alcohol, $(CH_3)_2CHOH$, and dimethyl amine, $(CH_3)_2NH$. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Secondary amine value** *n.* The number of milligrams of potassium hydroxide (KOH) equivalent to the secondary amine basicity in 1 g of sample.

**Secondary backing** *n.* A layer of material, usually woven jute, polypropylene, vinyl, or latex foam, laminated to the underside of a carpet to improve body and dimensional stability.

**Secondary colors** (1831) *n.* Green, orange, and violet, each of which is obtained by mixing two primary colors. It is necessary to specify pigments or filters regarding primary and secondary colors. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. Mayer R, Sheehan S (1991) Artist's handbook of materials and techniques. Viking Adult, New York. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Secondary creek** The non-recoverable component of creep.

*Also see delayed deformation.*

**Secondary emission** (1931) *n.* The emission of electrons from a surface that is bombarded by particles (as electrons or ions) from a primary source. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Secondary forces** Forces generated by the interactions between atoms other than a covalent bond. Secondary forces include hydrogen bonding, ionic interaction, and dispersion forces.

**Secondary plasticizer** (extender plasticizer) *n.* A plasticizer that is less compatible with a given resin that is a primary plasticizer and thus would exude or cause surface tackiness if used in excess of a certain concentration. Secondary plasticizers are used in conjunction with primaries to reduce cost or to obtain improvement in electrical or low-temperature properties.

**Secondary reference standard** *n.* A standard which has been calibrated relative to a primary standard and which, when used with the calibration values, essentially reproduces the primary standard.

**Secondary treatment** *n.* The second step in most waste-treatment systems, in which bacteria consume the organic parts of the wastes.

**Second-order transition** *n.* A thermal transition that involves a change in heat capacity, but does not have a latent heat. The glass transition is a second order transition. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

*See glass transition.*

**Second-order transition temperature** *n.* The temperature at which the non-crystalline (amorphous) portions of polymer melt or become plastic. An inflection point or change is stress–strain properties occurs at this point; however, for most fibers, this change is small. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.

**Seconds** *n.* (1) Imperfect fabrics (woven or knitted) containing flaws in the weave, finish, or dyeing, and sold as "seconds". (2) *See yarn quality.*

**Second-surface decorating** *n.* A decorating process used with transparent plastics in which the decoration is applied to the back of the part so that it is visible from the front but is not exposed to possible damage.

**Second virial coefficient** *n.* The second constant of the virial coefficient describes the interaction between two molecules. For polymer solutions, the second virial coefficient $A_2$ is related to the excluded volume by the expression

$$A_2 = Nu_2/2M_2^2,$$

where $N$ is the Avogadro's number and $M_2$ is the solute molecular weight. The name "virial coefficient" comes from the "virial theorem" that was much used toward the end of the 19th century. This theorem states:

$$\text{average of } (mv)^2/2 = -\text{average of } 0.5 \, (Xx + Yy + Zz).$$

Here $m$ is the mass of the particles, $v$ is their velocity, $x$, $y$, and $z$ are their coordinates, and $X$, $Y$, and $Z$ are the components of the forces that act upon them. The expression on the right-hand side was call "virial" because forces were considered [*vis* (Latin) = force]. The virial could be expanded into a series whose coefficients were consequently the virial coefficients. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

S

**Section beam** *n.* (1) A large, flanged roll upon which warp yarn is wound at the beam warper in preparation for slashing. (2) Small flanged or unflanged beams assembled side-by-side on the shaft of a warp beam for further processing.

**Section mark** *n.* A fabric defect consisting of marks running warpwise in an evenly repeating pattern, caused by the improper setting of sections in silk system (or indirect) warping.

**Section modulus** ($Z$) *n.* In a beam under load, the quotient of the moment of inertia of the beam's cross-section about its neutral axis divided by the distance from the neutral axis to the outermost surface of the beam ($I/c$). The bending moment divided by the section modulus gives the maximum stress in the beam at any point along it.

**Sediment** \ˈse-də-mənt\ [MF, fr. L *sedimentum* settling, fr. *sedēre* to sit, sink down] (1547) *n.* Any solid which can settle or be centrifuged from the main portion of the liquid, for example, foots, meal, grain, and gum.

**Seebeck effect** *n.* The electrical phenomenon responsible for the action of a thermocouple. If a circuit consists of two metals, one junction being hotter than the other, a current flows in the circuit. The magnitude and direction of the current depend on the metals chosen and on the difference in temperature between the junctions. If the cold junction is held at a known constant temperature, e.g., 0°C, the current becomes a measure of the temperature at the other junction. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Seediness** \ˈsēd-ē-nəs\ *n.* (1) Particles in a coating caused by reactive pigments and acid components of the vehicle. (2) Defect in a clear varnish or lacquer caused by small particles sometimes visible when examined by transmitted light. On application, varnished or lacquered surfaces may present a bitty, specky or sandy appearance due to this defect.

**Seeding** *n.* Formation of small, undesirable particles or granules in a paint, varnish or lacquer.

**Seeds** *n.* Undesirable particles which develop in a liquid coating by partial gelation of the vehicle or by agglomeration of pigment particles.

*See seediness.*

**Seedy** \ˈsēd-dē \ (1574) *adj.* Descriptive of a paint finish that is not smooth owing to undispersed pigment particles or insoluble gel particles in the paint.

**Seersucker** \ˈsir-ˌsə-kər\ [Hindi *śīrśaker*, fr. Per *shīr-o-shakar*, lit., milk and sugar] (1722) *n.* Lightweight fabric, made of cotton or manufactured fiber, having crinkled stripes made by weaving some of the warp threads slack and others tight. Woven seersucker is more expensive than imitations made by chemical treatment.

**Segregated oils** *n.* Drying oils which are obtained from the semidrying types by removal of non-drying constituents. This removal may be effected by selective crystallization, solvent extraction, or vacuum distillation.

**Segregation** *n.* (1) A close succession of parallel, rather narrow and sharply defined, wavy lines of color on the surface of a plastic, said color differing in shade from surrounding areas, and creating the impression that components of the plastic have separated. (2) In 1952, PV Danckwerts introduced the terms scale of segregation and intensity of segregation to define the state of a heterogeneous mixture and to quantify the effectiveness of mixing processes.

**Selected ordinate method** *n.* A method for determining the CIE tristimulus values by adding the reflectances or transmittances at unequally spaced intervals of wavelength, so selected for each of the tristimulus values that the summation of the reflectances or transmittances give the same tristimulus values obtained by integration of weighted regularly spaced wavelength values. The accuracy of this technique is poor relative to that obtained with the weighted ordinate method unless an extremely large number of readings at different wavelengths is used (e.g., more than 100 for each tristimulus value). McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Selenium red** \sə-ˈlē-nē-əm\ *n. See cadmium red.*

**Self-adhesion** (1958) *adj. See autohesion.*

**Self-cross-linking** *See self-curing and ambient cure.*

**Self-curing** *adj.* Undergoing cure (cross-linking) without the application of heat.

*See self-vulcanizing and ambient cure.*

**Self-dissociation** *adj.* The production of cations and anions by dissociation of solvent molecules without interaction with other species.

**Self-etch primer** *See wash primer.*

**Self-extinguishing** *adj.* A somewhat loosely used term denoting the ability of a material to cease burning after the source of flame has been removed. PRV, vinyl chloride-acetate co-polymers, polyvinylidene chloride, some nylons, and casein plastics are examples of self-extinguishing materials. Troitzsch J (2004) Plastics flammability handbook: principle, regulations, testing and approval. Hanser–Gardner Publications, New York. Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997.

*See also flammability and flame retardant.*

**Self-ignition temperature** *See autoignition temperature.*

**Self-lifting resistance** *adj.* The ability of dried films of organic coating materials to resist deformation upon application of an

additional coat of the same material. For a method of test, 141a, Method 6252.
*See federal standard*

**Self-luminous paint** *See luminous paint.*

**Self-polishing wax** *See liquid emulsion polymer coating and liquid water emulsion wax.*

**Self-priming** *adj.* Use of same coating for primer and for subsequent coats. It may be thinned differently for the various coats.

**Self-sealing paint** *n.* A paint which, when applied over a surface of varying porosity, seals the surface and yet dries with a uniform color and sheen.

**Self-thermosetting** *See self-curing.*

**Self-tone** *n.* Wall covering in which shades of one color are featured. Habitually used for damasks and in flocking.

**Self-twist yarn** *n.* An inherently twist-stable, two-ply structure having a ply twist that is alternately *S*- and *Z*-directed along the yarn.

**Self-vulcanizing** *adj.* Pertaining to an adhesive that undergoes vulcanization without the application of heat.
*See self-curing.*

**Selvage** \ˈsel-vij\ [ME *selvage*, prob. fr. MD *selvegge*, selvage, fr. *selv* self + *egge* edge; akin to OE *self* and to OE *ecg* edge] (15c) *n.* The narrow edge of woven fabric that runs parallel to the warp. It is made with stronger yarns in a tighter construction than the body of the fabric to prevent raveling. A fast selvage encloses all or part of the picks, and a selvage is not fast when the filling threads are cut at the fabric edge after every pick.
*Also spelled "selvedge".*

**Selvedge** *See selvage.*

**Semi-automatic molding machine** *n.* A machine in which only part of the operation is controlled by the direct actions of a person. The automatic segments are controlled by the machine's instruments or by a computer according to a predetermined program.

**Semibatch reactors** *n.* In a semibatch reactor, some of the reactants are loaded into the reactor as a single charge and the remaining reactants are then fed gradually. Alternatively, a semibatch reactor may be loaded with reactants in a single charge, and then some of the products are drawn from the reactor.

**Semiconductor** \-ˈdək-tər\ (1838) *n.* A substance whose electrical conductivity increases with increasing temperature.

**Semicrystalline** \-ˈkris-tə-lən\ (1816) *adj.* Describing a polymer having both amorphous and crystalline regions in the range 20–80%. Most so-called "crystalline polymers" are, in most articles made from them, actually semicrystalline.

**Semicure** *adj.* A preliminary, incomplete cure given to certain rubber articles to cause the rubber to set in some desired shape. Full vulcanization is subsequently completed by a final cure.

**Semidrying oil** Oils which possesses the characteristics of a drying oil but to a less degree; for example, upon being exposed to oxygen it only partially hardens or is changed to a sticky mass. There is no definite line of demarcation between drying and semidrying oils.

**Semigloss** \ˈse-mē-ˌgläs\ (1937) *adj.* A gloss range between high gloss and eggshell, approximately 35–70 on the 60° gloss scale.
*See gloss.*

**Semigloss lacquer** \ˈla-kər\. Lacquers having the appearance of having been frictionally rubbed. Usually arrived at through the introduction of a pigment (inert). A type of satin finish.

**Semipermeable membrane** \-ˈpər-mē-ə-bəl ˈmen-ˌbrān\ *n.* A thin partition between two solutions that allows some molecules to pass through but not others.

*See osmometer and osmosis.*

**Semipositive mold** A mold with a plunger that fits loosely within the cavity as the mold begins to close, allowing excess material to escape as flash. As the mold nears complete closing, the plunger fits more closely to exert full molding pressure on the material. The semipositive mold combines the free flow of material inherent in a flash-type mold with the high density of moldings obtained with a positive mold.

**Semirigid plastic** *n.* For the purposes of general classification, a plastic that has a modulus of elasticity in either flexure or tension of between 70 and 700 MPa at 23°C and 50% relative humidity when tested in accordance with ASTM D 747, D 790, D 638, or D 882 (ASTM D 883).

*See also rigid plastic.*

**Semitransparent stain** *n.* A coating which is formulated to change the color of a surface, but not conceal the surface.

*See also stain and opaque stains.*

**Senegal gum** \ˌse-ni-ˈgól\ *n.* Form of gum Arabic obtained from Senegal. It is a natural exudation from *Acacia Senegal* and is water-soluble. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

*See acacia gum.*

**Sensation** \sen-ˈsā-shən\ [ML *sensation-*, *sensatio*, fr. LL, understanding, idea fr. L *sensus*] (1615) *n.* Mode of mental functioning that is directly associated with stimulation of the organism.

**Sensitizer** \ˈsen(t)-sə-ˌtīz-ər\ [*sensitive* + *-ize*] (ca. 1859) *n.* An agent which cleanses the ink-repellant, non-printing areas of lithographic printing plates.

**Separate application adhesive** *See adhesive, separate application.*

**Sepia** \ˈsē-pē-ə\ [L, cuttlefish, ink, fr. Gk *sēpia*] (1821) *n.* Dark brown artists' pigment, which occurs as a natural secretion in cuttlefish.

**Sequential arrangement** *n.* The arrangement of mer units in a polymer. A head-to-tail polymer exemplifies one possible sequence.

**Sequential winding** *See biaxial winding.*

**Sequestering agent** *n.* A chemical that prevents metallic ions from precipitating from solutions of anions that would normally, without the sequestering agent being present, precipitate those ions.

*See also chelate and chelating agent.*

**Sequestrant** *n.* Any compound that will inactivate a metallic ion by forming a water-soluble complex in which the metal is held in a non-ionizable form. This results in prevention of the usual precipitation reactions of the metal.

**Sequestration** *See chelation.*

**Serge** \ˈsərj\ [ME *sarge*, fr. MF, fr. (assumed) VL *sarica*, alter. of L *serica*, fem. of *sericus* silken] (14c) *n.* (1) Any smooth-faced cloth made with a two-up and two-down twill weave.

**Serging** *n.* (1) Overcasting the cut edge of a fabric to prevent raveling. (2) Finishing the edge of a carpet by oversewing rather than binding. Generally, the sides of a carpet are serged and the ends bound.

**Sericin** \ˈser-ə-sən\ [ISV, fr. L *sericum* silk] (ca. 1868) *n.* Silk gum. The gelatinous protein that cements the fibroin filaments in a silk fiber. It is removed in the process called degumming.

**Sericite** *See aluminum potassium silicate.*

**Serpentine** \ˈsər-pən-ˌtēn\ [ME, fr. ML *serpentina*, *serpentinum*, fr. LL, fem.&neuter of *serpentinus* resembling a serpent] (15c) *n.* A type of asbestos containing chrysotile.

A mineral or rock consisting essentially of a hydrous magnesium silicate usually having a dull green color and often a mottled appearance.

*See asbestos.*

**Served yarn** *n.* In aerospace textiles, a reinforcing yarn such as graphite or glass around which two different yarns are wound, i.e., one in the *Z*-direction and one in the *S*-direction, etc., for protection or compaction of the yarn bundle.

**Service factor** *n.* (1) *See factor of safety.* (2) The fraction (or percentage) of planned operating time during which a device or system satisfactorily accomplishes its anticipated mission.

**Service life** *n.* The time over which a part or system will continuously and satisfactorily perform its designed functions under stated service conditions. Service life may be determined by actual life testing or may be estimated by extrapolation from shorter-term testing, or from short-term testing under more severe conditions, as at higher temperature via time-temperature equivalence.

**Sesame oil** \ˈse-sə-mē *also* ˈse-zə-\ (1870) *n.* Pale yellow oil, almost odorless, from the seeds of cultivated varieties of *Sesamum indium.* Sp gr, 0.916; Saponification value, 188–193; iodine value, 103–122. Syn: benne, teel, or gingelli oil.

**Set** *n.* (1) To convert an adhesive into a fixed or hardened state by chemical or physical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents. (2) Condition of a paint or varnish film when it has dried to a point where, for all practical purposes, it ceases to flow.

*See cure and dry.*

**Set** *v.* To become at least partly fixed or hardened by chemical or physical action, such as condensation polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents. *See also cure.* (2, *n*) *See permanent set.*

**Setaflash closed tester** *n.* A closed cup flash point tester in which a small sample of the material is heated in a crucible or cup, and at a definite temperature, the vapor–air mixture which forms is ignited by a dipping flame. Reference ASTM D 3278.

**Set mark** *n.* A fabric defect consisting of narrow bars or bands across the full width of the fabric that may appear either as a tight, loose, or corduroy effect caused by loom stops improperly reset by the weaver. Set marks are sometimes caused by the weaver ripping out filling yarn and then not properly adjusting the pick wheel to obtain the proper relation between the fell of the cloth and the reed.

**Set off** *vt.* An undesirable transfer of ink from the printed sheet to the back of the sheet adjacent to it.

**Set off of ink** *n.* The transferring or smearing of ink from freshly printed matter to another surface with which the undried print comes in contact, particularly from the face of one sheet onto the back of the sheet on top of it in the delivery pile or rewind roll.

**Setoglaucine** *See rhoduline blue 66.*

**Set point** *n.* The value set in a control instrument at which a control action will be taken when the instrument's sensor signals that the quantity controlled has just passed above (or below) the set value.

**Set point setting agent** Syn: curing agent.

**Setting of ink** *n.* The initial phase of the drying process by slight absorption of the vehicle by the paper, wherein printed sheets, though not fully dry, can be handled without smudging.

**Setting temperature** *See temperature, setting.*

**Setting time** *n.* Of adhesives, castings, or hand lay-ups and spray-ups, the time from application until the material has become

firm and handleable and will no longer flow by gravity, usually a time less than that required to dry completely or to reach a full cure or full strength.
*See time, setting.*

**Setting up** *n.* (1) Conversion of liquid paint during storage to a gel-like or pseudosolid condition. The process is usually reversible by agitation and thinning but may be permanent when chemically reactive pigments or highly polymerized media are involved. (2) The thickening which occurs when paint stands in a open can. (3) The increasing viscosity of a paint film as it dries.

**Settling** *n.* The sinking of pigments, extruders or other solid matter in a paint on standing in a container, with a consequent accumulation on the bottom of the can.

**Set-to-touch time** *n.* The time required for the coating to reach a point where the adhesion to an external object is less than the internal cohesion of the film.
*See drying time.*

**Set yarns** False-twist yarns stabilized to produce bulk.

**Sewing thread** *See thread.*

**Seydel converter** *n.* Tow-to-top processing equipment. Seydel combines the prestretching and breaking process in one machine.

**S-finishing** *n.* A finishing process applied to acetate and triacetate fabrics using a sodium hydroxide solution to give surface saponification; i.e., the fiber "skin" is converted to cellulose. It improves the hand and reduces the tendency to acquire a static charge.

**S glass** *n.* A specialty glass composition containing 64% silica, 25% alumina, and 10% magnesia that provides high strength – 4.5 GPa in fibers – sometimes used as reinforcement for laminates where high specific strength is wanted.
*See also glass–fiber reinforcement.*

**Sgraffito** \zgra-ˈfē-(ˌ)tō\ [It, fr. pp of *sgraffire* to scratch, produce sgraffito] (ca. 1730) *n.* Decoration by cutting away parts of a surface layer (as of plaster or clay) to expose a different colored ground.

**Sgraffito painting** *n.* Form of mural decoration in which a design is produced by scratching through a white or tinted topcoat of limewash to expose the darker colored mortar underneath.

**Shade** \ˈshād\ [ME, fr. OE *sceadu*; akin to OHGr *scato* shadow, Gk *skotos* darkness] (before 12c) *n.* (1) In ink manufacture, commonly used as a Syn: hue. (2) Term employed to describe a particular hue, or variation of a primary hue, such as a red shade blue. (3) Term used to describe the depth of color, such as a pale shade. (4) Term used to describe a mixture with black (or gray) as opposed to a tint, which is a mixture with white. (5) Verb used to describe the process of making a small modification in a color by the addition of colorant(s).
*See also shading and blending.*

**Shade bar** *See mixed end and filling.*

**Shade cloth** *n.* A plain-weave cotton or linen fabric that is heavily sized and is often given oil treatment to make it opaque. The fabric is used for curtains and shades.

**Shade filling** *n.* A defect consisting of a bar running across the fabric caused by a difference in appearance of the filling yarn, and occurring at a quill change or knot.

S

**Shading** *n.* In cut-pile fabrics, an apparent change in color when the pile is bent, caused by differences in the way light is reflected off the bent fibers. This phenomenon is a characteristic of pile fabrics, not a defect.

**Shading and blending** *n.* Altering the color of a paint slightly by the addition of black tinting color to create a decorative effect of graduated colors when applied to adjacent areas. The lap areas often are brushed and rolled to achieve a subtle blending.

*See also shade.*

**Shadow printing** *See printing, wrap printing.*

**Shaft** *n.* (1) A term often used with reference to satins indicating the number of harnesses employed to produce the weave. (2) *See harness.*

**Shaft mark** A fabric defect characterized by a number of floating ends, usually caused by a broken harness strap on the loom.

**Shag carpet** *n.* A loosely tufted carpet construction with cut pile 1–5 in. in length and with greater than normal spacing between tufts.

**Shale oil** \ˈshā(ə)l\ (1857) *n.* An oil obtained by destructive distillation from shale tar, which, in turn, is obtained by distilling shale. Shale is a bituminous type of mineral, mined similarly to bituminous coal, and is found in many places throughout the world. Shale oil varies in specific gravity from 0.750 to 0.850. Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York.

**Shank** \ˈshaŋk\ [ME *shanke*, fr. OE *scanca*; akin to ON *shakkr* crooked, Gk *skazein* to limp] (before 12c) *n.* The section of an extruder screw to the rear of the flighted sections. The forward part of the shank contains a milled keyway holding the key that engages the tubular drive shaft and may act as a shear safety protecting the screw from over torquing, while the rear part of the shank engages the radial and thrust bearings.

**Shared-electron bond** *See covalent bond.*

**Sharkskin** \ˈshärk-ˌskin\ (1851) *n.* (1) An irregularity of the surface of an extrudate in the form of finely spaced sharp ridges perpendicular to the extrusion direction, believed to be caused by a relaxation effect on the melt at the die exit. (2) A hard-finished, twill fabric, woolen or worsted, made of simple weaves with a two-color arrangement of warp and filling yarns. (3) A plain-weave sportswear fabric made of dull-luster acetate or triacetate yarns.

**Sharp coat** *n.* A coat of white lead in oil, thinned liberally with turpentine or white spirit. A sharp coat used for the treating of new plaster following the trowel is frequently referred to as "sharp color".

**Sharp paint** *n.* Rapid-drying paint which yields a flat film for use as a seal coat. It is usually highly pigmented and contains a minimum amount of binder. Sharp paints dry off to a tack-free condition chiefly by evaporation of solvent. They are used as priming or sealing coats.

**Shaw pot** *n.* A name used in the early years of the industry for the original transfer-molding machine. It consisted of a conventional hydraulic press with a pot suspended above the mold. Material was charged into pot, then forced into the mold by the closing of the press.

**Shear** \ˈshir\ (before 12c) *n.* The movement, in a fluid or solid body, of a layer parallel to adjacent layers.

*See also shear strain and shearing stress.*

**Shear degradation** (rheomalaxis) *n.* Chain scission of a polymer caused by subjecting it to an intense shear field, such as exists in the close clearances of extruders and internal mixers.

**Shear flow** *n.* The flow caused by the relative parallel or concentric motion of the surfaces confining a liquid, as in an extruder screw; or caused by a pressure drop, in the direction of flow, from the entrance of a flow passage to its exit, as in a die. Sometimes the two basic driving modes coexist, as in the metering sections of most extrusion screws and in wire-covering dies. In the direction crosswise to any laminar flow, successive layers slide past each other in shear.

**Shear heating** Syn: viscous dissipation.

**Sheariness** *n.* Variation in gloss or sheen on a paint surface, which should have been uniform in this respect. This variation is due to differences in film thickness.

**Shearing** *n.* A dry finishing operation in which projecting fibers are mechanically cut or trimmed from the face of the fabric. Woolen and worsted fabrics are almost always sheared. Shearing is also widely employed on other fabrics, especially on napped and pile fabrics where the amount varies according to the desired height of the nap or pile. For flat-finished fabrics such as gabardine, a very close shearing is given.

**Shearing strength** *n.* The maximum shear stress which a material is capable of sustaining. Shear strength is calculated from the maximum load during a shear or torsion test is based on the original dimensions of the cross-section of the specimen.

**Shearing stress** *n.* The tangential shearing force which is acting on a material to produce motion or flow in it.

**Shear modulus** ($G$, modulus of rigidity) *n.* The ratio of shear stress to shear strain within the proportional limit of a material. If the material exhibits no proportional region, a secant modulus is used.

**Shear rate** (shear-strain rate, velocity gradient) *n.* The rate of change of shear strain with time. In concentric-cylinder flow where the gap between the cylinders is much smaller than the cylinder radii, shear rate is almost uniform throughout the fluid and is given by $\pi(R_1 + R_2)N/(R_2 - R_1)$, where $R_1$ and $R_2$ are the radii of the cylinders, one rotating, the other stationary, and $N$ is the rotational speed in revolutions per second. The universally used unit of shear rate is $s^{-1}$. In tube flow, the shear rate varies from zero at the center to its maximum at the tube wall where, for a Newtonian liquid, it takes on the value $4Q/\pi R_3$, where $Q$ is the volumetric flow rate and $R$ is the tube radius.

**Shear strain** *n.* The amount of movement of one layer relative to an adjacent layer divided by the layer thickness. This may be expressed as an angle of shear, in radians.

**Shear strength** *n.* The maximum shear stress required to shear the specimen in such a manner that the moving portion completely clears the stationary portion.

**Shear stress** *n.* Force per unit area acting in the plane of the area to which the force is applied. In an elastic body, shear stress is equal to shear modulus times shear strain. In an inelastic fluid, shear stress is equal to viscosity times the shear rate. In viscoelastic materials, shear stress will be a function of both shear strain and shear rate.

**Shear thickening** *n.* A rheological flow characteristic evidenced by an increase in viscosity with increasing rates of shear, an increase of flow resistance with agitation. Shear thickening is *also known as dilatant flow.*

*See also dilatancy.*

**Shear thinning** *See thixotropy.*

**Sheary** *See sheariness.*

**Sheath-core fibers** *n.* Bicomponent fibers of either two polymer types, or two variants of the same polymer. One polymer forms a core and the other surrounds it as a sheath.

**Sheathing** *n.* Structural insulating board for use in housing and other building construction, which may be integrally treated, impregnated or coated to give it additional water resistance.

**Shed** *n.* A path through and perpendicular to the warp in the loom. It is formed by raising some warp threads by means of their harnesses while others are left down. The shuttle passes through the shed to insert the filling.

**Shedding** *n.* (1) The operation of forming a shed in weaving. (2) A loss of nominal length staple at any process in a staple yarn plant.

**Sheen** \ˈshēn\ (1602) *n.* An attribute of object mode of appearance, which is similar to luster; gloss with poor distinctness-of-image reflectance. Frequently, in the paint industry, sheen is used synonymously with "low-angle sheen", a characteristic where a material appears to be matte when illuminated and viewed near to the perpendicular, but appears to be glossy when illuminated and viewed at an angle near to the grazing angle, such as 85° off the perpendicular. Sheen is therefore frequently evaluated in terms of gloss measurements made on a 75° or 85° gloss meter.

*See gloss and luster.*

**Sheers** \ˈshirs\ (ca. 1920) *n.* Transparent, lightweight fabrics of different constructions and yarns, especially those of silk and manufactured fibers. Examples are chiffons, some crepes, georgette, and voile.

**Shier** *n.* A short length of a single pick that appears to be cut out of the plane of the fabric.

**Sheet** \ˈshēt\ [ME *shete*, fr. OE *scyte*; akin to OE *scēat* edge, OHGr *scōz* flap, skirt] (before 12c) (sheeting) *n.* Sheet is distinguished from film in the plastics and packaging industries according to thickness: a web under 0.25 mm thick is usually called film, whereas thicker webs are called sheet. Sheeting is most commonly made by extrusion, casting, and calendering, but some, such as decorative laminates, are compression molded.

**Sheet die** *n.* A heavy-walled, extremely rigid steel structure, bolted to an extruder head, whose inner passages form the molten plastic leaving an extruder screw into the shape of a flat sheet. Most modern sheet dies are of the coat hanger type with multizone temperature control, and contain adjustable choker bars and die lips for close control of lateral variation in the sheet thickness.

*See coat hanger die, choker bar, and flexible-lip die.*

**Sheeter lines** *n.* Parallel scratches or projecting ridges distributed over considerable area of a plastic sheet such as might be produced during a slicing operation.

**Sheet line** *n.* The entire assembly necessary to produce plastic sheet, including the extruder, die, polishing-roll stand, cooling conveyor, pull rolls, and winder, or cutter and stacker, and all associated controls.

**Sheet-molding compound (SMC)** *n.* A fiberglass-reinforced thermosetting compound in sheet form, usually rolled into coils interleaved with plastic film to prevent autoadhesion. This term was chosen to replace the term prepreg, which was deemed to be confusing and insufficiently definitive. SMC can be molded into complex shapes with little scrap, and is low in cost.

**Sheet thermoforming** \-ˈthər-mə-ˌfórm-\ (thermoforming) *n.* The process of forming a thermoplastic sheet into a three-dimensional shape by clamping the sheet in a frame, heating it to render it soft and flowable, then applying differential pressure to make the sheet conform to the shape of a mold or die positioned below the frame. When the pressure is applied entirely by vacuum drawn through tiny holes in the mold surface, the process is called *vacuum forming*. When above-atmospheric pressure is used to partially perform the sheet, the process becomes *air-assist vacuum forming*. In another variation, mechanical pressure is applied by a plug to perform the sheet prior to applying vacuum (*plug-assist forming*). In the *drape-forming* modification, the softened sheet is lowered to drape over the high points of a male mold prior to applying vacuum. Still other modifications are *plug-and-ring forming* (using a plug as the male mold and a ring matching the outside contour of the finished article); *ridge forming* (the plug is replaced with a skeleton frame); *slip forming* or *air-slip forming* (the sheet is held in pressure pads that permit it to slip inward as forming progresses); and *bubble forming* (the sheet is blown by air into a blister, then pushed into a mold by means of a plug). In *free forming* the sheet is formed entirely by gentle inflation with air and touches no mold, a method used to make cockpit canopies. James F Carley (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH.

**Shelf life** (1927) (storage life) *n.* The length of time over which a product will remain suitable for its intended use during storage under specific conditions (*see ASTM, www.astm.org*). The term is applied to some finished products as well as to raw materials. Premixes and prepregs, being reactive materials, enjoy considerably longer shelf lives if refrigerated.

*See also storage stability.*

**Shelf life** *n.* The resistance to deterioration by oxygen and ozone in the air, by heat and light, or by internal chemical action.

*See storage life.*

**Shell** \\ˈshel\\ [ME, fr. OE *sciell*; akin to OE *scealu* shell, ON *skel*, Gk *skallein* to hoe] (before 12c) *n.* A principal set of electron energies in an atom; designated by K, L, M, N, etc, or *n* (principal quantum number) = 1, 2, 3, 4, etc.

**Shellac** \\shə-ˈlak\\ [*¹shell* + *lac*] (1713) *n.* Alcohol-soluble, orange-colored resin which is the secretion of the female of the insect (*Laccifer lacca, Coccus lacca*) found in great quantities in India and Indochina. The Shellac appears as an incrustation on the twigs of certain trees. After feeding, the insect produces through its proes a gummy substance that hardens into a protective covering called lac. The lac is washed and dried, and when dissolved in ethanol will form a liquid suitable for application to furniture, etc. An esterification begins when dissolved in ethanol, but this process prevents from shellac from completely drying and provides a sticky-gum type of coating. It forms the basis of "French Polish" and several other types of spirit varnish and is used for adhesive purposes. An often heard complaint about shellac is that it will not completely dry. Shellac has been largely replaced by better performing synthetic varnishes, etc. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

**Shell molding** *n.* In metal foundries, a process of casting metal objects in thin molds made from sand or a ceramic powder mixed with a thermosetting-resin binder. Some authors have misused the term by equating it to plastics processes such as dipping and slush casting.

**Shellolic acid** *n.* Very complex constituent of shellac believed to consist of a tricyclic nucleus, with two carboxyl and two hydroxyl groups.

**Sherardizing** *n.* Method of coating steel or cast iron articles in intimate contact with zinc. The articles are heated with zinc dust for several hours. The zinc forms an alloy, at the interface of the ferrous surface, thus producing a thin, tightly adherent coating.

**Shift factor** *n.* The amount by which the logarithm of the modulus (or compliance) of a plastic, measured at temperature $T$ (K) must be shifted along the time axis to bring it onto a single curve with the modulus measured at $T_g$, the glass-transition temperature; the shift factor relationships is

$$\log a_T = \frac{-17.4(T - T_g)}{51.6 + (T - T_g)}.$$

Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

*See time–temperature equivalence and Williams–Landell–Ferry equation.*

**Shiner** *n.* A relatively short streak caused by a lustrous section of a filament yarn. The principal cause is excessive tension applied to a yarn during processing.

**Shingle stain** *n.* A low-viscosity, pigmented, penetrating paint for use on wood shingles to provide color and protection against moisture penetration.

**Shire** *See shier.*

**Shish–Kebab structure** \ˈshish-kə-ˌbäb\ *n.* A term borrowed from the broiling kitchen to designate a polymeric microstructure in which the random-coil chain of an amorphous polymer (shish) has been interlaced with crystalline cross-segments (kebab) produced by shearing the polymer in the molten condition or in solution. The string-of-lumps microstructure so resembles the edible delicacy that its borrowed name seems quite apt. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Shoe** *See chase.*

**Shoe fold** *n.* A manner of folding fabric. The piece is folded from both ends into 12 or 16-fold. The length of the fold depends upon the length of the piece.

**Shogged stitch** *See racked stitch.*

**Shop coat** *n.* One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.

**Shop painting** *See shop coat.*

**Shop primer** *See pre-fabrication primer.*

**Shop priming** *n.* Act of priming new wood or metal on the maker's premises prior to delivery to the purchaser.

**Shore hardness** *See indentation hardness.*

**Short** \ˈshórt\ [ME, fr. OE *sceort*; akin to OHGr *scurz* short, ON *skortr* lack] (before 12c) *adj.* (1) In reinforced plastics, an imperfection caused by an absence of surface film in some areas or by lighter, unfused particles of material showing through a covering surface film, accompanied possibly by thin-skinned blisters. (2) Lacking toughness or elasticity. A dried film is referred to as being short when it is quite brittle. The undried material is referred to as being short when it is crumbly and has no flowing properties; opposite of length.

**Short-beam shear strength** *n.* Shear strength of reinforced-plastics materials as measured in three-point bending of a specimen whose length between end supports is about five times the specimen depth. ASTM D 2344 describes one such test for flat specimens and short arcs cut from relatively large rings, while ASTM D 4475 describes a similar test for pultruded round rod.

**Short-chain branching** *n.* The presence of 2- to 4-carbon side chains along the backbone of a polymer molecule. In an average low-density polyethylene molecule, both ethyl and butyl side chains, mostly the latter, are believed to be present, with a total of 50 in a typical molecule, in addition to one much longer branch.

**Short-cut staple** *n.* Staple fiber less than 0.75-in. long. Typically used in wet-laid non-woven processes to make fabrics, or as reinforcement in plastics, concrete, asphalt, and other materials.

**Short fibers** *n.* A somewhat relative term: inorganic fibers from 12 to 38 mm long are referred to as "short staple", those longer than 76 mm, "long staple". In fiber-reinforced thermoplastics sold in pellet form, the fibers are less than 12 mm long, yet provided substantial reinforcement. Studies have shown that most of the possible strength gain is achieved with an aspect ratio of about 200 or more. Since glass–fiber diameters are about 10 μm, a length of 2 mm should be sufficient. For *modulus* improvement, greater lengths are beneficial.

**Short ink** *n.* A highly pigmented ink which is stiff and cannot be drawn out to a thread.

**Short-liquor dyeing** *See dyeing.*

**Shortness** *n.* A qualitative term that describes an adhesive that does not string cotton, or otherwise form filaments or threads during application. It is the property of a printing ink which is characterized by a lack of flow. Opposite of length.

**Short oil alkyd** *n.* An alkyd resin containing les than 40% oil in solids.

**Short oil varnish** *n.* A varnish containing little oil in comparison with the amount of resin present, less than 15 gal oil per 100 lb (1.25 loil/kg) resin.

**Short shot** *n.* In injection molding, failure to fill all cavities of the mold completely, caused by too low melt temperature, too low injection pressure, insufficient plastication time, too constricted gates, too viscous resin, inadequate venting of cavities, etc. Short shots are often made deliberately when testing a new multicavity mold to reveal the pattern of runner flow and the sequence of cavity filling.

**Shortstopper** *n.* A term used for an agent added to a polymerization-reaction mixture to inhibit or terminate polymerization.

**Shot** \ˈshät\ *n.* (1) One complete cycle of a molding machine. (2) In woven pile floor coverings, the number of filling yarns per row of tufts. (3) Imprecise. Syn: shot weight.

**Shot blasting** *See shot.*

**Shot capacity** *n.* The maximum weight of plastic that can be delivered to an injection mold by one stroke of the ram or screw. In the case of screw-injection molding machines that are not equipped with backflow-preventing valves at the end of the screw, slippage of material may occur in the screw flights and may not be reckoned with in calculations of shot capacity that are based on cubic displacement.

**Shot peening** *n.* Blasting with round iron shot, round steel shot, or any material which retains its spherical shape for peening purposes.

*Also known as shot blasting.*

**Shot weight (shot)** *n.* In injection and transfer molding, the entire mass of plastic delivered in one complete filling of the mold, including the molded parts, sprue, runners, cull, and flash.

**Show card colors** *See poster color.*

**Show through** *n.* (1) *See photographing.* (2) The transparency of printed sheets which permits printing to be seen from the other side of the sheet.

**Shredding** \ˈshred-, *esp Southern*ˈsred-\ {shredded; shredding} (before 12c) *v.* The separation of compressed fibers in pulp sheets prior to acetylation in acetate manufacture.

**Shrinkage** \ˈshriŋ-kij, *esp Southern* ˈsriŋ-\ (1800) *n.* Disruption of the level plane of the finished surface, resulting in a loss of gloss or wrinkling. Contraction of the wooden substrate, frequently resulting in cracking and/or checking of the coated surface.

**Shrinkage allowance** *n.* The dimensional allowance that must be made in molds to compensate for shrinkage of the plastic compound on cooling. The ASTM method for determining shrinkage from molded bars or disks and mold dimensions is D 955. This method does not provide for additional shrinkage that may occur as molded materials age beyond the first 48 h after removal from the mold.

**Shrinkage force** *n.* The force generated by thermoplastic materials when they are subjected to elevated temperatures.

**Shrinkage pool** *n.* An irregular, slightly depressed area on the surface of a molding caused by uneven shrinkage before hardening is complete.

**Shrink film** *n.* (1) Films which shrink when heated and are useful for packaging articles. (2) The pre-stretched or oriented film used in shrink packaging.
*See also heat-shrinkable film.*

**Shrink fit** *n.* A method of joining circular and annular parts in which the outer member, having a slightly smaller inside diameter than the inner member's outside diameter, is heated, causing it to expand, then slipped into place over the inner member and allowed to cool. Alternatively, one can chill the inner member in liquid nitrogen, slip it into the outer member, and let is warm. Care must be taken in designing the joint to have the final stresses in both members well below yield values so as not to lose the joint to creep over time. *Compare snap fit.*

**Shrink fixture** Syn: cooling fixtures.

**Shrink mark** *See sink mark.*

**Shrink packaging** *n.* A method of wrapping articles utilizing pre-stretched (oriented) films that are warmed to cause them to shrink tightly around the enclosed articles. First, the article is placed in a loose envelope of two layers of film, usually in the form of a V-folded strip. This envelope is heated sealed around the edges and detached from the strip, both of which operations can be done with an L-shaped, thermal-impulse sealer and cutter. The package is then conveyed through a hot-air oven or other heating device to shrink the film.

**Shrink tunnel** *n.* An oven in the form of a tunnel mounted over, or containing a continuous conveyor belt, used to shrink oriented films in the shrink-packaging process.

**Shrink wrap** (1966) (stretch wrap) *vt.* The use of plastic films for unitizing several boxes or items loaded on a pallet. Film may simply be stretched over the materials to be protected, pulled tight and secured; or shrunk by application of heat. ASTM D 4649 (section 15.09) is a guide to the selection of such materials.
*See also shrink packaging.*

**Shrival finish** *See ripple finish.*

**Shutter** \ˈshə-tər\ (1542) *n.* A movable screen or cover used to cover an opening, especially a window.

**Shuttle** \ˈshə-tᵊl\ [ME *shittle*, prob. fr. OE *scytel* bar, bolt, akin to ON *skutill* bolt, OE *scēotan* to shoot] (14c) *n.* A boat-shaped device, usually made of wood with a metal tip that carries filling yarns through the shed in the weaving process. It is the most common weft-insertion device. The shuttle holds a quill, or pin, on which the filling yarn is wound. It is equipped with an eyelet at one end to control rate. The filling yarn is furnished during the weaving operation.

**Shuttle chafe mark** *n.* A fabric defect that is usually seen as groups of short, fine lines across the fabric, often running for some distance in the piece and usually in the same area. Although these marks run in the direction of the filling, they are actually caused by the shuttle rubbing across and damaging the warp ends, producing a dull, chalky appearance.

**Shuttleless loom** *n.* A loom in which some device other then a shuttle is used for weft insertion.

*Also see loom and weft insertion.*

**Si** *n.* Chemical symbol for the element silicon.

**SI** *n.* (1) Abbreviation for silicon or polydimethylsiloxane. (2) Abbreviation for "international systems of units", derived from the official French name, *Le Systèm International d'Unitès.* An internationally agreed coherent system of units, derived from the MKS system, now in use for all scientific purposes and thereby replacing the cgs system and the f.p.s. system. The seven basic units are: the *metric* (symbol m), *kilogram* (kg), *second* (s), *ampere* (A), *Kelvin* (K), *mole* (mol), and *candela* (cd). The *radian* (rad) and *steradian* (sr) are supplementary units. Derived units include the *hertz* (Hz), *newton* (N), *joule* (J), *watt* (W), *coulomb* (C), *volt* (V), *farad* (F), *ohm* (Ω), *weber* (wb), *tesla* (T), *henry* (H), *lumen* (lm), and *lux* (lx).

**Siamese blow** \ˌsī-ə-ˈmēz, -ˈmēs\ *n.* A colloquial term denoting the process of blow molding two or more objects or parts of objects in a single blowing mold, then cutting them apart.

**SiB** *n.* Abbreviation for polycarboranesiloxane.

**Siccatives** *n.* Any reagent which catalyzes or promotes oxidation of oils; a drier.

*See driers.*

**Side bar** *n.* A loose piece used to carry one or more molding pins, and operated from outside the mold (seldom seen today).

**Side-draw pin** *n.* A projecting mold element used to core a hole in a direction other than the direction of mold closing, and which must be retracted before the mold is opened and the part ejected.

**Siding** *n.* The finish covering an exterior wall of a frame building; the siding may be a cladding material such as wood, aluminum, or cement asbestos (but not masonry); applied vertically or horizontally. Syn: weatherboarding.

*Also see clapboard, drop siding.*

**Siding shingle** *n.* A shingle of any of a number of materials such as wood, cement asbestos, etc., used as a protective exterior wall covering over sheathing.

**Siemens** \ˈsē-mənz\ {*plural* siemens} [Werner von *Siemens* † 1892 German electrical engineer] (ca. 1933) (S) *n.* The SI unit of electrical conductance, equal to and replacing the *mho*, and the reciprocal of the ohm [1 S = 1 ampere/volt (A/V)].

**Sienna** \sē-ˈe-nə\ [It *terra di Siena*, lit., Siena earth, fr. *Siena*, Italy] (1787) *n.* A red variety of iron oxide pigment.

**Sierra leone copal** \sē-ˌer-ə-lē-ˈōn ˈkō-pəl\ *n.* Fossil copal of African origin, It becomes soluble in drying oils after running, and because of its pale color, which is maintained after running, is used to some extent in grinding media for whites and tinted whites, silver baking varnishes, etc.

**Sieve** \ˈsiv\ [ME *sive*, fr. OE *sife*, akin to OH Gr *sib* sieve] (before 12c) *n.* In laboratory work, an apparatus in which the apertures are square, for separating sizes of material.

**Sieve analysis** (screen analysis) *n.* The separation of particulate solids into sequentially finer size fractions by placing a weighed sample into the topmost of a stack of graded standard sieves, mechanically shaking and tapping the stack for 10 min, then weighing the material collected on each sieve and the pan beneath the lowest, finest sieve. The procedure is described in ASTM D 1921.

*Also known as screen analysis.*

**Sieve fraction** *n.* The mass fraction of a sieve-analyzed powder found between two successive screens in a sieve analysis. For example, one might say, "The −0.420, +0.250-mm fraction was 15.27%".

*See also mesh number.*

**Sieve number** *n.* A number used to designate the size of a sieve, usually the approximate number of sieve cross-wires per linear inch.

**Sieving** *n.* Separation of a mixture of various-sized particles, either dry or suspended in a liquid, into two or more portions, by passing through screens of specified mesh sizes.

*See sieve analysis. Also known as screening.*

**Sigma-blade mixer** *n.* A type of internal mixer having blades that are (roughly) S-shaped.

*See internal mixer.*

**Sigma (*σ*) bond** A covalent bond in which the electron charge cloud of a shared pair is centered on and symmetrical around the bond axis.

**Signature** \ˈsig-nə-ˌchúr\ [MF or ML; MF, fr ML *signatura*, fr. L *signatus*, pp of *signare* to sign, seal] (1536) *n.* In web printing and binding the name given to a printed sheet after it has been folded.

**Sign of double refraction** *n.* An empirical classification of crystals; it is positive for uniaxial crystals when $\varepsilon > \omega$, for biaxial crystals when $\gamma - \beta > \beta - \alpha$. It is negative for uniaxial crystals when $\varepsilon < \omega$, for biaxial crystals when $\gamma - \beta < \beta - \alpha$.

**Sign of elongation** *n.* This refers to the elongation of a substance in relation to refractive indices. If it is elongated in the direction of the high refractive index, it is said to be positive; if it is elongated in the direction of the low refractive index, it is negative.

**Silane** \ˈsi-ˌlān\ [ISV *sil*icon + meth*ane*] (1916) *n.* Common name for silicon tetrahydride. It is used as a doping agent for solid state devices, production of amorphous silicon.

**Silane coupling agent** *n.* Any silane or oxysilane that has the ability to bond inorganic materials such as glass, mineral fillers, metals, and metallic oxides to organic resins. The adhesion mechanism is due to two groups in the oxysilane structure. The $Si(OR_3)$ portion reacts with the inorganic reinforcement, while the organofunctional (vinyl-, amino-, epoxy-, etc.) group reacts with the resin. The coupling agent may be applied to the inorganic materials (e.g., glass fibers) as a pre-treatment and/or added to the resin. Examples of silane coupling agents are:

*N*-$\beta$(Aminoethyl)-$\gamma$-aminopropyltrimethoxy silane
$\gamma$-Aminopropyltrimethoxy silane
Bis($\beta$-hydroxyethyl)-$\gamma$-aminopropyltriethoxy silane
$\beta$-(3,4-Epoxycyclohexyl) ethyltrimethoxy silane
$\gamma$-Glycidoxypropyltrimethoxysilane
$\gamma$-Methacryloxypropyltrimethoxy silane
Sulfonylazidosilane
Vinyltrichlorosilane
Vinyltriethoxysilane
Vinyl-*tris*-($\beta$-methoxyethyl)silane

A newer class of silane coupling agents is known as *silyl peroxides*, represented by the general formula: $R'_mR''_{4\text{-}n\text{-}m}SI(OOR)_n$. A typical member of this family is vinyl-*tris*-(*t*-butylperoxy) silane. The coupling mechanism of the silyl peroxides, effected by heat only, is free-radical in nature. The conventional silanes require an eternal free-radical source and couple via an ionic mechanism initiate by hydrolysis. Mittal KL (ed) (2004) Silanes and other coupling agents, vol 3. VSP International Science Publishers, New York. Carley JF (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA.

**Silanes** *n.* Group of compounds resembling the saturated hydrocarbons, in which the carbon is replaced by silicon. For example, monosilane $SiH_4$, cf. methane $CH_4$; disilane $Si_2H_6$; cf. ethane $C_2H_6$.

**Silica** \ˈsi-li-kə\ [NL, fr. L *silic-*, *silex* hard stone, flint] (ca. 1801) (silicon dioxide) *n.* $SiO_2$. A substance occurring widely in minerals such as quartz, sand, flint, chalcedony, opal, agate, and many more. In powdered form it is used as a filler, especially in phenolic compounds for ablative nose cones of rockets. Synthetic silicas, made from sodium silicate or by heating silicon compounds, are useful in preventing plate-out.

*See also fumed silica.*

**Silica, amorphous** \-ə-ˈmór-fəs\ *n.*

*See amorphous silica.*

**Silica, crystalline** *n.* $SiO_2$. Pigment white 27 (77811). Pigment grade crystalline silica is quartz sand that has been crushed, ground, and/or air classified. A reinforcing filler for paints, elastomers, sealants. Chemically inert, heat resistant, non-conductive; imparts burnish resistance, sheen uniformity, good flatting in latex paints. Density, 2.56 g/cm$^3$ (22.1 lb/gal); O.A., 24–36; particle size, 1.5–9.0 μm. Syn: powdered quartz, silica flour, ground silica.

**Silica, diatomaceous** \-ˌdī-ə-tə-ˈmā-shəs\ *n.*

*See diatomaceous silica.*

**Silica flour** *See silica, crystalline.*

**Silica gel** *n.* A form of colloidal silica consisting of grains having many fine pores and capable of adsorbing, and firmly retaining at room temperature, substantial quantities of water and some other compounds. It is used to dry gas streams and organic liquids to very low moisture levels. It can be reactivated by heating to temperatures above 100°C. *Compare molecular sieve.*

**Silica, microcrystalline** \-ˈmī-krō-ˌkris-tə-lin\ *n.* $SiO_2$ Pigment white 27 (77811). Extender pigment obtained from extensive geologic formations of hard, compact, homogeneous, microcrystalline silica located in the vicinity of Hot Springs, Arkansas. Can be considered as a very finely divided or "micro" form of quartz in a bound state of subdivision. Excellent dielectric and low abrasive properties. Density, 2.65 g/cm$^3$ (22.1 lb/gal); O.A., 20.0; mean particle size, 4.0 μm. "Novaculite" is a generic name. Syn: novacite.

**Silica, soft** *See amorphous silica.*

**Silica, synthetic (aerogel and hydrogel)** *n.* $SiO_2$. Extremely porous and light weight synthetic silicas, which may contain up to 94% of "dead air" space that is enclosed by a tenuous webbing of microscopic silica filaments.

*See also sodium silicoaluminate.*

**Silica, synthetic (pyrogenic)** $SiO_2$. A colloidal silica used in the rubber, plastic and paint industry. High purity, non-reactive pigment which imparts thixotropy, flatting and pigment suspension. Density, 2.2 g/cm$^3$; O.A., 230; particle size, 0.012 μm.

**Silicate** \ˈsi-lə-ˌkāt\ [*silicic (acid)*] (1811) *n.* Any member of the very widely occurring compounds characterized by the presence of the elements, silicon, oxygen and one or more metals with or without hydrogen (e.g., talc).

**Silicate paints** Water-paints based on sodium, potassium, or lithium silicate. Used in zinc-rich paints. They are characterized by their non-flammability. Care must be exercised in the selection of pigments used with the silicate because of its alkalinity.

**Silicic acid** (1817) *n.* Any of various weakly acid substances obtained as gelatinous masses by treating silicates with acids.

**Silicon** \ˈsi-li-kən\ [NL *silica* + E –*on* (as in *carbon*)] (1817) *n.* Generic name for polymers with (–$SiR_2$–O–) links. Manufactured by Bayer, Germany; Dow, USA; and General Electric, USA.

**Silicon carbide** (1893) (SiC) *n.* In the form of crystals, produced in an electric furnace by reaction of carbon with sand, silicon carbide is a dense, extremely hard filler, used in some plastics to increase abrasion resistance, elastic modulus, and thermal conductivity.

**Silicon carbide abrasive** *n.* Of the many crystalline forms of silicon carbide produced in electric furnaces, the hexagonal, or alpha crystals made up of masses of interlocking crystals, in the major type used for coated abrasives. It is greenish black iridescent, has high thermoconductivity, low thermoexpansion, and great chemical stability, being unaffected by nitric, sulfuric, hydrochloric acids. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL. Harrington BJ (2001) Industrial cleaning technology. Kluwer Academic Publishers, New York.

**Silicon carbide waterproof paper** *n.* Hard, sharp, coated abrasive particularly suited for lacquer, plastics and non-ferrous metals, also for wet sanding primes, undercoats and between coats on wood and metal using water, oil, or other lubricants. *See coated abrasive.*

**Silicon carbide whiskers** *n.* These high-modulus SiC fibers are made by pyrolysis of organosilanes in hydrogen at 1500–2000°C and by other methods. The whiskers are very fine, with diameters of about 2.5 µm, density of 3.2 g/$cm^3$, ultimate strength of 20 GPa (3 Mpsi), and modulus of 480 GPa (more than twice that of steel).

**Silicone** \ˈsi-lə-ˌkōn\ [*silic*on + -*one*] (1943) *n.* One of a large family of semi-organic polymers (*polyorgano siloxanes*) comprising chains of alternating silicon and oxygen atoms, modified with various organic groups attached to the silicon atoms. Depending on the nature of the attached organic groups, molecular weight, and the extent of cross-linking between chains, the polymers may be oily fluids ranging in viscosity from 0.001 to over 1000 Pa s, or elastomers, or solid resins. The earliest silicones were dimethyl polysiloxanes, made by treating silicon derived from sand with methyl chloride in the presence of a catalyst to form a chlorosilane, hydrolyzing the chlorosilane to form a cyclic trimer of siloxane, then polymerizing the siloxane to form a dimethyl polysiloxanes. Many modifications have been made including the incorporation of phenyl groups, halogen atoms, alkyds, epoxides, polyesters, and other organic compounds containing –OH groups. The silicone fluids are used as lubricants, mold-release agents, heat-transfer fluids, and water-repellent coatings. The elastomers, often called silicone rubbers and reinforced with inorganic fillers or fibers, are vulcanizable (cross-linkable) and offer superior resistance to high temperature and weathering. The silicone resins, possessing good electrical properties and strength at high temperature, are widely used for encapsulating and potting electrical components and in reinforced laminates. Silicone coatings offer superior weathering resistance in direct sunlight. Skeist I (ed) (1990) Handbook of adhesives.

Van Nostrand Reinhold, New York. Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001. Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, OH. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Silicone foam** *n.* Foam based on fluid silicone resins is made by mixing the resins with a catalyst and blowing agent, pouring the mixture into molds, and curing at room temperature for about 10 h or at elevated temperatures for shorter periods. Silicone-foam sponge is made by mixing unvulcanized silicone rubber with a blowing agent and heating to the vulcanizing temperature.

**Silicone paint** *n.* Paint, based on silicone resins, that is resistant to very high temperatures and therefore useful on smokestacks, heaters, stoves, and electrical insulation; requires heat to cure or set; has a high resistance to chemical attack.

**Silicone plastics** *n.* Plastics based on silicone resins.

**Silicone-polycarbonate co-polymer** *n.* Introduced in 1969 by the General Electric Co., these thermoplastic co-polymers vary from strong elastomers to rigid engineering plastics, depending on composition. They can be extruded, cast, or molded into optically clear films.

**Silicone resins** *n.* Group of resins containing a substantial amount of silicon, distinguished by their outstanding heat resistance, high water repellency, and chemical resistance. They are made by preparing dialkyl dichlorsilanes from silicon tetrachloride and the corresponding alkyl magnesium bromide. The silanes are converted to silanediols, which are polymerized into resinous products. Mixtures of silanediols and triols are co-polymerized to yield thermosetting resins.

**Silicone rubber** (1944) *n.* A synthetic rubber made by vulcanizing an elastomeric silicone gum such as dimethyl silicone. A free-radical-generating catalyst such as benzoÿl peroxide is usually used as the vulcanizing agent. The tensile strength of unreinforced silicone rubber is low, about 350 kPa. Higher strengths are obtained by adding reinforcing fillers such as finely divided or fumed silica, or by putting crystallizing segments such as silphenylene into the polymer. Allcock HR, Mark J, Lampe F (2003) Contemporary polymer chemistry. Prentice-Hall, New York.

*See also silicone.*

**Silicon nitride** (1903) *n.* Any of several compounds of silicon and nitrogen; specifically a compound $Si_3N_4$ that is a hard ceramic used in high-temperature applications and in composites. Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**Silicon nitride whiskers** *n.* Very fine fibers of $Si_3N_4$ prepared by vapor-phase reaction of silicon and a silicate in nitrogen and hydrogen at 1400°C. Density is 3.2 g/cm$^3$, ultimate strength is 4.8 GPa (700 kpsi), and modulus is 276 GPa. They are used as reinforcements in specialty laminates.

**Silicosis** \ˌsi-lə-ˈkō-səs\ [NL, fr. silica + -osis] (1881) *n.* A form of pneumoconiosis resulting from occupational exposure to and inhalation of silica dust over a period of years; characterized by a slowly progressive fibrosis of the lungs, which may result in impairment of lung function; silicosis predisposes to pulmonary tuberculosis. Syn: stone-mason's disease, pneumosilicosis, silicatosis. A chronic disease of the lungs caused by the continued inhalation of silica dust. A disease due to breathing air containing silica characterized anatomically by generalized fibrous changes and the development of military modulation in both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, presence of fever, increased susceptibility to tuberculosis and by characteristic X-ray findings. Stedman's medical dictionary, 27th edn. Lippincott Williams and Wilkins, New York, 2000.

**Silk** {*often attributive*} [ME, fr. OE *seolc*, prob. ultimately fr. Gk *sērikos* silken] (before 12c) *adj.* British for *Satin Finish.* Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Silk fiber** *n.* A fine, strong, continuous filament produced by the larva of certain insects, especially the silkworm, when constructing its cocoons. The silkworm secretes the silk as a viscous fluid from two large glands in the lateral part of the body. The fluid is extruded through a common spinneret to form a double filament cemented together. This double silk filament, which is composed of the protein fibroin, ranges in size from 1.75 to 4.0 denier, depending upon the species of worm and the country of origin. The filament of the cocoon is softened and loosened by immersion in warm water and is then reeled off. Although raw silk contains 20–30% of sericin, or silk glue, and is harsh and stiff, silk is soft and white when all of the glue has been removed by steeping and boiling in soap baths. Ecru is harsher, as it has only about 5% of the sericin removed. Silk is noted for its strength, resiliency, and elasticity. The major sources of commercial silk are Japan and China.

**Silking** *n.* Surface defect characterized by parallel irregularities left on or in the dried surface of a glossy paint or varnish film, producing the appearance of silk. In dipping or flow coating, the irregularities appear in the direction of the flow in brushing, in the direction in which the film as finally brushed.

**Silk-screen** (1930) *n.* A printing process by which repeats of a motif or pattern can be made; the process involve the use of silk (or similar material of fine mesh) tightly stretched on frames; a separate frame is used for each color. Areas of the design to be printed in a given color are left open while the rest of he silk is treated with an insoluble coating. The ground-coated paper, fabric or other material on which the design is to be reproduced is laid out on long tables. The pattern is reproduced by drawing a suitable ink or paint across the screen with a rubber squeegee, which forces the color through the parts where the mesh is exposed, and the operator moves from one preset point to the next. By careful registering, a number of screens can be used in succession over the same design for multiple-color work.

**Silk screen ink** *n.* Quick drying, full bodied, volatile inks used in the silk screen printing process.

**Silk screen (screen process) printing** *n.* A process by which an image is transferred to a substrate by squeezing the ink through the unblocked areas of a metal or fiber screen.

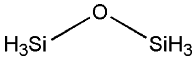
*See screen printing.*

**Sill** \ˈsil\ [ME *sille*, fr. OE *syll*; akin to OHGr *swelli* beam, threshold] (before 12c) *n.* The horizontal member that bears the upright portion of a frame; especially the base of a window.

**Silopren** *n.* Polysiloxane rubber. Manufactured by Bayer, Germany.

**Siloxane** \sə-ˈläk-ˌsān\ [*sil*icon + *ox*ygen + meth*ane*] (1917) *n.* (1) A chemical group with the structure shown in which the Rs

are usually alkyl and can be alkyl radicals or even just hydrogen. (2) A compound containing siloxane links. A simple representative is hexamethyldisiloxane, $(CH_3)_3SiOSi(CH_3)_3$. Siloxane links are common in silicone resins.
*See silicone.*



**Silver filler** \ˈsil-vər ˈfil-lər\ *n.* Particles or flakes of silver in the 1–15 μm size range, compounded with plastics to provide electrical conductivity. Flakes are mechanically flattened to provide layers of contiguous flakes and high conductivity. Silver oxide, sulfate, and carbonate are also good conductors and are used for the same purpose.

**Silver ink** *n.* A printing ink whose principal pigment consists of aluminum powder.

**Silver point** *n.* Method of drawing which consists of working with a silver tipped instrument on a specially prepared paper. The result is a drawing of great delicacy. Generally used by late medieval and renaissance artists, e.g., Leonardo da Vinci.

**Silver-spray process** *n.* A metallizing process based on glass-mirror art. The plastic article is first cleaned and lacquered as in vacuum metallizing, then the lacquer is sensitized in an oxidizing aqueous solution of sulfuric acid and potassium dichromate. A silver-forming solution, e.g., silver nitrate and an aldehyde, is sprayed on the article with a two-nozzle spray gun so that the components mix at the surface. After rinsing and drying a final topcoat of lacquer is applied over the silver.

**Silver white** *n.* (1) Any of several white pigments used in paints. (2) A very pure variety of white lead; French white, China white.

**Silyl peroxide** *See silane coupling agent.*

**Sime, setting** *n.* The period of time during which an assembly is subjected to heat or pressure, or both, to set the adhesive.
*See also time, curing; time, joint conditioning; and time, drying.*

**Simon–Goodwin charts** *n.* A series of charts for graphically calculating color differences using the modified Mac Adam color difference equation.
*See Macadam color difference equation and Foster charts.*

**Simple harmonic motion** *n.* Periodic oscillatory motion in a straight line in which the restoring force is proportional to the displacement. If a point moves uniformly in a circle, the motion of its projection on the diameter (or any straight line in the same plane) is simple harmonic motion. If $r$ is the radius of the reference circle, $\omega$ the angular velocity of the point in the circle, $\theta$ the angular displacement at the time $t$ after the particle passes the mid-point of its path, the linear displacement

$$x = r\sin\theta = r\sin\omega t.$$

The velocity at the same instant

$$v = r\omega\cos\theta = \omega\sqrt{r^2 - x^2}.$$

The acceleration

$$a = -\omega^2 x.$$

The force for a mass $m$

$$F = m\omega^2 x = -\frac{4\pi^2 mx}{T^2}.$$

The period

$$T = 2\pi\sqrt{\frac{x}{a}}.$$

In the above equations the cgs system calls for $x$ and $r$ in cm, $v$ in cm/s, $a$ in cm/s$^2$, $T$ in s, $m$ in gram, $F$ in dyne, $\theta$ in radian, and

$\omega$ in radian/s. Weast RC (ed) (1971) Handbook of chemistry and physics, 52nd edn. CRC Press, Boca Raton, FL.

**Simple liquid** *See Newtonian liquid.*

**Simple machine** *n.* A contrivance for the transfer of energy and for increased convenience in the performance of work. *Mechanical advantage* is the ratio of the resistance overcome to the force applied. Velocity ratio is the ratio of the distance through which force is applied to the distance through which resistance is overcome. *Efficiency* is the ratio of the work done by a machine to the work done upon it. If a force $f$ applied to a machine through a distance $S$ results in a force $F$ exerted by the machine through a distance $s$, neglecting friction

$$fS - Fs.$$

The theoretical mechanical advantage or velocity ratio in the above case is

$$\frac{S}{s}.$$

Actually, the force obtained from the machine will have a smaller value than will satisfy the equation above, If $F'$ be the actual force obtained, the practical mechanical advantage will be

$$\frac{F'}{f}.$$

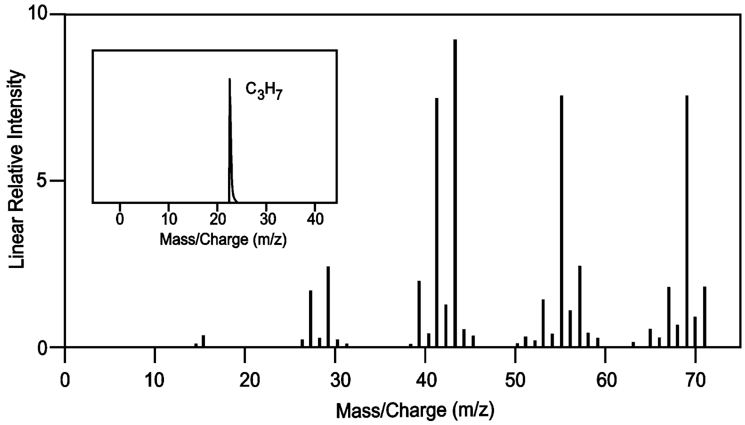
The efficiency of the machine

$$E = \frac{F's}{fS}.$$

**Simplified flow equation** *n.* An equation giving the delivery rate of a single-screw extruder as a function of the screw diameter, screw speed, channel depth in the metering section, and room-temperature density of the plastic. Underlying assumptions include: the screw is single-flighted in the metering section, with typical dimensional proportions and shape factors, and a lead angle of 17.7°; the feeding and plasticating capabilities of the screw (and drive) are sufficient to keep the metering section filled with melt; the feedstock is not pre-heated; and the total resistance to melt flow of screens and die does not entail excessive head pressure at the desired rate.

*See net flow.*

**SIMS** Scanning ion mass spectroscopy. Analysis of polymeric is a good application of SIMS, where metallic elements are often not observed. It is a microanalytical surface method of material examination.



A SIMS spectrogram is shown. Gooch JW (1997) Analysis and deformulation of polymeric materials. Plenum Press, New York.

**Simulated spun yarns** *n.* Filament yarns that have been modified to have aesthetics similar to those of spun yarns. Simulated spun yarn have looped or hairy surfaces.

**Singeling** *n.* The process of burning off protruding fibers from yarn or fabric by passing it over a flame or heated copper plates. Singeing gives the fabric a smooth surface and is necessary for fabrics that are to be printed and for fabrics where smooth finishes are desired. Complete textile glossary. Celanese Corporation, New York, 2000.

**Single-circuit winding** *n.* A winding in which the filament path makes a complete traverse of the chamber, after which the following traverse lies immediately adjacent to the previous one.

**Single-knit fabric** *n.* Also called plain knit, a fabric constructed with one needle bed and one set of needles.

**Single roll** *See roll of wall covering.*

**Single-screw extruder** *See extruder, single-screw.*

**Single spread** *See spread.*

**Single-stage resin** (single-step resin).

*See resol.*

**Singles yarn** *n.* The simplest strand of textile material suitable for operations such as weaving and knitting. A singles yarn may be formed from fibers with more or less twist; from filaments with or without twist; from narrow strips of material such as paper, cellophane, or metal foil; or from monofilaments. When twist is present, it is all in the same direction.

*Also see yarn.*

**Singling** *n.* A yarn defect caused by the breaking of one or more strands in a plying operation with resulting unevenness in the finished product.

**Sinkage** \ˈsiŋ-kij\ (1883) *n.* The blotchy effect or loss of gloss due to absorption of the medium of a finishing coat by the undercoat.

*Also called sinking in.*

**Sinker** *n.* In weave design, a blank square indicating a filling thread over a warp thread at the point of intersection.

**Sinking** (hobbing) *n.* In mold making, pressing a hardened hob into annealed, soft mold steel or beryllium copper.

*See hob.*

**Sinking in** *See sinkage.*

**Sink mark** (shrink mark) *n.* A shallow depression or dimple on the surface of an injection-molded article, usually in a thick section, caused by local internal shrinkage after the gate seals, or by a slightly short shot. Sinks can be diminished or prevented by reducing melt and mold temperatures, opening gates, filling faster, increasing pressure-holding time, and/or raising injection pressure.

**Sinter** \ˈsin-tər\ [Gr *Sinter* slag, cinder, fr. OHGr *sintar*] (1871) {*transitive senses*} *v.* To cause to become a coherent mass by heating without melting.

**Sinter coating** *n.* A coating process in which the article to be coated is pre-heated to sintering temperature and immersed in a plastic powder, then is withdrawn and heated to a higher temperature to fuse the adhering sintered powder into a continuous skin on the article.

**Sintering** *n.* The welding together of powdered plastic particles at temperatures just below the melting or fusion range. The particles are fused together to form a relatively strong mass, but the mass as a whole does not melt and may retain some porosity.

**Sinter molding** *n.* The process of compacting fine thermoplastic particles by applying pressure at temperatures a little below the melting range and holding pressure until the particles fuse together, often followed by further heating and post-forming. Porous nylon bearings capable of absorbing lubricants are made by this method, and sinter molding is a main molding method for powders of polytetrafluoroethylene or ultra-high-molecular-weight polyethylene, which do not form true melts.

**Sisal** \ˈsī-səl\ [*Sisal*, port in Yucatán, Mexico] (1843) *n.* A strong, durable, white fiber obtained from the *agave* plant grown in India, Indonesia, Mexico, and the West Indies. Chopped sisal enjoys some use as reinforcement in thermosetting resins.

**Sissing** *See cissing.*

**Size** \ˈsīz\ [ME *sise*] (15c) *n.* (1) Usually a liquid composition to prevent excessive absorption of paints into plaster, old wall paint and similar porous surfaces; also a liquid composition used as a first coat on metal to improve adhesion of succeeding coats (latter usage is limited to the metal decorating industry). The terms “sealer” or “size” are almost synonymous, but usage has established certain differences. A sealer is ordinarily a thin varnish or clear lacquer and is usually applied on wood and metal surfaces. Ordinary painter’s size is a thin solution of glue, starch or other water-soluble substance and is usually applied on plaster surfaces, but size used in metal decorating is a thin varnish. Syn: sizing. (2) An ink that dries with a sticky surface that will hold metallic or other powders. (3) Composition applied to paper to fill up the space between fibers and to produce a smooth surface. (4) A sealer used to prepare the wall before wallpaper is applied. (5) In antiquing, a thin pasty varnish liquid use for adhering gold leaf. It acts as a filler on porous surfaces and creates a more even effect with the gold leaf. (6) The formation of a dried layer or the film so formed on the surface of a mass. (7) In the plastics industry, a Syn: coupling agent.
*See sizing.*

**Size-exclusion chromatography** (SEC, gel-permeation chromatography) *n.* A column-chromatography technique employing as the stationary phase a swollen gel made by polymerizing and cross-linking styrene in the presence of a diluent that is a nonsolvent for the styrene polymer. The polymer to be analyzed is introduced in dilute solution at the top of the column and then is eluted with pure solvent. The polymer molecules diffuse into the gel, and out of it, at rates depending inversely on their molecular size. As they emerge from the bottom of the column they are detected by the differential refractometer connected to a computer or recorder, where a plot of concentration versus retention time is developed. This is converted, through calibration information, to a molecular-weight distribution whose parameters are calculated and printed out by the computer.
*See also chromatography.*

**Size mark** *n.* A fabric defect that consists of a rough or frosted spin caused by uneven application or drying of the size.

**Sizing** *n.* (1) The process of applying a material to a surface to fill pores to smooth it and reduce absorption of a subsequently applied adhesive or coating, or to otherwise modify the surface. (2) Determining dimensions during design or production. *Also used as a* Syn: size.

**Sizing** *n.* (1) A generic term for compounds that are applied to warp yarn to bind the fiber together and stiffen the yarn to provide abrasion resistance during weaving.

Starch, gelatin, oil, wax, and manufactured polymers such as polyvinyl alcohol, polystyrene, polyacrylic acid, and polyacetates are employed. (2) The process of applying sizing compounds. (3) The process of weighing sample lengths of yarn to determine the count.
(*Also see slashing*).

**Sizing plate** *n.* In tubing and pipe extrusion, a plate with a central hole that may form the entrance to the water bath, and through which the still warm extrudate is passed to bring the outside diameter closer to its final dimension. At high line speeds, several plates having successively slightly smaller, smoothly finished openings may be used in sequence. *Compare sizing ring.*

**Sizing ring** (calibrator) *n.* In pipe extrusion, a hollow ring, slotted around its polished inside circumference, used to reduce the slightly oversize outside diameter of the warm pipe toward the desired final value. The core and slot of the ring are connected to a vacuum line. As the pipe passes through the ring, vacuum is applied to the core, sucking the pipe circumference against the slot and the ring's inside surface. Having made that seal, the operator raises the water level to submerge the pipe and cool it. Several rings of slightly decreasing inside diameters may be used in sequence for better control of pipe outside diameter and increased production rate. *Compare sizing plate.*

**Skein** \ˈskān\ [ME *skeyne*, fr. MF *escaigne*] (14c) *n.* A continuous strand of yarn or cord in the form of a collapsed coil. It may be of any specific length and is usually obtained by winding a definite number of turns on a reel under prescribed conditions. The circumference of the reel on which yarn is wound is usually 45–60 in.
*Also see hank.*

**Skein break factor** *n.* The comparative breaking load of a skein of yarn adjusted for the linear density of the yarn expressed in an indirect system. It is the product of the breaking load of the skein and the yarn number expressed in an indirect system (e.g., pounds times cotton count). A statement of the skein break factor must indicate the number or wraps in the skein, if this is not otherwise apparent. Without specifying the number of wraps, a statement of the skein break factor is meaningless.

**Skein breaking tenacity** *n.* The skein breaking load divided by the product of the yarn number in a direct numbering system and the number of strands placed under the tension (twice the number of wraps in the skein); preferably expressed in Newton per tex.

**Skein dyeing** *See dyeing.*

**Skewness** \ˈskyü-nəs\ (1894) *n.* The distance measured parallel to and along a selvage between the point at which a filling yarn meets this selvage and a perpendicular to the selvage from the point at which the same filling yarn meets the other selvage. Skewness may be expressed directly in inches or as a percentage of the width of the fabric at the point of measurement.

**Skimmings (tall oil)** *n.* Curd, not acidified or otherwise processed, skimmed from the black liquor of the alkaline paper pump industry, from which tall oil is obtained.

**Skin** *n.* (1) A relatively dense layer at the surface of a cellular polymeric material (ASTM D 883). (2) Film formed from a vehicle, liquid coating or ink composition or formed during storage. (3) An ungrounded, non-washable, low-priced grade of wallpaper.

**Skinning** *n.* Formation of a surface skin on paints or varnishes or printing inks in the container.

**Skin packaging** *n.* A variation of the thermoforming process in which the article to be packaged serves as the mold. The article is usually placed on a printed card prepared with an adhesive coating or mechanical surface treatment to seal the plastic film to the card.

*See also blister packaging.*

**Skipping** *n.* In coil coating, an irregular paint application usually occurring when improper contact is made between the applicator roll and the strip.

**Skippy** *n.* Said of paint too heavy-bodied for uniform application, which causes the brush to skip on the surface, leaving some spots insufficiently coated and others with too heavy a coating.

**Skips** *See holidays.*

**Skirting board** *See baseboard.*

**Skiving** \ˈskīv-iŋ\ {*skived; skiving*} [prob. of Scand origin; akin to ON *skīfa* to slice] (ca. 1825) *vt.* Slicing off a thin layer. Skiving is the method by which veneers are cut from logs and by which polytetrafluoroethylene film is produced from cylindrical bars of ram-extruded or sinter-molded resin. PTFE film is made in this way because, unlike most thermoplastics, it cannot be directly extruded into film.

**SKS** *n.* Co-polymer from butadiene and styrene. Manufactured by the USSR.

**Slab stock** *n.* Large, thick sheets of plastics, usually formed by casting from syrup or melt and used for fabrication of larger structures such as tanks.

**Slack end** *n.* An end woven under insufficient tension.

**Slack filling** *See slack pick.*

**Slack melt copal** *n.* Copal which has been run only to a limited extent, often at a comparatively low temperature.

**Slack mercerization** \ˌmərs-rə-ˈzā-shən\ *n.* A process for producing stretch in cellulosic fabrics.

**Slack pick** *n.* A single filling yarn woven under insufficient tension.

**Slack selvage** *n.* A self-descriptive fabric defect caused by incorrect balance of cloth structure between the ground and selvage or by the selvage ends being woven with insufficient tension.

**Slack thread** *See slack end.*

**Slack warp** *See slack end.*

**Slaked lime** *n.* Another name for calcium hydroxide, or quicklime which has been slaked by addition of water.

**Slam-off** *See smash.*

**Slasher** *n.* A machine used to apply size to the warp ends, while transferring the warp yarns from section beams to the loom beam.

**Slasher sizing** *See slashing.*

**Slashing** *n.* The process of sizing warp yarns on a slasher.

*Also see sizing* (1) *and slasher.*

**Slate** \ˈslāt\ [ME, fr. MF *esclat* splinter] (14c) *n.* A fine-grained metamorphic rock of varied composition, used in powdered form as a filler, especially in flooring compounds.

**Slate dust** *See slate powder.*

**Slate flour** *See slate powder.*

**Slate powder** *n.* Extender pigment obtained from slate. It is an aluminum silicate type of mineral, including a substantial amount of combined water. Used in wood and metal fillers.

*Also called slate dust or slate flour.*

**Sleazy** \ˈslē-zē *also* ˈslā-\ [origin unknown] (ca. 1645) *adj.* Thin, lacking firmness, open-meshed; usually describes poor-grade fabrics.

**Sleepy** *n.* Description of a recently applied glossy coating which has lost its initial gloss other than by bloom and has become dulled or lacking in luster.

**Sleeve ejector** *n.* A bushing-type knockout.

**Sleeving** *n.* A braided, knit, or woven product or fabric in tubular or cylindrical form that is less than 4 inches in width (i.e., 8 inches in circumference.

**Sley** *n.* The number of warp yarns per inch in a woven cloth on or off the loom.

**Slide waste** *n.* A yarn defect that is similar in appearance to a slub.

**Slime** \ˈslīm\ [ME, fr. OE slīm; akin to MHGr *slīm* slime, L *limus* mud] (before 12c) *n.* A general name for any moist, sticky substance formed by fungi.

**Sling psychrometer** \ˈsliŋ sī-ˈkrä-mə-tər\ *n.* A psychrometer containing independently matched dry- and wet-bulb thermometers suitably mounted for swinging through the atmosphere, for simultaneously indicating dry- and wet-bulb temperatures.

**Slip** \ˈslip\ [ME *slippen*, fr. MD or MLGr; akin to MHGr *slipfen* to slide, OHGr *slīfan* to smooth, and per. to Gk *olibros* slippery] (14c) *v.* (1) With reference to adhesives, slip is the ability to move or reposition the adherents after an adhesive has been applied to their surfaces. (2) Of plastic film, having low surface friction and sliding easily over another layer of film or over machine surfaces in film fabricating and packaging equipment.

**Slip** *n.* (1) Film of coating is said to have slip when it has negligible surface tackiness, and appears to be lubricated. In actual fact, lubricants which are incompatible with the non-volatile constituents of finishes are frequently added in order that they may be exuded to the surface and confer slip. Non-greasing gold and silver baking varnishes are typical products to which lubricants are added. (2) Denoting the ease with which two surfaces slide in contact with each other. *Note* — In a sense, it is the antithesis of friction, in that high coefficient of friction denotes poor slip and low coefficient of friction, good slip. (3) Vaporized coating material emitted from a spray gun.

**Slip agent (compound)** (slip additive) *n.* An additive (e.g., oleamide) which exudes to the surface of a coating during and immediately after application and drying or baking. The additive coats the surface and provides the necessary lubricity to reduce the coefficient of friction and improve slip characteristics. Some experts feel that slip agents also act as anti-blocking agents.

**Slip forming** (slip-ring forming) *n.* A variation of sheet thermoforming employing a sheet-clamping frame provided with tensioned pressure pads that permit the plastic sheet to slip inward as the part is being formed. This controlled slippage provides more uniform wall thickness in the formed article.

**Slippage** *n.* The movement of adherents with respect to each other during the bonding process. Sliding or slipping of the filling threads over the warp ends (or vice versa), which leaves open spaces in the fabric. Slippage results from a loose weave or unevenly matched warp and filling.

**Slip sheet** [$^{1}$*slip*] (1903) *n.* A sheet of paper placed between two freshly printed sheets to prevent set-off or blocking.

**Slit die** (slot die, strip die) *n.* A profile die with nearly rectangular opening, used to produce an extrudate with a thin, moderately wide, rectangular cross-section, but too narrow to be called sheeting. Sheet and film dies, which are more elaborate and have adjustable removable lips, are not considered to be slit dies. A die producing a *blocky* rectangular cross-section is called a *bar-stock die.*

**Slit-film yarn** *n.* Yarn of a flat, tape-like character produced by slitting an extruded film.

**Slit tape** *n.* A fabric, 12 in. or less in width, made by cutting wider fabric to the desired width. Slit tapes are made primarily of cotton, linen, jute, glass, or asbestos and are used principally for functional purposes.

**Slitting** *n.* (1) The conversion of a given width of plastic film or sheeting to several smaller widths by means of knives. The operation can be performed as the material emerges from a production unit such as a calender, film-casting unit, or an (extrusion) roll stand (*in-line slitting*); by unwinding, slitting, and then rewinding of rolls; or by slitting of rolls without unwinding (*roll slicing*). Slitting knives may be actual straight-edge knives, or razor blades, or circular knives. (2) In coil coating, a process by which a wide strip is slit into narrower size prior to recoiling.

**Sliver** *1 is usually* ˈsli-vər, *2 is usually* ˈslī-\\ [ME *slivere*, fr. *sliven* to slice off, fr. OE –*slīfan*; akin to OE -*slîfan* to cut] (14c) *n.* A continuous strand of loosely assembled fibers without twist. Sliver is delivered by the card, the comber, or the drawing frame. The production of sliver is the first step in the textile operation that brings staple fiber into a form that can be drawn (or reduced in bulk) and eventually twisted into a spun yarn.

**Sliver knitting** *n.* Circular knitting coupled with the drawing-in of a sliver by the needles to produce a pile-like fabric, usually for high-pile coats or heavy linings.

**Sloughed filling** *See looped filling.*

**Slow ray** *n.* The slow vibration of a crystal corresponding to the higher refractive index.

**Slow solvent** *n.* Solvent with a slow evaporation rate.

**Slub** \\ˈsləb\\ {*slubbed; slubbing*} [back-formation fr. *slubbing*] (1834) *vt.* A yarn defect consisting of a lump or thick place on the yarn caused by lint or small lengths of yarn adhering to it. Generally, in filament yarn, a slub is the result of broken filaments that have stripped back from the end to which they are attached.

**Slubber** *n.* A machine used in textile processes prior to spinning that reduces the sliver and inserts the first twist.

**Slubbing** *n.* The product of the slubber, it is the intermediate stage between sliver and roving.

**Slubbing frame** *See slubber.*

**Slub catcher** *n.* A mechanical or electronic device designed to aid in the detection and removal of slubs or neps in yarns, usually during coning.

**Slub yarn** *n.* Any type of yarn that is irregular in diameter; the irregularity may be purposeful or the result of error.
*Also see novelty yarn, nub yarn, and slub.*

**Slug** \\ˈsləg\\ [ME *slugge*, of Scand origin; akin to Norw dialect *slugga* to walk sluggishly] (15c) *n.* A thick place in a yarn or a piece of lint entangled in yarn, cord, or fabric.

**Slug molding** *n.* A process for making thin-walled containers of 200–300-ml capacity. Melt from an extruder is fed into a metering head that delivers a slug of precise mass into a cylindrical bushing. From the bushing the slug is propelled into a single-cavity mold by a high-speed ram that passes through the bushing. The finished part is removed by a mechanical arm and transferred to an air conveyor that takes it to an automatic stacking unit. Trimming is unnecessary.

**Slur** \ˈslər\ [obs. E dialect *slur* thin mud, fr. ME *sloor*; akin to MHGr *slier* mud] (1609) *n.* A condition caused by slippage at the moment of impression between any two of the following: paper, printing plate, image carrier, or blanket.

**Slurry** *n.* A mixture of water and any finely divided insoluble material such as clay or Portland cement.

**Slurry preforming** *n.* A method of preparing reinforcement performs by wet-processing techniques similar to those used in pump molding. For example, glass fibers suspended in water are directed onto a shaped screen that retains the fibers while allowing the water to pass through, thus forming a mat that has the shape of the object to be molded.

**Slush casting** *n.* A method of forming hollow objects, widely used for doll parts and squeeze toys, in which a hollow mold provided with a closable opening is filled with a fluid plastic mixture, usually a vinyl plastisol. Heat, applied to the mold before and/or after filling, causes a layer of material to gel against the inner mold surface. When the layer has attained the desired thickness, the excess fluid is poured out, and additional hat is applied to fuse the gelled layer. After cooling, the article is stripped from the mold. Molds for slush casting are thin-walled for rapid heat transfer and are made of electroformed copper or cast aluminum.

**Slushing** *n.* Process by which a coating is liberally applied to surfaces which require protection but which are more or less hidden from view and not readily accessible for painting by ordinary methods. The paint or similar material is swilled on and the excess drained off.

**Slushing oil** *n.* Oil used on metals to form a protective coating against rust and tarnish. It should coat the surface completely, and yet be removable without undue labor.

**Slush molding** *n.* The preferred term for the process resembling slush casting but employing dry, sinterable powders.

**SMA** Abbreviation for co-polymers of styrene and maleic anhydride.

**Small-angle X-ray scattering (SAXS)** *n.* A technique using high-intensity X-ray sources for determining a wide range of information on submicroscopic structures larger than 2 nm. Some applications with polymers are particle size and macromolecular structure of particles, scale of segregation in blends, void structures, and specific surface.

**Smalt** \ˈsmólt\ [MF, fr. OIt *smalto*, of Gme origin; akin to OHGr *smelzan* to melt] (1558) *n.* A deep blue potassium–cobalt glass pigment made by fusing pure sand and potassium carbonate with cobalt oxide, grinding and powering. Smalt is sometimes applied to freshly coated surfaces to provide unusual decorating effects.

**Smart skin** (smart composite) *n.* A composite containing molded-in sensors and micro transmitters that enable aerospace engineers to detect in-flight changes in temperature, strain, ice thickness, and cracks.

**Smash** (1) A relatively large hole in fabric characterized by many broken warp ends and floating picks. One cause is the breaking of one or both harness straps, permitting the harness to drop and break out warp ends. (2) The breaking of many yarn ends in a beaming operation, usually as a result of mechanical failures.

**SMC** *n.* Abbreviation for sheet molding compound.

**Smearing** *n.* The spreading of ink over areas of the plate and/or substrate where it is not wanted.

**Smectic** \ˈsmek-tik\ [L *smecticus* cleansing, having the properties of soap, fr. Gk *smēktikos*, fr. *smēchein* to clean] (1923) *adj.*
*See liquid-crystal polymer.*

**Smeraldino** *See hydrated chromium oxide.*

**Smith–Ewart kinetics** *n.* Emulsion polymerization kinetics describing the initiator that dissociates into free radicals, which can either travel into the micelle and start a polymerization directly (Smith–Ewart–Harkins theory) or react first with an emulsifier molecule, under transfer, forming an emulsifier radical, which then starts the polymerization (Medvedev theory).

**Smoke** \ˈsmōk\ [ME, fr. OE *smoca*; akin to OE *smēocan* to emit smoke, MHGr *smouch* smoke, and prob. to Gk *smychein* to smolder] (before 12c) *n.* Carbon or soot particles less than 0.1 μm in size which result from the incomplete combustion of carbonaceous materials such as coal or oil. Air suspension (aerosol) particles, often originating from combustion or sublimation.

**Smoke chamber test** *See flammability tests.*

**Smoked sheet** Smoked natural rubber.

**Smoke suppressants** *n.* An additive that, compounded into poorly burning polymers such as polyvinyl chloride, reduces smoke generation in fires. ASTM 2843 is a test for smoke generation, described under flammability.

**Smouldering** *n.* A slow, flameless, smoking burning of a fabric.

**SMS** Co-polymer from styrene and α-methyl styrene. Abbreviation for co-polymers of styrene and α-methylstyrene.

**Smudge** *n.* Mixture of residues of paints to which thinners are sometimes added. It is of unknown and variable quality and has no place in a normal paint system.

**Sn** *n.* Chemical symbol for tin (Latin: *stannum*).

**Snag** [of Scand origin; akin to ON *snagi* clothes peg] (ca. 1587) *n.* A pulled thread in knits. It is in the wale direction in warp knits and in the course direction in weft knits.

**Snap-back forming** *See vacuum snap-back forming.*

**Snap fit** *n.* A method of reversibly joining plastic parts in which one part has a concave element – usually a diameter – slightly smaller in an inside dimension than the outside dimension of the mating convex element of the second part. Behind the circle of interference the convex part will be relieved to a smaller diameter, the concave part to a larger one. To assemble, one forces (snaps) the two parts together. Once the zone of interference is passed, the momentarily high stress is partly or wholly relieved. Disassembly is easily accomplished by pulling the two members apart, but is unlikely to occur spontaneously. A ubiquitous application of the principle is seen in caps for polyolefin half- and whole-gallon milk bottles; another is the Tupperware® family of reusable food containers.

**Snarl** \ˈsnär(-ə)l [$^2$*snarl*] (14c) *v.* A short length of warp or filling yarn that has twisted on itself because of lively twist or insufficient tension. The snarling may occur during or prior to the weaving process.

***S/N* curve** Abbreviation for stress at failure versus number of cycles (curve).
*See fatigue curve.*

**Snell's law** *n.* Snell's law of refraction states that if $i$ is the angle of incidence through a transparent medium, $r$ is the angle of refraction, the index of refraction $n$, then

$$n = \frac{\sin\ i}{\sin\ r}.$$

**Snow ball** *See balling up.*

**$(\mathrm{SN})_x$** *See sulfur nitride polymer.*

**Soaking** *n.* Treatment of rayon yarns in a lubricating and sizing solution preparatory to hard twisting.

**Soap** \ˈsōp\ [ME *sope*, fr. OE *sāpe*; akin to OHGr *seifa* soap] (before 12c) *n.* The detergent obtained by the formation of a sodium or potassium salt of a fatty acid or mixture of fatty acids.

**Soap resistance** *n.* The relative ability to withstand the action of soap. It is a property required of inks used in printing soap wrappers.

**Soap, metallic** *n.* Any product derived by reacting a fatty acid with a metal. Metallic soaps are widely used as stabilizers for plastics. The fatty acids commonly used are lauric, stearic, ricinoleic, naphthenic, octanoic (2-ethylhexanoic), rosin, and tall oil. Typical metals are aluminum, barium, calcium, cadmium, copper, iron, lead, magnesium, tin, and zinc.

**Soaps** Metallic salts of fatty acids. There is also a tendency to apply the term to metallic salts of all organic acids.

*See surfactants.*

**Soapstone** \ˈsōp-ˌstōn\ (ca. 1681) *n.* Another name for the mineral from which talc is obtained.

**Society of automotive engineers (SAE)** *n.* Address: 400 Commonwealth Dr, Warrendale, PA 15906. Its 66,000 members are engineers, managers, and scientists in the field of self-propelled land, sea, air, and space vehicles. Among its publications is an annual handbook of standards, many of them shared with ANSI. The AMS 3000 series includes many standards on elastomers, casting resins, plastics extrusions, moldings, potting compounds, and reinforcing fibers.

**Society of plastics engineers (SPE)** *n.* The leading international organization devoted to plastics engineering and technology, with 35,000 members, headquartered at 14 Fairfield Drive, Brookfield, CT 06804-3911. In 1993, SPE had 86 geographic sections, including 14 outside USA, and 20 special-interest divisions. SPE publishes several journals, hold many regional and national technical meetings each year, including its annual technical conference (ANTEC), has sponsored publication of scores of books on all aspects of plastics, supports plastics education at all levels, and founded the Plastics Institute of America, now a separate organization.

**Society of the plastics industry (SPI)** *n.* An organization whose members include companies from all areas of plastics: materials producers, plastics sales people, processors and fabricators, designers and users of plastics products, and a few individual members. SPI's main address is 1275 K Street NW, Washington, DC 20005. SPI's Composites Institute is located at 355 Lexington Ave, New York, NY 10017. SPI sponsors a triennial international trade show. It has groups that interact with American National Standards Institute to promulgate standards for safe operation of plastics processing equipment and machinery and for certain plastics products such as pipe. The Composites Institute sponsors an annual technical conference on reinforced plastics. SPI lobbies for sensible legislation affecting plastics, and established and supports the Plastics Hall of Fame.

**Sodium aluminosilicate** \ˈsō-dē-əm ə-ˌlü-mə-nō-ˈsi-lə-ˌkāt\ *n.*

*See sodium silicoaluminate.*

**Sodium aluminum hydroxcarbonate** *n.* Na $Al(OH)_2CO_3$. Named Dawsonite (after the mineral of the same nominal composition) by Alcoa, this material is produced in the form of microfiber crystals useful for upgrading physical properties of thermoplastics. In PVC compounds it also acts as a smoke suppressant and HCl scavenger.

**Sodium azide** \ˈā-ˌzīd\ (ca. 1937) *n.* $NaN_3$. A poisonous crystalline salt used to make lead azide.

**Sodium borate** *n.* $Na_2B_4O_7$. Powder of glass-like plates becoming opaque when exposed to air. Slowly soluble in water.
*See borax.*

**Sodium borohydride** \-ˌbōr-ə-ˈhī-ˌdrīd\ [*sodium* + *boron* + *hydride*] (1946) *n.* $NaBH_4$. A white crystalline powder, used as a blowing agent for foamed plastics such as rigid PVC and polystyrene, and for elastomers. The material decomposes at room temperature in the presence of water and an acidic medium, releasing hydrogen.

**Sodium carbonate** (1868) *n.* $Na_2CO_3$. A sodium salt of carbonic acid used in making soaps and chemicals, in water softening, in cleaning and bleaching, and in photography.

**Sodium carboxymethyl cellulose** \-kär-ˌbäk-sē-ˌme-thəl ˈsel-yə-ˌlōs\ *n.*
*See carboxymethyl cellulose.*

**Sodium chlorate** (1885) *n.* $NaClO_3$. A colorless crystalline salt used as an oxidizing agent.

**Sodium chloride** (1868) *n.* An ionic crystalline chemical compound consisting of equal numbers of sodium and chlorine atoms.

**Sodium citrate** (1919) *n.* $Na_3C_6H_5O_7$. A crystalline salt used chiefly as a buffering agent, as an emulsifier, as an alkalizer and cathartic in pharmaceuticals, and as a blood anticoagulant.

**Sodium cyanide** (1885) *n.* NaCN. A white deliquescent poisonous salt used in electroplating, in fumigating, and in treating steel.

**Sodium dichromate** \-(ˌ)dī-ˈkrō-ˌmāt\ (1903) *n.* $Na_2Cr_2O_7$. A red crystalline salt used in tanning leather, in cleaning metals, and as an oxidizing agent.

**Sodium fluoride** (ca. 1903) *n.* NaF. A poisonous crystalline salt that is used in trace amounts in the fluoridation of water, in metallurgy, as a flux, and as a pesticide.

**Sodium fluoroacetate** \-ˌflúr-ō-ˈa-sə-ˌtāt\ (1945) *n.* A poisonous powdery compound.

**Sodium hydroxide** (1885) (lye, caustic soda) *n.* NaOH. A strong, cheap alkali, completely ionic, useful both as a reactant and a catalyst in polymer chemistry.

**Sodium hypochlorite** (1885) *n.* NaOCl. An unstable salt produced usually in aqueous solution and used as a bleaching and disinfecting agent.

**Sodium lithol red** *See lithol red.*

**Sodium metasilicate** \-ˌme-tə-ˈsi-lə-ˌkāt\ (ca. 1926) *n.* $Na_2SiO_3$. A toxic corrosive crystalline salt used mostly as a detergent or as a substitute for phosphates in detergent formulations.

**Sodium nitrate** (1885) *n.* $NaNO_3$. A deliquescent crystalline salt used as an oxidizing agent, a fertilizer, and in curing meat.

**Sodium nitrite** (ca. 1903) *n.* $NaNO_2$. A salt used in dye manufacture.

**Sodium polyacrylate** *n.* $(-CH_2CH-)_nCOONa$. A thickening agent, the sodium salt of polyacrylic acid.

**Sodium silicoaluminate** *n.* $9Na_2O\cdot 67SiO_2\cdot 12Al_2O_3$. Ultrafine synthetic precipitate formed by reacting an aluminum salt with an alkali silicate. Density, 2.1 g/cm$^3$ (17.5 lb/gal); O.A., 125; particle size, 0.1–0.4 µm. Syn: sodium aluminosilicate, synthetic silica pigment.

**Sodium stearate** \-ˈstē-ə-ˌrāt\ *n.* $NaOOCC_{17}H_{35}$. A water-soluble white powder, a soap, used as a non-toxic stabilizer.

**Sodium sulfate** (1885) *n.* $Na_2SO_4$. A bitter salt used in detergents, in the manufacture of wood pump and rayon, in dyeing and finishing textiles, and in its hydrated form as a cathartic.

**Sodium thiosulfate** (1885) *n.* $Na_2S_2O_3$. A hygroscopic crystalline salt used as a photographioc fixing agent and a reducing or bleaching agent.

**Soffit** \ˈsä-fət\ [F *soffite*, fr. It *soffitto*, fr. (assumed) VL *suffictus*, pp of L *suffigere* to fasten underneath] (1592) *n.* (1) The exposed undersurface of any overhead component of a building, such as a roof overhang, an arch, balcony, beam, cornice, lintel, or vault. *See eave.* (2) In wall coverings, border and soffit paper are the same. *See border.*

**Soft distemper** *n.* Usually based on whiting, lightly bound with glue, size or other water-soluble binder so that the coating will withstand dry rubbing without disturbance but can easily be removed by water washing.

**Softener** *n.* (1) A product designed to impart a soft mellowness to the fabric. Examples are glucose, glycerine, tallow, or any one of a number of quaternary ammonium compounds. (2) A substance that reduces the hardness of water by removing or sequestering the calcium and magnesium ions. (3) A substance used to reduce friction during mixing and processing when dry powders are added to polymers.

*See blender.*

**Softening point** *n.* The temperature at which a disc of a sample held within a horizontal ring is forced downward a distance of 25.4 mm (1 in.) under the eight of a steel ball as the sample is heated at a prescribed rate in a water or glycerol bath.

*See ball and ring method.*

**Softening range** *n.* A temperature interval over which a plastic changes from a rigid to a soft state or undergoes a rather sudden and substantial change in hardness (ISO). ASTM (www.astm.org) describes the Durrans' softening-point procedure for fully reactive epoxy resins.

*See also ball-and-ring test, melting point, and vicat softening point.*

**Soft ink** *n.* Printing composition exhibiting an almost complete absence of tack.

**Soft silica** *See amorphous silica.*

**Softwoods** The botanical group of trees that have needles or scale-like leaves and are evergreen for the most part, cypress, larch, and tamarack being the exceptions. The term has no reference to the hardness of the wood. Softwoods are often referred to as conifers and, botanically, they are called gymnosperms.

**Soil** *See dirt.*

**Soil burial test** *n.* A test of resistance of textile material to certain micro-organisms present in soil. The samples are buried in soil for an extended period, then removed and measured for strength loss.

**Soiling** The staining or smudging of textile materials resulting from the deposit of dirt, oil undesirable dye, etc.

**Sol** \ˈsäl, ˈsól\ [-*sol* (as in *hydrosol*),l fr. *solution*] (1899) *n.* Short for hydrosol. A fluid colloidal system in which the continuous phase is a liquid.

*See colloidal solution.*

**Solid** \ˈsä-ləd\ *n.* (1) A printed area uniformly and completely covered with ink. (2) Non-volatile matter in a coating composition, i.e., the ingredients of a coating composition which, after drying, are left behind and constitute the dry film.

*Also called non-volatile matter.*

**Solid** *n.* (15c) A state of matter in which the relative motion of the molecules is restricted and they tend to retain a definite fixed position relative to each other, giving rise to crystal structure. A solid may be said to have a definite shape and volume.

**Solid angle** (ca. 1704) *n.* Measured by the ratio of the surface of the portion of a sphere enclosed by the conical surface forming the angle, to the square of the radius of the sphere. Unit of solid angle – the steradian, the solid angle which encloses a surface on the sphere equivalent to the square of the radius. Dimension, unity.

**Solid casting** *n.* The process of forming solid articles by pouring a fluid resin or dispersion into an open mold, causing the material to solidify by curing or by heating and cooling, them removing the formed article. *Compare casting.*

**Solid-phase forming** *n.* This term includes the shaping of plastic sheets or billets into three-dimensional articles either at room temperature or at higher temperatures up to the softening or melting range by processes resembling those used in the metals-working industry. Among plastics suitable for at least some of the solid-phase processes are acrylonitrile-butadiene-styrene resins, acetals, cellulosics, polyolefins, polycarbonates, polyphenylene oxides, and polysulfones. Brittle materials such as acrylics and polystyrene cannot be formed by solid-phase processes.

**Solids** *n.* Non-volatile matter in a coating composition, i.e., the ingredients of a coating composition, which after drying, are left behind and constitute the dry film. *Also called non-volatile matter.*

**Solids by volume** *n.* The volume of the non-volatile portion of a composition divided by the total volume, expressed as a percent. Syn: volume solids.

**Solids content** *n.* The percentage by weight of the non-volatile matter in an adhesive. *Note* — The actual percentage of the non-volatile matter in an adhesive will vary considerably according to the analytical procedure that is used. A standard test method must be used to obtain consistent results.

**Solids-draining screw** (barrier screw) *n.* Any of a half-dozen designs of screws for single-screw extruders whose intent is to separate generated melt from the bed of solids as the melt is formed, the two main goals being better contact of the remaining bed with the hot barrel and preventing unmelted solids from passing into the metering section and die. The first of these, and still in use, was the maillefer screw. Some others bear the names Barr, Dray and Lawrence, Ingen Housz, Kim, SPR (for Scientific Processing & Research), and Uniroyal.

**Solid-state controls** *n.* Control instruments or motor-drive controls whose circuitry employs transistors and kindred elements rather than mechanical or vacuum-tube devices. Practically all modern process instruments are of this type.

**Solid-state polymerization** *n.* A chain-growth polymerization initiated by exposing to ionizing radiation a crystalline monomeric substance. A large number of olefinic and cyclic solid monomers have been so polymerized, the crystalline monomer converting directly to the polymer with no obvious change in appearance of the solid. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Soliton** \ˈsä-lə-ˌtän\ [*solitary* + $^{2}$-*on*] (1965) *n.* A solitary wave (as in a gaseous plasma) that propagates with little loss of energy and retains its shape and speed after colliding with another such wave. Solitons have had many physical applications included order-disorder phase transitions, crystal dislocations, charge density waves, and Josephson junction transmission lines. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Solprene** *See plastomer.*

**Solubility** *n.* (1) The mass of a substance that will dissolve in a given volume or mass of a solvent to form a solution that is homogeneous to the molecular level, sometimes expressed as weight percent. (2) When no solvent and conditions are specified, the solubility in water at room temperature is usually meant.

*See also miscibility.*

**Solubility** *n.* The concentration of a solute in a saturated solution; the maximum amount of solute which can be dissolved in a solution by simply adding it to a solvent at constant temperature.

**Solubility parameter (SP, *δ*)** *n.* The square root of the cohesive energy density of a polymer, solvent, or adhesive. For solvents, SP equals the square root of the heat of vaporization per unit volume $(\mathrm{J/cm^3})^{0.5}$. Values for polymers (which do not vaporize) are found by indirect methods. If the solubility parameters of a polymer and solvent differ by 3 $(\mathrm{J/cm^3})^{0.5}$ or less, the polymer will probably dissolve in the solvent differ by $(\mathrm{J/cm^3})^{0.5}$ or less, the polymer will probably dissolve in the solvent. SPs for organic solvents range from 13 for neopentane to 30 methanol; for polymers, from 13 for polytetrafluoroethylene to 32 for Polyacrylonitrile. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York. Barton AFM (1983) Handbook of solubility parameters and other cohesion parameters. CRC Press, Boca Raton, FL. Brandrup J, Immergut EH, Elias HG (eds) (1975) Polymer handbook. Interscience Publishers Inc., New York.

**Solubility parameter concept** *n.* Cohesive energy density of a plastic or solvent material. Burrell H (1955) Solubility parameters. Interchem Rev 14(3):31. Hansen CM, Beerbower A, Solubility Parameters, in Kirk-Othmer Encyclopedia of Chemical Technology, Suppl. Vol., 2nd edn. Standen A, Ed., Interscience, New York, 1971, 889. Hoy KL, Price BA, Martin.

**Solubility product, $K_{sp}$** *n.* The equilibrium constant for ionic solubility equilibrium. When a solid electrolyte (MA) dissolves at least two kinds (M and A) of particles (ions) are released to the solution (e.g., NaCl in water), then

$$\mathrm{MAM^+} + \mathrm{A^-},$$

$$\frac{[\mathrm{M^+}][\mathrm{A^-}]}{[\mathrm{MA}]} = K',$$

$$[\mathrm{M^+}][\mathrm{A^-}] = K'[\mathrm{MA}],$$

$$[\mathrm{M^+}][\mathrm{A^-}] = K_{\mathrm{sp},}$$

where $K_{sp}$ is called the *solubility product,* $[\mathrm{M^+}][\mathrm{A^-}]$ is called the *ion product*, and at ionic equilibrium the solubility product is equal to the ion product. The solubility product is useful for expressing the solubility and ionic strength of a substance in aqueous solution (Russell, 1980).

*Also called the solubility product constant.*

**Soluble** *n.* Capable of being dissolved, i.e., passing into solution.

**Soluble blue** *n.* A pigment dispersible in water that is made by treating an iron blue with sodium ferrocyanide or oxalic acid and used chiefly in permanent writing inks and laundry blues.

**Soluble drier** *See liquid driers; drier.*

**Solute** \ˈsäl-ˌyüt\ [L *solutus*, pp of *solvere*] (1893) *n.* That constituent, usually a solid substance, of a solution which is considered to be dissolved in the solvent. The solvent is usually present in larger percentage than the solute. A solution is saturated if it contains at given temperature as much of a solute as it can retain in the presence of an excess of that solute. A true solution is a mixture, liquid, solid, or gaseous, in which, the components are uniformly distributed throughout the mixture. The proportion of the constituents may be varied within certain limits.

**Solution** *n.* A single-phase mixture of two or more component, homogeneous at the molecular level, such as a resin dissolved in a liquid, that forms more or less spontaneously, will not separate, and has no fixed proportions of the components. Polymer solutions are used in the plastics industry to apply coatings, for film casting, and for spinning fibers. The term also includes gas/gas, gas-in-liquid, liquid/liquid, and solid/solid solutions.

**Solution casting** *See film casting.*

**Solution coating** *n.* Any coating process employing a solvent solution of a resin, as opposed to a dispersion, hot-melt or uncured thermosetting system.

*See also spread coating.*

**Solution dyed** *See dyeing, mass-colored.*

**Solution polymerization** *n.* A polymerization process in which the monomer, or mixture of monomers, and the polymerization initiators are dissolved in a non-monomeric solvent at the beginning of the polymerization reaction. The liquid is usually also a solvent for the resulting polymer or co-polymer. Solution polymerization is most advantageous when the resulting polymeric solutions are to be used for coatings, lacquers, or adhesives. Vinyl acetate, olefins, styrene, and methyl methacrylate are the monomers most often employed. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (2003) An introduction to plastics. John Wiley and Sons, New York. Solomon DH (1969) Kinetics and mechanisms of polymerization series, vol 2 – ring opening and vol 3 – step growth. Marcel Dekker Inc., New York.

**Solvation** (1909) *vt.* Adsorption of a micro-layer or film of water or other solvent on individual dispersed particles of a solution or dispersion. It also applies to the action of plasticizers on resin dispersions in plastisols. The process of swelling, gelling, or solution of a resin by a solvent or plasticizer as a result of chemical compatibility.

*See solubility parameter.*

**Solvency** *n.* The degree to which a solvent holds a resin or other paint binder in solution. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York. Barton AFM (1983) Handbook of solubility parameters and other cohesion parameters. CRC Press, Boca Raton, FL.

*See kauri-butanol value, aniline point, and solubility parameter. Also called solvent power.*

**Solvent** *n.* (1) Broadly defined, a liquid with the ability to dissolve other substances. Solvents are used by the plastics industry in three main ways. As intermediates, solvents are used in the production of many monomers and resins. In plastics processing, solvents are used in etching, welding, polishing, film casting, fiber spinning, and making laminates. Finally, solvents are widely used in adhesives, printing inks, and surface coatings for plastics, as well as those based on plastics and used on other materials. The major types of solvents used in all these applications are alcohols, esters, glycol ethers, ketones, aliphatic and aromatic hydrocarbons, chlorinated hydrocarbons, and nitroparaffins. (2) The constituent of a solution that is (usually) present in larger percentage; or, in the case of solutions of solids or gases in liquids, the constituent that is liquid in the pure state at room temperature. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

**Solvent balance** *n.* The condition wherein a blend of solvents and/or diluents produce the desired properties of solvency and solvent evaporation.
*See solvent imbalance.*

**Solvent bonding** *See solvent welding.*

**Solvent cement** *See adhesive.*

**Solvent cementing** (solvent bonding, solvent welding) *n.* The process of joining articles made of thermoplastic resins by applying a solvent capable of softening the surfaces to be joined, and pressing the softened surfaces together until the bond has gained strength. Plastics joined by this method include acrylonitrile-butadiene-styrene resin, acrylics, cellulosics, polycarbonates, polystyrenes, and vinyls. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Solvent diffusion** *n.* The migration of solvent molecules into or out of a polymer as driven by the concentration gradient. Diffusion is the rate-limiting process in drying plastics and is also important in extraction extrusion.

**Solvent dyeing** *See dyeing.*

**Solvent imbalance** *n.* The condition wherein the ratios of solvents and/or diluents are such that inadequate solvency or improper evaporation of volatiles results.
*See solvent balance.*

**Solvent paste wax** *n.* Similar to liquid solvent wax, except furnished in paste form. Occasionally colored.

**Solvent polishing** *n.* A method for improving the gloss of thermoplastic articles by immersion in, or spraying with a solvent that will dissolve surface irregularities, followed by evaporation of the solvent. The method is used primarily for cellulosics, for which dipping is suitable. Plastics that are subject to crazing, such as polystyrene, are usually sprayed rather than dipped.

**Solvent pop** *n.* Blistering caused by entrapped solvent.

**Solvent power** *n.* The strength of dissolving power of a solvent.
*See solvency.*

**Solvent release** *n.* The ability of a resin to influence the rate at which solvent evaporates from a coating.

**Solvent resistance** *n.* The ability of a plastic to withstand, unchanged, exposure to solvents. Plastics vary widely in their resistance to specific solvents.

**Solvent shock** *n.* The situation wherein some of the protective vehicle is washed off the fine pigment particles, allowing them to pull together into clusters or flocs or when flocs of resin form due to dilution with a solvent or diluent of insufficient strength.

**Solvent spinning** *See spinning, dry spinning.*

**Solvent-water blends solvation** *n.* The interaction of a solute with a solvent; the surrounding of solute particles by solvent particles.

**Solvent wax** *See liquid solvent wax.*

**Solvent welding** *See solvent cementing.*

**Sonic modulus** *n.* The tensile/compressive modulus ($E$) estimated by measurement of sound-wave propagation in a material. ASTM Test C 769 (section 15.01) describes such a method.

**Sonic velocity** *n.* The speed of sound in a material. In air at 20°C and 50% relative humidity, the velocity of a plane longitudinal sound wave is 344 m/s. In polymethyl methacrylate, polystyrene, and polyethylene it is 2680, 2350, and 1950 m/s, respectively.

**Soot-chamber test** (ASTM D 2741) *n.* A test evaluating the relative effectiveness of antistatic agents in blown polyethylene bottles. After conditioning at 23°C and 50% RH, each bottle is rubbed ten times with a paper towel to generate static charge, then placed in a test chamber at 15% RH for 2 h. Filter paper wetted with toluene is ignited and the smoke is blown into the test chamber. Fifteen minutes later the bottles are removed from the chamber and examined. Soot accumulation is judged to be clean (i.e., none), slight, moderate, or severe.

**Sorbic acid** \ˈsór-bik-\ [*sorb* fruit of the service or related trees, fr. F *sorbe*, fr. L *sorbum*] (1815) *n.* $CH_3CH{=}CHCH{=}CH$ COOH. Naturally occurring unsaturated monobasic acid. Mp, 134°C. Sorbic acid is used to improve characteristics of drying oils and to improve alkyds.

**Sorbitol** \ˈsór-bə-ˌtól\ [*sorb* fruit of the service or related trees + *-itol*] (1895) *n.* $C_6H_8(OH)_6$. Polyhydric alcohol which has attracted some interest as a component of synthetic drying oils and alkyd-type resins and surfactants. Sp gr, 1.47; mp, 97.5°C.

**Sorption** *n.* The process of one substance taking up and holding another by physical or chemical action. Usually the sorbed substance is mobile, a gas or vapor, and the sorbing phase is dense, a liquid or solid. However, components of liquids can also be sorbed by solids, as by a molecular sieve. Surface phenomenon which may be either absorption or adsorption or a combination of the two. Often used when the specific mechanism is not fully known. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

*See also absorption, adsorption, chemisorption, and persorption.*

**Souring** *n.* Any treatment of textile materials in dilute acid. Its purpose is the neutralization of any alkali that is present.

**Sov pren** *n.* Poly(chloroprene), manufactured by the USSR.

**Soya bean oil** (ca. 1916) *n.* A pale yellow semidrying oil extracted from the bean of the soybean plant, *Soja hispida*, a native of Asia, but also grown extensively throughout the world. Its drying properties are inferior to those of linseed but may be improved by suitable processing. When refined, it finds wide use as a component in both exterior and interior paints, but its widest use is in the preparation of alkyds. Coatings made with soybean oil are less prone to yellowing than those based on linseed oil.

*It is also called soybean oil.*

**Soybean meal** *n.* The product of grinding soybean residue after extraction of oil, sometimes treated with formaldehyde to reduce moisture absorption. It is used as a filler, often in conjunction with wood flour, in thermosetting resins.

**Soybean oil** *n.* A pale yellow oil extracted from soybeans, used in epoxidized form as plasticizers and stabilizers for vinyl resins.

**Sp** (0,1,2,3) *n.* Cleanliness of hand derusted steel according to SIS 0 55 900.

**Space dyeing** *See dyeing.*

**Space lattice** A regular, repeating array of points in space.

**Spachtling** *See spackle.*

**Spackle** \ˈspa-kəl\ {spackled; spackling} [*Spackle*] (1940) *vt.* A paste, compound, or powder which can be mixed into a paste; used to fill holes, cracks, and defects in wood, plaster, wallboard, etc., to obtain a smooth surface.

*Also known as spachtling, spackling, and sparkling.*

**Spandex®** \ˈspan-ˌdeks\ {*trademark*} [anagram of *expands*] (1959). Generic name for a manufactured fiber in which the fiber-forming substance is a long-chain synthetic polymer comprised of at least 85% of a segmented polyurethane (Federal Trade Commission). These fibers are used in garments to enhance stretch ability and resilience. Compared to its competitors for this purpose, spandex is stronger and stiffer, with better resistance to heat and oxidation.

**Spandex® fiber** *n.* A DuPont manufactured fiber in which the fiber-forming substance is a long chain synthetic polymer composed of at least 85% of a segmented polyurethane (FTC definition). Characteristics: spandex is lighter in weight, more durable, and more supple than conventional elastic threads and has between two and three times their restraining power. Spandex is extruded in a multiplicity of fine filaments, which immediately form a monofilament. It can be repeatedly stretched over 500% without breaking and still recover instantly to its original length. It does not suffer deterioration from oxidation as is the case with fine sizes of rubber thread, and it is not damaged by body oils, perspiration, lotions, or detergents. End uses: spandex is used in foundation garments, bathing suits, hose, and webbings.

**Spandex® polymers** *n.* Segmented polyurethane structure (Dupont Inc., KY, USA) with rubber-like elasticity.

**Spangles** *See glitter.*

**Spanishing** *n.* A printing process similar to valley printing. Ink is deposited on the bottoms and sides of depressed areas of an embossed plastic film.

**Spanish ocher** \-ˈō-kər\ *n. See iron oxides, natural.*

**Spanish red oxide** Ferric oxide mineral pigment from the Malaga district of Spain. Of bright shade, with good hiding power. Ferric oxide, 82–86%.

**Spanish white** *n.* Another name for Paris white.

*See whiting and calcium carbonate, natural.*

**Sparking** *See spackle.*

**Spark matching** *See electrical-discharge machining.*

**Sparkproof tools** *n.* Bronze beryllium tools or other non-metallic tools to prevent spark formation in potentially explosive atmospheres, as with concentrations of hydrocarbon solvent vapors within the explosive limits.

**Spark-testing** *n.* Method of detecting holidays (flaws) on metallic substrates by means of spark-test tool.

**Spar varnish** *n.* A very durable waterproof varnish for exterior use. Obtained its name from use in coating ships' spars.

**Spatter finish** *n.* A decorative effect wherein spots, globules or spatters of contrasting color appear on, or within the surface of, a white or differently colored background. The effect may be achieved through the use of a multicolor, multiphase single coat or by spattering the contrasting colors onto a base coat.

**Spattering** *n.* In antiquing, applying small specks of color to simulate textural qualities in wood. Usually done with a dry brush and little paint, or by flicking a toothbrush.

**SPC** *n.* Abbreviation for statistical process control.

**SPE** *n.* Abbreviation for Society of Plastics Engineering.

**Special boiling point spirits** *See SBP spirits.*

**Special industrial solvents** *n.* A special class of proprietary solvents manufactured in accordance with authorized formulas. They can be sold only for industrial or manufacturing use in quantities of 50 gallons or more, but otherwise no permit is required in USA.

**Specific adhesion** *n.* Adhesion between two surfaces that are held together by valence forces of the same type as those that give rise to cohesion, as opposed to mechanical adhesion in which the adhesive holds the parts together by interlocking action.

*See adhesion, specific and adhesion, mechanical.*

**Specific conductance** *See conductivity.*

**Specific gravity** (1666) (Sp gr) *n.* The ratio of the density of a liquid or solid material to the density of water at 4°C, or other specified temperature. The notation $d_{t_2}^{t_1}$ is often used to specify the two temperatures, the subscript $t_2$ being that of water. For gases, specific gravity is rationed on that of air at standard conditions, usually 101.325 kPa and 0°C. When buoyancy corrections are made to mass determinations of the densities, the term *absolute specific gravity* is used. Specific gravity is often misused as a Syn: density but the error is not as serious as the parallel error with specific heat because, in the density unit still in most common use, g/cm$^3$, water's density is very close to 1.000 at room temperature. The ASTM test for specific gravity (and density) of plastics by displacement is D 792. In the SI, the term "relative density" is preferred.

*See also density and bulk density.*

**Specific heat** (1832) *n.* Strictly, specific heat is the ratio of the heat capacity of a substance to that of water at 15°C. In traditional cgs and English units, the heat units (calorie and British thermal unit) were defined by the heat capacity of water, making that of water at room temperature closely equal to 1.00 in either system. Thus, for other materials, specific heat and heat capacity were numerically equal. This fact led to the use, still ongoing, of "specific heat" when the property meant was heat capacity. In the SI system, the heat capacity of water is 4.18 J/g K, whereas specific heats are dimensionless and not affected by changes in units, so are no longer equal to heat capacities. Soon, it is hoped, this confusing and now useless term will fade out of the language of science and engineering.

**Specific heat of a substance** *n.* The ratio of its thermal capacity to that of water at 15°C. Dimensions, unity. If the quantity of heat $H$ calories is necessary to raise the temperature of $m$ gram of a substance from $t_1$ to $t_2$°C, the specific heat, or more properly, thermal capacity of the substance

$$s = \frac{H}{m(t_2 - t_1)}.$$

*Specific heat by the method of mixture* – where a mass $m_1$ of the substance is heated to a temperature $t_1$, then placed in a mass of water $m_2$ at a temperature $t_2$ contained in a calorimeter with stirrer (or same material) of mass $m_3$, specific heat of the calorimeter $c_2 t_3$ the final temperature

$$m_1 s(t_1 - t_3) = (m_3 c + m_2)(t_3 - t_2).$$

*Black's ioce calorimeter* – If a body of mass $m$ and temperature $t$ melts a mass $m'$ of ice, its temperature being reduced to 0°C, the specific heat of the substance is,

$$s = \frac{801m'}{ml}.$$

*Bunsen's ice calorimeter* – A body of mass $m$ at temperature $t$ causes a motion of the mercury column of $l$ centimeter in a tube whose volume per unit length is $v$. The specific heat

$$s = \frac{884lv}{ml}.$$

**Specific humidity** *See humidity ratio.*

**Specific inductive capacity** *n.* The ratio of the capacitance of a condenser with a given substance as dielectric to the capacitance of the same condenser with air or a vacuum as dielectric is called the specific inductive capacity. The ratio of the dielectric constant of a substance to that of a vacuum. Syn: permittivity.

**Specific insulation resistance** *See volume resistivity.*

**Specific intensity** *n.* Specific intensity of a retroreflector is the ratio of the luminous intensity of the reflector at a given observation angle to the illumination of the projected area (perpendicular to the direction of illumination) of the reflector. The units may be expressed as candles/foot-candle.

**Specific luminance** *n.* Specific luminance of a retroreflector is the ratio of the luminance of the reflector to the illumination of its actual area.

**Specific modulus** *n.* Elastic modulus (usually the tensile modulus) divided by density, the SI unit being Pa/(kg/m$^3$) (technically reducible to J/kg, which blurs its derivation and true nature). For example, the specific moduli of neat acetal resin (homopolymer) and glass–fiber-reinforced epoxy are, respectively, 2.3 and 11 MPa/(kg/m$^3$).

**Specific permeability (of a film to moisture)** *n.* The milligram of water that permeate 1 cm$^2$ of film of 1 mm thickness each 24 h after a constant rate has been attained under the preferred conditions of 25°C and using 100% relative humidity inside the cup and a phosphorus pentoxide desiccated atmosphere outside the cup. The method requires that a moisture differential be established across the test specimen, and an apparatus provided which will permit weighing the amount of moisture, which has permeated through the film under the test conditions. Reference ASTM D 1653.

**Specific rate constant** *n.* The constant of proportionality in a rate law.

**Specific refractive increment** *n.* The rate of change of refraction index ($n$) of a solution with concentration ($c$). Precise values of specific refractive increments are obtained using a differential refractometer.

**Specific rotation** *n.* If there are $n$ gram of active substance in $v$ cubic centimeter of solution and the light passes through $l$ decimeters, $r$ being the observed rotation in degrees, the specific rotation (for 1 cm),

$$[\alpha] = \frac{rv}{nl}.$$

**Specific strength** *n.* Tensile strength (if some other is not specified) divided by density. The SI unit is Pa/(kg/m$^3$). For example, the specific strengths of neat acetal resin (homopolymer) and 30–33% glass-reinforced nylon 6/6 are, respectively, 48 and 118 kPa/(kg/m$^3$). Specific strength, like specific modulus is a more useful criterion than strength along for material selection when both strength and minimum weight are important in the design of a structure.

**Specific surface** *n.* Of porous solids, massed fibers, and particulate materials, the total surface area per unit of bulk volume or per unit mass. Specific surface is usually measured by gas adsorption or estimated from mercury-porosimetry measurements.

**Specific viscosity** *n.* Equal to the relative viscosity of the same solution $-1$. It represents the increase in viscosity that may be contributed by the polymeric solute. The specific viscosity, $\eta_{sp}$ is defined by the following equation:

$$\eta_{sp} = \eta_r - 1,$$

where, $\eta_r$ is the relative viscosity.
*See dilute-solution viscosity.*

**Specific volume** *n.* (1) The fractional increase in the viscosity of a solvent resulting from dissolution of a polymer. The specific viscosity, $\eta_{sp}$, is found by subtracting one from the relative viscosity $\eta_r$. (2) Reciprocal of specific gravity.
*Also known as bulking value.*

**Speck** \ˈspek\ [ME *specke*, fr. OE *specca*] (before 12c) *n.* (1) A contaminant in polymer such as gels, metal, or dirt that shows up as a dark spot. (2) A small particle of foreign substance that has not been removed from the stock before spinning.

**Specking** *n.* The removal of burrs, knots, and other objects that impair the finished appearance of woolens and worsteds.

**Speckled finish** *See multicolor finish.*

**Specks** *n.* Small particles of undispersed materials.

**Specky** *n.* A term used to describe dyed woolen fabric with specks of undyed vegetable matter on the face. The specks can be removed by carbonizing or covered by speck dyeing.

**Spectra** \ˈspek-trəm\ [NL, fr. L, appearance] (1671) *n.* Plural of spectrum.

**Spectral** *n.* Adjective referring to spectrum.
*See spectrophotometric.*

**Spectral match** *See color match.*

**Spectral power distribution curve** *n.* Intensity of radiant energy as a function of wavelength, generally given in relative power terms.

**Spectral series** *n.* Spectral lines or groups of lines which occur in an orderly sequence.

**Spectrochemical series** *n.* A listing of ligands in order of their ability to cause *d*-orbital splitting in a complex.

**Spectrogoniophotometer** *n.* Goniophotometer used to measure the geometric distribution of reflected or transmitted flux at individual wavelengths.

**Spectrograph** \spek-ˈtra-ˈgraf\ [ISV] (1884) *n.* A spectroscope equipped with a camera or some other device for recording the spectrum.
*Also see spectroscope.*

**Spectrometer** [ISV] (1874) *n.* An instrument for identifying and comparing materials by the dispersing of light and the study of the spectra formed.

**Spectrophotometer** \fə-ˈtä-mə-tər\ [ISV] (1881) *n.* An instrument for measuring the brightness of various portions of spectra. One useful application of this instrument is the formulation of colorants to match a given sample under all types of illumination. The instrument produces a curve representing the amounts of light energy the specimen to be matched absorbs over a wide range of wavelengths. Matching this curve assures that the developed compound will appear to be the same color as the specimen under any lighting condition. Another important application of the principle in a different instrumental format is the field of quantitative chemical analysis. An example of an ultra-violet and visible spectrophotometer is the Lambda 950 Spectrophotometer (courtesy of Perkin-Elmer Inc., MA, USA).
*See also colorimeter.*

**Spectrophotometer, abridged** *n.* Photometric device for measuring the transmittance, reflectance, or relative emittance at discrete wavelengths. The particular discrete wavelengths may be selected by the choice of a series of narrow bandpass filters (such as interference filters), or masks, etc. No continuous spectral curve can be obtained from such an instrument.

**Spectrophotometer, filter** *See filter spectrophotometer and spectrophotometer, abridged.*

**Spectrophotometric** *n.* Adjective referring to spectrophotometry. The word "spectral" is frequently used in place of the longer "spectrophotometric", but they are not necessarily synonymous. Spectral is the adjective referring to spectrum and is the more general term, hence a spectrophotometric curve is also a spectral curve.

**Spectrophotometric curve** *n.* A curve measured on a spectrophotometer; hence a graph of relative reflectance or transmittance (or absorption) as the ordinate, plotted versus wavelength or frequency as the abscissa. The most common curves in the visible region use wavelength units of nanometers, with the short wavelength units at the left of the scale.

**Spectrophotometric hiding** *See hiding, spectrophotometric, complete, and incomplete.*

**Spectrophotometry** [ISV] (1881) *n.* An analytical instrumental technique for measuring color values by the relative intensity of the component spectrum colors. Broadly, a technique which, by measuring the absorption (or reflection) of electromagnetic radiation from organic and inorganic substances, helps in their identification.

**Spectroscope** \-ˌskōp\ [ISV] (1861) *n.* An instrument for forming a spectrum for visual.

**Spectroscopy** *n.* The study of electromagnetic waves that are absorbed or emitted by substances when excited by the arc, a spark, X-rays, or a magnetic field. Each element emits light of characteristic wavelengths, by which minute quantities can be detected and estimated. An example of a spectrophotometer for the ultraviolet and visible spectrum is the Perkin-Elmer Lambda 25/35/45 UV/VIS (Courtesy of Perkin-Elmer Inc.).
*See also nuclear magnetic resonance.*

**Spectrum** *n.* Spatial arrangement of components of radiant energy in order of their wavelengths, wave number or frequency.

**Spectrum locus** *n.* The curve, connecting points in a chromaticity diagram, that represents various wavelengths of the visible spectrum.

**Specular** Mirror-like.

**Specular gloss** *n.* The luminous fractional reflectance of a specimen in the specular direction. It is sometimes measured at 60°

relative to a perfect mirror. The ASTM method for measuring specular gloss is D 523.

*See eflectance, specular, and gloss.*

**Specular reflectance** *See reflectance, specular.*

**Specular reflectance excluded (SCE)** *n.* Measurement of reflectance made in such a way that the specular reflectance is excluded from the measurement, diffuse reflectance. The exclusion may be accomplished by using 0° (perpendicular) incidence on the samples, thereby reflecting the specular component of the reflectance back into the instrument, by use of black absorbers or light traps at the specular angle when the incident angle is not perpendicular, or in directional measurements by measuring at an angle different from the specular angle.

**Specular reflectance included (SCI)** *n.* Measurement of the total reflectance from a surface, including the diffuse and specular reflectances.

**Specular reflection** *n.* Light striking a surface, and being reflected or turned back at an angle equal to the angle of incidence.

*See gloss.*

**Specular transmittance** (regular transmittance) *n.* Of a transparent plastic, the ratio of the light flux transmitted without diffusion to the flux incident (ASTM D 883).

*See also light transmittance and transmittance, specular.*

**Speed** \ˌspēd\ [ME spede, fr. OE spēd; akin to HGr *spuot* prosperity, speed OE *spōwan* to succeed, L *spes* hope, L *speti* to be in time] (before 12c) *n.* Time rate of motion measured by the distance moved over in unit time. cgs unit –1 cm/s. Dimension $[L\,T^{-1}]$.

**Speed reducer** (gear reducer) *n.* The gearbox between motor and screw coupling of an extruder that reduces the high speed of the motor shaft to the much lower speed, with inversely higher torque, of the extruder screw. The reduction of about 12–1 normally requires two stages. The gears may be spur gears (cheapest an least desirable), helical gears, or double-helical (herringbone) gears. Where the extruder is expected to handle a wide variety of plastics and products using an assortment of screws, a change-gear reducer is recommended. It enables the operator to quickly accomplish large changes in the reduction ratio, while also permitting safe and efficient operation of the variable-speed motor-drive and gears. One may still find a worm-bear reducer in an antique extruder long past its rightful retirement age.

**Spermaceti** \ˌspər-mə-ˈsē-tē\ [ME *sperma cete*, fr. ML *sperma ceti* whale sperm] (15c) *n.* A waxy solid obtained from certain fish oils, e.g., sperm oil.

**Spermaceti wax** \ˌspər-mə-ˈsē-tē\ *n.* Wax obtained from certain fish oils, e.g., sperm oil. It is characterized by a glistening white, crystalline appearance. Mp, 49°C; Sp gr, 0.960; iodine value, 4; saponification value, 126.

**Spew groove** Syn: flash groove.

**Spewing** *n.* (1) Migration of components to the surface of a coating usually because of its compatibility. (2) The formation of a film, or the collection of particles, on a paint surface during the drying process; it results from the migration, to the surface, of the insoluble or incompatible portion(s) of the paint binder.

*Also called greasiness.*

**Spew line** Syn: parting line.

**Sphenoid** \ˈsfē-ˌnóid\ [NL *sphenoides*, fr. Gk *sphēnoeidēs* wedge-shaped, fr. *sphēn* wedge] (1732) *adj.* A crystal form made up of two non-parallel faces not symmetrical about a plane of symmetry.

**Spherical aberration** (1868) *n.* Occurs when light rays of one wavelength that travel near the center of the lens (or mirror) focus at a different point than light rays of the same wavelength near the periphery. The phenomenon is known as spherical aberration. For axial pencils the error is known as axial spherical aberration; for oblique pencils, coma.

**Spherical angle** (1678) *n.* The angle between two intersecting arcs of great circles of a sphere measured by the plane angle formed by the tangents to the arcs at the point of intersection.

**Spherical mirrors** *n.* If $R$ is the radius of curvature, $F$ principal focus, and $f_1$ and $f_2$ any two conjugate focal distances

$$\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{F}=\frac{2}{R}.$$

If the linear dimensions of the object and image be $O$ and $I$, respectively, and a $u$ and $v$ their distances from the mirror

$$\frac{O}{I}=\frac{u}{v}.$$

**Spherulite** \ˈsfir-yə-ˌlīt\ (1823) *n.* A rounded aggregate of radiating crystals with a fibrous appearance under the microscope. Spherulites have been observed in most crystalline plastics. They originate from a nucleus such as a particle of contaminant, residual catalyst particle, or change fluctuation in density. They may grow through stages: first needles, then bundles and sheaf-like aggregates, and finally the spherulites. Spherulites may range in diameter from a few tenths of a micrometer to several millimeters. They are birefringent, displaying a characteristic maltese-cross insignia when viewed through crossed polarizers.

**SPI** *n.* Abbreviation for (the) Society of the Plastics Industry.

**Spider** *n.* (1) In a molding press, that part of an ejector mechanism that operates the ejector pins. (2) Within an end-fed extrusion die making a tubular section, the three or four legs extending from die to mandrel and supporting the mandrel at the center of the die. The spider legs may themselves be cored to pass a temperature-control fluid through the mandrel and into an extended calibrating mandrel attached to the die mandrel. Also called *spider fins.* (2) In rotational casting, the grid-work of metallic members supporting cavities in a multicavity mold.

**Spider legs** *n.* Film defect where the coating material on an upright surface separates or breaks and the liquid runs down in long, crooked channels.

**Spider lines** *n.* In blow molding or pipe extrusion, visible marks parallel to the parison or pipe axis and corresponding to the positions of the spider legs. They are due to incomplete welding of the divided stream downstream of those legs. These lines are the exterior traces of weld surfaces that go through the annular wall, surfaces that are sometimes weaker than the material between them.

**Spider runners** (spider gating) *n.* A design for melt distribution to multiple cavities in an injection mold in, which the cavities are arranged in a circle and fed by runners radiating from a central sprue.

**Spin** (1831) *n.* In nuclear physics, used to describe the angular momentum of elementary particles or of nuclei.

**Spindle** \ˈspin-dᵊl\ [ME *spindel*, fr. OE *spinel*; akin to OE *spinnan* to spin] (12c) *n.* A slender, upright, rotating rod on a spinning frame, roving frame, twister, winder, or similar machine. A bobbin is placed on the spindle to receive the yarn as the spindle is rotated at high speed.

**Spin drawing** *n.* (1) The reduction of roving during spinning by a roller drafting mechanism similar to that used on the roving frame. (2) Combined spinning and drawing in one operation in melt-spun fibers.

**Spin dyeing** (mass dyeing, dope dyeing) *n.* The process of coloring fibers or yarns by incorporating pigments or dyes in the material prior to spinning, either during or after polymerization of the material.

**Spin finish** *See lubricant.*

**Spin multiplier** *See twist multiplier.*

**Spinneret** \ˌspi-nə-ˈret\ (1826) *n.* (1) An extrusion die consisting of a plate with many tiny holes, through which a plastic melt or solution is forced, to make fine fibers and filaments. Early spinneret holes were round and thus produced fibers of circular cross-section. Today, spinneret holes have many different shapes, even annular ones, to produce fibers of corresponding cross-sections. One purpose is to decrease the fiber-bundle density, giving added warmth, moisture permeability, and enhanced dye receptivity to the textile fabric. An important application of hollow fibers is in artificial kidneys for dialysis. Filaments emerging from the spinneret may be hardened by cooling in air or water, or by chemical action of solutions. (2) A spinneret hole.

**Spinning** *n.* (1) The process of forming staple fibers by extruding polymers. There are three main variations of the process: *melt spinning, dry spinning*, and *wet spinning*. All employ extrusion dies with from one to thousands of tiny orifices, called *jets* or *spinnerets*. In melt spinning, the molten polymer is pumped first through sand-bed filters, then through the die orifices by small gear pumps operating at extremely high pressures. In both wet and dry spinning the polymer is dissolved in a solvent prior to extrusion. In dry spinning, the extrudate is subjected to a hot atmosphere that removes the solvent by evaporation. In wet spinning, the spinneret is immersed in a liquid that either diffuses the solvent or reacts with the fiber composition, precipitating it from solution. However produced, the fibers are then oriented to realize their optimal strength and modulus, four times or more that of the unoriented fibers. With larger fibers (*see monofilament*) this is done by reheating the fiber in a carefully controlled oven, and while it is warm, stretching it with Godet stands operating at a large speed differential. Much staple fiber is also oriented in this way. With melt-spun staple, the trend is toward accomplishing most, if not all of the orientation by high-speed windup and drawing as the extruded filaments are leaving the spinnerets. (2) Method of application which distributes the paint over a flat surface by centrifugal action. Different types of processes and types of spinning are listed below.

1. **Yarn from staple fiber:** the formation of a yarn by a combination of drawing or drafting and twisting prepared strands of fibers, such as rovings.
2. **Filament yarn:** in the spinning of manufactured filaments, fiber-forming substances in the plastic or molten state, or in solution, are forced through the fine orifices in a metallic plate called a spinneret, or jet, at a controlled rate. The solidified filaments are drawn-off by rotating rolls, or godets, and wound onto bobbins or pirns. There are several methods of spinning manufactured filaments:

2a **Dry spinning** *n.* The process in which a solution of the fiber-forming substance is extruded in a continuous stream into a heated chamber to remove the solvent, leaving the solid filament, as in the manufacture of acetate.

2b **Gel spinning** *n.* A spinning process in which the primary mechanism of solidification is the gelling of the polymer solution by cooling to form a gel filament consisting of precipitated polymer and solvent. Solvent removal is accomplished following solidification by washing in a liquid bath. The resultant fibers can be drawn to give a product with high tensile strength and modulus.

2c **Melt spinning** *n.* The process in which the fiber-forming substance is melted and extruded into air or other gas, or into a suitable liquid, where it is cooled and solidified, as in the manufacture of polyester or nylon.

2d **Phase-separation spinning** *n.* Extrusion of polymer and solvent at high temperature into a cooling zone. During the cooling process, a phase separation occurs, usually accompanied by crystallization of the solvent. Solvent can be removed before or after drawing.

2e **Reaction spinning** *n.* Process in which an initial pre-polymer is formed and then extruded into a reagent bath where polymerization and filament formation occur simultaneously. Spandex fibers can be made by this process.

2f **Wet spinning** *n.* The process in which a solution of the fiber-forming substance is extruded into a liquid coagulating medium where the polymer is regenerated, as in the manufacture of viscose or Cuprammonium rayon.

3. **Yarn from leaf and bast fiber** *n.* In the manufacture of leaf and bast fiber yarns, the terms “wet spinning” and “dry spinning” refer to the spinning of fibers in the wet state and in the air-dry state, respectively.
4. **Yarn from filament tow** *n.* The formation of a yarn from filament tow by a combination of cutting or breaking, drafting, and twisting in a single series of operations.
   *Also known as converting.*
5. **Non-woven fabric** *n.* Fabrics can be produced directly from molten or dissolved fiber-forming substances by several continuous processes: flash extrusion The process in which a fiber-forming substance in a volatile solvent is extruded from a high-temperature, high-pressure environment into lower temperature and pressure conditions, causing the solvent to rapidly evaporate, leaving a lacy, net-like fabric.

**Spinning frame** *n.* A machine used for spinning staple yarn. It drafts the roving to the desired size, inserts twist, and winds the yarn onto a bobbin. The term is generally used to indicate a ring spinning frame, although it does cover flyer spinning and cap spinning on the worsted system.

**Spinning solution** *n.* A solution of a fiber-forming polymer (e.g., cellulose acetate) in a suitable condition to be extruded by either dry spinning or wet spinning.

**Spinning twist** *n.* The twist added to yarn during spinning to give it strength and other desired characteristics.

**Spin quantum number, $m_8$** A quantum number which specifies the spin of an electron.

**Spin welding** (friction welding) *n.* A process for joining thermoplastic articles at circular mating surfaces by rotating one part in contact with the other until sufficient heat is generated by friction to produce a thin interfacial layer of melt. Rotation is stopped and pressure is maintained while the melt solidifies, completing the weld. The process can be performed manually in a drill press, or can be fully automated with devices for feeding, timing, controlling stroke and pressure of the press, and ejection. In a version of the process that is applicable to some non-circular joints, rotation is oscillatory through small, reversing arcs.

**Spiral-flow test** *n.* A method of evaluating the molding flow of a resin to injection or transfer molding in which the melt is injected into a spiral runner of constant trapezoidal cross-section with numbered and subdivided centimeter (or inches) marked along the runner. The mold is filled from a sprue at the center of the spiral and pressure is maintained until flow stops, the number just aft of the molded-spiral tip giving the flow distance. The spiral-flow test has been widely used since it was introduced in the early 1950s but has been standardized in USA only for thermosetting resins, in ASTM D 3123.

**Spiral grain** *n.* A form of cross grain in which the fibers extend spirally about instead of vertically along the bole of a tree or axis of a timber.

**Spiral-mandrel die** *n.* The most popular die design for extrusion of blown film, in which the melt, fed into a manifold at the bottom of the die, flows up to the die lip via multiple spiral grooves. The design is capable of handling a range of resins, provides even distribution to the lip, thus helping to minimize circumferential variations in film thickness, and has relatively low pressure drop.

**Spiral mold cooling** *n.* A method of cooling injection molds (or heating transfer molds) wherein the heat-transfer medium flows through a spiral passage in the body of the mold. In injection molds, the cooling medium is introduced at the center of the spiral, near the sprue section, because more heat is concentrated in this area.

**Spiral yarns** *n.* Specialty yarn made by winding heavier, slackly twisted yarn around a finer yarn with a hard twist to give a slubby appearance.

**Spirit** \ˈspir-ət\ [ME, fr. OF or L; OF, fr. L *spiritus*, lit., breath, fr *spirare* to blow, breathe] (13c) *n.* (1) In the paint industry, this term is used somewhat loosely but generally refers to commercial ethyl alcohol normally sold as industrial methylated spirit. (2) The term “mineral spirits” (in UK as “white spirit”, mainly defines a mixture of aliphatic hydrocarbons with a proportion of aromatic hydrocarbons.

**Spiriting off** *n.* Final operation in a French polishing process by which the last traces of oil are removed by drawing a rag, dampened with methylated spirit, rapidly and repeatedly over the surface.

**Spirit of wine** (1753) *n. See ethyl alcohol.*

**Spirits of rosin** *See rosin spirit.*

**Spirits of turpentine** *See turpentine, spirits of.*

**Spirit-soluble dye** *n.* Dye soluble in alcohol and insoluble in water; usually azo colors lacking the group $SO_2OH$.

**Spirit-soluble resin** *n.* A resin soluble in alcohol and insoluble in water.

**Spirit stains** Solution s of suitable dyes in solvent, which may also contain a proportion of resin as binder.

*See stain.*

**Spirit varnish** (1850) *n.* (1) Lacquer based on a solution of resin or resins in industrial methylated spirit. The more correct term would be "spirit lacquer". (2) A varnish which is converted to a solid film by solvent evaporation.

*See lacquer, See shellac.*

**Spitting** *See flying; misting.*

**Splash** *See splay.*

**Splay** \ˈsplā\ (splay marks, silver streaking) *n.* Scars or surface defects on injection molding arising from two main mechanisms. One is the injection of a high-velocity stream of molten material into the mold ahead of the general flow front. The prematurely injected melt, especially in the case of crystalline polymers with a sharp freezing point, cools and solidifies before the mold cavity is completely filled. These defects occur most frequently in the gate area, but may be washed into other areas of the cavity. Remedies are: increasing the mold temperature, local heating of the gate area, reduction of injection rate, and increasing the gate cross-section. The second mechanism is release of moisture or residual monomer or solvent in the melt in the form of fine bubbles at the part surface. The remedy for this type of splay is pre-drying to remove volatiles from the feedstock before it enters the molder and/or careful handling of regrind to prevent moisture pickup during recycling. These pre-cautions are especially important with hygroscopic resins sun as nylon 6/6.

**Splicing** *n.* (1) The joining of two ends of yarn or cordage. There are several methods used, e.g., by interweaving the strands, by the use of knots, by tapering, lapping, and cementing the ends, etc. (2) A method of reinforcing knits, e.g., the heels and toes of hosiery, by introducing an additional yarn for strength.

**Splinter** *n.* Two or more staple fibers adhering together, causing a stiff cluster that resists pulling apart in normal processing, and reacting in the yarn spinning process similarly to higher than nominal denier fiber.

**Splinter count** *n.* A measure of the number of coalesced fibers, mealy particles, or other such matter in staple fiber.

**Split** *See reed.*

**Split-disk method** (NOL ring test) *n.* A method of testing the tensile strength of tubular plastics and reinforced plastics embodied in ASTM D 2290.

**Split end** *n.* (1) A defect in fabric caused by breakage of some of the singles yarns in a plied warp yarn. (2) A defect in manufactured filament yarn caused by breakage of some of the filaments.

**Split-film fiber** *n.* A type of polypropylene fiber made by extruding a thin film, applying a high lengthwise draw to strongly orient it, at the same time weakening it in the transverse direction, pounding it to cause lateral fibrillation into narrow ribbons about 1 mm wide, and further orienting the ribbon fibers. These may be woven into a variety of products such as sacking, artificial turf, and indoor-outdoor carpet.

**Split-flow métier** *See split-draft metier.*

**Split spray** *n.* Unsymmetrical spray pattern resulting in the application of bands of paint of uneven thickness, caused either by a defective spray or nozzle or by partial blockage of the nozzle or air passages of a spray gun.

**Splitting** *n.* (1) A defect in a painted surface; results from the penetration of solvents, contained in a fresh coat of paint, into an older layer of paint over which it has been applied; likely to occur when the old layer has been sanded too much. (2) In the processing of tow, a defect in which the integrity of opened tow is disturbed by separation or division into two or more segments longitudinally. Splitting can be continuous or intermittent, long or short term. (3) In slashing, the separation of sized yarn ends before take-up on the slasher beam. Hess M, Morgans WM (1979) Paint film defects. John Wiley and Sons Inc., New York.

**Spontaneous change** \spän-ˈtā-nē-əs-\ *n.* A change which is thermodynamically probable; a possible change.

**Spontaneous combustion** (1795) *n.* Self-ignition of combustible material through chemical action (as oxidation) of its constituents).

*Known also as spontaneous ignition.*

**Spool** \ˈspül\ [ME *spole*, fr. MF or MD; MF *espole*, fr. MD *spoele*; akin to OHGr *spuola* spool] (14c) *n.* A flanged wooden or metal cylinder upon which yarn, thread, or wire is wound. The spool has an axial hole for a pin or spindle used in winding.

*Also see beam.*

**Spore** \ˈspōr\ [NL *spora* seed, spore, fr. Gk, act of sowing, seed, fr. *speirein* to sow] (1836) *n.* A simple reproductive body of lower plants. A spore is analogous to the seed of higher plants but lacks an embryo. It usually consists of one cell, but sometimes several spores are enclosed by a protective covering.

**Spot bonding** *See bonding* (2), *point bonding.*

**Spot finishing** *See spotting in.*

**Spotting** *n.* Development of small areas on a painted surface which differ in color or gloss from the major portion of the work.

**Spotting in** *n.* Rubbing down and refinishing small defective patches in coating. Syn: retouching, spot finishing.

**Spray-and-wipe painting** (fill-in marking) *n.* A decorating process for articles with depressed letters, figures, or designs. A lacquer or enamel is applied by spraying either the article's entire surface or a restricted area including the depression, then removing the excess wet paint by buffing or wiping the raised areas.

**Spray bonding** *See bonding* (2).

**Spray booth** *n.* An enclosed or semi-enclosed area used for the spray painting of fabricated items; may be equipped with a source of filtered air to keep the atmosphere dust-free, a waterfall backdrop to trap overspray, and an exhaust system to vent the fumes of the evaporating solvents.

**Spray coating** *n.* The application of a polymeric coating to a substrate by means of a spray gun. The process is used for coating any material with a plastic, and for coating plastics for decorative purposes. In the latter application, masks are usually employed to apply the coating only to selected areas. Wicks WZ Jr, Jones FN, Pappas SP (1999) Organic coatings. Wiley-Interscience, New York.

*See also coating spray, airless spray, electrostatic spray coating, flame spray coating, and plasma-spray coating.*

**Spray drier** *n.* A cylindrical or conical-bottomed chamber through which hot air rises and into which a resin emulsion is sprayed in small droplets. The solvent evaporates from the droplets as they fall and the dried-resin powder is removed from the chamber bottom by scraping or air blasting. Spray drying has been employed for emulsion-polymerized vinyl resin, and for amino and phenolic resins.

**Sprayed-metal mold** *n.* A mold made by spraying molten metal onto a master form to obtain at shell of desired thickness, which may subsequently be backed with plaster, cement, casting resin, etc. Such molds are used most commonly in sheet-forming processes.

**Spray gun** (1920) *n.* A tool, operated with compressed air or fluid pressure, which expels paint, mortar, etc., through a small orifice, onto the surface being coated. Syn: air brush, spraying pistol.

*See concrete gun.*

**Spraying** *n.* (1) Method of application in which the coating material is broken up into a fine mist, which is directed onto the surface to be coated. This atomization process is usually, but not necessarily, effected by a compressed air jet. (2) *See flying.*

*See airless spraying and hot spraying.*

**Spraying pistol** *See spray gun.*

**Spray molding** *See spray-up.*

**Spray mottle** *n.* Irregular surface of a sprayed film resembling the skin of an orange. The defect is due to the failure of the film to flow out to a level surface.

*See orange peel.*

**Spray pattern** *n.* Configuration of spray with gun held in a steady manner.

**Spray spinning** *See spun-bonded products.*

**Spray-up** *n.* A term coined in February, 1958, by the Engineering Editor of *Modern Plastics* to identify a new technique of reinforced-plastics molding that employed a gun that chops roving and impels the chopped strands through the focus of two resin sprays and onto the mold or mandrel. One resin stream contains catalyst, the other promoter, formulated to set quickly at room temperature. An advantage of the process is the ease with which section thickness may be varied in the molding to meet local strength and stiffness needs. The term spray-up was later extended to the foamed-plastics field, denoting the spraying of fast-reacting polyurethane or epoxy-resin systems onto surfaces where they react to foam and cure. In both areas the external mixing of streams by impingement avoids pot-life problems in spray equipment and tanks.

**Spread** *n.* The quantity of adhesive per unit joint area applied to an adherent, usually expressed in points of adhesive/1000 $ft^2$ of joint area. (1) Single spread refers to application of adhesive to only one adherent of a joint, (2) Double spread refers to application of an adhesive to both adherents of a joint.

**Spreadable life** *See pot life.*

**Spread coating** *n.* A process for coating fabrics, sheet metals, etc., with fluid dispersions such as vinyl plastisols. The substrate is supported on a carrier, and the fluid material is applied to it just ahead of a blade or "doctor knife" that regulates the thickness of the coating. The deposit is then heated to fuse the coating to the substrate, often followed by embossing to impart texture.

**Spreader** *n.* (1) *See torpedo.* (2) Any device, such as a knife or roller, a part of spread-coating equipment that helps to produce an evenly thick coating.

**Spreading** *n.* A thickening or enlarging of printed areas caused by bleeding or lateral penetration of ink.

**Spreading capacity** *n.* Average spreading rate to be expected from a paint when applied over a normal surface in a manner appropriate for that particular paint. Spreading rate will vary with the operator, the method of application, and the nature of the surface to be painted.

*See spreading rate.*

**Spreading rate** *n.* The area of surface over which a unit volume of paint will spread, usually expressed in $ft^2$/gal or $m^2$/l.

*See spreading capacity.*

**Spread stitch** *See pinhole.*

**Spring box mold** *n.* A type of compression mold equipped with a spacing fork that prevents the shifting of bottom-loaded inserts or loss of fine details, and which is removed after partial compression.

**Spring needle** *n.* A knitting machine needle with a long, flexible hook, or beard, that allows the hook to be closed by an action known as pressing so that the loops can be cast off. The hook springs back to its original position when the presser bar is removed.

*Also see latch needle.*

**Springwood** *n.* The portion of the annual growth ring that is formed during the early part of the season's growth. It is less dense and weaker mechanically than summerwood.

**Sprue** \ˈsprü\ [origin unknown] (1880) *n.* (1) In injection and transfer molding, the main feed channel connecting the machine nozzle with the runners leading to the various cavities. The sprue is usually conical, widening slightly toward the mold, so that, as the mold opens, the plastic within the sprue remains attached to the runners and the sprue is cleared for the next shot. (2) The conical plastic stub that is formed within the sprue with ach shot and is removed with the runners.

**Sprue bushing** (British: sprue bush) *n.* A hardened steel insert in an injection mold that contains the tapered sprue passage and has a suitable seat, usually hemispherical, making a seal with the nozzle of the injection cylinder.

**Sprue-ejector pin** Syn: sprue puller.

**Sprue gating** (direct gating) *n.* In injection molding with single-cavity molds, particularly those with circular symmetry, filling from the center with the sprue connected directly to the gate and mold cavity.

**Sprue lock** *n.* In injection molding, a portion of the plastic composition that is held in the cold-slug well by an undercut, used to pull the sprue out of the sprue passage as the mold is opened. The sprue lock itself is pushed out of the mold by an ejector pin. When the undercut occurs on the cavity-block retainer plate, this pin is called the *sprue-ejector pin.*

**Sprue puller** *n.* A pin having a Z-shaped slot undercut in its end, by means of which it pulls the molded sprue out of the sprue passage.

**Spun-bonded products** *n.* Non-woven fabrics formed by filaments that have been extruded, drawn, then laid on a continuous belt. Bonding is accomplished by several methods such as by hot roll calendering or by passing the web through a saturated-steam chamber at an elevated pressure.

**Spun-bonded sheet** *n.* A sheet structure resembling paper or felted fabric, made by heat sealing webs of randomly arranged, continuous thermoplastic fibers. Three such materials, of polyolefin and polyester fibers, were introduced by DuPont in 1968. Good qualities are all-directional tensile strength, high tear resistance, good flex life, and puncture resistance. Applications include wall coverings, book covers, tags, labels, mailing envelopes, industrial clothing, and filter media.

**Spun-dyed** *See dyeing, mass-colored.*

**Spun fabric** *n.* A fabric made from staple fibers that may contain one or a blend of two or more fiber types.

**Spunlaced fabric** *n.* A non-woven fabric produced by entangling fibers in a repeating pattern to form a strong fabric free of binders.

**Spunlike filament yarns** *See simulated spun yarns.*

**Spun roving** *n.* A glass–fiber strand, repeatedly doubled back on itself to form a roving, sometimes reinforced by one or more straight strands.

**Spun silk** *See schappe.*

**Spun yarn** (14c) *n.* (1) A yarn consisting of staple fibers usually bound together by twist. (2) A meltspun fiber before it is drawn.

**Spur** A term sometimes used to mean sprue.

**Sputtering** *See vacuum metallizing.*

**SQC** *n.* Abbreviation for (*statistical*) quality control.

**Square construction** *See balanced cloth.*

**Squeegee** A soft, flexible blade or roller used in wiping operations, particularly in screen printing and lay-up molding.

**Squeegee coat** *n.* Shellac, lacquer or similar materials applied in a heavy consistency or body by means of a rubber gasket or squeegee. Broom handles and lead pencils are coated in this manner.

**Squeeze molding** *n.* A process for making prototypes from sheet molding compounds (SMC) with inexpensive tooling and very low molding pressure, to develop designs for parts that will be produced by injection molding or from metal by die casting. An epoxy two-piece mold is prepared, details such as ribs, gussets, and bosses are positioned, then the mold is filled with reinforced SMC and pressed at 140–210 kPa until cured.

**Squeeze out** *adj.* Adhesive pressed out at the bond line due to pressure applied on the adherents.

**Squeeze rolls** *n.* Rolls used to apply pressure for removal of water or chemicals from fabric.

**SRIM** *n.* Abbreviation for structural reaction injection molding.

*See reaction injection molding.*

**SRP** Abbreviation for rubber-reinforced polystyrene.

*See rubber toughening.*

**SS** *n.* (1) Abbreviation for single-stage (resin). (2) Abbreviation for stainless steel.

*See resol.*

**SSF** Abbreviation for second, Saybolt, Furol.

**SSPC** *n.* Abbreviation for Steel Structures Painting Council.

**SSU** *n.* Abbreviations for second, Saybolt, universal.

**Stability** \stə-ˈbi-lə-tē\ {*plural* –ties} (14c) *n.* A term used to describe the tendency of a fiber or fabric to return to its original shape after being subjected to external influence, such as tension, heat, or chemicals.

**Stabilized fiber** *n.* Fiber that is heat or chemically treated to set the fiber properties and prevent deterioration, shrinkage, etc.

*Also see heat stabilized, heat setting and UV absorber.*

**Stabilizer** *n.* A chemical added to some plastics to assist in maintaining the physical and chemical properties of the compound at suitable values throughout the processing and service life of the material and articles made therefrom. An *emulsion stabilizer* serves to keep emulsions and suspensions from separating. A *viscosity stabilizer* is used in vinyl dispersions to retard viscosity increase on aging. An agent used primarily to protect plastics and rubbers from deterioration by oxidation is called an antioxidant. The remaining, and most important, types of stabilizers are those that protect plastics from the effects of heat and light. Such effects are evidenced by a change of color, ranging from slight yellowing to blackening; a progressive decrease in mechanical properties; a decrease in electrical properties; or undesirable surface conditions such as blisters, spew, or exudation of ingredients rendered incompatible by heat or light. Many resins are vulnerable to ultraviolet light because they are good absorbers of UV and because its photonic energy is high. Stabilizers that function primarily by absorbing UV are described under ultraviolet stabilizer.

Thousands of compounds have been proposed as heat stabilizers and as combination heat and light stabilizes for various plastics. The principal classes of such compounds are: (1) *Group II* metal salts of organic acids (primarily the barium, cadmium, and zinc salts of fatty acids, and phenols, the most important group). (2) *Organotin stabilizers.* (3) *Epoxy stabilizers.* (4) *Salts of mineral acids*, e.g., carbonates, sulfates, silicates, phosphates, and phosphates. (5) other organic compounds of metals and metalloids, e.g., alcoholates and mercaptides. Heat stabilizers are used nearly exclusively with vinyl resins.

*See also zinc stabilizer.*

**Stabilizers** *n.* Materials added to a plastic to impede or retard degradation that is usually caused by heat or ultraviolet radiation.

**Staging life** *See shelf life.*

**Stain** \ˈstān\ [ME *steynen*, partly fr. MF *desteindre* to discolor & partly Scand origin; akin to ON *steina* to paint] (1583) *n.* (1) A transparent or semitransparent solution or suspension of coloring matter (dyes or pigments or both) in a vehicle, designed to color a surface by penetration without hiding it, or to color a material into which it is incorporated. True stains are classified as water stains, oil stains, and spirit stains, according to the nature of the vehicle. The so-called "varnish stains" are varnishes colored with a transparent material. These do not have the same power of penetration as the true stains and leave a colored coating on the surface. (2) An undesirable change of color resulting from foreign matter. (3) To change the color by use of a staining agent.

**Stainer** *See tinter and colorist.*

**Staining** *n.* (1) The application of a liquid dye solution to a porous surface to impart color. (2) Discoloration produced by a rubber stock on organic finishes, lacquers, and fabrics, owing to the presence of discoloring type anti-oxidants in the compound. The condition is aggravated by exposure to heat, pressure, or sunlight. Also, discoloration of a surface due to migration of an ingredient from one rubber compound to an adjacent compound even through they may not be in actual contact with each other. (3) The undesired pickup of color by a fabric: (a) When immersed in water, dry cleaning solvent, or similar liquid medium that contains dyestuffs or coloring material not intended for coloring the fabric. (b) By direct contact with other dyed material from which color is transferred by bleeding or sublimation.

**Staining power** *n.* Degree to which a colored pigment imparts color to a white pigment under defined conditions of test. The details of procedure for determining staining power, normally laid down in specifications for pigments, need to be carefully adhered to if consistent results are to be obtained. The corresponding property of a white pigment is "reducing power".

*Also known as tinting strength.*

**Stainless steel** (1920) *n.* A generic term embracing over 70 standard ferrous alloys produced in either wrought or cast forms, containing from 12 to 30% chromium and from 0 to 22% nickel (18Cr, 8Ni is typical). Also present may be small percentages of other elements such as carbon, columbium, copper, molybdenum, tantalum, and titanium. Stainless and semi-stainless steels have been used in plastics processing equipment where corrosion is a problem. A stainless steel has sometimes been chosen instead of chrome plating in environments where the plating has to be frequently repeated. Stainless type 17-4 pH, containing 17% Cr, 4% Cu, and 0.35% Co, which is hardenable, has served well in extrusion dies for PVC.

**Stainless steel fiber** *n.* Textile fibers made of stainless steel. Steel fibers are used for antistatic purposes in carpets, for tire belt construction, and for high-temperature or heat-resistant end uses.

**Stain resistance** *n.* The ability of a plastic material to resist staining caused by traffic, coffee, tea, blood, waxing compounds, grease deposits, and other staining agents, In the case of plasticized PVC, the most severe staining is caused by shoe polish, tobacco smoke, lipstick, nail polish, ketchup, and mustard. The degree of staining can be reduced to some extent by use of certain plasticizers, e.g., butyl benzyl phthalate, diethylene glycol dibenzoate, dipropylene glycol dibenzoate, and 2,3,4-trimethyl-1,3-pentanediol monoisobutyrate benzoate.

**Staircase method** *See up-and-down method.*

**Staking** *n.* A term sometimes used for the process of forming a head on a protruding portion of a plastic article for the purpose of holding a surrounding part in place. Ultrasonic heating of the protrusion facilitates the staking operation.

**Stalk** *n.* A European term for spruce.

**Stamping** *See die cutting.*

**Stamp molding** *n.* A compression-molding variation in which the mold is closed so suddenly that the plastic is impacted rather than pressed, as in forging.

**Standard** \ˈstan-dərd\ [ME, fr. OF *estandard* rallying point, standard, of Gme origin; akin to OE *standan* to stand and to OE *ord* point] (12c) *n.* A reference point or a practice established by general agreement.

**Standard atmosphere** *n.* Air maintained at 70°F (21°C) and 65% relative humidity. When international testing is involved, a standard temperature of 20°C or, by agreement, 27°C may be used. Special humidity and temperature conditions are sometimes prescribed for the testing of certain textiles for specific service predictions, resistance to water or biological action, etc.

**Standard condition** *n.* Standard condition is that reached by a specimen when it is in moisture equilibrium with a standard atmosphere. Standard condition is seldom realized in practice since laboratory atmospheres are continually fluctuating between narrow limits, and it is not practical to wait for the attainment of moisture equilibrium, which would require several days or more for tightly wound samples of high regain material. Practically, specimens are brought to moisture equilibrium in the standard atmosphere for testing as defined in these definitions. The term "standard condition" should not be used as a Syn: the concept of "standard atmosphere".

**Standard conditions for gases** *n.* Measured volumes of gases are quite generally recalculated to 0°C temperature and 760 mm pressure, which have been arbitrarily chosen as standard conditions.

**Standard conditions for testing** *n.* Temperature: 23 ± 1.1°C (73.5 ± 2°F); relative humidity: 50 ± 4%. These conditions have been established for the use of all departments and establishments of the Federal Government, except where otherwise specified by an applicable specification (Fed. Stnd. No. 1). *Note* — In ISO, standard conditions are 23 ± 2°C and 50 ± 5% relative humidity.

**Standard hydrogen electrode (s.h.e.)** *n.* Electrodes consisting of a piece of platinum (coated with platinum black) in contact with hydrogen gas at 1 atm and with a solution in which the concentration of hydrogen ions is 1 M (actually, the hydrogen gas and hydrogen ions are at unit activity). The voltage of the s.h.e. is defined as zero.

**Standard light source** *n.* A reference light source whose spectral power distribution is known.
*See light source and illuminant.*

**Standard moisture regain** *n.* Accepted moisture allowance for textile materials expressed in percentages of their dry weight.

**Standard normal deviate** ($z$) *n.* The difference between any member of a normal distribution of measurements and the distribution (true) mean, divided by the standard deviation, i.e., $(x_i - \mu)/\sigma$. Compare this with the identically structured standardize measurement for a sample.

**Standard observer, 10° (1964)** *See observer, standard.*

**Standard observer, 2° (1931)** *See observer, standard.*

**Standard of performance** *n.* The measure of pollution control required by law, in the Clean Air Act of 1970.

**Standard perfect white diffuser** *See perfect diffuser.*

**Standard sand** *n.* Natural silica sand from Ottawa, IL, graded to pass a No. 20 (850 µm) sieve and be retained on a No. 30 (600 µm) sieve. This sand shall be considered standard when not more than 15 g are retained on the No. 20 sieve and not more than 5 g pass the No. 30 sieve after 5 min of continuous sieving of a 100 g sample. Used in sand grinding and the falling sand abrasion test, ASTM D 968.

**Standard, secondary standard** *n.* (1) An amount of a substance whose content of specified elements or compounds is known within error limits that are narrower than those of the analytical method or instrument to be calibrated with the standard. (2) An object having one or more measurable properties whose values have been certified by an appropriate standards-issuing authority to be within error limits that are usually narrower than those of the measuring method or instrument that the object will be used to calibrate. Examples are gauge blocks (“Jo blocks”) for micrometers, standard resistors and capacitors, standard cells (DC emf sources) for potentiometers, NIST-calibrated thermocouples and thermistors, balance weights, wavelength (or frequency) standards, tensile- and compressive-force standards, and time standards. Secondary standards that are traceable to government-maintained primary standards are the ultimate basis of all quantitative scientific and engineering work, of manufacturing-quality control, and of commerce. Standards and calibrations services are available from the National Institute of Standards and Technology, and from many private companies. *See also calibration.*

**Standard state** *n.* A reference state for specifying thermodynamic quantities, usually defined as the most stable form of the substance at 1 atm pressure. For a solute the standard state is the ideal, 1 M solution.

**Standard, white reflectance** *n.* In general usage, may refer to a physical white standard which is nearly a perfect white diffuser, such as pressed barium sulfate of high purity, pressed magnesium oxide or freshly smoked magnesium oxide. Other less perfectly diffusing or reflective materials, such as white ceramics, may be calibrated in reference to the perfect diffuser or to one of the near-perfect materials, and used in place of the material relative to which it is calibrated. Such a white reference standard should properly be called a secondary reference standard.

**Standing wire** *n.* A broad term describing fixed rods or strips extending through the loom reed, that control the height of the pile in a woven pile fabric.

**Stand oil** *n.* A drying oil which has been partially refined by allowing certain impurities to settle out after heat treatment. Generally used in UK to describe linseed oil. So-called because it was originally made by letting linseed oil stand in the sun for a time, often as much as seven to ten years, during which time a natural polymerization took place. The Dutch "Standolie" and German "Standöl" are counterparts of the English term which have been in use for hundreds of years, antidating the introduction and use of wood oil.

*See oil, heat-bodied.*

**Stannous 2-ethylhexanoate** \ˈsta-nəs ˈe-thəl-ˌhek-sə-ˈnō-āt\ (stannous octanoate) *n.* A polymerization catalyst for urethane foam.

**Staple** \ˈstā-pəl\ [ME, fr. MF *estaple*, fr. MD *stapel* emporium] (14c) *n.* Natural fibers or cut lengths from filaments. The staple length of natural fibers varies from less than 1 in. as with some cotton fibers to several feet for some hard fibers. Manufactured staple fibers are cut to a definite length, from 8 in. down to about 1–0.5 in. (occasionally down to 1 in.), so that they can be processed on cotton, woolen, or worsted yarn spinning systems. The term staple (fiber) is used in the textile industry to distinguish natural or cut length manufactured fibers from filament.

**Staple fabric** *See spun fabric.*

**Staple fiber** *n.* Short, spinnable fibers between 1 and 13 cm in length.

*See staple.*

**Staple processing** *n.* The conversion of staple into spun yarns suitable in evenness, size, twist, and strength for use in the weaving or knitting of fabrics.

*Also see textile processing.*

**Staple yarn** *See spun yarn.*

**Starch coating** *n.* Surface coating for flat paints and/or wallpaper. Made with colors that do not smear.

**Starch lump** *See hard size.*

**Starch, permanent** *n.* An aqueous emulsion of a synthetic resin for application to fabrics which when ironed become stiff as if starched.

**Stardust** Imperfections in high gloss finishes caused by minute blemishes, which give sparkling appearance.

**Stark effect** *n.* The splitting of a single spectrum line into multiple lines which occurs when the emitting material is placed in a strong electric field. The observed effect depends on the angle between the direction of the field and the direction of observation. The effect is due to the shifting of the energy states of certain orbits which all have the same energy in zero field.

**Starter strip** *n.* In the coil coating industry, a length of metal threaded through a line after shutdown. This is used repeatedly to attach new strip to be coated.

**Start up mark** *See set mark.*

**Starved area** *See resin-starved area.*

**Starve feeding** (starved feeding) *n.* In extrusion, regulating, with an auxiliary feeding device such as a weigh feeder or screw conveyor, the rate at which feedstock enters the feed port of the extruder so that the screw flights are less than full.

**Starved joint** *n.* A poorly bonded glue joint resulting from an insufficient quantity of glue in the joint.

*See joint, starved.*

**Starved surface** *See hungry surface.*

**Starving out** *n.* In the coil coating industry, similar to skipping in that it does not apply an even coating to the strip.

**Statcoulomb** \ˈstat-ˈkü-ˌläm\ *n.* The unit of electric charge in the metric system ($3 \times 10^9$ statcoulombs $= 1$ C).

**Static** \ˈsta-tik\ [NL staticusm fr. Gk *statikos* causing to stand, skilled in weighing, fr. *histanai* to cause to stand, weigh] (1638) *adj.* An accumulation of negative or positive electricity on the surface of fibers or fabrics because of inadequate electrical dissipation during processing. Static results in an electrical attraction or repulsion of the fibers relative to themselves, to machine parts, or to other materials, preventing the fiber from traveling in a normal path in the process.

**Static adhesion** *n.* In tire cord, the measurement of the strength of a cord-to-rubber bond under static conditions or very low strain rate.

**Static crack** *See shier.*

**Static eliminator** *n.* A mechanical or electrical device for draining off static electrical charge from plastics articles by creasing an ionized atmosphere in close proximity to the surface. Types include static bars, ionizing blowers and air guns, and radioactive elements. All except the latter operate on the principle that a high-voltage discharge from the applicator to ground creates an ionized atmosphere. A newer type employs ceramic microspheres containing radioisotopes that emit alpha particles. A layer of the microspheres is bonded to a substrate with a resinous binder, and the laminate is installed in an aluminum housing. By ionizing air this device provides a conductive path through which charge is drained.

**Static mixer** (motionless mixer) *n.* Any of several types of devices, used widely in the process industries and in plastics extrusion, that contain no moving parts but instead accomplish mixing by repeatedly splitting the melt (or other) stream and braiding or intertwining the streamlets. The scale of segregation of the different constituents in the flow or of hotter and cooler regions, is exponentially reduced in proportion to the number of stages. They are mainly used between extruder and die to insure the thermal homogeneity of the melt reaching the die lip, with consequent close control of extrudate thickness across the lip.

**Stationary or standing waves** *n.* Waves which are produced in a medium by the simultaneous transmission, in opposite directions of two similar wave motions. Fixed points of minimum amplitude are called *nodes.* A *segment* extends from one node to the next. An *antinode* or *loop* is the point of maximum amplitude between two nodes.

**Stationary platen** *n.* In an injection molder, the large front plate to which the front plate of the mold is bolted. This platen does not normally move.

**Statistical process control (SPC)** *n.* The application of statistical methods, both simple and advanced, to identifying and reducing sources of product-quality variation and output-quality limiters in production processes, the goal being to build quality ("zero defects") into the process rather than to remove defective items by inspection, as in (statistical) quality control.

**Staudinger index** \ˈstäd-in-jər ˈin-deks\ *n.* Intrinsic viscosity $[\eta]$ is identically equal to,

$$\lim_{c_2 \to 0} \frac{\eta_{sp}}{c_2} \equiv [\eta],$$

where $c_2$ is solute concentration (g/cm$^3$), and $\eta_{sp}$ is the specific viscosity derived from solute concentration and relative viscosity; $[\eta]$ is dependent on molecular weight and hydrodynamic volume of the solute or polymer. Staudinger H, Heuer WA

(1930) Relationship between the viscosity and the molecular weight of polystyrene (German). Ber 63B:222–234.
(*See Mark–Houwink equation*).

**Steady flow** (steady-state flow) *n.* Any flow in which velocities throughout the stream do not vary with time.

**Steady state** *n.* A condition of processes or parts of processes in which the state variables describing the process, e.g., temperature, pressure, compositions and velocities of streams, and amounts of materials residing in various process equipment, do not change with time. Most extrusion operations closely approximate the steady state except during startup and shutdown, whereas injection molding and sheet thermoforming are unsteady, *intermittent* processes.

**Steam chest** *n.* A steam-heated cabinet used in manufactured fiber production. Usually refers to the heated cabinet in which spin-drawing is done or to the cabinet around a stuffer-box crimper.

**Steam-distilled pine oil** *See pine oil.*

**Steam-distilled wood turpentine** *See turpentine.*

**Steam molding** *n.* A process for molding plastic-foam parts from pre-expanded beads of polystyrene that contain a volatile hydrocarbon, e.g., isopentane, as a blowing agent. The steam is usually in direct contact with the beads, but with thin-wall moldings such as coffee cups, may be used indirectly to heat mold surfaces that contain the beads. The process is widely used for molding packaging elements for the electronic-equipment industry, but it can also make huge "logs" that are subsequently sliced into foam "lumber".
*See polystyrene foam.*

**Steam plate** *See force plate.*

**Steam-set inks** *n.* Inks that dry by the application of steam or moisture.
*See moisture-set ink.*

**Stearic acid** \stē-ˈar-ik\ (1831) (octadecanoic acid) *n.* $CH_3(CH_2)_{16}COOH$. A saturated organic fatty acid obtained by the hydrolysis with sodium hydroxide (*saponification*) of beef tallow. Mp, 69°C; bp, 29°C per 100 mmHg. The salts, amides, and esters of this acid have long played important roles in the realm of plastics as lubricants, slip agents, and plasticizers, and stearic acid itself is present in numerous plastics compounds.

**Stearin** \ˈstē-ə-rən\ [F stéarine, fr. Gk *stear*] (1817) *n.* $C_3H_5(C_{18}H_{35}O_2)_3$. Glycerol tristearate, tristearin. Mol wt, 890.86; mp, 71.6°C; Sp gr, 0.943.
*Also spelled "stearine".*

**Stearin (stearine) pitch** *n.* Pitch obtained from stearin (Stearine), from the residues of distillation of fatty acids, vegetable oils, etc. They differ from other pitches or bitumens by the possibility of possessing both acid and saponification values and having a tendency to oxidize on exposure. Used in some inks to impart flow and good wetting qualities.
*Also spelled "stearine pitch".*

**Stearyl methacrylate** \-ˌme-ˈtha-krə-ˌlāt\ *n.* A group name for compounds of the general formula $CH_2{=}C(CH_3)OOC(CH_2)_n CH_3$, in which *n* is from 13 to 17. It is a polymerizable monomer for acrylic plastics.

**Steatite** \ˈstē-ə-ˌtīt\ [L *steatitis*, a precious stone, fr. Gk, fr. *steat-*, *stear*] (1758) *n.* High purity talc containing maximum allowable proportions of 1.5% CaO, 1.5% $Fe_2O_3$, and 4% $Al_2O_3$ as impurities.
*See magnesium silicate, non-fibrous.*

**Steel blue** (1817) *n.* Type of Prussian blue.
*See iron blue.*

**Steel plate printing** *n.* An intaglio type of printing using metal plates with the image etched or engraved below the surface.

*Also known as steel die printing.*

**Steel plate (steel die) printing** *n.* An intaglio type of printing using metal plates with the image etched or engraved below the surface.

**Steel structures painting council (SSPC)** *n.* The Society for Protection Coatings, address: 40, 24th Street, 6th Floor, Pittsburg, PA 15222-4656, www.sspc.org.

**Steel-rule die** *n.* A sharp-edged knife fashioned from thin steel strip, flexible enough to be shaped to complex outlines. It is used as the cutting element in die cutting.

**Steel wool** *n.* A matted mass of long, fine, steel fibers available in a variety of grades of coarseness. Used for cleaning and polishing surfaces, burnishing, removing film blemishes between coats and the internal dulling of coated surfaces.

**Stefan–Boltzmann law of radiation** *n.* The energy radiated in unit time by a black body is given by, $E = K(T_4 - T_o^4)$, where $T$ is the absolute temperature of the body, To the absolute temperature of the surroundings, and $K$ a constant. Holst GC (2002) Electro-Optical Imaging System Performance (SPIE Monograph, PM121), SPIE Press, Monograph Series, Bellingham, Washington. Klocek P (ed) (1991) Handbook of infrared optical materials. Marcel Dekker, New York.

**Stellite®** {*trademark*}. Trade name of the Hayes Stellite Co for a family of hard and corrosion-resistant metal alloys. Stellites 1 and 6 are used for hard-facing extruder screws by first machining a groove in what will become the flights' outer surfaces, then welding the alloy into the groove and grinding to final diameter and finish after machining the main screw channel. Both alloys are mainly cobalt, Stellite 1 containing about 31% chromium and 13% tungsten (W), while Stellite 6, the choice for use in Xaloy-306-lined extrusion cylinders, contains about 28% Cr and 3–6% W. Hardness of Stellite 1 is 52–55 on the Rockwell C scale; that of Stellite 6 is a little less.

**Stencil** \ˈsten(t)-səl\ [ME stanselen to ornament with sparkling colors, fr. MF *estanceler*, fr. *estancele* spark, fr. (assume.) VL *stincilla*, alter. of L *scintilla*] (1707) *n.* Method of applying a design by brushing ink or paint through a cutout overlay placed on the surface.

**Stenter** *See tenter frame.*

**Stepladder** \ˈstep-ˌla-dər\ (1751) *n.* A ladder having flat steps, or trends, in place of rungs; usually provided with a supporting frame to steady it.

**Stereobase unit** \ˈster-ē-ˌō-ˈbās ˈyü-nət\ *n.* The base unit of a polymer, taking steric isomerism into account.

**Stereoblock** \-ˈbläk\ *n.* A regular block (in a polymer) that can be described by one species of stereo repeating unit in a single sequential arrangement (IUPAC).

**Stereoblock polymer** *n.* A polymer whose molecules consist of stereoblocks connected linearly (IUPAC).

*See also stereo-specific.*

**Stereochemistry** The study of the spatial geometries of molecules and polyatomic ions.

**Stereochromy** A comparatively new method of mural painting in which water glass serves as the connecting medium between the color and its substratum and also as a protective coating.

**Stereograft polymer** *n.* A polymer consisting of chains of an atactic polymer grafted to chains of an isotactic polymer. For example, atactic polystyrene can be grafted to isotactic polystyrene under suitable conditions.

**Stereoisomerism** \ˌster-ē-ō-ˈī-sə-mər\ [ISV] (1894) *n.* A kind of isomerism in organic compounds arising from the fact that a carbon atom linked to four different groups can exist in two spatially different forms that, though chemically identical, are not superimposable. A simple example is lactic acid, $CH_3CH(OH–COOH)$.

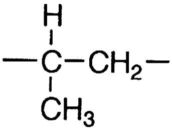
**Stereoisomers** Molecules or polyatomic ions with the same atoms and the same bonds but differing in the geometrical orientations of the atoms and bonds.

**Stereolithography** \ˌster-ē-ō-li-ˈthä-grə-fē\ *n.* The term sometimes used to describe the polymerization of acrylic and other liquid monomers using focused laser beams to form a three-dimensional solid object. Stereolithography is useful for low cost production of small models. Stereolithography is one of the more commonly used rapid manufacturing and rapid prototyping technologies. It is considered to provide high accuracy and good surface finish. It involves building plastic parts a layer at a time by tracing a laser beam on the surface of a vat of liquid photopolymer. The photopolymer is solidified by the laser light. Once a layer is completely traced, it is lowered a small distance into the liquid and a subsequent layer is traced, adhering to the previous layer. After many such layers are traced, a complete 3D model is formed. Some specific technologies require further curing of the polymer in an oven. For models that have delicate structures that must be supported against gravity to prevent collapse, fine supports may be added during fabrication, either automatically in software or manually, and subsequently removed. The devices used to perform stereolithography are called either SLAs for stereolithography-apparatus(es), or simply stereolithographs. Belfield KD, Crivello JV (eds) (2003) Photoinitiated polymerization. American Chemical Society Publications, Washington, DC.

**Stereoregularity** Alternate name for tacticity.

**Stereoregular polymer** *n.* A regular polymer whose molecules can be described by only one species of stereorepeating unit in a single sequential arrangement. A stereoregular polymer is always a tactic polymer, but a tactic polymer need not have every site of stereoisomerism defined (ISO).

**Stereorepeating unit** *n.* A configurational repeating unit having defined configuration at all sites of stereoisomerism in the main chain of a polymer molecule (IUPAC). In stereoregular polypropylene, the two simplest possible stereorepeating units are:



$$-\overset{\displaystyle H}{\underset{\displaystyle CH_3}{C}}-CH_2-$$

which would be the mers of the corresponding stereoregular polymers, the first being isotactic, the second, syndiotactic.

**Stereoselective polymerization** *n.* Polymerization in which a polymer molecule is formed from a mixture of stereoisomeric monomer molecules by incorporation of only one stereospecific species.

**Stereospecific** *n.* Of polymerization catalysts, implying a specific or definite order of spatial arrangement of molecules in the polymer resulting from the catalyzed polymerization. This ordered regularity of molecules (tacticity), in contrast to the branched or random structure found in other plastics, permits close packing of the molecular segments and leads to high crystallinity, as in polypropylene. The adjective is sometimes applied imprecisely to polymers to mean tactic.

**Stereospecific polymerization** *n.* A polymerization in which a tactic polymer is formed.

**Stereotypes** *n.* Printing plates cast in one piece from a heat-dried papier-mâché matrix containing the impression of the assembled type.

**Steric factor** *n.* The fraction of the collisions in an elementary process in which the colliding particles have the proper geometrical orientation with respect to each other to produce the activated complex.

**Steric hindrance** *n.* A characteristic of molecular structure in which the molecules have a spatial arrangement of their atoms such that a given reaction with another molecule is prevented or retarded.

**Steric number** *n.* The sum of the number of bonds and lone pairs around a bonded atom (VSEPR theory).

**Sticker** *n.* (1) A distortion in the weave characterized by tight and slack places in the same warp yarns. The principal causes are rolled ends on the beam, warp ends restricted by broken filament slubs, and knots catching at lease rods, drop wires, heddles, or reeds (*also see draw-back*). (2) *See hard size.*

**Sticklac** *n.* Raw material obtained directly from the tree, from which shellac is derived.

**Stick shellac** *n.* Shellac in a solid, sticklike form, which is manufactured in clear form and in numerous colors and shades to match all woods.

*Also called wood cement.*

**Sticky** *See pulling and drag.*

**Stiffness** *n.* (1) The load per unit area required to elongate the film 1% from the first point in the stress–strain curve where the slope becomes constant. (2) A term relating to the ability of a material to resist bending while under stress. Resistance to the bending is called flexural stiffness, and may be defined as the product of the modulus of elasticity and the moment of inertia of the section. *Compare rigid plastic.*

**Stiffness** *n.* Refers to the deformation behavior in the elastic region. Elastic or Hookean behavior implies that deformation effects due to load are completely recoverable – i.e., no permanent dimensional change occurs. In a theoretical sense this is seldom observed. Practical approximations are usually adequate. When plotted, the horizontal axis is strain, the vertical axis is stress.

*Also known as modulus of elasticity.*

**Stillingia oil** *n.* Pale yellow, limpid, drying oil; peculiar odor; mustard-like taste. Slightly soluble in alcohol. Sp gr, 0.943–0.945; iodine number, 160; saponification value, 210.

*See Chinese vegetable tallow.*

**Still life** Subject for painting composed of inanimate objects, e.g., fruit, flowers, dead fish, etc.

**Stipple** \ˈsti-pəl\ [D *stippelen* to spot, dot] (ca. 1762) *vt.* (1) To even out a coat of paint and remove brush marks and other imperfections, immediately after application, by systematically dabbing the surface with a soft stippling brush. (2) To produce a broken color or textured effect, either by applying spots of a different color or by disturbing the surface of the paint coat, e.g., with a stippling brush or rubber stippler.

**Stippler** *n.* (1) A broad flat-based brush having stiff bristles for producing a texture on a surface such as soft plaster or paint. (2) Any tool (as a rubber sponge or a textured or tufted roller) used to create a stippled surface.

**Stippling** *n.* (1) Method of painting by means of small dots, touches of color or pebbly-textured finish. (2) Engraving by means of dots; distinct from engraving in lines. (3) In antiquing, to obtain an irregular effect with a mottled appearance. It usually entails the use of a sponge, newspaper, or points of dry brush.

*See pointillism.*

**Stir-in resin** (dispersion resin, paste resin) *n.* A vinyl resin that does not require grinding or extremely high-shear mixing to effect dispersion in a plasticizer or to form a plastisol or organosols.

**Stitch bonding** *See bonding* (2).

**Stitched** *n.* Stapling device used in coil coating to connect the end of a coil to the beginning of another coil.

**Stitching** (stitch welding) *n.* (1) The progressive joining of thermoplastic film and sheets by successive applications of two small, mechanically operated electrodes, connected to the terminals of a radio-frequency generator, using a mechanism somewhat like that of an ordinary sewing machine. (2) The process of passing a fiber or thread through the thickness of fabric layers to secure them. In composite manufacture, stitching is used to make preforms or to improve damage tolerance of complex-shaped parts.

**Stock** *n.* Paper or other material to be printed. Substrate.

**Stock dyeing** *See dyeing.*

**Stockholm pine tar** \ˈstäk-ˌhō(l)m-\ *n.*

*See pine tar, Stockholm.*

**Stockinette** \ˌstä-kə-ˈnet\ [alter. of earlier *stocking net*] (1784) *n.* A knit fabric in tubular or flat form made with a plain stitch from yarns of wool, cotton, manufactured fibers, or a combination of these fibers. Stockinette fabrics are used for underwear, industrial applications, and other purposes. In heavier constructions, dyed and napped stockinette finds apparel uses. Also spelled stockinet.

**Stock temperature** *n.* In plastics processing, the temperature of the plastic (as opposed to temperatures of metal parts of the equipment) at any point. Often taken to mean, if not otherwise qualified, the temperature of the melt within an extruder had or leaving the nozzle of an injection molder. Stock temperatures may be measured by sturdy thermocouples or thermistors inserted into the plastic stock, or by infrared instruments pointed at emerging extrudates, sheets being thermoformed, etc.

*See melt temperature.*

**Stoddard solvent** \ˈstä-dərd-\ *n.* (1) A petroleum distillate comprising 44% naphthenic, 39% paraffin's, and 17% aromatics, used as a diluent in PVC organosols. (2) Petroleum spirits with a minimum flash of 37.8°C (100°F) and low odor level.

**Stoichiometric** \ˌstói-kē-ō-ˈme-trik\ (1892) *adj.* Pertaining to a mixture of chemical reactants, each ion or compound of which is present in the exact amount necessary to complete a reaction with no excess of any reactant. For example, each ingredient of a urethane-foam formula should be present in its stoichiometric quantity in order to assure a high-quality product.

**Stoichiometric balance** *n.* Mass balance of materials (non-energy) involving reactions and conversions.

**Stoke** \ˈstōk\ *n.* The deprecated cgs unit of kinematic viscosity, equal to $10^{-4}$ $m^2/s$.

**Stokes** *n.* The cgs unit of kinematic viscosity. A liquid with a viscosity of 1 P has a kinematic viscosity of one stokes if its density is one. A measure of kinematic viscosity equal to poises divided by density.

**Stokes' law** *n.* (1) The mathematical equation derived by G. G. Stokes which relates the velocity of fall $v$ of a spherical body under gravity $g$ through a fluid medium to the radius $r$ of the body, to the viscosity $\eta$ of the medium and to the difference between the density of the solid body ($D_s$) and that of the medium ($D_l$):

$$v = \frac{2(D_s - D_l)r^2 g}{9\eta}.$$

(2) The empirical law stating that the wavelength of light emitted by a fluorescent material is longer than that of the radiation used to excite the fluorescence. In modern language the emitted photons carry off less energy than is brought in by the exciting photons; the details accord with the energy conservation principle.

**Stoll-quartermaster universal ware tester** *n.* A versatile testing apparatus for measuring wear resistance of fabrics, yarns, thread, etc. It can be equipped with either of two testing heads, one for testing abrasion resistance of flat surfaces and the other for testing resistance to flexing and abrasion.

**Stop motion** *n.* Any device that automatically stops a textile machine's operation on the occurrence of a yarn break, a high defect count, etc.

**Stopper** *n.* Pigmented composition used for filling fine cracks and indentations to obtain a smooth, even surface preparatory to painting. Syn: filler.

**Storage life** *n.* The period of time during which a packaged adhesive can be stored under specified temperature conditions and remain suitable for use. *Sometimes called shelf life.* A Syn: shelf life.

*See also working life.*

**Storage modulus** *n.* In dynamic mechanical measurements, the part of the complex modulus that is in phase with the strain, with the symbol G′ if the testing mode is shear, E′ if it is tension or compression.

**Storage stability** *n.* General composite property of resistance to any change, generally in a closed container, over a period of time; color and liquid separation, formation of lumps, hard pigment settling, substantial changes in viscosity, pH, development of odor, etc., are examples of undesirable changes.

*See also shelf life.*

**Stormer viscometer** \ˈstórm-ər vis-ˈkä-mə-tər\ *n.* A rotational-type instrument in which the test liquid fills a stationary, baffled cup and the rotating element may be a concentric cylinder or one of several paddle designs. The rotor is powered by adjustable falling weights through step-up gearing. Because of the complex geometry with any of the Stormer rotors, viscosity cannot be directly calculated from the weight and the time required for the rotor to make 100 revolutions. For each configuration, the instrument must be calibrated with liquids of known viscosity to establish the instrument constant for use with unknown liquids or slurries. Operation of the instrument, used mostly in the paint industry, is described in ASTM D 562 (section 06.01).

*See Krebs–Stormer viscometer.*

**Stoving** (British). *See baking.*

**STP** *n.* Abbreviation for standard conditions of temperature and pressure. In scientific work these are 0°C and 101.325 kPa (1 atm). American gas industries and some others often choose 70°F (21.1°C) as their standard temperature.

**Straight-line pad sander** *n.* A portable sanding machine consisting of a backup pad that moves to and fro in a straight line, with a stroke of about 5/16 in. on an average of about 3200 times/min. The resulting scratch pattern is ideal when sanding with the grain in wood and far less noticeable than the swirls from an orbital pad sander when the finish coat is applied on either wood or metal.

**Strain** \ˈstrān\ [ME, fr. MF *estraindre*, fr. L *stringere* to bind or draw tight, press together, akin to Gk *strang-*, *stranx* drop squeezed out, *strangalē* halter] (14c) *v.* In tensile and compression testing, the ratio of the elongation to the gauge length of the test specimen, that is, increase, (or decrease) in length per unit of original length. The term is also used in a broader sense to denote a dimensionless number that characterizes the change in dimensions of an object during a deformation or flow process. In shear deformation, strain is the shear angle in radians. Strain is a dimensionless quantity, which may be measured conveniently in %, in in. per in., in mm per mm, etc.

*See also shear strain and true strain.*

**Strain birefringence** \-ˌbi-ri-ˈfrin-jən(t)s\ *n.* Double refraction in a transparent material subjected to stress and accompanying strain. One of the techniques of experimental stress analysis is based on this phenomenon.

*See also flow birefringence.*

**Strain energy** *n.* The recoverable, elastic energy stored in a strained body and recovered quickly upon release of stress. Strain energy in a perfectly elastic material is equal to the area beneath the stress–strain curve up to the strain being considered. For Hooke's-law material, it is equal to $0.5 \cdot \text{modulus} \cdot \text{strain}^2$. This area, which appears to have the dimensions of stress (Pa), is actually the strain energy per unit volume ($J/m^3$).

**Strain gauge** *n.* A small electrical element consisting of a very fine wire of many short runs and reverse turns embedded in a tape-like matrix. The strain gage is adhered to an object whose deformation under stress it is desired to measure. With complex objects, several gages may be attached at different locations and oriented in different directions. The gage undergoes the same strain as the object when stress is applied and the strain stretches the wire, which, through the many doublings-back, magnifies the change in length. The increase in resistance, proportional to object strain, is measured with a bridge circuit of which the gage is one branch.

**Strain hardening** *n.* An increase in hardness and strength caused by plastic deformation at temperatures lower than the re-crystallization range.

**Straining** *n.* The mechanical separation of relatively coarse particles from a liquid as distinguished from the process of filtration.

**Strain recovery curve** *See tensile hysteresis curve.*

**Strain relaxation** *n.* A misnomer for creep. What may be mistakenly meant by this term is stress relaxation.

*See creep.*

**Strand** \ˈstrand\ [ME *strond*] (15c) *n.* (1) A single fiber, filament, or monofilament. (2) An ordered assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit; includes slivers, roving, single yarns, plies yarns, cords, braids, ropes, etc. The number of filaments in a strand is usually 52, 102, or 204.

**Strand chopper** *n.* (1, pelletizer) A type of cutter into which multiple extruded and chilled strands are fed for cutting into short lengths about equal to the strand diameter. The strands are fed perpendicular to the edge of a thick stationary knife and are sheared off by several rotating knives bolted to a massive cylindrical head. The pellets so formed are discharged into a shipping container or conveyed into mass storage bins. In this way, molding powders are produced for extrusion or molding into finished products. Widely used by many smaller compounders and by reclaimers, this method of producing pellets has largely given way, in the plants of the large resin producers, to underwater pelletizing. (2) A device for chopping strands of fibrous reinforcement into lengths suitable for blowing onto a perform screen, compounding into premix, or combining with spayed resin in spray-up.

**Strapping** \ˈstra-piŋ\ (1657) *adj.* (1) Thin, flat, continuous-strip material available in widths from 6 to 25 mm, usually in coils, and designed to be used with hand-operated machines that dispense, tighten, and clamp the strip around a package or bundle of packages. The material may be steel, unidirectionally fiber-reinforced plastic, or oriented nylon or polypropylene. (2) High-strength hoisting straps woven from aramid fiber, replacing chains in many industries for handling loads with hoists.

**Strasbourg turpentine** \ˈsträs-ˌbúrg *or Gr* ˈshträs-ˌbúrk\ *n.* Oleoresinous exudation obtained from the white fir.

**Straw** \ˈstró\ [ME, fr. OE strēaw; akin to OHGr *strō* straw, OE *strewian* to strew] (before 12c) *n.* A general term for plant fibers obtained from stems, stalks, leaves, bark, grass, etc. They are made into hats, bags, shoes, mats, etc., by weaving, plaiting, or braiding.

**Streak** \ˈstrēk\ [ME *streke*, fr. OE *strica*; akin to OHGr *strich* line, L *striga* row] (before 12c) *n.* A discoloration (rust, oil, dye, grease, soap, etc.) extended as an irregular stripe in the cloth.

**Streamline flow** *n.* A streamline is a line in a fluid such that the tangent to it at every point is in the direction of the velocity of the fluid particle at that point, at the instant under consideration. When the motion of the fluid is such that, at any instant, continuous streamlines can be drawn through the whole length of its course, the fluid is said to be in streamline flow.

**Strength** \ˈstreŋ(k)th\ [ME *strengthe*, fr. OE *strengthu*; akin to OHGr *strengi* strong] (before 12c) *n.* The strength of a pigment is its opacity or tinting power.

**Strength count product** *See break factor.*

**Strength, dry** *n.* The strength of an adhesive joint determined immediately after drying under specified conditions or after a period.

*See strength, wet.*

**Strength (of an electrolyte)** *n.* The extent or degree of dissociation of an electrolyte in solution.

**Strength, tensile** (ca. 1864) *n.* (1) General: The strength shown by a specimen subjected to tension as distinct from torsion, compression, or shear. (2) Specific: The maximum tensile stress expressed in force per cross-sectional area of the unstrained specimen, for example, kilogram per square millimeter, pound per square inch. (3) Ability a material possesses of resisting deformation by the application of a force or load.

**Strength, wet** The strength of an adhesive joint determined immediately after removal from a liquid in which it has been immersed under specified conditions of time, temperature, and pressure. *Note*—The term is commonly used alone to designate strength after immersion in water. In the latex adhesives the term is also used to describe the joint strength when the adherents are brought together with the adhesive still in the wet state.

*See strength, dry.*

**Stress** \ˈstres\ [ME *stresse* stress, distress, short for *destresse*] (14c) ($\sigma$ or $\tau$) *n.* The force producing or tending to produce deformation in a body, divided by the area over which the force is acting. If the stress is tensile or compressive, the area is perpendicular to the stress; in shear it is parallel to the stress. The SI unit of stress is the pascal (Pa) equal to 1 Newton per square meter (N/m$^2$). Practical stresses are usually in the range from 1 kPa to 1 MPa. In theoretical mechanics, the stress tensor in a body has nine possible components, three of which are tensile/compressive, the others shear. In many cases, all but one or two of the components are zero or not relevant to the behavior question of interest. *Note* 1—Typical examples are tensile stress, shear stress and compressive stress. *Note* 2—Stress usually reaches a maximum at the time of rupture.

**Stress concentration** *n.* The magnification of applied stress in the vicinity of a notch, hole, inclusion, or inside corner. Minimizing stress concentrations is an important aspect of plastics product design.

**Stress corrosion** *n.* The preferential attack of areas under stress in a corrosive environment, when environment alone would not have caused corrosion.

**Stress cracking** (stress crazing) *n.* External or internal cracking in a plastic caused by tensile stresses less than the short-time tensile strength.

*See environmental stress cracking.*

**Stress-intensity factor** ($K$) *n.* A fracture-mechanics parameter that describes the magnifying of stress caused by a flaw in a material. It is defined by the equation,

$$K = fS(\pi a)^{0.5},$$

where $f$ is the factor dependent on the flaw geometry and the structure in which it is contained, $S$ the nominal or average stress caused by the load, and $a$ is the half the length of the flaw measured normal to the direction of stress.

**Stress relaxation** *n.* The decay of stress with time at constant strain. If a plastic specimen is strained and the recovery of the strain prevented, the chain segments of the molecules will tend to realign so as to lower the free energy of the system, sometimes by breaking covalent bonds. The elastic and retarded strains which would usually be recovered upon release of the stress are instead converted into unrecoverable strains when chain segments have been rearranged. The decrease in stress is often plotted against time in order to estimate when it will have fully decayed. The strains induced during processing of molten thermoplastics, particularly injection molding, often do not completely recover before cooling and become frozen into the material. At ambient temperatures these strains may slowly recover, as evidenced by warping and excessive shrinkage of parts. For this reason, some moldings with high molded-in strain are annealed while being securely held in shape-retaining fixtures, to permit stress relaxation. ASTM D 2991 describes a standard practice for testing stress relaxation of plastics.

**Stress rupture** *n.* The sudden, complete failure of a plastic member held under load. In laboratory testing, the temperature and rate of loading or, in longer-term tests, the time for which the load was sustained, should be stated along with the load and corresponding type and mode of stress. The mode of loading may be tensile, flexural, torsional, biaxial, or hydrostatic.

**Stress–strain curves** *n.* A graphical representation, showing the relationship between the change in dimension (in the direction of the applied stress) of the specimen from the application of an external stress, and the magnitude of that stress. In tension tests of textile materials, the stress can be expressed either in units of force per unit cross-sectional area, or in force per unit linear density of the original specimen, and the strain can be expressed either as a fraction or as a percentage of the original specimen length.

*Also see load–deformation curve.*

**Stress–strain diagram** *n.* The plot of stress on a test specimen, usually in tension or compression, versus the corresponding strain, usually carried to the point of failure. The test is usually carried out at constant crosshead speed, i.e., at a constant rate of nominal elongation. The stress plotted is usually the *nominal stress*, i.e., the measured force at any time divided by the original cross-sectional areas, normal to the force, over which the force is distributed. The strain plotted is usually also the nominal quantity, i.e., the increase in specimen gage length divided by the original length.

*See also true stress and true strain.*

**Stress whitening** *n.* Whiteness seen in some plastics and rubbers that are subjected to extreme stretching, thought to be due to the formation of light-scattering Microvoids (*microcavitation*) within the material.

**Stress wrinkles** *n.* Distortions in the face of a laminate caused by uneven web tensions, slowness of adhesive setting, selective absorption of the adhesive, or by reaction of the adherents with materials in the adhesive.

**Stretch** \ˈstrech\ (1541) *n.* An extension of the length of a material to the point of rupture to determine its tensile strength. Stretch is generally measured as a percentage of the original length.

**Stretch-blow molding** *n.* A blow-molding variant for making bottles from polyethylene terephthalate in which shaped performs (as distinct from simple tubular parisons) are injection molded, reheated through several zones, then inflated and stretched lengthwise to essentially the perform shape magnified many times, cooled, and released from the mold. The process may e done in a single stage, or in two essentially separate operations, or in an integrated two-stage method in a single machine (Husky, 1992).

*See also blow molding.*

**Stretch breaking** *n.* In conversion of tow-to-top, fibers are hot stretched and broken rather than cut to prevent some of the damage done by cutting.

**Stretched tape** *n.* Strong tape made of a crystalline plastic such as polypropylene or nylon, which has been unidirectionally oriented by warm stretching followed by cooling while under tension. Used mainly for strapping.

**Stretch-film wrapping** *See shrink wrap.*

**Stretch forming** *n.* A sheet-forming technique in which a heated thermoplastic sheet is stretched over a mold and subsequently cooled.

*See also drape forming and sheet thermoforming.*

**Stretch growth** *See secondary creep.*

**Stretching** *See orientation.*

**Stretch ratio** *n.* In making uniaxially oriented films and filaments, the length of a sample of stretched film or filament divided by its length before stretching.

*Also see blow-up ratio and draw ratio.*

**Stretch spinning** *n.* A term used in the manufacture of rayon. Rayon filaments are stretched while moist and before final coagulation to decrease their diameter and increase their strength.

**Stretch wrap** *See shrink wrap.*

**Stretch yarn** *See textured yarns.*

**Striae** \ˈstrī-ˌə\ [L, furrow, channel] (1563) *n.* Surface or internal thread-like inhomogeneities in a transparent plastic.

**Striation** \strī-ˈā-shən\ (ca. 1847) *n.* (1) In blow molding a rippling of thick parisons caused by a local weld-line effect in the melt, imparted by a spider leg. (2) In the mixing of contrasting colors of resin by viscous shear in the melt, as in extrusion, a layer of one color adjacent to one of the contrasting color. The thickness of the layer is called the *striation thickness* and the thinning of the layer is a measure of the effectiveness of mixing, corresponding to Danckwerts' scale of segregation. (3) Streaks or bands or various natures in fibers or fabrics.

*See spider lines.*

**Strié** *n.* A term describing any cloth having irregular stripes or streaks of practically the same color as the background.

**Strike through** *n.* The penetration of the vehicle of a printing ink through the sheet, so that it is apparent on the opposite side.

**String** (varnish) *n.* Varnish being polymerized will become viscous and form strings which suspend from an object when dipped in it and then withdrawn. The length of the string is an indication of the degree of polymerization.

**Stringiness** (1) The property of an adhesive that results in the formation of filaments or threads when adhesive transfer surfaces are separated. (*see also webbing*). *Note* — Transfer surfaces may be rolls, picker plates, stencils, etc. (2) The property of an ink which causes it to draw into filaments or threads.

**String-up** *See thread-up.*

**Stringy selvage** *See slack selvage.*

**Strip** \ˈstrip\ [ME, per. fr. MLGr *strippe* strap] (15c) *n.* (1) A length of wallpaper cut to fit height of wall. (2) A single section of the design, in a scenic wallpaper. (3) A board of lumber less than 4 in. (10 cm) wide.

**Strip coating** *n.* Strip coating or coil coating is the method of application of a coating to raw metal strip before its fabrication into finished products.

**Striping** *n.* In antiquing, painting a series of fine lines – in gold or a contrasting color – to enhance some basic design characteristics on a piece of furniture. It may be accomplished by a resist technique (such as taping a fine line effect over a surface, and then blocking out the rest of the area and spraying into the opening left by the tape). It may be painted free hand or with the use of a ruler or straight edge. It may be done with sizing and gold leaf.

*Also called Dutch gold.*

**Strippable coating** *n.* A temporary coating applied to finished articles to protect them from abrasion or corrosion during shipment and storage, which can be removed when desired without damaging the articles. Vinyl plastisols, applied by dipping, spraying, or roll coating, are often used for this purpose.

*See also release paper.*

**Strippable paper** *n.* A chemically treated stock tough enough to resist tearing, with a special formulation, which permits a release of the wall covering from the adhesive. This makes it possible to remove an entire strip from the wall without wetting. It is referred to as dry strippable.

**Stripper** *See paint and varnish remover.*

**Stripper plate** In molding, a plate that strips a molded piece from core pins or a force plug. The plate is actuated by opening the mold.

**Stripping** *n.* (1) Removing old paint, wallpaper, distemper, etc., by the use of a blowtorch, paint remover steam stripping appliance, stripping knife, or other scraping tools. (2) Sealing the joint between a metal sheet and a built-up roofing membrane. (3) Taping the joints between insulation boards. (4) A condition where the ink fails to adhere to and distribute uniformly on the metal rollers of the press. (5) A chemical process for removing color from dyed cloth by the use of various chemicals. Stripping is done when the color is unsatisfactory and the fabric is to be re-dyed. (6) The physical process of removing fiber that in embedded in the clothing of a card. (7) *See degumming.*

**Stripping agent** *See mold wash.*

**Stripping fork** (comb) *n.* A tool, usually of brass or laminated sheet, used to remove articles from molds.

**Stripping torque** *n.* (1) Of a self-tapping screw, the twisting moment in N m required to strip the threads formed by the screw in a softer material. (2) Of a molded-in insert, the torque required to break the mechanical bond between the plastic and the insert's knurled surface.

**Stroke** \ˈstrōk\ [ME; akin to OE *strīcan* to stroke] (13c) *n.* (1) The movement of a hydraulic piston, press ram, or other reciprocating machine member. (2) The distance between the extremes of movement of such a member in normal operation.

**Strong (electrolyte)** *n.* Completely, or almost completely, dissociated in solution.

**Strontium chromate** \ˈsträn(t)-sh(ē-)əm ˈkrō-ˌmāt\ *n.* $SrCrO_4$. Pigment Yellow 32 (77839). A bright yellow pigment of type similar to lead chromate except that it is not blackened by hydrogen sulfide. It is used in corrosion-resistant primers. Density, 3.67–3.82 g/cm$^3$ (30.6–31.9 lb/gal); O.A., 20–33; particle size, 10–30 µm. Syn: strontium yellow.

**Strontium white** *n.* Another name for the ground mineral, celestite.

**Strontium yellow** *See strontium chromate.*

**Structural adhesive** *n.* A bonding agent used for transferring required loads between adherents exposed to service environments typical for the structure involved.

**Structural foam** *n.* A term originally used for cellular thermoplastic articles with integral solid skins having high strength-to-weight ratios and also used for high-density cellular plastics that are strong enough for structural applications. Today the term is more apt to mean the products of SRIM (at reaction injection molding). In the original Union Carbide process called *structural-foam molding*, pellets of resin containing a blowing agent are fed into an extruder provided with an accumulator, where the melt is maintained above the foaming temperature but at a pressure high enough to preclude foaming. A piston in the accumulator forces a measured charge of molten resin into the mold, the volume of the charge being only about half of the mold volume, which is quickly filled, however, by the expansion of the gas. As the foam contacts the mold surfaces, the cells at those surfaces collapse to form a solid skin. Parts produced by this process are from three to four times as rigid as solid injection moldings of the same weight (because the latter are so much thinner). Many variations of the process have been developed, most employing injection molding or extrusion, with emphasis on elimination of swirls in the products.

**Structural formula** *n.* A drawing showing which atoms are bonded to each other in a molecule or polyatomic ion.

**Structured paint** *n.* Paint having a gel-like consistency which breaks down under the kind of shear exerted during brushing or roller application and re-forms when the shearing force is removed. When there is a time lag between the removal of the shearing force and the start of gel re-formation, the paint is said to be thixotropic. The thixotropic structure can vary from a very light gel to the fully gelled thixotropic paints of the non-drip type.

*See viscosity, structural.*

**Stucco** \ˈstə-(ˌ)kō\ [It, of Gr origin; akin to OHGr *stucki* piece, crust, OE *stocc* stock] (1598) *n.* (1) An exterior finish, usually textured; composed of Portland cement, lime, and sand, which are mixed with water. (2) A fine plaster used for decorative work or moldings. (3) Simulated stucco containing other materials, such as epoxy as a binder. (4) A partially or fully Calcined gypsum that has not yet been processed into a finished product.

**Stud** \ˈstəd\ [ME *stode*, fr. OE *studu*; akin to MHGr *stud* prop, OE *stōw* place] (before 12c) *n.* Upright post in the framework of a wall for supporting lath, sheets of wallboard or the like.

**Stuffer box** *n.* A mechanism for crimping in which a fiber bundle (e.g., tow or filament yarn) is jammed against itself, causing it to crimp. By the suitable application of heat (usually wet steam) and pressure to the stuffed tow, a high and permanent crimp can be forced into the bundle.

*Also see texturing, stuffer box method.*

**Stuffers** Extra yarns running in the warp direction through a woven fabric to increase the fabric's strength and weight.

**S twist** *See twist, direction of.*

**Styrenated alkyd** *See alkyd molding compound.*

**Styrene** \ˈstī-ˌrēn\ [ISV] (1885) (vinyl benzene, phenylethylene, and cinnamene) *n.* $C_6H_5CH{=}CH_2$. A colorless to yellowish oily liquid with a strong, sharp odor, produced by the catalytic dehydrogenation of ethylbenzene. Styrene monomer is easily polymerized by exposure to light, heat, or a peroxide catalyst, and even spontaneously, so a little inhibitor is added if it is to be stored. Styrene is a versatile comonomer, polymerizing readily with many other monomers, and is the active cross-linking monomer in most polyester laminating resins. Mol wt, 104.14; Sp gr, 0.909; mp, −33°C; bp, 145–146°C.

*Also known as vinylbenzene, styrol, styrolene, cinamene, and phenylethylene.*

**Styrene-acrylonitrile co-polymer (SAN)** *n.* Any of a group of co-polymers containing 70–80% styrene and 30–20% acrylonitrile and having higher strength, rigidity, and chemical resistance than straight polystyrene. These monomers may also be blended with butadiene to make a terpolymer or the butadiene may be grafted onto the SAN, either method producing ABS resin.

**Styrene butadiene** *n.* A group of thermo plastic elastomers. They are linear co-polymers of styrene and butadiene, produced by lithium catalyzed solution polymerization, with a sandwich molecular structure containing a long Polybutadiene center surrounded by shorter polystyrene ends. A co-polymer of styrene and butadiene made by emulsion polymerization for use in latex paints.

**Styrene butadiene latex** *See butadiene styrene latex.*

**Styrene-butadiene rubber (SBR, Buna-S, and GR-S)** *n.* A group of widely used synthetic rubbers comprising about three parts butadiene co-polymerized with one part of styrene, with many modifications yielding a large variety of properties. The co-polymers are first prepared as lattices, in which form they are sometimes used. The lattices can be coagulated to produce crumb-like particles resembling natural crepe rubber. SBR has better abrasion resistance than natural rubber and has largely supplanted it in tire treads, though not in sidewalls.

**Styrene butadiene thermoplastic (S/B, SB)** *n.* A group of thermoplastic elastomers introduced in 1965 (Shell chemical Co., London, Thermolastic®). They are linear block co-polymers of styrene and butadiene, produced by lithium-catalyzed solution polymerization, with a sandwich molecular structure containing a long polybutadiene center surrounded by shorter polystyrene ends. The materials are available in pellet form for extrusion, injection molding, and blow molding, and S/B sheets are thermoformable.

**Styrene-maleic** *n.* A anhydride co-polymer is an alternating co-polymer useful as a textile size an emulsifier.

**Styrene-maleic anhydride co-polymer** *n.* An alternating co-polymer useful as a textile size and emulsifier.

**Styrene resin** *n.* Synthetic resin made from vinylbenzene.

**Styrene-rubber plastic** *See high-impact polystyrene.*

**Styrenic plastic** (styrenic) *n.* A term that encompasses all the wide variety of thermoplastics in which styrene is the monomer or comonomer or in which polystyrene is a member of a polymer blend.

*See polystyrene.*

**Styroflex** {*trademark*}. Poly(styrene) (fibers), manufactured by Ndd. Seekabelwerke, Germany.

**Styrofoam** \ˈstī-rə-ˌfōm\ {*trademark*}. Poly (styrene) (foam), manufactured by Dow.

**Styrol** *n.* The name given to styrene by the chemist who first observed the monomer in 1839. The name was changed to styrene by German researchers around 1925.

**Styron** \ˈstī-rən\ *n.* Poly(styrene), also co-polymers, manufactured by Dow, USA.

**Styropor P** *n.* Poly(styrene) (foam), manufactured by BASF, Germany.

**Sublimation** \ˌsə-blə-ˈmā-shən\ [ME, fr. ML sublimatus, pp of *sublimare*] (15c) *n.* A phase change in which a substance, such as a dye, passes directly from the solid to the vapor phase without passing through a liquid phase. This process is the basis for transfer printing.

**Sublimed white lead** *n.* Another name for basic lead sulfate (Gooch, 1993).

**Sublistic® process** {*trademark*} *n.* A method of applying print designs to fabrics containing manufactured fibers by paper-transfer techniques. Developed by Sublistatic Corp., France.

*Also see printing, heat transfer printing.*

**Submarine gate** \ˈsəb-mə-ˌrēn\ (tunnel gate) *n.* In injection molds, a type of edge gate where the opening from the runner into the mold is located below the parting line or mold surface, as opposed to conventional edge gating where the opening is machined into the surface of the mold or mold cavity. With submarine gates, the item is broken from the runner system on ejection from the mold.

*See also gate.*

**Submicron reinforcement** *n.* Very fine whiskers that, when used as reinforcements for thermoplastic resins, are short enough to flow through restricted gates without breaking, yet have aspect ratios well over 200, adequate for good isotropic strength development in the composite. However, they are costly, so are used only for special applications.

**Subshell** *n.* The electrons within the same shell (energy level) of the atom are characterized by the same principal quantum number ($n$), and are further divided into groups according to the value of their azimuthal quantum numbers ($l$); the electrons which possess the same azimuthal quantum number for the same principal quantum number are considered to occupy the same subshell (or sublevel). The individual subshells are designated with the letters *s, p, d, f, g,* and hm as follows: An electron assigned to the *s*-subshell is called an *s*-electron, one assigned to the *p*-subshell is referred to as a *p*-electron, etc. In formulae of electron structure, the value of the principal quantum number ($n$) is prefixed to the letter indicating the azimuthal quantum number ($l$) of the electron; thus; e.g., a 4*f*-electron is an electron which has the principal quantum number 4 (i.e., assigned to the *N*-shell) and the orbital angular momentum 3 (*f*-subshell).

| *l* value | Designation of subshell |
|---|---|
| 0 | *s* |
| 1 | *p* |
| 2 | *d* |
| 3 | *f* |
| 4 | *g* |
| 5 | *h* |

**Sub spirits** *n.* Mineral spirits.
*See turpentine substitute.*

**Substance** *n.* The weight in pounds of a ream (500 sheets) of paper cut to the standard size (17 × 22) for business papers (bond, ledger, mimeograph, duplicator, and manifold). For example, 20 lb. Similar to basis weight of other grades of paper.

**Substitution reaction** *n.* A reaction in which one atom or group of atoms is substituted for another in a molecule.

**Substrate** \ˈsəb-ˌstrāt\ [ML *substratum*] (1807) *n.* (1) Any surface to which a coating or printing ink is applied. (2) The nonpainted material to which the first coat was applied; sometimes referred to as the original substrate. (3) Base on which organic coloring agents are precipitated to form lakes. *See base* (3). (4) Fabric to which coatings or other fabrics are applied. It can be of woven, knit, non-woven, or weft-insertion construction. Generally, substrate properties are dependent both on fiber type and fabric construction. Usually the fabric is scoured, heat-set, and otherwise finished prior to coating or bonding. Many smooth-surfaced manufactured fiber fabrics require impregnation with a latex prior to coating to ensure adequate adhesion.
*See ground.*

**Subtractive color mixture** *See colorant mixture.*

**Subtractive colorant mixture, complex** *n.* Colorant mixture which must take into account both the absorption and scattering of two or more of the individual pigments used in the mixture.
*See Kubelka–Munk theory.*

**Subtractive colorant mixture, simple** *n.* Colorant mixture which can be described by the single variable of absorption of radiant energy. The term can be used to describe mixture of liquids, which have no scattering or of pigment mixtures where almost all of the scattering comes from one major component, frequently white pigment or a textile fiber, for example.
*See Beer's law* (*liquids*) *and Kubelka–Munk theory.*

**Sub turps** *See turpentine substitute.*

**Succinic acid** (ˌ)sək-ˈsi-nik-\ [F *succinique*, fr. L *succinum* amber] (ca. 1790) *n.* $(CH_2)_2(COOH)_2$. A saturated dibasic acid. Mp, 184°C; bp, 235°C. Used in the preparation of alkyd type resins and plasticizers.

**Sucrose acetate isobutyrate** \ˈsü-ˌkrōs ˈa-ə-ˌtāt –ˈbyü-tə-ˈrāt\ (SAIB) *n.* A modifying extender for lacquers and finishes based on resins such as cellulose acetate butyrate, acrylics, alkyds, and polyesters.

**Sucrose octaacetate** *n.* $C_{12}H_{14}O_3$(OOCCH3)$_8$. A plasticizer for cellulosic resins and polyvinyl acetate.

**Sucrose octabenzoate** \-ˈben-zə-ˌwāt\ *n.* $C_{12}H_{14}O_3(OOCC_6H_5)_8$. A plasticizer for polystyrene, cellulosics, and some vinyls.

**Suction** \ˈsək-shən\ [LL *suction*-, *suctio*, fr. L *sugere* to suck] (1626) *n.* Force that causes a coating to be drawn into the pores of, or adhere to, a surface because of the difference between the external and internal pressures.

**Suede fabric** \ˈswād\ *n.* Woven or knitted cloth finished to resemble suede leather, usually by napping, shearing, and sanding techniques.

**Suede finish** *See ripple finish.*

**Sulfanilic acid** \ˌsəl-fə-ˈni-lik-\ [ISV *sulf-* + -*anil*ine + -*ic*] (1856) *n.* $C_6H_7NO_3S$. A crystalline acid obtained from aniline.

**Sulfar fiber** *n.* A manufactured fiber in which the fiber-forming substance is a long chain, synthetic polysulfide in which at least 85% of the sulfide (–S–) linkages are attached to two aromatic rings (FTC definition). The raw material is polyphenylene sulfide, which is melt spun and processed into staple fibers. These are high performance fibers with excellent resistance to strong chemicals and high temperature. They show excellent strength retention in harsh environments; are flame retardant; and are non-conducting. They find use in high-temperature filter fabrics, electrical insulation, coal-fired boiler bag houses, papermaker's felt, and high-performance composites.

**Sulfate** \ˈsəl-ˌfāt\ [F, fr. L sulfur] (1790) *n.* $SO_4$. (1) A salt or ester of sulfuric acid. (2) A bivalent group or anion characteristic of sulfuric acid and the sulfates.

**Sulfated oil** *n.* A newer term signifying the same type of material as sulfonated oil.

**Sulfate pin oil** *See pine oil.*

**Sulfate pitch** *See tall oil.*

**Sulfate pump** *See kraft pumps.*

**Sulfate resin** *See tall oil.*

**Sulfate wood turpentine** *See turpentine.*

**Sulfation** *n.* The introduction into an organic molecule of the sulfuric ester group (or its salts), $–O–SO_3H$, where the sulfur is linked through an oxygen atom to the parent molecule.

**Sulfide staining** *n.* (1) Discoloration of a plastic caused by the reaction of one of its constituents with a sulfide in a liquid, solid, or gas to which the plastic article has been exposed. Stabilizers based on salts of lead, cadmium, antimony, copper, or other metals sometimes react with external sulfides to form a staining metallic sulfide. (2) The formation of dark stains in a paint film, as a result of the reaction of atmospheric hydrogen sulfide with metallic compounds such as lead, mercury, or copper in the paint.

**Sulfite turpentine** *n.* This term is not in good usage, because the volatile oil recovered in the conversion of wood to pulp by the sulfite process consists chiefly of cymene, $C_{10}H_{14}$, rather than pinene and other terpenes.

**Sulfonate-carboxylate co-polymer** *See polysulfonate co-polymer.*

**Sulfonated** *n.* A term describing a material that has been reacted with sulfonic acid, usually to impart solubility, dyeability with cationic dyes, or other properties.

**Sulfonated castor oil** *See turkey red oil.*

**Sulfonated oil** *n.* A water-dispersible or soluble surface active material obtained by treating an unsaturated or hydroxylated fatty oil, acid, or ester with an agent capable of sulfating or sulfonating it at least partially.

*Also known as sulfated oil.*

**Sulfonation** *n.* The introduction into an organic molecule of the sulfonic acid group (or its salts), $-SO_3H$, where the sulfur atom is joined to a carbon atom of the parent molecule.

**Sulfone polymers** *n.* Alternate name for polysulfone.

**Sulfonic acid (1873)** *n.* Any acid containing the sulfonic group, $(SO_3H)$.

**Sulfonyl** \ˈsəl-fə-ˌnil\ (1920) *n.* An organic radical of the form $RSO_2-$, in which R may be aliphatic or aromatic. If the bond is filled by an –OH group, the compound is called a sulfonic acid. The sulfonyl chlorides are highly active reagents used in many organic syntheses.

**Sulfonylazidosilane** \-ˈā-zə(ˌ)dō-ˈsi-ˌlān\ *n.* Any of a family of organofunctional coupling agents that, in contrast to most other silane coupling agents, enter into direct chemical reaction with organic polymers. They function by insertion into carbon–hydrogen bonds, which avoids generation of free radicals and degradation of radical-sensitive polymers such as polypropylene, polyisobutylene, and polystyrene.

**Sulfonyldianiline** (aminophenyl sulfone) *n.* $(NH_2C_6H_4)_2SO_2$. A curing agent for epoxy resins.

**Sulfur dyes** *See dyes.*

**Sulfuric acid** (1790) *n.* $H_2SO_4$. A heavy corrosive oily dibasic strong acid that is colorless when pure and is a vigorous oxidizing and dehydrating agent.

**Sulfurized oil** *n.* An oil which has been reacted with sulfur or sulfur-containing compounds like sulfur chloride. The sulfur is believed to attach itself to the unsaturated bonds. Sulfur-treated oils set or polymerize rapidly, and they are also rather unstable on storage.

**Sulfur nitride polymer** (polysulfur nitride, polythiazyl) $[-(SN)-]n$. First synthesized in 1910 but ignored for six decades, this covalent polymer has been restudied and found to have the physical and electrical properties of a metal. It is formed by passing the vapor of $(SN)_4$ over a catalyst that cracks it to $(SN)_2$, which is condensed on a cold surface where it spontaneously polymerizes into crystalline form. The crystals are malleable and can be cold-worked into thin sheets or fibers under pressure, having an electrical conductivity similar to that of mercury, and superconducting near 0 K.

**Sulfurous acid** (1790) *n.* $H_2SO_3$. A weak unstable dibasic acid known in solution and through its salts and used as a reducing and bleaching agent.

**Sulfur vulcanization** *n.* The vulcanization of a diene rubber by heating to about 150°C with sulfur. In practice, a vulcanization accelerator and activators can be used in addition to sulfur.

**Sulphate pulp** *n.* Paper pulp made from wood chips cooked under pressure in a solution of caustic soda and sodium sulphide.

*Known as kraft.*

**Sulphite pulp** *n.* Paper pulp made from wood chips cooked under pressure in a solution of bisulphite of lime.

**Sumi** (Japanese) *n.* Black Chinese ink.

**Sumi-ye** (Japanese). A print in black and white only.

**Summerwood** \ˈsə-mər-ˌwúd\ (1902) *n.* The portion of the annual growth ring that is formed during the latter part of the yearly growth period. It is usually more dense and stronger mechanically than springwood.

**Sunflower oil** \-ˈflaú(-ə)r\ *n.* Seed oil of *Helianthus annus*, which grows in abundance in many parts of the world. It can only be regarded as a semidrying oil, but has the useful property of being non-yellowing. Sp gr, 0.930/15°C; iodine value, 135.

**Sunlight resistance** *See light resistance.*

**Superabsorbent** *n.* A material that can absorb many times the amount of liquid ordinarily absorbed by cellulosic materials such as wood pulp, cotton, and rayon.

**Superconducting polymers** *n.* A polymer exhibiting electrical conductivity of $\cong 10^{20}\,\mathrm{S.cm^{-1}}$.

**Supercooling** *n.* The rapid cooling of a normally crystalline plastic through its crystallization temperature so it does not get a change to crystallize and it remains in the amorphous state.

**Superheating** *n.* The heating of a liquid above its boiling point without boiling taking place.

**Superpolymers** *n.* Polymers having molecular weights above 10,000 (date). This term was first used by Carothers.

**Superposition principle** *See Boltzmann superposition principle.*

**Supersaturated solution** *n.* An unstable solution in which the concentration of solute is greater than its solubility.

**Superstruture paint** *n.* Ship paint used on part of the ship's structure above the main deck.

**Suppliers of advanced composite materials association (SACMA)** *n.* A recently formed industry group headquartered at 1600 Wilson Blvd, Suite 1008, Arlington, VA 22209.

**Supralen** *n.* Poly(ethylene) (pipes), manufactured by Mannesmann, Germany.

**Surah** \ˈsúr-ə\ [prob. alter. of *surat*, a cotton produced in Surat, India] (1873) *n.* A soft fabric of silk or filament polyester or acetate, usually a twill and often woven in a plaid. Surah is used for ties, mufflers, blouses, and dresses.

**Surface active** (1920) *adj.* Altering the properties and lowering the tension at the surface of contact between phases (soaps and wetting agents are typical surface-active substances).

**Surface-active agents** *n.* Substances that, when used in small quantities, modifies the surface properties of liquids or solids. A surface-active agent reduces surface tension in a fluid or the interfacial tension between two immiscible fluids, such as oil and water. Surfactants are particularly useful in accomplishing the wetting or penetration of solids by aqueous liquids and serve in the manner of detergent, emulsifying, or dispersing agents.
*See surfactants.*

**Surface area** *n.* Total area of the surface of all the particles in a mass of pigment; this is usually expressed in terms of $m^2/g$.

**Surface area (BET)** *n.* The total surface area of a solid calculated by the BET (Brunauer, Emmett, and Teller) equation, from nitrogen adsorption or desorption data obtained under specified conditions.

**Surface characteristics** *n.* All those properties attributable to surfaces, such as roughness, adsorptivity, coefficient of friction, surface energy, and chemical activity.

**Surface charge** *n.* The electrical charge on the surface of a substance.

**Surface conditioner** *n.* Preparatory coating applied to a chalked surface to bind chalk to the substrate, prior to top coating.

**Surface conductance** *n.* The direct-current conductance (A/V) between two electrodes in contact with a specimen of solid insulating material when the current is passing only through a thin film of moisture on the surface of the specimen.

**Surface density of electricity** *n.* Quantity of electricity per unit area.

**Surface density of magnetism** *n.* Quality of magnetism per unit area.

**Surface drying** *n.* The pre-mature drying of the surface of a liquid coating film, so that the under portion is retarded in drying. *See drying* (1) *and drying time.*

**Surface energy** *n.* (1) The free energy of the surfaces at an interface that arises because of differences in the tendencies of each phase to attract its own molecules. (2) The work that would be required to increase the surface area of a liquid by one unit area (3) An alternate aspect of surface tension.

**Surface pin** Syn: ejector-return pin.

**Surface preparation** *n.* A physical and/or chemical preparation of an adherent to render it suitable for adhesive joining.

**Surfacer** *n.* Pigmented composition for filling minor irregularities to obtain a smooth, uniform surface preparatory to applying finish coats; usually applied over a primer and sandpapered for smoothness. Some types combine the properties and functions of both a primer and a surfacer and are called primer surfacers.

**Surface resistivity** *n.* The electrical resistance between two parallel electrodes in contact with the specimen surface and separated by a distance equal to the contact length of the electrodes. The resistivity is therefore the quotient of the potential gradient, in V/m, and the current per unit of electrode length, A/m. Since the four ends of the electrodes define a square, the lengths in the quotient cancel and surface resistivities are reported in "ohms per square". For reproducibility of results, specimens must be carefully cleaned and dried, and protected from contamination.

**Surface tensiometer** *n.* An instrument used to measure surface and interfacial tensions of liquids.

**Surface tension** (1876) *n.* (1) (free-surface energy, surface energy) The work required to increase the surface of a solid or liquid (in contact with air) by one unit of area. Surface energy and surface tension are equivalent terms, but with liquids it is possible to measure directly the surface tension. The unit still in common use is dyne per centimeter, equal to 0.001 N/m, or, in surface-energy terms, 0.001 J/m2. Surface tension is measured with a *tensiometer* or by capillary rise. Surface energies of plastics are determined indirectly by observing the angles of contact of a graded series of increasingly polar liquids of known surface tension on the plastic surface (*see ASTM D* 2578), then applying regression analysis to determine the polar and non-polar components of surface energy. The surface energy is the sum of the two components. (2) The tension exhibited by the free surface of liquids measured in dyne per centimeter. (3) The tension exhibited by the free surface of liquids, measured in dyne per centimeter. Surface tension can be expressed as the total force along a line of length *l* on the surface of a liquid whose surface tension is *T*,

$$F = lT.$$

*Capillary tubes* – If a liquid of density $d$ rises a height h in a tube of internal radius $r$ the surface tension is,

$$T = \frac{rhdg}{2}.$$

The tension will be in dyne per cm is $r$ and $h$ are in cm, $d$ in g/cm$^3$ and $g$ in cm/s$^2$. *Drops and bubbles* – Pressure in dyne/cm$^2$ due to surface tension on a drop of radius $r$ cm for a liquid whose surface tension is $T$ dyne/cm.

$$P = \frac{2T}{r}.$$

For bubble of mean radius $r$ cm,

$$P = \frac{4T}{r}.$$

**Surface treating** *n.* Any method of treating a plastic surface to render it more receptive to adhesives, paints, inks, lacquers, or to other surfaces in laminating processes. The two methods in widest use are corona-discharge treating and flame treating. *See also casing, ion plating, irradiation, and plasma etching.*

**Surfacing mat** *n.* A very thin mat, usually 0.2–0.5 mm thick, of highly filamentized glass–fiber used primarily to produce a smooth, strong surface on a reinforced-plastic laminate.

**Surfactant** \(ˌ)sər-ˈfak-tənt\ [*surf*ace-*act*ive + -*ant*] (1950) *n.* Contracted from surface-active agents, these are additives which reduce surface tension and may form micelles and thereby improve wetting (wetting agents); help disperse pigments (dispersants); inhibit foam (defoamers); or emulsify (emulsifiers). Conventionally, they are classified as to their charge; anionic (negative); cationic (positive); non-ionic (no charge) or amphoteric (both positive or negative).

**Surging** *n.* Any irregularity in the output rate of an extruder. Extrusion engineers have recognized two kinds: long- and short-period surging. Long-period surging has been traced to diurnal changes in electrical supply an environmental conditions, while short-period surging, which has sometimes been so serious as to interrupt flow, is attributed to many causes such as bridging of pellets in the feed throat or compression section of the screw, too abrupt transition between deep feed flights and shallow metering flights, inadequate melting capability for the rate attempted, improper profile of barrel temperatures, voltage surges because of large loads coming on or going off the line, and changing character of feedstock loaded from bags into the hopper. In tracking down and correcting the causes of surging, it is imperative for the extruder to be equipped with instruments that sense melt temperature and pressure at the head, screw speed, extrusion rate, and either screw torque or motor kilowattage, with recorders or computer data acquisition to record these quantities.

**Surimono** (Japanese) *n.* A print, generally of small size and on thick soft paper, intended as a festival greeting or memento of some social occasion.

**Surlyn®** {*tradename*}. Trade name for an ionomer.

**Surlyn A** *n.* Ionomer (co-polymer from ethylene + some acrylic acid or maleic anhydride). Manufactured by DuPont, USA.

**SUS** *n.* Abbreviation for second, Saybolt universal. Viscosity is expressed in SUS, as determined by the Standard Method of

Test for Saybolt Viscosity, ASTM D 88, and may be determined by use of the SUS conversion tables specified in ASTM Method D 2161, following determination of viscosity in accordance with the procedures specified in the standard method of test viscosity of transparent and opaque liquids.

**Susceptibility (magnetic)** *n.* Measured by the ratio of the intensity of magnetization produced in a substance to the magnetizing force or intensity of field to which it is subjected. The susceptibility of a substance will be unity when unit intensity of magnetization is produced by a field of 1 G. Dimension $[\varepsilon^{-1} L^{-2} T^{2}]$, $[\mu]$.

**Suspending agent** *n.* A material used in a paint to improve its resistance to the settling of pigments.

*See anti-settling agent.*

**Suspension** *n.* A fluid medium with fine particles of any solid more or less stably dispersed therein. The particles are called the *disperse phase*, and the suspending medium is called the *continuous phase*. When the particles do not settle out and are small enough to pass through ordinary filters, the suspension is called a *colloid* or *colloidal suspension*. Solid particles suspended in air or other gas, particularly solid particles arising from burning, are called a *smoke*. In the plastics field, a suspension is essentially synonymous with dispersion.

*See also colloid and emulsion.*

**Suspension polymerization** (pearl, bead, or granular polymerization) *n.* A polymerization process in which the monomer, or mixture of monomers, is dispersed by mechanical agitation in a second liquid phase, usually water, in which both monomer and polymer are essentially insoluble. The monomer droplets are polymerized while maintained in dispersion by vigorous agitation. Polymerization initiators and catalysts used in the process are generally soluble in the monomer. According to the type of monomer, emulsifier, protective colloid, and other modifiers used, the resulting polymer may be in the form of pearls, beads, soft spheres, or irregular fine granules that are easily separated from the suspending medium when agitation is stopped. Suspension polymerization is used primarily for PVC, polyvinyl acetate, polymethyl methacrylate, polytetrafluoroethylene, and polystyrene.

**Sustained-pressure test** *n.* In testing pipe or tubing, subjecting the specimen to constant internal pressure over a long time, up to 1000 h or more, during and after which changes in diameter, wall thickness, and appearance are noted. It is a special-purpose creep test.

**Sward–Zeidler rocker** *n. See rocker hardness tester.*

**Swarf** \ˈswórf\ [of Scan origin; akin to ON *svarf* file dust; akin to OE *sweorfan* to file away] (1587) *n.* The work piece cuttings, dust, oil, grain particles, etc., created by abrading action of sandpaper, etc.

**Swatch** \ˈswäch\ [origin unknown] (1647) *n.* A piece of fabric used as a representative sample of any fabric.

**Sweating** *n.* (1) Exudation of oily matter from a film of paint, varnish, or lacquer after the film has apparently dried. (2) On a paint or varnish film, the development of gloss on a dull or matte finish; caused by rubbing the film. (3) Development of gloss in a dry film of paint or varnish after it has been flatted down (sanding). (4) Often incorrectly used to describe condensation of moisture from humid atmospheres on relatively cold surfaces, e.g., walls.

**Swedish oil** \ˈswē-dish-\. *See tall oil.*

**Swedish olein** *See tall oil.*

**Swedish pine oil** *See tall oil.*

**Swedish resin** *See tall oil.*

**Swedish rosin** *See tall oil.*

**Swedish rosin oil** *See tall oil.*

**Sweep blast** *n.* *See NACE* No. 4 *brush-off blast cleaned surface finish.*

**Swelling** *n.* (1) Volume expansion of a material specimen or manufactured article due to a rise in temperature (*see coefficient of thermal expansion*) or absorption of water or other liquid. It is usually expressed as a percentage of the original volume or, sometimes, as percentage change in lineal dimensions. (2) Extrudate swelling.

**Swirl** \ˈswər(-ə)l\ (15c) *n.* A term applied to visual and tactile surface roughness sometimes observed in the structural-foam-molding process. It results from jetting at the gate of the mold, causing surface wrinkling as the polymer melt flows along the wall of the mold. The condition can be alleviated by measures such as reducing the filling speed and raising the temperature of melt and/or mold.

**Syenite** \ˈsī-ə-ˌnīt\ [L *Syenites* (*lapis*) stone of Syene, fr. *Syene*, ancient city in Egyptian] (ca. 1796) *n.* An igneous rock composed primarily of alkali feldspar together with other minerals, such as hornblende.

S

**Sylvic acid** *See abietic acid.*

**Sylvic oil** *See tall oil.*

***Sym-*** (*s*-). Prefix abbreviation for symmetrical, referring to the relative location of atoms, chain groups, or substituents groups in a cyclic compound. Two examples are *sym*-trioxane, 1,3,55-$(\mathrm{CH_2O})_3$, and 1,3,5-trinitrobenzene (the corresponding 1,2,4-isomer in each case being unsymmetrical). The prefix is usually ignored in alphabetizing lists of compound names.

**Symbiont** \ˈsim-bē-ˌänt\ [prob. fr. Gr, mod. of Gk *symbiount-*, *symbiōn*, pp of *symbioun*] (1887) *n.* An organism which lives in a state of symbiosis.

**Symbiosis** A living together of dissimilar organisms.

**Symbiotic** Living in that relation called symbiosis.

**Sympathetic ink** *n.* Inks that give markings which become invisible and can be made visible by the use of a developing solution.

**Syndet** \sin-ˈde\ *n.* A contraction for the term "synthetic detergent" used loosely to signify synthetic detergents or compositions containing synthetic detergents.
*See detergent.*

**Syndiotactic** *n.* Derived from the Greek words *syndio*, meaning "every other" and *tattoo*, meaning "to put in order". The term refers to polymers having alternating, different substituent groups along the chain capable of exhibiting mirror-image symmetry (*see enantiomer*). The polymer structure has such groups attached to the backbone chain in an order a–b–a–b– on one side of the chain and b–a–b–a– on the other.
*See also isotactic and tacticity.*

**Syndiotactic polymer** *n.* A tactic polymer in which the conventional base unit possesses, as a component of the main chain, a carbon atom with two different lateral substituents, these substituents being so arranged that a hypothetical observer advancing along the bonds constituting the main chain finds opposite steric configurations around these chain atoms in successive conventional base units. *Note*—The true base unit is thus twice the size of the conventional base unit.
*See syndiotactic, tactic polymer, atactic polymer, and isotactic polymer.*

**Syneresis** \sə-ˈner-ə-səs\ [LL *synaeresis*, fr. Gk *synairesis*, fr. *synairein* to contact, fr. *syn-* +

*harein* to take] (ca. 1577) *n.* The separation of liquid from a gel. The spontaneous exudation or squeezing out of solvent or diluents as a separate phase, which may occur when a gel stands undisturbed; the gel structure slowly densifies but there is no net volume change in the system.

**Synergism** [NL *synergismus*, fr. Gk *synergos*] (1910) *n.* A phenomenon wherein the effect of a combination of two ingredients (or other experimental factors) is greater than the sum of their individual effects, or, in the case of polymer blends or composites, then would be estimated by a simple law of mixtures. For example, some stabilizers and some fire retardants for plastics have a mutually reinforcing effect and are thus termed synergistic. Similarly, some plastic alloys have higher strength than either of the neat resins.

**Synergistic** (ca. 1847) *adj.* Relating to the cooperative action of two or more discrete agencies such that their combined effect is different than the sum of the effects due to the individual agencies.

*See synergism.*

**Synergy** (1660) *n. See synergism.*

**Syntactic foam** \sin-ˈtak-tik\ (cellular mortar) *n.* A term applied to composites of tiny, hollow spheres in a resin or plastic matrix. The spheres are usually of glass, although phenolic microspheres were used in the early years of the art. The resin most used is epoxy, followed by polyesters, phenolics, and PVC. Syntactic foams of the most common type – glass microspheres in a binder of high-strength thermosetting resin – are made by mixing the spheres with the fluid resin, its curing agent, and other additives, to form a fluid mass that can be cast into molds, troweled onto a surface or incorporated into laminates. After forming, the mass is cured by heating. These foams are characterized by densities lower than those of the matrix resins, ranging from 0.57 to 0.67 g/cm$^3$, and very high compressive strengths. Their first applications were for deep-submergence buoys capable of withstanding depths of 6000 m. When both gas bubbles *and* hollow glass spheres are used in the same mixture, the resulting composite has been called a *diafoam.*

**Synthetic** \sin-ˈthe-tik\ [Gk *synthetikos* of composition, component, fr. *synthithenai* to put together] (1697) *adj.* Substances resulting from synthesis rather than occurring naturally.

**Synthetic detergent** *n.* A detergent produced by chemical synthesis and comprising an organic composition other than soap. Often contracted to syndet.

**Synthetic fiber** (man-made fiber) *n.* A class name for various fibers (including filaments), distinguished from natural fibers such as wool and cotton, produced from fiber-forming substances which may be: (1) Modified or transformed natural polymer, e.g., alginic and cellulose-based fibers such as acetates and rayon's. (2) Polymers synthesized from chemical compounds, e.g., acrylic, nylon, polyester, polyurethane, polyethylene, polyvinyl, and carbon/graphite fibers. (3) Fibers of mineral origin, e.g., glass, quartz, boron, and alumina.

**Synthetic magnetite** *See black iron oxide.*

**Synthetic paint** *n.* A vague term which sometimes means paints containing synthetic resins rather than naturally occurring oils or gums in the vehicle. The use of this term is deprecated.

**Synthetic "papers"** *n.* Non-cellulosic "papers" are film-based. The main plastics being used or studied for this purpose are polystyrene, polypropylene, high-density polyethylene, and polyvinyl chloride.

**Synthetic pine oil** *See pine oil.*

**Synthetic resin** (1907) *n.* Complex, substantially amorphous organic semi-solid or solid material built up by chemical reaction of simple molecules.

*See resin, synthetic.*

**Synthetic rubber** *n.* An elastomer manufactured by a chemical process, as distinguished from natural rubber obtained from trees; rubber like with respect to its degree of elasticity.

**Synthetic yellow ocher** *n.* Synthetic yellow iron oxide reduced with aluminum silicate and other extender pigments.

*See iron oxides, synthetic.*

**Syrian asphaltum** \ˈsir-ē-ə as-ˈfól-təm, *esp British* -ˈfal-\ *n.* Natural asphaltum mined near Damascus. It is not readily soluble in petroleum hydrocarbons, and its value to the paint trade is limited.

*Known also as Egyptian asphaltum.*

**System** \xsis-tem\ [LL *systemat*-, *systema*, fr. Gk *systēmat*-, *systēma*, fr. synistanai to combine, fr. *syn*- + *histanai* to cause to stand] (1603) *n.* A portion of the universe under observation or consideration.

# T

**t** \ˈtē\ {*often capitalized, often attributive*} (before 12c) *n.* Symbol for elapsed time, for thickness, or for Student's *t*.

**T** (1) Symbol for torque. (2) SI abbreviation for tera-.

**Taber abraser** *n.* An instrument used to measure abrasion resistance. Specimen on a turntable rotates under a pair of weighted abrading wheels that produce abrasion through sideslip. This is a product of Taber Industries Inc., www.taberindustries.com. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

*See also wear cycles.*

**Tab gate** *n.* In injection molding, a small removable tab of approximately the same thickness as the molded item usually located perpendicularly to the item. The tab is used as a site for edge-gate location, typically on items with large flat areas.

**Tablet** \ˈta-blət\ [ME *tablett*, fr. MF *tablete*, dim. of *table* table] (14c) *n.* A shape having opposite faces at least 4× but less than 1× greater than the other faces.

**Tablet test** *n. See flammability tests, methenamine pill test.*

**Tab out** *n.* A spot of ink applied to paper by a finger, using tapping action to distribute the ink to approximately printing film thickness.

**TAC** Abbreviation for triallyl cyanurate.

**Tacciometer** *n.* A device for measuring the surface stickiness or tackiness of a dried paint or varnish film. It operates on the principle that a suitably weighted piece of paper will or will not adhere to the coated surface. The instrument consists of three steel balls, which are placed on the paper, and these can be loaded further as required until on removing the load and the balls, the paper shows signs of adhering. The time during which the loaded paper is left in contact with the surface under test is usually specified, because the longer the time of contact, the greater the tendency for the paper to adhere.

**Tack** \ˈtak\ [ME *tak* something that attaches; akin to MD sharp point] (1574) *n.* (1) The pull-resistance exerted by a material adhering completely to two separating surfaces. In liquids, tack is a function of viscosity; in non-elastic plastic materials, tack (*tackiness*) is a function of plastic viscosity (sometimes *viscoelasticity*) and yield value. Cohesion becomes negligible since rupture occurs at very small areas. (2) Slight stickiness of the surface of a film of paint, varnish, or lacquer, apparent when the film is pressed with the finger. (3) A relative measurement of the cohesion of an ink film, which is responsible for its resistance to splitting between two rapidly separating surfaces. (4) The natural adhesiveness of rubber in the raw state. Also, the property of raw or compounded rubber, which causes layers of stock to cohere. It is a desirable property only when adhesion or cohesion is desired. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

*Also see ASTM (www.astm.org) for current standard method of testing.*

**Tack coat** *n.* An application of bituminous material to an existing, relatively absorbent surface, to prevent slippage planes, and to provide bond between the existing surface and the new surfacing.

**Tack, dry** *n.* The property of certain adhesives, particularly non-vulcanizing rubber adhesives, to adhere on contact to themselves at a stage in the evaporation of volatile constituents, even though they seem dry to the touch.

*Sometimes called aggressive tack.*

**Tack-free** *adj.* Freedom from tack of a coating after suitable drying time. In some cases, coatings are tack-free after application; tack does not develop until a little later.

*See tack and drying time.*

**Tackifier** *n.* A substance (e.g., rosin ester) that is added to synthetic resins or elastomeric adhesives to improve the initial tack and extend the tack range of the deposited adhesive film.

**Tackiness** *n.* The property of being sticky or adhesive.

**Tack rag** *n.* Fabric impregnated with a tacky substance such as a delayed drying varnish, which is used to remove dust from a surface after rubbing down and prior to further painting. Tack rag should be stored in an air-tight container to conserve its tackiness.

**Tack range** *n.* Period of time in which an adhesive will remain in the tacky-dry condition after application to an adhered, under specified conditions of temperature and humidity.

**Tacky** *v.* (1) That stage in the drying of a paint at which the film appears sticky when lightly touched with the finger. (2) Having a tack.

*Also called tacky dry.*

**Tacky-dry** *adj.* Pertaining to the condition of an adhesive when the volatile constituents have evaporated or been absorbed sufficiently to leave it in a desired tacky state.

**Tactic block** *n.* In a polymer, a regular block that can be described by only one species of configurational repeating unit in a single sequential arrangement.

**Tactic block polymer** *n.* A polymer whose molecules consist of tactic blocks connected linearly.

**Tacticity** \ˈtak-ti-ˌci-tē\ *n.* (1) The orderliness of the succession of configurational repeating units in the main chain of a polymer molecule. (2) Any type of regular or symmetrical molecular arrangement in a polymer structure, as opposed to random positioning of substituents groups along a polymer backbone. (3) The stereo specific configuration of a polymer containing repeating asymmetric centers. An *isotactic* polymer has the same configuration (orientation in space) at each asymmetric center while a *syndiotactic* polymer has alternating configurations at sequential asymmetric centers. An *atactic* polymer has no repeating stereo regularity of asymmetric centers. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See also stereo specific.*

**Tactic polymer** *n.* A polymer in which there is an ordered structure with respect to the configurations around at least one main-chain site of steric isomerism per conventional base unit. *Note*—The carbon (or other) atom in the chain at the site of the steric isomerism need not in a strict sense be an asymmetric atom, since in a chain of infinite length the two chain portions may be considered as equivalent; however, for the purpose of this definition, such atoms are referred to as asymmetric atoms.

*See syndiotactic polymer, isotactic polymer, and atactic polymer.*

**Taffeta** \ˈta-fə-tə\ [ME, fr. MF *taffetas*, fr. OIt *taffetà*, fr. Turkish *tafta*, fr. Persian *tāftah* woven] (14c) *n.* A plain-weave fabric with a fine, smooth, crisp hand, and usually a lustrous appearance. Taffeta fabric usually has a fine cross rib made by using a heavier filling yarn than warp yarn. Taffetas are produced in solid colors, yarn-dyed plaids and stripes, and prints. Changeable and moiré effects are often employed. Although originally made of silk, manufactured fibers are now often used in the production of taffeta.

**Tag closed tester** *n.* An instrument for determining the flashpoint of a liquid which has a viscosity of less than 45 SUS at 47.8°C (100°F), does not contain suspended solids and does not have a tendency to form a surface film while under test. Reference Standard Method of Test ASTM D 56 for Flashpoint by Tag Closed Tester.

**Tail** *n.* (1) Highest boiling solvent fraction. (2) Elongated, somewhat pointed extension of the lower portion of the rising bubble in a bubble tube viscometer, characteristic of a varnish or resin solution that is near or approaching gelation or which has a peculiar rheological characteristic,

**Tailings** *n.* The remains, residues, or final products produced on refining any substance. Syn: bottoms, foots.

**Tails** *n.* Finger-like spray pattern.

**Tak dyeing** *See kusters dyeing range.*

**Take-off** *n.* The mechanism for drawing extruded or calendared material away from the extruder or calendar. The most common form of extrusion take-off is a pair of endless caterpillar belts with resilient grip pads conforming to the section being extruded, driven at a speed synchronized with that of the extrudate.

**Take-up (twist)** *n.* The change in length of a filament, yarn, or cord caused by twisting, expressed as a percentage of the original (untwisted) length.

**Take-up (yarn-in-fabric)** *n.* The difference in distance between two points in a yarn as it lies in a fabric and the same two points after the yarn has been removed from the fabric and straightened under specified tension, expressed as a percentage of the straightened length. In this sense, take-up is contrasted to the crimp of a yarn in a fabric, which is expressed as a percentage of the distance between the two points in the yarn as it lies in the fabric. Take-up is generally used in connection with greige fabric.

**Talc** \talk\ [MF *talc* mica, fr. ML *talk*, fr. Arabic *ṭalq*] (1610) (steatite, talcum) *n.* $Mg_3SI_4O_{10}(OH)_2$. A natural hydrous magnesium silicate, sometimes used as a filler. *See magnesium silicate, non-fibrous.*

**Talloel** *See tall oil.*

**Tall oil** \ˈtäl, ˈói(ə)l\ [part trans. of Gr *Tallöl*, part trans. Swedish *tallolja*, fr. tall pine + *olja* oil] *n.* A generic name for a number of products from the manufacture of wood pulp by the alkali process sulfate or kraft process. To provide some distinction between the various products, designations are often applied in accordance with the process or composition, some of which are crude tall oil, acid refined tall oil, distilled tall oil, tall oil fatty acids, and tall oil rosin. The following designations for tall oil shall be considered obsolete: crude resinous liquid, finn oil, liquid resin, liquid rosin, resin oil, sulfate pitch, sulfate resin, sulfate rosin, Swedish pine oil, Swedish resin, Swedish rosin, Swedish rosin oil, Sylvic oil, talloel, tallol, Swedish oil, fluid resin, and Swedish olein.

**Tall oil, acid refined** *n.* Product obtained by treating crude tall oil in solvent solution with sulfuric acid under controlled conditions to remove dark color bodies and odoriferous materials. Removal of the solvent yields a product with lighter color and higher viscosity than crude tall oil with approximately the same fatty acids-to-rosin ratio.

**Tall oil, crude** *n.* Dark brown mixture of fatty acids, rosin, and neutral materials liberated by the acidification of soap skimming.

The fatty acids are a mixture of oleic acid and linoleic acid with lesser amounts of saturated and other unsaturated fatty acids. The rosin is composed of resin acids similar to those found in gum and wood rosin. The neutral materials are composed mostly of polycyclic hydrocarbons, sterols and other high-molecular weight alcohols.

**Tall oil, distilled** *n.* Class of products obtained by distilling crude tall oil in fractionating equipment under reduced pressure under such conditions that the ratio of rosin acids to fatty acids is varied over a wide range. The products, which generally contain less than 90% of fatty acids are known as distilled tall oils. The fatty acids are a mixture of oleic and linoleic acids with lesser amounts of saturated and other unsaturated fatty acids. The remainder consists of rosin and neutral materials.

**Tall oil fatty acids** *n.* Class of products generally containing 90% or more fatty acid obtained by fractionization of crude tall oil; The fatty acids are a mixture of oleic and linoleic acids with lesser amounts of saturated and other unsaturated fatty acids. The remainder consists of rosin and neutral materials. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, 2001.

**Tall oil heads (light ends)** *n.* Low-boiling fractions obtained by the fractional distillation of crude tall oil under reduced pressure. The composition of these products varies over a wide range but contains palmitic, oleic, linoleic, and stearic acids together with lesser amounts of other saturated and unsaturated fatty acids. The neutral materials content is normally high. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, 2001.

**Tall oil pitch** *n.* Undistilled residue from the distillation of crude tall oil. It is generally recognized that tall oil pitches contain some high-boiling esters and neutral materials with lesser amounts of rosin and fatty acids. Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York.

**Tall oil rosin** *n.* Rosin remaining after the removal of substantially all of the fatty acids from tall oil by fractional distillation or other suitable means. Such rosin shall have the characteristic form, appearance and other physical and chemical properties normal for other kinds of rosins. The fatty acid content shall not exceed 5%.
*See rosin.*

**Tall oil soap** *n.* Product formed by the saponification or neutralization of tall oil with organic or inorganic cases.

**Tallol** *See tall oil.*

**Tan** \ˈtan\ [F, tanbark, fr. OF, fr. ML *tanum*] (1674) *n.* (1) A light or moderate yellowish brown to brownish orange. (2) Japanese. A brick-red or orange color, consisting of red oxide of lead.

**Tan of dielectric loss angle** *n.* In an ideal condenser of geometric capacitance $C_0$, in which the polarization is instantaneous, the charging current $E\omega\varepsilon' C_0$ is 90° out of phase with the alternating potential. In a condenser in which absorptive polarization occurs, the current also has component $E\omega\varepsilon'' C_0$ in phase with the potential and determined by Ohm's law. This ohmic or loss current, which measures the absorption, is due to the dissipation of part of the energy of the field as heat. In vector notation, the total current is the sum of the charging current and the loss current. The angle $\delta$ between the vector for the amplitude of the total current and that for the amplitude of the charging current is the loss angle, and the tangent of this angle is the loss tangent of dielectric loss angle:

$$\tan\,\delta = \frac{\text{loss current}}{\text{charging current}} = \frac{\varepsilon''}{\varepsilon'},$$

where $\varepsilon'$ is the measured dielectric constant of the dielectric material in the condenser and $\varepsilon''$ is the imaginary part of the dielectric constant, commonly known as the loss factor or loss index.Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Tandem extruder** *See extruder, tandem.*

**Tandem line** *n.* In the coil coating field, a roller coat line with two coaters capable of applying and baking two coats (i.e., primer and enamel) prior to recoiling.

**Tangent modulus** *n.* The slope of the curve at any point on a static stress–strain graph ($d\sigma/d\varepsilon$) expressed in pascals per unit of strain. This slope is the tangent modulus in whatever mode of stress the curve has arisen from – tension compression, or shear. [Since strain is dimensionless, the unit given for modulus is normally just stress (Pa)]. Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York.

**Tanglelaced fabric** *See spunlaced fabric.*

**Tank coating** *n.* Paint used for the inside of tankers.

**Tank white** *n.* Good hiding, self-cleaning white paint for exterior metal surfaces.

**Tannin** \ˈta-nən\ [F, fr. *tanner* to tan] (1802) *n.* Organic acid obtained in the form of brownish white scales from gall nuts, sumac, and other plants used in dyeing, tanning, etc.

**Tan-ye (Japanese)** *n.* A print in which tan is the only or chief color used. Such prints, in which the tan was applied by hand, were among the earliest productions.

**Tape** *n.* (1) A narrow, woven fabric not over 8 in. in width. (2) In slide fasteners, a strip of material, along one edge of which the bead and scoops are attached, the bead sometimes being integral with the strip.
*Also see slit tape and non-elastic woven tape.*

**Taper** *n.* (1) In a conical transition section of an extruder screw, the vertex angle of the axial cone defined by the increasing root diameter of the screw. Compare with helical transition. (2) Often used. Syn: draft in molds.

**Tapered pattern** *n.* Elliptical-shaped spray pattern; a spray pattern with converging lines.

**Taper pin** *n.* A slightly conical, hard steel dowel driven into matting holes drilled into the contact faces of adjacent major machines components, after the components have been aligned, to preserve alignment. At least two pins are normally used at each such interface.

**Tape test** *n.* A type of adhesion test consisting of the application of an adhesive tape to a dried coating and rapidly removing the tape with a swift, jerking motion. The coating can be either scribed or unscribed, depending on the specification. The "wet adhesion" test for latex paints is performed by first wetting the paint with a specified quantity of water for the specified time and blotting off the excess surface water. The tape test is made immediately after blotting.

**Tape yarn** *See slit-film yarn.*

**Tap-out** *n.* Spot of ink applied to paper by a finger, using tapping action to distribute the ink to approximately printing film thickness. With experience, one can determine whether ink has the proper tack and working properties, and also can use the tap-out in color matching.
*Also called pat-out.*

**Tar** \ˈtär\ [ME *terr, tarr*, fr. OE *teoru*; akin to OE *trēow* tree] (before 12c) *n.* Brown or black bituminous material, liquid, or semisolid in consistency, in which the predominating constituents are bitumens obtained as condensates in the destructive distillation of coal, petroleum, oilshale, wood, or other organic materials, and which yields substantial quantities of pitch when distilled.

**Tar acid** *n.* Phenol or its homologues either individually or blended together. Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York.

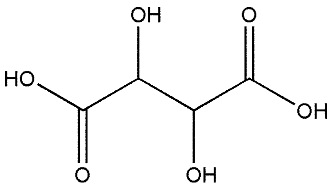
**Tar and gravel roofing** *See built-up roofing.*

**Tare** \ˈtar, ˈter\ [ME, fr. MF, fr. OIt *tara*, fr. Arabic *ṭarḥa*, literally, that which is removed] (15c) *n.* The weight of all external and internal packing material (including bobbins, tubes, etc.) of a case, bale, or other type of container.

**Tarpaulin** \tär-ˈpó-lən\ [prob. fr. $^{1}$*tar* + -*palling*, -*pauling* fr. *pall*] (1605) *n.* A water-resistant fabric used to protect loads or materials from the elements. Tarpaulin may be a coated fabric, a fabric with waterproof finish, or a fabric that is tightly constructed to prevent water penetration.

**Tar spirit** *n.* A powerful solvent of varying composition and properties obtained by distillation of wood tar. Boiling range is extended and has been known to vary from about 70 to 80°C to practically 260°C. Tar spirits have sharp penetrating odors, dark colors, and a pronounced tendency to attack mild steel containers.

**Tartaric acid** \(ˌ)tär-ˈtar-ik-\ (1810) *n.* COOHCH(OH)·CH(OH)COOH. Dihydroxydicarboxylic acid used in the preparation of plasticizers. Melting point, 169°C.



**Taslin® process** *n. See texturing, air jet method.*

**T-bend flexibility test** *n.* Simple method for determining the flexibility of coatings by bending a coated metal test strip over itself. A panel is bent and pressed flat by means of a jig to achieve a 180° bend. Subsequent folds are equivalent to bending the panel around a rod of diameter equal to the thickness of the panel.

**TBEP** *n.* Abbreviation for tributoxyethyl phosphate.

**TBT** *n.* Abbreviation for tetrabutyl titanate.

**TBTF** *n.* Abbreviation for tributyltin fluoride.

**TBTO** *n.* Abbreviation for tributyltin oxide.

***t*-Butyl peroxy neodecanoate** *n.* A polymerization initiator for vinyl chloride.

***t*-Butyl peroxy pentanoate** *n.* A peroxyester catalyst.

***t*-Butyl perphthalic acid** *n.* $(CH_3)_3CO_2{\cdot}CO$ $C_6H_4COOH$. A polymerization catalyst.

**TCE** *n.* Abbreviation for trichloroethylene.

**TCEF** *n.* Abbreviation for trichloroethyl phosphate, a plasticizer.

**TCP** *n.* Abbreviation for tricresyl phosphate.

**TDI** *n.* Abbreviation for toluene diisocyanate, an 80–20 mixture of the 2.4- and 2.6-isomers.

*See also toluene*-2,4-*diisocyanate and diisocyanate.*

**T-Die** *n.* A center-fed, slot die for extrusion of film whose horizontal cross section, together with the die adapter, resembles the letter T.

**Tear** *See run.*

**Teardrop die** *See manifold.*

**Tear resistance, strength** *n.* Resistance to tear shearing of a films or fabric material.

**Tear strength** *n.* The force or stress required to start or continue a tear in a fabric or plastic film.

*See elmendorf tear strength.*

**Tea seed oil** *n.* Non-drying oil. Iodine value, 90.

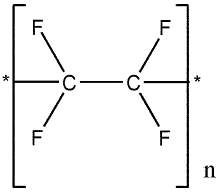
**Teasel burr** *n. See napping.*

**Tedlar** *n.* Poly(vinyl fluoride), manufactured by DuPont.

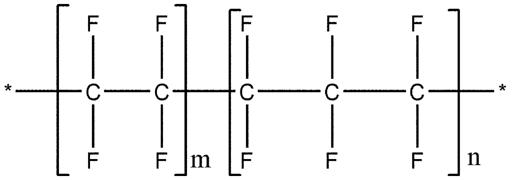
**Teel oil** *See sesame oil.*

**Teeth** *n.* The resultant surface irregularities or projections formed by the breaking of filaments or strings which may form when adhesive-bonded substrates are separated.

**Teflon®** \ˈte-ˌflän\ *n.* (1) A polymer of fluorinated ethylene. Very inert, and in the form of a film or an impregnator, used for its heat-resistant and non-sticking properties. (2) Trade name for fluorocarbon resins, including polytetrafluoroethylene, perfluoropropylene resin, and co-polymers, manufactured by DuPont.



**Teflon FEP** *n.* Co-polymer from tetrafluoroethylene and hexafluoropropylene, manufactured by DuPont.



**Tego** *n.* Phenoplast, manufactured by Resinous Products, USA.

**Tekaol** *n.* Linseed stand oil from which the low-polymerized (saturated) highly dispersed phase has been removed.

**Telechelic polymers** *n.* A polymer having purposely introduced end groups of a particular chemical type, e.g., acetal homopolymer that has been "end-capped" by treatment with acetic anhydride.

**Telegraphing** *n.* A condition in a laminate or other type of composite construction in which irregularities, imperfections, or patterns of an inner layer are visibly transmitted to the surface. *Note*—Telegraphing is occasionally referred to as photographing.

*See photographing.*

**Telescopic flow** *n.* A picturesque name for laminar flow in a circular tube, derived from visualizing successively smaller cylindrical shells of liquid, from the tube wall toward the center, each moving faster than the next outer one, sliding like the tubes of a sectional telescope.

*See laminar flow and Poiseuille flow.*

**Telomer** \ˈte-lə-ˌmir\ [ISV] (1940) *n.* (1) Low molecular weight polymer in which the terminal group on the end of the chain-like molecule is not the same as the side group. (2) A polymer composed of molecules having terminal groups incapable of reacting with additional monomers, under the conditions of the synthesis to form larger polymer molecules of the same chemical type. (3) An oligomer formed by addition polymerization in the presence of excess chain-transfer agent (polymerization stopper) whose free radicals become the end groups of the telomer.

**Tempera** \ˈtem-pə-rə\ [It *tempera*, literally, temper, fr. *temperare* to temper, fr. L] (1832) *n.* (1) A rapidly drying paint consisting of egg white (or egg yolk, or a mixture of egg white and yolk), gum, pigment, and water; especially used in painting murals. (2) A method of painting using tempera.

**Temperature** *n.* (1) The measured relative Celsius and Fahrenheit temperature scales and the absolute temperature, Kelvin; an indication of the degree hotness; average velocity of molecules; at absolute zero, 0°K, all motion in matter stops molecular velocity is zero; (2) The property of a substance which determines the direction of heat flow into or out of the substance; heat flows from a substance of higher temperature to one of lower temperature. The temperature of a substance measures the average kinetic energy of its particles. The fundamental temperature scale is now defined by means of the equation

$$\theta(X) = 273.15^{\circ}\mathrm{K}\ X/X_3,$$

where $\theta$ denotes the temperature; $X$ the thermometric property ($P$, $V$, . . .); the subscript 3 refers to the triple point of water; and 273.16°K is the arbitrary fixed point for the temperature associated with the triple point of water. The ideal gas temperature $\theta$ (numerically equal to the Kelvin temperature) in particular, is defined by either of the two equations:

$$273.15^{\mathrm{o}} \lim_{P_3 \to 0} \frac{P}{P_3}, \mathrm{const.}\, V,$$

$$\theta = 273.15^{\mathrm{o}} \lim_{P_3 \to 0} \frac{V}{V_3}, \mathrm{const},\ P.$$

Lide DR (ed) (2004) CRC Handbook of chemistry and physics. CRC Press, Boca Raton, FL.

*See entropy and enthalpy relationships.*

**Temperature checking** *n.* Tests of finishes as applied to furniture. It is a film rupture at an angle to the run of the grain.

*Also referred to as cold checking.*

**Temperature coefficient of refractive index** *n.* The change in refractive index ($n$) with temperature. The degree of variation of n depends on the composition of the substance and the state of aggregation, e.g., whether it is a solid or a liquid. It is usually about 100× larger for liquids than for solids and about −0.0005/°C for liquids.

**Temperature, color** *See color temperature.*

**Temperature, correlated color** *See correlated color temperature.*

**Temperature, curing** *n.* The temperature to which an adhesive or an assembly is subjected to cure the adhesive (*see also temperature, drying, and temperature, setting*). *Note*—The temperature attained by the adhesive in the process of curing it (adhesive curing temperature) may differ from the temperature of the atmosphere surrounding the assembly (assembly curing temperature).

**Temperature, drying** *n.* The temperature to which an adhesive on an adherend or in an assembly or the assembly itself is subjected to dry the adhesive (*see also temperature, curing, and temperature, setting*). *Note*—The temperature attained by the adhesive in the process of drying it may differ from the temperature of the atmosphere surrounding the assembly (assembly drying temperature).

**Temperature, maturing** *n.* The temperature, as a function of time and bonding condition, which produces desired characteristics in bonded components. *Note*—The term is specific for ceramic adhesives.

**Temperature of zero birefringence** *n.* The temperature at which the refractive indexes of a material are equal in two perpendicular directions (longitudinally and transversely for a fiber).

**Temperature profile** *n.* (1) In extrusion or injection molding, the sequence of barrel temperatures from feed opening to head, sometimes presented as a plot of temperature versus longitudinal position, hence *profile*. (2) The sequence of metal temperatures across a sheet or film die, or around a large blown-film die. (3) The sequence of temperatures across the width of a slab of newly extruded or cast plastic foam, is indicated by temperature sensors placed laterally at the same depth in the foam. (4) In analysis of non-isothermal, laminar flow of very viscous liquids (e.g., polymer melts) within tubes and dies, the sequence of temperatures from the one sidewall through the center to the opposite sidewall at any point along the axis of flow. Such profiles have also been measured experimentally with traversing thermocouples.

**Temperature resistance coefficient** *n.* The ratio of the change of resistance in a wire due to a change of temperature of 1°C to its resistance at 0°C. Dimension $[\theta^{-1}]$.

**Temperature, setting** *n.* The temperature to which an adhesive or an assembly is subjected to set the adhesive (*see also temperature, curing, and temperature, drying*). *Note*—The temperature attained by the adhesive in the process of setting it (adhesive setting temperature) may differ from the temperature of the atmosphere surrounding the assembly (assembly setting temperature).

**Template polymerization** *n.* The polymerization of monomers attached in some ordered fashion to a template to produce a polymer with a precisely determined structure complementary to that of the template.

**Tenacity** \tə-ˈna-sə-tē\ (1526) *n.* A term used in yarn and textile manufacturing to denote the strength of a yarn or filament of a given size. Numerically it is the Newton of breaking force per tex of lineal density (replacing the deprecated old unit, grams per denier). In testing tenacity, the yarn is usually pulled at the rate of 0.5 cm/s. To convert g/denier to N/tex, multiply by 0.0883.

*Also see breaking tenacity.*

**Tenax** Poly[oxy-1,4-(2,6-diphenyl)-phenylene], manufactured by AKZO, The Netherlands.

**Tencel®** Registered trademark of Tencel Inc. for their brand of cellulosic staple fiber classified as lyocell.

*See lyocell fiber.*

**Tensile bar** (dogbone specimen, dumbbell specimen) *n.* Any of several kinds of test specimens made for use in tests of tensile stress versus elongation. There are two main types, both having ends that have two to three times the cross section of the central, or gauge-length section, this geometry guaranteeing that, because the force is the same everywhere along the bar, the stress will be much lower in the end sections than in the gauge section. This geometry prevents failure at the grips and confines the plastic deformation, if any, to the gauge section. The first type is of rectangular cross section perpendicular to the length, and may be machined from sheet stock or molded. These are well defined by ASTM (www.astm.org), which also specifies certain geometries for specimens taken from tubing and round-rod stock. The round-rod specimens typify the second geometry, in which the transverse cross sections are circular. The flat type, but smaller, is also called for in the tensile-impact test. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Tensile factor** *n.* The empirical factor $T \times E^{1/2}$ that describes the tenacity elongation exchange relationship for a large number of manufactured fiber systems.

**Tensile heat-distortion temperature** *n.* An obsolete misnomer for deflection temperature.

**Tensile hysteresis curve** *n.* A complex load–elongation, or stress–strain curve obtained: (1) when a specimen is successively subjected to the application of a load or stress less than that causing rupture and to the removal of the load or stress according to a predetermined procedure; or (2) when a specimen is stretched less than the breaking elongation and allowed to relax by removal of the strain according to a predetermined procedure.

**Tensile-impact test** *n.* An impact test that uses a pendulum striker to break a dog-bone-shaped test specimen, described in ASTM D 1822 and 1822M. It differs from the Izod impact test in two important aspects: (1) the specimen is not notched and (2) it is broken in simple tension rather than bending. For these reasons, its interpretation is more straightforward.

**Tensile modulus** *n.* Syn: Young's modulus.

*See modulus of elasticity.*

**Tensile product** *n.* The product of tensile strength and elongation at break. In a Hooke's-law material (which few if any plastics are), the tensile product is twice the energy to rupture, so is related to toughness. In a material that exhibits a long, flat region of ductile elongation at constant stress during the tensile test, the tensile product is closely equal to the *nominal* energy to break.

**Tensile properties** *n.* Tensile properties are: linear density, tenacity, knot tenacity, loop tenacity, breaking strength, tensile strength, elongation at break, tensile module, work to break, yield point, creep, and elasticity.

**Tensile recovery curve** *See tensile hysteresis curve.*

**Tensile-shear strength** *n.* A measure of the shear strength of an adhesive bond in which two members are bonded in a lap joint, then pulled at both ends until the joint fails in shear. The strength is reported as the tensile force divided by the shear area (Pa). A double lap joint may be specified. Many tests of tensile–shear strength are listed among the ASTM Standards (www.astm.org).

**Tensile strain** *n.* The relative length deformation exhibited by a specimen subjected to a tensile force. Strain may be expressed as a fraction of the nominal gauge length or as a percentage.

*Also see elongation.*

**Tensile strength** (ca. 1864) *n.* The maximum nominal stress sustained by a test specimen being pulled from both ends, at a specified temperature and at a specified rate of stretching. When the maximum nominal stress occurs at the yield point it shall be designated *tensile strength at yield.* When it occurs at break, it shall be designated *tensile strength at break.* The ASTM test for plastics is D 638 (metric, D 638M). The SI unit or tensile strength is the pascal (N/m$^2$), but trade publications in the USA are still clinging to the pound (force) per square inch (psi). The strengths of commercial plastics that are neither plasticized nor fiber-reinforced range from about 14 to 140 MPa (2–20 kpsi).

*See strength, tensile.*

**Tensile stress** *n.* The resistance to deformation developed within a specimen subjected to tension by external force. The tensile stress is commonly expressed in two ways, either as (1) the tensile strength, i.e., the force per unit cross-sectional area of the unstrained specimen, or as (2) tenacity, i.e., the force per unit linear density of the unstrained specimen. The latter is more frequently used in textile testing.

**Tensile test** *n.* A method of measuring the resistance of a yarn or fabric to a force tending to stretch the specimen in one direction.

**Tensiometer** \ˌten(t)-sē-ˈä-mə-tər\ [*tension*] (1912) *n.* An instrument, invented by P. L. Du Noüy in 1919, for measuring surface tension of liquids and interfacial tensions between immiscible liquids, consisting of a horizontal, platinum-wire ring suspended from the end of a slender cantilever beam whose movement is indicated by a pointer on a circular scale. To measure surface tension, one submerges the horizontal ring in the test liquid, and then carefully raises it by turning the knob and pointer until the meniscus lifted by the ring breaks. The pointer indicates the surface tension in d/cm ($=10^{-3}$ N/m).

*See surface tensiometer and ASTM (www.astm.org).*

**Tenter frame** *n.* A machine that dries fabric to a specified width under tension. The machine consists essentially of a pair of endless chains on horizontal tracks. The fabric is held firmly at the edges by pins or clips on the two chains that diverge as they advance through the heated chamber, adjusting the fabric to the desired width.

**Tentering** *v.* Biaxial orientation of film or sheet by means of a tentering frame.

**Tentering frame (tenter frame)** *n.* A machine that continuously stretches, simultaneously in two perpendicular directions, a temperature-conditioned film or sheet, imparting biaxial orientation. Clamps attached to endless chains grip the sheet on both edges and, while accelerating in the direction of sheet travel, also move outward from the longitudinal centerline. Stretch ratio is about 3–4 in. in each direction, with about the same factor of increase in strength and modulus over those of the unoriented sheet. Tentering is usually done shortly downstream from the sheet extruder, but can also be done on film or thin sheet that has been extruded, cooled, and wound into coils for storage, then later reheated to be oriented.

**Tenter mark** *See clip mark.*

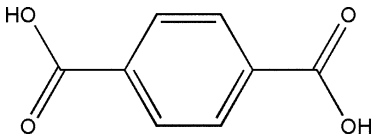
**Tera-(T)** The SI prefix meaning $\times 10^{12}$.

**Terebine** *n.* Form of liquid driers, originally made by combining linseed oil and natural resin with salts of lead and manganese and thinning with turpentine.

**Terephthalate polyester** \ˌter- ə(f)-ˈthaˉˌlāt, ˈpä-lē-ˌes-tər\ *n.* Any polymeric ester of terephthalic acid (1,4-benzene dicarboxylic acid), but in particular the three commercially important thermoplastic resins, polyethylene terephthalate, polybutylene terephthalate, and poly-cyclohexylene dimethylene terephthalate.

**Terephthaldehyde resin** *See polyester, saturated.*

**Terephthalic acid** \ˌter-ə(f)-ˈtha-lik ˈa-səd\ [ISV *tere*bene, mixture of terpenes from distilled turpentine + *phthalic acid*] (1857) (TPA, *para*phthalic acid, benzene-*p*-dicarboxylic acid) *n.* $C_6H_4(COOH)_2$. White crystals or powder, used in the production of alkyd resins and thermoplastic polyesters. Mol wt, 166.13, sublimes above 300°C without melting. Syn: *p*-phthalic acid, *p*-benzene-dicarboxylic acid.



**Terital** *n.* Poly(ethylene terephthalate), manufactured by Soc. Rhodiadoce, Italy.

**Terlenka** *n.* Poly(ethylene terephthalate), manufactured by AKU, The Netherlands.

**Terluran** *n.* High-impact poly(styrene) (graft polymer of styrene and acrylonitrile on styrene/butadiene co-polymer), manufactured by BASF, Germany.

**Termination** (chain termination) *n.* The final phase of a polymerization in which chain growth ends through reaction of polymeric free radicals with each other or with smaller entities.

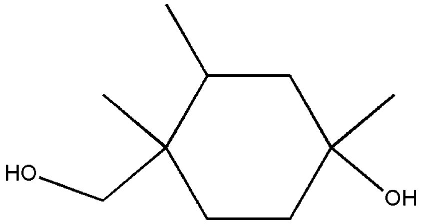
**Termolecular process** *n.* An elementary process in which the activated complex is formed from the simultaneous collision of three particles.

**Terpene** \ˈtər-ˌpēn\ [ISV *terp-* (fr. Gr *Terpentin* turpentine, fr. ML *terbentina*) + *-ene*] (1873) *n.* A class of unsaturated organic compounds having the empirical formula $C_{10}H_{16}$ occurring in most essential oils and oleoresinous plants. Structurally, the unimportant terpenes and their derivatives are classified as monocyclic (dipentene), bicyclic (pinene), and acyclic (myrcene).

**Terpene resins** *n.* Neutral hydrocarbon resins made by polymerization of *β*-pinene. They possess all the advantages of coumarone resins, e.g., neutrality, resistance to alkalis, etc., without the disadvantages of yellowing. They have excellent compatibility.

*See polyterpene resin.*

**Terpin** *n.* Terpinol, 4-hydroxy-α,α,4-trimethylcyclohexanemethanol. Additional names: *p*-menthane-1,8-diol; dipenteneglycol. Molecular formula: $C_{10}H_{20}O_2$. Molecular weight: 172.26. Percent composition: C 69.72%, H 11.70%, O 18.58%. Literature references from Merck Index, 13th edn. 2001: Both *cis*-and *trans*-modifications are known. The *cis*-compound is obtained most readily in the hydrated form, *cis*-terpin hydrate. Prepn of *cis*-form from oil of turpentine: Hempel, *Ann.* 180, 71 (1876); Wallach, *Ann.* 230, 225 (1885); Schmitt, *Mfg. Chemist* 26, 350 (1955). From *d*-limonene: Sword, *J. Chem. Soc.* 127, 1632 (1925). Prepn of *trans*-form from 1,8-cineole, α-terpineol or *cis*-terpin hydrate. Matsuura et al. (1958) Bull Chem Soc Japan 31, 990. Lombard, Ambroise, *Bull. Soc. Chim. France* 1961, 230. Structure of *cis*- and *trans*-forms: Baeyer, *Ber.* 26, 2861 (1893); Wagner, *ibid.* 27, 1636 (1894) (*See image*).



**Terpinenes** *n.* $C_{10}H_{16}$. Hydrocarbons of cyclic type, present in turpentines. Bp, about 179°C; Sp gr, 0.865 per 15°C.

**Terpineol** *n.* $C_{10}H_{17}OH$. Useful, powerful high-boiling solvent plasticizer. Bp, 210–220°C, depending upon the type, α, *β*, or *γ*.

**Terpinolene** *n.* $C_{10}H_{16}$. Hydrocarbon solvent, Bp, 183°C; mp, 15°C; flp, 44°C (111°F).

**Terpolymer** \ˌtər-ˈpä-lə-mər\ (1947) *n.* A polymer composed of molecules containing three chemically different types of monomers, or of the grafting of one monomer to the co-polymer of two different monomers. An important commercial terpolymer is ABS resin, derived from acrylonitrile, butadiene, and styrene.

**Terra alba** \ˈter-ə ˈal-bə\ *n.* $CaSO_4 \cdot 2H_2O$. A finely powdered form of gypsum, used as a filler. Another name for gypsum or calcium sulfate.

*See calcium sulfate, anhydrous.*

**Terra cariosa** *See rottenstone.*

**Terra cotta** {*often attributive*} [It *terra cotta*, literally, baked earth] (1722) *n.* A fine reddish-brown clay mixed with sand and baked until hard, used for pottery, statues and the like; also the reddish-brown color of baked clay.

**Terra di siena** *See raw sienna; see iron oxides, natural.*

**Terra ponderosa** *n.* Syn: barium sulfate.

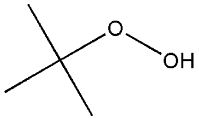
**Terrazzo** \tə-ˈra-(ˌ)zō\ [It, lit. terrace, perhaps fr. OP *terrassa*] (1897) *n.* Hard, marble-like flooring material consisting of 70% marble chips in cement, that is cast in place or precast, and then ground down to a smooth surface; used as a decorative surfacing on walls as well as floors. Syn: venetian mosaic. *Also called Terrazzo Concrete.*

**Terrazzo seal** *n.* A composition of alkali-resistant resins or waves in solvent of water.

**Terre verte** *n.* Essentially an iron silicate. It is used as a base for lakes. Syn: green earth.

**Terry cloth** *n.* A cotton or cotton-blend fabric having uncut loops on one or both sides. Made on a dobby loom with a terry arrangement or on a Jacquard loom. It is used for toweling, beach robes, etc.

***tert*-Butyl hydroperoxide** *n.* $(CH_3)_3COOH$. A highly reactive peroxy compound used as a polymerization catalyst (*See image*).



***tert*-Butyl perbenzoate** *n.* $C_6H_5{\cdot}O_2{\cdot}C(CH_3)_3$. A catalyst for the polymerization of acrylic and styrene monomers, and the curing of polyesters. Also use din the compounding of silicones and polyethylene. This peroxide has long been the workhorse in sheet molding compounds because it is stable enough for all practical purposes but is slow-reacting, requiring activation temperatures of 121–127°C unless boosted by a less stable peroxide.

***tert*-Butyl permaleic acid** *n.* $(CH_3)_3CC{\cdot}O_2{\cdot}COCH{=}CHOOH$. A polymerization catalysts.

**Tertiary** \ˈtər-shē-ˌer-ē\ [L *tertiarius* of or containing a third, fr. *tertius* third] (ca. 1656) *adj.* In organic chemistry, denoting a functional group in which three of its original hydrogen atoms have been replaced by other groups. Triphenylcarbinol, $(C_6H_5)_3$ COH, and *t*-butyl alcohol, $(CH_3)_3$–COH, are examples of tertiary alcohols. Trimethylamine, $(CH_3)_3N$, is a tertiary amine.

**Tertiary amine value** *n.* The number of milligrams of potassium hydroxide (KOH) equivalent to the tertiary amine basicity in 1 g of sample.

**Tertiary colors** (ca. 1864) *n.* Shades that are obtained by mixing the three primary colors or by mixing one or more of the secondary colors with gray or black.

**Terylene** *n.* Poly(ethylene terephthalate), manufactured by ICI, Great Britain.

**Tesla** \ˈtes-lə\ [Nikola *Tesla*] (1958) (T) *n.* The SI unit of magnetic-flux density, equal to one weber per square meter ($1\ Wb/m^2$). The older, now deprecated unit, the *gauss*, is equal to $10^{-4}$ T.

**Test fence** *n.* An apparatus consisting of a fence strategically located in a part of the country for specific weather conditions (temperature, humidity, sunlight duration, etc.) and facing a specific direction and angle, It contains a series of exposure racks on which test panels are exposed. Coated test panels on various substrates (wood, metal, plastic, cementitious, etc.) are tested for exterior durability properties such as chalk resistance, tint retention, adhesion, racking, peeling, etc. The panels are exposed for various durations of time. Typical directions are north and south. Typical angles are vertical, horizontal, 5° and 45°. Examples of USA test fence locations include: Arizona, Delaware, Florida, New Jersey, Pennsylvania, and Puerto Rico.
*See exposure rack.*

**Test method** *n.* A definitive, standardized set of instructions for the identification, measurement, or evaluation of one or more qualities, characteristics, or properties of a material.

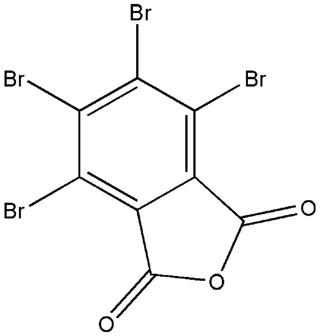
**Test pattern** *n.* Spray pattern used in adjusting spray gun.

**TETA** Abbreviation for triethylenetetramine.

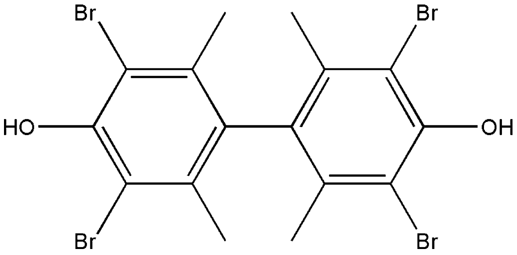
**Tetrabasic lead fumarate** *n.* $4PbO{\cdot}PbC_2H_2(COO)_2{\cdot}2H_2O$. A creamy-white powder used as a heat stabilizer for electrical-grade plastisols, and insulation. It is also used as a curing agent for chlorosulfonated polyethylene.

**Tetrabromobisphenol A** \ˈter-trə-ˈbrō-(ˌ)mōˈbis-ˈfē-ˌnōl\ [4,4′-isopropylidene bis 2,6-dibromophenol)] *n.* $(CH_3)_2C(C_6H_2Br_2OH)_2$ (*see structure at bisphenol a.*). An off-white, crystalline solid, used as a flame retardant in epoxy resins, polyesters, and polycarbonates. Whittington's dictionary of plastics.

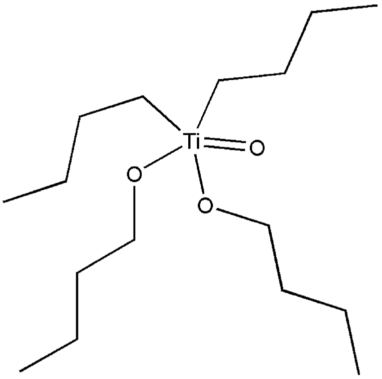
**Tetrabromophthalic anhydride** \ˈter-trə-ˈbrō-(ˌ)mō-ˈtha-lik (ˌ)an-ˈhī-ˌdrīd \ *n.* $Br_4C_6$–2,3-$(CO)_2O$. A reactive intermediate containing 69% bromine, used as a flame retardant (*See image*).



**2,2′,6,6′-Tetrabromo-3,3′,5,5′-Tetramethyl-*p,p′*Biphenol (TTB)** *n.* An aromatic brominated flame retardant synthesized easily by a two-step process from 2,6-dimethylphenol. The unusual chemical structure of TTB enables its use as both a reactant and additive flame retardant. It has been used in high-impact polystyrene. Whittington's dictionary of plastics (*See image*).



**Tetrabutyl titanate** \ˈter-trə-byü-tᵊl ˈtī-tᵊn-ˌāt\ (TBT, butyl titanate, titanium butylate) *n.* $Ti(OC_4H_9)_4$. A catalyst for condensation and cross-linking reactions, also used to improve the adhesion of plastic compounds to metals (*See image*).



**Tetrachloride** \ˈter-trə-ˈklōr-ˌīd\ *n.* A chloride, such as carbon tetrachloride, containing four atoms of chlorine.

**Tetrachlorobisphenol** \ˈter-trə-ˈklō-ˈbī-ˈfē-ˌnōl\ [4,4′-isopropylidene bis(2,6-dichlorophenol)] *n.* $(CH_3)_2C(C_6H_2Cl_2OH)_2$ (*see structure at bisphenol A*). A monomer for flame-retardant epoxies, polyesters, and polycarbonates.

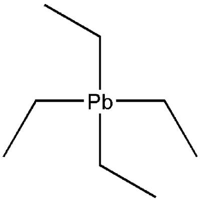
**Tetrachloroethane** \ˈter-trə-ˈklō-ˈe-ˌthān, *British usually* ˈē-\ *n.* $C_2H_2Cl_4$. Solvent, used at one time as the principal constituent of non-flammable paint remover, but now largely discontinued because of its toxicity. Bp, 147°C; vp, 11 mmHg per 20°C. Syn: carbon tetrachloride.

**Tetraethylene glycol dicaprylate** *n.* ($C_7H_{15}COOCH_2CH_2OCH_2CH_2)_2O$. A plasticizer for vinyl chloride polymers and co-polymers (*See image*).

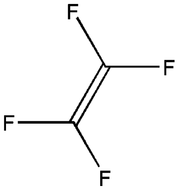
**Tetraethylene glycol di(2-ethylhexanoate)** *n.* ($C_8H_{17}COOCH_2CH_2O$–$CH_2CH_2)_2O$. A secondary plasticizer for vinyl resins and a primary plasticizer for cellulosic plastics and synthetic rubbers. In vinyls, it is used at levels of 15–20% for the total plasticizer to impart good low-temperature flexibility. In nitrocellulose lacquer, it imparts cold-check resistance (*See image*).

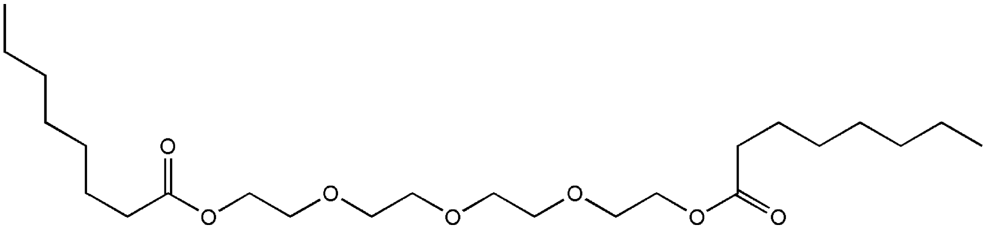
**Tetraethylene glycol monostearate** *n.* $C_{17}H_{35}COO(CH_2CH_2O)_4OH$. A plasticizer for ethyl cellulose and cellulose nitrate.

**Tetraethyl lead** (1923) *n.* $(PbC_2H_5)_4$. A heavy oily poisonous liquid used as an antiknock agent.

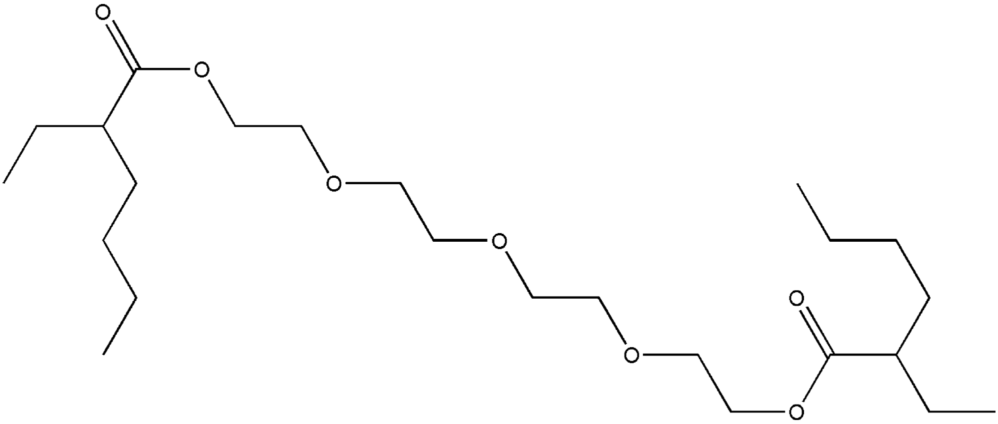


**Tetrafluoroethylene (TFE, perfluoroethylene)** *n.* $CF_2{=}CF_2$ A colorless gas used as the monomer for polytetrafluoroethylene resins. Prepared by the thermal cracking at about 700°C of cholordifluoromethane, itself produced by reaction of hydrogen fluoride with chloroform. The production of polytetrafluoroethyelene and its co-polymer is carried out by free radical polymerization.

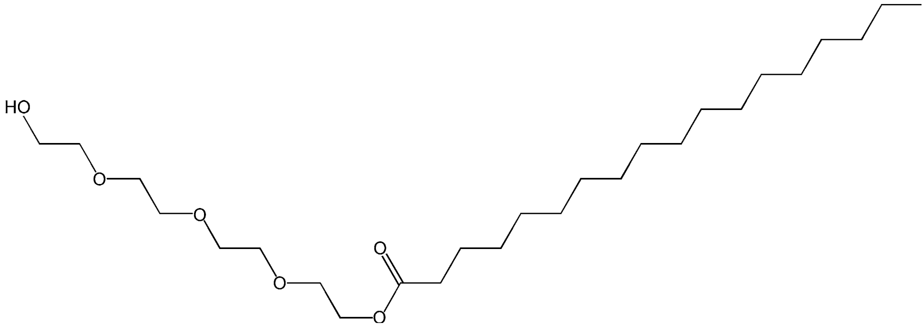




Tetraethylene glycol dicaprylate



Tetraethylene glycol di(2-ethylhexanoate)



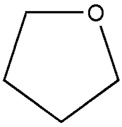
**Tetraethylene glycol monostearate**

**Tetrafluoroethylene-ethylene co-polymer** *See poly(ethylene-tetrafluoroethylene).*

**Tetrafluoroethylene fiber** *See polytetrafluoroethylene fiber.*

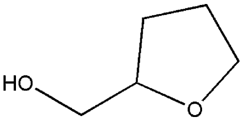
**Tetrafluoroethylene–hexafluoropropylene co-polymer (FEP)** *See fluorinated ethylene–propylene resin.*

**Tetrahydrofuran** \ˈte-trə-ˈhī-(ˌ)drō-ˈfyúr-ˌan\ (THF, tetramethylene oxide) *n.* A colorless liquid obtained by the catalytic hydrogenation of furan, with the empirical formula $C_4H_8O$.

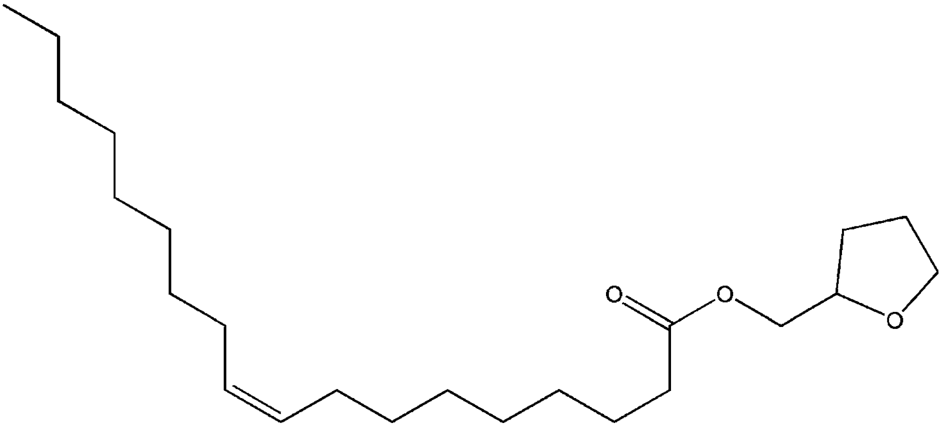


**Tetrahydrofurfuryl alcohol** In addition to its many uses as an industrial intermediate, THF is a powerful solvent for PVC, polyvinylidene chloride, and many other polymers. It is often used as the carrier solvent for size-exclusion chromatography of polymers. Its presence in relatively small amounts increase the "bite" of vinyl printing inks, lacquers, and adhesives. THF has been polymerized to polytetramethylene ether glycol for use in the production of polyurethanes.

**Tetrahydrofurfuryl alcohol** *n.* $C_4H_7OCH_2OH$. High-boiling solvent. Used as a solvent for vinyl resins, Bp, 178°C; vp, <1 mmHg per 30°C.
*Also known as "THFA" and tetrahydrofuryl.*

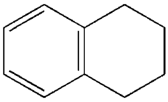


**Tetrahydrofurfuryl oleate** *n.* $CH_3(CH_2)_7CH{=}CH(CH_2)_2C_4H_7O$. A plasticizer for polystyrene, and cellulosic, acrylic, and



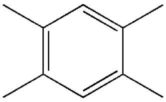
vinyl resins. In vinyls, it is used as a secondary plasticizer imparting resistance to low temperatures, and as a lubricant in stiff or highly filled calendering and extrusion compounds.

**Tetrahydronaphthalene** (1,2,3,4-tetrahydronaphthalene, Tetralin) *n.* $C_{10}H_{12}$. This bicyclic, high-boiling, semi-aromatic hydrocarbon, produced by the partial hydrogenation of naphthalene, is an involatile solvent for rubbers, PVC, and natural resins. Bp, 198–210°C; Sp gr, 0.971/20°C; flp, 77°C (170°F); vp,<1 mmHg per 30°C. It is used in alkyd compositions, chlorinated rubber finishes, and in paint removers.
*Also called tetralin.*



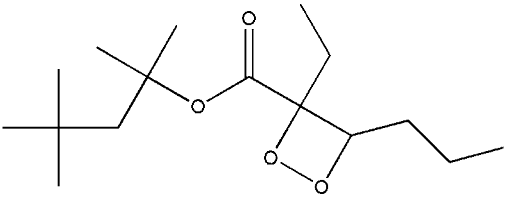
**Tetramer** \ˈte-trə-mər\ (1929) *n.* A polymer formed from four molecules of a monomer and/or made up of four mer units.
*See oligomer.*

**1,2,4,5-Tetramethylbenzene** Explicit name for durene.

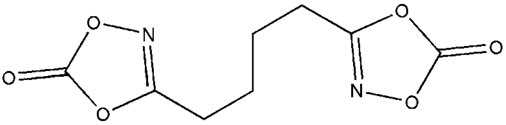


**Tetramethylbisphenol** *n.* A compound for producing polycarbonate.

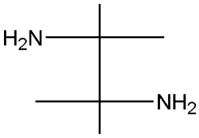
**1,1,3,3-Tetramethylbutyl peroxy-2-ethylhexanoate** *n.* A liquid peroxide superior to (solid) benzoyl peroxide as a catalyst for polyesters and, because it is a liquid, easier to handle.



**5,5′-Tetramethylene di(1,3,4-dioxazol-2-one)** (Adiponitrile carbonate, ADNC) *n.* A white crystalline solid, capable of being reacted with diols and polyols to form light-stable urethane coatings, elastomers, and foams.

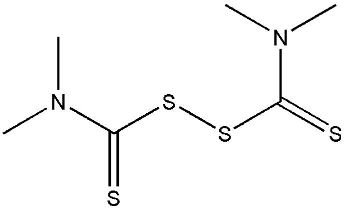


**Tetramethylethylenediamine** (TMEDA, *N,N,N′,N′*-tetramethylethylenediamine) *n.* $(CH_3)_2NCH_2CH_2N(CH_3)_2$. An anhydrous, corrosive liquid used as a catalyst for urethane foams, coatings, and elastomers, and as a curing agent.



**Tetramethylene glycol** *See 1,4-butylene glycol for epoxy resins.*

**Tetramethylthiuram disulfide (TMTD)** *n.* $[(CH_3)_2NCS_2-]_2$. A white, crystalline powder used as a fungicide, bacteriostat, and rodent repellent in vinyl compounds, and as a secondary accelerator in rubber curing.



**Tetrapolymer** Syn: quaterpolymer.

**Tex** *n.* (1) A convenient unit of lineal density of fibers: the mass in grams of 1 km of fiber length. The SI equivalent is $10^{-6}$ kg/m (1 mg/m). Compare cut, denier, and grex number. (2) The system of yarn numbering based on the use of tex units.

*Also see yarn number.*

**Texanol®** *n.* 2,2,4-trimethylpentanediol monoisobutyrate. A proprietary high boiling ester alcohol water-insoluble coalescent. Flash point, 188°C (Cleveland open cup); density, 7.92 lb/gal; Sp gr, 0.95.

**Textile** \ˈtek-ˌstīl\ [L, fr. neuter of *textilis* woven, fr. *texere*] (1626) *n.* Originally, a woven fabric; now applied generally to any one of the following: (1) Staple fibers and filaments suitable for conversion to or use as yarns, or for the preparation of woven, knit, or non-woven fabrics. (2) Yarns made from natural or manufactured fibers. (3) Fabrics and other manufactured products made from fibers as defined above and from yarns. (4) Garments and other articles fabricated from fibers, yarns, or fabrics when the products retain the characteristic flexibility and drape of the original fabrics. Schoeser M (2003) World textiles: a concise history. Thames and Hudson. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Textile materials** *n.* A general term for fibers, yarn intermediates, yarn, fabrics, and products made from fabrics that retain more or less completely the strength, flexibility, and other typical properties of the original fiber or filaments. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Textile processing** *n.* Any mechanical operation used to translate a textile fiber or yarn to a fabric or other textile material. This includes such operations as opening, carding, spinning, plying, twisting, texturing, coning, quilling, beaming, slashing, weaving, and knitting. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Schoeser M (2003) World textiles: a concise history. Thames and Hudson.

**Texture** *n.* The structural quality of a surface. A term describing the surface effect of a fabric, such as dull, lustrous, wooly, stiff, soft, fine, coarse, open, or closely woven; the structural quality of a fabric.

**Textured** *adj.* An adjective used to describe continuous filament manufactured yarns (and woven and knit fabrics made therefrom) that have been crimped or have had random loops imparted, or that have been otherwise modified to create a different surface texture.

*Also see textured yarns and texturing.*

**Textured paint** *See plastic paint.*

**Textured yarns** *n.* Yarns that develop stretch and bulk on subsequent processing. When woven or knitted into fabric, the cover, hand, and other aesthetics of the finished fabric better resemble the properties of a fabric constructed from spun yarn. The 10 types of textured yarns are: *Bulked yarn* – Qualitative term to describe a textured yarn. A bulked yarn develops more bulk than stretch in the finished fabric. *Coil yarn* – A textured yarn that takes on a coil or spiral configuration when further processed. A coil yarn can be either a torque yarn or a non-torque yarn. A coil yarn can be formed by the false twist or edge crimp methods. Some bilateral fibers become coiled on further processing. *Core-bulked yarn* – A bulky or textured yarn composed of two sets of filaments, one of which is straight to give dimensional stability and forms a core around and through which the other set is coiled or looped to give bulk. *Crinkle yarn* – A torque-free textured yarn that is characterized by periodic wave configurations. Crinkle yarns can be formed by the stuffer box, gear crimping, or knit-de-knit methods. *Entangled yarn* – A textured yarn of one variant that develops bulk by the air-jet texturing method. *Modified stretch yarn* – A stretch yarn that develops more bulk than usual but less bulk than a bulked yarn in the finished fabric. *Non-torque yarn* – A yarn that does not rotate or kink when permitted to hang freely. A non-torque yarn may be the result of plying two equal but opposite torque yarns. *Set yarn* – A textured yarn that is heat relaxed to reduce torque. Set yarns are not stretch yarns. *Stretch yarn* – Qualitative term to describe a textured yarn. A stretch yarn develops more stretch than bulk in the finished fabric. *Torque yarn* – When a torque yarn is permitted to hang freely it rotates or kinks to relieve the torque introduced into the yarn during texturing. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York. *Also see texturing.*

**Texture-finished paint** *See plastic paint.*

**Texturing** *n.* The process of crimping, imparting random loops, or otherwise modifying continuous filament yarn to increase cover, resilience, abrasion resistance, warmth, insulation, and moisture absorption or to provide a different surface texture. Texturing methods can be placed roughly into six groups. *Air jet method* – In this method of texturing, yarn is led through the turbulent region of an air jet at a rate faster than it is drawn off on the far side of the jet. In the jet, the yarn structure is opened, loops are formed, and the structure is closed again. Some loops are locked inside and others are locked on the surface of the yarn. An example of this method is the Taslan process (*also see textured yarns, core-bulked yarn, and entangled yarn*). *Edge crimping method* – In this method of texturing, thermoplastic yarns in a heated and stretched condition are drawn over a crimping edge and cooled. Edge-crimping machines are used to make Agilon yarns (*also see textured yarns, coil yarn*). *False-twist method* – This continuous method for producing textured yarns utilizes simultaneous twisting, heat-setting, and untwisting. The yarn is taken from the supply package and fed at controlled tension through the heating unit, through a false-twist spindle or over a friction surface that is typically a stack of rotating discs called an aggregate, through a set of take © 2001, Celanese Acetate LLC up rolls, and onto a take-up package. The twist is set into the yarn by the action of the heater tube and subsequently is removed above the spindle or aggregate resulting in a group of filaments with the potential to form helical springs. Much higher processing speeds can be achieved with friction false twisting than with conventional spindle false twisting. Both stretch and bulked yarns can be produced by either process. Examples of false-twist textured yarns are Superloft®, Flufflon®, and Helanca® (*also see textured yarns, coil yarn*). *Gear crimping method* – In this texturing method, yarn is fed through the meshing teeth of two gears. The yarn takes on the shape of the gear teeth (*also see textured yarns, crinkle yarn*). *Knit–de–knit method* – In this method of texturing, the yarn is knit into a 2 in. diameter hoseleg, heat-set in an autoclave, and then unraveled and wound onto a final package. This texturing method produces a crinkle yarn (*also see textured yarns, crinkle yarn*). *Stuffer box method* – The crimping unit consists of two feed rolls and a brass tube stuffer box. By compressing the yarn into the heated stuffer box, the individual filaments are caused to fold or bend at a sharp angle, while being simultaneously set by a heating device. Kadolph SJJ,

Langford AL (2001) Textiles. Pearson Education, New York. Complete textile glossary. Celanese Acetate LLC, New York, 2000.
*Also see textured yarns.*

**TFE** *n.* Abbreviation for tetrafluoroethylene.

**$T_g$** *See glass transition temperature.*

**TGA** *n.* Thermogravimetric analysis, generates a plot of "mass versus temperature"; useful for determining temperatures of decomposition $T_d$ or other thermogravimetric events. Abbreviation for thermogravimetric analysis.

**THEA** *See tetrahydrofurfuryl alcohol.*

**Thénard's blue** *n.* Another name for cobalt blue.
*See cobalt blue.*

**Theoretical weight** *n.* The weight of a part calculated from its specified dimensions and the density of the material.

**Theory** \ˈthē-ə-rē\ [LL *theoria*, fr. Gk *theōria*, fr. *theōrein*] (1592) *n.* A proposed explanation or justification of observed behavior made in terms of a model.

**Thermal adhesive** *n.* Special type of adhesive which only develops its adhesive properties when heat is applied to it, and partial liquefaction occurs.

**Thermal analysis** *n.* Methods of analysis that involve programmed heating of a material and observing the accompanying physical and chemical reactions, changes of state ($T_g$, $T_m$, etc.), or changes in physical or mechanical properties. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.
*See differential thermal analysis, differential scanning calorimeter, dynamic mechanical analyzer, and thermogravimetric analysis.*

**Thermal black** *See carbon black.*

**Thermal bonding** *See thermobonding.*

**Thermal capacity** *n.* The quantity of heat necessary to produce unit change of temperature in unit mass. It is ordinarily expressed as calories per gram per degree centigrade. Numerically equivalent to specific heat.
*See heat capacity and specific heat.*

**Thermal capacity or water equivalent** *n.* The total quantity of heat necessary to raise any body or system unit temperature, measured as calories per degree centigrade in the cgs system. Dimension [M].

**Thermal character** *n.* A tactile property of a textile material. It is the difference felt in the temperature of the material and the skin of the person touching it.

**Thermal conductivity** (*k*) *n.* The basic measure of steady heat-transfer rate within solid materials (and still fluids) by atomic or molecular contact and vibration. It derives from Fourier's law of heat conduction and may be thought of as the rate of heat flow between two opposite faces of a unit cube whose other faces are perfectly insulated when the temperature at the warmer face is 1 K above that of the cooler face. The SI dimensions corresponding to this concept are $(\mathrm{J/S})/(\mathrm{m^2\,K/m})$, which reduces to W/m K. Some conversions from other units to SI are given in the Appendix. For plastics and other materials, *k* increases with rising temperature. Lide DR (ed) (2004) CRC Handbook of chemistry and physics. CRC Press, Boca Raton, FL. Ready RG (1996) Thermodynamics. Pleum Publishing Company, New York. Seanor DA (1982) Electrical conduction in polymers. Academic Press, New York.

**Thermal decomposition** *n.* The chemical decomposistion of a plastic resulting from increasing temperature (or heat) *t*. With a given polymer, it occurs at a temperature at which some components of the material are separating, reacting together, or depolymerizing, with observable changes in micro- or macro-structure, mechanical, and/or electrical properties, and, usually, reduction in molecular weight. Groenewoud WM

(2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York. Ready RG (1996) Thermodynamics. Pleum Publishing Co., New York.

**Thermal diffusivity** ($\alpha$) *n.* An important property for unsteady (transient) heat transfer, particularly in solid materials, equal to the thermal conductivity divided by the product of heat capacity and density, i.e., $\alpha = k/C\rho$, the SI unit is $m^2/s$. For most solids, *a* increases slowly with rising temperature. Thermal diffusivity comes into play in the heating and cooling of thermoformable sheets, in the cooling of injection moldings in the mold, and the cooling of extrudates. The most-used method for measuring thermal diffusivity of solids, the thermal-pulse method, has so far been adopted by ASTM only for synthetic carbon and graphite. Ready RG (1996) Thermodynamics. Plenum Publishing Co., New York.

**Thermal discharge** *n.* The introduction of water from a point source at a temperature different from the ambient temperature of the receiving waters.

*See point source.*

**Thermal expansion** *n.* The coefficient of linear expansion or expansivity is the ratio of the change in length per °C to the length at 0°C. The coefficient of volume expansion (for solids) is approximately three times the linear coefficient. The coefficient of volume expansion for liquids is the ratio of the change in volume per degree to the volume at 0°C. The value of the coefficient varies with temperature. The coefficient of volume expansion for a gas under constant pressure is nearly the same for all gases and temperatures and is equal to 0.00367 for 1°C. Dimension, $[\theta^{-1}]$. If $l_0$ is the length at 0°C, $\alpha$ the coefficient of linear expansion, the length at $t$°C is

$$l_t = l_0(1 + \alpha t).$$

*General formula for thermal expansion* — The rate of thermal expansion varies with the temperature. The general equation giving the magnitude $m_0$ is the magnitude at 0°C is

$$m_t = m_0(1 + \alpha t + \beta t^2 + \gamma t^3 + \cdots),$$

where $\alpha$, $\beta$, $\gamma$, etc. are empirically determined coefficients. *Volume expansion* — If $V$ represents volume and $\beta$ the coefficient of expansion,

$$V_t = V_0(1 + \beta t).$$

For solids,

$$\beta = 3\alpha(\text{approximately}).$$

**Thermal-expansion coefficient** *See coefficient of thermal expansion.*

**Thermal fixation** *See dyeing.*

**Thermal fluid** *n.* Any of many types of heat-stable, non-corrosive liquids such as glycols, silicone and other oils, and the eutectic mixture of biphenyl and biphenyl oxide (“Dowtherm A”) that are used to transfer heat by convection. Water, saturated steam, and glycol solutions are also important. Examples of applications in the plastics industry are jacketed molds for rotational casting, heating of calendars, injection-mold chilling, controlling the temperatures of cored extrusion screws, and maintaining temperatures of liquids in storage tanks.

**Thermal-gradient elution** *n.* Method of fractionation in which a small amount of polymer, dispersed on a support, is placed on the top of a column of an inert material. The polymer is eluted from the column by extraction with solvents of increasing solvent power, as in column extraction, but, in addition, a temperature gradient is imposed along the length of the column.

**Thermal gravimetric analysis** *n.* Syn: thermogravimetric analysis.

**Thermal history** (heat history) *n.* The integrated product of time × temperature for a plastic, from the time it was first subjected to a high temperature to the present moment under consideration. Thermal history is an important consideration in processing (and reprocessing) heat-sensitive polymers such as rigid PVC and polypropylene.

**Thermal impulse sealing** *See impulse sealing.*

**Thermally foamed plastic** *n.* A cellular plastic produced by applying heat to effect gas-generating decomposition or volatilization of a constituent (after ASTM D 883).

**Thermally stabilized** *See heat stabilized.*

**Thermally stimulated current (TSC)** *n.* A technique useful in studying the transitions of amorphous, polar polymers with rising temperature. A preheated sample is electrically oriented by applying a strong electric field, then chilling the polymer with the field applied. The sample is removed from the field and reheated on a temperature ramp while the current generated by the release of dipoles is tracked. current peaks relate to relaxation times of molecular motions within the polymer. The technique is often carried out at a number of different preheating temperatures and the result subjected to relaxation-map analysis in order to distinguish relaxations occurring at various molecular-weight levels in a typical polymer.

**Thermal neutrons** *n.* Neutrons slowed down by a moderator to an energy of a fraction of an electron volt — about 0.025 eV at 15°C.

**Thermal paint** Coating containing small granules of metallic powder that create a resistance when current is applied and thereby heat the substrate.

**Thermal polymerization** *n.* A polymerization process performed solely by heating in the absence of a catalyst. Monomers such as styrene and methyl methacrylate are examples of those that can be thermally polymerized.

**Thermal properties** *n.* All properties of materials involving heat or changes in temperature. In Section 08 of ASTM's Annual Book of Standards ("Plastics"), tests listed under "Thermal Properties" include many properties, from brittleness temperature, coefficient of expansion, deflection temperature, etc., to heat of fusion, glass-transition temperature, thermal conductivity, heat capacity, mold shrinkage, flammability, and many more.

**Thermal resistance (*R*-valve)** *n.* The ability of a material to retard the conductive passage of heat; the reciprocal of conductance. While plastics, with very few exceptions, are good thermal insulators, the property is of especial interest for cellular plastics, often used to provide thermal insulation. The $R$-value of a layer of thermal insulation is given by: $R = \Delta T/q$, the ratio of the temperature drop in the direction of heat flow from one surface of the layer to the other, divided by the rate of heat flow per unit of surface area (*heat flux*). English units are customary in the USA. That is not as fundamental as property as thermal conductivity because the thickness of the layer is implicit in the resistance and should be separately stated.

**Thermal sealing (thermal heat sealing)** *n.* A method of bonding two or more layers of plastics by pressing them between heated dies or tools that are maintained at a relatively constant temperature.
*See also heat sealing.*

**Thermal sensitivity** *n. See heat sensitivity and thermal history.*

**Thermal stability** *n.* Syn: heat stability.

**Thermal stabilizer** *See stabilizer.*

**Thermal stress cracking (TSC)** *n.* Crazing and cracking of some thermoplastics that result from overexposure to elevated temperatures.

**Thermal volatilization analysis (pyrolysis analysis, TVA)** *n.* Ramp heating of a plastic with passage of the evolved volatiles through one or more chemical detectors, sometimes with intervening, controlled-temperature, vapor-condensing traps. TVA is a powerful technique when coupled with thermogravimetric analysis.

**Thermal welding** *n.* A method of bonding two or more layers of plastics by pressing them between heated dies or tools that are maintained at a relatively constant temperature.

**Thermionic emission** *n.* Electron or ion emission due to the temperature of the emitter. The rate of emission increases rapidly with rising temperature, and is also very sensitive to the state of the emitting surface.

**Thermistor** \ˈthər-ˌmis-tər\ [*therm*al res*istor*] (1940) *n.* A contraction of *thermal resistor*; a semiconductor whose resistance varies sharply and reproducibly with temperature, therefore useful for temperature measurement, and sometimes used for that purpose in plastics industry.

**Thermoband welding** *n.* Trade name for a variant of hot-plate welding in which a metallic tape acting as a resistance element is adhered to the material to be welded. Low voltage is applied to heat the tape, and the adjacent plastic, to the plastic's melting range. Pressure may be applied to the joint while it cools.

**Thermobonding** *n.* A technique for bonding fibers of a web with meltable powders or fibers, using infrared heating, hot air, or hot-calendaring (*also see bonding, bonding with binder fibers, and powder-bonded nonwoven*).

**Thermochemical equation** *n.* A chemical equation which includes an indication of the heat liberated or absorbed during the reaction.

**Thermochromic** *n.* Changing color with changing temperature, a characteristic of special materials useful as temperature indicators.

**Thermocompression bonding** *n.* The joining together of two materials without an intermediate material by the application of pressure and heat in the absence of an electrical current.

**Thermocouple** \ˈthər-mə-ˌkə-pəl\ (1890) (TC) *n.* A pair of connected, welded junctions formed by two wires of dissimilar metals such as iron and constantan. If a temperature difference exists between the two junctions, a weak emf, 40–50 μV/K, is generated in nearly linear proportion to the $\Delta T$. Originally, one junction was placed in an ice bath to serve as a *reference*. Then, the emf developed in the circuit was simply convertible to temperature. Modern thermocouples employ a single junction and the instrument to which the TC is connected senses its own temperature and compensates the incoming signal for the difference between that temperature and 0°C. Plain wire TCs respond very rapidly to temperature changes but those used in plastics-processing equipment are always sheathed in a sturdy protective tube, so are slower. Metal compositions of commercial TC wires are so carefully controlled that, except for exacting laboratory work, it is usually unnecessary to calibrate thermocouples. In one type of hand-held instrument, called a pyrometer, the TC is integral with a microammeter whose needle moves across a temperature scale. Thermocouples are the most used temperature sensors in plastics processing because they are sturdy, simple, reliable, readily available, and cheap. Weast RC (ed) (1978) CRC handbook of chemistry and physics, 59th edn. The CRC Press, Boca Raton, FL.

**Thermodynamics, law of** *n.* I – *The energy of the universe is constant.* Energy can neither be created nor be destroyed only changed in form. When a system gains heat, its energy increases, and when a system does work, its energy decreases. II – *The entropy of the universe is always expanding.* Entropy is a measure of disorder. In all energy changes, if no energy enters or leaves the system, the potential energy of the state will be less than that of the initial state. In the process of energy exchange, some energy will dissipate as heat. A transformation whose only final result is to transform into work heat from a source, which, at the same temperature, is impossible (postulate of Lord Kelvin). A transformation whose only final result is to transfer heat from a body at a given temperature to a body at a higher temperature is impossible (postulate of Clausius). III – *A state of perfect order is a state of minimum entropy* (e.g., a perfect crystalline structure at absolute zero temperature). The British scientist and author C. P. Snow had an excellent way of stating these laws: I – You cannot win (i.e., you cannot get something for nothing, because matter and energy are conserved. II – You cannot break even (you cannot return to the same energy state, because there is constant increase in disorder). III – You cannot get out of the game (because absolute zero temperature is not attainable). Ready RG (1996) Thermodynamics. Pleum Publishing Co., New York.

**Thermodynamic temperature** *See Kelvin.*

**Thermoelasticity** *n.* Rubber-like elasticity exhibited by a rigid plastic and resulting from an increase in temperature. In this state, the plastic may be formable into a different shape. Retention of the desired shape may be achieved by cooling in place after forming. With thermosetting materials, prolonged heating may be necessary to effect cure in place.

**Thermoelectric power** *n.* Measured by the electromotive force produced by a thermocouple for unit difference of temperature between the two junctions. It varies with the average temperature and is usually expressed in microvolt per °C. It is customary to list the thermoelectric power of the various metals with respect to lead.

**Thermoform** (1956) *n.* To change the shape of a plastic rod, profile, tube, or sheet by first heating it to make it pliant, next, forming the desired shape, and finally, cooling the formed shape. Sheet thermoforming is by far the most important class of these operations.

**Thermoformability** *n.* The ease with which a heat-softened plastic sheet (or rod, etc.) can be given a new permanent shape, particularly by the techniques of sheet thermoforming. Some attempts have been made to devise tests of sheet thermoformability, but none have been widely used or adopted by ASTM as of 1992.

**Thermoforming** (1) *n. See sheet thermoforming.* (2) Any process in which heat softening is used to assist in the forming or reshaping of a plastic rod, tube, bar, sheet, or profile. When performed directly following extrusion of the profile, the term *post-forming* is often used.

**Thermogram** *n.* A plot of the percent of original mass of a specimen remaining during a program of linearly rising temperature versus the specimen temperature. *See thermogravimetric analysis.*

**Thermographic non-destructive testing** *n. See infrared thermography.*

**Thermographic-transfer process** *n.* A modification of hot stamping wherein the design to be transferred is first printed (in reverse) on a film, from which it is transferred to the plastic part by means of heat and pressure.

**Thermography** \(ˌ)thər-ˈmä-grə-fē\ (1840) *n.* Printing process in which the ink, while still wet on the sheet, is dusted with a resinous powder that adheres to the ink. The sheets are then put through a heating process, which causes the particles of powder to fuse together with the ink, giving a raised effect to the letters, which simulate steel-die engraving.

**Thermogravimetric analysis (TGA)** *n.* A testing procedure in which the diminishing mass of a specimen is recorded as the specimen's temperature is raised at a uniform rate (sometimes referred to as *ramped*). Typical apparatus consists of an analytical balance supporting (on a wire or rod) a platinum crucible containing the specimen, the crucible being situated inside an electric furnace, and means for recording and plotting the percent mass remaining versus temperature. Some TGA tests are conducted in air, bothers in controlled, successive atmospheres such as nitrogen in the first stage, followed by air in the second stage. Thermogravimetric curves so obtained (*thermograms*) provide the useful information regarding polymerization and pyrolysis reactions, the efficiencies of stabilizes and activators, the thermal stability of final materials, and direct analysis. An example of a TGA instrument is the Diamond TG/DTA, image courtesy of Perkin-Elmer Inc. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.

**Thermolastic** *See styrene-butadiene thermoplastic.*

**Thermomechanical analysis** *n.* TMA or thermomechanical analysis is the measurement of material properties (coefficient of thermal expansion, modulus, etc.) by utilizing a mechanical probe or other mechanical sensor (static or oscillating) and measuring its load/position relative to the material being studied while increasing temperature. An example of a TMA instrument is the Perkin-Elmer Diamond TMA, image courtesy of Perkin-Elmer Inc). Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.

**Thermomechanical spectrum** *n.* A plot of a mechanical property such as tensile modulus or strength vresus temperature.

Thermogravimetric analysis (TGA)

Thermomechanical analysis

**Thermoplastic** \ˌthər-mə-ˈplas-tik\ (1883) *n.* A resin or plastic compound that, as a finished material, is capable of being repeatedly softened by heating and hardened by cooling. Examples of thermoplastics are: acetal, acrylic, cellulosic, chlorinated polyether, fluorocarbons, polyamides (nylons), polycarbonate, polyethylene, polypropylene, polystyrene, some types of polyurethanes, and vinyl resins (adjective). Of an organic material, capable of being repeatedly softened and hardened by heating and cooling.

**Thermoplastic elastomers (TPE)** *n.* Any of a family of polymers that resemble elastomers in that they are highly resilient and can be repeatedly stretched to at least twice their initial lengths with full, rapid recovery, but are true thermoplastics and thus do not require curing or vulcanization as do most rubbers.

*See elastomer for examples.*

**Thermoplastic polyester** *n.* Any of a class of linear terephthalate polyesters that are true thermoplastics. Commercially important are polyethylene, terephthalate, polybutylene terephthalate, and polycycloxexylenedimethylene terephthalate. USA sales of these resins in 1992 totaled 1.24 $T_g$ ($1.37 \times 10^6$ tons).

**Thermoplastic polyolefin (TPO)** *n.* Any of a group of elastomers produced by either of two processes. In one, polypropylene is melt-blended with from 15 to 85% of terpolymer elastomer, ethylenepropylene rubber, or styrene-butadiene rubber. In the other, propylene is co-polymerized with ethylene–propylene elastomer in a series of reactions. The smaller elastomeric domains obtained in the latter process are claimed to provide improved properties over the blended materials.

**Thermoplastic resins** *n.* Resins which remain fluid on heating and do not become infusible, and they flow whereas *thermoset* resins do not flow because they are cross-linked or set.

**Thermoplastic rubbers** *n.* Thermoplastic elastomers (rubbers).

*See elastomer.*

**Thermoplastics** *n.* Material that can be molded and shaped when heated.

**Thermoset** \ˈthər-mō-ˌset\ (1947) *n.* A material which will undergo or has undergone a chemical reaction by the action of heat, catalysis, ultraviolet light, etc., leading to a relatively infusible state.

**Thermoset adhesives** *n.* Adhesives, which undergo a chemical reaction by action of heat, catalysts etc., leading to a relatively infusible state.

**Thermosetting** *n.* Having the property of undergoing a chemical reaction by the action of heat, catalysts, ultraviolet light, etc., leading to a relatively infusible state (nonflowing).

**Thermosetting ink** *n.* An ink which polymerizes to a permanently solid and infusible state upon the application of heat.

**Thermosetting plastic (thermoset)** *n.* A resin or plastic compound that in its final state is substantially infusible and insoluble. Thermosetting resins are often liquids at some stage in their manufacture or processing, which are cured by heat, catalysis, or other chemical means. Much cross-linking occurs. After being fully cured, thermosets cannot be melted while reheating. Some plastics that are normally thermoplastic can be made unmeltable by means of cross-linking treatments or reactions. Some thermosetting plastics are alkyd, allyl, amino, epoxy, furane, phenolic, polyacrylic ester, polyester, and silicone resins.

**Thermosetting resin** *n.* (1) A resin that cross-links and becomes insoluble in a solvent after curing (usually with the aid of catalysts and/or heat). (2) A resin which polymerizes to a permanently solid and infusible state upon the application of heat.

**Thermosol process** *See dyeing, thermal fixation.*

**Thermospray** *See flame spray.*

**Thermotropic polymer** *n.* Polymer that exhibits liquid crystal formation in melt form. In thermotropic polymers there must be a balance between having the necessary degree of molecular perfection to preserve the liquid crystal formation and the amount of imperfection to permit melting at workable temperatures. These polymers give high-modulus, highly oriented, extrusion products.

*See liquid-crystal polymer.*

**Theta solvent** *n.* A solvent, at a particular temperature, in which the polymer is at the edge of solubility and exists in the form of a statistical coil. Long-range forces between polymer molecular segments are balanced by polymer solvent interactions. At these conditions the second virial coefficient becomes zero and entropy is at its minimum. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Flory PJ (1969) Statistical mechanics of chain molecules. Interscience Publishers Inc., New York. Flory PJ (1953) Principles of polymer science. The Cornell University Press, Ithaca, NY.

**Theta solvents** *n.* Solvents for a particular polymer in dilute solution, and at a temperature called the theta temperature that slows the polymer chains to assume their unperturbed, random-coil configurations with theoretical root-mean-square distances between chain ends. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Flory PJ (1969) Statistical mechanics of chain molecules. Interscience Publishers

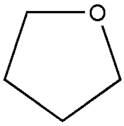
Inc., New York. Flory PJ (1953) Principles of polymer science. The Cornell University Press, Ithaca, NY.

**Theta state** *n.* A term introduced by Dr. Paul Flory to describe the condition in a polymer solution in which there is little interaction between the molecules of the solvent and those of the polymer, and in which the polymer molecules exist as statistically distributed coils. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York. Flory PJ (1969) Statistical mechanics of chain molecules. Interscience Publishers Inc., New York. Flory PJ (1953) Principles of polymer science. The Cornell University Press, Ithaca, NY.

**Theta temperature** *n.* (1) ($\theta$, Flory temperature). $\theta$ is also the temperature for the polymer solution at which the second virial coefficient in the equation giving molecular weight from osmotic pressure approaches zero. (2) The critical temperature of mixing for a polymer of infinitely high degree of polymerization.

*See theta solvent. See Flory temperature.*

**THF** *n.* Abbreviation for tetrahydrofuran. CAS registry number: 109-99-9. Additional names: Diethylene oxide; tetramethylene oxide. Molecular formula: $C_4H_8O$. Molecular weight: 72.11. Percent composition: C 66.62%, H 11.18%, and O 22.19%, Literature references: Preparation from 1,4-butanediol: Schmoyer, Case, *Nature* 187, 592 (1960). Manufactured by catalytic hydrogenation of maleic anhydride: Gilbert, Howk, USA 2772293 (1956 to Du Pont); of furan: Banford, Manes, USA 2846449 (1958 to Du Pont); Manly, USA 3021342 (1962 to Quaker Oats). Stabilization to prevent excessive peroxide formation on storage with 0.05–1.0% *p*-cresol, 0.05–0.1% hydroquinone, or less than 0.01–0.1% 4,4-thiobis(6-*tert*-butyl-*m*-cresol): Bordner, Hinegardner, USA 2489260; USA 2525410; Campbell, USA 3029257 (1949, 1950, and 1962 all to Du Pont). Review of toxicology and biological effects: Moody DE (1991). Drug Chem Toxicol 14:319–342. Properties: liquid. Ether-like odor. mp −108.5°C. $d_4^{20}$ 0.8892. $bp_{760}$ 66°C; $bp_{176}$ 25°C. Flash pt 1°F. $nD^{20}$ 1.4070. Dipole moment: 1.70. UV cut-off for spectro grade: 220 nm. Miscible with water, alcohols, ketones, esters, ethers, and hydrocarbons. Distil only in presence of a reducing agent, such as ferrous sulfate; peroxide explosions have occurred: Angew Chem 68: 182 (1956), mp −108.5°C, $bp_{760}$ 66°C; $bp_{176}$ 25°C, flash pt 1°F. Index of refraction: $nD^{20}$ 1.4070, density: $d_4^{20}$ 0.8892, caution: potential symptoms of overexposure are irritation of eyes and upper respiratory system; nausea, dizziness and headache; CNS depression. (DHHS/NIOSH 97–140, 1997) p 302. Use: solvent for high polymers, especially polyvinyl chloride, as reaction medium for Grignard and metal hydride reactions. In the synthesis of butyrolactone, succinic acid, and 1,4-butanediol diacetate, solvent in histological techniques, may be used under Federal Food, Drug & Cosmetic Act for fabrication of articles for packaging, transporting, or storing of foods if residual amount does not exceed 1.5% of the film: Fed Reg 27:3919 (April 25, 1962). Merck index, 13th edn. Merck and Co. Inc., Whitehouse Station, NJ, 2001.



*See NIOSH pocket guide to chemical hazards*

**Thick** \ˈthik\ [ME *thikke*, fr. OE *thicce*; akin to OHGr *dicki* thick, OIr *tiug*] (before 12c) *adj.* Having relatively great consistency.

**Thick-and-thin yarn** *n.* A novelty yarn of varying thickness.

**Thickener** *n.* (1) Any material used to thicken a liquid. (2) An additive used to thicken (increase viscosity) or modify the rheology of a coating. Syn: bodying agent.
*See thixotrope.*

**Thickening agent (anti-sagging agent)** *n.* A substance that increases the viscosity and/or thixotropy of fluid dispersions or solutions. Such agents are used widely in adhesives, coatings and paints to prevent flow and slumping while they are setting or drying to their final form. Examples of thickening agents are bentonite, calcium carbonates with high oil absorption, clays, chrysotile asbestos, hydrated siliceous minerals, magnesium oxide, soaps, stearates, and special organic waves.

**Thick filling** *See coarse thread.*

**Thickness gauging** *n.* The thickness of many calendered, extruded, and cast products must be measured while they are produced in order to control the thickness within specified tolerance limits. The simplest methods called *contact gauging*, use tools such as calipers, micrometers, and rolls that physically touch the product being measured. Today these are mostly used for checking and backup while *non-contact methods* make on-line measurements and transmit signals to computers, which in turn order process adjustments to be made. Non-contact gauging devices employ nuclear radiation (*see beta-ray gauge*), infrared radiation, ultrasound, air nozzles with means for measuring back pressure which varies with product thickness, electrical-capacitance sensors, and optical devices employing beams of light.

**Thickness variation** *n.* The differences in thickness among different locations in a product of desired uniform thickness, such as film, sheet, pipe, wire coatings, laminates, bar stock. etc. In making sheet and film, one must be concerned with thickness variation in both the *machine direction* and *transverse direction*, since they usually have quite different causes and cures. The same is true of wall thickness in pipe, where the directions are axial and circumferential (the thickness itself is radial). Thickness variations are often of concern in molded and thermoformed products, even though major differences in thickness are there by design. In extruded products, when thickness variations are even a few percent of nominal, more material must be extruded per unit length of product in order to meet minimum thickness specifications, thus increasing unit cost and reducing profit.

**Thin end** *See fine end* (1).

**Thin-layer chromatography** *See chromatography.*

**Thinner** *n.* (1) The portion of a paint, varnish, lacquer, or printing ink, or related product that volatilizes during the drying process. (2) Any volatile liquid used for reducing the viscosity of coating compositions or components; may consist of a simple solvent, or diluent or a mixture of solvents and diluents. (3) Solvents, diluents, low viscosity oils, and vehicles added to ink to reduce their viscosity, consistency or tack.

**Thinners** *n.* Liquids incapable of dissolving a resin but which can partly substitute for a solvent and, at the same time, reduce the viscosity of a paint, varnish, lacquer, or adhesive.
*See also diluent.*

**Thinning ratio** *n.* The amount of thinner that is recommended for a given quantity of paint.

**2,2′-Thiobis(4-*t*-octylphenolate)-*N*-butylamine nickel** (Cyasorb UV 1084) *n.* An ultraviolet absorber used in polyolefins for items such as agricultural film wherein good weatherability is required.

**Thiocyanogen value** \-sī-ˈa-nə-jən ˈval-(ˌ)yü\. Measure of the number of single double bonds in a substance, for example, an oil. Whereas thiocyanogen is selective in its action, adding on to isolated double bonds only, iodine is not selective and thus a combination of both thiocyanogen and iodine values provides a means of assessing quantitatively the different types of unsaturated components in a material.

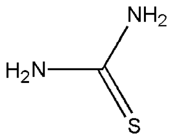
**Thioindigoid maroons** (73395) *n.* These are maroon in masstone and violet in tint. They are considerably bluer than most organic maroon pigments and find application in shading durable maroon finishes. Generally speaking, thioindigoid maroons are not bake resistant enough, nor sufficiently lightfast in weak tints to be used effectively as toning agents for whites. Some varieties bleed slightly in aromatic and ketone solvents. The non-bleeding types find extensive use in automotive finishes.

**Thioindigo pigments** \-ˈin-di-ˌgō ˈpig-mənt\ *n.* Vat dyes covering the orange, red, violet, and brown shade ranges. They are noted for their brightness of shade and generally good fastness properties.

**Thiokol®** *n.* A line of polysufides and similar materials. Manufactured by Thiokol, USA. *See polysulfide rubber.*

**Thiourea** \-yú-ˈrē-ə\ [NL] (1894) *n.* $NH_2CSNH_2$. Mp, 180°C; Sp gr, 1.42. Used in the preparation of thiourea–formaldehyde resins.

*Known also as thiocarbamide.*



**Thiourea-formaldehyde resin** *n.* An amino resin made by polycondensation of thiourea (thiocarNbamide) $[(NH_2)_2CS]$ with formaldehyde.

**Thiourea resins** *n.* Resins made by the interaction of thiourea and aldehydes.

**Thixotropic** *adj.* (1) A liquid or dispersion that exhibits a reduction in viscosity with *time* at constant shear stress, opposite effect is *rheopectic* (not to be confused with *pseudoplastic,* reduction of viscosity with *shear stress*). (2) A term that describes full-bodies material which undergoes a reduction in viscosity when shaken, stirred, or otherwise mechanically disturbed and which readily recovers the original full-bodied condition on standing.

*See body; false body.*

**Thixotrope** *n.* Additive used to impart thixotropy to a coating.

*See thickener.*

**Thixotropic agent** *n.* A chemical that imparts the property of thixotropy to a solution or suspension.

*See also thickening agent.*

**Thixotropic fluid** *See thixotropy.*

**Thixotropic paint** *n.* Paint which, while free-flowing and easy to manipulate under a brush, sets to a gel within a short time when it is allowed to remain at rest. Because of these qualities a thixotropic paint is less likely to drip from a brush then other types and can be applied in rather thicker films without running or sagging.

**Thixotropy** \thik-ˈsä-trə-pē\ [ISV *thixo-* (fr. Gk *thixis* act of touching, fr. *thinganein* to touch)] (1927) *n.* (1) A time-dependent decrease in the viscosity of a liquid subjected to shearing or stirring, followed by a gradual recovery when the action is stopped. This is a desirable property in most paints because the painter wants the paint to spread easily but not to sag or slump when brushing, rolling, or spraying is stopped. The term is often mistakenly applied to pseudoplastic fluids. (2) The property of a coating or other material that enables it to thicken or stiffen in a relatively short time on standing at rest but, upon isothermal agitation or manipulation to change to a very soft consistency or to a fluid of high viscosity, the process being completely reversible (gel–sol–gel transformation).

*Also called false body and shear thinning.*

**Thomson thermoelectric effect** *n.* The designation of the potential gradient along a conductor which accompanies a temperature gradient. The magnitude and direction of the potential varies with the substance. The coefficient of the Thomson effect or specific heat of electricity is expressed in joule per coulomb per degree centigrade.

**Thornel** *n.* Graphite yarn, originally manufactured by Union Carbide, USA.

**Thread** \ˈthred\ [ME *thred*, fr. OE *thrîd*; akin to OHGr *drāt* wire, OE *thrāwan* to cause to twist or turn] (before 12c) *n.* (1) A slender, strong strand or cord, especially one designed for sewing or other needlework. Most threads are made by plying and twisting yarns. A wide variety of thread types are in use today, e.g., spun cotton and spun polyester, core-spun cotton with a polyester filament core, polyester or nylon filaments (often bonded), and monofilament threads. (2) A general term for yarns used in weaving and knitting, as in "thread count" and "warp thread".

**Thread count** *n.* (1) The number of ends and picks per inch in a woven cloth. (2) The number of wales and courses per inch in a knit fabric.

**Threaded-roll process** *n.* A high-speed method developed by Celanese for converting crimped continuous filament tow into highly bulked, uniformly spread webs of up to 108 in. widths. The webs are useful in a variety of products, such as cigarette filters, sleeping pillows, and battings.

**Threading up** *v.* Actions taken in starting an extrusion operation after turning on the preheated extruder at low speed and beginning the flow of feedstock. As the first extrudant emerges from the die, it is gripped and moved by hand through the various parts of the downstream equipment until each of the driven elements is itself moving the extrudate. Extrusion rate is then gradually increased to the target level.

**Threadlines** *n.* The fiber lines of a manufactured fiber in extrusion or subsequent processes.

**Thread out** *See end out.*

**Thread-up** *n.* The process of directing or threading fiber or fabric through all machine positions to start or restart a process, or the configuration resulting therefrom.

**Threat plug** *n.* The male part of a mold that shapes an internal threat in the molding and must be unscrewed from the finished piece. Automatic unscrewing molds can do this mechanically for scores of bottle caps molded in a single shot.

**Three-bar fabric** *n.* A tricot fabric made on a machine equipped with three guide bars.

**Three-center bond** *n.* A bond consisting of an electron pair shared among, and bonding, three atoms; found in electron-deficient compounds.

**Three-dimensional braid (3-D braid)** *n.* A recent development in building reinforcement performs for complex shapes that permits the placing of reinforcing fibers in three orthogonal (or non-orthogonal) directions so as to best support multidirectional stresses expected to act on the finished part in service.

**Three-dimensional weaving** *n.* To produce three-dimensional textiles, yarns are simultaneously woven in three directions (length, width, and thickness) rather than in the conventional two. The types of structures that can be produced fall into four broad classes: (1) Contoured fabrics. (2) Expandable fabrics. (3) Interwoven fabrics (4) Contoured interwoven fabrics. *Also see double weave.*

**Three-plate mold** *n.* An injection mold with an intermediate movable plate that permits center or offset gating of each cavity.

**Three-roll mill** *See triple roller mill.*

**Three-roll stack (haul-off)** *n.* The vertical array of three polished and cored, chrome-plated rolls that receives molten sheet from a sheet die and chills it while impressing the high finish of the rolls on the sheet itself. The position of the center roll is fixed, while the upper and lower rolls are pressed toward the center roll against adjustable stops by air cylinders exerting pressures of 300 + kPa/cm of roll width. Roll temperature is separately controlled by warm water pumped through the shell annuli at high velocity. The molten sheet passes into the nip of the two upper rolls, whose speed, relative to the mean melt velocity in the die, determines how much the sheet is drawn down. Embossed sheet can be made by replacing the center roll with an embossing roll.

**Threshold limit value (TLV)** *n.* Refers to airborne concentrations of substances, and represents conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect. These values may be breathed continually for 8 h/day without harm. Because of wide variation in individual susceptibility, exposure of an occasional individual at or even below the threshold limit may not prevent discomfort, aggravation of a pre-existing condition, or occupational illness. Threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. The American Conference of Governmental Industrial Hygienists (ACGIH) adopts a list of threshold limit values (TLV) each year for more than 450 substances.

**Through-dry** *See dry-through.*

**Through-drying** *n.* Uniform drying throughout the film as opposed to bottom-drying or top-drying.

**Throughput** *n.* The amount of raw material processed in a specific time. This is the actual amount, not a percentage.

**Throwing** *n.* (1) Defect of impregnating insulating varnishes used on high-speed rotating equipment, and evidenced by the ejection of particles of varnish by the centrifugal force generated. (2) A textile term referring to the act of imparting twist to a yarn, especially while plying and twisting together a number of yarns. A person doing this is called a *thruster.*

**Throwing out** *n.* (1) *See gas checking.* (2) Formation of a precipitate. (3) Flocculation.

**Throwing power** *n.* The ability of an electrode position coating or resin to cover an interior surface to which the current has limited access.

**Throw out** *n.* A precipitate or floc.

**Throwster** \ˈthrō-stər\ (15c) *n.* A company that specializes in putting additional twist in yarn. More recently, the term also applies to a company that specializes in texturing yarns.

**Thrum** \ˈthrem\ [ME, fr. OE –*thrum* (in *tungethrum* ligament of the tongue), akin to OHGr *drum* fragment] (14c) *n.* The fringe of warp yarns that remains on the loom when the woven fabric has been cut free.

**Thurst bearing** *n.* Of an extruder, the heavy-duty bearing upon which the rear shoulder of the screw shank pushes as it transmits the rearward force due to the head pressure. Three types of thrust bearings are in use for single-screw extruders. In order of increasing merit they are *flat-roller bearings, capered-roller bearings*, and *spherical-roller bearings*.

*See thurst load. See also B-10 life.*

**Thurst load** *n.* In an extruder or screw-injection molder, the rear-directed force in reaction to the forward buildup of pressure in the screw, culminating in the heard pressure acting over the whole screw cross-section, and equal to $\pi D^2 P/4$. This force is much less in an injection molder of the same screw diameter because, while the screw is turning, the head pressure is low and when the screw stops, the injection rams take up the thrust. Therefore, their thrust bearings can be much smaller than those of equal-size extruders.

*See also B-10 life.*

**Thus** *n.* Oleoresinous exudation of rosin type. Because of its relative softness it has been used to a small extent in spirit varnishes as a plasticizer.

**Ti** *n.* Chemical symbol for the element titanium.

**Ticking** \ˈti-kiŋ\ [$^{2}$*tick*] (1649) *n.* A durable, closely woven fabric used for covering box springs, mattresses, and pillows. Ticking may be woven in a plain, satin, or twill weave, usually with strong warp yarns and soft filling yarns.

**Tie bar** *n.* In a plastic molding press, one of two or four sturdy, cylindrical, steel posts that provide structural rigidity to the clamping mechanism and accurately guide platen movement.

**Tie back** *See sticker* (1)

**Tie coat** *n.* Intermediate coat used to bond different types of paint coats. Syn: block coat, transition primer, and barrier coat.

**Tiffany finish** *n.* A wall decoration in which a number of translucent paints are applied in various hues in an irregular manner and modified by wiping, blending, etc.; a kind of scumbling.

**Tight cure** *n.* Sufficient vulcanization to give a product good tensile strength and good snap or elasticity.

**Tight or loose end** *n.* A taut or slack warp end caused by too much or too little tension on an individual end while weaving, by ridgy section or warp beams, by incorrect tensions in beaming or sizing, or as a result of faulty fabric design.

**Tight spot** *See twit.*

**Tile** \ˈtī(ə)l\ {*often attributive*} [ME, fr. OE *tigele*, fr. L *tegula* tile; akin to L *tegere* to cover] (before 12c) *n.* A ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay and other ceramic materials, called the body of the tile, having either a "glazed" or "unglazed" face and fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics.

**Tile-like coating (TLC)** *n.* System applied by conventional means and intended to produce vitreous (tile-like) finishes on relatively rough masonry or other cementitious walls and ceilings. They are generally thicker, harder, and more washable than conventional paints.

*See also high-build coating.*

**Time, assembly** *n.* The time interval between the spreading of the adhesive on the adherend and the application of pressure or heat, or both, to the assembly. *Note*—For assemblies involving multiple layers or parts, the assembly time begins with the spreading of the adhesive on the first adherend. (1) Open assembly time is the time interval between the spreading of the adhesive on the adherend and the completion of assembly of the parts for bonding. (2) Closed assembly time is the time interval between completion of assembly of the parts for bonding and the application of pressure or heat, or both, to the assembly.

**Time, curing** *n.* The period of time during which an assembly is subjected to heat or pressure, or both, to cure the adhesive (*see also curing time, time, joint conditioning, and time setting*). *Note*—Further cure may take place after removal of the assembly from the conditions of heat or pressure, or both.

*See time, joint conditioning.*

**Time, drying** *n.* The period of time during which an adhesive on an adherend or an assembly is allowed to dry with or without the application of heat or pressure, or both.

**Time, joint conditioning** *n.* The time interval between the removal of the joint from the conditions of heat or pressure, or both, used to accomplish bonding and the attainment of approximately maximum bond strength.

*Sometimes called joint aging time.*

**Time–temperature equivalence** *n.* Because an increase in temperature accelerates molecular motions, mechanical behavior of polymers at one temperature can be used to predict those at another by means of a shift factor equal to the ratio of relaxation time at the second temperature to that at the first. The principle can be used to combine measurements made at many temperatures into a single master curve for a reference temperature over many decades of time.

*See Williams–Landell–Perry equation.*

**Time-to-break** *n.* In tensile testing, the time interval during which a specimen is under prescribed conditions of tension and is absorbing the energy required to reach maximum load.

**Tinctorial strength** \tiŋ(k)-ˈtōr-ē-əl-\ (ca. 1864) *n.* The relative ability of a pigment or dye to impart color value to a printing ink.

*See color strength.*

**Tinge** *See cast.*

**Tin stabilizer** *See organotin stabilizer.*

**Tint** \ˈtint\ [alter. of earlier *tinct*, fr. L *tinctus* act of dyeing, fr. *tingere* to tinge. (1, *n*) The color produced by the mixture of white pigment with absorbing (generally chromatic) colorants. The color of the resulting mixture is lighter and less saturated than the color without the addition of the white. (2, *vt*) To impart or apply a tint.

*See shade* (4) *and tinting.*

**Tinter** *n.* Colored pigments ground in media compatible with paint vehicles, added in relatively small proportions to already prepared paints to modify their color. With the introduction of latex paints of many types, tinters have been developed which can be used both with organic solvent-thinned paints and with water-thinned paints. Such dual-purpose tinters are known as universal tinters.

*Also called stainer.*

**Tinting** *n.* (1) Final adjustment of the color of a paint to the exact color required. (2) In lithography, a uniform discoloration of the background caused by the bleeding or washing of the pigment in the fountain solution.

**Tinting (or tint) strength, absorption** *n.* Relative change in the absorption of a standard white pigment when a specified amount of absorbing pigment, black or chromatic, is added. This is basically the common definition of tinting strength.

**Tinting (or tint) strength, scattering** *n.* Relative change in the scattering of a standard (masstone) black when a specified amount of scattering pigment, white or chromatic, is added.

*See tinting strength.*

**Tinting strength** *n.* The relative ability of a unit quantity of colorant to alter the color of another colorant to which it is added. In popular usage, tinting strength is an index of the effectiveness with which a chromatic colorant imparts color to a standard white pigment. This definition of the term can be misleading, however. The tinting strength of a yellow, when added to a black, depends on its scattering; the tinting strength, as determined from a mixture with white, tells nothing about its behavior when mixed with colorants of low scattering, or black in the extreme case. In a mixture of pigments, the absorption strength or the scattering strength, or both, may affect its apparent strength. Therefore, In any case, tinting strength comparisons of materials of different chemical type may vary with the concentrations of colorants used, so care must be exercised in selecting relative concentrations or concentration ranges.

*Also called tint strength and staining power. see tinting strength, absorption, and timing strength, scattering.*

**Tint-tone** *n.* Color obtained when a masstone pigment is mixed with a white pigment in a vehicle system.

**Tip-sheared carpet** *n.* A textured pile carpet similar to a random-sheared carpet, but with a less defined surface effect.

**Tire-builder fabric** *n.* Fabric consisting of tire cord in the warp with single yarn filling at extended intervals.

**Tire construction** *n.* The geometry of the various layers of tire fabric in the final tire. Three constructions are commonly used. *Bias Tire* – In this construction, tire fabric is laid alternately at bias angles of 25°–400° to the tread direction. An even number of layers (or piles) is used. *Radial tire* – In a radial tire, tire fabric traverses the body of the tire at 90° to the tread direction. Atop the tire fabric are laid alternating narrow layers of fabric at low angles of 10°–300° to the tread direction; the belt that is formed around the tire body restricts the movement of the body. *Bias/belted tire* – This tire construction combines features of the preceding two. The first layers of fabric are identical to the bias tire. The belt is added in alternating layers at 20° to the tread direction.

**Tire cord** *n.* A textile material used to impart the flex resistance necessary for tire reinforcement. Tire yarns of polyester, rayon, nylon, aramid, glass, or steel are twisted to 5–12 turns/in. Two or more of these twisted yarns are twisted together in the opposite direction to obtain a cabled tire cord. The twist level required depends on the material, the yarn linear density, and the particular application of the cord. Normally, tire cords are twisted to about the same degree in the *S* and *Z* directions, which mean that the net effect is almost zero twist in the finished cord.

*Also see tire fabric.*

**Tire fabric** *n.* A loose fabric woven to facilitate large-scale dipping, treating, and calendering of tire cords. Usually, 15–35 tire cords/in. of warp are woven into a tire fabric by 2–5 light filling yarns/in. In these fabrics, the strength is in the warp and the filling only holds cords in position for processing. The filling yarns are normally broken during tire molding. The warp cords are polyester, rayon, nylon, aramid, glass, or steel and range in strength from 30 to over 100 lb/cord. A 60 in. fabric would normally have a warp strength of about 7,000 lb. Such fabrics are used for tire carcasses and tire belts. More conventional square woven fabrics are used in certain parts of a tire such as the bead, chafer, and wrapping.

*Also see tire cord.*

**Titanate** \ˈtī-tᵊn-ˌāt\ (1839) *n.* (1) Any various multiple oxides of titanium dioxide with other metallic oxides. (2) A titanium ester of the general formula $Ti(OR)_4$.

**Titanate coupler** *n.* One of a family of organo-titanium compounds first developed by Kenrich Petrochemicals in 1978 and burgeoning since then. Types available include monoalkoxy, chelate, coordinate, and quaternary salts. They form molecular bridges between organic matrices (resins) and inorganic fillers and reinforcements. Conductivities of metal-filled plastics are increased by one to four orders of magnitude, while melt viscosities are reduced by factors of 0.3–0.1.

**Titania** \tī-ˈtā-nē-ə\ [NL] (1922) *n. See titanium dioxide.*

**Titanium brown** *n.* Brown pigment made by precipitating a mixed solution of cobalt and ferrous salts, containing a suspension of titanium hydroxide, with sodium carbonate. The mixed precipitate is washed and calcined.

**Titanium dioxide** (1877) (titanic anhydride, titanic acid anhydride, titanium white, and titania) *n.* $TiO_2$. A white powder available in two crystalline forms, both tetragonal: *anatase* and *rutile*. Both are widely used as opacifying and brightening pigments in thermosets and thermoplastics, used alone when whites are desired or in conjunction with other pigments when tints are desired. They are essentially chemically inert, lightfast, resistant to migration and heat. The rutile form is denser and has the higher refractive indices (2.61 and 2.90 vs. 2.55 and 2.45 for the anatase form), and thus has somewhat greater opacifying power for a given volume percent and particle-size distribution.

**Titanium dioxide, anatase** *n.* $TiO_2$. Pigment white 6 (77891). A high opacity, bright pigment of the chalking type, used as a prime pigment in paints, rubber, plastics. Prepared from the mineral, ilmenite, or rutile ore. Density, 3.8–4.1 g/cm$^3$ (32–34 lb/gal); O.A., 18–30; particle size, 0.3 µm, refractive index, 2.55. Syn: titania. *See also titanium dioxide, rutile.*

**Titanium dioxide, rutile** *n.* $TiO_2$. Pigment white 6 (77891). A high-opacity, bright white pigment, non-chalking type, used as a prime pigment in paints, rubber, plastics. Prepared from the mineral, ilmenite, or rutile ore. Density, 3.9–4.2 g/cm$^3$ (33–35 lb/gal); O.A., 16–48; particle size, 0.2–0.3 µm, refractive index, 2.76. Syn: titania. *See also titanium oxide, anatase.*

**Titanium green** *n.* Complex pigments based on calcined mixtures of titanium oxide or hydroxide with suitable other metallic oxides, carbonates, etc. The other metallic compounds include those of zinc.

**Titanium lithopone** *n.* This may be made by mixing a minor proportion of titanium dioxide into lithopone, or possibly by the co-precipitation of the usual lithopone constituents in the presence of titanium hydroxide. The resultant product in the latter case is subjected to controlled calcinations. *Also known as titanated lithopone.*

**Titanium pigments** *n.* Titanium dioxide ($TiO_2$), rutile, and anatase, are the best examples of white pigments.

**Titanium trichloride** *n.* $TiCl_3$. A catalyst for olefin polymerization.

**Titanium white** (1920) *n.* A brilliant white lead-free pigment consisting of titanium dioxide often together with barium sulfate and zinc oxide.

**Titanium yellow** *See nickel titanate.*

**Titrant** \ˈtī-trənt\ (1939) *n.* The substance slowly added during a titration.

**Titration** \tī-ˈtrā-shən\ (ca. 1859) *n.* The slow addition of a solution of one reactant to one of a second reactant until the equivalence point is signaled by an indicator color change or other method.

**Tobacco cloth** *n.* A thin, lightweight, open cloth used to shade and protect tobacco plants.

**Tobacco seed oil** *n.* Seed oil obtained from *Nicotiana tabacum.* Considerable divergencies in composition of the oil have been reported. Some types contain as much as 70% linoleic acid, whereas others contain no linoleic acid and more than 54% of linoleic acid. In consequence, its constants as reported vary considerably. Certain types have excellent drying properties, and can replace linseed oil without detriment.

**Tobias acid** \tə-ˈbī-əs ˈa-səd\ *n.* Intermediate used in the manufacture of dyestuffs. 2-naphthylamine-1-sulfonic anti-oxidant, generally regarded as safe by the Food and Drug Administration. It has been shown to be a good heat stabilizer in polyolefins, providing protection at levels around 250 ppm. Both ATP and its breakdown products are environmentally safe.

**Tocopherols** \tō-ˈkä-fə-ˌról\ In I[ISV] (ultimo. fr. Gk *tokos* childbirth, offspring (akin to Gk *tiktein* to beget) + *pherein* to carry, bear] (1936) *n.* occurring anti-oxidants in vegetable oils.

**Toe closing** *n.* In knitting hosiery, this term refers to closing the toe opening. It may be knit closed, or in tube hosiery, sewn closed.

**TOF** *n.* Abbreviation for trioctyl phosphate.

**Toggle action** *n.* A mechanism that magnifies force exerted on a knee joint. It is used as a means of closing and locking press platens and also serves to apply pressure at the same time.

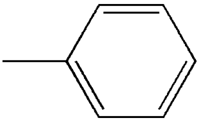
**Toile** \ˈtwäl\ [F, cloth, linen, fr. MF] (1794) *n.* (1) A broad term describing many simple plain weave twill fabrics, especially those made from linen. (2) Sheer cotton and linen fabrics.

**Tole** \ˈtōl\ {*often attributive*} [F *tôle*, fr. MF dialect *taule*, fr. L *tabula* board, tablet] (1927) *n.* Painted tin ware.

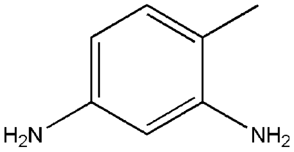
**Tolerance** *n.* The total range of variation (usually bilateral) permitted for a size, position, or other required quantity; the upper and lower limits between which a dimension must be held.

**Tolerance interval** *n.* The specified allowance of variation of a dimension (or other quantity) above and below the nominal or target values in a production part or product. For a process whose average level and random variation are in control, symmetrical tolerance limits should be at least six processes standard deviations apart in order to approach zero percent defective parts. Tolerances are better understood and getting much more attention now than a few decades ago when a New York molder was asked about tolerances on parts he was producing. His reply: “Hey, we got lotsa tolerance here! We hire people no matter what color or nationality they are”.

**Toluene (tuluol)** \ˈtäl-yə-ˌwēn\ [F *toluène*, fr. *tolu* balsam fr. the tropical Americal tree *Myroxylon balsamum*, fr. Sp *tolú*, fr. Santiago de *Tolú*, Colombia] (1871) (toluol, methylbenzene, methylbenzol) *n.* $H_3CC_6 H_5$. A colorless, flammable liquid with a sharp, benzene-like odor, used as a solvent for cellulosics, vinyl organosols, and other resins and is used in the manufacture of coatings. Toulene is also a synthesis intermediate for polyurethanes and polyesters. The commercial product has a boiling range, 105–112°C; flp, 50°C; vp, 26 mmHg per 30°C. The term “toluol” is still used commercially but is not preferred.

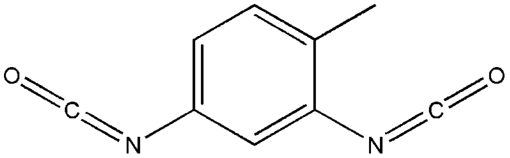


**Toluene-2,4-diamine** \-ˈdī-ə-ˌmēn\ (TDA, *m*-tolylene diamine) *n.* $H_3CC_6H_3(NH_2)_2$. A colorless, crystalline material used in the product of toluene diisocyanate, a key material in the manufacture of polyurethanes.

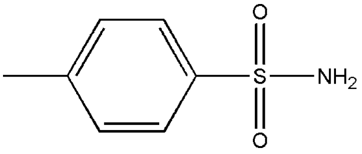


**Toluene-2,4-diisocyanate (2,4-toulene diisocyanate, Br: tolylene diisocyanate, TDI)** *n.* $H_3CC_6H_3(NCO)_2$. A water-white to pale yellow liquid with a sharp, pungent odor, produced by reacting toluene-2,4-diamine with phosgene (some of the 2,6-isomer is usually present). It reacts with water to produce carbon dioxide. TDI is widely used in the production of polyurethane foams and elastomers, but is toxic and requires careful handling to keep its concentration in work-space air below the permissible threshold limits.

*See also diisocyanate.*

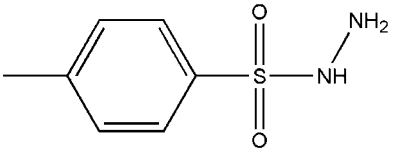


***p*-Toluenesulfonamide** \-ˌsəl-ˈfä-nə-ˌmīd\ (PTSA) *n.* $H_3CC_6H_4SO_2NH_2$. White leaflets, existing also in the *o*-form; both are used as solid plasticizers for ethyl cellulose, polyvinyl acetate, and rigid PVC.

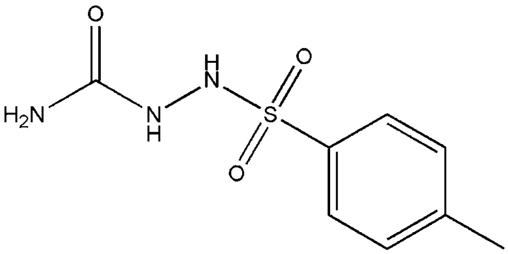


**Toluenesulfonamide resin** *n.* Resins made by the interaction of toluene sulfonamide and formaldehyde.

***p*-Toluenesulfonylhydrazide** *n.* A blowing agent similar to benzene–sulfonylhydrazide, but having higher melting and decomposition temperatures.



***p*-Toluenesulfonylsemicarbazide** *n.* A blowing agent with a high decomposition temperature (235°C) that makes it useful for foaming plastics that are processed at high temperatures, such as high-density polyethylene, polypropylene, rigid PVC, acrylonitrile–butadiene–styrene resins, polycarbonates, and nylons.



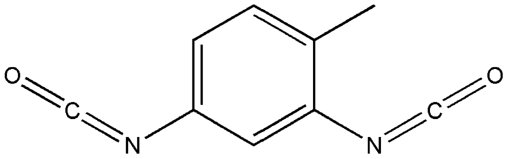
**Toluidine blue** \tə-ˈlü-ə-ˌdēn-\ (1898) *n.* A basic thiazine dye that is related to methylene blue and is used as a biological stain.

**Toluidine reds** *n.* Pigment red 3 (12120). Series of red dyestuffs made by diazotizing 2-nitro-*p*-toluidine and coupling this with *β* naphthol under alkaline conditions. By altering the conditions of preparation, reds of different shade, brilliance, strength, etc. are obtained.

**Toluidine toner** *See toluidine reds.*

**Toluidine yellow** *See Hansa yellow.*

**2,4-Tolulene diisocyanate** *n.* British Syn: toluene-2,4-diisocyanate.



**Tone** \ˈtōn\ (1660) *v.* (1) A modification of a full-strength color (mass tone) secured by blending with other colors. (2) Use of this term is to be deprecated since it is variously employed in different senses. According to the context, "hue" or "undertone" are, respectively, the preferred terms.

*See hue and undertone color.*

**Toner** *n.* (1) A single organic pigment which does not contain inorganic pigment (extender), or a single inorganic pigment having maximum absorption strength for the given type of pigment. (2) Also loosely applied to pure pigment dyestuff, but this use of the term is deprecated. (3) A highly concentrated pigment and/or dye used to modify the hue or color strength of ink.

*See lake. Also: the "ink" in electrostatic printing.*

**Tongue tear strength** *n.* The average force required to tear a rectangular sample with a cut in the edge at the center of the shorter side. The two tongues are gripped in a tensile tester and the force required to continue and tear is measured.

**Toning blue** *See iron blue.*

**Tooth** *n.* In a dry paint film, a fine texture imparted either by a proportion of relatively coarse or abrasive pigment or by the abrasives used in sanding; this texture improves the rubbing properties and also provides a good base for the adhesion of a subsequent coat of a paint or varnish.

**Top** *n.* (1) A wool sliver that has been combed to straighten the fibers and to remove short fiber; an intermediate stage in the production of worsted yarn. (2) A similar untwisted strand of manufactured staple delivered by the comb or made directly from tow.

**Top coat** *n.* The coating intended to be the last coat applied in a coating system; usually applied over a primer, undercoaters, or surfacers.

*See coat. Also known as finish coat.*

**Top color** *n.* Colors used on the ground color to form a design.

*See face color.*

**Top drying** *n.* Drying of a film at the top only, e.g., cobalt naphthenate is used as a top drier.

**Top dyeing** *n.* (1) The process of covering with an additional dye, not necessarily of the same color or class, to obtain the desired shade. (2) Fiber in top form is placed in cans and dyed in a batch-dye vessel with reverse cycling capability. An expensive process that is used primarily for fancy yarns.

**Topology of polymers** \tə-ˈpä-lə-jē-\ *n.* The surface texture of polymers.

**Toptone** *See masstone.*

**Torpedo** *n.* (1) (spreader) A streamlined, conicylindrical block, supported by three ridges (*spider*) and placed in a path of flow of the plastic pellets within the heating cylinder of a plunger-type injection molder, to spread the stock into a thin annulus, thus providing intimate contact with the heating surfaces. (2) Years ago, some extruder screws ended in smooth torpedoes only a little less in diameter than the barrels, the idea being to provide final shear mixing and improve homogeneity of the melt arriving at the die. (3) The core of an in-line pipe die supported by spider legs is sometimes called a torpedo.

**Torque** \ˈtórk\ [F, fr. L *torques*, fr. *torquēre* to twist] (1695) *n.* A force or a combination of forces that produces or tends to produce a twisting or rotating motion. In reference to yarn, torque refers to the yarn's tendency to turn on itself, or kink, as a result of twisting.

**Torque produced by the action of one magnet on another** *n.* The turning moment experienced by a magnet of pole strength $m'$ and length $2l'$ placed at a distance $r$ from another magnet of length $2l$ and pole strength $m$, where the center of the first magnet is on the axis (extended) of the second and the axis of the first is perpendicular to the axis of the second

$$C = \frac{mm'll'}{r^2} = \frac{2MM'}{r^3}.$$

If the first magnet is deflected through an angle $\theta$, the expression becomes

$$C = \frac{2MM'}{r^3}\cos\theta.$$

**Torque yarns** *See textured yarns.*

**Torr** \ˈtór\ [Evangelista *Torricelli*] (1949) *n.* A unit of pressure: 1 torr = 1 mmHg = $\frac{1}{760}$ atm. The torr (for E. Torricelli, who invented the mercury barometer in 1643) was introduced a few decades ago when people grew weary of saying "millimeters of mercury", to which it was set equal. Now the torr, too, is depreciated.

**Torsion** [LL *torsion-*, *torsio* torment, alter. of L *tortio*, from *torquēre* to twist] (1543) *n.* Engineering term for modes of shear stress and shear strain caused by twisting of bodies. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Torsional braid analysis** *n.* A method of performing torsional tests on small amounts of materials in states in which they cannot support their own weight, e.g., liquid thermosetting resins. A glass braid is impregnated with a solution of the material to be tested. After evaporation of the solvent, the impregnated braid is used as a specimen in an apparatus that measures motion of the oscillating braid as it is being heated at a programmed rate in a controlled atmosphere. ASTM D 4065 provides information on torsional testing. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Torsional modulus** *n.* Shear modulus ($G$) as measured in a test in which the specimen is twisted. In ASTM D 1043, the test specimen is a flat rectangular bar with length about seven times its width of 6.35 mm and thickness 1/3 the width. The apparent shear modulus is given by

$$G = kTL/ab^3\phi,$$

where $T$ is the torque exerted on the specimen, $L$, $a$, and $b$ are its length, width, and thickness, $\phi$ the angle of twist, and $k$ is the coefficient dependent on units and the ratio $a/b$. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Torsional rigidity** *n.* Of a fiber, wire, bar, tube, or profile shape subjected to twisting of one end relative to the other, the torque required to produce a twist of 1 rad. This rigidity is proportional to the shear modulus of the material and is strongly dependent on all dimensions, especially section thickness.

**Torsional test** *n.* A test for determining shear properties of plastics, such as shear modulus, based on measuring the torques required to twist a specimen through a prescribed arc.

*See ASTM, www.astm.org, or standard test methods.*

**Torsional vibration** *See angular harmonic motion.*

**Torsion–braid analyzer** *n.* An instrument which permits the measurement of thermomechanical properties of polymers that are undergoing structural changes during cure. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Torsion pendulum** *n.* A device for performing dynamic mechanical analysis in which a sample is deformed torsionally and allowed to oscillate in free vibration. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Tortuosity factor** *n.* (1) The distance a permeating molecule must travel to pass through a film, divided by the thickness of the film. (2) The mean length of path of fluid molecules passing through a packed bed or porous medium (such as open-cell foamed plastic) divided by the thickness of the bed in the direction of the pressure gradient. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Total color difference** *n.* The perceived difference between two colors, including the differences in hue, saturation, and lightness; generally used as a value calculated from a color difference equation and designated as $\Delta E$. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See color difference and color difference equations.*

**Total denier** *n.* The denier of a tow before it is crimped. It is the product of the denier per filament and the number of filaments in the tow. The total denier after crimping (called crimped total denier) is higher because of the resultant increase in weight per unit length.

**Total denier (of tow)** *n.* The product of the denier per filament times the number of filaments in a tow.

**Total reflectance** *See reflectance, total.*

**Total reflection** *n.* When light passes from any medium to one in which the velocity is greater, refraction ceases and total reflection begins at a certain critical angle of incidence of $\theta$ such that

$$\sin\,\theta = \frac{1}{n},$$

when $n$ is the index of the first medium with respect to the second. If the second medium is air $n$ has the ordinary value for the first medium. For any other second medium,

$$n = \frac{n_1}{n_2},$$

where $n_1$ and $n_2$ are the ordinary indices of refraction for the first and second medium respectively. Moller KD (2003) Optics. Springer-Verlag, New York. Kokhanovsky AA (2004) Light scattering media optics. Springer-Verlag, New York. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Total shear** *n.* A concept (1956) that indicates shear mixing in extruders, but also applicable to other processes in which shear is the principal flow mode. It is the integrated product of shear rate times time over the region in which a melt is undergoing shear flow. The ratio of initial to final *striation thickness* is proportional to total shear.

*See striation.*

**Total solids** *See solids.*

**Total transmittance** *See transmittance, total.*

**TOTM** Abbreviation for trioctyl trimellitate.

**Touch-dry** *See set-to-touch time and drying time.*

**Touch-up painting** *n.* Application of paint on small areas of painted surfaces to repair mars, scratches, and small areas where the coating has deteriorated, in order to restore the coating to an unbroken condition.

**Toughness** *n.* A term with a wide variety of meanings, no single precise mechanical definition being generally recognized, but tensile strength with pact resistance is indicator of toughness. Also, it is the measure of the ability of a sample to absorb mechanical energy without breaking, usually defined as the area underneath a stress–strain curve. Toughness generally implies a lack of brittleness; having very substantial elongation to break accompanied by high tensile strength. One proposed definition for toughness is the energy per unit volume to break a material, equal to the area under the stress–strain curve. Toughness has also been equated to impact resistance, especially resistance to repeated impacts. Energy required to break a specimen in the tensile-impact test, divided by the gauge-length volume of the specimen, is a fairly straightforward toughness measure. Also, that energy to break in tension is definitely dependent on the time scale of the test. Toughness has also been equated to resistance to abrasion, and to resistance to penetration by points and cutting with sharp tools (*see ASTM standards, www.astm.org*). Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Tow** \ˈtō\ [ME, fr. OE *tow-* spinning; akin to ON *tō* tuft of wood for spinning, OE *tawian* to prepare for use] (14c) *n.* A large strand of continuous manufactured fiber filaments without definite twist, collected in loose, rope-like form, usually held together by crimp. Tow is the form that most manufactured fiber reaches before being cut into staple. It is often processed on tow-conversion machinery into tops, sliver, or yarn, or on tow-opening equipment to make webs for various uses. Wallenberger FT, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Towpreg** A prepreg consisting of resin-impregnated TOW, that may be braided or woven to form a reinforced-plastic structure. Wallenberger FT, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Chung DD (1994) Carbon fiber compositers. Elsevier Science and Technology Books, New York.

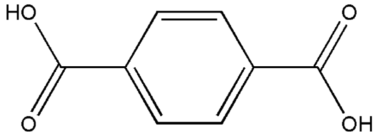
**Toxic** \ˈtäk-sik\ {*combining form*} [NL, fr. L *toxicum*]. Poisonous.

**Toxicity** *n.* (1) The measure of the adverse effect exerted on the human body by a poisonous material. (2) A relative property of a chemical agent with reference to a harmful effect on some biological mechanism and the condition under which this effect occurs. The quality of being poisonous. Ashford NA, Miller CS (1997) Chemical exposures: low levels and high stakes. John Wiley and Sons, New York.

**Toxic pollutants** *n.* Those pollutants, which, after discharge and upon contact with any organism, either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions or physical deformities in such organisms or their offspring. Ashford NA, Miller CS (1997) Chemical exposures: low levels and high stakes. John Wiley and Sons, New York.

**Toxic substance** *n.* A substance that demonstrates the potential to induce cancer, to produce short and long term disease or bodily injury, to affect health adversely, to produce acute discomfort, or to endanger life of man or animal, resulting from exposure via the respiratory tract, skin, eye, mouth, or other routes in quantities which are reasonable for experimental animals or which have been reported to have produced toxic effects in man. Ashford NA, Miller CS (1997) Chemical exposures: low levels and high stakes. John Wiley and Sons, New York.

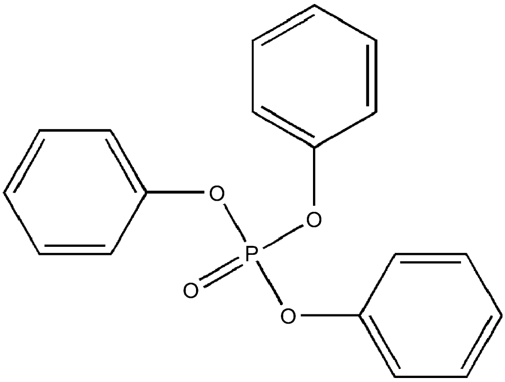
**TPA** *n.* Abbreviation for tererphthalic acid.



**TPE** *n.* Abbreviation for thermoplastic elastomer.

**TPO** *n.* Abbreviation for thermoplastic polyolefin.

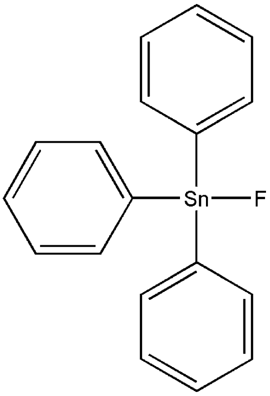
**TPP** *n.* Abbreviation for triphenyl phosphate.



**TPR** *n.* Registered trade name of Uniroyal Inc. (Washington, DC) for a family of thermoplastic rubbers based mainly on ethylene and propylene. Grades range in hardness (Shore A scale) from 65 to 90. Processable by the usual thermoplastics methods, these materials have the properties of vulcanized rubber.

**TPS** *n.* Abbreviation used by the British Standards Institution for "toughened polystyrene," equivalent to USA high-impact polystyrene.

**TPTF** *n.* Abbreviation for triphenytinfluoride. A toxicant used in anti-fouling paints.



**TPX** *n.* Poly(4-methyl-pentene-1). Manufactured by ICI, Great Britain. Abbreviation for poly(4-methylpentene).

**TR** *n.* Thermoplastic elastomers. Abbreviation used by British Plastics Institution for Thio Rubber.
*See polysulfide rubber.*

**Tracking** *n.* An electrical-breakdown phenomenon in polymers in which current caused by an excessive voltage difference between two conductors in contact with an insulating material gradually creates a conductive leakage path across the surface of the material by forming a carbonized track that appears as a thin, wriggly line between the electrodes. Dissado LA, Fothergill CJ (eds) (1992) Electrical degradation and breakdown of polymers. Institution of Electrical Engineering (IEE), London.

**Tractive force of a magnet** *n.* If a magnet with induction $B$ has a pole face of area $A$ the force is

$$F = \frac{B^2 A}{8\pi}.$$

If $B$ and $A$ are in cgs units, $F$ will be in dyne.

**Trade molder** *n.* The British term for custom molder.

**Trade sales coating** *See architectural coatings.*

**Trade sales paints** *n.* Coatings applied on-site at ambient conditions by the consumer using application methods such as brushing or roller coating.

*See also architectural coatings.*

**Traffic marking** *n.* Marring or discoloration, or both, of a floor surface by traffic.

**Traffic paint** *n.* Paint specially formulated to withstand wear of vehicular traffic and to be highly visible at night; used to mark center lines on roadways, traffic lanes, crosswalks, etc. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

*See also beaded paint.*

**Tragacanth** \ˈtra-jə-ˌkan(t)th\ [MF *tragacanthe*, fr. L *tragacantha*, fr. Gk *tragakantha*, fr. *tragos* goat + *akantha* thorn] (1573) *n.* Water-soluble gum derived from *Astragalus* shrubs, and exported from Iran, Iraq, Turkey, India, Syria, and neighboring countries. It is obtained both as a natural and as an artificial exudation. It resembles gum Arabic in being composed of calcium, magnesium and potassium salts. It is used as a stabilizer for emulsions. Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York.

**Trailing flight face (trailing flight)** *n.* In an extruder screw, the rear side of any flight. The forward side is called the leading flight face.

***trans-*** {*prefix*} [L *trans-*,*tra-* across, beyond, through, so as to change, fr. *trans* across, beyond]. An organic-chemistry prefix denoting an isomer in which certain atoms or groups are located on opposite sides of a plane of symmetry. Usually ignored when alphabetizing names of compounds. Compare *CIS-*. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Transducer** \-ˈdü-sər\ (1924) *n.* A device that transforms the value of a physical variable into an electrical signal, usually voltage or current. Examples are: thermocouple, pressure transducer, linear variable differential transformer (a motion transducer), tachometer generator, and force cell.

**Transesterification** *n.* In the production of polyester from dimethyl terephthalate and ethylene glycol, the process of exchanging ethylene glycol for the methyl groups to obtain bis-*p*-hydroxyethyl terephthalate. The methanol generated in the reaction is removed as it is formed to drive the reaction to completion.

**Transfer coating** *n.* A process for coating fabrics such as knits, which are extremely difficult to coat directly by conventional spread-coating methods. In a typical version of the process, a layer of plastisol is cast against a silicone-treated release paper. This first layer becomes the top coat or wear layer in the final product. After gelling of the first layer a second coating of urethane solution is applied to serve as an adhesive layer that bonds the wear layer to the fabric substrate. The composite is finally heated and pressed together, and the paper is stripped away. Many variations of this process are possible, e.g., using vinyl or polyurethane foam, embossing, etc. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Transfer molding** *n.* A molding process used mainly for thermosetting resins and vulcanizable elastomers. The molding material, usually preheated, is placed in an open "pot" with a hole in its bottom atop the closed mold. The cross-sectional areas of this pot are about 15% larger than the total projected area of all cavities and runners in the mold. A ram is placed in the pot above the material. Pressure, applied by a press platen to the ram, forces the molding material through the runners and gates, and into the cavities of the heated mold. Following a heating cycle in which the material is cured or vulcanized, the press is opened and the parts are ejected. In a variation called *plunger molding*, resembling injection molding, the plunger is more a part of the press rather than of the mold, and pressure is applied to the plunger by an auxiliary hydraulic ram. The compound flows faster in plunger molding and more frictional heat is developed, so molding cycles are generally shorter than in transfer molding. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Transfer-molding pressure** *n.* The pressure applied to the cross-sectional area of the material pot or cylinder (MPa or kpsi). Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Transfer paper** *n.* The temporary backing employed in decalcomania. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Transfer printing** Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

*See decalcomania.*

**Transfer roll** *n.* In the coil coating industry, the roll between the pick-up roll and applicator roll where three rolls are present in a coating operation.

**Transfer roller** *See anilox roller.*

**Transfer tail** A long end of yarn wound at the base of a package that permits increased warping or transfer efficiency by providing an easily accessible connecting point for the succeeding package.

**Trans isomer** \-ˈī-sə-mər\ *n.* Any isomer in which two identical groups are located on opposite sides of a structure. Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ.

**Transition** \tran(t)-ˈsi-shən\ [L *transition-*, *transitio*, fr. *transire*] (1551) *n.* The pronounce change in the properties of a material that occur at a certain temperature (the transition temperature) or over a range of temperatures. First-order transition is one in which a discontinuity in the intensive properties occurs. Second-order transitions are associated with the onset of particular modes of molecular motion. Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.

**Transition element** *n.* A member of one of the B groups, which intervene between group IIA and IIIA in the periodic table.

**Transition metal** [fr. their being transitional between the more highly electropositive and the less highly electropositive elements] (1940) *n.* Any of various metallic elements (as chromium, iron, and nickel) that have valence electrons in two shells instead of only one.

*Known also as transition element.*

**Transition primer** *n.* Coating compatible with primer and also with a finish coat, which is not compatible with the primer.

*See block coat, tie coat and barrier coat.*

**Transition section** (transition zone, compression section) *n.* In a metering-type screw for a single-screw extruder the section of decreasing channel volume per turn between the feed and metering sections, in which the plastic is changing state from a loosely packed bed of particles-*cum*-voids, to a void-free melt. The transition may be abrupt or gradual, the latter having been found more satisfactory for nearly all thermoplastics, and may be accomplished by increasing the root diameter of the screw or by reducing the lead angle or both. Reducing the root diameter has been by far the preferred method and may be done conically or helically.

*See conical transition, helical transition, and compression ratio.*

**Transition temperature** *n.* (1) The glass-transition temperature. (2) More generally, any temperature at which a polymer exhibits an abrupt change in phase or measurable property, or at which a property's rate of change with temperature changes abruptly (second-order transition).

**Translucency** \-sᵊn(t)-sē\ (ca. 1610) *n.* Appearance state between complete opacity and complete transparency; partially opaque.

**Translucent** *n.* Transmission of light in such a way that image-forming rays are irregularly refracted and reflected.

**Translucent coating** *n.* A liquid formulation (such as varnish, shellac, or lacquer) which when dry forms a translucent film.

**Transmission** \tran(t)s-ˈmi-shən\ [L *transmission-*, *transmissio*, fr. *transmittere* to transmit] (1611) *n.* Process by which radiant energy is transmitted through a material or an object.

**Transmission electron microscopy** *n.* The transmission electron microscopy is applied to observe phase domain of a size of 50–1000 Å. This and applying dyeing techniques such as oxidizing the unsaturated domain with $OsO_4$ and $RuO_4$. Staniforth M, Goldstein J, Echlin P, Lifshin E, Newbury DE (2002) Scanning electron microscopy and X-ray microanalysis. Springer-Verlag, New York.

**Transmittance** (ca. 1855) *n.* (1) Of light, that fraction of the emitted light of a given wavelength, which is not reflected or absorbed, but passes through a substance. (2) The ratio of the transmitted radiant flux to the incident flux.

*See light transmittance.*

**Transmittance, diffuse** *n.* Ratio of radiant flux transmitted in all forward directions, except the undeviated direction (the specular transmittance), to incident flux.

**Transmittance, internal** *n.* Ratio of radiant flux reaching the exit surface of material to flux which penetrated entry surface; sometimes referred to as transmittancy.

**Transmittance, specular** *n.* Ratio of flux transmitted without change in image-forming state to incident flux; undeviated transmitted beam.

**Transmittance, total** *n.* Ratio of total flux transmitted in all forward directions to incident flux; includes both diffuse and specular transmittances.

**Transmutation** \ˌtran(t)s-myú-ˈtā-shən\ [ME *transmutacioun*, fr. MF or L; MF *transmutation*, fr. L *transmutation-*, transmutatio, fr. *transmutare*] (14c) *n.* The transformation of one element into another.

**Transparency** *n.* State of being transparent or completely non-scattering; attribute of located mode of appearance that permit perception of object or space through or beyond a surface or within a volume. It can also be written as, the degree to which a material or substance transmits light.

**Transparent** *adj.* Adjective to describe a material, which transmits light without diffusion or scattering.

**Transparent coating** *n.* A liquid formulation (such as varnish, shellac, or lacquer) which, when dry, forms a transparent film.

**Transparent inks** *n.* Inks which lack hiding power and permit light to pass through. They permit previous printing to show through, the two colors blending to produce a third, e.g., a transparent yellow over a blue to produce a green, where the two colors are superimposed. Printing ink handbook, 5th edn. National Association of Printing Ink Manufacturers Inc., Kluwer Academic Press, London, UK, 1999. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink handbook, 5th edn. Blueprint, New York.

**Transparent painting** *n.* Painting with transparent pigments as opposed to opaque ones, e.g., glazing, water color painting. Transparent pigment is converted to opaque pigment by the addition of white.

**Transparent plastic** *n.* A plastic that transmits incident light with negligible scattering and little absorption, enabling objects to be seen clearly and brightly through it. At least nine basic classes of plastics are generally regarded as being permanently transparent in thick sections; some others possess near-transparency, at least for a limited period. The nine are: acrylics (foremost in usage for transparency), cellulosics, allyl Diglycol carbonates, some epoxies, nylons, and plasticized PVCs, polycarbonate, polysulfone, crystal polystyrene, and polyphenyl sulfone.

**Transputer** *n.* A type of process–control architecture in which computing elements are linked not only by a systems' bus but also by additional links combining software and hardware, called "firmware" links. The gain in speed of handling control tasks (as of 11/91) is about a factor of 20, permitting the use of complex control algorithms for, say, injection molding, that could not be used with conventional microprocessor/bus systems.

**Transuranic** \ˌtran(t)-syú-ˈra-nik\ (1935) *adj.* Of, relating to, or being an element with an atomic number greater than that of uranium (92).

**Transuranic elements** *n.* Elements of atomic numbers above 92. All of them are radioactive and are products of artificial nuclear changes. All are members of the actinide group.

**Transverse direction** *n.* (1) In extruding sheet or film, the direction of the width, crosswise to the direction of extrusion. (2) In a uniaxially oriented plastic, either direction perpendicular to the direction of orientation (stretching). In a biaxially oriented sheet, the direction perpendicular to both axes (the plane) of orientation. (3) In a fiber-reinforced laminate the thickness direction or, in a laminate with unidirectional reinforcement, either of the two directions perpendicular to the fiber lengths.

**Trapezoid tear tester** \ˈtra-pə-ˌzóid\ *n. See elmendorf tear tester.*

**Trapped end** *n.* An end that is unable to unwrap or unwind from the beam. Trapping of an end may be prolonged or intermittent depending upon the cause of trapping (e.g., rolled ends at the selvage, short ends, or mechanical difficulties).

**Trapped-sheet forming** *n.* A process announced in 1956 for high-speed, pressure-thermoforming of thin, biaxially oriented polystyrene sheet into snap lids for dairy-product containers, so called because each circle in the sheet was edge-restrained during heating to prevent its shrinking and losing its oriented strength.

**Trapping** *n.* Printing of one ink film on another, in multicolor wet printing. Successful trapping depends upon the relative tack and thickness of the ink film applied.

*See wet printing.*

**Travel** \ˈtra-vəl\ *n.* Change in color as the angle of viewing a goniochromatic material, such as a metallic paint film, is changed from the perpendicular to near-grazing. *Sometimes called flop or flip-flop.*

**Traveler** *n.* A C-shaped, metal clip that revolves around the ring on a ring spinning frame. It guides the yarn onto the bobbin as twist is inserted into the yarn.

**Traverse length** *n.* The lateral distance between the points of reversal of the wind on a yarn package.

**Traverse ratio** *See wind ratio.*

**Travis** *n.* Vinyl acetate/vinylidene cyanide copolymer, originally manufactured by Hoechst–Celanese, Germany.

**Treated pigment** *n.* A pigment that has been processed during manufacturing to impart specific properties.

**Treater** *n.* (1) Equipment for preparing resin-impregnated reinforcements, including means for passing a continuous web or strand through a resin tank, controlling the amount of resin picked up, drying and/or partly curing the resin, and rewinding the impregnated reinforcement. (2) The equipment used in corona-discharge treatment.

**Tree bark** *n.* A term describing the rippled or wavy effect sometimes seen when a bonded fabric is stretched in the horizontal (widthwise) direction. This defect is caused by bias tensions present when two distorted or skewed fabrics are bonded.

**Tree formation** *n.* The generation of a tree-like void structure in a transparent plastic by electron bombardment at a point on the surface. The effect in acrylic blocks is dramatically decorative. Similar breakdown structures form in dielectrics subjected to strong electric fields, eventually penetrating the dielectric and causing a short circuit. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York. Seanor DA (1982) Electrical conduction in polymers. Academic Press, New York.

**Tremolite** \ˈtre-mə-ˌlīt\ [F trémolite, fr. *Tremola*, valley in Switzerland] (1799) *n.* $Ca_2Mg_5Si_8O_{22}(OH, F)_2$. A silicate mineral similar to and sometimes sold as fibrous talc. It can be used in many applications in place of asbestos as a filler.

**Trevira** *n.* Polyester (fiber), manufactured by Hoechst, Germany.

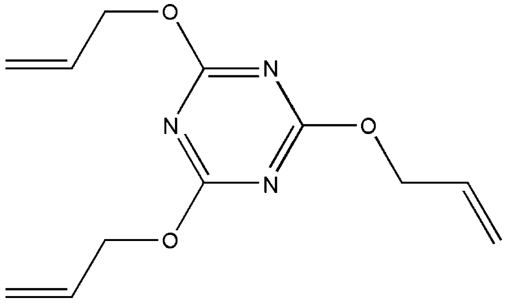
**Triacetate** \(ˌ)trī-ˈa-sə-ˌtāt\ [ISV] (1885) *n.* A generic term for film or fibers of cellulose acetate in which at least 92% of the hydroxyl groups are acetylated.
*See also cellulose triacetate.*

**Triacetate fiber** *n.* A manufactured fiber produced from cellulose triacetate in the forms of filament yarn, staple, and tow. Cellulose triacetate fiber differs from acetate fiber in that during its manufacture the cellulose is completely acetylated whereas acetate, which is diacetate, is only partially acetylated. A fiber may be called triacetate when not less than 92% of the hydroxyl groups are acetylated. Fabrics of triacetate have higher heat resistance than acetate fabrics and can be safely ironed at higher temperatures. Triacetate fabrics that have been properly heat-set (usually after dyeing) have improved ease-of-care characteristics because of a change in the crystalline structure of the fiber. Complete textile glossary. Celanese Acetate LLC, New York, 2000.
*Also see acetate fiber.*

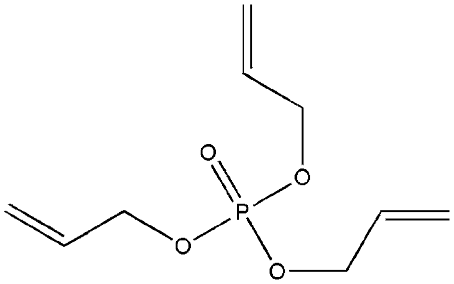
**Triacetin** *n.* A type of plasticizer for acetate fibers. It is widely used to add firmness to cigarette filter rods. Syn: glyceryl triacetate.

**Triad** \ˈtrī-ˌad *also* -əd\ [L *triad-*, *trias*, fr. Gk, fr. *treis* three] (1546) *n.* Group of three colors harmoniously related to each other.

**Triallyl cyanurate (TAC, 2,4,6-triallyloxyl-1,3,5-triazine)** *n.* $(CH_2{=}CHCH_2OC)_3N_3$. This heterocyclic compound, a solid below 110°C, is highly reactive and is used in co-polymerizations with vinyl-type monomers to form allyl resins. It is also used to cross-link unsaturated polyesters and raise their softening temperatures.



**Triallyl phosphate (TAP)** *n.* ($CH_2$=CH $CH_2O)_3PO$. A monomer that can be polymerized with methyl methacrylate to produce flame-retardant co-polymers.



**Triangle or polygon of forces** *n.* If three or more forces acting on the same point are in equilibrium, the vectors representing them form, when added, a closed figure.

**Triaryl phosphate** *n.* A synthetic-ester type plasticizer derived from isopropylphenol feedstock, useful as a flame-retarding plasticizer in vinyl plastisols.

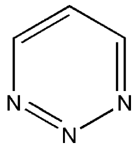
**Triaxial braid** *n.* A braided structure with axial yarns running in the longitudinal direction.

**Triaxial-braid performing** *n.* Any braiding technique for fibrous reinforcements by which three-dimensional performs for reinforced-plastics structures are produced.

**Triaxial fabrics** *n.* Completely isotropic fabrics made in a weaving process employing three yarns at 60° angles to each other. These fabrics have no stretch or distortion in any direction. With equal sizes and number of yarns in all three directions, the fabric approaches equal strength and stiffness in all directions. Yates M (2002) Fabrics. W. W. Norton and Co., New York.

**Triaxial weaving** *v.* Weaving in which the cloth is made from three yarns whose axes are 120° apart. When used as a reinforcing medium, the cloth yields a laminate whose properties in the plane are nearly isotropic.

**Triazine** \ˈtrī-ə-ˌzēn\ [ISV] (1894) *n.* Any of three compounds containing a ring composed of three carbon and three nitrogen atoms.



**Triazine resin (NCNS resin)** *n.* A class of thermosetting polymers prepared from primary and secondary biscyanamides with pendant arylsulfonyl groups. The biscyanamides are reacted together in solutions to form soluble pre-polymers by addition polymerization. By refluxing these solutions, stable laminating varnishes are obtained. Alternatively, evaporation of solvents from the solutions yields the pre-polymers in powder form for molding. Laminates prepared with triazine resins have good mechanical strength at high temperatures and are relatively fire-retardant.

**Tribasic** \(ˌ)trī-ˈbā-sik\ (1837) *adj.* Pertaining to acids having three replaceable hydrogen atoms per molecule, e.g., phosphoric acid, the most important one; or to acid salts in which two of three available hydrogens have been replaced by metals.

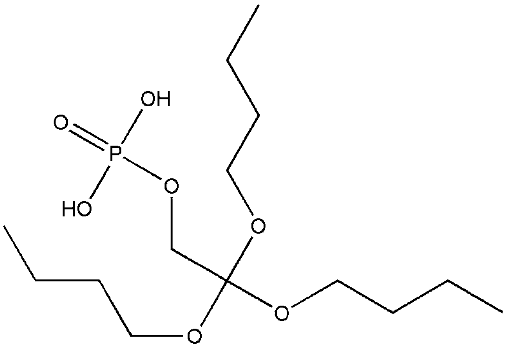
**Tribasic lead maleate** *n.* A yellowish-white crystalline powder, an effective heat stabilizer for vinyls and a curing agent for chlorosulfonated polyethylene (Gooch, 1993).

**Tribasic lead sulfate** *n.* $3PbO \cdot PbSO_4 \cdot H_2O$. A heat stabilizer, especially for vinyl electrical-insulation compounds. It is very effective, has good electrical properties, and produces no gassing.

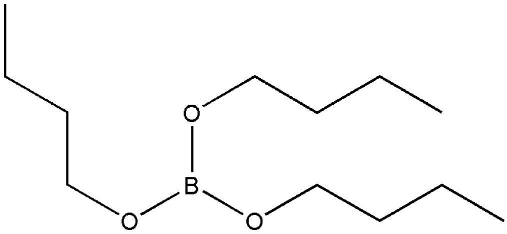
**Triblock polymers** *n.* A block co-polymer consisting of two terminal blocks of repeating units and a central block of B units.

**Tribology** \trī-ˈbä-lə-jē\ (1966) *n.* The engineering science that deals with friction, wear, and lubrication of surfaces sliding or rolling on one another, and the design of systems and components, such as gears and bearings, in which these actions are involved.

**Tributoxyethyl phosphate** *n.* $(C_4H_9O\,C_2H_4O)_3PO$. A primary plasticizer for cellulosic, acrylic, and vinyl resins, imparting low-temperature flexibility and flame retardance. In vinyl plastisols, small amounts of tributoxyethyl phosphate markedly reduce viscosity. However, when used alone or in high percentages, this plasticizer causes inconveniently rapid gelation. It is an organic phosphate with wide applications in floor polishes, paints, synthetic rubbers and as a deformer. It is probably best known in emulsion floor polishes as a leveling agent. Abbreviation for TBEP.

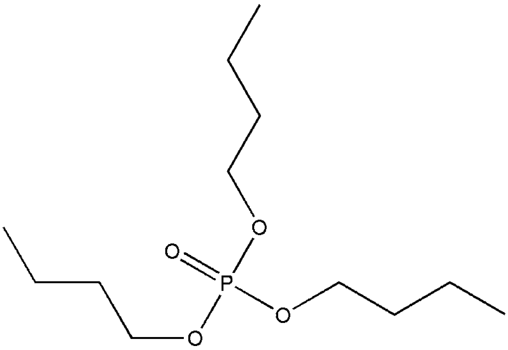


**Tributyl borate (butyl borate)** *n.* $(C_4H_9)_3BO_3$. A colorless liquid, used as an anti-blocking agent in plastic films and sheets.



**Tributyl citrate** *See butyl citrate.*

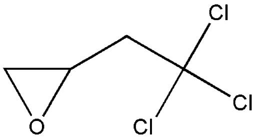
**Tributyl phosphate (TBP)** *n.* $(C_4H_9O)_3PO$. A colorless liquid used as a primary plasticizer and solvent for cellulose acetate, chlorinated rubber and, in special applications, for vinyl resins. Its relatively high volatility limits its use as a plasticizer for vinyls.



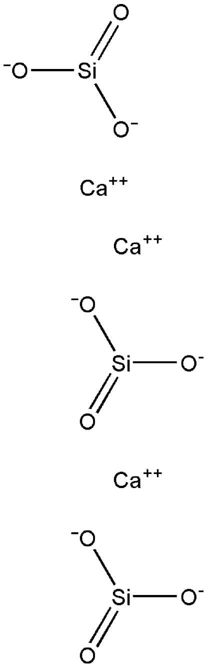
**Tricalcium silicate** *n.* A compound which is a main constituent of Portland cement.

**Tricel** *n.* Cellulose triacetate, manufactured by Bayer, Germany.

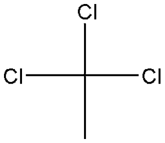
**4,4,4-Trichloro-1,2-butylene oxide (TCBO)** *n.* $Cl_3CCH_2CHOCH_2$. This highly reactive, liquid epoxides is used for modifying polyols to achieve fire retardance in polyurethane foams.



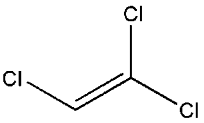
**1,1,1-Trichloroethane (methyl chloroform)** *n.* $CH_3CCl_3$. A non-flammable solvent that can be milled with resins to produce



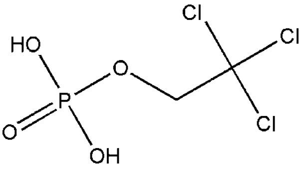
non-flammable adhesives. Less used than formerly because of the perceived need to minimize release of chlorinated compounds into the atmosphere.



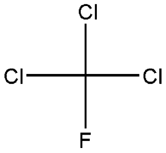
**Trichloroethylene (TCE, trichloroethene)** *n.* $ClCH{=}CCl_2$. Until recently, a non-flammable solvent widely used for degreasing. It is a suspected cancer agent, mutagen, and stratospheric-ozone destroyer.



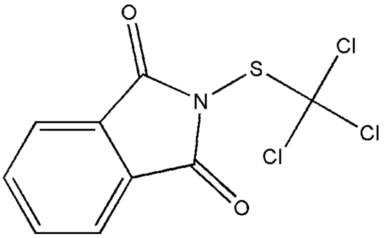
**Trichloroethyl phosphate** *n.* $C_2H_4CL_3PO_4$. Plasticizer of special value in the formulation of fire-resisting lacquers, Bp, 220°C per/20 mmHg.



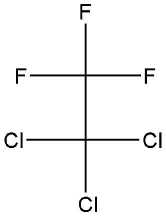
**Trichlorofluoromethane (Freon 11, Genetron 11)** *n.* $CCl_3F$. A chemically inert blowing agent used until recently with water in flexible polyurethane formulations to control foam density and load-bearing properties. It is also a refrigerant and former aerosol propellant. Freon 11 has been phased out of most applications since 1995, in the general push to reduce fluorocarbons in the atmosphere.



***N*-(trichloromethylthio) Phthalimide** *n.* A bacteriostatic agent used in vinyl fabrics for hospitals and households. It stops the growth of bacteria such as *staphylococcus aureus* that cause pink staining in white and pastel-colored PVCs.



**Trichlorotrifluorethane (Freon 113)** *n.* $Cl_2FCCClF_2$. A colorless, nearly odorless solvent that boils at 47°C, formerly used as a blowing agent for integral-skin polyurethane foam, but now because of its suspected action on stratospheric ozone, being phased out.



**Trichromat** \ˈtrī-krō-ˌmat\ [back-formation fr. *trichromatic*] (1929) *n.* Person requiring mixtures of three component primaries to match colors. Normal observers fall into this classification: the CIE standard observer is defined in terms of the amounts of three primary colors required to match all spectral colors. Not all trichromats are normal, however. Some observers exhibit anomalous trichromatism, requiring abnormal proportions of three primary colors for color matching.

**Trichromatic** (ca. 1890) *adj.* Of or consisting of three colors.

**Trichromatic coefficients** *n.* Alternate term for chromaticity coordinates or coefficients. *See chromaticity coordinates, general, and chromaticity coordinates.*

**Tricot** \ˈtrē-(ˌ)kō\ [F, fr. *tricoter* to knit, fr. MF, to agitate, hop ultim. fr. OF *estriquier* to stroke, of Gr origin; akin to OE *strīcan* to stroke] (1872) *n.* A generic term for the most common type of warp-knit fabric. It has fine wales on the face and course-wise ribs on the back. It can be made in a plain jersey construction or in meshes, stripes, and many other designs. Tricot is usually made of triacetate, acetate, polyester, nylon, or rayon.

*Also see jersey and knitting* (1).

**Tricot beam** *n.* A metal flanged beam, commonly 42 in. width, on which yarn is wound for use as a supply for the tricot machine.

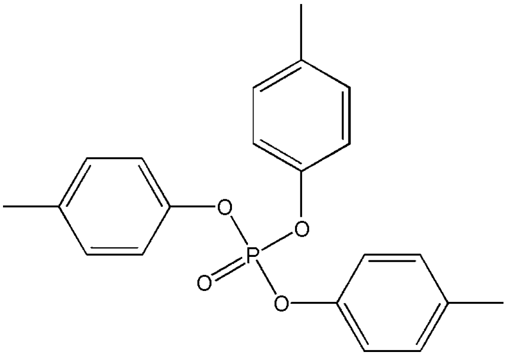
**Tricot fabric yield** *n.* The number of square yards per pound of greige or finished tricot fabric.

**Tricot knitting** *See knitting* (1).

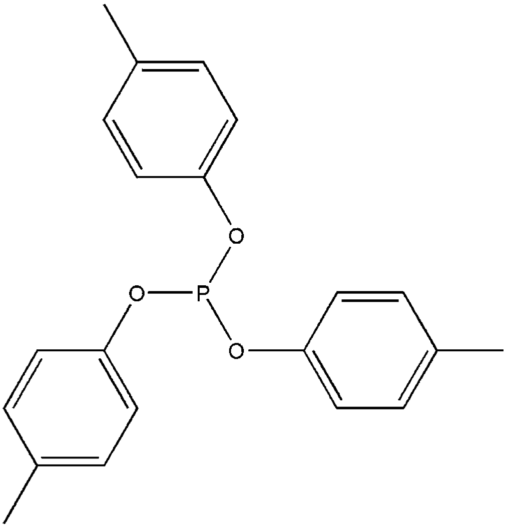
**Tricot section** *See tricot beam.*

**Tricresyl phosphate (TCP, TCF, and tritolyl phosphate)** *n.* $(CH_3C_6H_4)_3PO_4$. One of the most important and earliest of all commercial plasticizers. Also suitable for cellulosics, alkyds, and polystyrene. Like all other phosphate plasticizes, TCP imparts flame retardance and fungus resistance, even when used in amounts as low as 5% of the total plasticizer content. TCP and cresyldiphenyl phosphate are the plasticizers most widely used for these properties. Bp, 430–440°C; flp, 216°C (420°F). Syn: tritolyl phosphate.

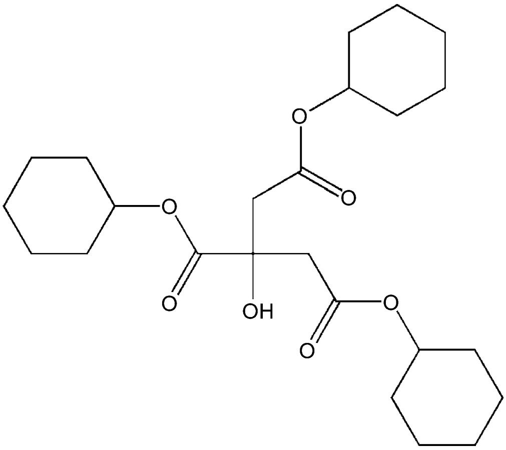
*Known also as TCP.*



**Tricresyl phosphite** *n.* $(CH_3C_6H_4O)_3P$. A colorless liquid used as a flame retardant plasticizer and stabilizer for thermoplastics.

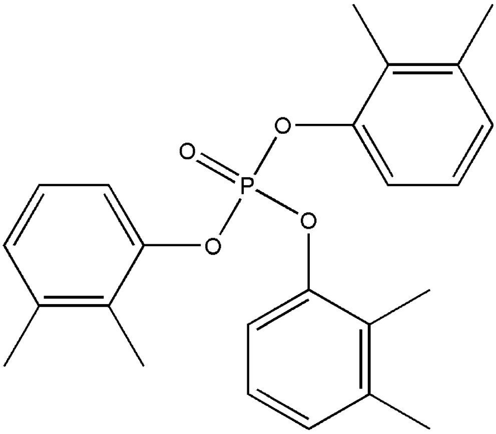


**Tricyclohexyl citrate** *n.* $(C_6H_{11}OOCCH_2)_2C(OH)COOC_6H_{11}$. A non-toxic plasticizer for polystyrene, cellulosics, acrylics, and vinyls.



**Tridecyl phosphite** *n.* $(C_{10}H_{21}O)_3P$. A colorless liquid used as a stabilizer for polyolefins and PVC.

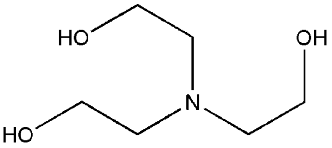
**Tridimethylphenyl phosphate (trixylenyl phosphate, TXP)** *n.* A plasticizer for cellulosics and vinyl compounds in which a low-density, electrical-grade, flame-retardant plasticizer is required.



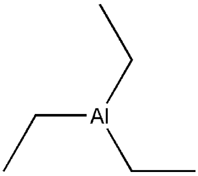
**Tridirectional laminate** *n.* A reinforced-plastics material having reinforcing fibers running in three principal directions. If the directions are 120° apart and there are equal percentages of fiber lying in the three directions, the laminate properties will be almost isotropic in the laminate plane.

**Trienol** *n.* Synthetic tung oil of Swiss origin, practically indistinguishable from the natural oil.

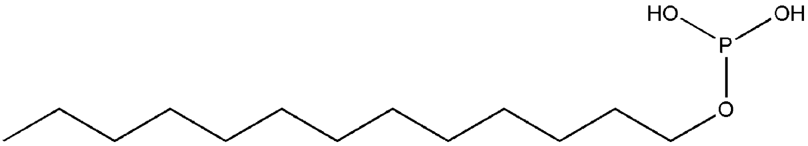
**Triethanolamine** 2,2,2″-nitrilotriethanol. *n.* $N(CH_2CH_2OH)_3$. Very hygroscopic, viscous liquid with a slight ammoniacal odor. Turns brown on exposure to air and light, Used in the manufacture of surfactants and emulsions. Mol wt, 149.19; Sp gr, 1.124 (9.37 lb/gal); mp, 21.2°C.

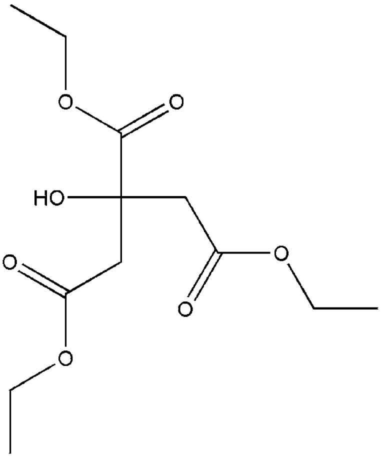


**Triethyl aluminum** \(ˌ)trī-ˈe-thəl-\ (aluminum triethyl, ATE) *n.* $(C_2H_5)_3Al$. A catalyst for the polymerization of olefins.

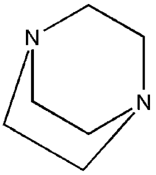


**Triethyl citrate (ethyl citrate)** *n.* $(C_2H_5OOCCH_2)_2C(OH)COOC_2H_5$. An ester of citric acid, used as a plasticizer for many thermoplastics including vinyls, cellulosics, and polystyrene. It has won FDA approval for use in food packaging.

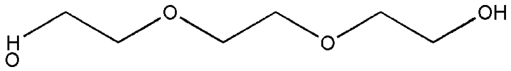




**Triethylenediamine** (1,4-diazabicyclo-2,2,2-octane, DABCO) *n.* This tertiary diamine, whose structure is shown below, is the most widely used amine catalyst for polyurethane foams, elastomers, and coatings. It is soluble in water and polyols.



**Triethylene glycol** *n.* $(CH_2OCH_2CH_2OH)_2$. Polyhydric alcohol. Bp, 285°C; flp, 166°C (331°F); vp, <0.1 mmHg per 20°C.

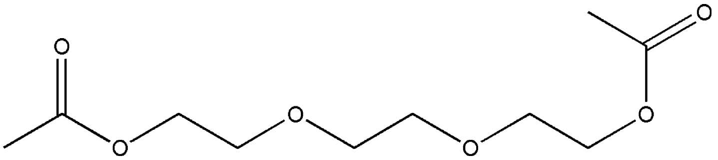


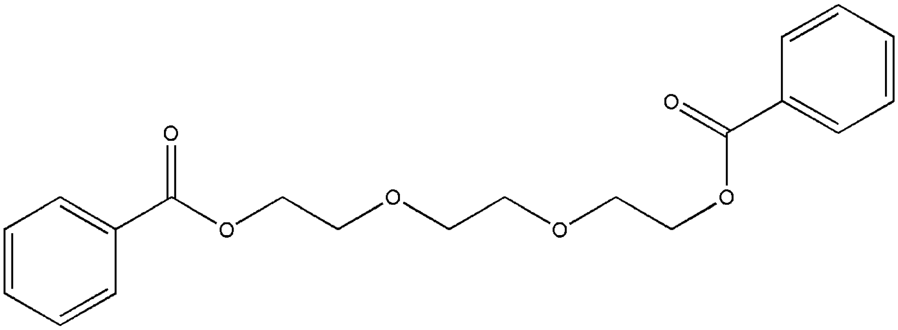
**Triethylene glycol diacetate** *n.* $(-CH_2OCH_2CH_2OOCCH_3)_2$. A plasticizer for cellulosic plastics and some acrylic resins.

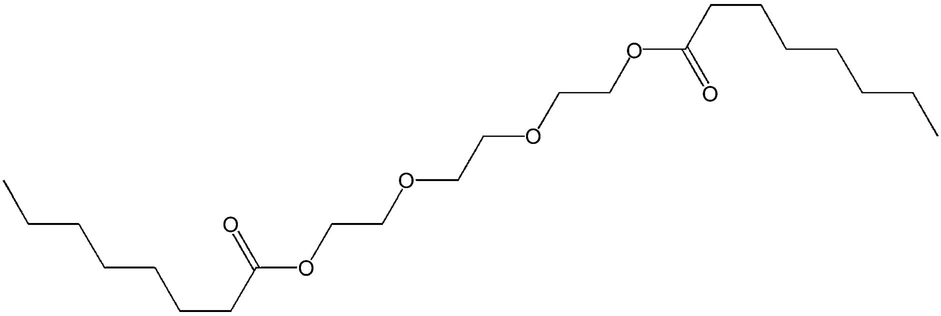
**Triethylene glycol dibenzoate** *n.* $(-CH_2OCH_2CH_2OOCC_6H_5)_2$. A secondary plasticizer, partly compatible with all common thermoplastics. In most resin systems it has a tendency to crystallize and bloom at higher concentrations, which property may be used to advantage to prevent blocking.

**Triethylene glycol dicaprylate (triethylene glycol trioctanoate)** *n.* $(-CH_2OCH_2CH_2OOCC_7H_{15})_2$. A plasticizer for ethyl cellulose and vinyl resins, with good low-temperature flexibility.

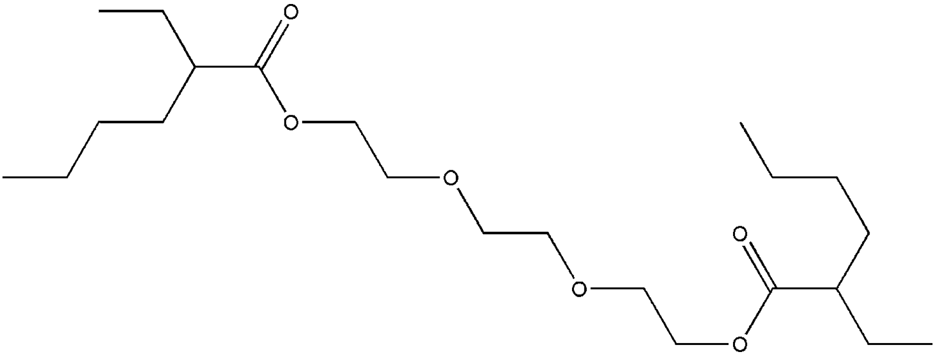
**Triethylene glycol di(2-ethylhexanoate)** *n.* $(-CH_2OCH_2CH_2OOC\text{-}C_7H_{15})_2$. A plasticizer for cellulosic plastics, polymethyl







Triethylene glycol dicaprylate



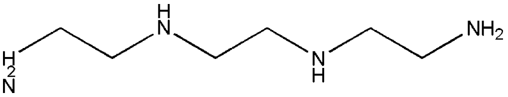
Triethylene glycol di(2-ethylhexanoate)

methacrylate, PVC, and vinyl chloride–vinyl acetate co-polymers. In vinyls it is usually used as a secondary plasticizer at 10–25% of the total plasticizer, to impart low-temperature flexibility.

**Triethylene glycol dipelargonate** *n.* $(-CH_2OCH_2CH_2OOCC_8H_{17})_2$. A plasticizer for vinyls and cellulosics.

**Triethylene glycol dipropionate** *n.* $(-CH_2OCH_2CH_2OOCC_2H_5)_2$. A plasticizer for cellulosic resins and polymethyl methacrylate.

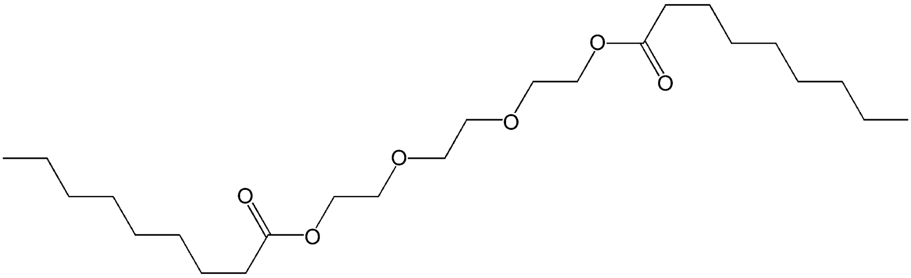
**Triethylenetetramine (TETA)** *n.* $(-CH_2NHCH_2CH_2NH_2)_2$. A viscous, yellowish liquid, teta is used as a room temperature curing agent for epoxy resins.

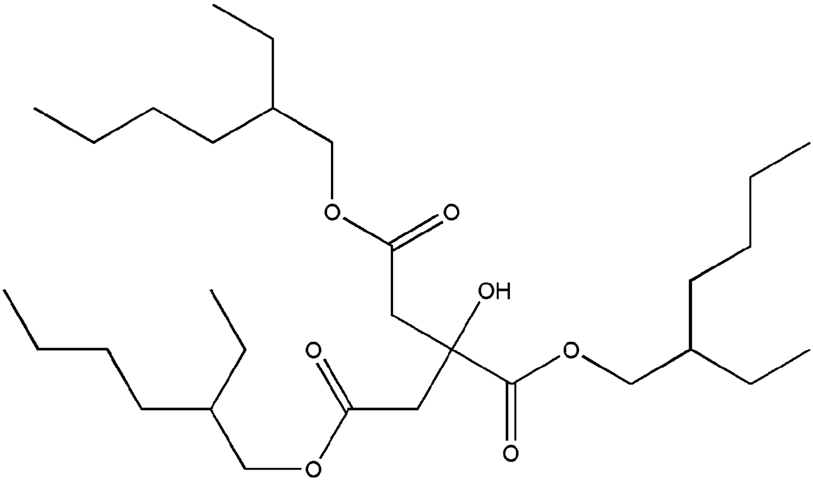


**Tri(2-ethylhexyl) citrate** *n.* A nontoxic plasticizer for PVC.

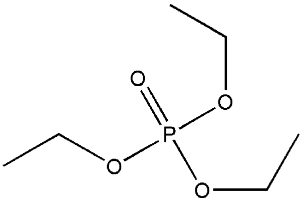
**Tri(2-ethylhexyl) phosphate** *See trioctyl phosphate.*

**Triethyl phosphate (TEP)** *n.* $(C_2H_5O)_3PO$. A flame-retardant plasticizer for cellulosics, acrylics, some vinyl polymers, and unsaturated polyesters.





Tri(2-ethylhexyl) citrate

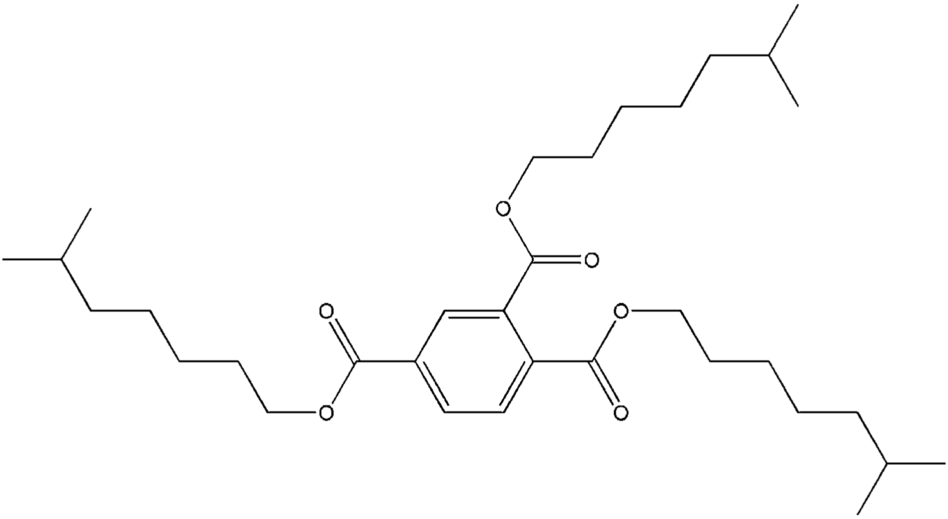


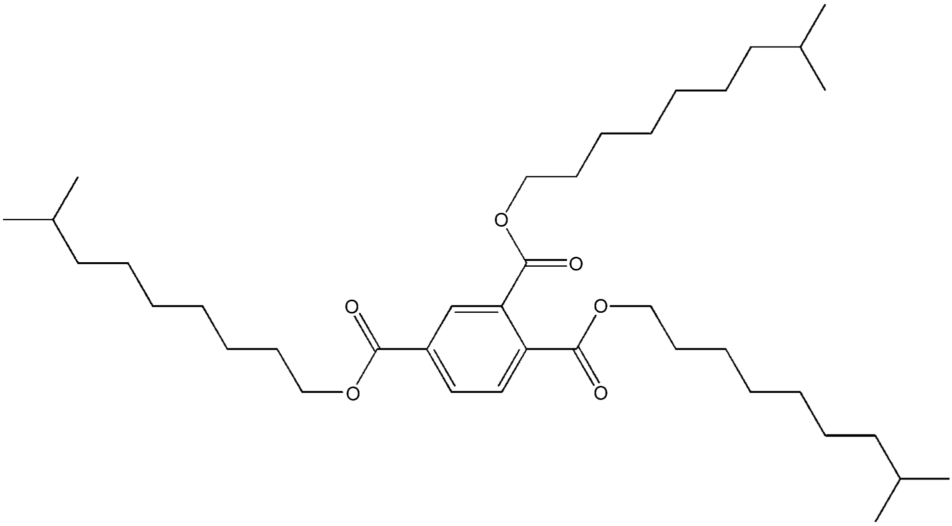
**Triglyceride** \(ˌ)trī-ˈgli-sə-ˌrīd\ [ITS] (ca. 1860) *n.* Ester obtained by the interaction of the three reactive hydroxyl groups of glycerol with fatty or other acids.

**Trihydrazide triazine** \-ˈhī-drə-ˌzīd ˈtrī-ə-ˌzēn \ *n.* A heterocyclic chemical blowing agent that decomposes at 250–260°C yielding, per gram, about 175 cm$^3$ of gas consisting mostly of ammonia and nitrogen. It is used in foaming polypropylene, acrylonitrile-butadiene-styrene resin, nylon, and other high-melting resins.

**Triisodecyl trimellitate** *n.* $(C_{10}H_{21}OOC)_3C_6H_3$. An involatile plasticizer for PVC.

**Triisooctyl trimellitate (TIOTM)** *n.* $(C_8H_{17}OOC)_3C_6H_3$. A plasticizer for cellulosic and vinyl plastics with low volatility, high resistance to soapy-water extraction, and





**Triisooctyl trimellitate**

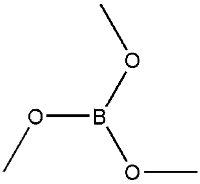
essentially no marring effect on lacquered surfaces.

**Trim** *n.* (1) The visible woodwork or moldings of a room, such as the baseboards, cornices, casings, etc. (2) Any visible element, usually of metal or wood, which protects or covers joints, edges, or ends of another material; the finishing around fittings and openings, as a door trim, window trim, etc.

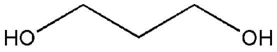
**Trimer** *n.* An oligomer formed by the union of three molecules of a monomer and/or made up of three mer units.

*See cyclic trimer, polymer and oligomer.*

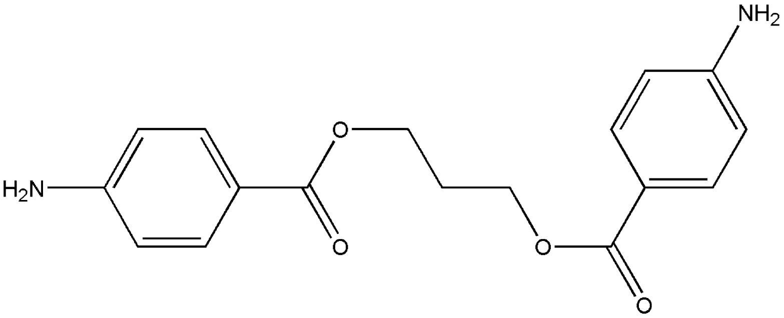
**Trimethyl borate (methyl borate, trimethoxyborine)** *n.* $(CH_3O)_3B$. A colorless liquid used as a flame retardant in plastics.



**Trimethylene glycol** *n.* Syn: 1,3-propanediol. *See glycol.*

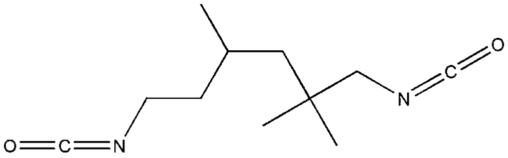


**Trimethylene glycol di-*p*-aminobenzoate** *n.* A diamine curing agent for polyurethanes introduced in 1976 to replace the popular but toxic MOCA®. It is very soluble in a variety of coating solvents.

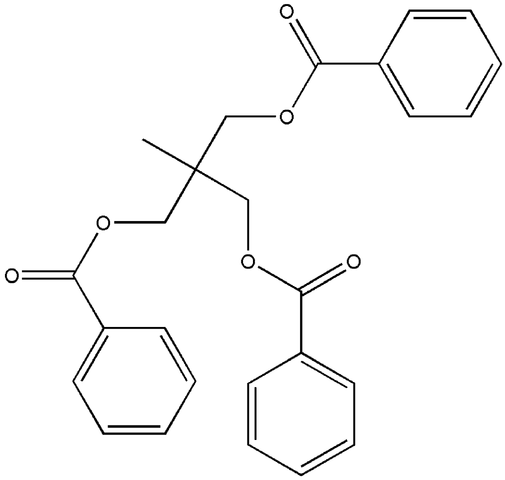


**2,2,4-Trimethyl-1,6-hexane diisocyanate (TMDI)** *n.* $OCNCH_2C{-}(CH_3)_2CH\ (CH_3)$

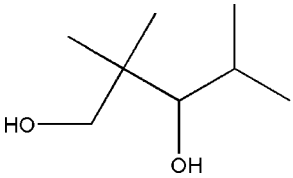
$CH_2CH_2NCO$. A branched aliphatic isocyanate used in making polyurethanes.



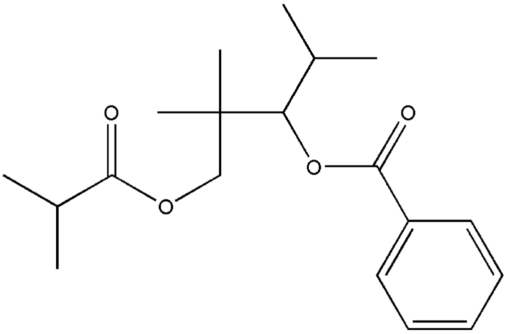
**Trimethylolethane tribenzoate** *n.* A solid plasticizer for PVC.



**2,2,4-Trimethyl-1,3-pentanediol (trimethylpentanediol, TMPD)** *n.* $(CH_3)_2CH(OH)C(CH_3)_2CH_2OH$. One of the principal glycols used in making polyester resins, alkyd resins, and polyester plasticizers, containing one primary and one secondary hydroxyl group. It is made by the aldol condensation of isobutyraldehyde, yielding a water-insoluble white solid. TMPD is used in producing linear unsaturated polyesters and is particularly good for gel-coating resins.



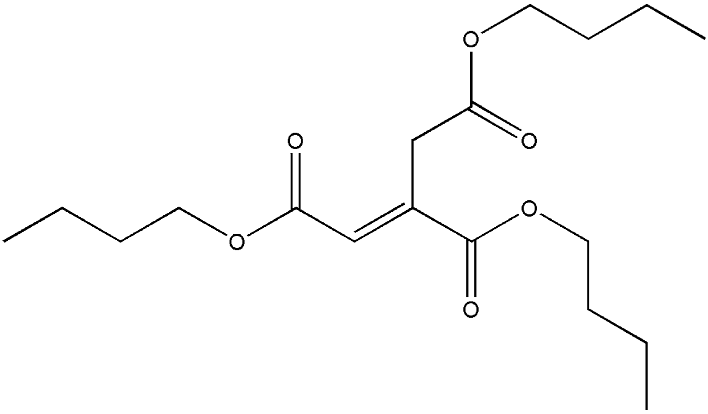
**2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate benzoate** *n.* A plasticizer for PVC imparting good stain resistance.

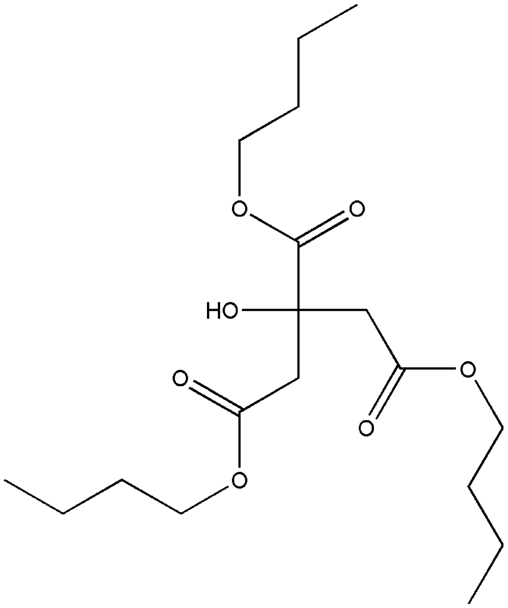


**Trimmed papers** *See pretrimmed papers.*

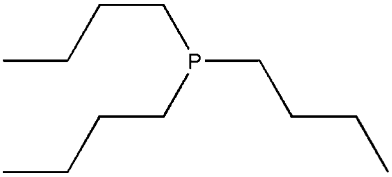
**Tri-*n*-butyl aconitate** *n.* $C_3H_3(COOC_4H_9)_3$. A combination plasticizer and stabilizer for polyvinylidene chloride and synthetic rubbers.

**Tri-*n*-butyl citrate** *n.* $C_2H_4(OH)(COOC_4H_9)_3$. A non-toxic plasticizer for most thermoplastics, including cellulosics, polystyrene, and vinyls.





**Tri-*n*-butyl phosphine** *n.* $(C_4H_9)_3P$. A curing agent for epoxy resins, and a catalyst for vinyl and isocyanate polymerizations.

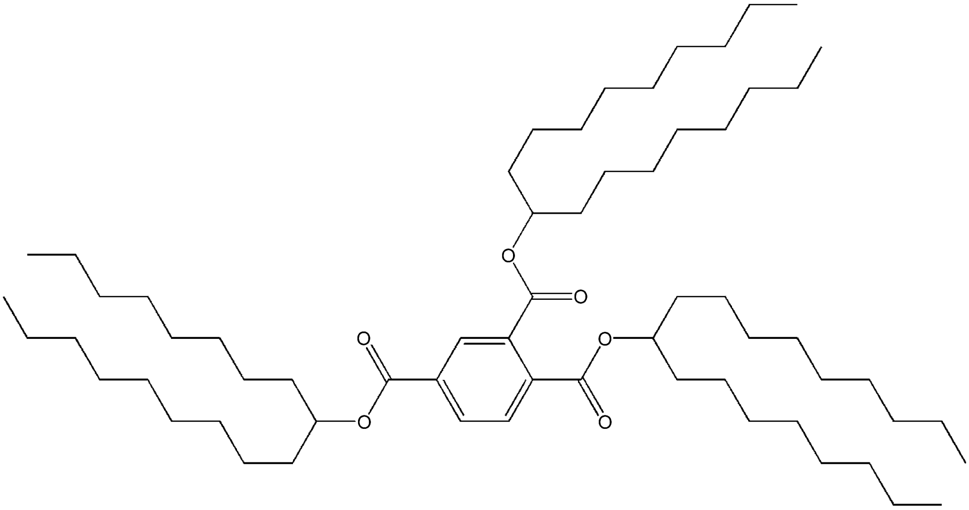


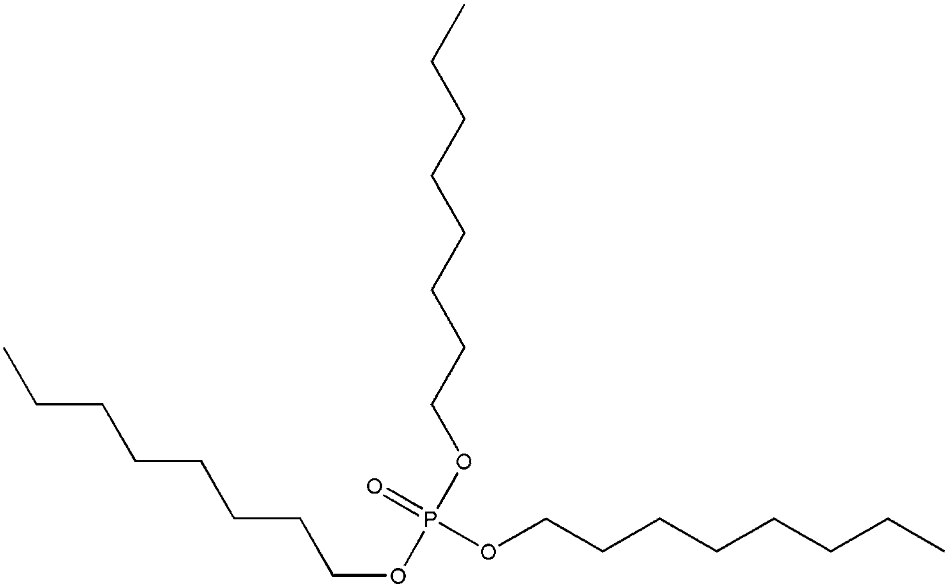
**Tri(*n*-octyl-*n*-decyl) trimellitate (NODTM)** *n.* A low-temperature plasticizer for vinyls and cellulosics.. It is used in heavy-duty applications such as truck seating, film and sheeting subject to wide temperature ranges, and in baby wear.

**Tri-*n*-propyl phosphate** *n.* $(C_3H_7)_3PO_4$. A plasticizer and solvent. Sp gr, 1.012; bp, 135–140°C.

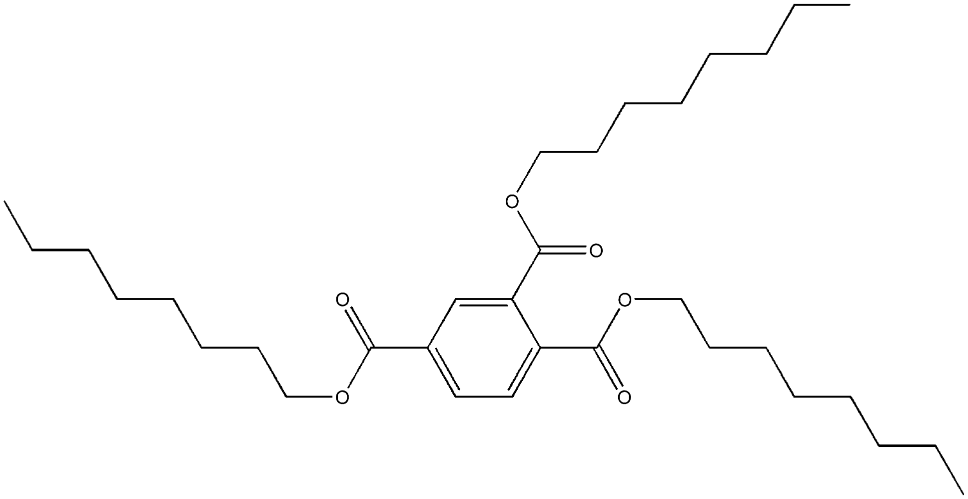
**Trioctyl phosphate [TOP, TOF, and tri-(2-ethylhexyl) phosphate]** *n.* $[C_4H_9CH(C_2H_5)CH_2O]_3PO$. A plasticizer for PVC, imparting good low-temperature flexibility, resistance to water extraction, flame and fungus resistance, and minimum change in flexibility over a wide temperature range. It is also compatible with polyvinyl butyral, ethyl cellulose, and cellulose acetate–butyrate resins with a high butyral content.

**Trioctyl trimellitate (TOTM)** *n.* $(C_8H_{17}OOC)_3C_6H_3$. A primary plasticizer for vinyls that hold up well at high temperatures. It combines the permanence of polymeric plasticizers with the low-temperature properties of monomerics. In vinyls, it is used for auto interior parts and for wire insulation good for temperatures to 105°C. It is also used with cellulosics and acrylics.





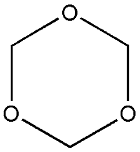
Trioctyl phosphate



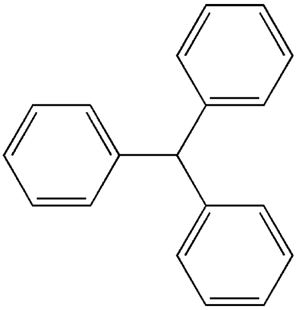
Trioctyl trimellitate

**Triol** \ˈtrī-ˌól, -ˈōl\ (1936) *n.* A term sometimes used for *trihydric alcohol*, i.e., an alcohol containing three hydroxyl (–OH) radicals.

**1,3,5-Trioxane** *n* (*sym*-trioxane, triformol, trioxin) $\overline{CH_2OCH_2OCH_2O}$. The stable, cyclic trimer of formaldehyde, a colorless, crystalline solid. It is easily depolymerized in the presence of acids to its monomer, or may be further polymerized to form acetal resins. This trimer should not be confused with paraformaldehyde.

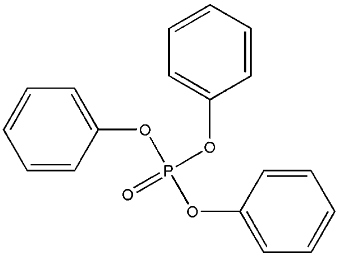


**Triphenylmethane** \ˌtrī-ˌfe-nᵊl-ˈme-ˌthān\ [ISV] (ca. 1885) *n.* $CH(C_6H_5)_3$. A crystalline hydrocarbon that is the parent compound of many dyes.



**Triphenyl phosphate** *n.* $(C_6H_5)_3PO_4$. A crystalline powder, one of the original synthetic plasticizers for cellulose nitrate. It is also a flame retardant for vinyls, cellulosics, acrylics, and polystyrene. Bp, 410°C; mp, 50°C; flp, 220°C (428°F).

*Known also as TPP.*



**Triple-daylight mold** *n.* A mold having four plates: feed plate, floating cavity plate, stripper plate, and moving mold plate. When the mold opens, all the plates move apart making three openings among them.

**Triple-roller mill** *n.* Type of mill used for the fine grinding of pigmented compositions. The pigment agglomerates are dispersed by passage between accurately machined steel or granite cylinders, the clearance between the cylinders being capable of very delicate adjustment. The cylinders or rollers are made to operate at different speeds. The rough pigment-medium mix is fed between two rollers rotating towards each other at different speeds, and it is finally transferred to the third roller, which operates at the maximum speed. Pigment dispersion is effected by a reduction of agglomerates, controlled by the clearance between the rollers, and by a shearing action developed by the viscous medium on rollers, which are rotating at different speeds. Roller mills are ideal for grinding stiff pigment pastes.

**Tripoli** \ˈtri-pə-lē\ [F, fr. *Tripoli*, region of Africa\ (ca. 1601) *n.* An earth consisting of very friable soft schistose deposits of silica and including diatomite and kieselguhr.

*See rottenstone.*

**Tripolite** *See diatomaceous silica.*

**Tris(2-chloroethyl phosphate)** *n.* $(CH_2Cl CH_2O)PO$. A plasticizer for polystyrene, cellulosics, and vinyls. It is also effective as a flame retardant for unsaturated polyesters and polyurethane foams.

**Tris(2,3-dibromopropyl) phosphate** *n.* $(CH_2 BrCHBrCH_2O)_3PO$. A flame retardant for unsaturated polyesters, polyurethane foams, and other plastics.

**Tris(1,2-dichloroisopropyl) phosphate** *n.* $[CH_2ClC(CH_3)ClO]_3PO$. A flame retardant for unsaturated polyesters.

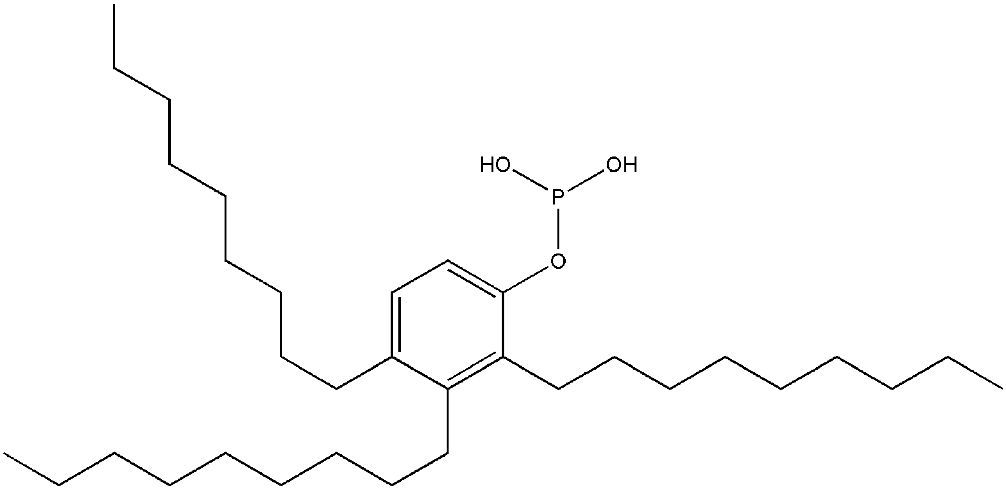
**Tris(2,3-dichloropropyl) phosphate** *n.* $(CH_2 ClCHClCH_2O)_3PO$. A plasticizing flame retardant for many plastics including vinyls, cellulosics, acrylics, polyolefins, phenolics, polyesters, and polyurethane foams.

**Triskelion cross-section** *n.* A trilobal cross-section in which the radiating arms are curved or bent.

*Also see cross section.*

**Trisnonylphenyl phosphite (TNPP)** *n.* An FDA sanctioned heat stabilizer and antioxidant used in styrene-butadiene copolymers.

**Tristimulus** \(ˌ)trī-ˈstim-yə-ləs\ (1933) *adj.* (1) Color readings based on the primary colors: yellow, magenta, and cyan. (2) Of, or consisting of, three stimuli generally



**Trisnonylphenyl phosphite**

used to describe components of additive mixture required to evoke a particular color sensation.

**Tristimulus colorimeter** *n.* Instrument used to measure quantities, which can be used to obtain an approximation of tristimulus values. They are normally equipped with three (or four) special filters to obtain R, G, and B values which must then be normalized to CIE magnitude. They were designed and are properly used only for measuring the color difference between two similar, non-metameric samples. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Tristimulus computation data** *n.* Products of relative spectral-energy distribution of an illuminant multiplied by each of the three color matching functions; in the CIE system designated as $E_c\bar{x}$, $E_c\bar{y}$, $E_c\bar{z}$, e.g., for Illuminant C and the color mixture data for the standard observer at designated wavelengths.

*See tristimulus values.*

**Tristimulus integration** *n.* Use of tristimulus computation data to determine tristimulus values of a sample; in the CIE system, the summation of the products of the reflectance or transmittance at regular wavelength intervals by the tristimulus computation data for the same wavelengths.

*See tristimulus values and tristimulus integrator.*

**Tristimulus integrator** *n.* Device for performing the tristimulus integration calculation, generally attached directly to a spectrophotometer. Several types have been used: mechanical analog type using specially cut cams giving a continuous integration, digital-mechanical type using selected ordinates (generally 100), and digital-computer type using weighted ordinates, must commonly at 10 nm intervals. The latter is most generally used today, because of the flexibility in obtaining CIE tristimulus values for any observer whose color matching functions are known, and any illuminate of defined spectral-power distribution.

*See tristimulus values.*

**Tristimulus values, CIE** *n.* Amounts (%) of the three components necessary in a three-color additive mixture required for matching a color; in the CIE system, they are designated as *X*, *Y*, and *Z*. The illuminant and standard observer color matching functions used must be designated; if they are not, the assumption is made that the values are for the 1931 observer (2° field) and Illuminant C. The values obtained depend on the method of integration used and on the relationship of the nature of the sample and on the instrument design used to measure the reflectance or transmittance. Tristimulus values are not, therefore, absolute values characteristic of a sample, but relative values dependent on the method used to obtain them. Approximations of CIE tristimulus values may be obtained from measurements made on a tristimulus colorimeter, giving measurements generally normalized to 100, which must then be normalized to equivalent CIE values. The filter measurements should be properly designated as R, G, and B instead of *X*, *Y*, and *Z*. The calculation of tristimulus values in the CIE System is illustrated in the equation below for Y.

$$Y = k \int E(\lambda)\bar{y}(\lambda)R \quad \text{or} \quad T(\lambda)\mathrm{d}(\lambda),$$

where $k$ is a normalizing factor to bring $Y$ for a perfect white to 100.000%, and $\mathrm{d}\lambda$ is the wavelength interval used. When a large number of wavelengths is not used, the integration should be designated as a summation

$$Y = k \sum E(\lambda)\bar{y}(\lambda)R \quad \text{or} \quad T(\lambda)\Delta\lambda.$$

McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

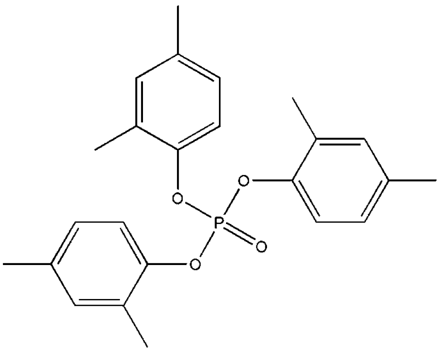
**Tritactic polymer** *n.* An isotactic or syndiotactic polymer that is also of the *cis*- or *trans* form because the molecules are unsaturated and have double bonds.

**Tritium** \ˈtri-tē-əm\ [NL, fr. Gk *tritos* third] (1933) *n.* An isotope of hydrogen with a mass of three, structure, two neutrons, and one proton in its nucleus. Hydrogen 3, $^{3}_{1}$H.

**Tritolyl phosphate (TTP)** *n. See tricresyl phosphate.*

**Trivial name** *n.* A name that is not produced by any systematic procedure of naming. Trivial names may be derived from geographic locations, names of people, or from descriptive words. Examples: "aragonite" after Aragon, Spain; "wollastonite" in honor of the English chemist, W. H. Wollaston; and "magnetite" alluding to its highly magnetic property.

**Trixylenyl phosphate (TXP)** *n. See tridimethylphenyl phosphate* (*See image*).



**Trolit AE** *n.* Cellulose ether, manufactured by Dynamit Nobel, Germany.

**Trolitan** Phenol-formaldehyde resin. Manufactured by Dynamit Nobel, Germany.

**Trolit F** *n.* Cellulose nitrate. Manufactured by Dynamit Nobel, Germany.

**Trolitul** *n.* Poly(styrene), manufactured by Dynamit Nobel, Germany.

**Trommsdorf effect** *n.* The acceleration of a reaction such as polymerization which continues to increase uncontrollably without external stimulus (also referred to as gel effect). Lenz RW (1967) Organic chemistry of high polymers. Interscience Inc., New York. *See autoacceleration.*

**Trompe l'oeil** \(ˌ)trómp-ˈləi, trōⁿp-lîi\ {*often attributive*} [F *trompe-l'oeil*, literally, deceive the eye] (1889) *n.* Literally, "fool-the-eye". A design that creates a three-dimensional illusion by means of shadow and graphic textures.

**Tronal** *n.* High-impact poly(styrene), manufactured by Dynamit Nobel, Germany.

**Trough** *n.* In the coil coating field, synonymous with pan.

**Trovidur** *n.* Poly(vinyl chloride), manufactured by Dynamit Nobel, Germany.

**Trovitherm** Poly(vinyl chloride) (films), manufactured by Dynamit Nobel, Germany.

**True density (solid density)** *n.* Of a specimen of porous material, the mass of the specimen divided by (volume of the specimen less the volume of its voids), i.e., $\rho_t = M/[V(1-\varepsilon)]$, where $\varepsilon$ is the void fraction and $V$ is the specimen volume. *Compare apparent density.*

**True strain** *n.* In a tensile test, the integral of the differential increase in length divided by the length at that point in the test, i.e.,

$$\text{True strain} = \int_{Lo}^{L_f} \frac{\mathrm{d}L}{L} = \ln(L_f/L_o).$$

In this equation, $L_o$ is the original gauge length of the specimen and $L_f$ is the gauge length at the stress–strain point of interest. True, strain is always less than nominal strain (*see strain*), but the difference is small unless the strain is large. For example, a nominal strain of 0.5 (50%) corresponds to a true strain of 0.41 (41%).

**True stress** *n.* The quotient of force divided by true cross-sectional area in the specimen's gauge length, at any point during a tensile or compressive test. True stress is always larger than nominal stress (*see stress*), but the difference is negligible at low strains. In a ductile plastic having a Poisson's ratio of 0.4, for example, if the true strain were 0.41 (41%), the cross-sectional area would be 70% of the initial area so true stress would be 1.43 times nominal.

**True tensile strength** *n.* The maximum tensile stress expressed in force per unit area of the specimen at the time of rupture. *Also see tensile strength.*

**Truss** \ˈtrəs\ *n.* Framework of wood or metal beams, stiffened by cross braces; used for roofs, bridges, etc.

**TSC** *n.* Abbreviation for thermal stress cracking or thermally stimulated current.

**T-slot die** *See manifold.*

**TTB** *See 2,2′,6,6′-tetrabromo-3,3′,5,5′-tetramethyl-p,p′-biphenol.*

**T-300** *n.* Temperature at which the torsional modulus of an air-dried film is 300 kg/cm$^2$; a relative parameter of film stiffness.

**Tub** *See beck.*

**Tube** *n.* (1) A cylindrical holder or bobbin used as a core for a cylindrical yarn package. (2) A cylindrical yarn package.

**Tubelength, mechanical** *n* The distance from the shoulder of the objective to the upper end of the drawtube. The mechanical tubelength for biological and most polarizing microscopes is 160 mm; Leitz formerly had a 170 mm tube length.

**Tubelength, optical** *n.* The distance from the back focal plane of the objective to the image formed by the objective (intermediate image).

**Tubing** *n.* (1) Any of a wide range of continuous extrusions, usually having circular annular cross sections, and flexible enough to be wound on a core or coiled. Some large-diameter tubing has such thin walls that it is flattened before winding. Some stiff but coilable, small-diameter tubing, such as saran and nylon tubing used for automotive fuel lines and compressed-air service, has relatively thick walls. Unlike pipe, tubing is not usually cut to standard lengths nor is it expected to be nearly straight. With tubing and pipe, the internal diameter (ID) is usually more carefully controlled than the outside diameter (OD). (2) Cylindrical fabric made by braiding, waving, or knitting. The term *sleeving* is applied to such tubing less than 10 cm in diameter.

**Tubing die** *n.* A die with an annular opening used to extrude plastics tubing. The core (*mandrel*) of the die may be fitted with a water-cooled extension that aids in chilling the extrudate and bringing its internal diameter within tolerances.

*See also pipe die.*

**Tubular fabric** *n.* A fabric woven or knit in a tube form with no seams, such as seamless pillowcases, some knit underwear fabrics, and seamless hosiery.

*Also see circular-knit fabric.*

**Tubular film** *See film blowing.*

**Tuck stitch** *n.* A knitting stitch made when a needle receives a new yarn without losing its old loop.

**Tuft** \ˈtəft\ [ME, mod. of MF *tufe*] (14c) *n.* (1) A cluster of soft yarns drawn through a fabric and projecting from the surface in the form of cut yarns or loops. (2) The portion of pile-like material that comprises a tufted fabric or carpet. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

*Also see tufted fabric and tufted carpet.*

**Tufted carpet** *n.* Carpet produced by a tufting machine instead of a loom. It is an outgrowth of hand-tufted bedspreads. Today, broadloom tufting machines produce over 90% of all domestic carpeting. Tufting machines are essentially multi-needle sewing machines that push the pile yarns through a primary backing fabric and hold them in place to form loops as the needles are withdrawn. The loops are then either released for loop-pile carpets or cut for cut-pile carpets. The pile yarns may be either pre-dyed or uncolored, in which case, the greige carpet is then piece-dyed or printed. In either case, a latex or other binding agent is applied to the backstitch to lock the tufts in place and to secure the secondary backing fabric. Formerly, all carpets were woven, either by hand or machine. The significantly greater productivity of tufting has revolutionized the carpet industry and made soft floor coverings available to the mass market. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Tufted fabric** *n.* Cotton sheeting, lightweight duck, or other fabric decorated with fluffy tufts of multiple-ply, soft-twist cotton yarns or manufactured fiber yarns closely arranged in continuous lines or spaced at intervals to produce the type of fabric called candlewick. The tufts are inserted and cut by machine in previously woven fabric or are woven in by the loom and afterwards cut to form the tufts. They have a chenille-like softness and bulk and are erroneously called chenille. Patterns vary from simple straight lines and elaborate designs to completely covered materials resembling long pile fabrics. They may be white, solid colored, or multicolored. Tufted fabrics are used for bedspreads, bath mats, and robes, etc. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Tukon** *See penetrometer.*

**Tulle** \ˈtül\ [F, fr. *Tulle*, France] (ca. 1818) *n.* A fine, very lightweight, machine-made net usually having a hexagonal mesh effect. Tulle is used in ballet costumes and veils.

**Tumbling** *n.* (1) Process by which paint is applied to small articles, such as hairpins, children's building bricks, etc., which are unsuitable for coating by any of the normal methods. The articles are placed in a drum, together with a little more paint than will be sufficient to cover the total surface of all the articles, and the drum is rotated until the paint is evenly distributed. The articles are then emptied from the drum, generally onto wire trays, and the coating air-dried or baked. (2) A finishing operation for small plastic articles in which gates, flash and fins are removed and/or surfaces are polished, by rotating them in a barrel together with wooden pegs, sawdust, and (sometimes) polishing compounds. The barrels are usually of octagonal shape with alternate open and closed panels. The open panels covered with screen to permit fragments of removed material to fall out. Blocks of dry ice may be added to the tumbling medium to embrittle the parts and thus facilitate cleaner break-off of flash; but in this case the barrel must be closed to retard evaporation of the dry ice. (3) Process used in some paint storehouses whereby containers are repeatedly up-ended to redisperse pigments which may have settled or caked during storage of the paint. *Also called rumbling, barreling, barrel finishing, and barrel polishing.*

**Tumbling agitator (tumble mixer)** *n.* A cylindrical or conical vessel rotating about a horizontal or inclined axis, with internal ribs that lift the material and then let it tumble back into the charge. They are used mainly for blending dry materials, e.g., color concentrates and resin pellets.

**Tungates** *n.* Metallic soaps derived from tung oil.

**Tung oil** \ˈtəŋ\ [part translation of Chinese (Beijing) *tóngyóu*] (1881) *n.* Drying oil obtained from *Aleurites fordii* or *Montana* now grown in many different parts of the world. The Japanese tung oil is obtained from *Aleurites cordate.* Tung oil is distinguished by the presence of a very high proportion of elaeostearic acid, which contains three conjugated double bonds, It dries rapidly, polymerizes readily on heating, "reacts" with certain types of pure phenolic resins, possesses outstanding water resistance, and webs or frosts on drying unless properly heat-treated. Sp gr, 0.939–0.943/15°C; refractive index, 1.486–1.522; iodine value, 145–175; saponification value, 189–195. *Known also as China wood oil, wood oil, and Mu oil.*

**Tung or China wood oil** *n.* A vegetable oil having exceptional drying properties and chemical resistance. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Tungsten** \ˈtəŋ-stən\ [Sw, fr. *tung* heavy + *sten* stone] (1796) (W) *n.* A hard, dense metallic element that has occasionally been used in powder form as a plastics filler to increase density. Tungsten carbide extremely hard and widely used in metal-cutting tools, has also been used to impart abrasion resistance in plastics.

**Tungstomolybdic pigments** *See phosphomolybdic pigments.*

**Tunnel gate** *n.* Syn: submarine gate.

**Tunnel test** *See flammability tests.*

**Tunneling** *n.* A condition occurring in incompletely bonded laminates, characterized by release of longitudinal portions of the substrate and deformation of these portions to form tunnel-like structures.

**Turbid** \ˈtər-bəd\ [L *turbidus* confused, turbid, fr. *turba* confusion, crowd; prob. fr. Gk *tyrbē* confusion] (1626) *adj.* Characteristic of a liquid or solid having a relatively great amount of non-setting floc, gels, suspended matter, particles, droplets, or other insoluble or separated matter, even though the liquid is translucent and transmits at least a little light.

**Turbidity ($\tau$)** *n.* Parameter used to express the intensity of light scattering. It is defined as

$$\tau = (1/l)[\log(I_0/I)],$$

where $I$ is the intensity of a beam of light, of initial intensity $I_0$, after passing through a length $l$ of the scattering medium. It is related to the Raleigh ratio ($R_\theta$) by $\tau = (16/3)R_\theta$.

**Turbulence** *n.* Deviation from streamline or telescopic flow. Turbulent flow occurs at relatively high rates of shear and indicates the existence of eddy currents in sheared material.

**Turbulent flow** *n.* Flow for which the stream Reynolds number exceeds about 2100–4000. Polymer solutions, particularly dilute ones, can easily experience turbulent flow but polymer melts rarely (if ever) do because of their extremely high viscosities.

**Turkey red** [*Turkey*] (1789) *n.* Red oxide of iron obtained by calcinations at relatively low temperatures. Hydroxide or carbonate of iron is precipitated from a solution of an iron salt, and the precipitate is washed before calcinations. Soft, brilliant pale reddish brown pigments are obtained. Opacity is high.

**Turkey red oil** *n.* Sulfonated castor oil. The term is sometimes applied to the sodium salt of this product. The oil is chiefly the reaction product of sulfuric acid with the hydroxyl groups of castor oil, but some secondary reactions also occur. Turkey red oil is used as a wetting agent.

**Turkey umber** *n.* Type of umber derived from Cyprus and originally exported via Turkey.

*See umber.*

**Turn** *n.* The distance parallel to the axis of a yarn or rope in which a strand makes one complete spiral.

*Also see twist.*

**Turnbull's blue** *See iron blue.*

**Turned over edge** *n.* A curled selvage.

**Turnkey** *n.* An adjective describing a complete manufacturing system or facility, such as a polymerization plant of sheet-extrusion line, delivered to the customer in ready-to-operate condition.

**Turpentine** \ˈtər-pən-ˌtīn\ [ME *terbentyne*, *turpentyne*, fr. MF & ML; MF *terbentine*, *tourbentine*, fr. ML *terbentina*, fr. L *terebinthina*, feminine of *terebinthinus* of terebinth, fr. *terebinthus* terebinth, fr. Gk *terebinthos*] (14c) *n.* A colorless, volatile oil distilled from the products of certain pine trees and consisting primarily of a complex mixture of terpene hydrocarbons of the general formula $C_{10}H_{16}$. Turpentine was formerly extensively used in paints and varnishes but has now been largely replaced by mineral spirits or white spirit. Four kinds of turpentine are now recognized: (1) *Gum turpentine* or *bum spirits.* Obtained by distilling the crude exuded gum or oleoresin collected from living trees. (2) *Steam-distilled wood turpentine.* Obtained from the oleoresin within the wood of pine stumps or cuttings, either by direct steaming of the mechanically disintegrated wood or after solvent extraction of the oleoresin from the wood. (3) *Sulfate wood turpentine.* Recovered during the conversion of wood to paper pulp by the sulfate processes. (4) *Destructively distilled wood turpentine.* Obtained by fractionation of certain oils recovered by condensing the vapors formed during the destructive distillation of pine wood.

*Also known as turps.*

**Turpentine, oil of** *See oil of turpentine.*

**Turpentine, spirits of** (ca. 1792) *n. See turpentine.*

**Turpentine substitute** *n.* This term is not recommended, because its use to describe a paint thinner of mineral spirits origin is illegal under the Federal Naval Stores Act. Syn: sub spirits and sub turps.

**Turps** *See turpentine.*

**Tuscan red** *n.* Red pigment made from a mixture of iron oxide and an alizarine dye.

**Tusche** \ˈtüsh, ˈtü-shə\ [Gr, fr. *tuschen* to lay on color, fr. F *toucher*, lit., to touch, fr. OF *tuchier*] (1885) *n.* A lithographic drawing or painting material of the same nature as lithographic ink. Also used as a resistant in the etching process.

**Twaddell hydrometer** *n.* Form of technical hydrometer used for measuring the specific gravity of liquids. It does not give a direct reading, but the specific gravity is calculated from the following simple equation: $T^\circ = 200(d - 1)$, where $T^\circ$ is the reading in degrees Twaddell, and $d$ is the required Sp gr.

**Tweed** \ˈtwēd\ [prob short for Scots *tweedling*, *twidling* twilled cloth] (1841) *n.* An irregular, soft, flexible, unfinished, shaggy wool or wool-blend fabric made with a 2/2 twill weave. Tweeds are used in all types of coat fabrics and suitings.

**Twilight vision** *n.* Rod vision by the dark-adapted eye in dim light.

**Twill weave** *n.* A cloth weave in which the warp yarn runs alternately over two fill yarns and under one fill yarn. The twos and ones may be staggered with adjacent or regularly spaced warp yarns to produce a diagonal effect. In Dutch twill, wires of different sizes are used to produce a very dense screen with tortuous passages (light does not pass directly through) and an effective mesh number of 1200 or more. Twilled screens have sometimes been used in fiber extrusion and twill-woven cloths are used in some reinforced-plastics structures.

**Twilo process** *n.* A spinning process in which yarn is made by binding fibers with an adhesive, then removing the adhesive after the yarn is made into fabric.

**Twine** \ˈtwīn\ [ME *twin*, fr. OE *twīn*, akin to MD *twijn* twine, OE *twā* two] (before 12c) *n.* (1) A plied yarn made from medium-twist single yarns with ply twist in the opposite direction. (2) A single-strand yarn, usually 3 or 4 mm in diameter, made of hard fibers, such as henequen, sisal, abaca, or chromium, and sufficiently stiff to perform satisfactorily on a mechanical grain binder.

**Twinning** *n.* A movement of planes of atoms in the crystal lattice parallel to a specific (twinning) plane so that the lattice is divided into two symmetrical parts which are differently oriented. The amount of movement of each plane is proportional to its distance from the twinning plane.

**Twin-plane** *n.* The common composition plane of a crystal. It always coincides with a possible crystallographic face.

**Twin-screw extruder** *See extruder, twin-screw.*

**Twin-shell forming** *n.* A high-speed thermoforming process for producing bottles and other hollow objects. Two thermoplastic sheets from separate roll-unwind stands are conveyed through heating apparatus, then positioned between facing halves of vacuum-forming molds. After closing the molds, vacuum is drawn on each half to simultaneously form the articles and seal the edges. When molds are arranged on a pair of endless conveyors, the process becomes continuous, sheets being fed into one end and a continuous web of formed products emerging from the other end, ready for separation from the waste portion of the sheets. The trim is ground and returned to the sheet-extrusion operation.

**Twist** *n.* (1) A textile term, the number of turns (360°) per unit length that a multifilament yarn, staple yarn, or other structure is turned or twisted around its longitudinal axis into a stable structure. (2) The unintended, progressive spiraling seen in some protruded products.

**Twist bleed** *See twit.*

**Twist direction** *n.* The direction of twist in yarns and other textile strands is indicated by the capital letters *S* and *Z*. Yarn has *S*-twist if when it is held vertically, the spirals around its central axis slope in the same direction as the middle portion of the letter *S*, and *Z*-twist if they slope in the same direction as the middle portion of the letter *Z*. When two or more yarns, either single or plied, are twisted together, the letters *S* and *Z* are used in a similar manner to indicate the direction of the last twist inserted.

**Twisting** *n.* (1) The process of combining filaments into yarn by twisting them together or combining two or more parallel singles yarns (spun or filament) into plied yarns or cords. Cables are made by twisting plied yarns or cords. Twisting is also employed to increase strength, smoothness, and uniformity, or to obtain novelty effects in yarn. (2) A very high level of twist is added to single or plied yarns to make crepe yarns. This operation generally is called creping or throwing. (3) The process of adding twist to a filament yarn to hold the filaments together for ease in subsequent textile processing, etc.

**Twist multiplier** *n.* The ratio of turns per inch to the square root of the yarn count.

**Twist setting** *n.* A process for fixing twist in yarns to deaden torque and eliminate kinking during further processing. There are several methods that use steam to condition the packages of yarns.

**Twit** *n.* A short section of real twist in false-twist yarn that prevents crimp development and hence causes a pinhole effect in fabric.

*Also called twist bleed or tight spot.*

**Twitchell reagent** *n.* Reagent employed for the splitting or hydrolysis of oils and fats, and made by the interaction of sulfuric acid, oleic acid and naphthalene.

**Two-color molding** *See double-shot molding.*

**Two-compartment coating** *n.* Cross-linking systems, which must be stored in separate containers before use. Otherwise, they would react and form a useless gel.

*Also called two-pot coating.*

**Two-component gun** *n.* Spray gun having two separate fluid sources leading to the spray head.

**Two-component spray gun** *n.* A spray head with fittings for attachment to two separate feed lines, each carrying one component of a reactive resin mixture, e.g., as in urethane foam-in-place molding or polyester gel-coating.

**Two-for-one twister** *n.* A twister that inserts twist at a rate of twice the spindle speed. For example, at a spindle speed of 2,000 rpm, 4,000 turns/min are inserted in the yarn.

**Two-level mold (double-decker mold)** *n.* An injection mold having two layers of cavities, used in making low-mass articles with large projected areas, so as to make best use of both plasticating and clamping capacities.

**Two-pot (or two part)** *n.* Systems inks or coatings in which two reactive components are mixed together only at press time.

**Two-pot coating** *See two-compartment coating.*

**Two-roller mills** *n.* These are used for purposes similar to the triple-roller mills, except that only two rollers are involved.

**Two-roll mill** *See roll mill.*

**Two-shot injection molding** *n.* Confusingly, this term has been used in the literature for two processes that are distinctly different. One is described under double-shot molding. In the other process, one first injects a metered amount of one material into a single-cavity mold. As this material just begins to chill against the cold mold surfaces, a second material is injected. This fills the interior and forces the first material outward to the cavity surfaces. The second polymer, usually a reclaimed material forms the interior of the finished article, while the virgin material first injected forms the outer shell and surface of the article.

**Two-shot molding** *See double-shot molding.*

**TXP** *n.* Abbreviation for trixylenyl phosphate, Syn: tridi-methylphenyl phosphate.

**Tylose** *n.* Cellulose ether. Manufactured by Kalle, Germany.

**Tympan** \ˈtim-pən\ [in one sense, fr. ME, fr. OE *timpana*, fr L *tympanum*; in other senses, fr. ML & L *tympanum*] (before 12c) *n.* The roller opposite the printing roller on a rotary press over which the paper web passes.

**Tympan sheet** *n.* A sheet of paper or cloth placed between the impression surface (platen or cylinder press) and the paper to be printed.

**Tyndall effect** *n.* The scattering of a beam of light by a colloid.

**Tynex** *n.* Nylon-6,6 manufactured by DuPont, USA.

**Type-8 nylon** *n.* Not to be confused with nylon-8. Type-8 nylon is a chemically treated nylon-6/6. It is thermoplastic, light yellow, with a leathery flexibility and excellent resistance to common solvents and abrasion. It has been used to impart abrasion resistance to the denim knees of jeans and overalls by impregnation of the cloth, and as an abrasion- and solvent-resistant coating for work gloves.

**Type high** *n.* 0.918 in.; the standard in letterpress printing.

**Type J thermocouple** *n.* A thermocouple made up of one or two welded junctions of iron and constantan wires and widely used in measuring temperatures in plastics-processing equipment.

**Type K thermocouple** *n.* A thermocouple made up of one or two welded junctions of chromel and alumel wires, widely used in measuring high temperatures in oxidizing atmospheres, and enjoying considerable use in plastics processing.

**Type P thermocouple** *n.* A thermocouple made up of one or two welded junctions of copper and constantan wires, used more in the measurement of low temperatures than high ones.

**Typography** \tī-ˈpä-grə-fē\ [ML *typographia*, fr. Gk *typos* impression, cast + -*graphia* -graphy] (1610) *n.* Processes of making an impression using a raised, pigmented surface, from type, line etching, halftones, or rubber stamps.

*See letterpress.*

# U

**U** \ˈyü\ *n.* (1) Chemical symbol for the element uranium. (2) In heat-transfer engineering symbol for overall conductance.

**Ubbelohde viscometer** (1) (Cannon–Ubbelohde viscometer) An instrument made of Pyrex glass and consisting of an upper reservoir that drains through a marked capillary to a lower, vented chamber and thence to a second reservoir. The time taken by the test liquid to drain through the capillary is proportional to the viscosity (with slight corrections). This is one of several similar types used to measure viscosities of polymer solutions (*see ASTM*, *www.astm.org*). (2) Capillary viscometer for measurement of viscosity molecular weight of polymers in solution; advantage over Ostwald–Fenske and Cannon–Fenske is that the measurement is independent of the amount of solution in the viscometer and measurement at a series of concentrations can easily be made by successive dilution; also used for measuring intrinsic viscosity. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

*See also viscosity.*

**Uchiwa-ye [Japanese]** *n.* A print in the shape of a fan.

**UF** Abbreviation for urea–formaldehyde resin. *See amino resin.*

**UHMWPE** *n.* Abbreviation for ultra-high-molecular-weight polyethylene.

**Ultimate elongation** \ˈəl-tə-mət (ˌ)ē-ˌlóŋ-ˈgā-shən\. In a tensile test, the nominal elongation at rupture. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

*See elongation.*

**Ultimate strength** *n.* The maximum nominal stress a material can withstand when subjected to an applied tensile, compressive, or shear load. If the mode of loading is not specified, it is assumed to be tensile. In materials that exhibit a definite yield strength, ultimate strength will usually mean the nominal stress at break, which can be less than the maximum. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Ultimate tensile strength** *See tensile strength.*

**Ultracentrifugation** \-ˌsen-trə-fyú-ˈgā-shən\ (1930) *vt.* Rotating a fluid in a centrifuge in excess of about 15,000 rpm; useful for separating components from mixtures of solids, liquids, and gases; and useful for ultra-cleaning or filtering solids from solutions. Gooch JW (1997) Analysis and deformulation of polymeric materials. Plenum Press, New York. Krause A, Lange A, Ezrin M (1988) Plastics analysis guide: chemical and instrumental methods. Oxford University Press, UK.

**Ultracentrifuge** \-ˈsen-trə-ˌfyüj\ (1924) *n.* A small centrifuge capable of rotational speeds to 100,000 rpm, creating sedimentation forces up to a million times gravity. At lower speeds and long-sedimentation times, an equilibrium radial distribution of larger and smaller molecules is attained. As the centrifuge spins, a narrow, collimated light beam is passed through a cell containing a polymer solution. By measuring refractive index or light absorption at different radii (i.e., depths in the cell), and using complex data-reduction methods, the number- and weight-average molecular weights of the polymer can be estimated and a graph of the molecular-weight distribution drawn. A second method uses the same techniques to measure sedimentation velocities at much higher speeds and over shorter time periods. Ultracentrifugation has been most useful with biological polymers, which tend to be all one size (*monodisperse*), making the data analysis less complicated. Krause A, Lange A, Ezrin M (1988) Plastics analysis guide: chemical and instrumental methods. Oxford University Press, UK.

**Ultra high-molecular weight** *n.* Capillary viscometer for measurement of viscosity molecular weight of polymers in solution; advantage over Ostwald–Fenske and Cannon–Fenske is that the measurement is independent of the amount of solution in the viscometer and measurement at a series of concentrations can easily be made by successive dilution; also used for measuring intrinsic viscosity.

**Ultra-high-molecular-weight polyethylene (UHMWPE)** *n.* Any polyethylene having an average molecular weight (Mw) in the range from 1 to 5 million g/mol. Density is about 0.94 g/cm$^3$. These materials, like polytetrafluoroethylene, do not truly melt and are processed by compression and sintering, and related methods. Small amounts of PE resins having somewhat lower molecular weight may be added as processing aids.

**Ultra-low-density-polyethylene (ULDPE)** *n.* Any linear polyethylene with density less than 0.90 g/cm$^3$, and possibly as low as 0.86 g/cm$^3$. ULDPE films have better optical properties and better resistance to puncture, impact, and tearing than conventional linear low-density PEs.

**Ultramarine blue** \-mə-ˈrēn\ [ML *ultramarinus* coming fr. beyond the sea, fr. L *ultra-* + *mare* sea] (1598) $Na_6Al_6Si_6O_{24}S_2$ (light); $Na_7Al_6Si_6O_{24}S_3$ (medium); $Na_8Al_6Si_6O_{24}S_4$ (dark) *n.* (1) A natural type of mineral origin. It is also known as genuine ultramarine and *lapis lazuli.* (2) The synthetic types are produced in several shades by heating sulfur, clay, soda ash, and a reducing agent. They have good lightfastness and good alkali resistance, but poor opacity and poor tinting strength. Density, 2.2–2.7 g/cm$^3$ (18.6–20.2 lb/gal); O.A., 25–39; particle size, 0.8–2.0 µm. (3) A natural or synthetic inorganic blue pigment occasionally used for printing inks. Syn: brillain ultra-marine, factious ultramarine, French blue, French ultramarine, Guimet's blue, Huemann's blue, laundry blue, oriental blue, and permanent blue.

**Ultramarine blue pigment** *n.* A pigment family comprising a complex of double silicates of sodium and aluminum in combination with sodium polysulfide. They produce bright, clean tones even in combination with white pigments, and are resistant to the high-temperatures employed in processing thermoplastics. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Ultramarine green** *n.* Ultramarines cover a color range from pink to violet to blue and green. The pinks, violets, and greens are especially weak colors, and the green is no longer an item of commerce. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Ultramarine violet** *n.* $H_2Na_{46}Al_6Si_6O_{24}S_2$. Pigment violet 15 (77007). Ultramarine violet is produced by mixing ultramarine blue with ammonium chloride and heating at about 150°C for several hours. It is chemically and physically similar to ultramarine blue. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Ultramide A** *n.* Nylon-6,6, manufactured by BASF, Germany.

**Ultramide B** *n.* Nylon-6, manufactured by BASF, Germany.

**Ultramides** Nylon-6,10, manufactured by BASF, Germany.

**Ultrapas** *n.* Melamineformaldehyde resin, manufactured by Dynamit Nobel, Germany.

**Ultrasonic** \-ˈsä-nik\ (1923) *n, adj.* Vibrations above the hearing range of humans.

**Ultrasonic assembly** *n.* A process for using ultrasonic energy for assembling polymer parts.

**Ultrasonic cleaning** *n.* A method used for thoroughly cleaning molded plastics for electrical components and mechanical parts. A piezoelectric transducer (e.g., a crystal of barium titanate), mounted on the side or bottom of a cleaning tank, is excited by an ultrasonic generator to produce high-frequency vibrations in the cleaning medium. These vibrations cause intense cavitations in the liquid and dislodge contaminants from crevices, and even from blind holes, that normal cleaning method would not remove.

**Ultrasonic C-scan** *n.* A non-destructive inspection technique for reinforced plastics in which the energy absorbed from a short ultrasonic pulse is measured. This is quantitatively different for sample containing delaminations, voids, or too little or too much reinforcement, than for solid samples of the correct composition.

**Ultrasonic degating** *n.* A degating method used for small plastic parts produced by a family mold. The molding-machine operator removes the runner system and attached parts from the mold and loads, the branched structure into the degating machine, where the runner makes contact with an ultrasonic horn. High-frequency-sound vibrations are transmitted through the runners to the narrow gates, causing them to melt, and the pats drop through holes into a sorting system.

**Ultrasonic frequency** *n.* A sound frequency above the limit of human audibility, approximately 18 kHz. Most ultrasonic devices operate well above this level. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Ultrasonic inserting** *n.* A method of incorporating metallic inserts into plastics articles by means of ultrasonic heating. A plain cylindrical hole or well is molded in the plastic article by means of a core pin, the hold diameter being slightly less than that of the insert. Ultrasonic vibration and light pressure are applied as the metal part is being inserted, melting the plastic within a small radial distance of the inside hole surface. The displaced melt flows into the knurls, flutes, or undercuts in the insert's outer surface and freezes, locking the insert into position.

**Ultrasonic prepreg cutting** *n.* A recently introduced method for cutting prepregs that uses an intense and extremely narrow beam of ultrasonic energy.

**Ultrasonic sealing** *n.* Same for sealing films, etc. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Ultrasonic staking** *n.* The process of forming a head on a protruding peg in a plastic article for the purpose of holding a surrounding part in position (*see staking*), utilizing ultrasonic heating and pressure to melt the tip of the protrusion and form it into a head. The process is very fast, usually taking only a fraction of a second.

**Ultrasonic welding (ultrasonic sealing)** *n.* A method of welding or sealing thermoplastics in which heating is accomplished with vibratory mechanical pressure at ultrasonic frequencies (20–40 kHz). Electrical energy is converted to ultrasonic vibration by a transducer, directed to the area to be welded by a horn, and localized heat is generated by friction and impact at the surfaces to be joined. Other parts of the assembly are not heated. The process is most effective for rigid and semi-rigid plastics, since the energy is rapidly dissipated in soft, flexible materials. It will work with dissimilar plastics if they are melt-compatible and melt in the same temperature range. Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York.

**Ultraviolet** \ˌəl-trə-ˈvī-(ə-)lət\ (1840) (UV) *n, adj.* The region of the electromagnetic spectrum between the X-ray region and the violet end of the visible-light range, including wavelengths from about 3 to 200 nm. Photons of radiation in the UV region have sufficient energy to initiate some chemical reactions and to degrade many neat resins. The term "ultraviolet light" is incorrect because light refers only to visible radiant energy. (the term "light" is limited to the visible region of the spectrum).

*See light*

**Ultraviolet absorber** *n.* Substance, which absorbs ultraviolet radiation more readily than the coating material in which it is dissolved or dispersed, and which transforms the ultraviolet energy into longer wavelength energy which is relatively harmless to the coating. While some pigments are relatively non-transparent to ultraviolet radiation, the term is usually used to describe compounds, which are physically dissolved in the coating and do not affect transparency to visible light. These UV absorbers are a class of stabilizers, which have intense absorption up to 350–370 nm, but are transparent in the visible. Examples of these are benzotriazoles and 2-hydroxybenzophenones. They are widely used to stabilize exterior varnishes against UV degradation.

**Ultraviolet absorbers** *n.* Absorbers for ultraviolet energy, which are usually strong nucleophilic agents and decompose peroxides ionically by $S_N2$ reactions; e.g., benzonephenones {G UV-Absorber m, F absorbeur d'UV, absorbeur m, S absorbente de UV, absorbente m, I assorbitore UV, assorbitore m}.

**Ultraviolet curing (or UV curing)** *n.* (1) Conversion of a wet coating or printing ink film to a solid film by the use of ultraviolet radiation. (2) The process by which certain polymers or coatings are cured, with the aid of a photoinitiator, by exposure to ultraviolet radiation. One such polymer system is the oligomer tris(2-hydroxymethyl) isocyanurate triacrylate with an initiator and an acrylic monomer such as 2-phenoxyethyl acrylate in ratios from 10 to 100 parts per 100 parts of the triacrylate (USP 4,812,489).

**Ultraviolet degradation** *n.* One of the most serious degradation threats to plastics being used outdoors. Changes in plastics such as crazing, chalking, dulling of the surface, discoloration, and fading; changes in electrical properties; lowering of strength and toughness; and even disintegration, have been caused by exposure to UV radiation, particularly the longer wavelengths near the visible violet. The presence of oxygen can exacerbate the process. Chain scission is the major mechanism.

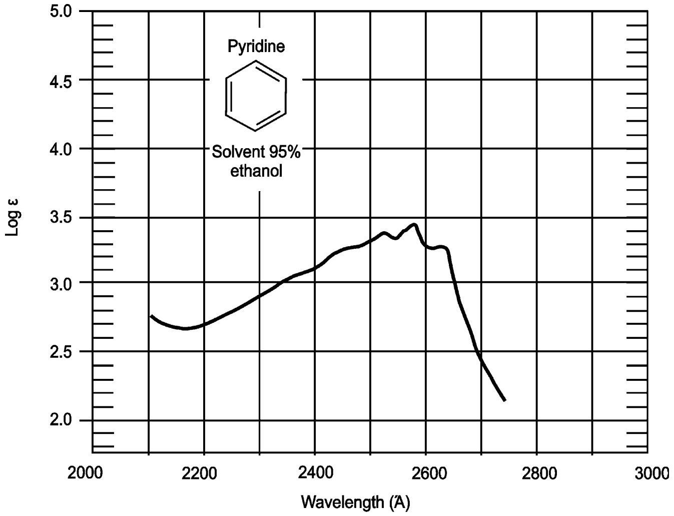
**Ultraviolet light (deprecated)** *See ultraviolet.*

**Ultraviolet printing (UV printing, UV-curing decoration)** The process of printing or decorating with inks that cure rapidly by exposure to ultraviolet light. The inks are solvent-free, thus avoiding problems with air-pollution regulations, and contain a UV-sensitive catalyst that cures the ink in as little as 1 s. Mercury-vapor lamps can be used as the source of UV light. For polymers that are subject to degradation by UV-induced oxidation, equipment has been designed to blanket the exposed area with nitrogen.

**Ultraviolet resistance** *n.* Ability to retain strength and resist deterioration on exposure to sunlight. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Ultraviolet spectrophotometry** *n.* A method of chemical analysis similar to infrared spectrophotometry, except that the spectrum is obtained with ultraviolet light. It is somewhat less sensitive than the IR method for polymer analysis, but is useful for identifying and measuring plasticizers and anti-oxidants. An example of a UV spectrum of pyridine is shown. Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D. Van Nostrand Co., New York.

**Ultraviolet spectroscopy** *n.* Spectroscopic analysis using the ultraviolet (UV) wavelengths (<400 nm) and useful for detecting unsaturated chemical groups, conjugation, etc.



**UV spectrum of pyridine. (Source: Silverstein RM, Bassler GC, Morrill TC, Spectroscopic Identification of Organic Compounds, John Wiley and Sons, New York 1974.)**

**Ultraviolet stabilizer** *n.* An additive that protects plastics against ultraviolet degradation, and that may accomplish its protection in various ways. An additive that preferentially absorbs UV radiation and dissipates the associated energy in a harmless manner is sometimes called an *ultraviolet absorber* or *ultraviolet screening agent.* Additives that do not actually absorb UV radiation but protect the polymer in some other manner are called *ultraviolet stabilizers* or other names indicative of the mechanism of stabilization. For example, products that remove the energy absorbed by the polymer before photochemical degradation can occur are called *energy-transfer agents* or *excited-state quenchers.* Other modes of UV stabilization are singlet-oxygen quenching, free-radical scavenging, and hydroperoxide decomposition. Classes of such stabilizers in use are the benzophenones, benzotriazoles, substituted acrylates, aryl esters, and compounds containing nickel or cobalt. Still another group consists of dispersed pigments, such as the very effective carbon black, which, of course, color the plastics and render them opaque.

**Umber** \ˈəm-bər\ [prob. fr. obs. E, shade, color, fr. ME *umbre* shade, shadow, fr. MF, fr. L *umbra*] (1568) Pigment Brown 7. *n.* A naturally occurring brown earth containing ferric oxide, together with silica, alumina, manganese oxides, and lime. Raw umber pigment is umber, which has been ground; burnt umber pigment is umber calcined at a low temperature and ground.

**Uncertainty principle** (1929) *n.* A principle in quantum mechanics which states: it is impossible to discern simultaneously and with high accuracy both the position and the momentum of a particle (as an electron). Also known as Heisenberg uncertainty principle. General chemistry. Brookes/Cole, New York, 2003.
*See indeterminacy.*

**Uncrimping energy** *See crimp energy.*

**Undercoat** \ˈən-dər ˌkōt\ (1648) *n.* (1) A coat of paint applied on new wood, or over a primer, or over a previous coat of paint; improves the seal and serves as a base for the topcoat, for which it provides better adhesion. (2) Any paint which acts as a base for enamel. (3) Any primer which is colored.

**Undercoating** \-ˌkō-tiŋ\ (1922) *n.* A bituminous coating sprayed on the underside of automobiles to minimize rusting.

**Undercure** \-ˈkyúr\. A condition or degree of cure that is less than optimum, i.e., when insufficient time and/or temperature has been allowed for adequate cure; may be evidenced by tackiness, longness, or inferior physical properties.

**Undercut** \-ˌkət\ (1859) *n.* A lateral indentation in a molded part (or protuberance in a mold) that tends to impede withdrawal of a molded part from the mold. Articles of flexible materials such as plasticized vinyls can often be removed without difficulty from molds with severe undercuts, but undercuts must either be avoided in rigid materials or, where they must be part of the design, the mold must have movable parts that withdraw (*side draws*) before the part is to be ejected. Slight undercuts are sometimes deliberately designed into one half of a mold to cause a part to remain in that half when the mold opens.
*See also side-draw pin.*

**Undercutting** *n.* The action of etching solution on the sides of the resist of photomechanically prepared plates.

**Underhue** *See undertone color.*

**Undertone** \-ˌtōn\ (1806) *n.* The color of am thin film of ink as seen on a white background. The appearance of an ink when viewed by light transmitted through the film.

**Undertone color** *n.* Color of a thin layer of pigment-vehicle mixture applied at incomplete hiding on a white background; sometimes referred to as cast or under hue. The term is sometimes used to refer to the color resulting when a pigment is mixed with white, but this should more properly be called tint-tone.

**Underwater pelletizing** *n.* A system, used mostly with 15-cm diameter and larger, high-output extruders in resin-manufacturing plants, in which a circular, heated dire plate containing up to several hundred strand holes is enclosed within a water-tight casing and sprayed with water, while a rapidly spinning fly-knife slices the emerging strands of melt into lengths about equal to their diameters and flings the warm globs into the water spray. The water falling to the bottom carries the pellets out of the casing and onto a dewatering screen and drying conveyor. A delicate balance must be reached among several requirements: (1) cutting the pellets cleanly and chilling them instantly so that they do not grow "tails" nor form doubles and larger clusters; (2) maintaining a uniform metal temperature of the die over its entire face so that melt does not freeze in the holes and the extrusion rate is the same in all; (3) matching the knife speed with the extrusion rate to get the desired pellet length; and (4) draining the emerging pellets in a way that uses their remaining sensible heat to fully dry them but cools them sufficiently so that they do not soften and fuse together in the collecting bin. Surface tension in the molten particles rounds them into nearly spherical or ellipsoidal final shapes.

**Undrawn tow** *See drawn tow.*

**Undrawn yarn** *n.* Extruded yarn (filaments), the component molecules of which are substantially unoriented. Undrawn yarn exhibits predominantly plastic flow in the initial stages of stretching and represents an intermediate stage in the production of a manufactured yarn.

**Undulose extinction** *n.* Non-uniform extinction of a substance between crossed polars. The areas of complete extinction move progressively with a fanlike motion across the surface of the substance as the stage is rotated.

**Uneven dyeing** *n.* A fabric dyeing that shows variations in shade resulting from incorrect processing or dyeing methods or from use of faulty materials.

**Uneven shrinkage** A wavy, warpwise condition in the fabric that prevents it from lying flat on a horizontal surface.

**Uneven surface** *n.* An irregular surface characterized by non-uniformity in the physical configuration of the yarns or fibers making up the surface of the fabric.

**Uneven yarn** *n.* A yarn that varies in diameter to an abnormal degree.

**Unfinished worsted** *n.* A worsted fabric with a relatively soft hand and a light nap.

**Uniaxial** \ˌyü-nē-ˈak-sē-əl\ (ca. 1828) *adj.* Of one primary axis and refractive index such as a drawn polymer fiber (e.g., drawn polyamide).

**Uniaxial crystals** *n.* Anisotropic crystals in the tetragonal and hexagonal systems having one unique crystallographic direction and either two (tetragonal) or three (hexagonal) directions which are alike and perpendicular to the unique direction. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York.

**Uniaxial load** *n.* A condition whereby a test sample or structural member is stressed in only one direction.

**Uniaxial orientation** *n.* An orientation process that stretches the product in only one direction, as in manufacture of staple fiber, monofilaments, and melt-cast film.

**Uniaxial strain** *n.* Tensile or compressive strain in a single direction – the usual testing mode – and typically in the length direction of a test specimen or structural member.

*See also strain and true strain.*

**Uniaxial stress** *n.* Tensile or compressive stress in a single direction, usually the lengthwise direction of a test specimen or structural member.

*See also stress and true stress.*

**Unicellular plastic** \ˌyü-ni-ˈsel-yə-lər-\. A term that has sometimes been used for closed-cell foamed plastic.

**Unidirectional fabric** \ˌyü-ni-də-ˈrek-shnəl-\. A fabric having reinforcing fibers in only one direction.

**Unidirectional laminate** \-ˈla-mə-ˌnāt\. A reinforced-plastic structure in which substantially all of the fibers are parallel. The modulus of elasticity ($E$) and strength of such a laminate in the direction of reinforcement will be somewhat more than the product of the volume fraction of reinforcing fiber times its corresponding properties. However, properties in the transverse directions are essentially those of the matrix resin.

*See law of mixtures. See also bi- and tridirectional laminate.*

**Uniform chromaticity coordinates** *n.* Chromaticity coordinates yielding an approximately uniform chromaticity diagram for colors of equiluminosity. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See uniform chromaticity scale diagram.*

**Uniform chromaticity scale diagram** *n.* Any one of a variety of transformations of the CIE chromaticity diagram to a diagram on which all pairs of just noticeably different colors of equal luminance are represented by pairs of points separated by nearly equal distances.

**Uniform chromaticity spacing** *See uniform chromaticity scale diagram.*

**Uniform circular motion** *n.* If $r$ is the radius of a circle, $v$ the linear speed in the arc, $\omega$ the angular velocity, and $T$ is the period or time of one revolution,

$$\omega = \frac{v}{r} = \frac{2\pi}{Y}.$$

The acceleration toward the center is

$$a = \frac{v^2}{r} = \omega^2 r = \frac{4\pi^2 r}{T^2}.$$

The centrifugal force for a mass $m$,

$$F = \frac{mv^2}{r} = m\omega^2 r = \frac{4\pi^2 mr}{T^2}.$$

In the above equations, $\omega$ will be in radian per second and $a$ in cm/s$^2$ if $r$ is in cm, $v$ in cm/s, and $T$ in second. $F$ will be in dyne if mass is in gram and other units as above. *Application to the solar system* – If $M$ is the mass of the Sun, $G$ the constant of gravitation, $P$ the period of the planet, and $r$ is the distance of the planet from the Sun, then the mass of the Sun

$$M = \frac{4\pi^2 r^3}{GP^2} \quad (G = 6.670 \times 10^{-8} \text{ in cgs units}).$$

If $P$ is the period and $r$ is the distance of a satellite revolving around the planet, the above expression for $M$ gives the mass of the planet. The formula is written on the assumption that the orbit of the planet or satellite is circular, which is only approximately true. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Uniform color scale** *n.* A scale wherein the units of color difference that are judged to be equal have equal scale differences. McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Uniform color space** Three-dimensional space wherein all pairs of colors, judged to be equally different, are separated by nearly equal distances.

**Uniform lightness scale** *n.* A scale wherein the units of lightness that are visually judged to be equal have equal scale values, and the lightness differences judged to be equal are represented by equal scale differences.

**Uniformly accelerated rectilinear motion** *n.* If $v_0$ is the initial velocity, $v_t$, the velocity after time $t$, the acceleration is

$$a = \frac{v_t - v_0}{t}.$$

The velocity after time $t$ is

$$v_t = v_0 + at.$$

Space passed over in time $t$ is

$$s = v_0 t + \frac{1}{2}at^2.$$

Velocity after passing over space $s$ is

$$v = \sqrt{v_0^2 + 2as}.$$

Space passed over in the $n$th second is

$$s = v_0 + \frac{1}{2}a(2n - 1).$$

In the above and following similar equations the values of the space, velocity, and acceleration must be substituted in the same system. For space in cm, velocity will be in cm/s and acceleration in cm/s$^2$. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Unimolecular process** *n.* An elementary process in which the probability of collisional deactivation of the activated complex greatly exceeds the probability of its decomposing to form products.

**Union cloth** *n.* A term describing a fabric woven from two or more types of yarn. For example, a union cloth may have a cotton warp and a wool filling.

*Also see combination fabric.*

**Unit** \ˈyü-nət\ [back-formation fr. *unity*] (1570) *n.* Specific magnitude of a quantity, set apart by appropriate definition, which is to serve as a basis of comparison or measurement for other quantities of the same nature.

**Unit, angstrom** \ˈyü-nət ˈaŋ-strəm\.

*See angstrom unit.*

**Unit cell** (1915) *n.* The basic unit for describing the arrangement of atoms in a crystal. The smallest parallelepiped, which can generate the crystal lattice by repeated translations along the axes of the lattice.

**Unit elongation** Syn: *elongation.*

**Unit mold** *n.* A mold designed for quick changing of interchangeable cavities or cavity parts.

**Unit of time** *n.* The fundamental invariable unit of time is the ephemeris second, which is defined as 1/31,556,925.9747 of the tropical year for 1900 January 0$^d$12$^h$ ephemeris time. The ephemeris day is 86,400 ephemeris seconds.

**Unloading valve** *n.* A valve that limits the maximum pressure in a hydraulic line

(or other fluid space) to a desired value by diverting the flow of fluid from a pump to a bypass line.
*See also rupture disk.*

**Unopened staple** *n.* Staple fiber in bunches or clusters in the bale in such a condition that it will not process smoothly through carding and subsequent operations in the spun-yarn plant.

**Unperturbed dimensions** *n.* The dimension of a polymer coil in dilute solution at the theta temperature. Under these conditions, the long-range interactions between segments of the polymer chains, causing the chain to contract, are just balance by solvation forces.

**Unpolarized light** *n.* A bundle of light rays having a common propagation direction but different vibration directions.

**Unrelaxed yarn** *n. See relaxed yarn.*

***Uns-* (*unsym-*)** *adj.* Abbreviation for unsymmetrical, a prefix denoting unsymmetrical disposition of substituents of organic compounds with respect to the carbon skeleton or a functional group. It is usually ignored in alphabetization of compound names.

**Unsaponifiable matter** *n.* That portion of fats and resins which does not react with alkali to form a soap.

**Unsaturated compound** *n.* An organic compound having one or more incidences of two or three bonds between two adjacent atoms, usually carbon or nitrogen atoms, and capable of adding other atoms at such points to reduce it to a single bond, thus becoming saturated. Multiple unsaturation is common, as in dienes, aromatics, oils, and fats.

**Unsaturated hydrocarbon** *n.* A hydrocarbon with one or more multiple bonds.

**Unsaturated polyester** *See polyester, unsaturated.*

**Unsaturated solution** *n.* A solution in which the concentration of solute is less than its solubility.

**Unsaturation, analysis** *n.* Measurement of unsaturated bonds and conjugation; e.g. ultraviolet spectroscopy.

**Unwind unit (unwind)** *n.* (1) In plastics coating and film laminating, a stand or a driven machine holding a roll of the substrate to be coated or laminated and supplying the web to the coating equipment at the rate and tension needed. (2) In molding from continuous prepreg, a similar units as in (1) but sometimes including additional functions.

**Unzipping** *n.* The fast reversal of polymerization, with release of monomer that can occur in addition to homopolymers once a stable end group has been removed. Copolymerization helps to minimize unzipping. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**UP** *n.* Abbreviation used by the British Standards Institution for unsaturated polyester. *See polyester, unsaturated.*

**Up-and-down method (staircase method)** *n.* A testing protocol sometimes used to estimate the average value of a property that, with limited resources for testing, must be tested at discrete levels of experimental factors, such as temperature or impact energy, that are strong determinants of the property. One specimen is tested at level A of the factor and passes or fails. If passes, the factor intensity is raised to level B, significantly higher than A, and the test is repeated with a new specimen. (If it fails at level A, intensity is lowered.) If it passes at level B, intensity is again raised, to level C. When it eventually fails, the level is reduced one level, and so on, until the allotted number of specimens has been tested. This procedure has been used in determining brittleness temperature and in several impact tests. The method is fairly efficient at determining the average sought; but at the expense of standard deviation.

**Updraft metier** *n.* A dry spinning machine in which the air flow within the drying cabinet is countercurrent to the yarn path (upward).

**Upper critical solution temperature** *n.* The maximum temperature for phase separation of polymer–solvent solutions to occur (Flory–Huggins theory); also, phase separation occurs when the temperature is raised until a lower critical solution temperature is reached, the phenomenon is explained by the free-volume theories of polymer solutions. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

**Upper Newtonian viscosity ($\mu_{\infty}$)** *n.* The coefficient of viscosity of a fluid at very high-shear rates, where Newtonian behavior is observed, although the fluid is non-Newtonian at lower shear rates. This is often true for polymer melts that have chains that disentangle at shear rates above a critical shear rate.

*See, e.g., Powell–Eyring model.*

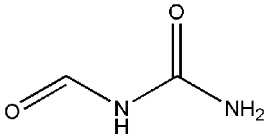
**Upstroke press** *n.* A hydraulic press in which the main ram is situated below the moving table, pressure being applied by an upward movement of the ram.

**Uptwister** *n.* A machine used for twisting yarns in an upward path from a rotating vertical supply package to a horizontal take-up package. Used for spun yarns and to a small extent for adding twist to some filament yarns.

**Uptwisting** *n.* The process of twisting yarn on the uptwister. The yarn to be twisted, which has been wound on a balanced support package, is placed on a revolving spindle. The yarn from the revolving supply package is fed upward through a gathering eye or guide, over a stop motion and a tension bar or bars, through a traversing guide, and onto the revolving collecting package.

**Urea** \yü-ˈrē-ə\ [NL, fr. F *urée*, fr. *urine*] (1806) *n.* $NH_2CONH_2$. Mp, 132°C; Sp gr, 1.323. *n.* A white, crystalline powder derived from the decomposition of ammonium carbonate. It is used in the production of urea–formaldehyde resins. Syn: carbamide.

**Urea–formaldehyde** (1928) *n.* A thermosetting synthetic resin made by condensing urea with formaldehyde. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.



**Urea–formaldehyde foam** *n.* A foam produced by combining a urea–formaldehyde resin with a detergent-type foaming agent under pressure. Upon release of pressure, a foam of about the consistency of shaving cream emerges and cold-cures within 2–4 h. The foam is of low density, noncombustible, and dries within 1–2 days. The dried foam has some resiliency, good thermal-insulation qualities, and is sound-absorbent. Although not recommended for continuous exposure to temperatures above 100°C, the material does not decompose and release gases until heated to a much higher temperature.

**Urea–formaldehyde polymers** *n.* The cheapest synthetic polymer used as bonding elements between faces and core of a laminated structure. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Urea–formaldehyde resins** *n.* Any of a group of resins formed by the interaction of urea and formaldehyde under conditions that include heat and pH control. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

*See amino resin.*

**Urea plastic** *See amino resin.*

**Urea resins** *n.* A synthetic resin made from urea and an aldehyde.

**Urethane** \ˈyür-ə-ˌthān\ [F *uréthane*, fr. *ur-* $^{1}$ur- + *éth-* eth- + *ane*] (1838) *n.* (1) (ethyl carbamate) $H_2NCOOC_2H_5$. This compound may be thought of as urea in which one $-NH_2$ group has been replaced by an ethoxy group, $-OC_2H_5$. Curiously, urethane itself has no direct application in making polyurethanes. (2) A compound of the general structure RHNCOOR′, formed by reaction of an alcohol with an isocyanate, which is (1), above with one of the amino hydrogens replaced by *R* and the ethyl of ethoxy broadened to include the other alkyl or aryl radicals. (3) A chain unit in polyurethanes, – RHNCOOR′ – which is formed by the reaction of a diol and an isocyanate. (4) Shorthand substitute forpolyurethane. Mp, 48–50°C; bp, 182–184°C. Syn: ethyl carbamate, urethan, and ethyl urethane.

**Urethane coating** *n.* Coating vehicles containing a polyisocyanate monomer reacted in such a manner as to yield polymers containing any ratio, proportion or combination of urethane linkages, active isocyanate groups or polyisocyanate monomer. The reaction products may contain excess isocyanate groups available for further reaction at time of application or may contain essentially no free isocyanate as supplied. ASTM (www.astm.org) has designated five types of urethane coatings. *Type I* is a one-component system modified with a drying oil such as linseed or soya, which reacts with oxygen from the air to affect cure, used in wood finishes. *Type II* is based on isocyanate-terminated prepolymers in a solvent that dries by evaporation and cures by reaction with moisture in the air. It is used for coating wood, rubber, and leather. *Type III* is based on a blocked isocyanate, a polyester, a curing agent, and a suitable solvent. The applied coating is heated to effect curing. It is used for wire covering and industrial finishes. *Type IV* is a two-component system, one having a prepolymers made from a diisocyanate and a polyol, the other being a catalyst such as a tertiary amine. It is used for heavy-duty industrial finishes with good resistance to chemicals, abrasion, and corrosion. *Type V* is also a two-component system, one being a polyisocyanate (usually an adduct of a diisocyanate and trimethylolpropane) and the other being a polyol, in solvents that evaporate after application of the coating. The reaction proceeds at ambient temperatures without the aid of a catalyst. It is used as a high-performance industrial coating. Klempner D, Frisch KC (2001) Advances in urethane science and technology. Rapra Technology Ltd., UK. James F Carley (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., USA.

**Urethane foams** *n.* Urethane in the form of rigid foam displays superior thermal insulating qualities, hard degree of hardness, mar resistance, flexibility, and good chemical resistance, when used as a coating resin. Urethane foams consist of about two-thirds of polyol. This allows urethane foams to produce pyrolysis products similar to those of diol or triol.

*See polyurethane foam.*

**Urethane-imide modified foam** *See polyurethane-imide modified foam.*

**Urethane plastic** *See polyurethane and polyurethane foam.*

**Urshiol** *n.* Hydroxy acid of aromatic type present in *Rhus vernicifera*, the basis of Japanese lacquer.

**Urushi** Japanese word for lacquer.

**Urushiol** \yú-ˈrü-shē-ˌól, ú-ˈ, -ˌōl\ [ISV, fr. Japanese *urushi* lacquer + ISV *¹-ol*] (1908) *n.* A mixture of pyrocatechol derivatives with saturated or unsaturated side chains of 15 or 17 carbon atoms that is an oily toxic irritant principle present in poison ivy and some related plants (genus *Rhus*) and in oriental lacquers derived from such plants. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, Conshohocken, PA, 2001.

**Urushi-ye (Japanese)** *n.* A print for which lacquer is used to intensify the color. The term is generally employed to describe only the early hand-colored prints in which lacquers, colors, and metallic rust were applied to the printed black outline. Gair A (1996) Artist's manual. Chronicle Books LLC, San Francisco. Mayer R, Sheehan S (1991) Artist's handbook of materials and techniques. Viking Adult, New York.

**Urylon** *n.* Poly(non-amethylene urea), manufactured by Tokyo, Japan.

**Usable life** *See pot life.*

**Useful life** *n.* The length of time the coating is expected to remain in service.

**USA gallon** *See gallon, USA*

**Uster tester** *n.* An instrument that provides a continuous measurement of the variation in weight per unit length of sliver, roving, and yarn.

**u, v** *n.* Chromaticity coordinates in one of the CIE Uniform Color Spacings (1964).

**UV** *n.* Abbreviation for ultraviolet radiation. *See ultraviolet.*

**UV absorbers** *n.* Polymer additives that absorb light in the UV region or that trap radicals produced in fiber during photo-oxidation. They provide stabilization against actinic degradation. Some critical applications include geotextiles, recreational surface polymers and fibers, tenting tarpaulins, etc. Fouassier .J-P (1995) Photoinitiation, photopolymerization and photocuring Hanser–Gardner Publications, New York.

**UV stabilizers** *n.* Additives which do not actually absorb UV radiation but protect the polymer in some other manner are called ultraviolet stabilizers. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

# V

**v** \ˈvē\ (15c) *n.* (1) Symbol for velocity.

**V** (1) SI abbreviation for volt. (2) Chemical symbol for the element vanadium. (3) Symbol for system volume.

**Vacancy** \ˈvā-kən(t)-sē\ (1599) *n.* A lattice point in a crystal at which a particle is missing.

**Vacations** *See holidays.*

**Vacuum bag molding** *See bag molding.*

**Vacuum calibration** Syn: vacuum sizing.

**Vacuum casting** *n.* A method used for casting fluid thermosetting resins to avoid inclusions of air bubbles. The mold is placed in a vacuum chamber and filled with resin from an external hopper. Vacuum is applied to pull out bubbles, held until they have all risen to the surface, then released. Curing follows.

**Vacuum filter** Filtering system in which filtrate is removed by application of a vacuum.

**Vacuum forming** (straight vacuum forming) *n.* Process in which heated thermoplastic sheets are converted to other configurations by causing them to flow into molds with application of a vacuum. The simplest, original technique of sheet thermoforming.

**Vacuum impregnating** *n.* The process of impregnating electrical components by subjecting the parts to a moderate vacuum to remove air and other volatiles, introducing the impregnant to penetrate the parts, then releasing the vacuum and curing. Epoxy, phenolic, and polyester resins are often used.

*See also potting and encapsulation.*

**Vacuum metalizing** *n.* (1) A decorating process used to make plastic objects resemble shiny metals by depositing very small thicknesses of metals on plastics and films. The process consists of cleaning the surface of the object to be coated followed by placing it in a vacuum chamber where the metal is vaporized or cathode-sputtered to produce vapor that condenses on the surface of the object. A thin film of lacquer or other coating is usually applied to the metallized surface to protect the luster of the coating. Madox DM (1998) Handbook of physical vapor deposition (PVD) processing. Noyes Data Corporation, New York.

**Vacuum molding** *n.* This type of molding is used to mold fiberglass-reinforced plastics. The method allows molding without high temperatures and pressures. In this technique, layers of reinforced media are applied to the mold by hand. Resin is either sprayed or brushed on after each layer is positioned. The flexible sheet (usually cellophane or polyvinyl acetate) is placed over the lay up. Joints and seals are sealed and a vacuum causes the bag to collapse over the face of the product not contacting the mold. The resultant pressure tends to eliminate voids and forces out any excess resin or entrapped air. Madox DM (1998) Handbook of physical vapor deposition (PVD) processing. Noyes Data Corporation, New York.

**Vacuum–pressure impregnation** *n.* Method for the commercial impregnation of electrical equipment with insulating varnish. It consists in first subjecting the equipment to a vacuum in order to remove as much occluded air as possible, permitting the varnish to enter also under vacuum to replace the air, and finally reducing the vacuum and applying pressure in order to assist the somewhat viscous varnish through the narrow interstices left between the fine windings, etc.

**Vacuum venting** *n.* The drawing of a vacuum on the cavity of an injected (or other) mold in order to eliminate molding defects such as short shots, voids and, particularly, burned spots (*dieseling*). The vacuum may be drawn by means of tubes leading to vents to sharp corners, blind holds, etc. In one implementation of the concept, the entire mold is enclosed in a vacuum-tight box with a parting line coplanar with that of the mold, its mating surfaces sealed by O-rings.

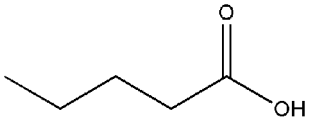
**Valance** \ˈva-lən(t)s, ˈvā\ [ME *vallance*, perhaps fr. *Valence*, France] (15c) *n.* (1) In ionic chemical bonding, the property of an element that is measured by the number of atoms of hydrogen (or its equivalent) that one atom of the element can hold in combination if negative, or can displace in a reaction if positive. Many elements have more than one valence, corresponding to lower and higher states of oxidation or reduction. In covalent bonding, valance number of outermost-shell electrons that an element has available for sharing with other elements. (2) Short drapery at top of a window. A decorative frame used to conceal the top of curtains and fixtures. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Valence electrons** *n.* Electrons which are gained, lost, or shared in a chemical reaction.

**Valence shell** *n.* The shell of electrons with the highest principal quantum number *n* in an atom.

**Valerian** \və-ˈlir-ē-ən\ [ME, fr. MF or ML; MF *valeriane*, fr. ML*vaeriana*] *n.* Any of a genus (*valeriana* of the family valerianaceae, the valerian family) of perennial herbs many of which possess medicinal properties. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR.

**Valeric acid** \və-ˈlir-ik¯\ pentanoic acid [*valerian; fr.* Its occurrence in the roof of valerian] (1857) *n.* Any of four isomeric fatty acids or a mixture of these; a liquid acid of disagreeable odor obtained from valerian or made synthetically and used in organic synthesis (*See image*).



**Valley printing** (inlay printing) *n.* A printing process for flat plastic surfaces in which ink is applied to the raised portions of an embossing roll that simultaneously embosses the plastic surface and deposits ink in the valleys of the embossed surface. The process is similar to flexographic heating in that both print from raised portions of a cylinder.

**Value** \ˈval-(ˌ)yü\ [ME, fr. MF, fr. (assumed) VL *valuta*, fr. feminine of *valutus*, pp of L *valēre* to be worth, be strong] (14c) (color value) *n.* The lightness of a color. A color may be classified as equivalent to some member of a series of shades ranging from black (the zero-value member) to white. The other two fundamental characterizers of color are *hue* and *saturation.*

**Value extrusion** *n.* An extrusion operation in which melt pressure and, to a lesser extent, throughput are controlled by an adjustable value. For example, when a screen pack is used to remove foreign matter from the melt stream, a valve may be inserted between the screen pack and the die.

**Value, munsell** *See munsell value.*

**Vanadium** \və-ˈnā-dē-əm\ [NL, fr. ON *Vanadīs* Freya] (1833) *n.* A grayish malleable ductile metallic element found combined in minerals and used especially to form alloys.

**Vanadium driers** *n.* Group of rather dark-colored driers, based on soluble vanadium salts, which are fairly strong surface-drying catalysts.

**van der Waals equation *np* and free volume effects** \ˈvan-dər-ˌwólz-\ *n.* The van der Waals equation is expressed as:

$$\left(p+\frac{a}{\upsilon^2}\right)(\upsilon-b)=RT.$$

It makes allowance both for the volume occupied by the molecules and for the attractive force between the molecules; *b* is the effective volume of molecules in 1 mol of gas; and *a* is a measure of the attractive force between the molecules. For values of *R*, *a*, and *b* see a table of van der Waal's constants for gases in Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL.

**van der Waals forces** [Johannes D. *van der Waals* † 1923 Dutch physicist] (1926) (secondary valence force, intermolecular force) *np.* An attractive force, much weaker than primary covalence bonds, between molecules of a substance in which all the primary valences are saturated. They are believed to arise mainly from the *dispersion effect*, in which temporary dipoles induce other dipoles in phase with themselves. The primary van der Waals forces are *dipole–dipole* (polar molecules) and *London forces* (nonpolar molecules). These forces are attributed to the attractions between molecules and from non-covalent bonds. Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York.

**Vandyke brown** \van-ˈdīk ˈbraún\ [fr. its use by the painter Vandyke] (ca. 1850) *n.* (1) A very dark, deep-brown natural earth pigment consisting essentially or organic matter obtained from peat or lignite found chiefly in parts of Germany; its principal uses are in artists' colors, stains and graining. (2) A synthetic pigment of similar color.
*Also called cassel brown and cassel earth.*

**van't Hoff's principle** \vänt-ˈhóf\ [Jaobus Hen.dri.cus *van't Hoff*, 1852–1911, D physical chemist] *np.* If the temperature of interacting substances in equilibrium is raised, the equilibrium concentrations of the reaction are changed so that the products of that reaction which absorb heat are increased in quantity, or if the temperature for such equilibrium is lowered, the products which evolve heat in their formation are increased in amounts. Lide DR (ed) (2004) Handbook of chemistry and physics. CRC Press, Boca Raton, FL. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL.

**Vapor** \ˈvā-pər\ [ME *vapour*, fr. MF *vapeur*, fr. L *vapor* steam, vapor] (14c) *n.* As most frequently used, the term vapor means a substance that, although present in the gaseous phase, generally has a stable liquid or solid state at ambient temperature. *Gas*, on the other hand, is used for substances that do not have stable liquid or solid states at ambient conditions. Thus, we speak of *water vapor* but *oxygen* and *nitrogen gases* in the atmosphere.

**Vapor barrier** (ca. 1941) *n.* A moisture-impervious layer or coating (such as special paint, or a membrane on roofing felt or on building paper) that prevents the passage of moisture of vapor into a material or structure.

**Vapor degreaser** *n.* An apparatus in which metal surfaces are cleaned by solvent vapors.

**Vapor degreasing** *n.* A process of removing grease from parts and equipment components by suspending them with a closed chamber over a pool of boiling, nonflammable solvent such as a mixture of chlorofluorinated hydrocarbons.

**Vapor–liquid chromatography** *See chromatography.*

**Vapor permeability** *n.* That characteristic of a material, which permits the passage of a vapor or gas. The permeability is measured under carefully specified conditions, such as total pressure, partial pressure on the two sides of the specimen, temperature, and relative humidity. As the fibers of a material such as paper have such a high affinity for water (vapor), vapor permeability should not be confused with air permeability or porosity.

**Vapor pressure** (1875) *n.* The pressure of the vapor phase when a solid or liquid is in equilibrium with its vapor. Vapor pressure increases exponentially with absolute temperature at a rate that is unique for each pure substance and closely related to its heat of vaporization. In homologous organic compounds, vapor pressure at any temperature decreases with increasing molecular weight. The term has little meaning for plastics because of high polymers decompose before evaporating. The relative vapor pressure density of solvents is given by the following equation:

$$d_{vp} = \frac{M_s}{M_{air}},$$

where $M_s$ is the molecular weight solvent and $M_{air}$ is the molecular weight of air. The vapor density increases with molecular weight of solvent. The Clausius–Clapeyron equation (Wypych, 2001) gives the relationship between molecular weight of solvent and vapor pressure:

$$\frac{\mathrm{d}\ln p}{\mathrm{d}T} = \frac{M\Lambda}{RT^2},$$

where $p$ is the vapor pressure, $T$ the temperature, $M$ the molecular weight of solvent, $\Lambda$ the heat of vaporization, and $R$ is the gas constant. Vapor pressure at any temperature can be estimated by use of the Antoine equation (Wypych, 2001):

$$\log p = A - \frac{B}{C + T},$$

where $p$ is the vapor pressure of solvent and $A$, $B$, and $C$ are constants. Vapor pressure of a solvent increases with temperature. $A$, $B$, and $C$ constants and vapor pressures of many pure substances at a temperature, are plotted "log $P$ vs. $1/T$", where $P$ is the vapor pressure (mmHg) of a solvent, $T$ the temperature (K), and developed the equation,

$$\log\ P = m\frac{1}{T} + b$$

and

$$m = \frac{-\Delta H_{vap}}{2.303\ R},$$

where $m$ is the molar heat of vaporization, $\Delta H_{vap}$ the heat to vaporize 1 mol of solvent or liquid to from an ideal gas at one atmosphere pressure, and $R$ is the ideal gas constant. This form of the Clausius–Claperon equation is useful for determining $\Delta H_{vap}$ when the vapor pressure is known at two different temperatures; the vapor pressure at a given temperature if $\Delta H_{vap}$ is known and if the vapor pressure is known at another temperature; and the temperature at which a liquid has a given vapor pressure if $\Delta H_{vap}$ and the vapor pressure at one temperature are known. Barrow (1973) expressed the Clausius–Claperon equation as

$$\frac{\mathrm{d}(\ln\ P)}{\mathrm{d}T} = \frac{\Delta H_{vap}}{RT^2}$$

and

$$\frac{\mathrm{d}(\ln\ P)}{\mathrm{d}(1/T) = -\frac{\Delta H_{vap}}{R}},$$

and the integrated form

$$\log\ P = -\frac{\Delta H_{vap}}{2.303\ R}\frac{1}{T} + \text{constant}.$$

Mixtures of miscible solvents have limited predictability using Raoult's law:

$$p_{12} = m_1 p_1 + (1 - m_1) p,$$

where $p_{12}$ is the vapor pressure of mixture, $m_1$ the molar fraction of component 1, and $p_1$, $p_2$ are the vapor pressures of the components 1 and 2. Lide DR (ed) (2004) Handbook of chemistry and physics. CRC Press, Boca Raton, FL. Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York.

**Vapor–pressure lowering** *n.* One of the colligative properties of a solution and the basis of a method for determination of the molecular mass of a solute. For a dilute solution, the solvent vapor pressure lowering is determined by $(p_0 - p)/p_0 = x_2$, where $p_0$ and $p$ are the vapor pressures of the pure solvent and the solution, respectively, and $x_2$ is the mole fraction of the solute.

**Vapor–pressure osmometer** *n.* An instrument for determining number-average molecular weight of a polymer utilizing the "vapor pressure versus molecular weight relationship."

**Vapor transmission** *n.* If the vapor is not otherwise identified, this phase is understood to mean water–vapor transmission rate.

**Varnish** \ˈvär-nish\ [ME *vernisch*, fr. MF *vernis*, fr. OIt or ML; OIt *vernice*, fr. ML *veronic-*, *veronix* sandarac] (14c) *n.* (1) A liquid composition which is converted to a transparent solid film after application as a thin layer. *Bituminous* – A dark colored varnish containing bituminous ingredients. The varnish may be either of the oil or spirit type. *Oil* – A varnish which contains resin and drying oil as the basic film-forming ingredients and is converted to a solid film primarily by chemical reaction. *Spar* – A varnish for exterior surfaces. The name originates from its use on spars of ships. *Spirit* – A varnish which is converted to a solid film, primarily by solvent evaporation. (2) In printing ink technology, a broad term including fluid compositions comprising one or more of the following: oils, resins, solvents, driers and waxes; used either as a vehicle or to cover surfaces. Raaf JJ (1967) Dictionary of paint, varnish and lacquer terms. English Language Services Inc., New York. Paint, coatings dictionry, Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978.
*See oil.*

**Varnish remover** *See paint and varnish remover.*

**Varnish stain** *n.* A varnish which is colored with a transparent material, leaving a colored coating on the surface; has less penetrating power than a true stain.
*See stain.*

**Varnish tree** (1758) *n.* Any of various trees yielding a milky juice from which in some cases varnish or lacquer is prepared.

**Vat dyes** *n.* Those dyes, which are insoluble in water, dilute acids and alkaline solutions. Exposure of material dyed with such a color base produces the original colored compound by oxidation.
*See dyes.*

**Vegetable black** *n.* Originally, a sooty product, obtained by burning vegetable oils with restricted air. Most vegetable black today is obtained by burning coal-tar oil.
*See lampblack.*

**Vegetable drying oil** *See drying oil.*

**Vegetable fiber** *n.* A textile fiber of vegetable origin, such as cotton, kapok, jute, ramie, and flax. Wallenberger FT, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Vegetable oil** (1797) *n.* An oil extracted from vegetable matter; especially castor, linseed, safflower, soya, and tung oil; used in paints and plastics.

**Vehicle** \ˈvē-ə-kəl *also* ˈvē-ˌhi-kəl\ [F *véhicule*, fr. L *vehiculum* carriage, conveyance, fr. *vehere* to carry] (1612) *n.* The liquid portion of an ink that holds and carries the pigment and provides workability, and drying properties, and binds the pigment to the substrate after the ink has dried. Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc., New York.

**Veil** \ˈvā(ə)l\. A thin mat of very fine, relatively long fibers used at the outermost layer of a composite in order to improve surface appearance and smoothness. Murphy J (1998) Reinforced plastics handbook. Elsevier Science and Technology Books, New York.

**Veiling** *n.* (1) Formation of a cobweb pattern. (2) Curtaining or sagging. Murphy J (1998) Reinforced plastics handbook. Elsevier Science and Technology Books, New York.

**Velocity** \və-ˈlä-sə-tē\ [MF *velocité*, fr. L *velocitat-*, *velocitas* fr. *veloc-*, *velox* quick; prob. akin to L *vegēre* to enliven] (ca. 1550) *n.* Time rate of motion in a fixed direction. cgs units – one centimeter per second. If *s* is space passed over in time *t*, the velocity,

$$\bar{v} = \frac{s}{t}.$$

Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw Hill Science, New York.

**Velocity gradient** *n.* The change d*v* in relative velocity *v* between parallel planes with respect to the change d*r* in perpendicular distance *r* throughout the depth of material being sheared. Velocity gradient has the same dimensions as rate of shear, which is reciprocal seconds. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York.

**Velocity of a compressional wave** *n.* The velocity of a compressional wave in an elastic medium, in terms of elasticity *E* (bulk modulus) and density *d*,

$$V = \sqrt{\frac{E}{d}}.$$

For the velocity of sound in air, where *p* is the pressure and *d* the density

$$V = \sqrt{\frac{1.4\,p}{d}}.$$

Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL.

**Velocity of a transverse wave** (in a stretched cord) *n.* If *T* is the tension of the cord and *m* the mass per unit length,

$$V = \sqrt{\frac{T}{m}}.$$

**Velocity of a wave** *n.* The velocity of propagation in terms of wavelength *λ* and the period *T* or frequency *n* is

$$V = \frac{\lambda}{T} = n\lambda.$$

**Velocity of efflux of a liquid** *n.* If *h* is the distance from the opening to the free surface of the liquid, the velocity of efflux is

$$V = \sqrt{2gh}.$$

The above is the theoretical discharge velocity disregarding friction and the shape of orifice. For water issuing through a circular opening with sharp edges of area, *A*, the volume discharged per second is given approximately by

$$Q = 0.62\,A\sqrt{2gh}.$$

**Velocity of sound, variation with temperature** *n.* The velocity is in m/s at any temperature $t$ in °C is given approximately by

$$V = V_0\sqrt{1 + \frac{t}{273}},$$

$$V = 331.5 + 0.607t.$$

The *variation with humidity* is given by the equation

$$V_d\,V_h\sqrt{1 - \frac{e}{p}\left(\frac{\gamma_w}{\gamma_a} - \frac{5}{8}\right)},$$

where $V_d$ is the velocity in dry air, $V_h$ that in air at barometric pressure $p$ in which the pressure of water vapor is $e$. $\gamma_w$ and $\gamma_a$ are the specific heat ratios for water vapor and for air, respectively. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL.

**Velocity of water waves** *n.* If the depth $h$ is small compared with the wavelength, then the velocity is

$$V = \sqrt{gh}.$$

In deep water for a wavelength $\lambda$,

$$V = \sqrt{\frac{g\lambda}{2\pi}}.$$

If the wavelength is very small less than about 1.6 cm, the velocity increases as the wavelength decreases and is expressed by the following

$$V = \sqrt{\frac{2\pi T}{\lambda d} + \frac{g\lambda}{2\pi}},$$

where $T$ is the surface tension and $d$ the density of the liquid $V$ will be given in cm/s if $h$ and $\lambda$ are in cm, $g$ in cm/s$^2$, $T$ in dyne/cm and $d$ in g/cm$^3$. Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL.

**Velocity profile** *n.* A profile of the fluid velocity in a stream at various points along a coordinate direction perpendicular to the flow and in which direction the velocity is changing most sharply. This graph has the form of a parabola for a Newtonian liquid in laminar flow through a circular tube. For pseudoplastic liquids (polymer melts), the curve is a parabola of higher degree, usually 2.25–4 (instead of 2.0), rising more rapidly near the tube wall and flattening near the center. For a pure drag flow between parallel surfaces, the profile is linear regardless of the type of fluid. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.

**Velour** \və-ˈlúr\ [F *velours* velvet, velour, fr. MF *velours*, *velour*, fr. OF *velous*, fr. L *villosus* shaggy, fr. *villus* shaggy hair] (ca. 1706) *n.* (1) Generally, a soft, closely woven fabric with a short, thick pile, weighting about 10–20 ounces per yard and made in a plain or satin weave. Velour is usually made of cotton or wool, or with a cotton warp in wool, silk, or mohair velour. It is also made in blends of spun manufactured fiber and wool. Velours are used for coats, draperies, upholstery, powder puffs, and other pile items. (2) A felt with velvet-like texture used for men's and women's hats. Complete textile glossary. Celanese Corporation, Three Park Avenue, New York.

**Velvet carpet** *n.* A woven carpet in which the pile ends are lifted over wires that are inserted in the same manner as the filling and that cut the pile as they are withdrawn.

**Velveteen** \ˌvel-və-ˈtēn\ (1776) *n.* A fabric with a low filling pile made by cutting an extra set of filling yarns woven in a float formation and bound to the back of the material at intervals by weaving over and under one or more warp ends. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Velvet fabric** *n.* A warp-pile woven fabric with short, dense cut pile that produces a rich fabric appearance and soft texture. Two methods are used for weaving velvets. In the double-cloth method, two fabrics are woven face to face with the pile ends interlocking. A reciprocating knife cuts through these pile ends to produce two separate pieces of velvet. In the second method, pile ends are lifted over cutting wires that are inserted with the filling and that are withdrawn to cut the pile. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Veneer** \və-ˈnir\ [Gr *Furnier*, fr. *furnieren* to veneer, fr. F *fournir* to finish, equip] (1702) *n.* Thin finishing or surface layer of fine wood, laminated plastic, formica or the like, bonded to a substrate. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York. Hoadley RB (2000) Understanding wood. The Taunton Press, Newtown, CT.

**Veneer plywood** *n.* Plywood which is faced with a decorative wood veneer.

**Venetian glass** \ və-ˈnē-shən-\ {*often capitalized V*} (ca. 1845) *n.* An often colored glassware made at Murano near Venice of a soda-lime metal and typically elaborately decorated with gilt, enamel, or engraving.

**Venetian mosaic** \-mō-ˈzā-ik\. *See terrazzo.*

V

**Venetian red** (ca. 1753) *n.* Chemically prepared oxide of iron, red pigment, made by calcining hydrated lime and ferrous sulfate, varies in tinting strength according to the amount of ferric oxide.

**Venetian window** *n.* A window with one large fixed central pane and smaller panes at each side.

**Venice turpentine** *n.* Same as larch turpentine, the oleoresin of the European larch tree (*Larix europea* or *Larix deciduas*). The term is also now used widely to describe the clear yellow liquid portion of pine oleoresin, or a synthetic product of similar composition made by dissolving rosin in a terpene solvent.

**Vent** *See air vent.*

**Vented extruder** *See extruder, vented.*

**Venturi cooling ring** *n.* A design of air-cooling ring for blown-film extrusion in which a slot around the inside of the ring and near the bottom injects air vertically upward at high velocity. This not only cools the bubble but also, by lowering air pressure between the bubble and the annular jet, helps to quickly expand the bubble and stabilize its position and movement.

**Verdigris** \ˈvər-də-ˌgrēs\ [ME *vertegrez*, fr. OF *vert de Grice*, literally, green of Greece] (14c) *n.* $Cu(C_2H_3O_2)_2{\cdot}2Cu(OH)_2$. (1) The dibasic acetate of copper, which is a greenish blue, crystalline powder with an acetic odor. Used as a pigment. (2) The blue or green corrosion products, which form the patina on copper, brass, or bronze upon weathering. Syn: aerugo.

**Verditer** Basic copper carbonate.

**Vergeboard** *See bargeboard.*

**Vermiculite** \(ˌ)vər-ˈmi-kyə-ˌlīt\ [L *vermiculus* little worm] (1824) *n.* Hydrated magnesium–aluminum–iron silicate capable of expanding 6–20 times the volume of the unexpanded mineral when heated to about 1,100°C; the platelets exhibit an active curling movement when heated, hence the name. The expanded material is sometimes used as a density-reducing filler in plastics.

**Vermiculus** *See mercuric sulfide.*

**Vermillion (vermilion)** \vər-ˈmil-yən\ [ME *vermilioun*, fr. OF *vermeillon*, fr. *vermeil*, adj., bright red, vermilion, fr. LL *vermiculus* kermes, fr. L, little worm] (13c) *n.* A red mineral pigment consisting of a sulfide of mercury.

*See mercuric sulfide.*

**Versamid®** *n.* Group of "polymerized" vegetable oils whose ester groups are converted with di- and tramlines. Manufactured by General Mills, USA.

**Vert emeraude (dull)** *n. See chromium oxide green.*

**Vertical extruder** *n.* An extruder arranged so that the barrel is vertical and extrusion is usually downward or upward.

**Vertical flame test** *See flammability tests.*

**Vertical grain** *See edge grain.*

**Vertical pattern** *n.* A spray pattern whose longest dimension is vertical.

**Very-low-density polyethylene (VLDPE)** *n.* Any polymer of ethylene with some higher-olefin content, in the density range from 0.90 to 0.915 g/cm$^3$, produced by the Union Carbide gas-phase process (Flexomer®). The materials have low moduli, with properties between those of low-density polyethylene and ethylene-propylene rubbers. They are useful for stretchable films.

*See also ultra-low-density polyethylene.*

**Vestamides** *n.* Various nylon grades, manufactured by Hüls, Germany.

**Vestan** *n.* Polycondensate from terephthalic acid and 1,4-dimethylol cyclohexane, manufactured by Hüs, Germany.

**Vestolen A** *n.* Low-pressure poly(ethylene), manufactured by Hüls, Germany.

**Vestolen P** *n.* Poly(propylene), manufactured by Hüls, Germany.

**Vestolit** *n.* Poly(vinyl chloride), manufactured by Hüls, Germany.

**Vestopal** *n.* Unsaturated polyester, dissolved in styrene, manufactured by Hüls, Germany.

**Vestoran** *n.* Vinylchloride–vinyl acetate co-polymer, manufactured by Hüls, Germany.

**Vestyron** *n.* Poly(styrene), manufactured by Hüls, Germany.

**VF** Vulcan fiber.

**$VF_2$/HFP** *n.* Abbreviation for vinylidene fluoride–hexafluoro-propylene co-polymer.

**$\upsilon_i$** Symbol for volume fraction of component *i* in a blend or composite; or for a velocity component in the *i*-direction.

**Viable** \ˈvī-ə-bəl\ [F, fr. MF, fr. *vie* life, fr. L *vita*] (ca. 1832) *adj.* Living; able to germinate or grow.

**Vibrathane** *n.* Polyurethane elastomer, manufactured by Naugatuck, USA.

**Vibration modes** Vibrational energy due to change in length and angle in the molecule.

**Vibration welding** A joining method in which two plastic parts are pressed together and one is vibrated through a small angular displacement in the plane of the joint. The frictional heat so generated melts the plastic at the interface. Vibration is stopped and pressure and alignment are maintained until the joint freezes.

**Vibratory feeder** *n.* A device for conveying dry materials from storage hoppers to processing machines, comprising a tray or tube vibrated by mechanical or electrical pulses. The frequency and amplitude of vibration control the rate of transport.

**Vibroscope** *n.* An instrument for determining the mass per unit length of a fiber.

**Vicara** *n.* Albumin fiber, manufactured by Virginia–Carolina Chemical, USA.

**Vicat test** *n.* A test for determining softness of a polymer at temperature; an indentor under fixed load will penetrate a specified distance into the material.

**Vicat softening point** *n.* The temperature at which a flat-nosed needle of 1-mm$^2$ circular cross section penetrates a thermoplastic specimen to a depth of 1 mm under a specified load using a uniform rate of temperature rise (www.astm.org). This test is used for thermoplastics such as vinyls, polystyrene, acrylic, and cellulosics that have no definite melting ranges.

**Vicinal** *adj.* Description of substitution on the same atom (e.g., 1,1-choro-) compared to geminal substitution (e.g., chloro-).

**Vickers hardness** *n.* A test similar to that of brinell hardness using an indenter in the form of a square-based diamond pyramid, with a vertex angle of 136° between the opposite faces. The result is expressed as the applied load divided by the projected area of the impression.

**Viewing angle** *n.* The angle between the viewing ray and a normal to the surface at the point of incidence.

*Also called observation angle.*

**Viewing geometry** *n.* The geometry by which the incident illumination is projected onto the sample and by which the observed light is collected and transmitted to the detector.

*See angle of incidence, angle of viewing, and angle of reflection.*

**Viewing ray** *n.* The line connecting the point of incidence on the surface and the center of the receptor entrance stop.

**Vinal** \ˈvī-ˌnal\ [poly*vin*yl *al*cohol] (ca. 1939) *n.* Generic name for a manufactured fiber in which the fiber-forming substance in any long-chain synthetic polymer is composed of at least 50% by weight of vinyl alcohol units (–$CH_2CHOH$–), and in which the total of the vinyl alcohol units and any one or more of the various acetal units is at least 85% by weight of the fiber.

**Vinal fiber** *n.* A manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 50% by weight of vinyl alcohol units and in which the total of the vinyl alcohol units and any one or more of the various acetal units is at least 85% by weight of the fiber (FTC definition). Vinal fibers show good chemical resistance but soften at comparatively low temperatures. Vinal fibers are used for apparel, industrial goods, and fishnets.

**Vine black** *n.* Intense blue-black pigment made by the partial burning of vine cuttings.

**Vinidur** *n.* Poly(vinyl chloride) film, manufactured by BASF, Germany.

**Vinnipas** *n.* Poly(vinyl acetate), manufactured by Wacker, Germany.

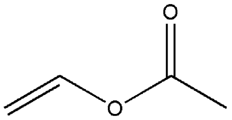
**Vinnol** *n.* Poly(vinyl chloride), manufactured by Wacker, Germany.

**Vinoflex** Vinyl chloride/vinyl ether copolymer, manufactured by BASF, Germany.

**Vintahite** *See gilsonite.*

**Vinyl** \ˈvī-nᵊl\ [ISV, fr. L *vinum* wind] (1863) *n.* The unsaturated, univalent radical $CH_2$:CH– derived from ethylene which is the basis for all vinyl plastics. The name vinyl is used when the open bond is filled by anything but H (ethene) or a hydrocarbon radical (olefin).

**Vinyl acetate** *n.* $H_2C{=}COOCH_3$. A colorless liquid obtained by the reaction of acetylene and acetic acid in the presence of a catalyst such as mercuric oxide (*See image*).

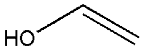


It is the monomer for polyvinyl acetate, and a co-monomer and intermediate for many members of the vinyl plastics family.

**Vinyl acetate plastics** *n.* Plastics based on resins made by the polymerization of vinyl acetate or co-polymerization of vinyl acetate with other unsaturated compounds, the vinyl acetate being in greatest amount by mass.

*See polyvinyl acetate.*

**Vinyl alcohol** (1873) (ethanol) *n.* $H_2C{=}CHOH$. A conceptual compound, the theoretical monomer of polyvinyl alcohol but unknown in the free state. All attempts to synthesize it have led instead to its tautomer, acetaldehyde ($CH_3CHO$) (*See image*).

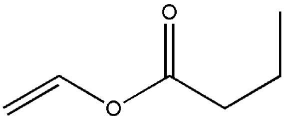


**Vinyl alcohol plastic** *See polyvinyl alcohol.*

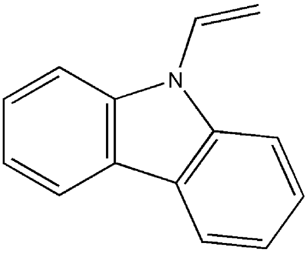
**Vinylation** *n.* The process of forming a vinyl derivative by reaction of alcohols, amines, or phenols with acetylene. Such derivatives are intermediates for polymers.

**Vinyl Benzene** *See styrene.*

**Vinyl butyrate** *n.* $CH_2{=}CHOOC_3H_7$. A volatile liquid monomer for polymers used in water-based paints (*See image*).

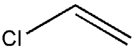


**9-Vinylcarbazole** (*N*-vinylcarbazole) *n.* A tricyclic tertiary amine, $H_2C{=}CHN(C_6H_4)_2$, with the structure shown below (*See image*).



This monomer, derived from acetylene and carbazole, is used in the production of poly (*n*-vinylcarbazole).

**Vinyl chloride** (1872) (chlorethylene, chloroethene, VC) *n.* $H_2C{=}CCl$. A colorless gas at normal temperatures and pressures that boils at −13.9°C, made by reacting ethylene with chlorine or hydrogen chloride to obtain ethylene dichloride, which is cracked to form vinyl chloride (*See image*).



Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Vinyl chloride–ethylene co-polymer** *n.* Any co-polymer of vinyl chloride with small percentages of ethylene. These resins possess superior heat stability and hot strength, and require lesser amounts of impact modifiers to achieve satisfactory impact strength than does straight PVC homopolymer. They are useful in producing films and bottles for packaging, since their better heat stability provides more latitude in selecting nontoxic stabilizers.

**Vinyl chloride plastics** *n.* These are plastics based on reins prepared by the polymerization of vinyl chloride or co-polymerization of vinyl chloride with other unsaturated compounds, vinyl chloride being in greatest amount by mass. Wickson EJ (ed) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

*See polyvinyl chloride.*

**Vinyl coating** *n.* One in which the major portion of binder is of the vinyl resin family.

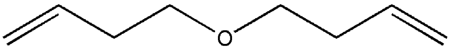
**Vinyl cyanide** *See acrylonitrile.*

**Vinyl ester resin** *n.* Any of several epoxy-related resins in which the epoxides groups have been replaced by ester groups, typically acrylic. When cured, they have excellent resistance to strong chemicals such as chlorine and caustics.

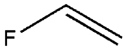
**Vinyl ether** *See vinylethyl ether, vinylisobutyl ether, and vinylmethyl ether.*

**Vinylethylene** Syn: butadiene.

**Vinylethyl ether** (EVE, ethylvinyl ether) *n.* $H_2C{=}CHOC_2H_5$. A colorless monomer that can be polymerized either in the liquid or gaseous state. In plastics, it is used as a co-monomer and intermediate (*See image*).



**Vinyl fluoride** (fluoroethylene, fluoroethene) *n.* $H_2C{=}CHF$. A colorless gas, the monomer for polyvinyl fluoride (*See image*).



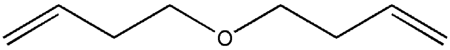
**Vinyl foam** *n.* Although cellular vinyls can be produced by many methods, including mechanical frothing and leaching-out of soluble additives, the most widely used procedure is chemical blowing. From 1 to 2% of a blowing agent such as azobisforamdie is incorporated in a vinyl compound or dispersion, remaining inert until it is decomposed by processing heat to release a gas.

**Vinylformic acid** *See acrylic acid.*

**Vinyl group** The unsaturated univalent radical $CH_2$:CH–.

**Vinylidene** \vī-ˈni-lə-ˌdēn\ [ISV *vinyl* + *-ene*] (1898) *n.* Indicating a bi-substituted ethylene in which both hydrogen atoms on one carbon atom have been replaced, i.e., $H_2C{=}CXY$, or the vinylidene group, $H_2C{=}C{=}$. X and Y are usually the same element.

**Vinylidene chloride** *n.* $CH_2{:}CCl_2$. A monomer. Bp, 37°C. A colorless, volatile liquid that is produced by the dehydrochlorination of 1,1,2-trichloroethane. It is a monomer for polyvinylidene chloride and is a comonomer with vinyl chloride (*see saran*) and other monomers such as acrylonitrile. (*See image*).



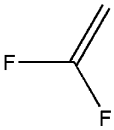
Also known as *1,1-dichloroethylene*

**Vinylidene chloride–acrylonitrile co-polymer** *n.* Any VC co-polymer containing 5–15% acrylonitrile, and mainly used as coatings for cellophane, paper, and films or other polymers. They are comparable with saran in their low permeability to oxygen and carbon dioxide, and have good chemical resistance, toughness, transparency, and heat-sealability. They have also found some applications as low-flammability fibers.

**Vinylidene chloride plastics** *n.* Plastics based on polymer resins made by the polymerization of vinylidene chloride or co-polymerization of vinylidene chloride with other unsaturated compounds, the vinylidene chloride being in the greatest amount by mass.

*See polyvinylidene chloride and saran.*

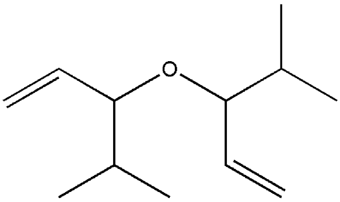
**Vinylidene fluoride** (1,1-difluoroethylene) *n.* $H_2C{=}CF_2$. A colorless, nearly odorless gas prepared by the dehydrohalogenation of 1-chloro1,1-difluoroethane, or by the dehalogenation of 1,2-dichloro-1,1-difluorethane. It polymerizes readily in the presence of free-radical initiators to produce the homopolymer polyvinylidene fluoride, and is also co-polymerized with olefins and other fluorocarbon monomers to make fluorocarbon elastomers. (*See image*).



*See polyvinylidene fluoride*

**Vinylidene fluoride–hexafluoropropylene co-polymer** ($VF_2$/HFP) *n.* Any of a family of chemical- and heat-resistant, vulcanizable elastomers containing 60–85% $VF_2$ (DuPont's Viton® A). Terpolymers with small amounts of tetrafluoroethylene are also available.

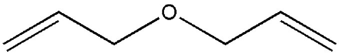
**Vinylisobutyl ether** (isobutylvinyl ether, IVE) *n.* $H_2C{=}CHOCH_2{-}CH(CH_3)_2$. A colorless, flammable liquid used to make polymers and co-polymers used in coatings, adhesives, and lacquers; and modifiers for alkyd resins and polystyrene. (*See image*).



*See polyisobutylvinyl ether*

**Vinylite, vinyon** *n.* Vinyl chloride/vinyl acetate co-polymer, manufactured by Carbide & Carbon Chemical, USA.

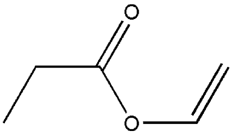
**Vinylmethyl ether** (methyl vinyl ether) *n.* A low-boiling liquid (6°C) or gas, polymerizable to poly(vinylmethyl ether). It is also used as a modifier for alkyd resins and polystyrene (*See image*).



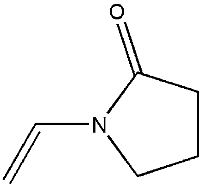
**Vinylon** *n.* Poly(vinyl alcohol) (fiber), manufactured by Synthetic Fiber Manufacturers Group, Japan.

**Vinyl plastics** *n.* Plastics based on resins made from monomers containing th vinyl group, $CH_2{=}CH{-}$.
*See vinyl resin.*

**Vinyl propionate** *n.* A volatile liquid, the monomer for emulsion-paint polymers (*See image*).



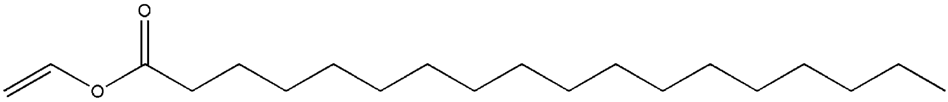
**1-Vinyl-2-pyrrolidone** (*N*-vinyl-2-pyrrolidone) *n.* A cyclic monomer derived from acetylene and formaldehyde, with the structure below (*See image*).



*See poly(1-vinylpyrrolidone).*

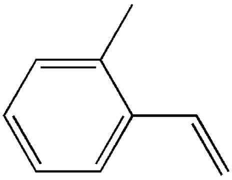
**Vinyl resins** (1934) *n.* According to common chemical nomenclature, all resins and polymers made from monomers containing the vinyl group, $H_2C{=}CHX$. In the chemical literature, polystyrene, polyolefins, polymethyl methacrylate and many other styrenic, ethenic, and acrylic co-polymers are classified as vinyls. In the plastics literature, the above materials are given their own classifications and the term vinyl is restricted to compounds in which X, above, is not H, a hydrocarbon radical, nor an acrylic-type ester. In daily use, the term vinyl plastics refers primarily to polyvinyl chloride and its co-polymers, and secondarily to the following: polyvinyl acetal, polyvinyl acetate, poly-vinyl alcohol, polyvinyl butyral, poly(*n*-vinylcar-bazole), polyvinyl dichloride, polyvinyl formal, polyvinylidene chloride, polyisobutylvinyl ether, and poly (1-vinylpyrrolidone). Mishra MKM, Yagci Y (1998) Handbook of vinyl polymerization. Marcel Dekker, New York.

**Vinyl stearate** *n.* $H_2C{=}CHOOCC_{17}H_{35}$. A white, waxy solid, used as an internal plasticizer by means of co-polymerization at low levels (*See image*).

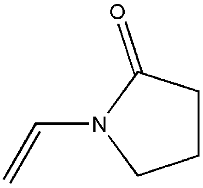


**Vinylstyrene** Syn: divinylbenzene.

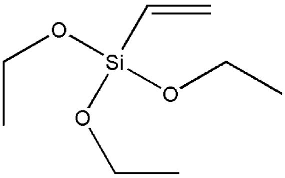
**Vinyltoluene** *n.* $H_2C{=}CHC_6H_4CH_3$. A colorless liquid, the commercial forms comprising a 60:40 mixture of the *m*- and *p*-isomers, used as a solvent and as a polymerizable monomer in place of styrene in the production of polyester resins (*See image*).



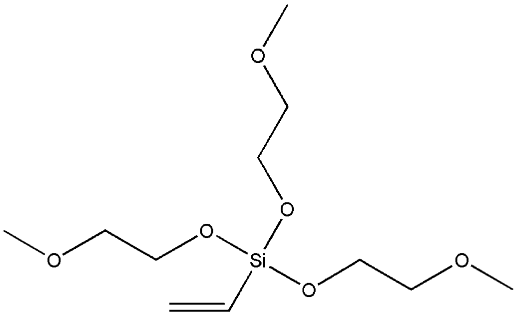
**Vinyltrichlorosilane** *n.* $H_2C{=}CHSiCl_3$. A coupling agent used in glass-reinforced polyesters (*See image*).



**Vinyltriethoxysilane** *n.* $H_2C{=}CHSi(OC_2H_5)_3$. A coupling agent used in glass-reinforced polyesters, polyethylene, and polypropylene (*See image*).



**Vinyl-tris(*β*-methoxyethoxy)silane** *n.* $H_2C{=}CHSi(OCH_3OC_2H_5)_3$. A silane coupling agent used in glass-reinforced polyester and -epoxy structures (*See image*).



**Vinyl wallcoverings** *n.* At present there are six types: (1) vinyl laminated to paper, (2) paper laminated to lightweight woven cloth and vinyl-coated, (3) vinyl laminated to lightweight woven cloth, natural or synthetic, (4) vinyl laminated to lightweight Non-woven cloth, natural or synthetic, (5) vinyl laminated to Non-woven paper/fabric web, and (6) a man-made base impregnated with vinyl. Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York.

**Vinyon** *n.* Generic name for a manufactured fiber in which the fiber forming substance is any long-chain synthetic polymer composed of at least 85% by weight of vinyl chloride units, $–CH_2CHCl–$ (Federal Trade Commission).

**Vinyon fiber** *n.* A manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of vinyl chloride units (FTC definition).

**Virgin material** *n.* Any plastic compound or resin that has not been subjected to use or processing other than that required for its original manufacture.

**Veridian** \və-ˈri-dē-ən\ [L viridis] (1882) *n.* A chrome green that is a hydrated oxide of chromium.

**Viscoelastic** \ˌvis-kō-ə-ˈlas-tik\ [*viscous* + *-o-* + *elastic*] (1935) *adj.* Having both viscous and elastic properties.

**Viscoelasticity** *n.* (1) A mechanical property involving a combination of elastic and viscous behavior; conforming to neither just simple elastic nor simple viscous behavior; also, strongly dependent on temperature. *See shift factor and WFL equation.* (2) The property of a polymer that characterizes it as neither an ideal solid nor a viscous liquid, but seeming to have the character of both. In addition, to having some of the characteristics of elastic solids, they possess some of the characteristics of viscous liquids. Polymeric materials show creep under a certain load and stress relaxation if stretched. In other words, the tendency of a plastic to respond to stress (or strain) as if it were a combination of an elastic solid and a viscous liquid. This property, possessed by all plastics to some degree, dictates that while plastics have solid-like characteristics such as elasticity, strength, and form stability, they also have liquid-like characteristics such as flow over time that depend on temperature, pressure, and stress. As a result, the response to stress depends on both the rate of application of the stress and the time for which it is maintained. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

*See Maxwell model, Voigt model, and time-temperature equivalence.*

**Viscometer (viscosimeter)** \vis-ˈkä-mə-tər\ [*visc*osity + *-meter*] (ca. 1883) *n.* An instrument for measuring the viscosity and other flow properties of fluids, emulsions and dispersions having low to moderate viscosities. Instruments used with highly viscous materials, such as polymer melts, are usually called *rheometers.* A widely used type of viscometer is the rotational type, in which a rotor turns within a cup containing the liquid sample and the torque required to turn the rotor or to hold the cup stationary is measured, along with speed of rotation. Of the many other types, some measure the rate at which a bubble rises through the liquid, or a ball falls through it; others measure the time required for a known quantity of the liquid to drain by gravity through an orifice at the bottom of a cup. Air-bubble viscometer, Brookfield viscometer, capillary viscometer, ford viscosity cups, Stormer viscometer, viscosity, and Zahn viscosity cup. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Van Wazer R, Lyons JW, Kim KY, Colwell RE (1963) Viscosity and Flow Measurement, A Laboratory Handbook of Rheology, Interscience Publishers, New York.

**Viscometers** *n.* Instruments for measuring viscosity including mechanical probe and torque types as the Brookfield viscometer, capillary tube types as the Cannon–Fenske or Ostwald–Fenske, and flow through orifice types as the Ford cup.

**Viscose** \ˈvis-ˌkōs\ [obs. *viscose*, adj, viscous] (1896) *n.* (1) A solution of xanthated cellulose in dilute sodium hydroxide from which rayon fibers and cellophane films are formed. The xanthated cellulose is produced by reacting alkali cellulose, i.e., wood fibers or cotton linters treated with sodium hydroxide, with oxygen and carbon disulfide. Rayon produced by this method is known as *viscose rayon.* (2) Generic name for fibers from regenerated cellulose (prepared by the xanthate method). Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

*See also rayon.*

**Viscose process** *n.* (1) One of the methods of producing rayon (*also see rayon fiber*). (2) The chemical process used in the manufacture of cellophane.

*Also see viscose solution.*

**Viscose rayon** One type of rayon. It is produced in far greater quantity than cuprammonium rayon, the other commercial type.

*Also see rayon fiber.*

**Viscose solution** The solution obtained by dissolving cellulose xanthate in caustic soda, from which viscose filaments and cellophane are produced.

**Viscosimeter (deprecated)** *See viscometer.*

**Viscosity** \vis-ˈkä-sə-tē\ [ME *viscosite*, fr. MF *viscosité*, fr. ML *viscositat-*, *viscositas*, fr. LL *viscosus* viscous] (15c) *n.* The ratio of the shear stress existing between laminae of moving fluid and the rate of shear between these laminae. *Note*—A fluid is said to exhibit Newtonian behavior when the rate of shear is proportional to the shear stress. A fluid is said to exhibit non-Newtonian behavior when an increase or decrease in the rate of shear is not accompanied by a proportional increase or decrease in the shear stress. The resistance to flow; $\eta=$ dyne s/cm$^2$, shear stress (dyne/cm$^2$) divided by shear rate (s$^{-1}$); where two opposite planes traveling at 0 and $v$ velocities at $d$ distance at $F$ force is expressed by

$$F/A = \eta\, v/d,$$

where, $F$ is the force, $A$ the area, $v$ the velocity, and $d$ is the distance. Goodwin, JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, Cambridge, UK. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York.

**Viscosity coefficient, $\eta$** *n.* Resistance to flow, a fundamental property of fluids, first quantitatively defined by Issac Newton in his *Principia*. A modern version of his equation of viscosity is:

$$\tau_{xz} = -\eta \frac{\mathrm{d}v_z}{\mathrm{d}x},$$

in which d$v_z$/d$x$ is the rate of change of $z$-directed velocity at the coordinate location $x$ in the fluid, $x$ being directed perpendicular to $z$; $\eta$ is the viscosity, a function of temperature and, more weakly, static pressure and $\tau_{xz}$ is the $z$-directed *shear-stress* (*force*) component acting on an imagined element of fluid surface normal to the $x$-direction. d$v_z$/d$x$, the *velocity gradient*, often written without the subscript, is also called the *shear rate*, usually symbolized as $\gamma$. The negative sign indicates that the stress in the fluid opposes the velocity. In the conceptually simplest case, that of steady flow between parallel plates separated by a distance $h$, one of which is moving with velocity $v$ relative to the other, the stress is just the force $F$ required to drag the moving plate divided by the plate area $A$, and Newton's equation reduces to: $F/A = -\eta\,(V/h)$. For the circular-tube geometry of orifice-type rheometers, the shear rate and stress vary from zero at the tube axis to a maximum at its inside surface, while the velocity does just the reverse. Since, for ordinary fluids, Newton's law holds throughout the fluid, it also holds at the tube wall (unless there is slip, rarely proved with polymeric solutions and melts). Rheologists have found it convenient to report their measurements in terms of the shear stress at the tube wall, $\Delta P{\cdot}R/2L$, and the Newtonian (or *apparent*) shear rate at the wall, $4Q/\pi R^3 = 4V/R$, which contain all the quantities they actually measure, i.e., the pressure drop from entrance to exit, the tube radius, and the steady flow rate, $Q$, which is equal to $\pi R^2$ times the average velocity $V$. By Newton's law, the viscosity is given by the quotient of the shear stress and the shear rate, i.e., $\pi R^4 \Delta P/8QL$. This expression is just an inversion of the Hagen–Poiseuille equation. Newton's equation applies accurately to ordinary fluids such as water, pure organic liquids, familiar oils and honey, even to dilute solutions of polymers, but not to concentrated polymer solutions or most molten plastics. Measurements show that these latter materials deviate from Newton's law in that their viscosities, as given by the quotient of shear stress/shear rate, diminish with rising shear rate (and stress). That is, they are non-Newtonian and pseudoplastic. Because some chemical engineers like to think of shear stress in its alternate identity, *momentum flux*, because many instruments were developed to measure viscosities related to specific industrial uses, and many viscosity units have evolved because viscosity ranges widely for different fluids and conditions such as temperature. The international unit of viscosity is the SI unit of viscosity, the pascal-second (Pa s). If, in the parallel-plate setup described above, the plate areas where 1 m$^2$, their separation 1 m, their relative velocity 1 m/s, and the drag force 1 N, the viscosity would be exactly 1 Pa s. The dynamics of fluid flow over bodies is reviewed in. For many years the *poise* has been used, equal to 0.1 Pa s, and the centipoise, as their working units. Plastics engineers have also used the psis ($1\mathrm{b_f}$ s/in.$^2$= 6,895 Pa s). The Pa s may also be viewed, through the momentum-flux perspective, as 1 kg/ms. Many early instruments tried to gauge viscosity by the time required for a vessel full of liquid to drain through a short tube in its bottom. These, with suitable corrections, provide estimates of the kinematic viscosity. If mass-based viscosity units are used, kinematic viscosity will have the dimensions length/time or m$^2$/s in SI. Clearly, one must be careful in using reported viscosities to identify unambiguously the units used. In the older literature, and even today, the pound and kilogram may be either force or mass units, though in SI the kilogram, one of the seven base units, is strictly assigned to mass. To convert a kinematic viscosity to an equivalent absolute viscosity, one must know the liquid's density at the stated temperature. The old scientific unit, the Stokes, equal to 1 cm$^2$/s, is closely related to the poise. All liquid viscosities decrease with rising temperature, some much more steeply than others. The range of polymer-connected viscosities is very wide, from 0.001 Pa s for very dilute solutions at room temperature to 100–5000 Pa s for molten plastics, and many times more for cooler amorphous polymers. Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists, Royal Society of Chemistry, Cambridge, UK. Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York. Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York. James F Carley (eds) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., USA.

*See ASTM* (www.astm.org) for the current and appropriate method for determining viscosity.

*See also the following viscosity-related terms.*

*Bingham plastic*
*Brookfield viscometer*
*Capillary rheometer*
*Capillary viscometer*
*Consistency*
*Cup-flow test*
*Dilatancy*
*Dilute-solution viscosity*
*Extrusion plastometer*
*Intrinsic viscosity*
*Kinematic viscosity*
*Laminar flow*
*Melt-flow index*
*Newtonian flow*
*Pseudoplastic fluid*
*Reduced viscosity*
*Relative viscosity*
*Rheology*

*Hagen–Poiseuille equation*
*Inherent viscosity*
*Initial viscosity*
*Specific viscosity*
*Stormer viscometer*
*Thixotropy*
*Ubbelohde viscometer*
*Ultra-viscoson*
*Viscoelasticity*
*Rheometer*
*Rheopexy*
*Saybolt viscosity*
*Viscometer*
*Viscous flow*
*Yield value*
*Weissenbert*
*Rheogoniometer*
*Zahn viscosity cup*

**Viscosity, absolute dynamic** *n.* The force per unit area that resists the flow of two parallel fluid layers past one another when their differential velocity is 1 cm/s/cm separation. The viscous force is described by Newton's equation:

$$f = \eta A(\mathrm{d}v/\mathrm{d}x),$$

where $A$ is the area (cm$^2$), (d$v$/d$x$) the velocity gradient (s$^{-1}$), and $\eta$ is the coefficient of absolute viscosity (poise).

**Viscosity, apparent** *n.* The quantity obtained by dividing the shearing force by the rate of shear. This is a term applied only to non-Newtonian materials. It is not a constant for a given material, because its value depends on the rate of shear selected in making the measurement. Apparent viscosity is obtained by "one-point" methods. It has no general scientific value, and it is doubtful whether it has any real technical value.

**Viscosity-average molecular weight** *n* $(M_\mathrm{v}, \overline{M}_\mathrm{v})$. An averaged molecular weight for high polymers that relates most closely to measurements of dilute-solution viscosities of polymers. The defining equation is

$$M_\mathrm{v} = \left[\frac{\sum\limits_{i=1}^{\infty} N_i M_i^{1+a}}{\sum\limits_{i=1}^{\infty} N_i M_i}\right]^{1/a},$$

where $N_\mathrm{i}$ is the number of individual molecules having the molecular mass $M_\mathrm{i}$. The exponent $a$, between 0.6 and 0.8 for many polymer/solvent systems, is best evaluated from measured viscosities of dilute solutions of narrow-molecular-mass fractions of polymers, determining the intrinsic viscosity $[\eta]$ for each fraction, then fitting the following equation to the data: $[\eta] = K^1 M^a$. For $a = 1$, occasionally seen, $M_\mathrm{v}$ = the weight-average molecular weight, $M_\mathrm{w}$. Kamide K, Dobashi T (200) Physical chemistry of polymer solutions. Elsevier, New York. Slade PE (2001) Polymer molecular weights, vol. 4. Marcel Dekker, New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Viscosity coefficient** (1866) *n.* The shearing stress necessary to induce a unit velocity flow gradient in a material. In actual measurement, the viscosity coefficient of a material is obtained from the ratio of shearing stress to shearing rate. This assumes the ratio to be constant and independent of the shearing stress, a condition which is satisfied only by Newtonian fluids. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

**Viscosity cup** *n.* An efflux viscometer. *See viscometer.*

**Viscosity/density ratio** *n*, $\eta/\rho$, where $\eta$ is the viscosity of the polymer solution; $\rho$ is the density of the polymer solution.

**Viscosity depressant** *n.* A substance that, when added in a relatively minor amount to a liquid, lowers its viscosity. Such materials, e.g., ethoxylated fatty acids, are often incorporated in vinyl plastisols to lower their viscosities without increasing plasticizer levels.

**Viscosity index** (1929) *n.* An arbitrary number assigned as a measure of the constancy of the viscosity of a lubricating oil with change of temperature with higher numbers indicating viscosities that change little with temperature.

**Viscosity, intrinsic** *See intrinsic viscosity.*

**Viscosity, kinematic** *n.* Viscosity of a substance divided by the density of the substance at the temperature of measurement. Kinematic viscosity is commonly obtained from capillary and outflow viscometer data. The unit is the stokes. A liquid having a relative density of one has a kinematic viscosity of one stokes if its viscosity is one poise. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

**Viscosity number** *n.* The IUPAC term for reduced viscosity. $(\eta - \eta_0)/\eta_0 c$, where $\eta$ is the viscosity of the polymer solution; $\eta_0$ is the viscosity of the pure solvent; $c$ is the concentration of the polymer solution in grams of solute per milliliter of solution.

**Viscosity, plastic** *n.* Resistance to flow in excess of the yield value in a plastic material. Plastic viscosity is proportional to (shearing stress-yield value)/rate of shear. The coefficient of plastic viscosity is the force in excess of the yield value, tangentially applied, that will induce a unit velocity gradient. Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York.

*See plastic flow and plasticity.*

**Viscosity ratio** *n.* The ratio of the viscosities of the polymer solution (of stated concentration) and of the pure solvent at the same temperature.

**Viscosity, relative (for liquids)** *n. See viscosity, specific (for liquids).*

**Viscosity, relative (for suspensions and solutions)** *n.* The ratio between the viscosity of a composition ($\eta$), divided by the viscosity of the liquid phase ($\eta_0$). It is designated as $\eta_{rel}$.

**Viscosity, specific (for liquids)** *n.* The ratio between the viscosity of a liquid and the viscosity of water at the same temperature. Specific viscosity is sometimes used interchangeably with relative viscosity for liquids.

**Viscosity, specific (for suspensions and solutions)** *n.* The viscosity of a composition ($\eta$) minus the viscosity of the liquid ($\eta_0$), divided by the viscosity of the liquid phase. The symbol is $\eta_{sp}$. Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York.

**Viscous** \ˈvis-kəs\ [ME *viscouse*, fr. LL *viscosus* full of birdlime, viscous, fr. L *viscum* mistletoe, birdlime; akin to OHGr *wīhsila* cherry Gk *ixos* mistletoe] (14c) *adj.* Having relatively great viscosity. A qualitative term denoting the material to which it is applied is "thick" and flows sluggishly, rather than being "thin" and flowing freely. The transition region between "free-flowing and "viscous" corresponds roughly to viscosities from 1 to 30 Pa s.

**Viscous dissipation** (viscous-heat generation) *n.* In melt processing, wherever there is flow, the resistance of molecules to flow, i.e., viscosity causes heat to be generated within the melt. The rate of dissipation equals the product of shear stress times shear rate, or viscosity times the square of the shear rate. Because both the viscosity and shear rate are high in processes such as extrusion, injection and transfer molding, and intensive mixing, viscous dissipation is a principal mechanism of heating plastics in those processes.

**Viscous flow** *n.* A type of fluid in which all particles of the fluid flow in a straight line parallel to the axis of a container pipe or channel, with little or no mixing or turbidity. This definition arises from O. Reynolds' classic experimental demonstration of the transition from viscous to turbulent flow, which is described in most elementary texts on fluid flow.

*See also laminar flow.*

**Visible light** *n.* The narrow band in the electromagnetic spectrum that the human eye perceives from about 380 nm (violet) to 760 nm (red). Johnson SF (2001) History of light and colour measurement: a science in the shadows. Taylor and Francis, UK.

**Visible spectrophotometry** *n.* An analytical instrumental technique based on selective absorption of visible radiation from organic and inorganic substances which helps in their identification.

**Vision** \ˈvi-zhən\ [ME, fr. OF, fr. L *vision-*, *visio*, from *vidēre* to see] (14c) *n.* Process of seeing; ocular perception.

**Vision, defective color** *See color vision, defective.*

**Vision, normal colo** *See color vision, normal.*

**Vistanex** Poly(isobutylene). Manufactured by Standard Oil, USA.

**Visual** \ˈvi-zhə-wəl\ [ME, fr. LL *visualis*, fr. L *visus* sight, fr. vidēre to see] (1603) *adj.* Of or pertaining to sight; ocular.

**Viton** *n.* Vinylidene fluoride/hexafluoropropylene co-polymer, manufactured by DuPont, USA.

**Vitreous enamel** *n.* Silicate glass fired on metal.

*Also called porcelain enamel.*

**Viton®** *n.* DuPont's trade name for a family of co-polymer fluoroelastomers with a wide range of properties among them, but, in particular, good resistance to high temperatures and chemicals. They are used for gaskets, O-rings, oil seals, diaphragms, pump and valve linings, hose, tubing, and coating fabrics.

**VLDPE** *n.* Abbreviation for very-low-density polyethylene.

**VM & P Naphtha** *n.* Varnish maker's and painter's naphtha. Any number of narrow-boiling-range fractions of petroleum with boiling points of about 93–149°C according to specific use. The term "benzine" is still used for VM&P Naphtha but is not preferred in modern nomenclature. *Known also as painter's naphtha.*

**Void** \ˈvóid\ (1616) *n.* (1) In a solid plastic article or laminate, an unfilled space within the article large enough to scatter light (in transparent materials) or other radiant energy that might be used to detect such spaces. (2) In cellular plastics, a cavity unintentionally formed and substantially larger than the characteristic individual cells (ISO). (3) An empty volume within any material or liquid medium.

*See also blister.*

**Void fraction** *n.* The fraction or percentage of the volume of an article or material sample, such as fiber, powder or foam, that is within the material, and contains only vacuum or gas.

**Voids** *n.* (1) *See holidays.* (2) *See microvoids.* (3) Interstitial space in media mill. Knowledge of the void volume is necessary to calculate the optimum charge.

**Voigt element** *n.* This is a Voight model which is a component, together with other Voight or Maxwell components, of a more complex viscoelastic model system, such as the standard linear solid.

**Voigt model** *n.* A conceptual, mechanical model useful as an analogy to the deformation behavior of viscoelastic materials. It consists of, side-by-side (in parallel), an elastic coil spring and a viscous dashpot rigidly connected at each end. When the ends are pulled apart, they will separate gradually and ever more slowly until the spring is stretched to a length corresponding in to the pulling force divided by the spring stiffness (spring constant), when motion stops. Compare this with the Maxwell model. Kamide K, Dobashi T

(2000) Physical chemistry of polymer solutions. Elsevier, New York.

**Voile fabric** \ˈvói(ə)l-\. A sheer spun cloth that is lightweight and soft. It is usually made with cylindrical, combed yarn. Voile is used for blouses, children's wear, draperies, bedspreads, etc. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Volatile** \ˈvä-lə-təl, *esp British* –ˌtīl\ [F, fr. L *volatilis*, fr. *volare* to fly] (1605) *adj.* (1) The easily evaporated or vaporized components of any coating composition in contrast to the non-volatile components. (2) Easily evaporated or vaporized at temperatures below about 40°C; low-boiling.

**Volatile loss** The loss in weight, usually unintended, of a substance due to evaporation of one or more constituents.

**Volatiles content** The percent weight loss, through loss of volatiles, from a plastic or impregnated reinforcement held at a specific temperature for a specified time (sometimes, under vacuum).

**Volatile thinner** *See thinner.*

**Volatility** *n.* Of liquids and some solids, the tendency to evaporate when exposed to the atmosphere. This qualitative idea is closely related to vapor pressure. The *relative volatility* of two liquids at any temperature is the ratio of their vapor pressures at that temperature.

**Volt** \ˈvōlt, ˈvólt\ [F *volte*, fr. It *volta* turn, fr. *voltare* to turn, from (assumed) VL *volvitare*, freq. of L *volvere* to roll] (1688) *n.* (V) The SI unit of electromotive force (emf), equal to the difference in electric potential between two points of a conductor carrying a constant current of one ampere when the power dissipated between these points equals, one watt (i.e., in SI, $1\,V \equiv 1\,W/A$). It is also the potential difference required to cause a steady current of one ampere to flow through a conductor whose resistance is one ohm.

**Volume** \ˈväl-yəm\ [ME, fr. MF, fr. L *volumen* roll, scroll, fr. *volvere* to roll] (14c) *n.* The space occupied by an article or sample of material, including any voids, within the defining surfaces. The SI unit of volume is the cubic meter, $m^3$, known in the past by the name *stere*, now deprecated (but alive and well in crossword puzzles). SI also allows the use of convenient subvolumes, e.g., $m^3$, $cm^3$. The exponent also operates on the abbreviated prefix in each case [i.e., $1\,cm^3 = 1\,cm^3 = 10^{-6}\,m^3$, not $0.01\,m^3$]. The special name *litre* (*liter* in the US English) has been approved for the cubic decimeter ($dm^3$) but is to be used only for volumetric capacity and dry and liquid measure. No prefix other than milli- (m) or micro- (μ) should be used with liter. Some conversions of other volume units to SI are given in the Appendix.

**Volume coefficient of thermal expansion** (cubical expansion coefficient) *n.* The rate of change of volume of a material with rising temperature, divided by the volume, i.e.,

$$\frac{\left(\frac{\partial V}{\partial T}\right)_P}{V},$$

where $P$ (subscript) reminding one that the coefficient, which is mildly pressure-sensitive, is tied to the particular pressure at which it has been measured (most often, atmospheric). The SI unit is $K^{-1}$. Over a short internal of temperature, the expression above is very nearly equal to the change in volume divided by the change in temperature, i.e., $\Delta V/\Delta T$. In isotropic materials, the cubical expansion coefficient is three times the linear expansion coefficient, the quantity *usually* meant by coefficient of thermal expansion. Groenewoud WM

(2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York.
see also dilatometer.

**Volume expansion** *n.* The change in volume of a test specimen under specified test conditions (ISO). This is usually expressed as a percentage of the original volume.
*See also swellling.*

**Volume resistivity** (specific insulation resistance) *n.* The ratio of the potential gradient parallel to the current in a material to the current density. In SI, volume resistivity is numerically equal to the direct current resistance between opposite faces of a one-meter cube of the material, with the unit ohm-meter (Ωm). The smaller cgs unit, Ωcm, is still widely used. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw Hill Science, New York. Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York.

**Volume solids, percent** *n. See solids by volume.*

**Vortex cell** *See benard cell.*

**VSEPR theory** Valence-shell electron-pair repulsion theory.

**Vulcanization** \ˌvəl-kə-nə-ˈzhən\ (1846) *n.* A chemical reaction in which the physical properties of a rubber are changed in the direction of decreased plastic flow, less surface tackiness, and increased tensile strength by reacting it with sulfur or other suitable agents.
*See also curing* (2) *and self-vulcanizing.*

**Vulcanize** *v.* To subject to vulcanization.

**Vulcanized fiber** *n.* (1) Resin-free cellulosic plastic. Made by immersing cotton waterleaf paper in a solution of zinc chloride, applying slight heat and pressure and subsequently leaching the zinc chloride from the newly created product. At the completion of this process, vulcanized fiber is no longer a paper, nor is it what is commonly known as chemboard; it is a completely new form of matter with unusual physical characteristics. (2) A nearly homogeneous material consisting of hydrated cellulose, made by subjecting cellulose to a parchmentizing process.

**Vulcanized fiber** [fr. *Vulcanized Fibre*, a trademark] (ca. 1884) *n.* Cellulosic material that has been partly gelatinized by action of a chemical (usually zinc chloride solution), then heavily compressed or rolled to the required thickness, leached free of the zinc chloride, and dried. It has been used for electrical insulation, luggage, and materials-handling equipment.

**Vulcanized oil** *n.* Vegetable oil which has been reacted with sulfur, or sulfur chloride.

**Vulcanizing** (vulcanization) *n.* The chemical reaction, usually accompanying by cross-linking, that induces extensive changes in the physical properties of a rubber or elastomer, brought about by reacting the material with sulfur and an accelerator. The discovery of vulcanization by C. Goodyear in 1839 was the beginning of a practical rubber-products industry. The changes brought about by vulcanizing include decreased plastic flow, reduced surface tackiness, increased moduli and resilience, much greater tensile strength, and considerably reduced solubility. Some thermoplastics, such as polyethylene can be modified to be vulcanizable. The associated cross-linking causes the final product to resist flow and deformation at temperatures above the melting range of the original polymer.

**Vulcollan** *n.* Polyurethane. Manufactured by Bayer, Germany.

# W

**w** \ˈdə-bəl-(ˌ)yü\ {*often capitalized, often attributive*} (15c) *n.* Symbol for width or, in thermodynamics, work done by a system.

**W** (1) The SI abbreviation for watt. (2) The chemical symbol for the element tungsten (from *wolframite*, the mineral in which it was first recognized. Hibbard MJ (2001) Mineralogy. McGraw-Hill Companies Inc., New York.

**Wainscot** \ˈwān-skət\ [ME, fr. MD *wagenschot*, prob. fr. *wagen* wagon + *schot* shot, crossbar] (14c) *n.* (1) Wall paneling, usually of wood. (2) A decorative or protective facing applied to the lower three or four feet of an interior partition or wall, making use of new material different from that of the upper wall, and often consisting of wood paneling or other facing material. Merriam-Webster's Collegiate Dictionary, 11th edn. Merriam-Webster Inc., Springfield, MA, USA, 2004.

*See dado.*

**Wale** \ˈwā(ə)l\ [ME, fr. OE *walu*; akin to ON *volr* staff and perhaps to ON *valr* round, L *volvere* to roll] (before 12c) *n.* (1) In knit fabrics, a column of loops lying lengthwise in the fabric. Number of wales per inch is a measure of the fineness of the fabric. (2) In woven fabrics, one of a series of ribs, cords, etc., running either warpwise or fillingwise. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Wallboard** \ˈwól-ˌbōrd\ (1906) *n.* Such boards as pressed cellulose fibers, plasterboard, cement-asbestos board, plywood, used in place of plaster interior surfaces. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Wallpaper** (1827) *n.* Paper, or paperlike material, usually decorated in colors, which is pasted or otherwise affixed to walls or ceilings of rooms.

**Wall stress** (1) In a filament-wound pressure vessel, the stress calculated from the pressure or load divided by the entire cross-sectional area of the wall (*not* just that of the reinforcement). (2) In a fluid flowing through a channel (such as a die, tube, or extruder-screw channel), the shear stress at any channel surface. In the simplest case of a fluid in steady flow through a circular tube of radius $R$ and length $L$, the wall stress is given by $\Delta P \cdot R/2L$, where $\Delta P$ is the pressure drop from inlet to outlet. Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics, John Wiley and Sons, New York.

**Walnut oil** Vegetable semidrying or drying oil obtained from *Juglans regia*. It is used chiefly by artists to whom its non-yellowing properties are attractive and in place of soya bean oil, in locations where walnut oil is economically available. It may contain as much as 63% of linoleic acid and 15% of linolenic acid. Sp gr, 0.926/15°C; iodine value, 140–150; saponification value, 195. Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany, Timber Press, Portland, OR. Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing and Material, 2001.

**Walnut-shell flou** *See nutshell flour.*

**Warm forging** The process of forming thermoplastic sheets or billets into desired shapes by pressing them between dies in a press, when the material and/or the dies have not been preheated. The blanks may be billets formed by extrusion, or may be die-cut from sheets. Strong AB (2000)

Plastics materials and processing. Prentice-Hall, Columbus, OH.

*See also cold forming and solid-phase forming.*

**Warm-setting adhesive** *See adhesive, warm-setting.*

**Warm-up** A milling operation to plasticize uncured rubber compounds before calendering, extruding, or molding.

**Warp** \ˈwórp\ [ME, fr. OE *wearp*; akin to OHGr *warf* warp, OE *weorpan* to throw, ON *verpa*] (before 12c). (1) A significant variation from the original, true, or plane surface. (2) In the textile industry, those threads of a cloth which are parallel to the selvage, i.e., running lengthwise in the loom. (3) To change shape spontaneously. This is seen particularly in flat surfaces such as sheet and sides of boxy shapes. Such changes are often traceable to creep caused by stresses generated during molding or forming, by uneven absorption of water or a solvent, by uneven heating, or, in fiber-reinforced thermosets, by unequal curing in thin and thick sections. Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York.

**Warpage** Distortion caused by non-uniform change of internal stresses.

*See dished.*

**Warp-drawing** Warp-drawn fibers may be taken up on packages other than beam.

*See draw-warping.*

**Warp holding place** *See sticker* (1).

**Warping** *See beaming.*

**Warp knitting** (1946) *n. See knitting* (1).

**Warp pile** The extra set of warp yarns that forms the surface in a double-woven pile fabric, including types such as velvet and velour. Upholstery fabrics such as mohair, plush, and friezé are produced by this method.

*Also see pile and velvet fabric.*

**Warp printing** *See printing.*

**Warp sheet** A sheet comprising up to several thousand ends that are combined to make up the warp during preparation for weaving or warp knitting.

*Also see warp.*

**Warp sizing** *See slashing.*

**Warp streaks** A fabric fault that shows as bands or streaks running warpwise. Warp streaks should not be confused with reed marks.

**Wash** \ˈwósh\ In reinforced-plastics molding, an area where the reinforcement placed in the mold has moved during closing of the mold, resulting in a resin-rich (and reinforcement-poor) region. Murphy J (1998) Reinforced plastics handbook. Elsevier Science and Technology Books, New York. Ash M, Ash I (1982–1983) Encyclopedia of plastics polymers, and resins, vols 1–3. Chemical Publishing Co., New York.

**Washability** Ease with which the dirt can be removed from a paint surface by washing; also refers to the ability of the coating to withstand washing without removal or substantial damage. Koleske JV (ed) (1995) Paint and coating testing manual. American Society for Testing and Materials.

**Washable distemper** *See washable water paint.*

**Washable water paint** Water paint which, in addition to a glue or casein binder, contains an emulsified oil or similar fixing agent, thus rendering it washable. Sometimes incorrectly described as *Washable distemper.* Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Wash-and-wear** (1956) *adj.* A generic term applied to garments that satisfactorily retain their original neat appearance after repeated wear and home laundering with little or no pressing or ironing. A wash-and-wear garment is essentially free from undesirable wrinkles both during wear and after laundering and retains any original pressed-in creases or pleats. The garments should meet normal consumer demands for durability, color, stability, and shrinkage. The performance of a wash-and-wear fabric or garment depends on several factors, including the types and amounts (percentages) of fibers used, the fabric construction, the finishing treatment, the presence of a colored pattern (either woven or printed), and the methods used for washing and drying. These factors determine, in any specific instance, if a fabric or garment's performance will meet customer requirements. Variable conditions result in the varying behavior of a specific fabric or garment. Garments are labeled to specify the appropriate care for optimal performance. *Also see ease-of-care and durable press.* Humphries M (2000) Fabric glossary. Prentice-Hall, Upper-Saddle River, NJ.

**Washboard** \ˈwósh-ˌbōrd\ (1742) *n. See baseboard.*

**Wash coat** A very thin semitransparent coat of paint; applied as a preliminary coating on a surface; acts as a sealer or guide coat.

**Washfastness** The resistance of a dyed fabric to loss of color or change in properties during home or commercial laundering.

**Washing** *See tinting.*

**Washing out** The removal of the original greasy ink on the design areas of etched lithographic plates.

**Washout inks** Inks used on textiles which are easily removed by washing.

**Wash primer** Priming paint usually supplied as one- or two-component systems. The paint contains carefully balanced proportions of an inhibiting chromate pigment, phosphoric acid, and a synthetic resin binder mixed in an alcohol solvent. On clean, light alloy or ferrous surfaces, and on many non-ferrous surfaces, such paints give excellent adhesion, partly due to chemical reaction with the substrate, and give a corrosion-inhibiting film, which is a good basis for the application of subsequent coats of paint. Although these materials are referred to as primes, the films which they produce are so thin that it is more correct to consider them as etching solutions and to follow them with an ordinary primer if maximum protection is required. Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc., New York. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York. *Also known as pre-treatment primers, etch primers and self-etch primers.*

**Washup** The process of cleaning the rollers, form or plate, and even the fountain of a press.

**Waste** \ˈwāst\ [ME *waste*, *wast*; in sense 1, fr. ONF *wast*, fr. *wast*, adj., desolate, waste fr. L *vastus*; in other senses, fr. ME *wasten* to waste] (13c) *n.* By-products created in the manufacture of fibers, yarns, and fabrics.

**Wasted loop effect** An intramolecular reaction involving gelation that does not occur at the predicted value because not all of the branching points on the growing chain are used effectively; many multifunctional units in the chain are wasted, and one theory is that the branch point leading out from the multifunctional repeating unit loops back to form a ring with another branch point on the same polymer molecule. Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York. Lenz RW (1967) Organic chemistry of synthetic high polymers. Interscience Publishers, New York.

**Water absorption** The percentage increase in weight of a plastic article when immersed in water for a stipulated time and at a specified temperature (usually room temperature). Most plastics absorb water to some extent, varying from almost zero in the case of polytetrafluoroethylene and polyolefins, to complete dissolution for some types of polyvinyl alcohol and polyethylene oxide. Water absorption can cause swelling, leaching of additives, plasticizing and hydrolysis, which in turn can cause discoloration, embrittlement, stress cracking, lowering of mechanical and electrical properties, and reduced resistance to heat and weathering. Grellman W, Seidler S (eds) (2001) Deformation and fracture behavior of polymers. Springer-Verlag, New York. Mark JE (ed) Physical properties of polymers handbook. Springer-Verlag, New York. Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York.

**Water-based coatings** Latex coatings and coatings containing water-soluble binders. Latex coatings. Syn: Water-borne coatings, water-reducible coatings. Wicks ZN, Jones FN, Pappas SP (eds) (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Water-based inks** Inks containing a vehicle whose binder is water-soluble or water-dispersible.

**Water-based paint** *See water paint and water-based coatings.*

**Waterblasting** Blast cleaning of metal using high-velocity water.

**Water-borne coatings** *See water-based coatings.*

**Water break** The appearance of a discontinuous film of water on a surface, signifying non-uniform wetting and usually associated with a surface contamination.

**Water-break-free** The ability of the rise water to cover the entire surface in an unbroken film.

**Water color** (1) An artists' colors in which the pigment has been mixed with gum as a binder. Gair A (1996) Artist's manual. Chronicle Books LLC, San Francisco. (2) The term used to describe that form of transparent water painting in which the white of the paper furnishes the lights and in which no white pigment is used during the painting of the picture. Paint/coatings dictionary. Compiled by Definitions Committee of the Federation of Societies for Coatings Technology, 1978.

**Water glass** (1612) *n.* Sodium or potassium silicate that is soluble in water.

**Water imbibition** *See imbibition.*

**Water-jet loom** *See jet loom.*

**Waterless dyeing** *See dyeing, solvent dyeing.*

**Water paint** (1) Paint, the vehicle of which is a water emulsion, water dispersion, or ingredients that react chemically with water. (2) A paint capable of being thinned or diluted with water, such as casein paint, latex paint, distemper, calcimine, and whitewash.

**Waterproof** \ˈwó-tər-ˌprüf\ (1736) *adj.* A term applied to materials that are impermeable to water; waterproof fabrics have had all their pores closed and are also impermeable to air and very uncomfortable.

**Waterproofing coatings** Coatings which are formulated to prevent penetration of the substrate by water. These coatings include but are not limited to bituminous roof and resilient type coatings.

**Water-reducible coatings** *See water-based coatings.*

**Water-reducible resins** Water-soluble types or lattices or emulsions. Resins which can be diluted (reduced) with water, water-cosolvent mixtures and sometimes with alkali (alkali-soluble resins). Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York.

**Water repellent** (1896) *adj.* A term applied to fabrics that can shed water but are permeable to air and comfortable to wear. These fabrics are produced by treating the material with a resin, wax, or plastic finish that is not completely permanent.

**Water repellents** Materials or treatment for surfaces to provide resistance to penetration of water.

**Water resistance** (1921) *adj.* The ability of a coating to resist damage or degradation due to water.

**Water-soluble polymers** Macromolecules exhibiting solubility in aqueous solutions. Water-soluble polymers can be divided into four categories, biopolymers, nonionic, ionic, and associative polymers.

**Water-soluble resins** Any of several resin types that are produced by polymerization reactions in which the chain growth results from breaking of ring structure or double bonds of the monomers. Examples are alkyl- and hydroxyalkyl cellulose derivatives, carboxymethyl cellulose, polyvinyl alcohol, polyvinyl pyrrolidone, polyacrylic acid, polyacrylamide, polyethylene oxide, and polyethylene-imide. Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc., New York.

**Water spotting** (1939) *n.* Any change in the appearance of surface resulting solely from the action of water.

*See rain spotting.*

**Water stain** *See stain.*

**Water vapor transmission (WVT, WVTR)** The rate of water vapor flow, under steady specified conditions, through a unit area of a material, between its two parallel surfaces and normal to the surfaces. Metric unit of measurements is 1 g per 24 h m$^2$. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995; www.astm.org

*See perm.*

**Water wax** *See liquid water emulsion wax.*

**Water white** A material that approaches the colorless nature of water; generally applied to colorless transparent liquids and solids. Abbreviation: WW.

**Watt** \ˈwät\ [James *Watt* † 1819] (1882) *n.* The SI unit of power, equal to 1 J/s (=1 m N/s), expressing the rate at which work is done or energy expended. In the case of alternating electric current, the watt is computed as the product of voltage across the circuit, times the current flow in amperes times the cosine of the phase angle between the current and the impressed voltage. In purely resistive DC circuits, watt = volt × ampere. Some conversions of other power units to SI are given in the Appendix.

**Wattle gum** Water-soluble or water-dispersible gum obtained from the Australian acacia tree.

**Wave equation** (1926) *n.* A mathematical equation describing the motion of a wave.

**Wave function** The mathematical relation which solves a wave equation. Each correctly obtained electron wave function corresponds to a disc.

**Wavelength** \-ˌleŋ(k)th\ (1850) *n.* Distance between two successive points of a periodic wave in the direction of propagation in which the oscillation has the same phase; designated as $\lambda$ in spectrophotometry. It is usually measured in nanometers or, formerly, in Angstrom units (1 nm = 10 Å). Giambattista A, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

*See frequency.*

**Wave mechanics** [*plural but singular or plural in construction*] (1926) *n.* The branch of physics which describes the behavior of small particles by assigning wavelike properties to them, also known as Quantum Mechanics.

**Wave motion** A progressive disturbance propagated in a medium by the periodic vibration of the particles of the medium. Transverse wave motion is that in which the vibration of the particles is perpendicular to the direction of propagation. Longitudinal wave motion is that in which the vibration of the particles is parallel to the direction of propagation.

**Wave number** (1873) *n.* The number of waves per unit distance of radiant energy of a given wavelength: the reciprocal of the wavelength.

**Wavy cloth** *See baggy cloth.*

**Wavy grain** Grain in which the fibers and other longitudinal elements collectively take the form of waves or undulations.

**Wavy selvage** *See slack selvage.*

**Wax** \ˈwaks\ [ME, fr. OE *weax*; akin to OHGr wax, Lithuanian *vaškas*] (before 12c) *n.* Any of various unctuous, viscous or solid heat-sensitive substances consisting essentially of high molecular weight hydrocarbons or esters of fatty acids ($C_{16}$–$C_{30}$), characteristically insoluble in water but soluble in most organic solvents.

**Wax** Solid, low-melting substances that may be of plant, animal, mineral, or synthetic origin. Waxes are generally slippery (though beeswax is somewhat sticky), plastic when warm, and, because their molecular weights are rather low, fluid when melted.
*See paraffin wax.*

**WAXS** Abbreviation for wide-angle-X-ray scattering.

**Wax set ink** A printing ink designed to set and dry instantly upon immersion of the print in a bath of molten wax.

**Wb** SI abbreviation for weber.

**Weak (electrolyte)** Only partially dissociated.

**Weak web** A web of fiber that, when being transferred from the card doffer to the calender rolls to form sliver, does not have sufficient strength from fiber cohesion or clinging entanglement to hold itself together while forming a continuous bridge in processing.

**Weal yarn** A yarn that is found to be either below standard breaking specifications or to be weak enough to cause an abnormally high degree of stops in textile processing.

**Wear cycles** In abrasion resistance tests using the Taber Abraser, the number of cycles of abrasion required to wear a film of specified thickness through to the test plate under a specified set of test conditions (Federal Standard 141a, Method 6192).

**Wear index** In abrasion resistance tests using the Taber Abraser, it is the loss in weight in milligram per 1,000 cycles of abrasion under a specific set of test conditions (Federal Standard 141a, Method 6192).

**Wear test** A test for fabric wear, abrasion, flexibility, washing, crushing, creasing, etc., in which the fabric is made into a garment, worn for a specific time, then assessed for performance.

**Weather** \ˈwe-t͟hər\ (15c) *v.* To age, deteriorate, discolor, etc., as a result of exposure to the weather.

**Weatherboarding** \-ˌbōr-diŋ\ (1632) *n. See siding.*

**Weathering** (15c) *v.* (1) Behavior of paint films when exposed to natural weather or accelerated weathering equipment, characterized by changes in color, texture, strength, chemical composition, or other properties. Natural outdoor weathering tests are normally carried out at selected exposure sites, on painted panels, generally exposed either vertically or at 45° facing south in the northern hemisphere. (2) The process of disintegration and decomposition as a consequence of exposure to the atmosphere, to chemical action, and the action of frost, water, and heat. (3) A broad term encompassing exposure of plastics to solar or ultraviolet light, temperature, oxygen, humidity, snow, wind, and air-borne dust and biological or chemical agents, such as smog. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA.

*See accelerated weathering.*

**Weather-ometer** An apparatus, used to estimate the life of coatings, in which specimen materials can be subjected to artificial and accelerated weathering tests which simulate natural weathering by the use of controlled cycles of ultraviolet radiation, light, water, and heat. Electric arcs, water spray, and heating elements are used to simulate the natural conditions of sun, rain, and temperature changes. Paint and coating testing manual (Gardner–Sward handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA.

*See accelerated weathering.*

**Weather resistance** The ability of a material, paint film, or the like to withstand effects of wind, rain, sun, etc., and retain its appearance and integrity.

**Weather stripping** (1846) *n.* Metal, wood, plastic, or other material installed around door and window openings to prevent air infiltration.

**Weather testing** Experimental tests that aim to predict the lifetime of manufactured articles.

**Weave** \ˈwēv\ [ME *weven*, fr. OE *wefan*; akin to OHGR *weban* to weave, Gk *hyphainein* to weave, *hyphos* web] (1581) *n.* A system or pattern of intersecting warp and filling yarns. There are three basic two-dimensional weaves: plain, twill, and satin. All other weaves are derived from one or more of these types.

*Also see plain weave, twill weave, and satin weave.*

**Weaving** The method or process of interlacing two yarns of similar materials so that they cross each other at right angles to produce woven fabric. The warp yarns, or ends, run lengthwise in the fabric, and the filling threads (weft), or picks, run from side to side. Weaving can be done on a power or handloom or by several hand methods.

*Also see loom and woven fabric.*

**Web** \ˈweb\ [ME, fr. OE; akin to ON *vefr* web, OE *wefan* to weave] (before 12c) *n.* (1) A continuous film or fabric in process in a machine. In extrusion coating, the *molten web* is that which issues from the die and becomes the coating, and the *substrate* (*web*) is the material being coated. (2) A continuous length of sheet material handled in roll form as contrasted with the same material cut into short lengths.

**Webbing** (British) *v.* Development of wrinkles, often in a well-defined pattern, in the surface of a paint or varnish during drying. This condition results from the irreversible swelling of a partially dried surface skin and may be aggravated by impure gas fumes during stoving in a gas oven in which case it is termed "gas checking." Webbing is generally regarded as a paint defect but is made use of in some paint finished to give a textured coating (e.g., wrinkling), which obscures minor faults and indentations in the surface to be coated. Paint/coatings dictionary. Federation of Societies for Coatings Technology, Philadelphia, Blue Bell, PA.

**Web coating** Any of a number of processes by which coatings are applied to continuous substrates such as papers, cloths, and metal foils, including calender coating, extrusion coating, flow coating, gravure coating, roller coating, spread coating plus other listed at coating methods.

**Weber** \ˈwe-bər, ˈvā-bər\ [Wilhelm E. *Weber* † 1891 German physicist] (2892) (Wb) *n.* The SI unit of magnetic flux, defined a the magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of one volt and the flux is reduced to zero at a uniform rate in one second. Therefore, 1 weber = 1 volt second. The former unit of flux, the Maxwell, part of the so-called "absolute" system of electrical units, equals $10^{-8}$ Wb.

**Weft** \ˈweft\ [ME, fr. OE; akin to ON *veptr* weft, OE *wefan* to weave] (before 12c) (woof, fill, filler yarn) *n.* In the textile industry, the transverse threads or fibers in a woven fabric; those fibers running crosswise to the warp.

*See filling.*

**Weft insertion** (1) Any one of the various methods, shuttle, rapier, water jet, etc., for making a pick during weaving. (2) A marriage of warp knitting and weaving brought about by inserting a length of yarn across the width of the knitting elements and fastening the weft yarn between the needle loop and the underlap.

*Also see metap weave-knit process.*

**Weft-knit fabric** (1943) *n. See circular-knit fabric and flat-knit fabric.*

**Weft knitting** (1943) *n. See knitting* (2).

**Weigh feeder** Syn: gravimetric feeder.

**Weighing equipment** Equipment for measuring the mass and/or weight of objects.

**Weight** \ˈwāt\ [ME *wight*, *weght*, fr. OE *wiht*; akin to ON *wœtt* weight, OE *wegan* to weight] (before 12c) *n.* The force with which a body on or near the earth's surface is attracted to the earth, equal to the body's mass × $g/g_c$, where $g$ is the acceleration due to gravity and $1/g_c$ is the proportionality constant in Newton's second law of motion (the law of momentum change). In the SI system, $g_c = 1.00000\,\text{kg m/N s}^2$ while $g$ varies slightly (at sea level) from $9.78039\,\text{m/s}^2$ at 0° latitude to $9.83217\,\text{m/s}^2$ at 90° latitude because of the earth's spin and consequent flattening at the poles, with its "standard value", at about 45°N latitude, being $9.80655\,\text{m}^2/\text{s}$. Thus the abhorred $\text{kg}_\text{f}$ is equated to 9.80655 N. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

*See also force.*

**Weight-average molecular weight** ($M_\text{w}$, $\overline{M}_\text{w}$) For a sample with distributed molecular weights (all commercial polymers), the defining equation is

$$M_\text{w} = \frac{\sum_{i=1}^{\infty} (N_i M_i)(M_i)}{\sum_{i=1}^{\infty} N_i M_i} = \frac{\sum_{i=1}^{\infty} N_i M_i^2}{\sum_{i=1}^{\infty} N_i M_i},$$

where $N_i$ is the number of individual molecules having molecular mass $M_i$ and $N_i M_i$ equals the mass of the $N_i$ molecules in the sample with molecular mass $M_i$. The numerator and denominator quantities are also known as the *second* and *first original moments* of the distribution. $M_\text{w}$ may be determined from measurements of light scattering or size-exclusion chromatography. And it is $M_\text{w}$ upon which melt viscosity in thermoplastics is strongly dependent. Allcock HR, Mark J, Lampe F (2003) Contemporary polymer chemistry, Prentice-Hall, New York. Slade PE (2001) Polymer molecular weights, vol. 4. Marcel Dekker, New York. Coleman MM, Strauss S (1998) Fundamentals of polymer science: an introductory text. CRC Press, Boca Raton, FL.

*See also molecular weight, molecular-weight distribution, number-average molecular weight, and viscosity-average molecular weight.*

**Weight-average molecular weight** A polymer molar mass average which is the mean value of the weight distribution of molecular sizes, defined as $M_w = \Sigma N_i M_i^2 / \Sigma N_i M_i = \Sigma w_i M_i / \Sigma w_i$, where $N_i$, $M_i$ and $w_i$ are the number of molecules, the molar mass, and the total with of the molecular species.

**Weighted ordinate method** Method of calculating tristimulus values from measurements made at regular wavelength intervals. *See tristimulus computational data, tristimulus integration, tris-timulus values, and selected ordinate method.*

**Weighted silk** Silk that has been treated with metallic salts during dyeing and finishing to increase the fabric's weight and improve its drape. Over-weighting can cause deterioration of the fabric.

**Weighting equipment** Equipment for measuring the mass and/or weight of objects.

**Weight loss** The loss of mass of an article or test sample as a result of exposure to particular conditions as, for example, a few hours at 90°C in a vacuum oven, or two years outdoors on a weathering panel, often expressed as a percentage of the original mass. This may be the same as weight loss when the latter is due exclusively to loss of volatiles.

*See also volatiles content.*

**Weight-per-gallon cup** Essentially, a metal (less fragile than glass) pycnometer to simplify computations; the popular size holds 83.2 g of water at 77°F (25°C) or 100 g for the Imperial gallon, so that multiplying the weight of the contents by 0.1 represents the density expressed in pounds per gallon.

**Weir** \ˈwar\ [ME *were*, fr. OE *wer*; akin to ON *ver* fishing place, OHGr *werien*, *werren* to defend] (before 12c) *n.* A simple device for controlling flow in open channels, consisting of a plate serving as a dam and having at its top center a V-notch or adjustable, rectangular, vertically sliding gate. Weirs can also be calibrated for flow measurement.

**Weissenberg effect** A phenomenon sometimes encountered in rotational-viscometry studies of polymer melts and solutions at high speeds, characterized by the tendency of the polymer solution to climb the wall of the cup or the shaft of the rotor immersed in it.

**Weissenberg number (new)** In the flow of viscoelastic liquids, the dimensionless Weissenberg number represents the ratio of the viscoelastic force to the viscous force and has sometimes been equated to $N_1/2\tau$, where $N_1$ is the first normal stress in a viscoelastic fluid flowing in simple shear and $\tau$ is the shear stress.

**Weissenberg rheogoniometer** A vertical cone-and-plate rheometer (K. Weissenberg, 1948, and improvers since) for viscoelastic liquids in which the cone can twist through a measured angle while the plate is rotated at speeds providing shear rates to $100\,s^{-1}$. The cone and plate are enclosed in an oven that provides control of the sample temperature. The plate shaft rests on a ball bearing at its bottom, which in turn rests on a force transducer. Thus, it is possible to measure both the restoring torque on the cone and the normal force on the plate. The first provides an estimate of the liquid's viscosity while the normal force gives an estimate of the normal stress.

*See also mechanical spectrometer.*

**Weld** \ˈweld\ [alter. of obs. E *well* to weld, fr. ME *wellen* to boil, well, weld] (1599) *v.* A metallic bond between like or unlike metals.

**Weldbonding** A process developed in the former USSR and introduced in the USA by the Air Force Materials Laboratory. Developed for the aerospace industry, the process combines spot welding with adhesive bonding of aluminum structures. It has provided an economical and efficient means of laying up and oven curing large, epoxy-bonded assemblies.

**Welding** The joining of two or more pieces of thermoplastic by fusion at adjoining areas, either with or without addition of plastic from another source (such as welding rod). The term includes *heat sealing*, with which it is synonymous in some countries, but in the USA the term heat sealing is limited to film and sheeting. Welding is almost always done with two (or more) pieces of the same plastic, but it can be done with compatible plastics that melt in the same temperature range. The various welding methods are described at the entries listed below. James F Carley (ed) (1993) Whittington's dictionary of plastics, Technomic Publishing Co. Inc., PA, USA. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

Butt fusion
Dielectric heat-sealing
Extruded-bead sealing
Friction welding
Heat sealing
High-frequency welding
Hot-gas welding
Hot-plate welding
Impulse sealing
Induction-welding
Jig welding
Spin welding
Stitching
Thermoband welding
Ultrasonic welding
Vibration welding

**Weld line (weld mark, flow line)** A flaw on a molded plastic article marking the meeting of two flow fronts within the mold. Because the two fronts may have cooled and skinned over before meeting, or had too little time in the molten state for interdiffusion of molecular segments across the interface, the weld may be imperfect and weak. (2) In extrusion of pipe, tubing, and some profiles from end-fed dies in which the cores are supported by spiders, a line parallel to the product axis where the flow front was split by a spider leg and subsequently reunited downstream. Weakness at such weld lines can depress the hoop strength of the pipe or tubing. James F Carley (ed) (1963) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., PA, USA. Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH.

**Weld slag** Amorphous deposits formed during welding.

**Weld splatter** Beads of metal left adjoining weld.

**Wenzel's blue** *See cobalt blue.*

**Westphal balance** Special kind of balance used for the determination of the specific gravity of liquids or solids, by a direct weighting method.

**Wet abrasion resistance** *See scrub resistance.*

**Wet adhesion test** *See tape test.*

**Wet and dry sandpaper** Sandpaper that can be used with water or other lubricants, making possible the sanding of some plastics and metals that is not possible with dry sanding. The lubricant cools the workpiece, washes away swarf, reduces friction, produces finer finishes, resists rusting (with additives), improves abrasive life, and combats loading of the coated abrasive. Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York. Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York.

**Wet edge** Edge of a wet painted area which remains workable. When painting large surfaces, it is generally necessary to join up to the edge of a paint film which has been left for an appreciable time; when this can be done by blending this edge with free-working paint without any lap showing, the film is said to present a wet edge. Syn: live edge.

**Wet-edge time** Length of time a coating remains wet enough to allow for brushing-in at the laps.

**Wet film gauge** Device for measuring wet film thickness of coatings.

**Wet film thickness** Thickness of the liquid coating film immediately after application.

**Wet flexural strength** The flexural strength measured after boiling a test specimen in water, usually less than the strength of the original, dry specimen.

*See also flexural strength.*

**Wet forming** The production of a nonwoven fabric web from an aqueous suspension of fibers by filtering the short fibers onto a screen belt or perforated.

**Wet layup** In the reinforced plastics molding, the process of forming an article by first applying a liquid resin (sometimes a special gel coat) to the mold surface, then applying a reinforcing backing layer with more resin.

**Wet-on-wet coating** Technique of painting whereby further coats are applied before the previous coats have dried, and the composite film then dries as a whole. The process requires specially formulated paints.

**Wet-out** The degree to which an impregnating resin has filled the voids among the filaments being impregnated. This may be expressed quantitatively as 100 × $(1-v_r-\mathrm{VF})/(1-v_r)$ in which $v_r$ is the volume fraction of reinforcing fiber in the laminate and VF is the final void fraction.

**Wet-out time** The time required for a resin to completely fill the interstices of a reinforcement material and wet the surfaces of the fibers, usually determined by an optical or light-transmission method.

**Wet printing** It is the process whereby another impression cleanly transfers over a previously printed wet film. Successful trapping depends upon the relative tack and thickness of the ink films applied.

*See trapping.*

**Wet rot** Decay of timber caused by fungi which flourish in alternate wet and dry conditions.

**Wet sanding** Process of sanding using waterproof papers with liquids, such as water, soluble oil (emulsion), straight cutting oils (mineral and fatty), mineral lard oil (mixture of mineral and lard oils, sulfurized and chlorinated cutting oils and wax).

*See wet and dry sandpaper.*

**Wet scrub resistance** Ability of a paint film to withstand scrubbing in contact with water.

*See scrub resistance.*

**Wet spinning** The process of forming synthetic fibers by extruding or forcing polymers through spinnerets. In wet spinning the polymer is dissolved in a solvent prior to extrusion. Also, in wet spinning, the jet or spinneret is immersed in a liquid, which either diffuses throughout the solvent or reacts with the fiber composition.

**Wet storage stain** *See white rust.*

**Wet strength** The strength of an adhesive joint determined immediately after removal from a liquid (usually water) in which it has been immersed under specified conditions of time, temperature, and pressure. Skeist I (ed) Handbook of adhesives. Van Nostrand Reinhold, New York.

*See strength, wet.*

**Wettability** (1913) *n.* The ability of a solid surface to accept contact of and by a liquid, allowing it to spread freely and completely cover the surface. Wettability is closely linked to the equality of components of surface energy and surface tension of the solid and liquid involved. If the surface is wettable by the liquid, the contact angle of a droplet on the surface will be less than 10°. Hartland S (ed) (2004) Surface and interfacial tension. CRC Press, Boca Raton, FL. O'Conner DJJ, Smart RS, Sexton BA (2003) Surface analysis methods in materials science. Springer-Verlag, New York.

**Wetted out** The condition of an impregnated reinforcement where in substantially all voids between the sized strands and filaments are filled with resin; 100% wet-out.

**Wetting** (1) Power a vehicle possesses of spreading uniformly and rapidly over the surface of pigment particles. A vehicle with good wetting properties assists in the grinding or dispersion of pigments and the ability to wet the surface to which the finished coating is applied. (2) Surrounding the pigment particles with varnish during the ink-making process. Pigments which wet out easily will grind more easily, form better ink bodies, and result in a finer dispersion. Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York.

**Wetting agents** (1927) *n.* A compound that causes a liquid to penetrate more easily into, or to spread over the surface of, another material, usually by reducing the liquid's surface tension. Common wetting agents are soaps, detergents, and surfactants. They are widely used in polymerization reactions and in preparing emulsions of plastics. Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York. Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York.
*See surfactants.*

**Wet winding** A filament-winding process wherein the strand is impregnated with resin just prior to contact with the mandrel.

**Wheatstone's bridge** \ˈhwēt-ˌstōn, ˈwēt-, *chiefly British* –stən-\ [Sir Charles *Wheatstone*] (1872) *n.* If the resistances, $r_1$, $r_2$, $r_3$, and $r_4$ form the arms of a Wheatstone's bridge in order as the circuit (omitting cell and galvanometer connections) is traced, when the bridge is balanced

$$\frac{r_1}{r_2} = \frac{r_4}{r_3} \quad \text{or} \quad \frac{r_1}{r_4} = \frac{r_2}{r_3}.$$

Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York.

**Whipcord** \ˈhwip-ˌkórd\ [fr. its use in making whips] (14c) *n.* A compact woven fabric having a very steep twill on the face of the goods. Whipcord is used in dress woolens, worsteds, or wool blends and in many types of uniforms.

**Whiskers** \ˈhwis-kər\ [singular of *whiskers* mustache, fr. ²*whisk*] (ca. 1600) *n.* A colloquial term used for nearly perfect, single-crystal fibers produced synthetically under controlled conditions from inorganic materials such as aluminum oxide, beryllium oxide, boron, boron carbide, graphite, magnesium oxide, metals, quartz, silicon carbide, and silicon nitride. They range in diameter from 0.5 to 30 μm, and in length from 1 μm to several mm. Whiskers are available as loose fibers, mats, and felts. Having tensile strengths and moduli from 5 to 10 times those of glass, they impart extremely high strength and stiffness to reinforced-plastics structures. Murphy J (1998) Reinforced plastics handbook, Elsevier Science and Technology Books, New York.

**White** \ˈhwīt\ [ME, fr. OE *hwīt*; akin to OHGr *hwīz* white and prob. to OChurch Slavonic *světŭ* light, Sanskrit *śveta* white, bright] (before 12c) *adj.* Most usually applied to neutral or near-neutral colors of high reflectance.

**White blast** Blast cleaning to white metal. *See nace No. 1.*

**White bole (bolus alba)** A Syn: Kaolin. *See aluminum silicate.*

**White earth** Non-specific description applied to several different types of white fillers.

**White goods** (ca. 1871) *n.* A broad term describing any goods that have been finished in the white conditions.

**White lac** Shellac which has been chemically bleached.

**White lead** (15c) *n. See carbonate white lead.*

**White metal** (1613) *n.* Blasting metal to specified appearance such as SSPC-SP-10, NACE No. 1, or SA-3 (Swedish Standard SIS 05 59 00).

**Whiteness** (before 12c) *n.* Perception of high lightness, high diffusion (scattering) and absence of hue generally applied to opaque or translucent solids or liquids.

**Whiteness index** Any of several numerical indices used to indicate the degree of whiteness; examples are the following:

1. $W = 4B - 3G$, where $B$ and $G$ refer to tristimulus colorimeter readings.
2. $W = 100 - [(100 - L)^2 + (a^2 + b^2)]^{1/2}$, where $L$, $a$, and $b$ refer to coordinates in Hunter's $L$, $a$, $b$ Color Difference Equation.
3. Chemstrand whiteness scale $W = 10\,(Y - 2p^2)^{1/2}$, where $Y$ is the CIE tristimulus value and $p$ is the CIE excitation purity.

McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Whitening** (1601) *n.* A finely divided form of calcium carbonate obtained by milling high-calcium limestone, marble, shell, or chemically precipitated calcium carbonate. *See limewashing; whitewash.*

**Whitening in the grain** Fault which sometimes develop in varnished or polished open-grained woods, filled or unfilled. It is manifested as a streaky white appearance. *See bleaching* (1).

**White Portland cement** A Portland cement, produced from raw materials low in iron, which hydrates to a white paste; used to yield a concrete of considerable whiteness.

**White reference standard** *See standard, white reflectance.*

**White reference standard, absolute** *See perfect diffuser and standard, white reflectance.*

**White reference standard, primary** *See standard, white reflectance.*

**White reference standard, secondary** *See secondary reference standard.*

**White rust** (ca. 1848) *n.* White corrosion products (zinc hydroxide and zinc oxide) on zinc-coated articles. They form when the parts are stored so close together that condensed moisture is entrapped between them and the air circulation is inadequate to assist drying. Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International – The Corrosion Society, Houston, TX.

Known also as *Wet Storage Stain.*

**White spirit** British name for mineral spirits.

**Whitewash** \-ˌwósh\ (1591) *n.* Cheap type of flat water paint based on lime or whiting loosely bound with glue, size, casein, or water-dispersible binders. Syn: limewashing, whitening.

**White zinc** (1847) *n.* Another name for zinc oxide.

**Whiting** [ME, fr. gerund of *whiten* to white] (15c) *n.* Calcium carbonate powder of high purity.

*See calcium carbonate, natural.*

**Wicking** (1949) (1) *vt.* Cord, loosely woven or braided tape, or tubing to be cut into wicks. (2) Dispersing or spreading of moisture or liquid through a given area, vertically or horizontally; capillary action in material.

**Wide-angle X-ray scattering (WAXS)** A technique for determining the amount of crystallinity and the sizes and perfection of crystals in polymers, in which diffraction patterns of X-rays scattering at 20°–50° from the incident beam are recorded on film and measured. X-rays of wavelength from 0.1 to 0.3 nm are used to elucidate structural features with sizes from 0.1 to 2 nm. Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models, Elsevier Science and Technology Books, New York.

**Wide-belt sander** A machine using the principle of a contact roll backup for a wide abrasive belt.

**Width** \ˈwidth\ [*¹wide*] (1627) *n.* A horizontal measurement of a material. In woven fabric, it is the distance from selvage to selvage, and in flat-knit fabric, the distance from edge to edge.

**Wien's displacement law** When the temperature of a radiating black body increases, the wavelength corresponding to maximum energy decreases in such a way that the product of the absolute temperature and wavelength is constant. $\lambda_{max} T = w$, where $w$ is known as *Wien's displacement constant.* Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York. Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York.

**Wijs method** Analytical method for determining the degree of unsaturation of a material, which involves the addition of iodine to the existing double bonds. The iodine is derived from a solution of iodine monochloride in glacial acetic acid.
*See iodine test and iodine value; hanus iodine number.*

**Wilkinite** *See bentonite.*

**Wilkinson's blue** *See iron blue.*

**Williams–Landell–Ferry equation** (WLF equation). An empirical equation for the time–temperature equivalence of creep and other properties that has been successful with many plastics. It is

$$\log_{10} a_T = \frac{-17.44\,(T - T_g)}{51.6 + T - T_g},$$

where $T$ and $T_g$ are the temperature of interest and the glass-transition temperature of the polymer, K, and $a_T$ is the shift factor, i.e., the ratio of the viscosities at the two temperatures. The equation holds over the range from $T_g$ to about $T_g + 100$ K.

**Williams unit** A wet-processing unit for open-width processing of fabric. The fabric passes up and down over rollers in the liquor. The unit is widely used for dyeing, washing, pretreating, and aftertreating.

**Wilton carpet** Woven carpet in which the pile yarns are woven in as an integral part of the carpet, being held in place by the filling, usually made on a loom with a Jacquard head.

**Winding** \ˈwīn-diŋ\ (before 12c) *n.* Winding is the process of transferring yarn or thread from one type of package to another to facilitate subsequent processing. The rehandling of yarn is an integral part of the fiber and textile industries. Not only must the package and the yarn itself be suitable for processing on the next machine in the production process, but also other factors such as packing cases, pressure due to winding tension, etc., must be considered. Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York.

**Window** \ˈwin-(ˌ)dō\ [ME *windowe*, fr. ON *vindauga*, fr. *vindr* wind (akin to OE *wind*) + *auga* eye; akin to OE ēage eye] (13c) *n.* A globule of incompletely plasticated material in a thermoplastic film, sheet, or molding that is visible when viewed by transmitted light. It is equivalent to fisheye except that the term window is usually employed to indicate a clear spot in an otherwise colored or opaque material. Rosato DV (ed) (1992) Rosato's plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York.

**Window paning** A fabric defect caused by non-uniform yarn. When thin sections of yarn become grouped together, the resultant increase in the transparency of the fabric is called window paning.

**Window sash** *See sash.*

**Wind ratio** The number of wraps that an end or ends make in traversing from one side of a wound package to the other side and back to the first side.

**Wine gallon** A standard US gallon of 231 in.$^3$ (3.78541). As commonly used, this term refers to alcohol at 60°F, which is the standard temperature prescribed by the Federal Government for gauging alcohol.

**Winterized oils** Oils (e.g., fish oils) which have been stored in a cold place for a long time to allow the solid (i.e., mostly saturated) components to settle out.

**Wipe-on plate** In offset lithography, a plate on which a light-sensitive coating is wiped on or applied with a coating machine.

**Wire-bar application** *See wire-wound rod.*

**Wire brush** (1) A hand cleaning tool comprised of bundles of wires. (2) The act of cleaning a surface with a wire brush including wire power brushes.

**Wire coating** The application of a plastic, rubber, or enamel coating to a single- or multi-strand wire, or to a cable of many previously coated single wires. Most wire coating is done by extrusion from the melt, but some, such as magnet wire for electric motors, have been done by passing the wire through a solution of thermosetting resin, then evaporating the solvent and curing the resin in an oven. Lineal rates on extrusion-coating lines range from 0.5 m/s on a line over coating a large cable containing hundreds of wires to 30 m/s on a line coating hood-up wire. Over 500 Gg (0.55 × $10^6$ tons) of leading thermoplastics were used to coat wire and cable in 1992.

**Wire gauge** (1833) (wire gage) *n.* (1) Any of several shorthand systems of consecutive numbers, each number relating inversely to a particular wire diameter. Steel producers in the USA use the steel wire gauge, ranging from 7/0 (0000000), (=0.4900 in.), to 0 (=0.3065 in.), to 50 (=0.0044 in). In Britain, the British Standard Wire Gauge (Imperial Wire Gauge) has long been used, with diameters close to those of the steel wire gauge. (This may be changing to metric.) Copper and aluminum wires, formerly given in Brown & Sharpe (B&S) wire gauge, are now specified in decimal-fractional inches. Contrarily, music- (piano-) wire sizes *increase* with their gauge numbers. The Standard for Metric Practice, ASTM E 380, has strangely omitted this important area of measurement. Presumably, in SI, there are no "gauges", and wire sizes are given in millimeter, as are screen sizes. (2) A metal plate perforated with graduated and labeled holes with which one may determine the size of a wire or drill bit by identifying the smallest hold through which the wire will pass.

**Wire-wound rod** A metal rod wound with a fine wire around its axis to that an ink or coating can be drawn down evenly and at a given thickness across a substrate. The thickness or gauge of the wire controls the depth of wet film applied by the rod. Syn: equalizer rod, meyer bar, wire-bar applicator.

**Withering** \ˈwith-riŋ\ (1579) *adj.* The loss of gloss caused by varnishing open-pore woods without filling pores, use of improper undercoating, or applying topcoat before undercoat has dried.

**Witherite** \ˈwi-thə-ˌrīt\ [Gr *Witherit*, irreg. fr. William *Withering* † 1799] (1794) *n.* *See barium carbonate.*

**WLF equation** Williams–Landell–Ferry equation:

$$\log a_{\mathrm{T}} = \frac{-17.4\,(T - T_g)}{51.6 + T - T_g},$$

where $a_{\mathrm{T}}$ is the shift factor, $T$ the selected temperature (°C), $T_g$ is the glass transition temperature (°C).

The shift factor is the shift in time scale corresponding to the difference between the selected and reference temperature, and the shift factor represents the temperature dependence of the rate of the segmental motion which underlies all viscoelastic behavior; the WLF equation demonstrates that all polymers, irrespective of their chemical structure, will exhibit similar viscoelastic behavior at equal temperature intervals ($T$–$T_g$) above their respective glass transition temperatures ($T_g$). Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York.

*See Williams–Landell–Ferry equation.*

**Wollastonite** \ˈwu-lə-stə-ˌnīt, ˈwä-\ [William H. *Wollaston*] (1823) *n.* *See calcium silicate, natural.*

**Wood** \ˈwüd\ [ME, fr. OE *wōd* insane; akin to OHGr *wuot* madness] (before 12c) *adj.* The hard, fibrous substance which composes the trunk and branches of a tree, lying between the pith and bark.

**Wood alcohol** (1861) *n.* $CH_3OH$. An impure alcohol historically obtained from the destructive distillation (pyrolysis in the absence of air) of wood, whose main constituent was methanol. Today, methanol is synthesized from carbon monoxide and hydrogen. It is toxic and is used as a denaturant in ethanol to make it impotable.

**Wood, built-up laminated** An assembly made by joining layers of lumber with mechanical fastenings so that the grain of all laminations is essentially parallel.

**Wood chipboard** *See particle board.*

**Woodcut** A wooden printing plate, the image of which has been left in relief by cutting away the background.

**Wood engraving** (1816) *n.* A relief printing surface consisting of a wooden block with a usually pictorial; design cut in the end grain.

**Wood failure** The rupturing of wood fibers in strength tests on bonded specimens, usually expressed as the percentage of the total area involved which shows such failure.

**Wood fiber** (1875) *n.* Any of various fibers in or associated with xylem.

**Wood filler** Heavily pigmented product used to fill the grain of wood before the application of undercoats or finishes.

**Wood finishing** The planning, sanding, and subsequent staining, varnishing, waxing, or painting of a wood surface.

**Wood flour** Very fine wood particles generated from wood reduced by a ball or similar mill until they resemble wheat flour in appearance, and of such size that the particles usually will pass through a 40-mesh screen.

**Wood, glued laminated** An assembly made by bonding layers of veneer or lumber with an adhesive so that the grain of all laminations is essentially parallel.

**Wood grain** A fabric defect that consists of fillingwise streaks resembling the irregular appearance of wood grain in lumber. Wood grain is usually caused by strained filling in quilling, the tension being more pronounced near the butt of the quill.

**Woodgraining** A group of processes used to impart wood-like appearance to sheets or shaped articles. The substrates may be of plastic, wood, steel, or any other material. Among the processes used are conventional laminating techniques, multiple-coat painting, hot stamping, and introduction of several colors into the melt during molding.

**Wood oil** *See tung oil.*

**Wood preservative coatings** Coatings which are formulated to protect wood from decay and insect attack.

**Wood pulp** (1866) *n.* The cellulosic raw material for viscose rayon and for acetate.

**Wood rosin** Rosin obtained from pine stumps.
*See rosin.*

**Wood tar** (1857) *n.* A black, syruplike, viscous fluid that is a by-product of the destructive distillation of wood and is used in pitch, wood preserving oils, preservatives, and medicine.

**Wood turpentine** (ca. 1909) *n. see turpentine.*

**Wood veneer** A thin sheet of wood, generally within the thickness range from 0.01 to 0.25 in. (0.3–6.3 mm) to be used in a laminate.
*See veneer.*

**Woof** \ˈwüf\ [alter. of ME *oof*, fr. OE *ōwef*, fr. *ō*- (fr. *on*) + *wefan* to weave] (before 12c) *n.* Syn: weft.
*See filling.*

**Wool** \ˈwül\ [ME *wolle*, fr. OE *wull*; akin to OHGr *wolla* wool, L *vellus* fleece, *lana* wood] (before 12c) *n.* The term is usually used for the fleece of sheep. More precisely defined as: The fiber from the fleece of the sheep or lamb or hair of the Angora or Cashmere goat (and may include the so-called specialty fibers from the hair of the camel, alpaca, llama, and vicuna) which has never been reclaimed from any woven or felted wool product. Wool is used in a variety of blends in which it is combined with nearly all natural or manufactured fibers. Schoeser M (2003) World textiles: a concise history. Thames and Hudson. Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Worbaloid** Cellulose nitrate., manufactured by Worbla AG, Switzerland.

**Work** \ˈwərk\ [ME *werk*, *work*, fr. OE *werc*, *weorc*; akin to OHGr *werc*, Gk *ergon*, Avestan *varəzem* activity] (before 12c) *n.* The action of a force through a distance; the product of force times the distance. Also, the action of a torque through an angular displacement; the product of the torque times the displacement in radians. The SI unit of work, the same as that of energy, is the joule (J), equal to 1 Nm.

**Work and tumble** To print one side of a sheet of paper, then turn the sheet over from gripper to back, using the same guide, and print the other side.

**Work and turn** To print one side of a sheet of paper, then turn the sheet over from left to right and print the other side. The same gripper is used for printing both sides.

**Work hardening** Alternate for strain hardening.

**Working distance** The distance between the top of the coverslip and the nearest portion of the objective.

**Working life** The period of time during which an adhesive, after mixing with catalyst, solvent, or other compounding ingredients, remains suitable for use. Syn: pot life and service life.

**Working loss** The irrecoverable loss of weight or yardage of a textile material that occurs during a textile process.

**Working stress** *See allowable stress.*

**Working time** Period of time during which an adhesive or coating, after mixing with catalyst, solvent or other compounding ingredients, remains suitable for use. *Also called working life. See pot life.*

**Work recovery** The ratio of recoverable work to the total work required to strain a fiber a specified amount under a given program of strain rate.

**Work-to-break** *See energy-to-break.*

**Worsted** \ˈwər-stəd\ [ME, fr. *Worsted* (now *Worstead*), England] (13c) *n.* A general term applied to fabrics and yarns from combed wool and wool blends. Worsted yarn is smooth-surfaced, and spun from evenly combed long staple. Worsted fabric is made from worsted yarns and is tightly woven with a smooth, hard surface. Gabardine and serge are examples of worsted fabrics.

**Woven fabric** Generally used to refer to fabric composed of two sets of yarns, warp and filling, that is formed weaving, which is the interlacing of these sets of yarns. However, there are woven fabrics in which three sets of yarns are used to give a triaxial weave. In two-dimensional wovens, there may be two or more warps and fillings in a fabric, depending on the complexity of the construction. The manner in which the two sets of yarns are interlaced determines the weave. By using various combinations of the three basic weaves, plain, twill, and satin, it is possible to produce an almost unlimited variety of constructions. Other effects may be obtained by varying the type of yarns, filament or spun, and the fiber types, twist levels, etc. Humphries M (2000) Fabric glossary. Prentice-Hall, Upper-Saddle River, NJ.

**Wrap-around** The phenomenon by which electrically charged paint droplets curve around to the rear side of the object being painted.

**Wrinkle** \ˈriŋ-kəl\ [ME, back-form. fr. wrinkled twisted, winding, prob. fr. OE *gewrinclod*, pp. of *gewrinclian* to wind, fr. *ge-*, perfective prefix + *-wrinclian* (akin to *wrencan* to wrench] (15c) *n.* (1) An imperfection in reinforced plastics that has the appearance of a wave molded into one or more plies of fabric or other reinforcing material (ASTM D 883). (2) In a plastic film or coated cloth, an inadvertent crease.

**Wrinkle finish** (1) Type of finish characterized by the presence of wrinkles of fairly uniform dimensions. The effect is obtained by inducing a pronounced but controlled tendency toward rapid surface dry. This finish is generally baked rather than air dried. The size of the wrinkle can be adjusted by variation in the type and amount of drier, type and amount of pigment, thickness of applied film and baking temperature. (2) A varnish or enamel film which exhibits a novelty effect similar to skin wrinkles.

**Wrinkle mark** *See steam mark.*

**Wrinkle recovery** It is the property of a fabric that enables it to recover from folding deformations.

**Wrinkle resistance** It is the property of a fabric that enables it to resist the formation of wrinkles when subjected to a folding deformation. Wrinkle resistance in a fabric is a desirable attribute, but it is not easily measured quantitatively. Wrinkle resistance varies from quite low in many fabrics to very high in resilient fabrics. In order to form a wrinkle, a fabric's wrinkle resistance must be overcome. The fabric may, however, produce strains and store potential energy that can become evident as wrinkle recovery under suitable conditions.

**Wrinkling** The distortion in a paint film appearing as ripples; may be produced intentionally as a decorative effect or may be a defect caused by during conditions or an excessively thick film.

*Also called crinkling riveling. See gas checking.*

**Wrong color pick** *See mixed end or filling.*

**Wrong pck** *See mispick.*

**Wurtzilite** *See asphaltic pyrobitumens.*

**WVTR** Abbreviation for water–vapor-transmission rate.

**WW** Initial letters meaning "water-white" and applied to a pale grade in a color scale of rosin. The term is also applied to other resins, or solutions of the same, which are practically colorless.

# X

**x** \ˈeks\ {*often capitalized, often attributive*} (before 12c) *n.* (1) Symbol for mole fraction, usually subscripted to indicate the component of interest. (2) Symbol for general variable, or independent variable, and the horizontal graphing axis, or abscissa. (3) One of the CIE chromaticity coordinates calculated as the fraction of the sum of the three tristimulus values attributable to the $X$-value:

$$x = \frac{X}{X + Y + Z}.$$

McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England. *See chromaticity coordinates, CIE.*

**$\bar{x}$** *n.* Special color matching functions of the CIE standard observer used for calculating the $X$ tristimulus value. McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

*See tristimulus computation data, tristimulus value, and color matching functions.*

**X** (1) One of the three CIE tristimulus values; the red primary. *See tristimulus values, CIE.* (2) Symbol, proceeded by a number, for power of magnification and, closely related, and sometimes used in place of x, the multiplication operator.

**Xanthate** \ˈzan-ˌthāt\ (1831) *n.* A sodium salt of a dithiocarbonic acid ester, in particular the one formed in the viscose-rayon process by the reaction between sodium hydroxide cellulose and carbon disulfide and having the structure shown below, called cellulose xanthate or *viscose.* The viscose is subsequently precipitated, filtered, extruded as filaments into dilute sulfuric acid, washed, and dried to make viscose that be spun into Rayon® fabric, and extruded thin sheets are called Cellophane®. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York. Ash M, Ash I (1982, 1983) Encyclopedia of plastics, polymers, and resins, vols I–III. Chemical Publishing Co., New York.

**Xanthating** *n.* A process in rayon manufacture in which carbon disulfide is reacted with alkali cellulose to produce bright orange cellulose xanthate.

**Xanthic** Containing yellow or pertaining to yellow color.

**Xenon** \ˈzē-ˌnän, ˈze-\ [Gk, neuter of *xenos* strange] (1898) *n.* A heavy, colorless, and relatively inert gaseous element that occurs in air as about one part in 20 million by volume and is used especially in thyratrons and specialized flashtubes. Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York.

**Xenon-arc aging** *n.* A test for evaluating the light stability of plastics, employing a xenon-gas-discharge lamp of special design that emits radiation duplicating the spectrum of natural sunlight more closely than most artificial sources. ASTM lists two such tests for plastics, D4459 with dry specimens and G26, in which the specimens may or may not be sprayed with water.

**Xenon-arc lamp** *n.* A type of light source used in fading lamps. It is an electric discharge in an atmosphere on xenon gas at a little below atmospheric pressure, contained in a quartz tube.

**XLPE** *n.* Abbreviation for cross-linked polyethylene.

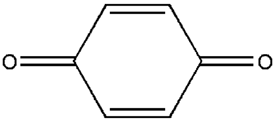
*See radiation cross-linking.*

**XPS** Abbreviation for expandable or expanded polystyrene.

*See polystyrene foam.*

**X-ray** \ˈeks-ˌrā\ {*often capitalized*} (1899) *n.* An electromagnetic radiation with wavelength in the range from 0.003 to 3 nm, produced by the bombardment of a target with cathode rays. Those with the shorter wavelengths are more energetic and are called *hard X-rays*, while those with the longer wavelengths are called *soft X-rays.*

**X-ray diffraction** *n.* Crystals, whose interatomic spacings are commensurable with the wavelengths of some X-rays, can act as diffraction gratings for X-rays. When X-rays are directed obliquely at a crystal surface, and the resulting radiation is captured on photographic film, a symmetrical pattern of spots is observed that is related to the positioning of atoms in the crystal. This 80-year-old plus technique has been useful in studying crystalline structure in polymers. An X-ray power data file for materials is available from ASTM. Suryanarayana C, Norton MG (2003) X-ray diffraction: a practical approach. Plenum Publishing Company, New York. Gooch JW (1997) Analysis and deformulation of polymeric materials. Plenum Press, New York.



*See also small-angle X-ray scattering and wide-angle X-ray scattering.*

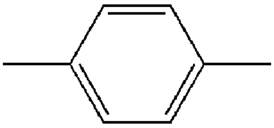
**X-ray microscopy** *n.* This instrument and technique is similar to an optical microscope except that X-rays are utilized to magnify and study an object instead of visual light. Images beneath a surface can be studied because X-rays penetrate materials including metals. Defects located within the interior of an object (plastic pipe) can be observed without disturbing the structure or cutting a cross-section. The technique is useful for studying the structure of materials such as composites, fibers, and plastics. Morrison GR (2004) X-ray microscopy: techniques and applications. World Scientific Publishing Company Inc., Singapore.

**X Units** *n.* X-ray wavelengths have been measured in two kinds of units. The older measurements are given in X units (XU), which are based on the effective lattice constant of rock salt being 2,814.00 XU. More recently X-ray wavelengths have been directly connected, through measurements with ruled gratings, to the wavelengths in the optical region and through them to the standard meter. It turned out that the XU which was originally intended as $10^{-11}$ cm was 0.202% larger than this value. It has become customary to give X-ray wavelengths in Angstrom units (Å) when the absolute scale is used (1 Å = $10^{-8}$ cm). The two are related by

$$1{,}000\,\mathrm{XU} = (1.00202 + 0.00003)\,\text{Å}$$

and wavelengths given in XU must be multiplied by 1.00202 and then divided by 1,000 in order to concert them from Angstrom units. Giambattista A, Richardson R, Richardson, RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Xylene** \ˈzī-ˌlēn\ [ISV] (1851) *n.* $C_6H_4(CH_3)_2$. A commercial mixture of the three isomers, *o*-, *m*-, and *p*-xylene, used as a solvent for alkyd resins, polystyrene, natural resins, rubber, and polyisobutylene. Wypych G (ed) (2001) *Handbook of solvents.* Chemtec Publishing, New York.



*Also known as Xylol* (*See image*).

**o-Xylene** (1,2-dimethylbenzene) 1,2-$C_6H_4(CH_3)_2$ *n.* A colorless liquid, insoluble in water, miscible with alcohol, ether, and many other organic liquids. Used as a feedstock in the production of phthalic anhydride. It can be extracted from the mixed isomers by distillation and can be isomerized to *p*-xylene. Mp, –25°C; Sp gr, 0.897 per 20°C; bp, 144°C.

**m-Xylene** (1,3-dimethylbenzene) $C_6H_4(CH_3)_2$ *n.* Colorless liquid, insoluble in water, miscible with alcohol, ether, and many other organic liquids. Bp, 139.3°C; Sp gr, 0.8684 per 15°C; mp. 47.8°C.

**p-Xylene** (1,4-dimethylbenzene) 1,4-$C_6H_4(CH_3)_2$ *n.* A colorless liquid, insoluble in water, miscible with alcohol, ether, and many other organic liquids. Used in the synthesis of terephthalic acid and dimethylterephthalate, both of which are intermediates for polyester fibers and films. Mp, 13.2°C; bp, 137–138°C; Sp gr, 0.8611 per 20°C.

**p-Xylene-$\alpha,\alpha'$-Diol** *n.* $C_6H_4(CH_2OH)_2$. A white crystalline solid used as a cross-linking agent in polyurethanes, and in the production of polyesters and polycarbonates.

**Xylenol resin** A phenolic-type resin produced by condensing xylenol (3,5-dimethylphenol) with an aldehyde. Polyphenylene oxide is made from 2,6-xylenol.

**Xylography** \zī-ˈlä-grə-fē\ [F *xylographie*, fr. *xyl-* + *-graphie*] (1816) *n.* The art of printing with wooden blocks. Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York.

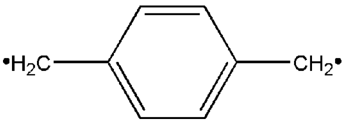
**Xylol** \ˈzī-ˌlōl\ [ISV] (1851) *n.* The term "xylol" is still used commercially for xylene, but is not preferred tin modern nomenclature.

*See xylene.*

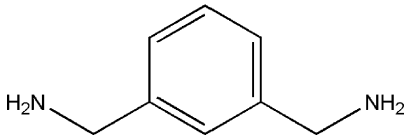
**Xylox resin®** *n.* Trade name for a family of heat-resistant thermosetting resins made by the condensation of aralkyl ethers and phenols, resulting in hydroxyphenylene-*p*-xylene prepolymers that can be cured to hard, intractable resins by reaction with hexamethylenetetramine or epoxy compounds. These thermosetting resins have the good qualities of phenolics and epoxies, with superior mechanical and electrical properties at elevated temperatures.

**p-Xylylene** \ˈzīl-el-ˌlēn\ (PX) $H_2C{=}C_6H_4{=}CH_2$ *n.* A highly reactive monomer from which parylene polymer is formed $(–CH_2C_6H_4CH_2–)_n$. The gaseous monomer readily forms a stable solid dimmer, convenient for shipping, from which the monomer is easily regenerated by heating. PX polymerizes spontaneously in vacuum on any cool surface to form tough, uniform, impervious films. Dimers with ring-substituted chlorine are also available.

*See also di-p-xylylene* and *parylene* (*See image*).



**m-Xylylenediamine** *n.* A solid diamine useful as curing agent for epoxy resins (*See image*).



**Xylylene diisocyanate** *n.* A mixture of the *m*- and *p*-isomers, used in the production of polyurethane coatings.

# Y

**y** \ˈwī\ *n.* Abbreviation. (1) Abbreviation for year. (2) Symbol for general dependent variable and the ordinate (vertical) axis in two-dimensional graphing. (3) One of the CIE chromaticity coordinates calculated as the fraction of the sum of the three tristimulus values, attributable to the *Y*-value:

$$y = \frac{Y}{X + Y + Z}.$$

*See chromaticity coordinates, CIE.*

**Ỷ** *n.* Special color matching function of the CIE standard observed used for calculating *Y* tristimulus value.

*See tristimulus computation data, tristimulus values, and color matching functions.* McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Y** *n.* Abbreviation. (1) Chemical symbol for the element yttrium, which has been used as a catalyst for ethylene polymerization. (2) One of the three CIE tristimulus values, equal to the luminous reflectance or transmittance; the green primary.

*See tristimulus values and luminous directional reflectance.*

**Yacca yum** *See accroides.*

**Yardage** \ˈyär-dij\ (1867) *n.* The amount or length of a fabric expressed in yards.

**Yard denier** *n.* The denier of a filament yarn. It is the product of the denier per filament and the number of filaments in the yarn.

**Yard goods** (1905) *n pl.* Fabric sold on a retail basis by the running yard.

**Yarn** \ˈyärn\ [ME, fr. OE *gearn*, fr. OHGr *garn* yarn, Gk *chordē* string, L *hernia* rupture, Sanskrit *hira* band] (before 12c) *n.* A generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric. Yarn occurs in the following forms: (1) a number of fibers twisted together (spun yarn); (2) a number of filaments laid together without twist (a zero-twist yarn); (3) a number of filaments laid together with a degree of twist; (4) a single filament with or without twist (a monofilament); or (5) a narrow strip of material, such as paper, plastic film, or metal foil, with or without twist, intended for use in a textile construction. Kadolph SJJ, Langford AL (2001) Textiles, Pearson Education, New York.

**Yarn construction** *n.* A term used to indicate the number of singles yarns and the number of strands combined to form each successive unit of a plied yarn or cord.

**Yarn dyeing** *See dyeing.*

**Yarn dyeing differences** *n.* Variations in take-up of dyes by yarns, resulting in streaks in finished fabrics.

**Yarn intermediate** *n.* A generic term for products obtained during the conversion of fibers to yarn, including card webs, laps, slivers, rovings, and tops.

**Yarn number** *n.* A relative measure of the fineness of yarns. Two classes of systems are in use: (1) Direct yarn number (equal to linear density) is the mass per unit length of yarn. This system is used for silk and manufactured filament yarns. (2) Indirect yarn number (equal to the reciprocal of linear density) is the length per unit mass of yarn. This system is used for cotton, linen, and wool-type spun yarns. Also *see cotton count.* Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Yarn number, equivalent single** *n.* The number of a plied yarn or cord determined by the standard methods used for singles yarns. Kadolph SJJ, Langford AL (2001) Textiles. Pearson Education, New York.

**Yarn quality** *n.* Various grades of yarn designated by the producer with respect to performance characteristics, e.g., first quality, second quality, etc.

**Yarn-to-cord conversion efficiency** In tire cord, this is a measurement relating tensile strength of untwisted yarn to tensile strength of cord. Increasing cord twist or increasing yarn diameter lowers conversion efficiency. Vincenti R (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York.

**Yarn variation** *See ring.*

**Year ring** *n.* An annual ring of growth in timber.

**Yellow accroides** *n.* Bright, yellow-colored resin obtained from Australia. It resembles red accroides, and is used to a limited extent in some types of spirit varnishes.

*See accroides.*

**Yellow chrome** *See chrome yellow.*

**Yellowing** (1598) *v.* Development of a yellow color on aging; most noticeable in the dried films of white paints or clear varnishes. Primary cause of yellowing is the formation of color bodies due to oxidation of the oil or other unsaturated components of the binder.

**Yellow iron oxide** *n.* $Fe_2O_3 \cdot xH_2O$. Pigment yellow (77492). A natural or synthetic iron oxide. It has excellent bleed resistance, chemical resistance (both acid and alkali), lightfastness, and dispersibility, as well as excellent toxicity ratings. However, these yellow oxides have only fair heat resistance since they are subject to color change bout 177°C due to loss of water of hydration. Syn: ferrite yellow, ocher, monohydrate of ferric oxide, and limonite.

**Yellow limonite** *n. See iron oxides, natural.*

**Yellowness** The attribute by which an object color is judged to depart from a preferred white toward yellow. Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York, www.astm.org

**Yellowness coefficient** *n.* Measure of the color of a molded acetate disc or dope solution. $C_y = 1 - T4400/T6400$, where $C_y$ is the yellowness coefficient; T4400 is the transmission at 4400A (blue); and T6400 is the transmission at 6400A (orange). Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York.

**Yellowness index** (YI) *n.* A measure of the yellowing of a plastic, such as might occur after lengthy exposure to light. It is determined according to ASTM D 1925, and is therein defined as the deviation in chroma from whiteness or water-whiteness in the dominant wavelength range from 570 to 580 nm. The index is computed from the three tristimulus values measured with a spectrophotometer, relative to a magnesium oxide standard. An example is the following:

$$YI = 100(R\text{-B})/G,$$

where $R$, $G$, and $B$ are tristimulus colorimeter readings, all normalized to 100. In CIE tristimulus terms, the equation becomes

$$YI = (128X\text{-}106Z)/Y \text{ (ASTM D 1925).}$$

Abbreviation is YI. McDonald R (ed) (1977) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Yellow ocher** (15c) (1) *n.* A mixture of limonite usually with clay and silica used as a pigment. (2) A moderate orange yellow.

**Yellow ocher, synthetic** *n.* A synthetic yellow iron oxide reduced with aluminum silicate or other extender pigments.

*See ocher.*

**Yellow pine** (1709) *n.* A hard resinous wood of the longleaf pine tree, having dark bands of summerwood alternating with lighter-colored springwood; used as flooring and in general construction.

**Yield** \ˈyē(ə)ld\ (15c) *n.* (1) Number of linear or square yards of fabric per pound of fiber or yarn. (2) The number of finished square yards per pound of greige fabric.

**Yield point** *n.* In tensile testing, the first point on the stress–strain curve at which an increase in strain occurs without an increase in stress. This is the point at which permanent (plastic) deformation of the specimen begins. Many plastics do not exhibit an identifiable yield point. Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

**Yield strength** *n.* The stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain. Unless otherwise specified, this stress will be the stress at the yield point (ASTM D 638 and D 638M).

*See also offset yield strength.* Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York, www.astm.org

**Yield value** *n.* A rheological term describing the flow properties of a printing ink, and defined as the minimum force required that produces flow, i.e., or the minimum shearing stress which must be applied to a plastic material to initiate flow or shearing within the fluid. It may be measured in dyne/cm$^2$ or newton/m$^2$ and is the shearing force producing infinitely slow rate of flow between adjacent planes.

Also known as *yield stress.* Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. John Wiley and Sons, New York. Coussot P(2005) Rheometry of pastes, suspensions and grannular materials: applications in industry and environment. John Wiley and Sons, New York.

**Young's modulus** *n.* A property of perfectly elastic materials, it is the ratio of change in stress to change in strain within the elastic limits of the material. The ratio is calculated from the stress expressed in force per unit cross-sectional area, and the strain expressed as a fraction of the original length. Modulus so calculated is equivalent to the force required to strain the sample 100% of its original length, at the rate prevailing below the elastic limit.

*See coefficient of elasticity and modulus of elasticity.* Shah V (1998) Handbook of plastics testing technology. John Wiley and Sons, New York.

# Z

**z** *n* \ˈzē, *Canadian, British, & Austral* ˈzed, *chiefly dial* ˈi-zərd\ {*often capitalized, often attributive*} *n.* (1) In rectangular and cylindrical coordinate systems, the symbol for the vertical (axial) coordinate. (2) Symbol for standard normal deviate. (3) One of the CIE chromaticity coordinates calculated as the fraction of the sum of the three tristimulus values attributable to the $Z$ primary:

$$z = \frac{Z}{X + Y + Z}$$

McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.
*See chromaticity coordinates, CIE.*

**z̄** Special color matching function of the CIE standard observer used for calculating the $Z$ tristimulus value.
*See tristimulus computation data, tristimulus values, and color matching functions.* McDonald R (ed) (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England.

**Z** *n.* (1) Symbol for atomic number, or electrical impedance. (2) One of the three CIE tristimulus values; the blue primary.

**Zaffre** *n. See cobalt blue.*

**Zahn cup** *n.* A device for measuring viscosity of paints, varnishes, and flexographic or gravure inks.

**Zahn viscosity cup** *n.* A one-shot device for obtaining quick measurements in a roughly linear way of the kinematic viscosity of the test liquid, typically a free-flowing fluid. The cup ful of test liquid is brought to the desired temperature in a bath of heating medium, then held over a collection vessel and allowed to empty through a short tube in its bottom. Measurements are reported as Zahn number–$X$ seconds, $X$ indicating which of five different cups was used. Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995.

**Zanzibar copal** \ˈzan-zə-ˌbär ˈkō-pəl, -ˌpal; kō-ˈpal\ *n.* A very hard fossil resin obtained from the eastern side of Africa, and in the past from the island of Zanzibar. *Known also as Animi.*

**Z-Average molecular weight** $(M_z, \bar{M}_z)$*n.* A higher-degree average than weight average or viscosity average, but closer to the former, and defined by the equation

$$M_z = \sum_{i=1}^{\infty} N_i M_i^3 \bigg/ \sum_{i=1}^{\infty} N_i M_i^2,$$

$M_z$ is more sensitive than the other averages to the largest molecules present in the sample. The sums in the numerator and denominator are also known as the *third* and *second original moments* of the molecular-weight distribution. Slade PE (2001) Polymer molecular weights, vol 4. , Marcel Dekker, New York. Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York. Elias HG (1977) Macromolecules. vols 1-2. Plenum Press, New York.

**Z-Calender** *n.* A calender with four rolls arranged so that, as the web of material (fabric) passes through them, the cross section of its path has a shape resembling the letter Z.

**Zein** \ˈzē-ən\ [NL *Zea*] (1822) *n.* A naturally occurring, high-molecular-weight protein, a polymer of amino acids linked by peptide bonds, derived from corn. It is considered to be a member of the protein family of plastics, the main member of which is casein plastic. Zein resins, rarely seen today, years ago were used for fibers (e.g., Vicara), films, and paper coating.

**Zein fiber** *n.* A manufactured fiber of regenerated protein derived from maize.

**Zero-point energy** *n.* The energy of a solid at absolute zero due to its residual nuclear, electronic, atomic, and molecular motion. The lowest energy state of a substance. Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science/Engineering/Math, New York.

**Zero-twist** *n.* Twistless, devoid of twist.

**Zeta potential** *n.* The potential across the interface of all solids and liquids. More specifically, it is the potential across the diffuse layer of ions surrounding a charged colloidal particle, and is largely responsible for colloidal stability.

Also known as *Electrokinetic potential.* Becher P (1989) Dictionary of colloid and surface science. Marcel Dekker, New York.

**Zeta space** *n.* Color difference equation devised by Saunderson and Milner.

*See Saunderson–Milner zeta space color difference equation.*

**Ziegler catalyst** \ˈtsē-glər ˈka-tᵊl-əst\. Any of a large group of catalysts made by reacting a compound of a transition metal chosen from groups IV–VIII of the periodic table with an alkyl, hydride, or other compound of a metal from groups I–III. A typical example is the reaction product of an aluminum alkyl with titanium tetrachloride or titanium trichloride. These catalysts were first discovered by the German chemist K. Ziegler (in the late 1940s) for the low-pressure polymerization of ethylene. Subsequent work by G. Natta (in the early 1950s) showed that these and similar catalysts are useful for preparing stereoregular polyolefins; thus, the family of catalysts is sometimes called *Ziegler–Natta catalysts.* Odian GC (1977) Principles of polymerization. John Wiley and Sons Inc., New York. Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York.

**Zimate** *n.* Trade name of the R. T. Vanderbilt Co., for a group of diallyl dithiocarbamates, useful as accelerators for curing rubber.

**Zinc** \ˈziŋk\ [Gr *Zink*] (1651) *n.* A bluish white crystalline metallic element of low to intermediate hardness that is ductile when pure but in the commercial form is brittle at ordinary temperatures and becomes ductile on slight heating. It is used especially as a protective coating for iron and steel.

**Zinc baryta white** Syn: lithopone.

**Zinc borates** *n.* White amorphous powders of indefinite composition containing various amounts of zinc oxide and boric oxide. They are used as flame retardants in PVC, polyvinylidene chloride, polyesters, and polyolefins, often in combination with antimony trioxide.

**Zinc–cadmium sulfides** *n.* Combination of zinc sulfide and cadmium sulfide, along with special additives, manufactured by highly specialized procedures and used as fluorescent pigments.

**Zinc chromate** *n.* $4ZnOK_2O_4CrO_3{\cdot}3H_2O$. Pigment yellow 36 (77955). Bright yellow pigment which chemically is substantially zinc chromate, although its precise composition is rather complex. Its chief use is in anticorrosive paints and primers for steel. Density, 3.36–3.49 g/cm$^3$ (28.1–29.1 lb/gal); O.A., 28–31; particle size, 0.2–5.0 µm.

*Also known as zinc yellow.*

**Zinc chloride** (1851) *n.* A poisonous caustic deliquescent salt $ZnCl_2$ used as a wood preservative, drying agent, and catalyst.

**Zinc coated** *See galvanizing.*

**Zinc drier** *n.* Zinc salts of acids generally used for driers, such as naphthenic or 2-ethyl hexoic, are not driers. However, when used with driers such as cobalt, it often prevents wrinkling and skinning. It acts as an auxiliary drier.

**Zinc dust** *n.* Finely divided zinc metal used as a pigment in protective paints for iron steel.

**Zinc ferrocyanide** *See antwerp blue.*

**Zinc green** *See cobalt green.*

**Zinc oxide** (1849) (Chinese white, flowers of zinc, and zinc white) *n.* ZnO. Pigment white 4 (77947). An amorphous white or yellowish powder, used as a pigment in inks, rubber, paint, and plastics for mildew resistance and film reinforcing properties. It is said to have the greatest power to absorb ultraviolet light of all commercially available pigments.

**Zinc palmitate** *n.* $Zn(OOCC_{15}H_{31})_2$. An amorphous white powder used as a lubricant in plastics.

**Zinc phosphate coating** *n.* A thin inorganic deposit formed on zinc treated with phosphoric acid.

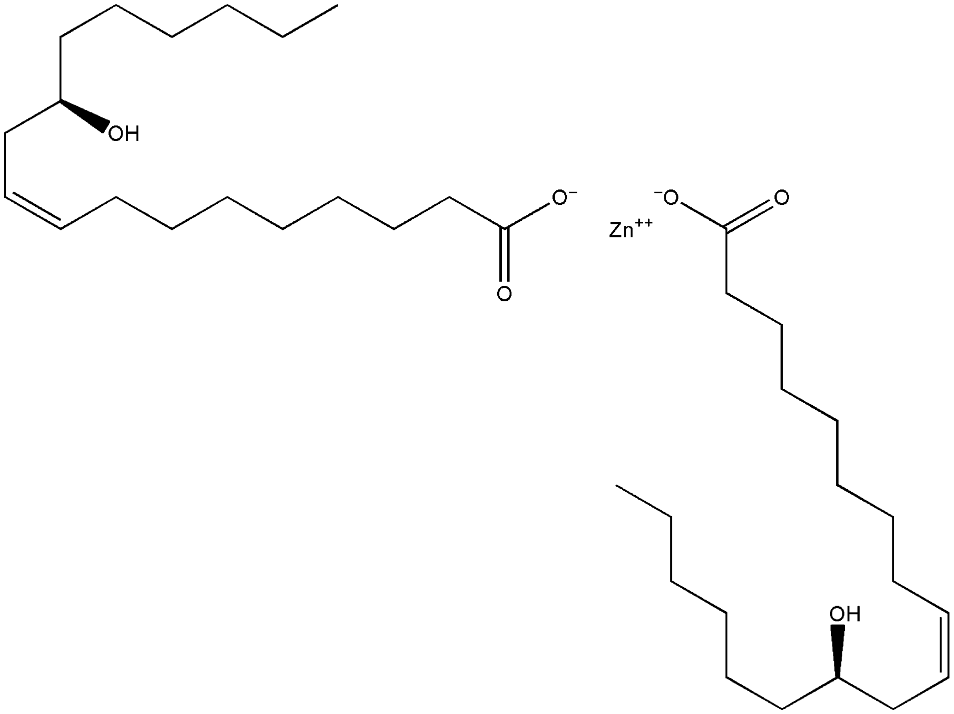
**Zinc resinate** *n.* Zinc soap of rosin with a melting point higher than rosin.

**Zinc-rich primer** *n.* Anti-corrosive primer for iron and steel incorporating zinc dust in a concentration sufficient to give electrical conductivity in the dried film, thus enabling the zinc metal to corrode preferentially to the substrate, i.e., to give cathodic protection. Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc. New York.

**Zinc ricinoleate** *n.* $Zn[OOC(CH_2)_7CH{=}CHCH_2CH(OH)C_6H_{13}]_2$. An amorphous white powder used as a stabilizer in vinyl plastics (*See image*).

**Zinc silicate primers** *n.* Inorganic zinc-rich primers that contain a silicate binder.

**Zinc stabilizer** *n.* Any of a group of zinc soaps of fatty acids, usually formulated in combination with barium and calcium soaps and organic phosphates in plasticized PVC compounds. Wickson EJ (ed)



(1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York.

**Zinc steareate** *n* $Zn(OOCC_{17}H_{35})_2$. A white powder used as a lubricant and stabilizer in vinyl compounds. An insoluble zinc soap used to produce matteness, flatting or thickening in coatings.

**Zinc sulfate** (1851) *n.* A crystalline salt $ZnSO_4$ used in making a white paint pigment, in printing and dying, in sprays and fertilizers, and in medicine as an astringent, emetic, and weak antiseptic.

**Zinc Sulfide** (1851) *n.* Pigment white 7 (77975). ZnS. Yellowish white pigment, soluble in acids, and insoluble in water. Certain specially treated grades of this pigment are used as fluorescent pigments. Density, 4.0 g/cm$^3$ (33.3 lb/gal); O.A., 13; particle size, 0.25 µm; refractive index, 2.37.

**Zinc white** (1847) *n.* Another name for zinc oxide.

**Zinc yellow** *n.* A yellow pigment consisting essentially of zinc chromate.
*See zinc chromate.*

**Zircon** \\ˈzər-ˌkän, -kən\\ [Gr, mod. of F *jargon* jargon, zircon, fr. I *giargone*] (1794) *n.* $ZrO_2{\cdot}SiO_2$. Occurs as natural double oxide. It is produced by physical separation of beach sand (Florida, Australia). Used in vitreous enamels and ceramics. Density, 4.56; particle size, 1.0–2.5 µm; refractive index, 2.0. Syn: zirconium silicate.

**Zirconia** \\ˌzər-ˈkō-nē-ə\\ [NL, fr. ISV *zircon*] (1797) (zirconium oxide) *n.* $ZrO_2$. A white monoclinic powder used as a pigment when good electrical properties are required. Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996.

**Zirconium driers** *n.* Zirconium salts of various organic acids such as naphthenic or 2-ethyl hexoic. Used as a replacement for lead in fume-proof paints or other lead-free paints, where equivalent through drying can be obtained. It is also used as an auxiliary drier where color and color retention are important.

**Zirconium oxide** *n.* $ZrO_2$. Pigment white 12 (77990). A natural mineral, baddeleyite. Present commercial grades are unsuitable as pigment grade in paint vehicles. Density, 5.68 g/cm$^3$; particle size, 1.0–2.0 µm; refractive index, 2.1–2.2. Syn: zirconium dioxide, zirconia, and bad-deleyite.

**Zn** *n.* Chemical symbol for the element zinc.

**Zr** Chemical symbol for the element zirconium.

**Z-Twist** *See twist, direction of.*

**Zunsober** *See mercuric sulfide.*

**Zwitterion** \\ˈtsvi-tər-ˌī-ˌän *also* ˌzwi-\\ [Gr, fr. *Zwitter* hybrid (fr. OHGr *zwitaran*, fr. *zwi-*) + *Ion* ion] (1906) *n.* A dipolar ion (positive and negative ends). Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York.

**Zytel 31** *n.* Nylon-6,10, manufactured by DuPont, USA.

**Zytel 101** *n.* Nylon-6,6, manufactured by DuPont, USA.

# Greek–Russian–English Alphabets

| Greek letter | | Greek name | English equivalent | Russian letter | | English equivalent |
|---|---|---|---|---|---|---|
| Α | α | Alpha | (ä) | А | а | (ä) |
| Β | β | Beta | (b) | Б | б | (b) |
| | | | | В | в | (v) |
| Γ | γ | Gamma | (g) | Г | г | (g) |
| Δ | δ | Delta | (d) | Д | д | (d) |
| Ε | ε | Epsilon | (e) | Е | е | (ye) |
| Ζ | ζ | Zeta | (z) | Ж | ж | (zh) |
| | | | | З | з | (z) |
| Η | η | Eta | (ā) | И | и | (i, ē) |
| Θ | θ | Theta | (th) | Й | й | (ē) |
| Ι | ι | Iota | (ē) | К | к | (k) |
| | | | | Л | л | (l) |
| Κ | k | Kappa | (k) | М | м | (m) |
| Λ | λ | Lambda | (l) | Н | н | (n) |
| | | | | О | о | (ô, o) |
| Μ | μ | Mu | (m) | О | о | (ô, o) |
| | | | | П | п | (p) |
| Ν | ν | Nu | (n) | Р | р | (r) |
| Ξ | ξ | Xi | (ks) | С | с | (s) |
| | | | | Т | т | (t) |
| Ο | ο | Omicron | α | У | у | ōō |
| Π | π | Pi | (P) | Ф | ф | (f) |
| | | | | Х | х | (kh) |
| Ρ | ρ | Rho | (r) | Х | х | (kh) |
| | | | | Ц | ц | (t$_s$) |
| Σ | σ | Sigma | (s) | Ч | ч | (ch) |
| Τ | τ | Tau | (t) | Ш | ш | (sh) |
| Υ | *v* | Upsilon | (ü, ōō) | Щ | щ | (shch) |
| | | | | Ъ | ъ | 8 |
| Φ | ø | Phi | (f) | Ы | ы | (ë) |
| Χ | χ | Chi | (H) | Ь | ь | (ë) |
| Ψ | ψ | Psi | (ps) | Э | э | (e) |
| | | | | Ю | ю | (ū) |
| Ω | ω | Omega | (ō) | Я | я | (yä) |

## English–Greek–Latin numbers

| English | Greek | Latin |
|---|---|---|
| 1 | mono | uni |
| 2 | bis | di |
| 3 | tris | Tri |
| 4 | tetrakis | tetra |
| 5 | pentakis | penta |
| 6 | hexakis | hexa |
| 7 | heptakis | hepta |
| 8 | octakis | octa |
| 9 | nonakis | nona |
| 10 | decakis | deca |

## International Union of Pure and Applied Chemistry: Rules Concerning Numerical Terms Used in Organic Chemical Nomenclature (specifically as prefixes for hydrocarbons)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | mono- or hen- | 10 | deca- | 100 | hecta- | 1000 | kilia- |
| 2 | di- or do- | 20 | icosa- | 200 | Dicta- | 2000 | dilia- |
| 3 | tri- | 0 | triaconta- | 300 | tricta- | 3000 | trilia- |
| 4 | tetra- | 40 | tetraconta- | 400 | tetracta | 4000 | tetralia- |
| 5 | penta- | 50 | pentaconta- | 500 | pentactra | 5000 | pentalia- |
| 6 | hexa- | 60 | hexaconta- | 600 | Hexacta | 6000 | hexalia- |
| 7 | hepta- | 70 | hepaconta- | 700 | heptacta- | 7000 | hepalia- |
| 8 | octa- | 80 | octaconta- | 800 | ocacta- | 8000 | ocatlia- |
| 9 | nona- | 90 | nonaconta- | 900 | nonactta- | 9000 | nonalia- |

Source: IUPAC, Commission on Nomenclature of Organic Chemistry (N. Lorzac'h and published in Pure Appl. Chem. 1986, 58, 1693–1696).

# Mathematics signs

| Sign | Definition | Sign | Definition |
|---|---|---|---|
| *Operations* | | *Operations* | |
| $+$ | Addition | $\sum$ | Summation |
| $-$ | Subtraction | $\prod$ | Product |
| $\times$ | Multiplication | $\int_a^b$ | Integral |
| $\cdot$ | Multiplication | $\oint$ | Contour integral |
| $\div$ | Division | | Logic |
| $/$ | Division | $\wedge$ | And, conjunction |
| $\circ$ | Composition | $\vee$ | Or, disjunction |
| $\cup$ | Union | $\neg$ | Negation |
| $\cap$ | Intersection | $\Rightarrow$ | Implies |
| $\pm$ | Plus or minus | $\rightarrow$ | Implies |
| $\mp$ | Minus or plus | $\Leftrightarrow$ | If and only if |
| | Convolution | $\leftrightarrow$ | If and only if |
| $\oplus$ | Direct sum, variation | $\exists$ | Existential quantifier |
| $\sqrt[3]{}$ | Cube root | $\forall$ | Universal quantifier |
| $\sqrt[n]{}$ | nth root | $\in$ | A member of |
| $:$ | Ratio | $\notin$ | Not a member of |
| $\amalg$ | Amalgamation | $\vdash$ | Assertion |
| $\because$ | Because | $\therefore$ | Hence, therefore |
| | | | |
| *Relations* | | *Radial units* | |
| $=$ | Equal to | $'$ | Minute |
| $\neq$ | Not equal to | $''$ | Second |
| $\approx$ | Nearly equal to | $^\circ$ | Degree |
| $\cong$ | Equals approximately, isomorphic | | |
| $<$ | Less than | *Constants* | |
| $\ll$ | Much less than | $\pi$ | pi (≈3.14159265) |
| $>$ | Greater than | e | Base of natural logarithms (≈2.71828183) |
| $\gg$ | Much greater than | | |
| $\leq$ | Less than or equal to | | |
| $\leq$ | Les than or equal to | *Geometry* | |
| $\leqq$ | Less than or equal to | $\perp$ | Perpendicular |
| $\geq$ | Greater than or equal to | $\parallel$ | Parallel |
| $\geq$ | Greater than or equal to | $\nparallel$ | Not parallel |
| $\geqq$ | Greater than or equal to | $\angle$ | Angle |
| $\equiv$ | Equivalent to, congruent to | ⩣ | Spherical angle |
| $\not\equiv$ | Not equivalent to, not congruent to | | Equal angles |

| | |
|---|---|
| $\mid$ | Divides, divisible by |
| $\sim$ | Similar to, asymptotically equal to |
| $:=$ | Assignment |
| $\in$ | A member of |
| $\subset$ | Subset of |
| $\subseteq$ | Subset of or equal to |
| $\supset$ | Superset of |
| $\supseteq$ | Superset of or equal to |
| $\propto$ | Varies as, proportional to |
| $\doteq$ | Approaches a limit, definition |
| $\rightarrow$ | Tends to, maps to |
| $\leftarrow$ | Maps from |
| $\mapsto$ | Maps to |
| | Maps into |
| | Maps into |
| | d'Alembertian operator |

*Miscellaneous*

| | |
|---|---|
| $i$ | Square root of –1 |
| $'$ | Prime |
| $''$ | Double prime |
| $'''$ | Triple prime |
| $\surd$ | Square root, radical |
| ! | Factorial |
| !! | Double factorial |
| $\varnothing$ | Empty set, null set |
| $\infty$ | Infinity |
| $\partial$ | Partial differential |
| $\Delta$ | Delta |
| $\nabla$ | Nabla, del |
| $\nabla^2, \Delta$ | Laplacian operator |

*Trigonometry*

| | |
|---|---|
| sin | sine |
| cos | cosine |
| tan | tangent |
| cot | cotangent |
| sec | secant |
| csc | cosecant |

# Appendices

C. Micro-organisms, biochemistry, and nomenclature

# Appendix A: Conversion factors

| To convert | Into | Multiply by |
|---|---|---|
| **A** | | |
| atm | cm of mercury | 76.0 |
| atm | ft of water (at 4°C) | 33.90 |
| atm | in. of mercury (at 0°C) | 29.92 |
| atm | kg/cm$^2$ | 1.0333 |
| atm | lb/in.$^2$ | 14.70 |
| atm | tons/ft$^2$ | 1.058 |
| **B** | | |
| Btu | ft-lb | 778.3 |
| Btu | g-cal | 252.0 |
| Btu | J | 1,054.8 |
| Btu | k-cal | 0.2520 |
| Btu | kW-h | $2.928 \times 10^{-4}$ |
| Btu/h | g-cal/s | 0.0700 |
| Btu/h | W | 0.2931 |
| **C** | | |
| cm | ft | $3.281 \times 10^{-2}$ |
| cm | in. | 0.3937 |
| cm | mile | $6.214 \times 10^{-6}$ |
| cm | mm | 10.0 |
| cm/s | ft/min | 1.1969 |
| cm/s | ft/s | 0.03281 |
| cm/s | k/h | 0.036 |
| cm/s | m/min | 0.6 |
| cc | ft$^3$ | $3.531 \times 10^{-5}$ |
| cc | in.$^3$ | 0.06102 |
| cc | m$^3$ | $10^{-6}$ |
| cc | gal (US liq.) | $2.642 \times 10^{-4}$ |
| cc | ` | 0.001 |
| ft$^3$ | in.$^3$ | 1,728.0 |
| ft$^3$ | m$^3$ | 0.02832 |
| ft$^3$ | gal (US liq.) | 7.48052 |
| ft$^3$ | 1 | 28.32 |
| ft$^3$/min | cm.$^3$/s | 472.0 |
| ft$^3$/min | gal/s | 0.1247 |
| ft$^3$/min | 1/s | 0.4720 |
| in.$^3$ | cc | 16.39 |
| in.$^3$ | ft$^3$ | $5.787 \times 10^{-4}$ |
| ft$^3$/lb | cm$^3$/g | 62.43 |
| in.$^3$/oz. | cc/g | 0.577 |
| in.$^3$ | gal | $4.329 \times 10^{-3}$ |
| in.$^3$ | 1 | 0.01639 |
| m$^3$ | ft$^3$ | 35.31 |
| m$^3$ | in.$^3$ | 61,023.0 |
| m$^3$ | gal (US liq.) | 264.2 |
| **D** | | |
| days | min | 1,440.0 |
| days | s | 86,400.0 |
| degrees (angle) | rad | 0.01745 |
| deg/s | rad/s | 0.01745 |
| dyne | g | $1.020 \times 10^{3}$ |
| dyne | J/cm | $10^{-7}$ |
| dyne | lb | $2.248 \times 10^{6}$ |
| **F** | | |
| ft | km | $3.048 \times 10^{4}$ |
| ft | m | 0.3048 |
| Ft of water | atm | 0.02950 |
| ft of water | in. of mercury | 0.8826 |
| ft of water | kg/cm$^2$ | 0.03048 |
| ft of water | lb/in.$^2$ | 0.4335 |
| ft/min | cm/s | 0.5080 |
| ft/min | m/min | 0.3048 |
| ft/s | cm/s | 30.48 |
| ft/s | m/min | 18.29 |
| ft-lb | Btu | $1.286 \times 10^{-3}$ |
| ft-lb | g-cal | 0.3238 |
| ft-lb | hp-h | $5.050 \times 10^{-7}$ |
| ft-lb | J | 1.356 |
| ft-lb | k-h | $3.766 \times 10^{-7}$ |
| ft-lb/min | Btu/min | $1.286 \times 10^{-3}$ |
| ft-lb/min | hp | $3.030 \times 10^{-5}$ |
| ft-lb/min | kg-cal/min | $3.24 \times 10^{-4}$ |
| ft-lb/min | kW | $2.260 \times 10^{-5}$ |
| **G** | | |
| gal | cc | 3,785.0 |
| gal | ft$^3$ | 0.1337 |
| gal | in.$^3$ | 231.0 |
| gal (liq. Br. Impt) | gal (US liq.) | 1.20095 |
| gal (US) | gal (Imp.) | 0.83267 |
| gal of water | lb of water | 8.3453 |
| gal/min | ft$^3$/s | $2.228 \times 10^{-3}$ |
| gal/min | 1/s | 0.06308 |

| To convert | Into | Multiply by |
|---|---|---|
| Agal/min | 1/min | 3.785 |
| g | oz (avdp) | 0.03527 |
| g | lb | $2.205 \times 10^{-3}$ |
| g/cm | lb/in. | $5.600 \times 10^{-3}$ |
| g/cc | lb/ft$^3$ | 62.43 |
| g/cc | lb/ft$^3$ | 0.03613 |
| g/cc | oz/in.$^3$ | 0.5781 |
| g/cc | lb/in.$^3$ | 0.03613 |
| g/cm$^2$ | lb/ft$^2$ | 2.0481 |
| **H** | | |
| hp | Btu/min | 42.44 |
| hp | ft-lb/s | 550.0 |
| hp | W | 745.7 |
| hp-h | Btu | 2,547 |
| hp-h | kg-cal | 641.1 |
| hp-h | k-h | 0.7457 |
| **I** | | |
| in. | cm | 2.540 |
| in. of mercury | atm | 0.03342 |
| in. of mercury | kg/cm$^2$ | 0.03453 |
| in. of mercury | lb/in.$^2$ | 0.4912 |
| in. of Water (at 4°C) | atm | $2.458 \times 10^{-3}$ |
| in. of Water (at 4°C) | in. of mercury | 0.07355 |
| in. of Water (at 4°C) | kg/cm$^2$ | $2.540 \times 10^{-3}$ |
| in. of Water (at 4°C) | lb/in.$^2$ | 0.03613 |
| **J** | | |
| J | Btu | $9.480 \times 10^{-4}$ |
| J/cm | g | $1.020 \times 10^{4}$ |
| J/cm | lb | 22.48 |
| **K** | | |
| kg/cm$^2$ | atm | 0.9678 |
| kg/cm$^2$ | ft of water | 32.81 |
| kg/cm$^2$ | in. of mercury | 28.96 |
| kg/cm$^2$ | lb/in.$^2$ | 14.22 |
| kg-cal | Btu | 3.968 |
| kg-cal | J | 4,186 |
| kg-cal | kW-h | $1.163 \times 10^{-3}$ |
| kg-m | Btu | $9.294 \times 10^{-3}$ |
| kg-m | k-h | $2.723 \times 10^{-6}$ |
| kW | Btu/min | 56.92 |
| kW | hp | 1.341 |
| kW | kg-cal/min | 14.34 |
| kW-h | Btu | 3,413 |
| kW-h | hp | 1.341 |
| kW-h | kg-cal | 860.5 |
| **L** | | |
| l | in.$^3$ | 61.02 |
| l | gal (U.S. liq.) | 0.2642 |
| 1/min | ft$^2$/s | $5.886 \times 10^{-4}$ |
| 1/min | gal/s | $4.403 \times 10^{-3}$ |
| **M** | | |
| m/min | cm/s | 1.667 |
| m/min | mile/h | 0.03728 |
| m/s | ft/s | 2.281 |
| m/s | k/min | 0.06 |
| m/s | mile/h | 2.237 |
| m-kg | cm-dyne | $9.807 \times 10^{7}$ |
| m-kg | lb-ft | 7.233 |
| mile (statute) | ft | 5,280 |
| mile (statute) | k | 1.609 |
| mile (statute) | yard | 1,760 |
| mile/h | cm/s | 44.70 |
| mile/h | ft/min | 88. |
| mile/h | m/min | 26.82 |
| mile/min | cm/s | 2,682 |
| mile/min | natural knots/min | 0.8684 |
| mm | ft | $3.281 \times 10^{-3}$ |
| mm | in. | 0.03937 |
| mils | cm | $2.540 \times 10^{-3}$ |
| mils | in. | 0.001 |
| **O** | | |
| oz | g | 28.3495 |
| oz | lb | 0.0625 |
| oz (fluid) | in.$^3$ | 1.805 |
| oz (fluid) | l | 0.02957 |
| oz/in.$^2$ | lb/in.$^2$ | 0.0625 |
| oz/in.$^2$ | g/cc | 1.733 |
| **P** | | |
| lb | dyne | $44.4823 \times 10^{4}$ |
| lb | g | 453.59 |
| lb of water | ft$^3$ | 0.01602 |
| lb of water | in.$^3$ | 27.68 |
| lb of water | gal | 0.1198 |
| lb of water/min | ft$^3$/s | $2.670 \times 10^{-4}$ |

| To convert | Into | Multiply by |
|---|---|---|
| lt-ft | cm-dyne | $1.356 \times 10^7$ |
| lb-ft | m-kg | 0.1383 |
| lb/ft$^3$ | g/cc | 0.01602 |
| lb/ft$^3$ | kg/m$^3$ | 16.02 |
| lb/in.$^3$ | g.cc | 27.68 |
| lb/in. | g/cm | 178.6 |
| lb/in.$^2$ | atm | 0.06804 |
| lb/in.$^2$ | ft of water | 2.307 |
| lb/in.$^2$ | in. of mercury | 2.036 |
| kb/in.$^2$ | kg/m$^2$ | 703.1 |
| lb/in.$^2$ | kg/cm$^2$ | 0.07031 |
| **Q** | | |
| quarts (liq.) | cc | 946.4 |
| quarts (liq.) | in.$^3$ | 57.75 |
| quarts (liq.) | l | 0.9463 |
| **S** | | |
| cm$^2$ | circular mils | $1.973 \times 10^5$ |
| cm$^2$ | ft$^2$ | $1.076 \times 10^{-3}$ |
| cm$^2$ | in.$^2$ | 0.1550 |
| ft$^2$ | cm$^2$ | 929.0 |
| in.$^2$ | ft$^2$ | 6.452 |
| m$^2$ | cm$^2$ | 10.76 |
| m$^2$ | in.$^2$ | 1,550 |
| m$^2$ | yard$^2$ | 1.196 |
| mm$^2$ | circular mils | 1,973 |
| mm$^2$ | in.$^2$ | $1.550 \times 10^{-3}$ |
| yard$^2$ | cm$^2$ | 8,361 |
| **T** | | |
| tons (long) | lb | 2,240 |
| tons (metric) | k | 1,000 |
| tons (metric) | lb | 2,205 |
| tons (short) | kg | 907.18 |
| tons (short) | lb | 2,000 |
| tons (short) | tons (long) | 0.89287 |
| tons (short) | tons (metric) | 0.9078 |
| **W** | | |
| W | Btu/h | 3,413 |
| W | erg/s | 107 |
| W | ft-lb/min | 44.27 |
| W | hp | $1.341 \times 10^{-3}$ |
| W | kg-cal/min | 0.01433 |
| W-h | Btu | 3.413 |
| W-h | g-cal | 859.85 |
| W-h | hp-h | $1.341 \times 10^{-3}$ |
| W-h | kg-m | 367.2 |
| **Y** | | |
| Yard | cm | 91.4 |

# Appendix B: International Standards Organization (ISO) units

The International System of units (SI) was adopted by the 11th general Conference on Weights and Measures (CGPM) in 1960. It is a coherent system of units built from seven SI base units, one for each of the seven dimensionally independent base quantities: they are meter, kilogram, second, ampere, Kelvin, mole, and candela, for the dimensions length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity, respectively. The definitions of the SI base units are given below. The SI derived units are expressed as products of powers of the base units, analogous to the corresponding relations between physical quantities but with numerical factors equal to unity.

In the International System there is only one SI unit for each physical quantity. This is either the appropriate SI base unit itself or the appropriate SI derived unit. However, any of the approved decimal prefixes, called SI prefixes, may be used to construct decimal multiples or submultiples of SI units.

It is recommended that only SI units be used in science and technology (with SI prefixes wherever appropriate). Where there are special reasons for making an exception to this rule, it is recommended always to define the units used in terms of SI units. This section was reprinted with the permission of IUPAXC.

## Definitions of SI base units

*Meter* — The meter is the length of path traveled by light in vacuum during a time interval of 1/299,792,458 of a second (17th CGPM, 1983).

*Kilogram* — The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram (3rd CGPM, 1901).

*Second* — The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom (13th CGPM, 1967).

*Ampere* — The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 m apart in vacuum, would produce between these conductors a force equal to $2 \times 10^{-7}$ N/m of length (9th CGPM, 1948).

*Kelvin* — The Kelvin, unit of thermodynamic temperature, is the fraction 1/27,316 of the thermodynamic temperature of the triple point of water (13th CGPM, 1967).

*Mole* — The mole is the amount of substance of a system, which contains as many elementary entities as there are atoms in 0.012 kg of cargon-12. When the mole is used, the elementary entities must be specific and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particle (14th gCPM, 1971).

Examples of the use of the mole:

- 1 mol of $H_2$ contains about $6.022 \times 10^{23}$ $H^2$ molecules, or $12.044 \times 10^{23}$ H atoms
- 1 mol of HgCl has a mass of 236.04 g
- 1 mol of $Hg_{2_{2+}}Cl_2$ has a mass of 472.08 g
- 1 mol of $Hg_2$ has a mass of 401.18 g and a charge of 192.97 kC
- 1 mol of $Fe_{0.91}S$ has a mass of 82.88 g
- 1 mol of $e^-$ has a mass of 548.60 μg and a charge of –96.49 kC
- 1 mol of photons whose frequency is $10^{14}$ Hz has energy of about 39.90 kJ

*Candela* — The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency $540 \times 10^{12}$ Hz ($0.556\,\mu m = \lambda$) and that has a radiant intensity in that direction of (1/683) watt per steradian (16th CGPM, 1979).

| Physical Quantity | Name of SI unit | Symbol for SI unit | |
|---|---|---|---|
| Length | meter | m | |
| Mass | kilogram | kg | |
| Time | second | s | |
| Electric current | ampere | A | |
| Thermodynamic temperature | Kelvin | K | |
| Amount of substance | mole | mol | |
| Luminous intensity | candela | cd | |
| Frequency[a] | hertz | Hz | $s^{-1}$ |
| Force | Newton | N | $m\,kg\,s^{-2}$ |
| Pressure, stress | pascal | Pa | $N\,m^{-2}$ ($=m^{-1}kg\,s^{-2}$) |
| Energy, work, heat | joule | J | $N\,m$ ($=m^2kg\,s^{-2}$) |
| Power, radiant flux | watt | W | $J\,s^{-1}$ ($=m^2kg\,s^{-3}$) |
| Electric charge | coulomb | C | $A\,s$ |
| Electric potential, electromotive force | volt | V | $J\,C^{-1}$ ($=m^2kg\,s^{-3}A^{-1}$) |
| Electric resistance | ohm | | $V\,A^{-1}$ ($=m^2kg\,s^{-3}A^{-2}$) |
| Electric conductance | siemens | S | $^{-1}$ ($=m^{-2}kg^{-1}s^3A^2$) |
| Electric capacitance | farad | F | $C\,V^{-1}$ ($=m^{-2}kg^{-1}s^4A^2$) |
| Magnetic flux density | tesla | T | $V\,s\,m^{-2}$ ($=kg\,s^{-2}A^{-1}$) |
| Magnetic flux | weber | Wb | $Vs$ ($=m^2kg\,s^{-2}A^{-1}$) |
| Inductance | henry | H | $V\,A^{-1}s$ ($=m^2kg\,s^{-2}A^{-2}$) |
| Celsius temperature[b] | degree Celsius | °C | K |
| Luminous flux | lumen | 1m | cd sr |
| Illuminance | lux | lx | $cd\,sr\,m^{-2}$ |
| Activity[c] (radioactive) | becquerel | Bq | $s^1$ |
| Absorbed dose[c] (of radiation) | gray | Gy | $J\,kg^{-1}$ ($=m^2s^{-2}$) |
| Dose equivalent[c] (dose equivalent index) | sievert | Sv | $J\,kg^{-1}$ ($=m^2s^{-2}$) |
| Plane angle[d] | radian | rad | 1 ($=m\,m^{-1}$) |
| Solid angle[d] | stradian? | sr | 1 ($=m^2m^{-2}$) |

[a] For radial (circular) frequency and for angular velocity the unit $rad\,s^{-1}$, or simply $s^{-1}$, should be used, and this may not be simplified to Hz. The unit Hz should be used only for frequency in the sense of cycles per second.

[b] The Celsius temperature $\theta$ is defined by the equation:

$$\theta/°C = T/K - 273.15.$$

The SI unit of Celsius temperature interval is the degree Celsius, °C, which is equal to the Kelvin, K. The °C should be treated as a single symbol, with no space between the ° sign and the letter C. (The symbol °K, and the symbol °, should no longer be used.)

[c] The unitsgray and sievert are admitted for reasons of safeguarding human health.

[d] The units radian and steradian are described as 'SI supplementary units'. However, in chemistry, as well as in physics, they are usually treated as dimensionless derived units, and this was recognized by CIPM in 1980. Since they are then of dimension 1, this leaves open the possibility of including them or omitting them in expressions of SI derived units. In practice this means that rad and sr may be used when appropriate and may be omitted if clarity is not lost thereby.

## SI prefixes

To signify decimal multiples and submultiples of SI units the following prefixes may be used.

| Factor | Prefix | Symbol | Factor | Prefix | Symbol |
|---|---|---|---|---|---|
| $10^{24}$ | yotta | Y | $10^{-1}$ | deci | d |
| $10^{21}$ | zetta | Z | $10^{-2}$ | centi | c |
| $10^{18}$ | exa | E | $10^{-3}$ | milli | m |
| $10^{15}$ | peta | P | $10^{-6}$ | micro | u |
| $10^{12}$ | tera | T | $10^{-9}$ | nano | n |
| $10^{9}$ | giga | G | $10^{-12}$ | pico | p |
| $10^{6}$ | meta | M | $10^{-15}$ | femto | f |
| $10^{3}$ | kilo | k | $10^{-18}$ | atto | a |
| $10^{2}$ | hecto | h | $10^{-21}$ | zepto | z |
| $10^{1}$ | deka | da | $10^{-24}$ | yocto | y |

Prefix symbols should be printed in roman (upright) type with no space between the prefix and the unit symbol. Example: kilometer, km.

When a prefix is used with a unit symbol, the combination is taken as a new symbol that can be raised to any power without the use of parentheses.

Examples

$$1\,cm^3 = (0.01\,m)^3 = 10^6 m^3$$

$$1\,\mu s^{-1} = (10^{-6} s)^{-1} = 10^6 s^{-1}$$

$$1\,V/cm = 100\,V/m$$

$$1\,mmol/dm^3 = mol\,m^{-3}$$

A prefix should never be used on its own, and prefixes are not to be combined into compound prefixes. Example: pm, not µµm.

The names and symbols of decimal multiples and sub-multiples of the SI base unit of mass, the kg, which already contains a prefix, are constructed by adding the appropriate prefix to the word gram and symbol g. Examples: mg, not µkg; Mg, not kkg.

The SI prefixes are not be used with °C.

## Units in use together with the SI

These units are not part of the SI, but it is recognized that they will continue to be used in appropriate contexts. SI prefixes may be attached to some of these units, such as milliliter, ml; millibar, mbar; megaelectronvolt, MeV; kilotonne, ktonne.

| Physical quantity | Name of the unit | For unit | Symbol value in SI units |
|---|---|---|---|
| Time | minute | min | 60 s |
| Time | hour | h | 3600 s |
| Time | day | d | 86 400 s |
| Plane angle | degree | o | (π/180) rad |
| Plane angle | minute | ′ | (π/10 800) rad |
| Plane angle | second | ″ | (π/648 000) rad |
| Length | Ängström[a] | å | $10^{-10}$ m |
| Area | barn | b | $10^{-28}$ $m^2$ |
| Volume | litre | l, L | $dm^3$ (=$10^{-3}$ $m^3$) |
| Mass | tonne | t | Mg (=$10^3$ kg) |
| Pressure | bar[1] | bar | $10^5$ Pa (=$10^5$ N $m^{-2}$) |
| Energy | electrovolt[b] | eV (=e × V) | ≈$1.60218 \times 10^{-19}$ |
| Mass | unified atomic mass unit[b,c3] | U (=$m_2$)<br>($^{12}$C)/12) | ≈$1.66054 \times 10^{-27}$ kg |

[a] The ängström and the bar are approved by CIPM for "temporary use with SI units", until CIPM makes a further recommendation. However, they should not be introduced where they are not used at present.

[b] The values of these units in terms of the corresponding SI units are not exact, since they depend on the values of the physical constants e (for the electronvolt) and $N_A$ (for the unified atomic mass unit), which are determined by experiment.

[c] The unified atomic mass unit is also sometimes called the Dalton, with symbol Da, although the name and symbol have not been approved by CGPM.

## Atomic units

For the purpose of quantum mechanical calculations of electronic wave functions, it is convenient to regard certain fundamental constants (and combinations of such constants) as though they were units. They are customarily called atomic units (abbreviated: au), and they may be regarded as forming a coherent system of units for the calculation of electronic properties in theoretical chemistry, although there is no authority from CGPM for treating them as units. The first five atomic units in the table below have special names and symbols. Only four of these are independent; all others may be derived by multiplication and division in the usual way, and the table includes a number of examples.

The relation of atomic units to the corresponding SI units involves the values of the fundamental physical constants, and is therefore not exact. The numerical values in the table are based on the 1986 CODATA values of the fundamental constants. The numerical results of calculations in theoretical chemistry are frequently quoted in atomic units, or as numerical values in the form (physical quantity)/(atomic unit), so that the reader may make the conversion using the current best estimates of the physical constants.

| Physical quantity | Name of unit | Symbol for unit | Definition and value of unit in SI |
|---|---|---|---|
| Mass | Electron rest mass | $m_e$ | $m_e \approx 9.1095 \times 10^{-31}$ kg |
| Charge | Elementary charge | $e$ | $e \approx 1.6022 \times 10^{-19}$ C |
| Action | Planck constant/ 2π | $h$ | $h = h/2\pi \approx 1.0546 \times 10^{-34}$ Js |
| Length | Bohr | $a_0$ | $4\pi\epsilon_0 h^2/m_e e^2 \approx 5.2918 \times 10^{-11}$ m |
| Energy | Hartree | $E_h$ | $h^2/m_e a_0^2 \approx 4.3598 \times 10^{-18}$ J |
| Time | au of time | $h/E_h$ | $\approx 2.44189 \times 10^{-17}$ s |
| Velocity[a] | au of velocity | $a_0 E_h/h$ | $\approx 2.1877 \times 10^{6}$ $s^{-1}$ |
| Force | au of force | $E_h/a_0$ | $\approx 8.2389 \times 10^{-8}$ N |
| Momentum linear | au of momentum | $h/a_0$ | $\approx 1.9929 \times 10^{-24}$ Ns |
| Electric current | au of current | $eE_h/h$ | $\approx 6.6236 \times 10^{-3}$ A |
| Electric field | au of electric field | $E_h/ea_0$ | $\approx 5.1422 \times 10^{11}$ V $m^{-1}$ |
| Electric dipole moment | au of electric dipole moment | $Ea_0$ | $\approx 8.4784 \times 10^{-30}$ C m |
| Magnetic flux density | au of magnetic flux density | $h/ea_0^2$ | $\approx 2.3505 \times 10^{5}$ T |
| Magnetic dipole moment[b] | au of magnetic dipole moment | $mh/m_e$ | $= 2\mu_B \approx 1.8548 \times 10^{-23}$ J$T^{-1}$ |

[a] The numerical value of the speed of light, when expressed in atomic units, is equal to the reciprocal of the fine structure constant α; c/(au of velocity) = $ch/a_0 E_h = \alpha^{-1}$ 137.04.

[b] The atomic unit of magnetic dipole moment is twice the Bohr magneton, μB.

## Conversion to SI units

The following tables give conversion factors from various units of measure to SI units. It is reproduced from NIST Special Publication 811, guide for the use of the International System of units (Superintendent of Documents, US government Printing Office, 1991), which in turn was derived from IEEE Std 268-1982, IEEE Standard Metric Practice (© 1982 by the Institute of Electrical and Electronics Engineers Inc.).

The SI values are expressed in terms of the base, supplementary, and derived units of SI in order to provide a coherent presentation of the conversion factors and facilitate computations (see the table "International System of Units" in this section). Powers of 10 can be avoided by using SI prefixes and shifting the decimal point if necessary. Conversion from a non-SI unit to a different non-SI unit may be carried out by using this table in two stages, e.g.

1 cal (thermochemical) = 4.184 J and 1 Btu (mean) = 1.05587E+03 J.

Thus, 1 Btu (mean) = (1.05587E + 03/4.184 cal (thermochemical) = 252.359 cal (thermochemical).

Conversion factors are presented for ready adaptation to computer readout and electronic data transmission. The factors are written as a number equal to or greater than 1 and less than 10 with six or less decimal places. This number is followed by the letter E (for exponent), plus or minus symbol, and two digits which indicate the power of 10 by which the number must be multiplied to obtain the correct value.

For example

3.523 90E−02 is 3.523 907 × $10^{-2}$ or 0.035 239 07.

Similarly:

3.386 389E + 03 is 3.386 389 × $10^{3}$ or 3 386.389.

An asterisk (*) after the sixth decimal place indicates that the conversion factor is exact and that all subsequent digits are zero. All other conversion factors have been rounded to the figures given in accordance with accepted practice. Where less than six decimal places are shown, more precision is not warranted.

| To convert from | To | Multiply by |
|---|---|---|
| abampere | ampere (A) | 1.000 000*E+01 |
| abcoulomb | coulomb (C) | 1.000 000*E+01 |
| abfaarad | farad (F) | 1.000 000*E+09 |
| abhenry | henry (H) | 1.000 000*E−09 |
| abmho | siemens (S) | 1.000 000*E+09 |
| abohm | ohm (Ω) | 1.000 000*E−09 |
| abvolt | volt (V) | 1.000 000*E−08 |
| acre foot | meter$^3$ (m$^3$) | 1.2335E+03 |
| acre | meter$^2$ (m$^2$) | 4.046 873E+03 |
| ampere hour | coulomb (C) | 3.600 000*E+03 |
| angstrom | meter (m) | 1.000 000*E−10 |
| are | meter$^2$ (m$^2$) | 1.000 000*E+02 |
| astronomical unit | meter (m) | 1.495 979E+11 |
| atmosphere (standard) | pascal (Pa) | 1.013 250*E+05 |
| atmosphere (technical = 1 kgf/cm$^2$) | pascal (Pa) | 9.806 650*E+04 |
| bar | pascal (Pa) | 1.000 000*E+05 |
| barn | meter$^2$ (m$^2$) | 1.000 000*E−28 |
| barrel (for petroleum, 42 gal) | meter$^3$ (m$^3$) | |
| board foot | meter$^3$ (m$^3$) | 2.359 737E−03 |
| British thermal unit (international table) | joule (J) | 1.055 056E+03 |
| British thermal unit (mean) | joule (J) | 1.055 87E+03 |
| British thermal unit (thermochemical) | joule (J) | 1.054 350E+03 |
| British thermal unit (39°F) | joule (J) | 1.059 67E+03 |
| British thermal unit (59°) | joule (J) | 1.054 68E+03 |
| British thermal unit (60°) | joule (J) | 1.054 68E+03 |
| Btu (international table)/(ft/hft$^2$°F) (thermal conductivity) | watt per meter kelvin (W/mK) | 1.730 735E+00 |
| Btu (thermochemical)/(ft/hft$^2$°F) (thermal conductivity) | watt per meter kelvin (W/mK) | 1.729 577E+00 |
| Btu (international table)/(in/hft$^2$°F) (thermal conductivity) | watt per meter kelvin (W/mK) | 1.442 279E–01 |
| Btu (thermochemical) (in/hft$^2$°F) (thermal conductivity) | watt per meter kelvin (W/mK) | 1.441 314E−01 |
| Btu (international table)/in/(sft$^2$°F) (thermal conductivity) | watt per meter kelvin (W/mK) | 5.192 204E+02 |
| Btu (thermal chemical)/in/(sft$^2$°F) (thermal conductivity) | watt per meter kelvin (W/mk) | 5.188 732E+02 |
| Btu (international table)/h | watt (W) | 2.930 711E−01 |
| Btu (international table)/s | watt (W) | 1.055 056E+03 |
| Btu (thermochemical)/h | watt (W) | 2.928 751E–01 |
| Btu (thermochemical)/min | watt (W) | 1,757 250E+01 |
| Btu (thermochemical)/s | watt (W) | 1.054 350E+03 |
| Btu (international table)/ft$^2$ | joule per meter$^2$ (J/m$^2$) | 1.135 653E+04 |

| | | |
|---|---|---|
| Btu (thermochemical)/ft$^2$ | joule per meter$^2$ (J/m$^2$) | 1.134 893E+04 |
| Btu (international table)/(ft$^2$h) | watt per meter$^2$ (W/m$^2$) | 3.154 591E+00 |
| Btu (international table)/(ft$^2$s) | watt per meter$^2$ (W/m$^2$) | 1.135 653E+04 |
| Btu (thermochemical)/(ft$^2$ h) | watt per meter$^2$ (W/m$^2$) | 3.152 481E+00 |
| Btu (thermochemical)/(ft$^2$ min) | watt per meter$^2$ (W/m$^2$) | 1.891 489E+02 |
| Btu (thermochemical)/(ft$^2$ s) | watt per meter$^2$ (W/m$^2$) | 1.134 893E+04 |
| Btu (thermochemical)/(in$^2$ s) | watt per meter (W/m$^2$) | 1.634 246E+06 |
| Btu (international table)/(h ft$^2$°F) | watt per meter$^2$ kelvin (W/m$^2$K) | 5.678 263E+00 |
| Btu (thermalcohemical)/(h ft$^2$ °F) | watt per meter$^2$ kelvin (W/m$^2$K) | 5.674 466E+00 |
| Btu (international table)/(s ft$^2$°F) | watt per meter$^2$ kelvin (W/m$^2$K) | 2.044 175E+04 |
| Btu (thermochemical)/(s ft$^2$°F) | watt per meter$^2$ kelvin (W/m$^2$K) | 2.042 808E+04 |
| Btu (international table)/lb | joule per kilogram (J/kg) | 2.326 000*E+03 |
| Btu (thermochemical)/lb | joule per kilogram (J/kg) | 2.324 444E+03 |
| Btu (international table)/(lb°F) (specific heat capability) | joule per kilogram kelvin (J/kgK) | 4.186 800*E+03 |
| Btu (thermochemical) (lb° F) (specific heat capacity) | joule per kilogram kelvin (J/kgK) | 4.184 000*E+03 |
| Btu (international table)/ft$^3$ | joule per meter$^3$ (J/m$^3$) | 3.725 895E+04 |
| Btu (thermochemical)/ft$^3$ | joule per meter$^3$ (J/m$^3$) | 3.723 402E+04 |
| bushel | meter$^3$ (m$^3$) | 3.523 907E−02 |
| calorie (international table) | joule (J) | 4.186 800*E+00 |
| calorie (mean) | joule (J) | 4.190 02E+00 |
| calorie (thermochemical) | joule (J) | 4.184 000*E+00 |
| calorie (15°C) | joule (J) | 4.185 80E+00 |
| calorie (20°C) | joule (J) | 4.181 90E+00 |
| calorie (kilogram, international table) | joule (J) | 4.186 800*E+03 |
| calorie (kilogram, mean) | joule (J) | 4.190 02E+03 |
| calorie (kilogram, thermochemical) | joule (J) | 4.184 000*E+03 |
| cal (thermochemical)/cm$^2$ | joule per meter$^2$ (J/m$^2$) | 4.184 000*E+04 |
| cal (international table)/g | joule per kilogram (J/kg) | 4.186 800*E+03 |
| cal (thermochemical)/g | joule per kilogram (J/kg) | 4.184 000*E+03 |
| cal (international table)/(g°C) | joule per kilogram kelvin (J/kgK) | 4.186 800*E+03 |
| cal (thermochemical)/(g° C) | joule per kilogram kelvin (J/kgK) | 4.184 000*E+03 |
| cal (thermochemical)/min | watt (W) | 6.973 333E−02 |
| cal (thermochemical)/s | watt (W) | 4.184 000*E+00 |
| cal (thermochemical)/(cm$^2$ min) | watt per meter$^2$ (W/m$^2$) | 6.973 333E−02 |
| cal (thermochemical)/(cm$^2$ s) | watt per meter$^2$ (W/m$^2$) | 4.184 000E+04 |
| cal (thermochemical)/(cm s°C) | watt per meter kelvin (W/mK) | 4.184 000E+02 |
| cd/in$^2$ | candela per meter$^2$ (cd/m$^2$) | 1.550 003E+03 |
| carat (metric) | kilogram (kg) | 2.000 000*E−04 |

| | | |
|---|---|---|
| centimeter of mercury (0°C) | pascal (Pa) | 1.333 22E+03 |
| centimeter of water (4°C) | pascal (Pa) | 9.806 38E+01 |
| centipoises | pascal second (Pas) | 1.000 000*E−03 |
| centistokes | meter$^2$ per second (m$^2$/s | 1.000 000*E−06 |
| chain | meter$^2$ (m$^2$) | 5.067 075E+01 |
| circular mill | meter$^2$ (m$^2$) | 5.067 075E−10 |
| clo | Kelvin meter$^2$ per watt (Km$^2$/W) | 2.003 712E−01 |
| cup | milliliter (ml) | 2.366E+02 |
| curie | becquerel (BQ) | 3,700 000*E+10 |
| darcy$^2$ | meter$^2$ (m$^2$) | 9.869 233E−13 |
| day | second (s) | 8.640 000*E+04 |
| day (sidereal) | second (s) | 8.616 409E+04 |
| degree (angle) | radian (rad) | 1.745 329E−02 |
| degree Celsius | kelvin (K) | $T_k=t_C+273.15$ |
| degree centigrade | See note below | |
| degree Fahrenheit | degree Celsius (°C) | $t_C=(t_F-32)/1.8$ |
| degree Fahrenheit | Kelvin (K) | $T_k=t_F/1.8$ |
| degree Rankine | Kelvin (K) | $T_K=T_R/1.8$ |
| °F h ft$^2$/Btu (international table) | kelvin meter$^2$ per watt (Km$^2$/W) | 1.761 102E−01 |
| °F h ft$^2$/Btu (thermochemical) | kelvin meter$^2$ per watt (Km$^2$/W) | 1.762 280E−01 |
| °F h ft$^2$/Btu (international) | kelvin meter$^2$ per watt | 6.933 472E+00 |
| Table in (thermal resistivity) | Km$^2$/W | |
| °F h ft$^2$/[Btu (thermochemical) in] (thermal resistivity) | kelvin meter$^2$ per watt (Km$^2$/W) | 6.938 112E+00 |
| denier | kilogram per meter (kg/m) | 1.111 111E−07 |
| dyne | newton (N) | 1.000 000*E−05 |
| dyne/cm | N/m | 1.000 000E−03 |
| dyne/cm | mN/m | 1.000 000 |
| dyne cm | newton meter (Nm) | 1.000 000*E−07 |
| dyne/cm$^2$ | pascal (Pa) | 1.000 000*E−01 |
| electronvolt | joule (J) | 1.602 19E−19 |
| EMU of capacitance | farad (F) | 1.000.000*E+09 |
| EMU of current | ampere (A) | 1.000 000*E−01 |
| EMU of electric potential | volt (V) | 1.000 000*E−08 |
| EMU of inductance | henry (H) | 1.000 000*E−09 |
| EMU of resistance | ohm (m) | 1.000 000*E−09 |
| erg | joule (J) | 1.000 000*E−07 |
| erg/cm$^2$s | watt per meter$^2$ (W/m$^2$) | 1.000 000*E−03 |
| erg/s | watt(W) | 1.000 000*E−07 |
| faraday (based on carbon-12) | coulomb (C) | 9.648 70E+04 |
| faraday (chemical) | coulomb (C) | 9.649 57E+04 |
| faraday (physical) | coulomb (C) | 9.652 19E+04 |
| fathom | meter (m) | 1.828 8E+00 |
| fermi (femtometer) | meter (m) | 1.000 000*E−15 |
| fluid ounce (USA) | meter$^3$ (m$^3$) | 2.957 353E−05 |
| foot | meter (m) | 3.048 000*E−01 |
| foot (USA survey) | meter (m) | 3.048 006E−01 |
| foot of water (39.2°F) | pascal (Pa) | 2.988 98E+03 |
| ft$^2$ | meter$^2$ (m$^2$) | 9.290 304E−02 |
| ft$^2$/h (thermal diffusivity) | meter$^2$ per second (m$^2$/s) | 2.580 640*E−05 |
| ft$^2$/s | meter$^2$ per second (m$^2$/s) | 9.290 340E−02 |
| ft$^3$ (volume, section modulus) | meter$^3$ (m$^3$) | 2.831 685E−02 |
| ft$^3$/min | meter$^3$ per second (m$^3$/s) | 4.719 474E−04 |

| | | |
|---|---|---|
| ft$^3$/s | meter$^3$ per second (m$^3$/s) | 2.831 685E−02 |
| ft$^4$ (second moment of area)[b] | meter$^4$ (m$^4$) | 8.630 975E−03 |
| ft/h | meter per second (m/s) | 8.466 667E−05 |
| ft/min | meter per second (m/s) | 5.080 000*E−03 |
| ft/s | meter per second (m/s) | 3.048 000*E−01 |
| ft/s$^2$ | meter per second$^2$ (m/s$^2$) | 3.048 000E−01 |
| footcandle | lux (lx) | 1.076 391E+01 |
| footlambert | candela per meter$^2$ (cd/m$^2$) | 3.426 259E+00 |
| ft lbf | joule (J) | 1.355 818E+00 |
| ft lbf/h | watt (W) | 3.766 161E−04 |
| ft lbf/min | watt (W) | 2.259 697E−02 |
| ft lbf/s | watt (W) | 1.355 818E+00 |
| ft·poundal | joule (J) | 4.214 011E−02 |
| g, standard acceleration of free fall | meter per second$^2$ (m/s$^2$) | 9.806 650*E+00 |
| gal | meter per second$^2$ (m/s$^2$) | 1.000 000*E−02 |
| gallon (Canadian liquid) | meter$^3$ (m$^3$) | 4.546 090*E−03 |
| gallon (UK liquid) | meter$^3$ (m$^3$) | 4.546 090*E−03 |
| gallons (USA liquid) | meter$^3$ (m$^3$) | 3.785 412E−03 |
| gallon (USA liquid) per day | meter$^3$ per second (m$^3$/s) | 4.381 264E−08 |
| gallon (USA liquid) per minute | meter$^3$ per second (m$^3$/s) | 6.309 020E−05 |
| gallon (USA liquid) per (hp h), specific fuel consumption (SFC) | meter$^3$ per joule (m$^3$/J) | 1.410 089E−09 |
| gamma | tesla (T) | 1.000 000*E−09 |
| gauss | tesla (T) | 1.000 000*E−04 |
| gilbert | ampere (A) | 7.957 747E−01 |
| gill (UK) | meter$^3$ (m$^3$) | 1.420 654E−04 |
| gill (USA) | meter$^3$ (m$^3$) | 1.182 941E−04 |
| grade | degree (angular) | 9.000 000E−01 |
| grade | radian (rad) | 1.570 796E−02 |
| grain | kilogram (kg) | 6.497 891*E−05 |
| grain/gal (USA liquid) | kilogram per meter$^3$ (kg/m$^3$) | 1.711 806E−02 |
| gram | kilogram (kg) | 1.000 000*E−03 |
| g/cm$^3$ | kilogram per meter$^3$ (kg/m$^3$) | 1.000 000*E+01 |
| gram/force/cm$^2$ | pascal (Pa) | 9.801 650*E+03 |
| hectare | meter$^2$ (m$^2$) | 1.000 000*E+04 |
| horsepower (550 ft lbf/s) | watt (W) | 7.456 999E+02 |
| horsepower (boiler) | watt (W) | 9.809 50E+03 |
| hosepower (electric) | watt (W) | 7.460 000*E+02 |
| horsepower (metric) | watt (W) | 7.354 99E+02 |
| horsepower (water) | watt (W) | 7.460 43E+02 |
| horsepower (UK) | watt (W) | 7.457 0E+02 |
| hour | second (s) | 3.600 000*E+03 |
| hour (sidereal) | second (s) | 3.590 170E+03 |
| hundredweight (long) | kilogram | 5.080 235E+01 |
| hundredweight (short) | kilogram (kg) | 4.535 924E+01 |
| inch | meter (m) | 2.540 000*E−02 |
| inch of mercury (32°F)[c] | pascal (Pa) | 3.386 38E+03 |
| inch of mercury (60°F)[c] | pascal (Pa) | 3.376 85E+03 |
| inch of water (39.2°F) | pascal (Pa) | 2.490 82E+02 |
| inch of water (60°F) | pascal (Pa) | 2.488 4E+02 |
| in$^2$ | meter$^2$ (m$^2$) | 6.451 600*E−04 |
| in$^2$ (volume; section modulus)[d] | meter$^3$ (m$^3$) | 1.638 706E−05 |
| in$^3$/min | meter$^3$ per second (m$^3$/s) | 2.731 177E−07 |
| in$^4$ (second moment of area)[b] | meter$^4$ (m$^4$) | 4.162 314E−07 |
| in/s | meter per second (m/s) | 2.540 000*E−02 |
| in/s$^2$ | meter per second$^2$ (m/s$^2$) | 2.540 000*E−02 |
| kayser | 1 per meter (1/m) | 1.000 000*E+02 |
| kelvin | degree Celsius | $t_C = T_K - 273.15$ |
| kilocalorie (international table) | joule (J) | 4.186 800*E+03 |
| kilocalorie (mean) | joule (J) | 4.190 02E+03 |
| kilocalorie (thermochemial) | joule (J) | 4.184 000*E+03 |
| kilocalorie (thermochemical)/min | joule (J) | 6.973 333E+01 |
| kilocalorie (thermochemical)/s | watt (W) | 4.184 000*E+03 |
| kilogram-force (kgf) | newton (N) | 9.806 650*E+00 |
| Kgf m | newton meter (N m) | 9.806 650*E+00 |
| Kgf s$^2$/m (mass) | kilogram (kg) | 9.806 650*E+00 |
| Kgf/cm$^2$ | pascal (Pa) | 9.806 650*E+04 |
| Kgf/m$^2$ | pascal (Pa) | 9.806 650*E+00 |
| Kgf/mm$^2$ | pascal (Pa) | 9.806 650*E+06 |
| Km/h | meter per second (m/s) | 2.777 778E−01 |
| kilopond (1 kp = 1 kgf) | newton (N) | 9.806 650*E+00 |
| KWh | pascal (Pa) | 6.894 757E+06 |
| Kip (1,000 lbf) | newton (N) | 4.448 222E+03 |
| Kip/in$^2$ (ksi) | pascal (Pa) | 6.894 757E+06 |
| knot (international) | meter per second (m/s) | 5.144 444E−01 |
| lambert | candela per meter$^2$ (cd/m$^2$) | 1/π*E+04 |
| langley | joule per meter$^2$ (J/m$^2$) | 4.184 000*E+04 |
| light year[e] | meter (m) | 9.460 73E+15 |
| liter | meter$^3$ (m$^3$) | 1.000 000*E−03 |
| lumen per ft$^2$ | lumen per meter$^2$ (lm/m$^2$) | 1.076 391E+01 |
| maxwell | weber (Wb) | 1.000 000*E−08 |
| mho | siemens (S) | 1.000 000*E+00 |
| microinch | meter (m) | 2.540 000*E−08 |
| micron | meter (m) | 1.000 000*E−06 |
| Mil | meter (m) | 2.540 000*E−05 |
| mile (international) | meter (m) | 1.609 344*E+03 |
| mile (USA statute) | meter (m) | 1.609 3E+03 |
| mile (international nautical) | meter (m) | 1.852 000*E+03 |
| m$^2$ (international) | meter$^2$ (m$^2$) | 2.589 988E+06 |
| mi$^2$ (USA statute) | meter$^2$ (m$^2$) | 2.589 998E+06 |
| mi/h (international) | meter per second (m/s) | 4.470 400*E−01 |
| mi/h (international) | Kilometer per hour (km/h) | 1.609 344*E+00 |
| mi/min (international) | meters per second (m/s) | 2.682 240*E+01 |
| mi/s (international) | meter per second (m/s) | 1.609 344*E+03 |
| millibar | pascal (Pa) | 1.000 000*E+02 |
| millimeter of mercury (0°C)[c] | pascal (Pa) | 1.333 220E+02 |
| millimeter | meter (m) | 1.000 000E−03 |
| minute (angle) | radian (rad) | 2.908 882E−04 |
| minute | second (s) | 6.000 000*E+01 |
| minute (sidereal) | second (s) | 5.983 617E+01 |
| nanometer | meter (m) | 1.000 000E−09 |
| oersted | ampere per meter (A/m) | 7.957 747E+01 |
| ohm centimeter | ohm meter (m) | 1.000 000*E−02 |
| ohm circular-mil per ft | ohm meter (m) | 1.662 426E−09 |

| | | |
|---|---|---|
| ounce (avoirdupois) | kilogram (kg) | 2.834 952E−02 |
| ounce (troy or apothecary) | kilogram (kg) | 3.110 348E−02 |
| ounce (UK fluid) | meter$^3$ (m$^3$) | 2.841 307E−05 |
| ounce (USA fluid) | meter$^3$ (m$^3$) | 2.957 353E−05 |
| ounce-force | newton (N) | 2.780 139E−01 |
| Ozf in | newton meter (N m) | 7.061 552E−03 |
| oz (avoirdupois)/gal (UK liquid) | kilogram per meter$^3$ (kg/m$^3$) | 6.236 023E+00 |
| oz (avoirdupois)/gal (USA liquid) | kilogram per meter$^3$ (kg/m$^3$) | 7.489 152E−00 |
| oz (avoirdupois)/in | kilogram per meter$^3$ | 1.729 994E−03 |
| oz (avoirdupois)/ft$^2$ | kilogram per meter$^2$ (kg/m$^2$) | 3.051 517E−01 |
| oz (avoirdupois)/yd$^2$ | kilogram per meter$^2$ (kg/m$^2$) | 3.390 575E−02 |
| parsec | meter (m) | 3.085 678E+16 |
| peck (USA) | meter$^3$ (m$^3$) | 8.809 768E−03 |
| pennyweight | kilogram (kg) | 1.555 174E−03 |
| perm (0°C) | kilogram per pascal second meter$^2$ (kg/Pa s m$^2$) | 5.721 35E−11 |
| perm (23°C) | kilogram per pascal second meter$^2$ (kg/Pa s m$^2$) | 5.745 25E−11 |
| perm in (0°C) | kilogram per pascal second meter (kg/Pa s m) | 1.453 22E−12 |
| perm in (23°C) | kilogram per pascal second meter (kg/Pa s m) | 1.459 29E−12 |
| phot | lumen per meter$^2$ (lm/m$^2$) | 1.000 000*E+04 |
| pica (printer's) | meter (m) | 4.217 518E−03 |
| pint (USA dry) | meter$^3$ (m$^3$) | 5.506 105E−04 |
| ping (USA liquid) | meter$^3$ (m$^3$) | 4.731 765E−04 |
| point (printer's) | meter (m) | 3.514 598*E−04 |
| poise (absolute viscosity) | pascal second (Pa s) | 1.000 000*E−01 |
| pound (avoirdupois)[g] | kilogram (kg) | 4.535 924E−01 |
| pound (troy or apothecary) | kilogram (kg) | 3.732 417E−01 |
| lb/ft | kilogram per meter (kg/m) | 1.488 164E+00 |
| lb ft$^2$ (moment of inertia) | kilogram meter$^2$ (kg m$^2$) | 4.214 011E−02 |
| lb ft$^2$ (moment of inertia) | kilogram meter$^2$ (kg m$^2$) | 2.926 397E−04 |
| lb/ft h | pascal second (Pa s) | 4.133 789E−04 |
| lb/ft s | pascal second (Pa s) | 1.488 164E−00 |
| lb/ft$^2$ | kilogram per meter$^2$ (kg/m$^2$) | 4.882 428E+00 |
| lb/ft$^3$ | kilogram per meter$^3$ (kg/m$^3$) | 1.601 846E+01 |
| lb/gal (UK liquid) | kilogram per meter$^3$ (kg/m$^3$) | 9.977 633E+01 |
| lb/gal (USA liquid) | kilogram per meter$^3$ (kg/m$^3$) | 1.198 264E+02 |
| lb/h | kilogram per second (kg/s) | 1.259 979E−04 |
| lb/hp h (specific fuel consumption, SFC) | kilogram per joule (kg/J) | 1.689 659E−07 |
| lb/in | kilogram per meter (kg m) | 1.785 797E−01 |
| lb/in$^3$ | kilogram per meter$^3$ (kg/m$^3$) | 2.767 990E+04 |
| lb/min | kilogram per second (kg/s) | 7.559 873E−03 |

| | | |
|---|---|---|
| lb/s | kilogram per second (kg/s) | 4.535 924E−01 |
| lb/yd$^3$ | kilogram per meter$^3$ (kg/m$^3$) | 5.932 E−01 |
| poundal | newton (N) | 1.382 550E−01 |
| poundal/ft$^2$ | pascal (Pa) | 1.488 164E+00 |
| poundal s/ft$^2$ | pascal second (Pa s) | 1.488 164E+00 |
| pound-force (lbf)[h] | newton (N) | 4.448 222E+00 |
| Lbf ft | Newton meter (N m) | 1.355 818E+00 |
| Lbf ft/in | Newton meter per meter (N m/m) | 5.337 866E+01 |
| Lbf in | Newton meter (N m) | 1.129 848E−01 |
| Lbf in/in | Newton meter per meter (N m/m) | 4.448 222E+00 |
| Lbf s/ft$^2$ | pascal second (Pa s) | 4.788 026E+01 |
| Lbf s/in$^2$ | pascal second (Pa s) | 6.894 757E+03 |
| Lbf/ft | newton per meter (N/m) | 1.459 390E+01 |
| Lbf/ft$^2$ | pascal (Pa) | 4.788 026E+01 |
| Lbf/in | newton per meter (N/m) | 1.751 268E+02 |
| Lbf/in$^2$ (psi) | pascal (Pa) | 6.894 757E+03 |
| Lbf/lb [thrust/weight (mass) ratio] | newton per kilogram (N/kg) | 9.806 650E+00 |
| quad | joule (J) | 1.055E+18 |
| quart (USA dry) | meter$^3$ (m$^3$) | 1.101 221E−03 |
| quart (USA liquid) | meter$^3$ (m$^3$) | 9.463 529E−04 |
| Rad (absorbed dose) | gray (Gy) | 1.000 000*E−02 |
| Rem (dose equivalent) | sievert (Sv) | 1.000 000*E−02 |
| Rhe | 1 per pascal second (1/Pa s) | 1.000 000*E+01 |
| rod | meter (m) | 5.029 210E+00 |
| roentgen | coulomb per kilogram (C/kg) | 2.58E−04 |
| second (angle) | radian (rad) | 4.848 137E−06 |
| second (sidereal) | second (s) | 9.972 696E−01 |
| shake | second (s) | 1.000 000*E−08 |
| slug | kilogram (kg) | 1.459 390E+01 |
| slug/ft s | pascal second (Pa s) | 4.788 026E+01 |
| slug/ft$^3$ | kilogram per meter (kg/m$^3$) | 5.153 788E+02 |
| statampere | ampere (A) | 3.335 641E−10 |
| statcoulomb | coulomb (C) | 3.335 641E−10 |
| stratfarad | farad (F) | 1.112 650E−12 |
| stathenry | henry (H) | 8.987 552E+11 |
| statmho | siemens (S) | 1.112 650E−12 |
| statohm | ohm () | 8.987 552E+11 |
| statvolt | volt (V) | 2.997 925E+02 |
| stere | meter$^3$ (m$^3$) | 1.000 000*E+00 |
| stilb | candela per meter$^2$ (cd/m$^2$) | 1.000 000*E+04 |
| stokes (kinematic viscosity) | meter$^2$ per second (cd/m$^2$) | 1.000 000*E−04 |
| tablespoon | milliliter (ml) | 1.479E+01 |
| teaspoon | meter$^3$ (m$^3$) milliliter (ml) | 4.929E+01 |
| tex | kilogram per meter (kg/m) | 1.000 000*E−06 |
| therm (EEG)[i] | joule (J) | 1.055 060*E+08 |
| therm (USA)[i] | joule (J) | 1.054 804*E+08 |
| ton (assay) | kilogram (kg) | 2.916 667E−02 |
| ton (long, 2240 lb) | kilogram (kg) | 1.016 047E+03 |
| ton (metric) | kilogram (kg) | 1.000 000*E+03 |
| ton (explosive energy of one tone of TNT) | joule (J) | 4.184E+09[j] |
| ton of refrigeration (12,000 Btu/h) | watt (W) | 3.517E+03 |
| ton (register) | meter$^3$ (m$^3$) | 2.831 685E+00 |

| | | |
|---|---|---|
| ton (short, 2,000 lb) | kilogram (kg) | 9.071 847E+02 |
| ton (long)/yd$^3$ | kilogram per meter$^3$ (kg/m$^3$) | 1.328 939E+03 |
| ton (short)/yd$^3$ | kilogram per meter$^3$ (kg/m$^3$) | 1.186 553E+03 |
| ton (short)/h | kilogram per second (kg/s) | 2.519 958E−01 |
| ton-force (2,000 lbf) | newton (N) | 8.896 443E+03 |
| tonne | kilogram (kg) | 1.000 000*E+03 |
| torr (mmHg, 0°C)[c] | pascal (Pa) | 1.333 22E+02 |
| unit pole | weber (Wb) | 1.256 637E−07 |
| Wh | joule (J) | 3.600 000*E+03 |
| Ws | joule (J) | 1.000 000*E+00 |
| W/cm$^2$ | watt per meter$^2$ (W/m$^2$) | 1.000 000*E+04 |
| W/in$^2$ | watt per meter$^2$ (W/m$^2$) | 1.550 003*E+03 |
| Yard | meter (m) | 9.144 000*E−01 |
| yd$^2$ | meter$^2$ (m$^2$) | 8.361 274E−01 |
| yd$^3$ | meter$^3$ (m$^3$) | 7.645 549E−01 |
| yd$^3$/min | meter$^3$ per second m$^3$/s) | 1.274 258E−02 |
| year (365 days) | second (s) | 3.153 600*E+07 |
| year (sidereal) | second (s) | 3.155 815E+07 |
| year (tropical) | second (s) | 3.155 693E+07 |

*Note*—the centigrade temperature scale is obsolete. The unit, degree centigrade, is only approximately equal to the degree Celsius

[a] The darcy is a unit for measuring permeability of porous solids

[b] This is sometimes called the moment of section or area moment of inertia of a plane section about a specified axis

[c] Conversion factors for mercury manometer pressure units are calculated using the standard value for the acceleration of gravity and the density of mercury at the stated temperature. Higher levels of precision are not justified because the definitions of the units do not take into account the compressibility of mercury or the density value change caused by the revised practical temperature scale, ITS-90.

[d] The exact conversion factor is 1.638 706 4*E−05

[e] This conversion factor is based on the astronomical unit of time of one day (86,400 s); an interval of 36, 525 days is one Julian century *See* the Astronomical Almanac for the Year (1991) USA government Printing Office, Washington, DC, pK6

[f] In 1964 the general conference on weights and measures re-established the name liter as a special name for the cubic decimeter. Between 1901 and 1964, the liter was slightly larger (1.000028 dm$^3$); in the use of high-accuracy volume data of that time interval, this fact must be kept in mind

[g] The exact conversion factor is 4.535 923 7 *E−01

[h] The exact conversion factor is 4.448 221 615 260 5 *E+00

[i] The therm (EEC) is legally defined in the Council Directive of 20 December 1979, Council of the European Communities. The therm (USA) is legally defined in the Federal Register of July 27, 1968. Although, the therm (EEC), which is based on the International Table Btu, is frequently used by engineers in the USA, the therm (USA) is the legal unit used by the USA natural gas industry

[j] Defined (not measured) value

Note concerning the foot:

The U.S. Metric Law of 1866 gave the relationship, 1 meter equals 39.37 inches. Since 1893 the U.S. yard has been derived from the meter. In 1959 a refinement was made in the definition of the yard to bring the U.S. yard and the yard used in others countries into agreement. The U.S. yard was changed from 3600/3937 m to 0.9144 m exactly. The new length is shorter by exactly two parts in a million. At the same time it was decided that any data in feet derived from and published as a result of geodetic surveys within the United States would remain with the old standard (1 ft = 1200/3937 m) until further decision. This foot is named the U.S. survey foot and has the following relationships:

1 rod (pole or perch) = 16 ½ feet
1 chain = 66 feet
1 mile (U.S. statute) = 5280 feet

| | atmos | Torr | µmHz | psi |
|---|---|---|---|---|
| Torr | 0.00131579 | 1 | 1000 | 0.01933672 |
| µmHz | 1.31579 × 10$^{-6}$ | 0.001 | 1 | 1.933672 × 10$^{-5}$ |
| Psi | 0.0680456 | 51.7151 | 51715.1 | 1 |

To convert a pressure value from a unit in the left hand column to a new unit, multiply the

## Conversion of temperatures

| From | To | |
|---|---|---|
| °Celsius | °Fahrenheit | $t_F = (t_c \times 1.8) + 32$ |
| | Kelvin | $T_k = t_c + 273.15$ |
| | °Rankin | $T_R = (t_c + 273.15) \times 1.8$ |
| °Fahrenheit | °Celsius | $t_c = \frac{(t_F - 32)}{1.8}$ |
| | Kelvin | $t_k = \frac{(t_F - 32)}{1.8} + 273.15$ |
| | °Rankin | $T_R = t_F + 459.67$ |
| Kelvin | °Celsius | $t_c = T_K - 273.15$ |
| | °Rankin | $T_R = T_K \times 1.8$ |
| °Rankin | °Fahrenheit | $t_F = T_R - 459.67$ |
| | Kelvin | $t_k = \frac{t_R}{1.8}$ |

## Designation of large numbers

| | U.S.A. | Other countries |
|---|---|---|
| $10^6$ | million | million |
| $10^9$ | billion | milliard |
| $10^{12}$ | trillion | billion |
| $10^{15}$ | quadrillion | billard |
| $10^{18}$ | quintillion | trillion |

## Conversion factors for pressure units

| | Pa | kPa | MPa | bar |
|---|---|---|---|---|
| Pa | 1 | 0.001 | 0.000001 | 0.00001 |
| kPa | 1000 | 1 | 0.001 | 0.01 |
| MPa | 1,000,000 | 1,000 | 1 | 10 |
| bar | 100,000 | 100 | 0.1 | 1 |
| atmos | 101,325 | 101.325 | 0.101325 | 1.01325 |
| Torr | 133.322 | 0.133322 | 0.000133322 | 0.00133322 |
| μmHz | 0.133322 | 0.000133322 | $1.33322 \times 10^{7}$ | $1.33322 \times 10^{-6}$ |
| psi | 6894.757 | 6.894757 | 0.006894757 | 0.06894757 |

| | atmos | Torr | μmHz | psi |
|---|---|---|---|---|
| Pa | $9.8692 \times 10^{-6}$ | 0.0075006 | 7.5006 | 0.0001450377 |
| kPa | 0.0098692 | 7.5006 | 7500.6 | 0.1450377 |
| MPa | 9.8692 | 7500.0 | 7,500,600 | 145.0377 |
| bar | 0.98692 | 750.06 | 750,060 | 14.50377 |
| atmos | 1 | 760 | 760,000 | 14.69594 |

value by the factor appearing in the column for the new unit. For example:

1 kPa = $9.8692 \times 10^{-3}$ atmos

1 Torr = $1.33322 \times 10^{-4}$ MPa

*Notes*: μmHz is often referred to as "micron"

Torr is essentially identical to mmHg

psi is pounds per square inch

## Sub-units of the meter

1 m = 1.0 E+0m
= 1.0 E−1dm
= 1.0 E−2cm
= 1.0 E−3 mm
= 1.0 E−6μm
= 1.0 E−9nm
= 1.0 E−10Å

## Commonly used units

Area
Density
Energy
Flow rate
Force
Frequency
Heat

## Commonly used units

Heat capacity
Heat flux
Length
Mass
Perms, permenance, and permeability
Power
Pressure
Strength
Stress
Temperature
Thermal conductivity
Thermal diffusivity
Time
Torque
Velocity
Viscosity
Volume
Work

# Appendix C: Micro-organisms, biochemistry, and nomenclature

## 1. Nomenclature of biochemistry and micro-organisms

**Abiotic factor** A physical feature of the environment that interacts with organisms.

**ABO blood group system** One of the blood typing systems that is based on the presence or absence of blood group antigens A and B on red blood cells.

**Abortive infection** Viral infection in which viruses enter a cell but are unable to express all of their genes to make infectious progeny.

**Abscess** An accumulation of pus in a cavity hollowed out by tissue damage.

**Absorbance ($A^\lambda$)** A dimensionless number that indicates how well a solution of a substance absorbs light of a given wavelength. It is defined as the negative logarithm of the fraction of light wavelength $\lambda$ that passes through a sample of the solution; its value depends on the length of the light path, the concentration of the solution, and the extinction coefficient of the substance at that wavelength.

**Absorption** Process in which light rays are neither passed through nor reflected off an object but are retained and either transformed to another form of energy or used in biological processes.

**Accidental parasite** A parasite that invades an organism other than its normal host.

**Acetylcholinesterase** An enzyme found in cholinergic synapses that breaks down acetylcholine and thus terminates its action on the postsynaptic cell.

**Acid** A substance that releases hydrogen ions when it is dissolved in water.

**Acidic dye** *See anionic dye.*

**Acidophile** An acid-loving organism that grows best in an environment with a pH of 4.0–5.4.

**Acme** (sometimes referred to a fulminating) During the illness phase of the disease process, the time of most intense signs and symptoms.

**Acne** Skin condition caused by bacterial infection of hair follicles and the ducts of sebaceous glands.

**Acquired Immune Deficiency Syndrome (AIDS)** An infectious disease caused by the human immunodeficiency virus that destroys the individual's immune system.

**Acquired immunity** Immunity obtained in some manner other than by heredity.

**Acridine derivative** A chemical mutagen that can be inserted between bases of the DNA double helix, causing frameshift mutations.

**Acrobe** An organism that uses oxygen, including ones that must have oxygen.

**Actinomycetes** Gram-positive bacteria that tends to form filaments.

**Action potential** A wave of transient depolarization that travels along the membrane of a nerve cell (or any other kind of excitable cell, such as a muscle cell) as a result of fluxes of ions across the membrane. A nerve impulse.

**Activated sludge system** Procedure in which the effluent from the primary stage of sewage treatment is agitated, aerated, and added to sludge containing aerobic organisms that digest organic matter.

**Activated state** With respect to a chemical reaction, a transient high-energy state of a reactant molecule (such as an unfavorable electron configuration or strained conformation) that enables the molecule to undergo the reaction.

**Activation energy** The energy required to start a chemical reaction.

**Active immunity** Immunity created when an organism's own immune system produces antibodies or other defenses against an agent recognizes as foreign.

**Active immunization** Use of vaccines to control diseases by increasing herd immunity through stimulation of the immune response.

**Active site** The site on an enzyme molecule where the substrate binds and where the reaction is facilitated. It is often a cleft or pocket in the surface of the enzyme.

**Active transport** (1) Movement of molecules or ions across a membrane against a concentration gradient; requires expenditure of energy from ATP (2) The transport of a substance across a biological membrane by a mechanism that can work against a concentration (or electrochemical) gradient. It always requires the expenditure of cellular energy. *Compare facilitated transport, passive transport.*

**Acute disease** A disease that develops rapidly and runs it course quickly.

**Acute hemorrhagic conjunctivitis** Eye disease caused by an enterovirus.

**Acute inflammation** The relatively short duration of inflammation during which time host defenses destroy invading microbes and repair tissue damage.

**Acute necrotizing ulcerative gingivitis (ANUG)** A severe form of periodontal disease.

*Also known as Trench Mouth.*

**Acute phase protein** Protein, such as C-reactive protein or mannose-binding protein, that forms a non-specific host-defense mechanism during an acute phase response.

**Acute phase response** A response to an acute illness that produces specific blood proteins called acute phase proteins.

**Acute respiratory disease (ARD)** Viral disease that occurs in epidemics with cold symptoms as well as fever, headache, and malaise, sometimes causes viral pneumonia.

**Adenovirus** A medium-sized, naked DNA virus that is highly resistant to chemical agents and often causes respiratory infections or diarrhea.

**Adenylylation** In cells, the transfer of an adenylyl moiety from AT to another molecule. Some enzymes are regulated by reversible adenylylation.

**Adherence** The attachment of a micro-organism to a host's cell surface.

**Adhesin** A protein or glycoprotein on attachment pili (fimbriae) or capsules that help a micro-organism attach to a host cell.

**Adipocytes** Fat cells; cells that are specialized for storing triacylglycerols and for releasing them to the blood in the form of fatty acids and glycerol as required.

**Adrenergic receptors** Cell-surface receptors that bind epinephrine and norepinephrine. There are several different types with somewhat different ligand specificities and effects (The term comes from *adrenaline*, the old name for epinephrine.)

**Adsorption** The attachment of the virus to the host cell in the replication process.

**Aerobic respiration** Processes in which aerobic organisms gain energy from the catabolism of organic molecules via the Krebs cycle and oxidative phosphorylation.

**Aerosol** A cloud of tiny liquid droplets suspended in air.

**Aerotolerant anaerobe** A bacterium that can survive in the presence of oxygen but does not use oxygen in its metabolism.

**Affinity constant** *See association constant.*

**Aflatoxin** Fungal toxin that is a potent carcinogen, found in food made from contaminated grain or peanuts infested with *Aspergillus flavus* and other aspergilli.

**African sleeping sickness** Disease of equatorial Africa caused by protozoan blood parasites of the genus *Trypanosoma*.
*Also known as Trypanosomiasis.*

**Agammaglobulinemia** Primary immunodeficiency disease caused by failure of B cells to develop, resulting in lack of antibodies.

**Agar** A polysaccharide extracted from certain marine algae and used to solidify medium for the growth of micro-organisms.

**Agar plate** A plate of nutrient medium solidified with agar.

**Agglutination reaction** A reaction of antibodies with antigens the results in agglutination, the clumping together of cells or other large particles.

**Agonist** In molecular biology, a substance that mimics the cellular effects of a natural compound (such as a hormone or neurotransmitter) by binding to and activating the same cellular receptor. *Compare antagonist.*

**Agranulocyte** A leukocyte (monocyte or lymphocyte) that lacks granules in the cytoplasm and has rounded nuclei.

**A Helix** A right-hand helix structure of nucleic acid duplexes that has a smaller pitch and a larger diameter than the B-DNA helix. It is the structure adopted by RNA duplexes and RNA–DNA hybrid molecules

**AIDS (Acquired Immune Deficiency Syndrome)** An infectious disease caused by the human immunodeficiency virus that destroys the individual's immune system.

**Alcoholic fermentation** Fermentation in which pyruvic acid is reduced to ethyl alcohol by electrons from reduced NAD (NADH)

**Alditols** Compounds that are produced by reducing the carbonyl group on a monosaccharide (i.e. reducing R–CH=O to $R{-}CH_2{-}OH$)

**Aldose** A monosaccharide in which the carbonyl group comes at the end of the chain and thus represents an aldehyde group. *Compare ketose.*

**Algae** (singular: *alga*) Photosynthesis, eukaryotic organisms in the kingdoms Protista and Plantae.

**Alkaline** Condition caused by an abundance of hydroxyl ions (OH–) resulting in a pH of greater than 7.0.
*Also known as basic.*

**Alkaliphile** A base- (alkaline) loving organism that grows best in an environment with a pH of 7.0–11.5.

**Alkaloids** A large group of nitrogenous basic substances found in plants. Most of them taste bitter, and many are pharmacologically active. The term can also be used for synthetic compounds.

**Alkylating agent** A chemical mutagen that can add alkyl groups ($-CH_3$) to DNA bases, altering their shapes and causing errors in base pairing.

**Allele** The form of a gene that occupies the same place (locus) on the DNA molecule as another form but may carry different information for a trait.

**Allergen** An ordinarily innocuous foreign substance that can elicit an adverse immunological response in a sensitized person.

**Allergy** When the immune system reacts in an exaggerated or inappropriate way to a foreign substance.
*Also known as hypersensitivity.*

**Allograft** A graft of tissue between two organisms of the same species those are not genetically identical.

**Allosteric** With respect to enzymes, an effect that is produced on the activity of one part of an enzyme (such as an active site) by the binding of an effector to a different part of the enzyme.

**Allosteric site** The site at which a non-competitive inhibitor binds.

**Alpha (α) hemolysin** A type of enzyme that partially lyses red blood cells, leaving a greenish ring in the blood agar medium around the colonies.

**Alpha (α) hemolysis** Incomplete lysis of red blood cells by bacterial enzymes.

**Alternative pathway** One of the sequences of reactions in non-specific host responses by which proteins of the complement system are activated.

**Alternative splicing** The splicing of a eukaryotic RNA transcript in different ways, to include or exclude certain exons from the final mRNA.

***Alu* elements** DNA sequences about 300 base pairs long that occur in many copies scattered throughout the genome of mammals; the human genome has hundreds of thousands of them. They may serve an unknown function, or they may be purely "parasitic," spreading as mobile elements through the genome.

**Alveolus** A saclike structure arranged in clusters at the ends of the respiratory bronchioles, having walls one cell layer thick, where gas exchange occurs.

**Amantadine** An antiviral agent that prevents penetration by influenza A virus.

**Ames test** Test used to determine whether a particular substance is mutagenic, based on its ability to induce mutations in auxotrophic bacteria. A strain of the bacterium *Salmonella typhimurium* having a mutation that disables an enzyme necessary for histidine utilization is exposed to the substance in question and plated on a medium lacking histidine. A reversion mutation that activates the mutant enzyme causes the cells to grow on this medium.

**Amino acid** An organic acid containing an amino group and a carboxyl group, composing the building blocks of proteins.

**Aminoglycoside** An antimicrobial agent that blocks bacterial protein synthesis.

**Amino terminus** *See N-terminus.*

**Amoebic dysentery** Severe, acute form of amebiasis, caused by *Entamoeba histolytica.*

**Amoeboid movement** Movement by means of pseudopodia that occurs in cells without walls, such as amoebas and some white blood cells.

**Amphibolic pathway** A metabolic pathway that can yield either energy or building blocks for synthetic reactions.

**Amphipathic** For a molecule, the property of having both hydrophobic and hydrophilic portions. Usually one end or side of the molecule is hydrophilic and the other end or side is hydrophobic.

**Amphitrichous** The presence of flagella at both ends of the bacterial cell.

**Ampholyte** A substance whose molecules have both acidic and basic groups.

**Anabolic pathway** A chain of chemical reactions in which energy is used to synthesize biologically important molecules.

**Anabolism** Chemical reactions in which energy is used to synthesize large molecules from simple components.
*Also known as synthesis.*

**Anaerobe** An organism that does not use oxygen, including some organisms that are killed by exposure to oxygen.

**Anaerobic** Refers to the absence of oxygen or the absence of a need for it; processes that must or can occur without oxygen are called anaerobic processes.

**Anaerobic respiration** Respiration in which the final electron acceptor in the electron transport chain is an inorganic molecule other than oxygen, e.g., sulfate, nitrate, etc.

**Analytical study** An epidemiological study that focuses on establishing cause-and-effect relationships in the occurrence of diseases in populations.

**Anamnestic response** Prompt immune response due to “recall” by memory cells.

*See secondary response.*

**Anaphylactic shock** Condition resulting from a sudden extreme drop in blood pressure caused by an allergic reaction.

**Anaphylaxis** An immediate, exaggerated allergic reaction to antigens, usually leading to detrimental effects.

**Androgens** The male sex hormones; specifically, the steroid hormones testosterone, dihydrotestosterone, and androstenedione, which act mainly to promote male sexual development and maintain male sex characteristics.

**Angstrom (Å)** Unit of measurement equal to 0.0000000001 m, or $10^{-10}$ m. No longer officially recognized.

**Animalia** The kingdom of organisms to which all animals belong.

**Animal passage** The rapid transfer of a pathogen through animals of a species susceptible to infection by the pathogen.

**Anion** \ˈa-ˌn ī - ə n\ [GK, neut. of *aniōn, prp.* Of *anienai* to go up, fr. *ana*- + *ienai* to go] (1834) *n.* A negatively charged ion.

**Anionic** \ˌa-(ˌ)n ī-ˈä-nik\ (ca. 1920) *adj.*

**Anionic dye** An ionic compound, used for staining bacteria, in which the negative ion imparts the color.

*Also known as acidic dye.*

**Anomers** Stereoisomes of cyclized monosaccharide molecules differing only in the configuration of the substituents on the carbonyl carbon (This carbon is a center of Chirality in the cyclized but not in the open-chain form of the molecule.)

**Antagonism** The decreased effect when two antibiotics are administered together.

**Antagonist** In biochemistry, a substance that counteracts the cellular effects of a natural compound (such as a hormone or neurotransmitter) by binding to the cellular receptor for the compound and blocking its action. *Compare agonist.*

**Anthrax** A zoonosis caused by *Bacillus anthracis* that exists in cutaneous, respiratory (“woolsorters disease”), or intestinal forms; transmitted by endospores.

**Antibiosis** The natural production of an antimicrobial agent by a bacterium or fungus.

**Antibiotic** A chemical substance produced by micro-organisms that can inhibit the growth of or destroy other micro-organisms.

**Antibodies** A set of related proteins that are produced by B lymphocytes and can bind with specificity to antigens. Some types are released into body fluids and mediate humoral immunity; other types are retained on the surface of the B cell or are taken up and displayed by some other cell types.

**Antibody** A protein in response to an antigen that is capable of binding specifically to that antigen.

*Also known as immunoglobulin.*

**Antibody titer** The quantity of a specific antibody in an individual’s blood, often measured by means of agglutination, reactions.

**Anticodon** A three-base sequence in tRNA that is complementary to one of the mRNA codons, forming a link between each codon and the corresponding amino acid.

**Antigen** A substance that the body identifies as foreign and toward which it counts an immune response.

*Also known as immunogen.*

**Antigen binding site** The site on the antibody to which the antigen (epitope) binds)

**Antigen challenge** Exposure to a foreign antigen.

**Antigenic determinant** *See epitope.*

**Antigenic drift** Process of antigenic variation that results from mutations in genes coding for hemagglutinin and neuramindase.

**Antigenic mimicry** Self-antigen that is similar to an antigen on a pathogen.

**Antigenic shift** Process of antigenic variation probably caused by a reassortment of viral genes.

**Antigenic variation** Mutations of influenza viruses that occur by antigenic drift and antigenic shift.

**Antigenic Presenting Cell** An immunological cell, such as a macrophage, dendritic cell, or B cell, that processes antigen fragments and presents peptide fragments from the antigen on its cell surface.

**Antihistamine** Drug that alleviates symptoms caused by histamines.

**Antimetabolite** A substance that is a structural analog of a normal metabolite or otherwise resembles it and that interferes with the utilization of the metabolite by the cell.

**Antimicrobial Agent** A chemotherapeutic agent used to treat diseases caused by microbes.

**Antioxidant** A strongly reducing compound, such as ascorbic acid, which counteracts the tendency of a metabolite to undergo oxidation to a potentially toxic or harmful species.

**Antiparallel** The opposite head-to-tail arrangement of the two strands in a DNA double helix.

**Antiport** A membrane transport process that couples the transport of a substance in one direction across a membrane to the transport of a different substance in the other direction. *Compare symport.*

**Antisense RNA** An RNA molecule that is complementary to an mRNA; it can block translation of the mRNA by forming a duplex with it. Gene expression can be regulated by the production of antisense RNAs.

**Antiseptic** A chemical agent that can be safely used externally on tissues to destroy micro-organisms or to inhibit their growth.

**Antiserum** (plural: *antisera*) Serum that contain a high concentration of antibodies against a particular antigen.

**Antitoxin** An antibody against a specific toxin.

**Antiviral protein** A protein induced by interferon that interferes with the replication of viruses.

**Apicomplexan** A parasite protozoan such as *Plasmodium*, that generally has a complex life cycle.
*Also known as Sporozoan.*

**Aplastic crisis** A period during which erythrocyte production ceases.

**Apoenzyme** The protein portion of an enzyme.

**Apolipoproteins** The specific proteins that constitute the protein fraction of lipoproteins; they mediate the interactions of lipoproteins with tissues.

**Apoptosis** Programmed cell death (as distinguished from necrosis).
*See autolysis.*

**Arachnid** An anthropod with two body regions, four pairs of legs, and mount parts that are used in capturing and tearing apart prey.

**Archaea** One of the three domains of living things; all members are bacterial.

**Archaebacteria** A group of prokaryotes that are biochemically distinct from the true bacteria (eubacteria) and that separated from them early in the history of life. Modern archaebacteria mostly live in extreme environments, such as acid hot springs.

**Archaeobacteria** Prokaryotic organisms lacking peptidoglycan in their cell walls and differing from eubacteria in many ways.

**Arenavirus** An enveloped RNA virus that causes Lassa fever and certain other hemorrhagic fevers.

**Anthropod** Makes up the largest group of living organisms, characterized by a jointed chitinous exoskeleton, segmented body, and joined appendages, associated with some or all of the segments.

**Arthus reaction** A local reaction seen in the skin after subcutaneous or intradermal injection of an antigenic substance, immune complex (Type-III) hypersensitivity.

**Artificially acquired active immunity** When an individual is exposed to a vaccine containing live, weakened, or dead organisms or their toxins, the host's own immune system responds specifically to defend the body, e.g., by making specific antibodies.

**Artificially acquired immunity** When an individual's immune system is stimulated to react by some man-made process, e.g., given a vaccine or an immune serum.

**Artificially acquired passive immunity** When antibodies made by other hosts are introduced into a new host, e.g., via mother's milk or shots of gamma globulin.

**Ascariasis** Disease caused by a large roundworm, *Ascaris lumbricodes*, acquired by ingestion of food or water contaminated with eggs.

**Ascomycota** *See sac fungus.*

**Ascospore** One of the eight sexual spores produced in each ascus of a sac fungus.

**Ascus** (plural: *asci*) Saclike structures produced by sac fungi during sexual reproduction.

**Aseptic technique** A set of procedures used to minimize chances that cultures will be contaminated by organisms from the environment.

**Asiatic cholera** Severe gastrointestinal disease caused by *Vibrio cholerae*, common in areas of poor sanitation and fecal contamination of water.

**Aspergillosis** Skin infection caused by various species of *Aspergillus*, which can cause severe pneumonia in immuno-suppressed patients.

*Known also as farmer's lung disease.*

**Association constant (*K*)** An equilibrium constant that indicates the tendency of two chemical species to associate with each other; it is equal to the concentration of the associated form divided by the product of the concentrations of the free species at equilibrium.

*Known also as affinity constant.*

**Asthma** Respiratory anaphylaxis caused by inhaled or ingested allergies or by hypersensitivity to endogenous micro-organisms.

**Asymmetric carbon** A carbon molecule that carries four different substituents and therefore acts as a center of chirality, meaning that the substance can occur in two different enantiomers (stereoisomers that are non-superimposable mirror images of each other).

**Atherosclerotic plaques** The protruding masses that form on the inner walls of arteries in atherosclerotic disease. A mature plaque consists partly of lipid, mainly cholesterol esters, which may be free or contained in lipid-engorged macrophages called foam cells, and partly of an abnormal proliferation of smooth-muscle and connective-tissue cells.

**Athlete's foot** A form of ringworm in which hyphae invade the skin between the toes, causing dry, scaly lesions.

*Also known as tinea pedis.*

**Atom** The smallest chemical unit of matter.

**Atomic force microscope (AFM)** Advanced member of the family of scanning tunneling microscopes, allowing 3-dimensional views of structures from atomic size to about 1 μm.

**Atomic number** The number of protons in an atom of a particular element.

**Atomic weight** The sum of the number of protons and neutrons in an atom.

**Atopy** Localized allergic reactions that occur first at the site where an allergen enters the body.

**Atrichous** A bacterial cell without flagella.

**Attachment pilus** Type of pilus that helps bacteria adhere to surfaces. *Also known as fimbria.*

**Attenuation** (1) A genetic control mechanism that terminates transcription of an operon prematurely when the gene products are not needed (2) The weakening of the disease-producing ability of an organism.

**Auditory canal** Part of the outer ear lined with skin that contains many small hairs and ceruminous glands.

**Autoantibody** An antibody against one's own tissue.

**Autocatalytic** Refers to a reaction that an enzyme catalyzes on part of its own structure, such as cleavage performed by a protease on its own polypeptide precursor.

**Autoclave** An instrument for sterilization by means of moist heat under pressure.

**Autograft** A graft of tissue from one part of the body to another.

**Autoimmune disorder** An immune disorder in which individuals are hypersensitive to antigens on ells of their own body.

**Autoimmunity** A condition in which the body mounts an immune response against one of its own normal components.

**Autoimmunization** The process by which hypersensitivity to "self" develops, it occurs when the immune system responds to a body components as if it were foreign.

**Autolysis** Programmed cell death; the orderly self-destruction of a cell in a multicellular organism. It is the process by which unwanted cells are eliminated in the body. *Known also as apoptosis.*

**Autonomously replicating sequences (ARSs)** Sequences in yeast chromosomes that, when incorporated into an artificial plasmid, enable the plasmid to replicate efficiently in yeast cells.

**Autotroph** Organisms that can synthesize their organic compounds entirely from inorganic precursors in particular needing only $CO_2$ as a carbon source. *Compare heterotrophs.*

**Autotrophy** "Self-feeding" – the use of $CO_2$ as a source of carbon atoms for the synthesis of biomolecules.

**Auxotrophic mutant** An organism that has lost the ability to synthesize one or more metabolically important enzymes through mutation, therefore requires special substances in its growth medium.

**Auxotrophs** Micro-organism strains that requires as a nutrient a particular substance that is not required by the prototype strain. Usually the requirement results from a mutation that disables an enzyme necessary for the endogenous synthesis of the substance.

**Axial filament** A subsurface filament attached near the ends of the cytoplasmic cylinder of spirochetes that causes the spirochete body to rotate like a corkscrew. *Also known as endoflagellum.*

**Axis of symmetry** An imaginary axis through a structure, such that rotating the structure around the axis through an appropriate angle leaves the appearance of the structure unchanged.

**Axon** A threadlike process extending from a nerve cell by which impulses are transmitted to other nerve cells or to effector cells such as muscle or gland cells. Most nerve cells have one axon; shorter processes that function ion receiving impulses form other neutrons are called dendrites.

**Babesiosis** A protozoan disease caused by the Apicomplexan *Babesia microti* and other species of *Babesia*.

**Bacillary angiomatosis** A disease of the small blood vessels of the skin and internal organs caused by the rickettsial organism *Bartonella hensalae*.

**Bacillary dysentery** *See shigellosis.*

**Bacillus** (plural: *bacilli*). A rod-like bacterium.

**Bacteremia** An infection in which bacteria are transported in the blood but do not multiply in transit.

**Bacteria** (singular: *bacterium*). All prokaryotic organisms.

**Bacteria** When spelled with a capital B, it is the name of one of the three domains of living things; all members are bacterial.

**Bacterial conjunctivitis** A highly contagious inflammation of the conjunctiva caused by various bacterial species.
*Also known as pinkeye.*

**Bacterial endocarditis** A life-threatening infection and inflammation of the lining and valves of the heart.
*Also known as infective endocarditis.*

**Bacterial enteritis** An intestinal infection caused by bacterial invasion of intestinal mucosa or deeper tissues.

**Bacterial lawn** A uniform layer of bacteria grown on the agar surface in a Petri dish.

**Bacterial meningitis** An inflammation of the meninges that cover the brain and spinal cord by any one of several bacterial species.

**Bactericidal** Referring to an agent that kills bacteria.

**Bacteriocin** A protein released by some bacteria that inhibits the growth of other strains of the same or closely related species.

**Bacteriocinogen** A plasmid that directs production of a bacteriocin.

**Bacteriophage** A virus that infects bacteria.
*Also known as phage.*

**Bacteriostatic** Referring to an agent that inhibits the growth of bacteria.

**Bacteroid** Irregularly shaped cells usually found in tight packets that develop from *Rhizobium* swarmer cells and form nodules in the roots of leguminous plants.

**Balantidiasis** Type of dysentery caused by the ciliated protozoan *Balantidium coli.*

**Balantitis** An infection of the penis.

**Barophile** An organism that lives under high hydrostatic pressure.

**Barotholin gland** A mucus-secreting gland of the female external genitalia.

**Bartonellosis** Rickettsial disease, caused by *Bartonella bacilliformis*, that occurs in two forms.
*See also oroyo fever and verruga peruana.*

**Base** A substance that absorbs hydrogen ions or donates hydroxyl ions.

**Base analog** A chemical mutagen similar in molecular structure to one of the nitrogenous bases found in DNA that causes point mutations.

**Basic dye** *See cationic dye.*

**Basidiomycota** *See club fungus.*

**Basidiospore** A sexual spore of the club fungi.

**Basidium** (plural: *basidia*). A clublike structure in club fungi bearing four external spores on short, slender stalks.

**Basophil** A leukocyte that migrates into tissues and helps initiate the inflammatory response by secreting histamine.

**B cell** *See b lymphocyte.*

**B-DNA** A DNA duplex with a specific right-hand helix structure. It is the usual form of DNA duplexes in vivo.

**Beer's law** The equation that relates the absorbance of a solution sample at a given wavelength to the length of the light path, the concentration of the dissolved substance,

and the extinction coefficient of the substance at that wavelength.
*See extinction coefficient.*

**Benign** Not harmful.

**Beta ($\beta$) hemolysin** A type of enzyme that completely lyses red blood cells, leaving a clear ring in the blood agar medium around the colonies.

**Beta ($\beta$) hemolysis** Complete lysis of red blood cells by bacterial enzymes.

**Beta oxidation** A metabolic pathway that breaks down fatty acids into 2-carbon pieces.

**Bile acids** A family of amphipathic cholesterol derivatives that are produced in the liver and excreted in the bile; salts of the bile acids emulsify fat in the intestine.

**Bilirubin** A yellow substance, the product of the breakdown of hemoglobin from red blood cells.

**Binary fission** Process in which a bacterial cell duplicates its components and divides into two cells.

**Binocular** Referring to a light microscope having two eyepieces (oculars).

**Binomial nomenclature** The system of taxonomy developed by Linnaeus in which each organism is assigned a genus and specific epithet.

**Biochemistry** The branch of organic chemistry that studies the chemical reactions of living systems.

**Bioconversion** A reaction in which one compound is converted to another by enzymes in cells.

**Biogenic amines** A set of low-molecular-weight amino acid derivatives that contain a basic amino group and function in the body as intercellular mediators. Examples are serotonin, histamine, and epinephrine.

**Biogeochemical cycle** Mechanism by which water and elements that serve as nutrients are recycled.

**Biohydrometallurgy** The use of microbes to extract metals from ores.

**Biological oxygen demand (BOD)** The oxygen required to degrade organic wastes suspended in water.

**Biological vector** An organism that actively transmits pathogens that complete part of their life cycle within the organism.

**Bioremediation** A process that uses naturally occurring or genetically engineered micro-organisms to transform harmful substances into less toxic or non-toxic compounds.

**Biosphere** The region of the earth inhibited by living organisms.

**Biotic factor** An organism in the biosphere.

**Blackfly fever** Illness resulting from bites by blackflies, characterized by an inflammatory reaction, nausea, and headache.

**Blackwater fever** Malaria caused by *Plasmodium falciparum* that results in jaundice and kidney damage.

**Blastomycetic dermatitis** Fungal skin disease caused by *Blastomyces dermatitidis*; characterized by disfiguring, granulomatous, pus-producing lesions.

**Blastomycosis** Fungal skin disease caused by *Blastomyces dermatitidis* that enters the body through wounds.

**Blocking antibody** IgG antibody, elicited in allergy patients by increasing doses of allergen, that complexes with allergen before it can react with IgE antibody.

**Blood agar** Type of medium containing sheep blood used to identify organisms that cause Hemolysi, or breakdown of red blood cells.

**Blood–brain barrier** Formation in the brain of special thick-walled capillaries without pores in their walls that limit entry of substances into brain cells. Physically the barrier consists of tight junctions between endothelial cells; these cells have transporters for polar substances such as glucose that need to enter the brain.

**Blood group antigens** A group of oligosaccharides that are carried in the form of glycoproteins and glycolipids on the surface of cells, including blood cells; they are encoded by a large number of polymorphic gene loci and can provoke an immune response in an individual with different blood group antigens.

**B Lymphocyte** A lymphocyte that is produced in and matures in bursal-equivalent tissue, it gives rise to antibody-producing plasma cells.

*Known also as B cell.*

**Body tube** Microscope part that conveys an image from the objective to the eyepiece.

**Bohr effect** The effect of pH on oxygen binding by hemoglobin, by which a decrease in pH causes a decrease in oxygen affinity. The effect promotes both the release of oxygen from hemoglobin in the tissues and the release of $CO_2$ from the blood to the air in the lungs.

**Boil** *See furuncle.*

**Bolivian hemorrhagic fever** A multisystem disease caused by an arenavirus with insidious onset and progressive effects.

**Bone Stink** Putrefaction deep in the tissues of large carcasses that is caused by several species of *Clostridium.*

**Bongkrek disease** Type of food poisoning caused by *Pseudomonas cocovenenans*, named for a native Polynesian coconut dish.

**Botulism** Disease caused by *Clostridium botulinum.* The most common form, food-borne botulism, results from ingestion of preformed toxin and is, therefore, an intoxication rather than an infection.

**Bradykinin** Small peptide thought to cause the pain associated with tissue injury.

**Brain abcess** A pus-filled cavity caused by micro-organisms reaching the brain from head wound or via blood from another site.

**Branch migration** During recombination, the migration of a cross-over point (holiday junction) by simultaneous unwinding and rewinding in both duplexes.

**Bread mold** A fungus with complex mycelia composed of aseptate hyphae with chitinous cross walls.

*Known also as zygomycota or conjugation fungus.*

**Bright-field illumination** Illumination produced by the passage of visible light through the condenser of a light microscope.

**Brill–Zinsser disease** A recurrence of an epidemic typhus infection caused by reactivation of latent organisms harbored in the lymph nodes.

*Known also as recrudescent typhus.*

**Broad spectrum** Referring to the range of activity of an antimicrobial agent that attacks a wide variety of micro-organisms.

**Bronchial pneumonia** Type of pneumonia that begins in the bronchi and can spread through surrounding tissue toward the alveoli.

**Bronchiole** A finer subdivision of the air-conveying bronchi.

**Bronchitis** An infection of the bronchi.

**Bronchus** (plural: *bronchi*). A subdivision of the trachea that conveys air to and from the lungs.

**Brucellosis** A zoonosis highly infection for humans, caused by any of several species of *Brucella.*

*Also known as undulant fever and malta fever.*

**Bubo** Enlargement of infected lymph nodes, especially in the groin and armpit, due to accumulation of pus, characteristic of bubonic plague and other diseases.

**Bubonic plague** A bacterial disease, caused by *Yersinia pestis* and transmitted by flea bites, that spread in the blood and lymphatic system.

**Budding** Process that occurs in yeast and a few bacteria in which a small new cell develops from the surface of an existing cell.

**Buffering** The ability of a mixture of an acid and its conjugate base at a pH near their $pK_a$ to minimize pH changes caused by an influx of acid or base. The Henderson–Hasselbach equation is useful relating pH, $pK$ and [salt]/[acid].

**Bulking** Phenomenon in which filamentous bacteria multiple, causing sludge to float on the surface of water rather than settling out.

**Bunyavirus** An enveloped RNA virus that causes some forms of respiratory distress and hemorrhagic fever.

**Burkitt's lymphoma** A tumor of the jaw, seen mainly in African children, caused by the Epstein–Barr virus.

**Burst size** The number of new virions released in the replication process.
*Known also as viral yield.*

**Burst time** The time from absorption to release of phages (in the replication process).

**Calorie** A unit of energy defined as that amount of heat energy that will raise the temperature of 1 g of water by 1°C. 1 calorie = 4.182 J.

**Calvin cycle** The cycle of photosynthetic dark reactions by which $CO_2$ is fixed, reduced, and converted to glyceraldehydes-3-phosphate (the precursor of hexose monophosphates).

**Cancer** An uncontrolled, invasive growth of abnormal cells.

**Candidiasis** A yeast infection caused by *Candida albicans* that appears as thrust (in the mount) or vaginitis.
*Known also as Moniliasis.*

**Canine parvovirus** A parvovirus that causes severe disease in dogs.

**Canning** The use of moist heat under pressure to preserve food.

**Capillary** A blood vessel that branches from an arteriole.

**Capnophile** An organism that prefers carbon dioxide gas for growth.

**Capsid** The protein coating of a virus, which protects the nucleic acid core from the environment and usually determines the shape of the virus.

**Capsomere** A protein aggregate that makes up a viral capsid.

**Capsule** (1) A protective structure outside the cell wall, secreted by the organism. (2) A network of connective fibers covering organs such as the lymph nodes.

**Carbapenem** A bactericidal antibiotic that acts on bacterial cell walls.

**Carbohydrate** A compound composed of carbon, hydrogen, and oxygen that serves as the main course of energy for most living things.

**Carbohydrates** In general, substances that have the stoichiometric formula $(CH_2)_n$, where $n \geq 3$, or that are derived from such a substance by the addition of functional groups.

**Carbon cycle** Process by which carbon from atmospheric carbon dioxide enters living and non-living things and is recycled through them.

**Carboxyl terminus** *See C-terminus.*

**Carbuncle** A massive pus-filled lesion resulting from an infection, particularly of the neck and upper back.

**Carcinogen** A cancer-producing substance.

**Cardiovascular system** Body system that supplies oxygen and nutrients to all parts of the body and removes carbon dioxide and other wastes from them.

**Carnitine** A low-molecular-weight lysine derivative that shuttles fatty acids through the inner mitochondrial membrane to the matrix. The fatty acyl moiety is transferred from CoA to carnitine for transit through the membrane and is then transferred back to CoA; the carnitine released on the matrix side of the membrane is shuttled back for reuse.

**Carrier** An individual who harbors an infectious agent without having observable clinical signs or symptoms.

**Cascade** A set of reactions in which magnification of effect occurs, as in the complement system.

**Casein hydrolsate** A substance derived from milk protein that contains many amino acids, used to enrich certain media.

**Caseous** Characterizing lesions with a “cheesy” appearance that form in lung tissue of patients with tuberculosis.

**Caspases** A family of proteases involved in apoptosis.

**Catabolic pathway** A chain of chemical reactions that capture energy by breaking down large molecules into simpler components.

**Catabolism** The sum of all the metabolic processes by which complex molecules are broken down to simpler ones, including the processes by which molecules are broken down to yield cellular energy. *Compare anabolism.*

**Catabolite activation** In bacteria, a transcriptional control system that induces the synthesis of enzymes for the catabolism of energy substrates other than glucose when glucose levels are low. It involves an activator protein, CRP, that binds cyclic AMP under conditions of low glucose; this complex then binds to DNA sites and promotes transcription of the appropriate genes.

**Catabolite repression** Process by which the presence of a preferred nutrient (often glucose) represses the genes coding for enzymes used to metabolize some alternative nutrient.

**Catalase** An enzyme that converts hydrogen peroxide to water and molecular oxygen.

**Caterrhal state** Stage of whooping cough characterized by fever, sneezing, vomiting, and a mild, dry persistent cough.

**Cathepsins** Lysosomal proteases that function in degrading proteins in lysosomes and are also released into the cell at large during cell autolysis (programmed cell death)

**Cation** \ˈkat¯ˌī-ən\ [Gk. *kation*, neut. of *katiōn*, prp. of *katienai* to go down, fr. *kata-cata* + *ienai* to go] (1834) *n.* A positively charged ion.

**Cationic dye** An ionic compound, used for staining bacteria in which the positive ion imparts the color.

*Known also as basic dye.*

**Cat scratch fever** A disease caused by *Afipia felis*, or more commonly, *Bartonella (Rochalimaea) hensalae* and transmitted in cat scratches and bites.

**Cavitation** The formation of a cavity inside the cytoplasm of a cell.

**Cell culture** A culture in the form of a monolayer from dispersed cells and continuous cultures of cell suspensions.

**Cell-mediated immune response** The immune response to an antigen carried out at the cellular level by T cells.

**Cell-mediated immunity** The immune response involving the direction action of T cells to activate B cells or to destroy microbe-infected cells, tumor cells, or transplanted cells (organ transplants).

**Cell-mediated (Type-IV) hypersensitivity** Type of allergy elicited by foreign substances from the environment, infectious agents, transplanted tissue, and the body’s own malignant cells, mediated by T cells. *Known also as delayed hypersensitivity.*

**Cell membrane** A selectively permeable lipoprotein bilayer that forms the boundary between a bacterial cell's cytoplasm and its environment.

**Cell strain** Dominant cell type resulting from subculturing.

**Cell theory** Theory formulated by Schleiden and Schwann that cells are the fundamental units of all living things.

**Cellular slime mold** Fungus like protest consisting of amoeboid, phagocytic cells that aggregate to form a pseudoplasmodium.

**Cell wall** Outer layer of most bacterial, algal, fungal, and plant cells that maintains the shape of the cell.

**Cementum** The hard, bony covering of the tooth below the gumline.

**Center of chirality** With respect to organic compounds, a carbon atom that has four different substituents attached to it; such a group cannot be superimposed on its own mirror image and therefore can occur in two enantiomers.

**Central nervous system** The brain and spinal cord.

**Centromere** The region of a chromosome where the two sister chromatids are attached together. It is also the site of attachment for spindle fibers during mitosis and meiosis.

**Cephalosporin** An antibacterial agent that inhibits cell wall synthesis.

**Cercaria** A free-swimming fluke larva that emerges from the snail or mollusk host.

**Cerumen** Earwax.

**Ceruminous gland** A modified sebaceous gland that secrets cerumen.

**Cervix** An opening at the narrow lower portion of the uterus.

**$C_4$ cycle** A cycle in some plants that minimizes the wasteful effects of photorespiration by using an enzyme other than rubisco to perform the initial fixation of $CO_2$. This enzyme is found in mesophyll cells, where it fixes $CO_2$ into a four-carbon compound (hence $C_4$) This fixed carbon is shuttled into sheltered bundle-sheath cells, where it is released as $CO_2$ and enters the Calvin cycle.

**Chagas' disease** Disease caused by *Trypanosoma cruzi* that occurs in the southern United States and is endemic to Mexico; transmitted by several kinds of reduviid bugs.

**Chancre** A hard, painless, non-discharging lesion; a symptom of primary stage syphilis.

**Chancroid** Sexually transmitted disease caused by *Haemphilus ducreyi* that causes soft, painful skin lesions on the genitals, which bleeds easily.

**Chaotropic** The property of being able to disrupt the hydrogen bonding structure of water. Substances that are good hydrogen bonders, such as urea or guanidine hydrochloride, are chaotropic. Concentrated solutions of these substances tend to denature proteins because they reduce the hydrophobic effect.

**Chaperonins** Proteins that are involved in managing the folding of other proteins. Some of them help proteins to fold correctly; some prevent premature folding; and some prevent polypeptides from associating with other polypeptides until they have folded properly.

**Chemical bond** The interaction of electrons in atoms that form a molecule.

**Chemical cross-linking** A technique for investigating the mutual arrangement of components in a complex. The complex is exposed to a reagent that can form chemical cross-links between adjacent components and is then disaggregated and analyzed. Components that are linked together can be assumed to be neighbors in the complex.

**Chemical equilibrium** A steady state in which there is no net change in the concentrations of substrates or products.

**Chemically non-defined medium** *See complex medium.*

**Chemical potential ($\overline{G}$)** In a system, the free energy that resides in a chemical component per mole of the component present. For example, in a system consisting of $a$ moles of component A and $b$ moles of component B, the total free energy $G$ would be the sum of the free energy in the two components: $G = a\overline{G}_A + b\overline{G}_B$. *Known also as partial molar free energy.*

**Chemiosmosis** Process of energy capture in which a proton gradient is created by means of electron transport and then used to drive the synthesis of ATP.

**Chemiosmotic coupling** The coupling of an enzyme-catalyzed chemical reaction to the transport of a substance across a membrane either with or against its concentration gradient. The outstanding example is the coupling of ATP synthesis to the movement of protons across a membrane in response to a proton gradient.

**Chemoautotroph** An autotroph that obtains energy by oxidizing simple inorganic substances such as sulfides and nitrates.

**Chemoheterotroph** A heterotroph that obtains energy from breaking down ready-made organic molecules.

**Chemolithotroph** *See chemoautotroph.*

**Chemostat** A device for maintaining the logarithmic growth of a culture by the continuous addition of fresh medium.

**Chemotaxis** The process by which bacteria sense a concentration gradient of a particular substance in the medium and move either up or down the gradient.

**Chemotherapeutic agent** Any chemical substance used to treat disease.
*Known also as drug.*

**Chemothrapeutic index** The maximum tolerable dose of a particular drug per kilogram body weight divided by the minimum dose per kilogram body weight that will cure the disease.

**Chemotherapy** The use of chemical substances to treat various aspects of disease.

**Chickenpox** A highly contagious disease, characterized by skin lesions, caused by the varicella-zoster herpes virus; usually occurs in children.

**Chigger dermatitis** A violent allergic reaction caused by chiggers, the larvae of *Trombicula* mites.

**Childbed fever** *See puerperal fever.*

**Chiral** With respect to a molecule or other object, the property of being non-superimposable on its mirror image. An atom that makes a molecule chiral, such as a carbon with four different substituents, is called a chiral atom or center of chirality.

**Chitin** A polysaccharide found in the cell walls of most fungi and the exoskeltons of anthropods.

**Chlamydias** Tiny, non-motile, spherical bacteria; all are obligate intracellular parasites with a complex life cycle.

**Chloramphenicol** A bacteriostatic agent that inhibits protein synthesis.

**Chlorination** The addition of chlorine to water to kill bacteria.

**Chloroplast** A chlorophyll-containing organelle found in eukaryotic cells that carry out photosynthesis.

**Chloroquine** An antiprotozoan agent effective against the malaria parasite.

**Chocolate agar** Type of medium made with heated blood, so named because it turns a chocolate brown color.

**Chromatin** The filamentous material of eukaryotic chromosomes, consisting of DNA with associated histones and other proteins. During interphase it is dispersed and fills most of the nucleus; during nuclear division it condenses into compact chromosomes.

**Chromatophore** The internal membranes of photosynthetic bacteria and cyanobacteria.

**Chromophore** A chemical group that absorbs light at characteristic wavelengths.

**Chromosomal resistance** Drug resistance of a micro-organism due to a mutation in chromosomal DNA.

**Chromosome** A structure that contains the DNA of organisms.

**Chromosome mapping** The identification of the sequence of genes in a chromosome.

**Chronic amebiasis** Chronic infection caused by the protozoan *Entamoeba histolytica*.

**Chronic disease** A disease that develops more slowly than an acute disease, is usually less severe, and persists for a long, interdeterminate period.

**Chronic fatigue syndrome** Previously called chronic EBV syndrome. Disease of uncertain origin, similar to mononucleosis, with symptoms including persistent fatigue and fever.

**Chronic inflammation** A condition in which there is a persistent, indecisive standoff between an inflammatory agent and the phagocytic cells and other host defenses attempting to destroy it.

**Chylomicron** A type of lipoprotein that is produced in the intestinal villi and serves to transport dietary lipids in the circulation.

**Cilium** (plural: *cilia*) A short cellular projection used for movement that beats in coordinated waves.

**Ciliate** A protozoan that moves by means of cilia that cover most of its surface.

**Circular dichroism** The property of absorbing right circularly polarized light and left circularly polarized light to different extents. Stereoisomers exhibit circular dichroism. Also, some types of secondary structure, such as $\alpha$ helices and $\beta$ sheets in proteins, exhibit a predictable circular dichroism at specific wavelengths.

**Circular dichroism spectrum (CD spectrum)** An absorption spectrum obtained using circularly polarized light; it gives the circular dichroism of the substance over a range of wavelengths.

**Cis-dominant** Refers to a mutation in a genetic regulatory element that affects the expression of appropriate genes *only* on the same chromosome, not on another homologous chromosome present in the same call. *Cis*-dominance demonstrates that a regulatory element does not code for a diffusible factor.

**Cistron** The smallest unit of DNA that must be intact to code for the amino acid sequence of a polypeptide; thus, the coding part of a gene, minus 5' and 3' untranslated sequences and regulatory elements.

**Citric acid cycle** A cycle of reactions that takes place in the mitochondrial matrix and results in the oxidation of acetyl units to $CO_2$ with the production of reducing equivalents and ATP. It is a central pathway in oxidative respiration. Other substrates besides acetyl-CoA can enter the cycle at intermediate points.

*Known also as tricarboxylic acid cycle and Krebs cycle.*

**Classical pathway** One of the two sequences of reactions by which proteins of the complement system are activated.

**Clathrate structure** The cage-like structure of organized water molecules that forms around a hydrophobic molecule in solution. The structure has lower entropy than liquid water, which helps explain why hydrophobic substances dissolve poorly in water.

**Clonal deletion** The process in which the binding of lymphocytes to self-antigens triggers a genetically programmed destruction of those lymphocytes.

**Clonal selection theory** A model (proved correct) describing how the body is ale to produce specific immune response against a vast array of antigens. The B and T cells produced by the body have randomly generated antigen specificities. When a particular antigen enters the body, it induces proliferation only in B and T cells that happen to be specific for it. Thus, the antigen selects the cells that will mount an immune response against it and stimulates them to undergo Clonal proliferation.

**Clone** A group of genetically identical cells, organisms, or DNA sequences descending from a single parent cell.

**Club fungus** A fungus, including mushrooms, toadstools, rusts, and smuts, that produces spores on basidia.

*Known also as basidiomycota.*

**Cluster of differentiation marker** An antigen found on the cell surface of B and T cells that can be used to distinguish the cells from one another.

**Coagulase** A bacterially produced enzyme that accelerates the coagulation (clotting) of blood.

**Coarse adjustment** Focusing mechanism of a microscope that rapidly changes the distance between the objective lens and the specimen.

**Coated pit** A cell membrane pit that is lined on its cytosolic side by a meshwork of the protein clathrin. Coated pits participate in the mechanism of receptor-mediated endocytosis, in which surface receptors that have bound specific extracellular substances are gathered into coated pits, which pinch off to become cytoplasmic vesicles.

**Coccidioidomycosis** Fungal respiratory disease caused by the soil fungus *Coccidioides immitis.*

*Known also as valley fever.*

**Coccus** (plural: *cocci*). A spherical bacterium.

**Codon** A sequence of three bases in mRNA that specifies a particular amino acid in the translation process.

**Coelom** The body cavity between the digestive tract and body wall in higher animals.

**Coenzyme** An organic small molecule that binds to an enzyme and is essential for its activity but is not permanently altered by the reaction. Most coenzymes are derived metabolically from vitamins.

**Cofactor** An inorganic ion necessary for the function of an enzyme.

**Colicin** A protein released by some strains of *Escherichia coli* that inhibits growth of other strains of the same organism.

**Coliform bacterium** Gram-negative, non-spore-forming, aerobic or facultatively anaerobic bacterium that ferments lactose and produces acid and gas, significant numbers may indicate water pollution.

**Colloid** A mixture formed by particles too large to form a true solution dispersed in a liquid.

**Colonization** Growth of micro-organisms on epithelial surfaces such as skin or mucous membranes.

**Colony** A group of descendants of an original cell.

**Colony hybridization** A technique that is used to screen bacteria for the presence of a specific recombinant DNA sequence. Colonies of the bacteria are transferred to a filter, treated to lyse the cells and denature the DNA, and then exposed to a labeled DNA probe that is complementary to part of the sequence in question. Colonies that bind the probe possess the sequence.

**Colorado tick fever** Disease caused by an orbivirus carried by dog ticks, characterized by headache, backache, and fever.

**Colostrum** The protein-rich fluid secreted by the mammary glands just after childbirth, prior to the appearance of breast milk.

**Commensal** An organism that lives in or on another organism without harming it and that benefits from the relationship.

**Commensalism** A symbiotic relationship in which one organism benefits and the other one neither benefits nor is harmed by the relationship.

**Common-source outbreak** An epidemic that arises from contact with contaminated substances.

**Communicable infectious disease** Infectious disease that can be spread from one host to another.

*Known also as a contagious disease.*

**Community** All the kinds of organisms present in an environment.

**Competence factor** A protein released into the medium that facilitates the uptake of DNA into a bacterial cell.

**Competitive inhibitor** A molecule similar in structure to a substrate that competes with the substrate by binding to the active site. The inhibitor can reversibly occupy the active site but does not undergo the reaction.

**Complementary base pairing** Hydrogen bonding between adenine and thymine (or uracil) bases or between guanine and cytosine bases.

**Complement** A set or more than 20 large regulatory proteins that circulate in plasma and when activated form a non-specific defense mechanism against many different micro-organisms.

*Known also as a contagious disease.*

**Complement fixation test** A complex serologic test used to detect small quantities of antibodies.

**Complement system** *See complement.*

**Completed test** The final test for coliforms in multiple-tube fermentation in which organisms from colonies grown on eosin methylene blue agar are used to inoculate broth and agar slants.

**Complex medium** A growth medium that contains certain reasonable well-defined materials but that varies slightly in chemical composition from batch to batch.

*Known also as a chemically non-defined medium.*

**Complex virus** A virus, such as bacteriophage or poxvirus, that has an envelope or specialized structures.

**Compound** A chemical substance made up of atoms of two or more elements.

**Compound light microscope** A light microscope with more than one lens.

**Compromised host** An individual with reduced resistance, being more susceptible to infection.

**Concatemer** A DNA molecule that consists of a tandem series of complete genomes. Some phage genomes form concatemers during replication as part of a strategy for replicating the full length of a linear DNA duplex.

**Condenser** Device in a microscope that converges light beams so that they will pass through the specimen.

**Condyloma** *See genital wart.*

**Confirmed test** Second stage of testing for coliforms in multiple-tube fermentation in which samples from the highest dilution showing gas production are streaked into eosin methylene blue agar.

**Confocal microscopy** A light-microscopy technique that allows high resolution in thick samples.

**Congenial rubella syndrome** Complication of German measles causing death or damage to a developing embryo infected by virus that crosses the placenta.

**Congenital syphilis** Syphilis passed to a fetus when treponemes cross the placenta from mother to child before birth.

**Conidium** (plural: *conidia*). A small, asexual, aerial spore organized into chains in some bacteria and fungi.

**Conjugation** (1) The transfer of genetic information from one bacterial cell to another by means of conjugation pili. (2) The exchange of information between two ciliates (protests).

**Conjugation pilus** A type of pilus that attaches two bacterial together and provides a means for the exchange of genetic material.
*Known also as sex pilus.*

**Conjuctiva** Mucous membranes of the eye.

**Consensus sequence** For a group of nucleotide or amino acid sequences that show similarity but are not identical (e.g., the sequences for a family of related regulatory gene sequences), an artificial sequence that is compiled by choosing at each position the residue that is found there mot often in the sequences under study.

**Consolidation** Blockage of air spaces as a result of fibrin deposits in lobar pneumonia.

**Constitutive** With respect to gene expression, refers to proteins that are synthesized at a fairly steady rate at all times instead of being induced and repressed in response to changing conditions.

**Constitutive enzyme** An enzyme that is synthesized continuously regardless of the nutrients available to the organism.

**Consumer** An organism that obtains nutrients by eating producers or other consumers.
*Known also as heterotroph.*

**Contact dermatitis** Cell-mediated (Type-IV) hypersensitivity disorder that occurs in sensitized individuals on second exposure of the skin to allergens.

**Contact transmission** A mode of disease transmission effected directly, indirectly, or by droplets.

**Contagious disease** *See communicable infectious disease.*

**Contamination** The presence of microorganisms on inanimate objects or surfaces of the skin and mucous membranes.

**Continuous cell line** Cell culture consisting of cells that can be propagated over many generations.

**Continuous reactor** A device used in industrial and pharmaceutical microbiology to isolate and purify a microbial product often without killing the organism.

**Control variable** A factor that is prevented from changing during an experiment.

**Convalescent stage** The stage of an infectious disease during which tissues are repaired, healing takes place, and the body regains strength and recovers.

**Comb's antiglobulin test** An immunological test designed to detect anti-Rh antibodies.

**Cooperative transition** A transition in a multipart structure such that the occurrence of the transition in one part of the structure makes the transition likelier to happen in other parts.

**Copy number** The number of copies per cell of a particular gene or other DNA sequence.

**Core** The living part of an endospores.

**Cori cycle** The metabolic cycle by which lactate produced by tissues engaging in anaerobic glycolysis, such as exercising muscle, is regenerated to glucose in the liver and returned to the tissue via the bloodstream.

**Cornea** The transparent part of the eyeball exposed to the environment.

**Coronavirus** Virus with clublike projections that causes colds and acute upper respiratory distress.

**Cortex** A laminated layer of peptidoglycan between the membranes of the endospores septum.

**Corynebacteria** Club-shaped, irregular, non-spore-forming, Gram-positive rods.

**Coryza** The common cold.

**Countable number** A number of colonies on an agar plate small enough so that one can clearly distinguish and count them (30–300 per plate).

**Counterion atmosphere** A cloud of oppositely charged small ions (*Counterions*) that collects around a macroion dissolved in a salt solution. Counterion atmospheres partly shield macroions from each other's charges and thus affect their interactions.

**Covalent bond** A bond between atoms created by the sharing of pairs of electrons.

**Cowpox** Disease caused by the vaccinia virus and characterized by lesions, inflammation of lymph nodes, and fever, virus is used to make vaccine against smallpox and monkeypox.

**Crepitant tissue** Distorted tissue caused by gas bubbles in gas gangrene.

**Creutzfeldt–Jakob disease (CJD)** A transmissible spongiform encephalopathy of the human brain caused by prions.

**Crista (cristae)** A fold in the inner mitochondrial membrane that project into the mitochondrial matrix. The enzymes of the electron transport chain and oxidative phosphorylation are located mainly on the cristae.

**Cross-reaction** Immune reaction of a single antibody with different antigens that are similar in structure.

**Cross-resistance** Resistance against two or more similar antimicrobial agents through a common mechanism.

**Croup** Acute obstruction of the larynx that produces a characteristic high-pitched barking cough.

**Cruiform** In a DNA duplex, a structure that can be adopted by a palindromic sequence, in which each strand base-pairs with itself to form an arm that projects from the main duplex and terminates in a hairpin loop. The two arms form a "cross" with the main duplex.

**Crustacean** A usually aquatic anthropod that has a pair of appendages associated with each body segment.

**Cryoelectron microscopy** A variation of electron microscopy in which samples are frozen in a glassy ice matrix.

**Cryptococcois** Fungal respiratory disease caused by a budding, encapsulated yeast, *Filobasidiella neoformans*.

**Cryptosporidiosis** Disease caused by protozoans of the genus *Cryptosporidium*, common in AIDS patients.

**C-Terminus** The end of a polypeptide chain that carries an unreacted carboxyl group. *Known also as carboxyl terminus. See also N-terminus.*

**Curd** The solid portion of milk resulting from bacterial enzyme addition and used to make cheese.

**Curie** The basic unit of radioactive decay; an amount of radioactivity equivalent to that produced by 1 g of radium, mainly $2.22 \times 10^{12}$ disintegrations per minute.

**Cyanobacteria** Photosynthetic, prokaryotic, typically unicellular organisms that are members of the kingdom Monera.

**Cyanosis** Blush skin characteristic of oxygen-poor blood.

**Cyclic photophosphorylation** In photosynthesis, Photophosphorylation (light-dependent ATP synthesis) that is linked to a cyclic flow of electrons from photosystem II down an electron transport chain and back to photosystem II; it is not coupled to the oxidation of $H_2O$ or to the reduction of $NADP^+$. *Compare non-cyclic photophosphorylation.*

**Cyclins** Proteins that regulate the cell cycle by binding to and activating specific nuclear protein kinases. Cyclin-dependent kinase activations occur at three points during the cell cycle, thus providing three decision points as to whether the cycle will proceed.

**Cyst** A spherical, thick-walled cell that resembles an endospores, formed by certain bacteria.

**Cysticercus** An oval white sac with a tapeworm head invaginated into it.
*Known also as a bladder worm.*

**Cystitis** Inflammation of the bladder.

**Cytochrome** An electron carrier functioning in the electron transport chain; heme protein.

**Cytokine** One of a diverse group of soluble proteins that have specific roles in host defenses.

**Cytokinesis** The division of a eukaryotic cell to form two cells. It usually accompanies nuclear division, although nuclear division can occur without cytokinesis.

**Cytomegalovirus** One of a widespread and diverse group of herpsviruses that often produces no symptoms in normal adults but can severely affect AIDS patients and congenitally infected children.

**Cytopathic effect (CPE)** The visible effect viruses have on cells.

**Cytoplasm** The semifluid substance inside a cell, excluding, in eukaryotes, the cell nucleus.

**Cytoplasmic streaming** Process by which cytoplasm flows from one part of a eukaryotic cell to another.

**Cytoskelton** An organized network of rod-like and fiber-like proteins that pervades a cell and helps give it its shape and motility. The cytoskelton includes action filaments, microtubules, and a diverse group of filamentous proteins collectively called intermediate filaments.

**Cytosol** The fluid medium that is located inside a cell but outside the nucleus and organelles (for eukaryotes) or the nucleoid (for prokaryotes). It is a semiliquid concentrated solution or suspension.

**Cytotoxic drug** A drug that interferes with DNA synthesis, used to suppress the immune system and prevent the rejection of transplants.

**Cytotoxic (Type-II) hypersensitivity** Type of allergy elicited by antigens on cells, especially red blood cells, that the immune system treats are foreign.

**Cytotoxin** Toxin produced by cytotoxic cells that kills infected host cells.

**Dark-field illumination** In light microscopy, the light that is reflected from an object rather than passing through it, resulting in a bright image on a dark background.

**Dark reactions** Part of photosynthesis in which carbon dioxide gas is reduced by electrons form reduced NADP (NADPH) to form various carbohydrate molecules, chiefly glucose. These photosynthetic subprocesses do not depend *directly* on light energy; specifically, the synthesis of carbohydrate from $CO_2$ and $H_2O$. *Compare light reactions.*

**Dark repair** Mechanism for repair of damaged DNA by several enzymes that do not require light for activation; they excise defective nucleotide sequences and replace then with DNA complementary to the unaltered DNA strand.

**Daughter cell** One of the two identical products of cell division.

**Deaminating agent** A chemical mutagen that can remove an amino group ($-NH_2$) from a nitrogenous base, causing a point mutation.

**Death phase** *See decline phase.*

**Debridement** Surgical scraping to remove the thick crust or scab that forms over burnt tissue (eschar)

**Decimal reduction time (DRT; also called D-value)** The length of time needed to kill 90% of the organisms in a given population at a specified temperature.

**Decline phase** (1) The fourth of four major phases of the bacterial growth curve in which cells lose their ability to divide (due to less supportive conditions in the medium) and thus die. (2) In the stages of a disease, the period during which the host defense finally overcome the pathogen and symptoms begin to subside.
*Known also as death phase.*

**Decomposer** Organism that obtains energy by digesting dead bodies or wastes of producers and consumers.

**Defined synthetic medium** A synthetic medium that contains known specific kinds and amounts of chemical substances.

**Definitive host** An organism that harbors the adult, sexually reproducing form of a parasite.

**Degranulation** Release of histamine and other preformed mediators of allergic reactions by sensitized mast cells and basophils after a second encounter with an allergen.

**Dehydration synthesis** A chemical reaction that builds complex organic molecules.

**Delayed (Type-IV) hypersensitivity** *See cell-mediated (Type-iv) hypersensitivity.*

**Delayed hypersensitivity ($T_{DH}$) cells** Those T cells (inflammatory $T_H1$) that produce lymphokines in cell-mediated (Type-IV) hypersensitivity reactions.

**Deletion** The removal of one or more nitrogenous bases from DNA, usually producing a frameshift mutation.

**Delta hepatitis** *See hepatitis D.*

**Denaturation** For a nucleic acid or protein, the loss of tertiary and secondary structure so that the polymer becomes a random coil. For DNA, this change involves the separation of the two strands. Denaturation can be induced by heating and by certain changes in chemical environment. It can also be stated as the disruption of hydrogen bonds and other weak forces that maintain the structure of a globular protein, resulting in the loss of its biological activity.

**Dengue fever** Viral systemic disease that causes severe bone and joint pain.
*Known also as breakbone fever.*

**Denitrification** The process by which nitrates are reduced to nitrous oxide or nitrogen gas.

**Dental caries** The erosion of enamel and deeper parts of teeth.
*Known also as tooth decay.*

**Dental plaque** A continuously formed coating of micro-organisms and organic matter on tooth enamel.

**Deoxyribonucleic acid (DNA)** Nucleic acid that carries hereditary information from one generation to the next.

**Depurination** Cleavage of the glycosidic bond between C-1′ of deoxyribose and a purine base in DNA. Used in Maxam–Gilbert sequence analysis.

**Dermal wart** A fungal skin disease.

**Dermatophyte** A fungus that invades keratinized tissue of the skin and nails.

**Dermis** The thick inner layer of the skin.

**Descriptive study** An epidemiologic study that notes the number of cases of a disease, which segments of the population are affected, where the cases have occurred, and over what time period.

**Desensitization** Treatment designed to cure allergies by means of injections with gradually increasing does of allergen.

**Deuteromycota** *See fungi imperfecti.*

**Diabetes melllitus** A disease caused by a deficiency in the action of insulin in the body, resulting either from low insulin levels or from inadequate insulin levels combined with unresponsiveness of the target cells to insulin. The disease is manifested primarily by disturbances in fuel homeostasis, including hyperglycemia (abnormally high blood glucose levels).

**Dialysis** The process by which low-molecular-weight solutes are added to or removed from a solution by means of diffusion across a semipermeable membrane.

**Diapedsis** The process in which leukocytes pass out of blood into inflamed tissues by squeezing between cells of capillary walls.

**Diarrhea** Excessive frequency and looseness of bowel movements.

**Diastereomers** Molecules that are stereoisomers but not enantiomers of each other. Isomers that differ in configuration about two or more asymmetric carbon atoms and are not complete mirror images.

**Diatom** An alga or plantlike protest that lacks flagella and has a glasslike outer shell.

**Dichotomous key** Taxonomic key used to identify organisms, composed of paired (either-or) statements describing characteristics.

**Dielectric constant** A dimensionless constant that expresses the screening effect of an intervening medium on the interaction between two charged particles. Every medium (such as a water solution or an intervening portion of an organic molecule) has a characteristic dielectric constant.

**Difference spectrum** With respect to absorption spectra, a spectrum obtained by loading the sample cuvette with the substances under study and a reference cuvette with an equimolar sample of the same substances in a known state (e.g., fully oxidized) and recording the difference between the two spectra.

**Differential medium** A growth medium with a constituent that causes an observable change (in color or pH) in the medium when a particular chemical reaction occurs, making it possible to distinguish between organisms.

**Differential stain** Use of two or more dyes to differentiate among bacterial species or to distinguish various structures of an organism; for example, the Gram stain.

**Diffraction** Phenomenon in which light waves, as they pass through a small opening, are broken up into bands of different wavelengths.

**Diffraction pattern** The pattern that is produced when electromagnetic radiation passes through a regularly repeating structure; it results because the waves scattered by the structure interact destructively in most directions (creating dark zones) but constructively in a few directions (creating bright spots) For the pattern to be sharp, the radiation wavelength must be somewhat shorter than the repeat distance in the structure.

*See also X-ray diffraction.*

**Diffusion coefficient (*D*)** A coefficient that indicates how quickly a particular substance will diffuse in a particular medium under the influence of a given concentration gradient.

**DiGeorge syndrome** Primary immunodeficiency disease caused by failure of the thymus to develop properly, resulting in a deficiency of T cells.

**Digestive system** The body system that converts ingested food into material suitable for the liberation of energy or for assimilation into body tissues.

**Dikaryotic** Referring to fungal cells within hyphae that have two nuclei, produced by plasmogany in which the nuclei have not united.

**Dilution method** A method of testing antibiotic sensitivity in which organisms are incubated in a series of tubes containing known quantities of a chemotherapeutic agent.

**Dimer** Two adjacent pyrimidines bonded together in a DNA strand, usually as a result of exposure to ultraviolet rays.

**Dimorphism** The ability of an organism to alter its structure when it changes habitats.

**Dinoflagellate** An alga or plantlike protest, usually with two flagella.

**Diphtheria** A severe upper respiratory disease caused by *Corynebacterium diphtheriae*, can produce subsequent myocarditis and polyneuritis.

**Diphtheroid** Organism found in normal throat cultures that fails to produce exotoxin but is otherwise indistinguishable from diphtheria-causing organisms.

**Dipicolonic acid** Acid found in the core of endospores that contributes to its heat resistance.

**Diploid** For a cell or an organism, the possession of two homologous sets of chromosomes per nucleus (with the possible exception of sex chromosomes, which may be present in only one copy). *Compare haploid.*

**Diploid fibroblast strain** A culture derived from fetal tissues that retains fetal capacity for rapid, repeated cell division.

**Direct contact transmission** Mode of disease transmission requiring person-to-person body contact.

**Direct fecal – oral transmission** Direct contact transmission of disease in which pathogens from fecal matter are spread by unwashed hands to the mouth.

**Direct microscopic count** A method of measuring bacterial growth by counting cells in a known volume of medium that fills a specially calibrated counting chamber on a microscope slide.

**Disaccharide** A carbohydrate formed by the joining of two monosaccharides.

**Disease** A disturbance in the state of health wherein the body cannot carry out all its normal functions.

*See also epidemiology and infectious disease.*

**Disinfectant** A chemical agent used on inanimate objects to destroy micro-organisms.

**Disinfection** Reducing the number of pathogenic organisms on objects or in materials so that they pose no threat of disease.

**Dismutation** A reaction in which two identical substrate molecules have different fates; particularly, a reaction in which one of the substrate molecules is oxidized and the other reduced.

**Disk diffusion method** A method used to determine microbial sensitivity to antimicrobial agents in which antibiotic disks are placed on an inoculated Petri dish, incubated, and observed for inhibition of growth.

**Dispersion forces** Weak intermolecular attractive forces that arise between molecules are close together, because the fluctuating electron distributions of the molecules become synchronized so as to produce a slight electrostatic attraction. These forces play a role in the internal packing of many biomolecules.

**Disseminated tuberculosis** Type of tuberculosis spread throughout body, not seen in AIDS patients, usually caused by *Mycobacterium avium-intercellulare.*

**Dissociation constant** For an acid, the equilibrium constant $K_a$ for the dissociation of the acid into its conjugate base and a proton. For a complex of two biomolecules, the equilibrium constant $K_d$ for dissociation into the component molecules.

**Distillation** The separation of alcohol and other volatile substances from solid and non-volatile substances.

**Divergent evolution** Process in which descendants of a common ancestor species undergo sufficient change to be identified as separate species.

**DNA gyrase** An enzyme that is able to introduce negative superhelical turns into a circular DNA helix.

**DNA hybridization** Process in which the double strands of DNA of each of two organisms are split apart and the split strands from the two organisms are allowed to combine.

**DNA polymerase** An enzyme that moves along behind each replication fork, synthesizing new DNA strands complementary to the original ones.

**DNA replication** Formation of new DNA molecules.

**DNA tumor virus** An animal virus capable of causing tumors.

**Domain** A portion of a polypeptide chain that folds on itself to form a compact unit that remains recognizably distinct within the tertiary structure of the whole protein. Large globular proteins often consist of several domains, which are connected to each other by stretches of relatively extended polypeptide. A new taxonomic category above the kingdom level, consisting of the archaea, bacteria, and eukarya.

**Donovan body** A large monon-uclear cell found in scrapings of lesions that confirms the presence of granuloma inguinale.

**DPT vaccine** Diphtheria, killed whole cell pertussis and tetanus vaccine.

**Dracunculiasis** Skin disease caused by a parasitic helminth, the guinea worm *Dracunculus medinensis.*

**Droplet nucleus** A particle consisting of dried mucus in which micro-organisms are embedded.

**Droplet transmission** Contact transmission of disease through small liquid droplets.

**Drug** *See chemotherapeutic agent.*

**Drug resistance factors** Bacterial plasmids that carry genes coding for resistance to antibiotics.

**DTaP vaccine** Diphtheria, tetanus, and acellular pertussis vaccine.

**D-value** *See decimal reduction time.*

**Dyad** A set of paired chromosomes in eukayotic cells that are prepared to divided by mitosis or meiosis.

**Dyad axis** A twofold axis of symmetry.

**Dysentery** A severe diarrhea that often contains mucus and sometimes blood or pus.

**Dysuria** Pain and burning on urination.

**Eastern equine encephalitis** Type of viral encephalitis seen most often in the eastern United States, infects horses more frequently than human.

**Ebola virus** A filovirus that causes hemorrhagic fevers.

**Eclipse period** Period during which viruses have absorbed to and penetrated host cells but cannot yet be detected in cells.

**Ecology** The study of relationships among organisms and their environment.

**Ecosystem** All the biotic and abiotic components of an environment.

**Ectoparasite** A parasite that lives on the surface of another organism.

**Eczema herpecticum** A generalized eruption caused by entry of the herpevirus through the skin, often fatal.

**Edema** An accumulation of fluid in tissues that causes swelling.

**Editing** *See RNA editing.*

**Ehrlichiosis** A tick-borne disease found in dogs and human and caused by *Ehrlichia canis* and *E. chaeffeenis.*

**Einstein** One mole of photons.

**Electrolyte** A substance that is ionizable in solution.

**Electron** A negatively charged subatomic particle that moves around the nucleus of an atom.

**Electron acceptor** An oxidizing agent in a chemical reaction.

**Electron donor** A reducing agent in a chemical reaction.

**Electron micrograph** A "photograph" of an image taken with an electron microscope.

**Electron microscope** Microscope that uses a beam of electrons rather than a beam of light and electromagnets instead of glass lenses to produce an image.

**Electron spin resonance** A form of spectroscopy that is sensitive to the environment of unpaired electrons in a sample.

*Known also as electron paramagnetic resonance or EPR.*

**Electron transport** Processes in which pairs of electrons are transferred between cytochromes and other compounds.

**Electron transport chain** (1) A series of compounds that pass electrons to oxygen (the final electron acceptor). (2) A sequence of electron carriers of progressively higher reduction potential in a cell that is linked so that electrons can pass from one carrier to the next. The chain captures some of the energy released by the flow of electrons and uses it to drive the synthesis of ATP.

*Known also as respiratory chain.*

**Electrophoresis** (1) Process used to separate large molecules such as antigens or proteins by passing an electrical current through a sample on a gel. (2) A method for separating electrically charged substances in a mixture. A sample of the mixture is placed on a supporting medium (a piece of filter paper or a gel) to which an electrical field is applied. Each charged substance migrates toward the cathode or the anode at a speed that depends on its net charge and its frictional interaction with the medium.

*See also gel electrophoresis.*

**Electroporation** A brief electric pulse produces temporary pores in the cell membrane, allowing entrance of vectors carrying foreign DNA.

**Element** Matter composed of one kind of atom.

**Elementary body** An infectious stage in the life cycle of chlamydias.

**Elephantiasis** Gross enlargement of limbs, scrotum, and sometimes other body parts from accululation of fluid due to blockage of lymph ducts by the helminth *Wuchereria bancrofti*.

**Elongation factors** Non-ribosomal protein factors that are necessary participants in the chain-elongation cycle of polypeptide synthesis; they interact with the ribosome-mRNA complex or with other major cycle participants.

**Enamel** The hard substance covering the crown of a tooth.

**Enantiomers** Stereoisomers that are non-superimposable mirror images of each other. The term *optical isomers* comes from the fact that the enantiomers of a compound rotate polarized light in opposite directions.

*Known also as optical isomers.*

**Encephalitis** An inflammation of the brain-caused by a variety of viruses or bacteria.

**Endemic** Referring to a disease that is constantly present in a specific population.

**Endemic relapsing fever** Tick-borne cases of relapsing fever caused by several species of *Borrelia*.

**Endemic typhus** A flea-borne typhus caused by *Rickettsia typhi*.

**Endergonic** In a non-isolated system, a process that is accompanied by a positive change in free energy (positive $\Delta G$) and therefore is thermodynamically not favored. *Compare exergonic.*

**Endocrine glands** Glands that synthesize hormones and release them into the circulation. The hormone-producing gland cells are called endocrine cells.

**Endocytosis** Process in which vesicles form by invagination of the plasma membrane to move substances into eukaryotic cells.

**Endoenzyme** An enzyme that acts within the cell producing it.

**Endoflagellum** *See axial filament.*

**Endogenous infection** An infection caused by opportunistic micro-organism already present in the body.

**Endogenous pyrogen** Pyrogen secreted mainly by monocytes and macrophages that circulates to the hypothalamus and causes an increase in body temperature.

**Endometrium** The mucous membrane lining the uterus.

**Endonuclease** An enzyme that cleaves a nucleic acid chain at an internal phosphodiester bond.

**Endoparasite** A parasite that lives within the body of another organism.

**Endoplasmic reticulum** A highly folded membranous compartment within the cytoplasm that is responsible for a great variety of cellular tasks, including the glycosylation and trafficking of proteins destined for secretion or for the cell membrane or some organelles. It also functions in lipid synthesis, and the enzymes of many pathways of intermediate metabolism are located on its surface.

**Endorphins** A class of endogenous brain peptides that exert analgesic effects in the central nervous system by binding to opiate receptors. They are produced by cleavage of the large polypeptide pro-opiomelanocortin.

**Endospore** A resistant, dormant structure, formed inside some bacteria, such as *Bacillus* and *Clostridium*, that can survive adverse conditions.

**Endospore septum** A cell membrane without a cell wall that grows around the core of endospores.

**Endosymbiotic theory** Holds that the organelles of eukaryotic cells arose from prokaryotes that came to live, in a symbiotic relationship, inside the eukayote-to-be cell.

**Endotoxin** A toxin incorporated in Gram-negative bacterial cell walls and released when the bacterium dies.

*Known also as lipopolysaccharide.*

**End-product inhibition** *See feedback inhibition.*

**Energy** *See internal energy.*

**Energy charge** A quantity that indicates the state of a cell's energy reserves. It is equal to the cell's reverses of the free energy sources ATP and ADP (taking into account that ADP stores less free energy than ATP) divided by the total supply of ATP and its breakdown products ADP and AMP ([ATP] + ½[ADP])/([ATP] + [ADP] + (AMP]).

**Enhancer sequence** A DNA sequence that is distant from a gene but to which a protein factor that affects the gene's transcription can bind to exert its action. It is possible that DNA looping brings enhancer-bound proteins into proximity with the gene's promoter.

**Enrichment medium** A medium that contains special. nutrients that allow growth of a particular organism.

**Enteric bacteria** Members of the family enterobacteriaceae, many of which are intestinal, small facultatively anerobic Gram-negative rods with peritrichous flagella.

**Enteric fever** Systemic infection, such as typhoid fever, spread throughout the body from the intestinal mucosa.

**Enteritis** An inflammation of the intestine.

**Enterocolitis** Disease caused by *Salmonella typhimurium* and five *paratyphi* that invade intestinal tissue and produce bacteremia.

**Enterohemorrhagic strain of Escherichia coli** One that causes bloody diarrhea and is often fatal; often from contaminated food.

**Enteroinvasive strain** Strain of *Escherichia coli* with a plasmid-borne gene for a surface antigen (K antigen) then enables it to attach to and invade mucosal cells.

**Enterotoxicosis** *See food poisoning.*

**Enterotoxigenic strain** Strain of *Escherichia coli* carrying a plasmid that enables it to make an enterotoxin.

**Enterotoxin** An exotoxin that acts on tissues of the gut.

**Enterovirus** One of the three major groups of picornaviruses that can infect nerve and muscle cells, the respiratory tract lining, and skin.

**Enthalpy (*H*)** A thermodynamic quantity (function of state) that is equal to the internal energy of a system plus the product of the pressure and volume: $H = E + PV$. It is equal to the heat change in constant-pressure reactions, such as most reactions in biological systems.

**Entropy (*S*)** A thermodynamic quantity (function of state) that expresses the degree of disorder or randomness in a system. According to the second law of thermodynamics, the entropy of an opens system tends to increase unless energy is expended to keep the system orderly.

**Envelope** A bilayer membrane found outside the capsid of some viruses, acquired as the virus buds through one of the host's membrane.

**Enveloped virus** A virus with a bilayer membrane outside its capsid.

**Enzyme** A protein catalyst that controls the rate of chemical reaction in cells.

**Enzyme induction** A mechanism whereby the genes coding for enzymes needed to metabolize a particular nutrient are activated by the presence of that nutrient.

**Enzyme-linked immunosorbent assay (ELISA)** Modification of radioimmunoassay in which the anti-antibody, instead of being radioactive, is attached to an enzyme that causes a color change in its substrate.

**Enzyme repression** Mechanism by which the presence of a particular metabolite represses the genes coding for enzymes used in its synthesis.

**Enzyme–substrate complex** A loose association of an enzyme with its substrate.

**Eosinophil** A leukocyte present in large numbers during allergic reactions and worm infections.

**Epidemic** Referring to a disease that has a higher than normal incidence in a population over a relatively short period of time.

**Epidemic keratoconjunctivitis** Eye disease caused by an adenovirus.

*Known also as shipyard eye.*

**Epidemic relapsing fever** Louseborne cases of relapsing fever caused by several species of *Borrelia.*

**Epidemic typhus** Louseborne rickettsial disease caused by *Rickettsia prowazekii*, seen most frequently in conditions of overcrowding and poor sanitation.

*Known also as classic, European, or louseborne typhus.*

**Epidemiologic study** A study conducted in order to learn more about the spread of a disease in a population.

**Epidemiologist** A scientist who studies epidemiology.

**Epidemiology** The study of factors and mechanisms involved in the spread of disease within a population.

**Epidermis** The thin outer layer of the skin.

**Epiglottitis** An infection of the epiglottis.

**Episomes** Plasmids that can undergo integration into the bacterial chromosome.

**Epitope** The specific portion of an antigen particle that is recognized by a given antibody or T-cell receptor.

*Known also as antigenic determinant.*

**Epstein-Barr virus (EBV)** Virus that causes infectious monon-ucleosis and Burkitt's lymphoma.

**Ergot** Toxin produced by *Claviceps, purpurea*, a parasite fungus of rye and wheat that causes ergot poisoning when ingested by humans.

**Ergot poisoning** Disease caused by ingestion of ergot, the toxin produced by *Claviceps purpurea*, a fungus of rye and wheat.

**Erysipelas** Infection caused by hemolytic streptococci that spreads through lymphatics, resulting in septicemia and other diseases.

**Erythrocyte** A red blood cell.

**Erythromycin** An antibacterial agent that has a bacteriostatic effect on protein synthesis.

**Eschar** The thick crust or scab that forms over a severe burn.

**Essential amino acids** Amino acids that must be obtained in the diet because they cannot be synthesized in the body (at least not in adequate amounts)

**Essential fatty acids** Fatty acids that must be obtained in the diet because they cannot be synthesized in the body in adequate amounts. Examples are linoleic acid and linolenic acid.

**Ethanbutol** An antibacterial agent effective against certain strains of mycobacteria.

**Etiology** The assignment or study of causes and origins of a disease.

**Eubacteria** True bacteria.

**Englenoid** An alga or plantlike protest, usually with a single flagella and a pigmented eyespot (stigma).

**Eukarya** One of the three domains of living things; all members are eukaryotic.

**Eukaryotes** Organisms whose cells are compartmentalized by internal cellular membranes to produce a nucleus and organelles. *Compare prokaryotes.*

**Eukaryote** An organism composed of eukaryotic cells.

**Eukaryotic cell** A cell that has a distinct cell nucleus and other membrane-bound structures.

**Eutophication** The nutrient enrichment of water from detergents, fertilizes, and animal manures, which cause overgrowth of algae and subsequent depletion of oxygen.

**Exanthema** A skin rash.

**Exergonic** (1) In a non-isolated system, a process that is accompanied by a negative change in free energy (negative $\Delta G$) and therefore is thermodynamically favored. *Compare endergonic.* (2) Releasing energy from a chemical reaction.

**Exocrine cell** A cell that secretes a substance that is excreted through a duct either into the alimentary tract or to the outside of the organism. Exocrine cells are grouped together in exocrine glands.

**Exocytosis** Process by which vesicles inside a eukaryotic cell fuse with the plasma membrane and release their contents from the eukaryotic cell.

**Exoenzyme** An enzyme that is synthesized in a cell but crosses the cell membrane to act in the periplasmic space or the cell's immediate environment.

*Known also as extracellular enzyme.*

**Exogenous infection** An infection caused by micro-organisms that enter the body from the environment.

**Exogenous pyrogen** Exotoxins and endotoxins from infectious agents that cause fever by stimulating the release of an endogenous pyrogen.

**Exon** A region in the coding sequence of a gene that is translated into protein (as opposed to introns, which are not) The name comes from the fact that exons are the only parts of an RNA transcript that are seen outside the nucleus. *Compare intron.*

**Exonuclease** An enzyme that removes segments of DNA.

**Exosporium** A lipid-protein membrane formed outside the coat of some endospores by the mother cell.

**Exotoxin** A soluble toxin secreted by microbes into their surroundings, including host tissues.

**Experimental study** An epidemiological study designed to test a hypothesis about an outbreak of disease, often about the value of a particular treatment.

**Experimental variable** The factor that is purposely changed in an experiment.

**Exponential rate** The rate of growth in a bacterial culture characterized by doubling of the population in a fixed interval of time.

*Known also as logarithmic rate.*

**Exportins** A class of proteins involved in transporting materials out of nuclei.

*See importins.*

**Extinction coefficient ($\varepsilon_\lambda$)** A coefficient that indicates the ability of a particular substance in solution to absorb light of wavelength $\lambda$. The molar extinction coefficient, $\varepsilon_M$, is the absorbance that would be displayed by a 1 M solution in a 1 cm light path.

**Extracellular enzyme** *See exoenzyme.*

**Extrachromosomal resistance** Drug resistance of a micro-organism due to the presence of resistance (*R*) plasmids.

**Extreme Thermoacidophile** Organism requiring very hot and acidic environment, usually belonging to domain archaea.

**Fab fragment** The portion of an antibody that contains an antigen-binding site.

**Faciliated diffusion** Diffusion (down a concentration gradient) across a membrane (from an area of higher concentration to lower concentration) with the assistance of a carrier molecule, but not requiring ATP.

**Facilitated transport** The movement of a substance across a biological membrane in response to a concentration or electrochemical gradient where the movement is facilitated by membrane pores or by specific transport proteins. *Compare active transport, passive transport.*

*Known also as facilitated diffusion.*

**Facultative** Able to tolerate the presence or absence of a particular environmental condition.

**Facultative anaerobe** A bacterium that carries on aerobic metabolism when oxygen is present but shifts to anerobic metabolism when oxygen is absent.

**Facultative parasite** A parasite that can live either on a host or freely.

**Facultative psychrophile** An organism that grows best at temperatures below 20°C but can also grow at temperatures above 20°C.

**Facultative thermophile** An organism that can grow both above and below 37°C.

**FAD** Flavin adenine dinucleotide, a coenzyme that carries hydrogen atoms and electrons.

**Fastidious** Referring to micro-organisms that have special nutritional needs that are difficult to meet in the laboratory.

**Fat** A complex organic molecule formed from glycerol and one or more fatty acids.

**Fatty acid** A long chain of carbon atoms and their associated hydrogens with a carboxyl group at one end.

**Fc fragment** The tail region of an antibody that may contain sites for macrophage and complement binding.

**Feces** Solid waste produced in the large intestine and stored in the rectum until eliminated from the body.

**Feedback inhibition** Regulation of a metabolic pathway by the concentration of one of its intermediates or, typically, its end product, which inhibits an enzyme in the pathway.

*Known also as end-product inhibition.*

**Feline panleukopenia virus (FPV)** A parvovirus that causes severe disease in cats.

**Female reproductive system** The host system consisting of the ovaries, uterine tubes, uterus, vagina, and external genitalia.

**Fermentation** Anaerobic metabolism of the pyruvic acid produced in glycolysis.

**Fermentations** Processes in which cellular energy is generated from the breakdown of nutrient molecules where there is no net change in the oxidation state of the products as *Compare* d with that of the reactants; fermentation can occur in the absence of oxygen.

**Fever** A body temperature that is abnormally high.

**Fibroblast** A new connective tissue cell that replaces fibrin as a blood clot dissolves, forming grandulation tissue.

**Fibrous proteins** Proteins of elongated shape, often used as structural materials in cells and tissues. *Compare globular proteins.*

**Fifth disease** A normal disease in children caused by the *Erythrovirus* called B19, characterized by a bright red rash on the cheeks and a low-grade fever.

*Known also as erythema infectiosum.*

**Filariasis** Disease of the blood and lymph caused by any of several different roundworms carried by mosquitoes.

**Filovirus** A filamentous virus that displays unusual variability in shape. Two filoviruses, the Ebola virus and the Marburg virus, have been associated with human disease.

**Filter paper disk method** Method of evaluating the antimicrobial properties of a chemical agent using filter paper disks placed on an inoculated agar plate.

**Filtration** (1) A method of estimating the size of bacterial populations in which a known volume of air or water is drawn through a filter with pores too small to allow passage of bacteria. (2) A method of sterilization that uses a membrane filter to separate bacteria from growth media. (3) The filtering of water through beds of sand to remove most of the remaining micro-organisms after flocculation in water treatment plants.

**Fimbria** *See attachment pilus.*

**Fine adjustment** Focusing mechanism of a microscope that very slowly changes the distance between the objective lens and the specimen.

**First law of thermodynamics** The law that states that energy cannot be created or destroyed and that it is therefore possible to account for any change in the internal energy of a system $\Delta E$ by an exchange of heat ($q$) and/or work ($w$) with the surroundings $\Delta E = Q - w$.

**First-order reaction** A reaction whose rate depends on the first power of the concentration of the reactant. *Compare second-order reaction.*

**Fischer projection** A convention for representing stereoisomers in a plane. The tetrahedron of bonds on a carbon is represented as a plane cross, where the bonds to the right and left are assumed to be pointing toward the viewer and the bonds to the top and bottom are assumed to be pointing away from the viewer. Fischer projections of monosaccharides are oriented with the carbonyl group at the top; the chiral carbon farthest from the carbonyl group (which is the one that determines whether the sugar is the D or the L form) is then drawn with its hydroxyl to the right for the D form and to the left for the L form.

**Five-kingdom system** System of classifying organisms into one of five kingdoms: Monera (Prokaryotae), Protista, Fungi, Plantae, and Animalia.

**Flagellar staining** A technique for observing flagella by coating the surfaces of flagella with a dye or a metal such as silver.

**Flagellum** (plural: *flagella*). A long, thin, helical appendage of certain cells that provides a means of locomotion.

**Flash pasteurization** *See high-temperature short-time pasteurization.*

**Flat sur spoilage** Spoilage due to the growth of spores that does not cause cans to bulge with gas.

**Flatworm** A primitive, unsegmented, hermaphroditic often parasitic worm.
*Known also as platyhelminthes.*

**Flavin adenine dinucleotide (FAD), flavin mononucleotide (FMN)** Coenzymes derived from vitamin $B_2$ (riboflavin) that function as electron acceptors in enzymes that catalyze electron transfer reactions.

**Flavivirus** A small, enveloped, (+) sense RNA virus that causes a variety of encephalitides, including yellow fever.

**Flavorprotein** An electron carrier in oxidative phosphorylation.

**Flocculation** The addition of alum to cause precipitation of suspended colloids, such as clay, in the water purification process.

**Flourescence-activated cell sorter (FACS)** A machine that collects quantities of a particular cell type under sterile conditions for study.

**Fluctuation test** A test to determine that resistance to chemical substances occurs spontaneously rather than being induced.

**Fluid-mosaic model** A model describing cellular membrane structure, according to which the proteins are embedded in a phosopholipid bilayer and are free to move in the plane of the membrane. This model is basically correct.

**Fluke** A flatworm with a complex life cycle; can be an internal or external parasite.

**Fluorescence** (1) Emission of light of one color when irradiated with another, shorter wavelength of light (2) The phenomenon by which a substance that absorbs light at a given wavelength reradiates a portion of the energy as light of a longer wavelength.

**Flourescence activated cell sorter (FACS)** Device that separates cells within a population based on whether or not they fluoresce.

**Flourescence miscroscopy** Use of ultraviolet light in a microscope to excite molecules so that they release light of different colors.

**Fluorescent antibody staining** Procedure in fluorescence microscopy that uses a fluorochrome attached to antibodies to detect the presence of an antigen.

**Fluoride** Chemical that helps in reducing tooth decay by poisoning bacterial enzymes and hardening the surface enamel of teeth.

**Flux** With reference to a chemical pathway, the rate (in moles per unit time) at which reactant "flows through" the pathway to emerge as product. The term can be used for the rate at which particles undergo any process in which they either flow or can be thought of metaphorically as flowing.

**Focal infection** An infection confined to a specific area from which pathogens can spread to other areas.

**Folliculitis** Local infection produced when hair follicles are invaded by pathogenic bacteria.
*Known also as pimple or pustule.*

**Fomite** A non-living substance capable of transmitting disease, such as clothing, dishes, or paper money.

**Food poisoning** A gastrointestinal disease caused by ingestion of foods contaminated with preformed toxins or other toxic substances.

*Known also as enterotoxicosis.*

**Footprinting** With respect to molecular genetics, a technique used to identify the DNA segment in contact with a given DNA-binding protein. The DNA-protein complex is subjected to digestion with a non-specific nuclease, which cleaves at the residues that are not protected by the protein.

**Formed elements** Cells and cell fragments comprising about 40% of the blood.

**F Pilus** A bridge formed from an F1 cell to an F2 cell for conjugation.

**F Plasmid** Fertility plasmid containing genes direction synthesis of proteins that form an F pilus (sex pilus, or conjugation pilus)

**$F^-$ Cell** A cell lacking the F plasmid; called recipient or female cell.

**$F^+$ Cell** A cell having an F plasmid, called donor or male cell.

**F′ Plasmid** An F plasmid that has been imprecisely separated from the bacterial chromosome so that it carries a fragment of the bacterial chromosome.

**Frameshift mutation** A mutation that changes the reading for a gene by adding or deleting one or two nucleotides, thereby reducing the remainder of the message 3′ to the mutation to gibberish.

**Frameshift suppressor** A mutant tRNA that contains either two or four bases in the anticodon loop and can suppress the effects of a particular frameshift mutation in a gene.

**Free energy (G)** A thermodynamic quantity (function of state) that takes into account both enthalpy and entropy: $G = H - TS$, where $H$ is enthalpy, $S$ is entropy, and $T$ is absolute temperature. The *change in free energy* ($\Delta G$) for a process, such as a chemical reaction, takes into account the changes in enthalpy and entropy and indicates whether the process will be thermodynamically favored at a given temperature. *Known also as Gibbs free energy.*

**Freeze-etching** Technique in which water is evaporated under vacuum from the freeze-fractured surface of a specimen before the observation with electron microscopy.

**Freeze-fracturing** Technique in which a cell is first frozen and then broken with a knife so that the fracture reveals structures inside the cell when observed by electron microscopy.

**Frictional coefficient** A coefficient that determines the frictional force on a particular particle (such as a molecule) in a particular medium at a given velocity. In the context of electrophoresis or centrifugation, it determines how fast a chemical species will move in a particular medium in response to a given electrical field or centrifugal force.

**Fulminating** *See* ACME.

**Functional group** Part o a molecule that generally participates in chemical reactions as a unit and gives the molecule some of its chemical properties.

**Fungi** (singular: *fungus*). The kingdom of non-photosynthetic, eukaryotic organisms that absorb nutrients from their environment.

**Fungi imperfecti** Group of fungi termed "imperfect" because no sexual stage has been observed in their life cycles.

*Known also as deuteromycota.*

**Furuncle** A large, deep pus-filled infection. *Known also as a boil.*

**Fusion proteins** Genetically engineered proteins that are made by splicing together coding sequences from two or more genes. The resulting protein thus combines portions from two different parent proteins.

**$F_0F_1$ complex** The enzyme complex in the inner mitochondrial membrane that uses energy from the transmembrane proton gradient to catalyze ATP synthesis. The $F_0$ portion of the complex spans the membrane, and the $F_1$ portion, which performs the ATP synthase activity, projects into the mitochondrial matrix.

**Gamete** A male or female reproductive cell.

**Gametocyte** A male or female sex cell.

**Gamma globulin** *See immune serum globulin.*

**Ganglion** An aggregation of neuron cell bodies.

**Gas gangrene** A deep would infection, destructive of tissue, often caused by a combination of two or more species of *Clostridium.*

**Gated channel** A membrane ion channel that can open or close in response to signals from outside or within the cell.

**Gel electrophoresis** A type of electrophoresis in which the supporting medium is a thin slab of gel held between glass plates. The technique is widely used for separating proteins and nucleic acids.

*See also electrophoresis, isoelectric focusing.*

**Gene** A linear sequence of DNA nucleotides that form a functional unit within a chromosome or plasmid.

**Gene amplification** A technique of genetic engineering in which plasmids or bacteriophages carrying a specific gene are induced to reproduce at a rapid rate within host cells.

**Generalized anaphylaxis** *See anaphylactic shock.*

**Generalized transduction** Type of transduction in which a fragment of DNA from the degraded chromosome of an infected bacteria cell is accidentally incorporated into a new phage particle during viral replication and thereby transferred to another bacterial cell.

**Generation time** Time required for a population of organisms to double in number.

**Genetic code** The code by which the nucleotide sequence of a DNA or RNA molecule specifies the amino acid sequence of a polypeptide. It consists of three-nucleotide codons that either specify a particular amino acid or tell the ribosome to stop translating and release the polypeptide. With a few minor exceptions, all living things use the same code.

**Genetic engineering** The use of various techniques to purposefully manipulate genetic material to alter the characteristics of an organism in a desired way.

**Genetic fusion** A technique of genetic engineering that allows transposition of genes from one location on a chromosome to another location; the coupling of genes from two different operons.

**Genetic homology** The similarity of DNA base sequences among organisms.

**Genetic immunity** Inborn or innate immunity.

**Genetic recombination** Any process that results in the transfer of genetic material from one DNA molecule to another. In eukaryotes, it can refer specifically to the exchange of matching segments between homologous chromosomes by the process of crossing over.

**Genetics** The science of heredity, including the structure and regulation of genes and how these genes are passed between generations.

**Gene transfer** Movement of genetic information between organisms by transformation, transduction, or conjugation.

**Genital herpes** *See herpes simplex virus Type-2.*

**Genital wart** An often malignant wart associated with sexual transmitted viral disease having a very high association rate with cervical cancer.

*Known also ad condyloma.*

**Genome** The total genetic information contained in a cell, an organism, or virus.

**Genotype** The genetic information contained in the DNA of an organism. *Compare phenotype.*

**Genus** A taxon consisting of one or more species, the first name of an organism in the binomial system of nomenclature; for example, *Escherichia in Escherichia coli.*

**German measles** *See rubella.*

**Germination** The start of the process of development of a spore or an endospore.

**Germ theory of disease** Theory that micro-organisms (germs) can invade other organisms and cause disease.

**Giardiasis** A gastrointestinal disorder caused by the flagellated protozoan *Giardia intestinalis.*

**Gibberellins** A family of diterpene plant growth hormones.

**Gibbs free energy** *See free energy.*

**Gingivitis** The mildest form of periodontal disease, characterized by inflammation of the gums.

**Gingivostomatitis** Inflammation of and damage to the glomeruli of the kidneys. *Known also as Bright's disease.*

**Globular proteins** Proteins whose three-dimensional folded shape is relatively compact. *Compare fibrous proteins.*

**Glomerulus** A coiled cluster of capillaries in the nephron.

**Glucocorticoids** The steroid hormones cortisol and corticosterone, which are secreted by the adrenal cortex. In addition to other functions, they promote gluconeogenesis in response to low blood sugar levels.

**Glucogenic** In fuel metabolism, refers to substances (such as some amino acids) that can be used as substrates for glucose synthesis.

**Gluconeogenesis** The processes by which glucose is synthesized from non-carbohydrate precursors such as glycerol, lactate, some amino acids, and (in plants) acetyl-CoA.

**Glucose transporter** A membrane protein that is responsible for transporting glucose across a cell membrane. Different tissues may have glucose transporters with different properties.

**Glycan** Another name for polysaccharide.

**Glycocalyx** Term used to refer to all substances containing polysaccharides found external to the cell wall.

**Clycolipids** Lipids that have saccharides attached to their head groups.

**Glycolysis** The initial pathway in the catabolism of carbohydrates, by which a molecule of glucose is broken down to two molecules of pyruvate, with a net production of ATP molecules and the reduction of two $NAD^+$ molecules to NADH. Under aerobic conditions, these NADH molecules are reoxidized by the electron transport chain; under anaerobic conditions, a different electron acceptor is used. An anaerobic metabolic pathway used to break down glucose into pyruvic acid while producing some ATP.

**Glycoprotein** A long, spikelike molecule made of carbohydrate and protein that projects beyond the surface of a cell or viral envelope; some viral glycoproteins attach the virus to receptor sites on host cells, while other said fusion of viral and cellular membranes.

**Glycosaminoglycans** Polysaccharides composed of repeating disaccharide units in which one sugar is either *N*-acetylgalactosamine or *N*-acetylglucosamine. Typically the disaccharide unit carries a carboxyl group and often one or more sulfates, so that most glycosaminoglycans have a high density of negative charges. Glycosaminoglycans are often combined with protein to form proteoglycans and are an important component of the extracellular matrix of vertebrates.

*Known also as mucopolysaccharides.*

**Glycosidic bond** A covalent bond between two monosaccharides.

**Glyoxysome** A specialized type of peroxisome found in plant cells. It performs some of the reactions of photorespiration, and it also breaks down fatty acids to acetyl-CoA by β-oxidation and converts the acetyl-CoA to succinate via the glyoxylate cycle, thus enabling plants to convert fatty acids to carbohydrates.

**Golgi apparatus** An organelle in eukaryotic cells that receives, modifies, and transports substances coming from the endoplasmic reticulum.

**Golgi complex** A stack of flattened membranous vesicles in the cytoplasm. It serves as a routing center for proteins destined for secretion or for lysosomes or the cell membrane; it performs similar functions for membrane lipids, and it also modifies and finishes the oligosaccharide moieties of glycoproteins.

**Gonorrhea** A sexually transmitted disease caused by *Neisseria Gonorrhoeae.*

**G Proteins** A family of membrane-associated proteins that transduce signals received by various cell-surface receptors. They are called G proteins because binding of GTP and GDP is essential to their action.

**Graft tissue** Tissue that is transplanted from one site to another.

**Graft-versus-host (GVH) disease** Disease in which host antigens elicit an immunological response from graft cells that destroys host tissue.

**Gram molecular weight** *See mole.*

**Gram stain** A differential stain that uses crystal violet, iodine, alcohol, and safranin to differentiate bacteria. Gram-positive bacteria stain dark purple; Gram-negative ones stain pink/red.

**Granulation tissue** Fragile, reddish, grainy tissue made up of capillaries and fibroblasts that appears with the healing of an injury.

**Granule** An inclusion that is not bounded by a membrane and contains compacted substances that do not dissolve in the cytoplasm.

**Granulocyte** A leukocyte (basophil, mast cell, eosinophil, and neutrophil) with granular cytoplasm and irregularly shaped, lobed nuclei.

**Granuloma** In a chronic inflammation, a collection of epithelial cells, macrophages, lymphocytes, and collagen fibers.

**Granuloma inguinale** A sexually transmitted disease caused by *Calymmatobacterium Granulomatis.*

*Known also as Donovanosis.*

**Granulomatous hypersensitivity** Cell-mediated hypersensitivity reaction that occurs when macrophages have engulfed pathogens but have failed to kill them.

**Granulomatous inflammation** A special kind of chronic inflammation characterized by the presence of granulomas.

**Granzyme** A cytotoxin produced by cytotoxic T cells that help kill infected host cells.

**Griseofulvin** An antifungal agent that interferes with fungal growth.

**Ground itch** Bacterial infection of sites of penetration by hookworms.

**Group translocation** An active transport process in bacteria that chemically modifies substance so it cannot diffuse out of the cell.

**Growth curve** The different growth periods of a bacterial or phage population.

**Growth factors** Peptide mediators that influence the growth and/or differentiation of cells; they differ from growth hormones in being produced by many tissues and in acting locally.

**Gumma** A granulomatous inflammation, symptomatic of syphilis, that destroys tissue.

**Gut-associated lymphatic tissue (GALT)** Collective name for the tissues of lymphoid nodules, especially those in the digestive, respiratory, and urogenital tracts; main site of antibody production.

**Half-life** For a chemical reaction, the time at which half the substrate has been consumed and turned into product. The term can also refer to the analogous point in other processes, such as the radioactive decay of an isotope.

*Known also as half-time.*

**Halobacteria** One of the groups of the archaeobacteria that lives in very concentrated salt environments.

**Halophile** A salt-loving organism that requires moderate to large concentrations of salt.

**Hanging drop** A special type of wet. mount often used with dark-field illumination to study motility of organisms.

**Hansen's disease** The preferred name for leprosy, caused by *Mycobacterium leprae*, it exhibits various clinical forms ranging from tuberculoid to lepromatous.

**Hantavirus pulmonary syndrome (HPS)** The "Sin Nombre" hantavirus responsible for severe respiratory illness.

**Haploid** (1) A eukaryotic cell that contains a single, unpaired set of chromosomes. (2) A molecule that is too small to stimulate an immune response by itself but can do so when coupled to a larger, immunogenic carrier molecule (usually a protein).

**Hapten** A small molecule that can act as an antigenic determinant when combined with a larger molecule.

**Haworth projection** A conventional planar representation of a cyclized monosaccharide molecule. The hydroxyls that are represented to the right of the chain in a Fischer projection are shown below the plane in a Haworth projection.

**Heat fixation** Technique in which air-dried smears are passed through an open flame so that organisms are killed, adhere better to the side, and take up dye more easily.

**Heat-shock proteins** A group of Chaperonins that accumulates in a cell after it has been subjected to a sudden temperature jump or other stress. They are thought to help deal with the accumulation of improperly folded or assembled proteins in stressed cells.

**Heavy chain (H chain)** Larger of the two identical pairs of chains comprising immunoglobulin molecules.

**Helicases** Enzymes that catalyze the unwinding of duplex nucleic acids.

**Helix-loop-helix motif** A binding motif that is found in calmodulin and some other calcium-binding proteins as well as in some DNA-binding proteins. It consists of two α-helix segments connected by a loop.

**Helix-turn-helix motif** A DNA-binding motif that is responsible for sequence-specific DNA binding in many transcription factors. It consists of two α-helix segments connected by a β turn; one of the helices occupies the DNA major groove and makes specific base contacts.

**Helminth** A worm, with bilateral symmetry; includes the roundworms and flatworms.

**Helper T cell ($T_H$)** (1) Lymphocytes that stimulate other immune cells, such as B cells and macrophages. (2) T lymphocytes whose role is to recognize antigens and help other defensive cells to mount an immune response. They help activate antigen-stimulated B cells (resulting in production of specific antibodies) and/or antigen-stimulated cytotoxic T cells (resulting in attack on antigenic cells), and they also produce immune mediators that stimulate non-specific defense responses.

**Hemagglutination** Agglutination (clumping) of red blood cells, used in blood typing.

**Hemagglutination inhibition test** Serologic test used to diagnose measles, influenza, and other viral diseases, based on the ability of antibodies to viruses to prevent viral hemagglutination.

**Heme** A molecule consisting of a porphyrin ring (either protoporphyrin IX or a derivative) with a central complexed iron; it serves as a prosthetic group in proteins such as myoglobin, hemoglobin, and cytochromes.

**Hemimethylated** With respect to DNA, refers to the condition in which one strand of the duplex is methylated and the other is not. Newly replicated DNA is hemimethylated; normally a methylase enzyme then methylates appropriate bases in the new strand.

**Hemoglobin** The oxygen-binding compound found in erythocytes.

**Hemolysin** An enzyme that lyses red blood cells.

**Hemolysis** The lysis of red blood cells.

**Hemolytic disease of the newborn** Disease in which a baby is born with enlarged liver and spleen caused by efforts of these organs to destroy red blood cells damaged by maternal antibodies; mother is Rh-negative and baby is Rh-positive.

*Known also as erythroblastosis fetalis.*

**Hemorrhagic uremic syndrome (HUS)** Infection with 0157-H7 strain of *Escherichia coli* causing kidney damage and bleeding in the urinary tract.

**Hepadnavirus** A small, enveloped DNA virus with circular DNA, one such virus causes hepatitis B.

**Hepatitis** An inflammation of the liver, usually caused by viruses but sometimes by an amoeba or various toxic chemicals.

**Hepatitis A (formerly called infectious hepatitis)** Common form of viral hepatitis caused by a single-stranded RNS virus transmitted by the fecal-oral route.

**Hepatitis B (formerly called serum hepatitis)** Type of hepatitis caused by a double-stranded DNA virus usually transmitted in blood or semen.

**Hepatitis C (formerly called non-A, non-B hepatitis)** Type of hepatitis distinguished by a high level of the liver enzyme alanine transferase, usually mild or inapparent infection but can be severe in compromised individuals.

**Hepatitis D** Severe type of hepatitis caused by presence of both hepatitis D and hepatitis B viruses, hepatitis D virus is an incomplete virus and cannot replicate without presence of hepatitis B virus as a helper.

*Known also as delta hapatitis.*

**Hepatitis E** Type of hepatitis transmitted through fecally contaminated water supplies.

**Hepatovirus** One of three major groups of picornaviruses that can infect nerves and is responsible for causing hepatitis A.

**Herd immunity** The proportion of individuals in a population who are immune to a particular disease.

*Known also as group immunity.*

**Heredity** Having both male and female reproductive systems in one organism.

**Herpes gladiatorium** Herpesvirus infection that occurs in skin injuries of wrestlers, transmitted by contact or on mats.

**Herpes labialis** Fever blisters (cold sores) on lips.

**Herpes meningoencephalitis** A serious disease caused by herpesvirus that can cause permanent neurological damage or death and that sometimes follows a generalized herpes infection or ascends from the trigeminal ganglion.

**Herpes pneumonia** A rare form of herpes infection seen in burn patients, AIDS patients, and alcoholics.

**Herpes simplex virus Type-1 (HSV-1)** A virus that most frequently causes fever blisters (cold sores) and other lesions of the oral cavity, and less often causes genital lesions.

**Herpes simplex virus Type-2 (HSV-2)** A virus that typically causes genital herpes, but which can also cause oral lesions.

*Known also as herpes hominis virus.*

**Herpesvirus** A relatively large, enveloped DNA virus that can remain latent in host cells for long periods of time.

**Heterogencity** The ability of the immune system to produce many different kinds of antibodies, each specific for a different antigenic determinant.

**Heterotroph** An organism that uses compounds to produce biomolecules.

**Heterotrophs** Organisms that cannot synthesize their organic compounds entirely from inorganic precursors but most consume at least some organic compounds made by other organisms. In particular, these organisms cannot use $CO_2$ as a carbon source. *Compare autotrophs.*

**Heterotrophy** "Other-feeding" the use of carbon atoms from organic compounds for the synthesis of biomolecules.

**Heterozygous** In a diploid organism, the possession of two different alleles for a given gene (as opposed to two copies of the same allele). *Compare homozygous.*

**Hib vaccine** Vaccine against *Haemophilus influenzae b.*

**High-density lipoprotein (HDL)** A type of lipoprotein particle that functions mainly to scavenge excess cholesterol from tissue cells and transport it to the liver, where it can be excreted in the form of bile acids.

**High-energy bond** A chemical bond that releases energy when hydrolyzed; the energy can be used to transfer the hydrolyzed product to another compound.

**High frequency of recombination (Hfr) strain** A strain of $F^+$ bacteria in which the F plasmid is incorporated into the bacterial chromosome.

**High-temperature short-time (HTST) pasteurization** Process in which milk is heated to 71.6°C for at least 15 s.

*Known also as flash pasteurization.*

**Hill coefficient ($n_H$)** A coefficient that indicates the degree of cooperativity of a cooperative transition; it is the maximum slope of a Hill plot of the transition.

**Histamine** Amine release by basophils and tissues in allergic reactions.

**Histocompatibility antigen** An antigen found in the membranes of all human cells that is unique in all individuals except identical twins.

**Histone** A protein that contributes directly to the structure of eukaryotic chromosomes.

**Histones** The proteins that participate in forming the nucleosomal structure of chromatin. Four of the five kinds of histones make up the core particle of the nucleosome; the 50 is associated with the linker DNA between nucleosomes. All histones are small, very basic proteins.

**Histoplasmosis** Fungal respiratory disease endemic to the central and eastern United States, caused by the soil fungus *Histoplasma capsulatium.*

*Known also as darling's disease.*

**Holding method** *See low-temperature long-time pasteurization.*

**Holliday junction** An intermediate during homologous recombination; a four-armed structure in which each of the participating DNA duplexes has exchanged one strand with the other duplex.

**Holoenzyme** A functional enzyme consisting of an apoenzyme and a coenzyme or cofactor.

**Homeo box** A common sequence element of about 180 base pairs that is found in homeotic genes. It codes for a sequence-specific DNA-binding element of the helix-loop-helix class.
*See also homeotic genes.*

**Homeotic genes** Genes that contain homeo box elements and typically are involved in controlling the pattern of organismal development. Homeotic mutations, which scramble portions of this pattern, affect homeotic genes. The nuclear DNA-binding proteins encoded by these genes presumably serve as transcriptional regulators for the coordinated expression of groups of genes.
*See also homeo box.*

**Homolactic acid fermentation** A pathway in which pyruvic acid is directly converted to lactic acid using electrons from reduced NAS (NADH)

**Homologous recombination** Genetic recombination that requires extensive sequence homology between the recombining DNA molecules. Meiotic recombination by crossing over in eukaryotes is an example.

**Homopolymer (biological)** A polymer that is made of only one kind of monomer. Starch, made only of glucosyl units, is an example. Polymers that include more than one kind of monomer, like polypeptides and nucleic acids, are called heteropolymers.

**Homozygous** In a diploid organism, the possession of two identical alleles for a given gene. *Compare heterozygous.*

**Hookworm** A disease caused by two species of small roundworms, *Ancylostoma duodenale* and *Necator americanus*, whose larvae burrow through skin and feet, enter the blood vessels, and penetrate lung and intestinal tissue.

**Horizontal transmission** Direct contact transmission of disease in which pathogens are usually passed by handshaking, kissing, contact with sores, or sexual contact.

**Hormone** A substance that is synthesized and secreted by specialized cells and carried via the circulation to target cells, where it elicits specific changes in the metabolic behavior of the cell by interacting with a hormone-specific receptor.

**Hormone-responsive element** A DNA site that binds an intracellular hormone–receptor complex; binding of the complex to a hormone-responsive element affects the transcription of specific genes.

**Host** Any organism that harbors another organism.

**Host-induced restriction and modification** A genetic system found in bacteria whereby a genetic element (often a plasmid) encodes both an enzyme for the methylation of DNA at a specific base sequence and an Endonuclease that cleaves unmethylated DNA at that sequence. The system thus *restricts* the DNA that can survive in the cell to DNA that is *modified* by methylation at the correct sequences.

**Host range** The different types of organisms that a microbe can infect.

**Host specificity** The range of different ghosts in which a parasite can mature.

**Human immunodeficiency virus (HIV)** One of the retroviruses that is responsible for AIDS.

**Human leukocyte antigen (HLA)** A lymphocyte antigen used in laboratory tests to determine compatibility of donor and recipient tissues for transplants.

**Human papillomavirus (HPV)** Virus that attacks skin and mucous membranes, causing papillomas or warts.

**Humoral immune response** A response to foreign antigens carried out by antibodies circulating in the blood.

**Humoral immunity** The immune response most effective in defending the body against bacteria, bacterial toxins, and viruses that have not entered cells.

**Humus** The non-living organic components of soil.

**Hyaluronidase** A bacterially produced enzyme that digests hyaluronic acid, which helps hold the cells of certain tissues together, thereby making tissues more accessible to microbes.

*Known also as spreading factor.*

**Hybridoma** A hybrid cell resulting from the fusion of a cancer cell with another cell, usually an antibody-producing white blood cell.

**Hybridomas** Cultured cell lines that are made by fusing antibody-producing B lymphocytes with cells derived from a mouse myeloma (a type of lymphocyte cancer). Like B cells, they produce specific antibodies, and like myeloma cells, they can proliferate indefinitely in culture.

**Hydatid cyst** An enlarged cyst containing many tapeworm heads.

**Hydrogen bond** An attractive interaction between the hydrogen atom of a donor group, such as –OH or =NH, and a pair of non-bonding electrons on an acceptor group, such as O=C. The donor group atom that carries the hydrogen must be fairly electronegative for the attraction to be significant.

**Hydrologic cycle** *See water cycle.*

**Hydrolysis** A chemical reaction that produces simpler products from more complex organic molecules.

**Hydrophilic** Refers to the ability of an atom or a molecule to engage in attractive interactions with water molecules. Substances that are ionic or can engage in hydrogen bonding are hydrophilic. Hydrophilic substances are either soluble in water or, at least, wettable. *Compare hydrophobic.*

**Hydrophobic** The molecular property of being unable to engage in attractive interactions with water molecules. Hydrophobic substances are non-ionic and non-polar; they are non-wettable and do not readily dissolve in water. *Compare hydrophilic.*

**Hydrophobic effect** With respect to globular proteins, the stabilization of tertiary structure that results from the packing of hydrophobic side chains in the interior of the protein.

**Hydrostatic pressure** Pressure exerted by standing water.

**Hyperimmune serum** A preparation of immune serum globulins having high titers of specific kinds of antibodies.

*Known also as convalescent serum.*

**Hyperparasitism** The phenomenon of a parasite itself having parasites.

**Hypersensitivity** Disorder in which the immune system reacts inappropriately, usually by responding to an antigen it normally ignores.

*Known also as an allergy.*

**Hypertonic solution** A solution containing a concentration of dissolved material greater than that within a cell.

**Hypha** (plural. *hyphae*). A long, threadlike structure of cells in fungi or actinomycetes.

**Hypochromism** With respect to DNA, a reduction in the absorbance of ultraviolet light of wavelength of about 260 nm that accompanies the transition from random-coil denatured strands to a double-strand helix. It can be used to track the process of denaturation or renaturation.

**Hypothesis** A tentative explanation for an observed condition or event.

**Hypotonic solution** A solution containing a concentration of dissolved material lower than that within a cell.

**IgA** Class of antibody found in the blood and secretions.

**IgD** Class of antibody found on the surface of B cells and rarely secreted.

**IgE** Class of antibody that binds to receptors on basophils in the blood or mast cells in the tissues, responsible for allergic or immediate (Type-I) hypersensitivity reactions.

**IgG** The main class of antibodies found in the blood; produced in largest quantities during secondary response.

**IgM** The first class of antibody secreted into the blood during the early stages of a primary immune response (a rosette of five immunoglobulin molecules) or found on the surface of B cells (a single immunoglobulin molecule).

**Illness phase** In an infectious disease, the period during which the individual experiences the typical signs and symptoms of the disease.

**Imidazole** An antifungal agent that disrupts fungal plasma membranes.

**Immediate (Type-I) hypersensitivity** Response to a foreign substance (allergen) resulting from prior exposure to the allergen.

*Known also as anaphylactic hypersensitivity.*

**Immersion oil** Substance used to avoid refraction at a glass–air interface when examining objects through a microscope.

**Immune complex** An antigen–antibody complex that is normally eliminated by phagocytic cells.

**Immune complex disorder** A disorder caused by antigen–antibody complexes that precipitate in the blood and injure tissues; elicited by antigens in vaccines, on micro-organisms, or on a person's own cells.

*Known also as immune complex (Type-III) hypersensitivity.*

**Immune cytolysis** Process in which the membrane attack complex of complement produces lesions on cell membranes through which the contents of the bacterial cells leak out.

**Immune serum globulin** A pooled sample of antibody-containing fractions of serum from many individuals.

*Known also as gamma globulin.*

**Immune system** Body system that provides the host organism with specific immunity to infectious agents.

**Immunity** The ability of an organism to defend itself against infectious agents.

**Immunocompromised** Referring to an individual whose immune defenses are weakened due to fighting another infectious disease, or because of an immunodeficiency disease or an immunosuppressive agent.

**Immunodeficiency** Inborn or acquired defects in lymphocytes (B or T cells).

**Immunodeficiency disease** A disease of impaired immunity caused by lack of lymphocytes, defective lymphocytes, or destructive lymphocytes.

**Immunodiffusion test** A serologic test similar to the precipitin test but carried out in agar gel medium.

**Immunoelectrophoresis** Serologic test in which antigens are first separated by gel electrophoresis and then allowed to react with antibody placed in a trough in the gel.

**Immunofluorescence** Referring to the use of antibodies to which a fluorescent substance is bound and used to detect antigens, other antibodies, or complement within tissue.

**Immunogen** *See antigen.*

**Immunogenic** Something that is a potent stimulator of antibody production and defense cell activity.

**Immunoglobulin (Ig)** The class of protective proteins produced by the immune system in response to a particular epitope.
*Known also as an antibody. See antibodies.*

**Immunological disorder** Disorder that results from an inappropriate or inadequate immune system.

**Immunological memory** The ability of the immune system to recognize substances it has previously encountered.

**Immunology** The study of specific immunity and how the immune system responds to specific infectious agents.

**Immunosuppression** Minimizing of immune reactions using radiation or cytotoxic drugs.

**Impetigo** A highly contagious pyoderma caused by staphylococci, streptococci, or both.

**Importins** A class of proteins involved in importing molecules into the nucleus.
*See exportins.*

**Inapparent infection** An infection that fails to produce symptoms, either because too few organisms are present or because host defenses effectively combat the pathogens.
*Known also as subclinical infection.*

**Inborn errors of metabolism** Human mutations that result in specific derangements of intermediary metabolism. Usually the problem is an enzyme that is inactive, overactive, too scarce, or too abundant; symptoms may result from the insufficient production of a necessary metabolite and/or from the accumulation of another metabolite to toxic levels.

**Incidence rate** The number of new cases of a particular disease per 100,000 population seen in a specific period of time.

**Inclusion** A granule or vesicle found in the cytoplasm of a bacterial cell.

**Inclusion blennorrhea** A mild chlamydial infection of the eyes in infants.

**Inclusion body** (1) An aggregation of reticulate bodies within chlamydias. (2) A form of cytopathic effect consisting of viral components, masses of viruses, or remnants of viruses.

**Inclusion conjunctivitis** A chlamydial infection that can result from self-inoculation with *Chlamydia trachomatis.*

**Incubation period** In the stages of infectious disease, the time between infection and the appearance of signs and symptoms.

**Index case** The first case of a disease to be identified.

**Index of refraction** A measure of the amount that light rays bend when passing from one medium to another.

**Indicator organism** An organism such as *Escherichia coli* whose presence indicates the contamination of water by fecal matter.

**Indigenous organism** An organism native to a given environment.
*Known also as a native organism.*

**Indirect contact transmission** Transmission of disease through fomites.

**Indirect fecal-oral transmission** Transmission of disease in which pathogens from feces of one organism infect another organism.

**Induced Dipole** A molecule has an induced dipole if an external electric field induces an asymmetric distribution of charge within it.

**Induced fit model** A model for how enzymes interact with substrates to achieve catalysis. According to this model, the empty active site of the enzyme only roughly fits the substrate(s), and the entry of substrate causes the enzyme to change its shape so as to both tighten the fit and causes the substrate to adopt an intermediate state that resembles the transition state of the uncatalyzed reaction. This is currently the dominant model for enzymatic catalysis.

**Induced mutation** A mutation produced by agents called mutagen that increases the mutation rate.

**Inducer** A substance that binds to and inactivates a repressor protein.

**Inducible enzyme** An enzyme coded for by a gene that is sometimes active and sometimes inactive.

**Induction** (1) The stimulation of a temperature phase (prophage) to excise itself from the host chromosome and initiate a lytic cycle of replication. (2) In cellular metabolism, the synthesis of a particular protein in response to a signal; for example, the synthesis of an enzyme in response to the appearance of its substrate.

**Induration** A raised, hard, red region on the skin resulting from tuberculin hypersensitivity.

**Industrial microbiology** Branch of microbiology concerned with the use of microorganisms to assist in the manufacture of useful products or disposal of waste products.

**Infant botulism** Form of botulism in infants associated with ingestion of honey.
*Known also as "floppy baby" syndrome.*

**Infection** The multiplication of a parasite organism, usually microscopic, within or upon the host's body.

**Infectious disease** Disease caused by infectious agents (bacteria viruses, fungi, protozoa, and helminths).

**Infectious hepatitis** *See hepatitis A.*

**Infectious mononucleosis** An acute disease that affects many systems, caused by the Epstein-Barr virus.

**Infestation** The presence of heminths (worms) or anthropods in or on a living host.

**Inflammation** The body's defensive response to tissue damage caused by microbial infection.

**Influenza** Viral respiratory infection caused by orthomyxoviruses that appears as epidemics.

**Initiating segment** It is the part of the F plasmid that is transferred to the recipient cell in conjugation with an Hfr bacterium.

**Innate immunity** Immunity to infection that exists in an organism because of genetically determined characteristics.

**Insect** An anthropod with three body regions, three pairs of legs, and highly specialized mouthparts.

**Insertion** The addition of one or more bases to DNA, usually producing a frameshift mutation.

**In situ hybridization** A technique for finding the chromosomal location of a particular DNA sequence by probing the chromosomes with a radiolabeled sequence that will hybridize with the sequence in question. The location of the probe is then visualized with radioautography.

**Intercalation** With respect to DNA, refers to the fitting (intercalation) of a small molecule between adjacent bases in a DNA helix.

**Interferon** (1) A small protein often released from virus-infected cells that binds to adjacent uninfected cells, causing them to produce antiviral proteins that interfere with viral replication. (2) All of the reactions in an organism that are concerned with storing and generating metabolic energy and with the biosynthesis of low-molecular-weight compounds and energy-storage compounds. It does not include nucleic acid and protein synthesis.

**Interleukin** A cytokine produced by leukocytes.

**Intermediate host** An organism that harbors a sexually immature stage of a parasite.

**Internal energy (*E*)** The energy contained in a system. For the purposes of biochemistry, the term encompasses all the types of energy that might be changed by chemical or non-nuclear physical processes, including the kinetic energy of motion and vibration of atoms and molecules and the energy stored in bonds and non-covalent interactions.

**Intoxication** The ingestion of a microbial toxin that leads to a disease.

**Intron** (1) Region of a gene (or mRNA) in eukaryotic cells that does not code for a protein. (2) A region in the coding sequence of a gene that is not translated into protein. Introns are common in eukaryotic genes but are rarely found in prokaryotes. They are excised from the RNA transcript before translation. *Compare exon.*

*Known also as the intervening region.*

**Invasiveness** The ability of a micro-organism to take up residence in a host.

**Invasive stage** Disease spreads into body from site of energy causing symptoms to appear.

**Ion** An electrically charged atom produced when an atom gains or loses one or more electrons.

**Ion-exchange resins** Polycationic or polyanionic polymers that are used in ion-exchange column chromatography to separate substances on the basis of electrical charge.

**Ionic bond** A chemical bond between atoms resulting from attraction of ions with opposite charges.

**Ionic strength (*I*)** A quantity that reflects the total concentration of ions in a solution and the stoichiometric charge (charge per atom or molecule) of each ion. It is defined as $I = \frac{1}{2}\sum_i M_i Z_i^2$ where $M_i$ and $Z_i$ are, respectively the molarity and stoichiometeric charge of ion *i*. It is used, for example, in calculating the effective radius of a counterion atmosphere.

**Ion pore** A pore in a cellular membrane through which ions can diffuse. It is formed by a transmembrane protein and can discriminate among ions to some degree on the basis of size and charge. Many ions pores are gated, meaning that they can open and close in response to signals.

**Iris diaphragm** Adjustable device in a microscope that controls the amount of light passing through the specimen.

**Ischemia** Reduced blood flow to tissues with oxygen and nutrient deficiency and waste accumulation.

**Isoelectric focusing** A version of gel electrophoresis that allows ampholytes to be separated almost purely on the basis of their isoelectric points. The ampholytes are added to a gel that contains a pH gradient and are subjected to an electric field,. Each ampholyte migrates until it reaches the pH that represents its isoelectric point, at which point it ceases to have a net electric charge and therefore comes to a halt and accumulates.

*See also gel electrophoresis, isoelectric point.*

**Isoelectric point (pI)** The pH at which the net charge on an ampholyte is, on average, zero.

**Isoenzymes** Different but related forms of an enzyme that catalyze the same reaction. Often differ in only a few amino acid substitutions.

*Known also as isozymes.*

**Isograft** A graft of tissue between genetically identical individuals.

**Isolation** Situation in which a patient with a communicable disease is prevented from contact with the general population.

**Isomer** An alternative form of a molecule having the same molecular formula but different structure.

**Isomorphorous replacement** The replacement of one atom in a macromolecule with a heavy metal atom in such a way that the structure of the macromolecule does not change. It is used in the determination of molecular structure by X-ray crystal diffraction.

**Isoniazid** An antimetabolite that is bacteriostatic against the tuberculosis-causing mycobacterium.

**Isotonic** Fluid containing the same concentration of dissolved materials as is in a cell; causes no change in cell volume.

**Isotope** An atom of a particular element that contains a different number of neutrons.

**Isozymes** *See isoenzymes.*

**Joule (J)** A unit for energy or work, defined as the work done by a force of 1 N when its point of application moves 1 m in the direction of the force. It is the unit of energy used in the Système Internationale (SI).

**Kala azar** Visceral leishmaniasis caused by *Leishmania donovani.*

**Kaposi's sarcoma** A malignancy often found in AIDS patients in which blood vessels grow into tangled masses that are filled with blood and easily ruptured.

**Karyogamy** Process by which nuclei fuse to produce a diploid cell.

**Keratin** A waterproofing protein found in epidermal cells.

**α-Keratins** A class of keratins that are the major proteins of hair. They consist of long α-helical polypeptides, which are wound around each other to form triplet helices.

**Keratitis** An inflammation of the cornea.

**Keratoconjunctivitis** Condition in which vesicles appear in the cornea and eyelids.

**Ketone bodies** The substances acetoacetate, β-hydroxybutyrate, and acetone, which are produced from excess acetyl-CoA in the liver when the rate of fatty acid β-oxidation in liver mitochondria exceeds the rate at which acetyl-CoA is used for energy generation or fatty acid synthesis.

**Ketose** A monosaccharide in which the carbonyl group occurs within the chain and hence represents a ketone group. *Compare* a*ldose.*

**Kidney** One of a pair of organs responsible for the formation of urine.

**Kirby–Bauer method** *See disk diffusion method.*

**Koch's postulates** Four postulated formulated by Robert Koch in the 19th century, used to prove that a particular organism causes a particular disease.

**Koplik's spots** Red spots with central bluish specks that appear on the upper lip mucosa in early stages of measles.

**Krebs cycle** A sequence of enzyme-catalyzed chemical reactions that metabolizes 2-carbon units called acetyl groups to $CO_2$ and $H_2O$.

*Known also as tricarboxylic acid cycle and the citric acid cycle.*

**Kupffer cells** Phagocytic cells that remove foreign matter from the blood as it passes through sinusoids.

**Kura** Transmissible spongiform encephalopathy disease of the human brain, caused by prions, associated with cannibalism and tissue/organ transplants.

**Lacrimal gland** Tear-producing gland of the eye.

**Lactobacilli** Type of regular, non-sporing, Gram-positive rod found in many foods;

used in production of cheeses, yogurt, sourdough, and other fermented foods.

**Lagging strand** During DNA replication, the strand that is synthesized in the opposite direction to the direction of movement of the replication fork; it is synthesized as a series of fragments that are subsequently joined. *Compare leading strand.*

**Lag phase** First of four major phases of the bacterial growth curve, in which organisms grow in size but do not increase in number.

**Large intestine** The lower area of the intestine that absorbs water and converts undigested food into feces.

**Laryngeal papilloma** Benign growth caused by herpesviruses that can be dangerous is such papillomas block the airway, infants are often infected during birth by mothers having genital warts.

**Laryngitis** An infection of the larynx, often with loss of voice.

**Larynx** The voicebox.

**Lassa fever** Hemorrhagic fever, caused by arenaviruses, that begins with pharyngeal lesions and proceeds to severe liver damage.

**Latency** The ability of a virus to remain the host cells for long periods of time while retaining the ability to replicate.

**Latent disease** A disease characterized by periods of inactivity either before symptoms appear or between attacks.

**Latent Period** Period of a bacteriophage growth curve that spans the time from penetration through biosynthesis.

**Latent viral infection** An infection typical of herpesviruses in which an infection in childhood that is brought under control later in life is reactivated.

**Lateral gene transfer** Genes pass from one organism to another within the same generation.

**Leader sequence** For an mRNA, the non-translated sequence at the 5′ end of the molecule that precedes the initiation codon. For a protein, a short N-terminal hydrophobic sequence that causes the protein to be translocated into or through a cellular membrane.
*Known also as signal sequence.*

**Leading strand** During DNA replication, the strand that is synthesized in the same direction as the direction of movement of the replication fork; it is synthesized continuously rather than in fragments. *Compare lagging strand.*

**Leavening agent** An agent, such as yeast, that produces gas to make dough rise.

**Legionellas** The causative bacterial agent in Legionnaires' disease, *Legionella pneumophila.*

**Leishmaniasis** A parasitic systemic disease caused by three species of protozoa of the genus *Leishmania* and transmitted by sandflies.

**Leproma** An enlarged, disfiguring skin lesion that occurs in the lepromatous form of Hansen's disease.

**Lepromatous** Referring to the nodular form of Hansen's disease (leprosy) in which a granulomatous response causes enlarged, disfiguring skin lesions called leptromas.

**Lepromin skin test** Test used to detect Hansen's disease (leprosy), similar to the tuberculin test.

**Leprosy** *See hansen's disease.*

**Leptospirosis** A zoonosis caused by the spirochete *Leptospira interrogans*, which enters the body through mucous membranes or skin abrasions.

**Leukocidin** An exotoxin produced by many bacteria, including the streptococci and staphylococci, that kills phagocytes.

**Leukocyte** A white blood cell.

**Leukocyte-endogenous mediator** A substance that helps to raise the body temperature while decreasing iron absorption (increasing iron storage).

**Leukocytosis** An increase in the number of white blood cells (leukocytes) circulating in the blood.

**Leukostatin** An exotoxin that interferes with the ability of leukocytes to engulf micro-organisms that release the toxin.

**Leukotriene** A reaction mediator released from mast cells after degranulation that causes prolonged airway construction, dilation, and increased permeability of capillaries, increased thick mucous secretion, and stimulation of nerve endings that cause pain and itching.

**Leukotrienes** A family of molecules that are synthesized from arachidonic acid by the lipoxygenase pathway and function as local hormones, primarily to promote inflammatory and allergic reactions (such as the bronchial construction of asthma).

**L Forms** Irregularly shaped naturally occurring bacteria with defective cell walls.

**Library** With respect to molecular genetics, a large collection of random cloned DNA fragments from a given organism, sometimes representing the entire nuclear genome.

**Ligand** In general, a small molecule that binds specifically to a larger one – for example, a hormone that binds to a receptor, the term can also be used to mean a chemical species that forms a coordination complex with a central atom, which is usually a metal atom.

**Ligase** An enzyme that joins together DNA segments.

**Light chain (L chain)** Smaller of the two identical pairs of chains constituting immunoglobulin molecules.

**Light microscopy** The use of any type of microscope that uses visible light to make specimens observable.

**Light reaction** The part of photosynthesis in which light energy is used to excite electrons from chlorophyll, which are then used to generate ATP and NADPH.

**Light reactions** The photosynthetic subprocesses that depend *directly* on light energy; specifically, the synthesis of ATP by photophosphorylation and the reduction of $NADP^+$ to NADPH via the oxidation of water. *Compare dark reactions.*

**Light repair** Repair of DNA dimers by a light-activated enzyme.

*Known also as photoreactivation.*

**Lineweaver-burk plot** A plot that allows one to derive the rate constant $k_{cat}$ and the Michaelis constant $K_M$ for an enzyme-catalyzed reaction. It is constructed by measuring the initial reaction rate $V$ at various substrate concentration $[S]$ and plotting the values on a graph of $1/V$ versus $1/[S]$.

**Linkage map** A map showing the arrangement of genes on a chromosome; it is constructed by measuring the frequency of recombination between pairs of genes.

**Linking number (*L*)** The total number of times the two strands of a closed, circular DNA helix cross each other by means of either twist or writhe; this equals the number of times the two strands are interlinked. It reflects both the winding of the native DNA helix and the presence of any supercoiling.

*See also twist, writhe.*

**Lipid** One of a group of complex, water-insoluble compounds.

**Lipid A** Toxic substance found in the cell wall of a Gram-negative bacteria.

**Lipid bilayer** A membrane structure that can be formed by amphipathic molecules in an aqueous environment; it consists of two back-to-back layers of molecules, in each of which the polar head groups face the water and the non-polar tails face the center of the membrane. The fabric of cellular membranes is a lipid bilayer.

**Lipids** A chemically diverse group of biological compounds that are classified together on the basis of their generally apolar structure and resulting poor solubility in water.

**Lipopolysaccharide** Part of the outer layer of the cell wall in Gram-negative bacteria. *Known also as an endoxtoxin.*

**Lipoproteins** Any lipid–protein conjugate. Specifically refers to lipid–protein associations that transport lipids in the circulation,. Each consists of a core of hydrophobic lipids surrounded by a skin of amphipathic lipids with embedded apolipoproteins. Different kinds of lipoproteins play different roles in lipid transport.

**Listeriosis** A type of meningitis caused by *Listeria monocytogenes* that is especially threatening to those with impaired immune systems.

**Loaiasis** Tropical eye disease caused by the filarial worm *Loa loa.*

**Lobar pneumonia** Type of pneumonia that affects one or more of the five major lobes of the lungs.

**Local infection** An infection confirmed to a specific area of the body.

**Localized anaphylaxis** An immediate (Type-I) hypersensitivity restricted to only some tissue/organs resulting in, e.g., reddening of the skin, watery eyes, hives, etc.

**Locus** The location of a gene on a chromosome.

**Logarithmic rate** *See exponential rate.*

**Log phase** Second of four major phases of the bacterial growth curve, in which cells divide at an exponential or logarithmic rate.

**Long terminal repeats (LTRs)** A pair of direct repeats several hundred base pairs long that are found at either end of a retroviral genome. They are involved in integration into the host genome and in viral gene expression.

**Lophotrichous** Having two or more flagella at one or both ends of a bacterial cell.

**Low-angle neutron scattering** A set of techniques that can be used to find the size of a particle in solution or to find the size or spacing of internal regions that can be distinguished by different neutron scattering power, such as the protein and nucleic acid components of a nucleoprotein particle or labeled proteins within a multisubunit complex.

**Low-density lipoprotein (LDL)** A type of lipoprotein particle that functions mainly to distribute cholesterol from the liver to other tissues. Its protein component consists of a single molecule of apoprotein B-100.

**Lower respiratory tract** Thin-walled bronchioles and alveoli where gas exchange occurs.

**Low-temperature long-time (LTLT) pasteurization** Procedure in which milk is heated to 62.0°C for at least 30 min.
*Known also as holding method.*

**Luminescence** Process in which absorbed light rays are reemitted at longer wavelengths.

**Lyme disease** Disease caused by *Borrelia burgdorferi*, carried by the deer tick.

**Lymph** The excess fluid and plasma proteins lost through capillary walls that are found in the lymphatic capillaries.

**Lymphangitis** Symptom of septicemia in which red streaks due to inflamed lymphatics appear beneath the skin.

**Lymphatic system** Body system, closely associated with the cardiovascular system, that transports lymph in lymphatic vessels through body tissues and organs, performs important functions in host defenses and specific immunity.

**Lymphatic vessel** Vessel that returns lymph to the blood circulatory system.

**Lymph node** An encapsulated globular structure located along the routes of the lymphatic vessels that helps clear the lymph of micro-organisms.

**Lymphocyte** A leukocyte (white blood cell) found in large numbers in lymphoid tissues that contribute to specific immunity.

**Lymphogranuloma venereum** A sexually transmitted disease, caused by *Chlamydia trachomatis*, that attacks the lymphatic system.

**Lymphoid nodule** A small, unencapsulated aggregation of lymphatic tissue that develops in many tissues, especially the digestive, respiratory, and unogenital tracts, collectively called gut-associated lymphatic tissue (GALT); they are the body's main sites of antibody production.

**Lymphoid stem cell** A cell in the bone marrow from which lymphocytes develop.

**Lyophokine** A cytokine secreted by T cells when they encounter an antigen.

**Lymphilization** The drying of a material from the frozen state, freeze-drying.

**Lysis** The destruction of a cell by the rupture of a cell or plasma membrane, resulting in the loss of cytoplasm.

**Lysogen** The combination of a bacterium and a temperate phage.

**Lysogenic** Pertaining to a bacterial cell in the state of lysogeny.

**Lysogenic conversion** The ability of a prophage to prevent additional infections of the same cell by the same type of phage; also the conversion of a non-toxin-producing bacterium into a toxin-producing one by a temperate phage.

**Lysogeny** The ability of temperature bacteriophages to persist in a bacterium by the integration of the viral DNA into the host chromosome and without the replication of new viruses or cell lysis.

**Lysosome** A small membrane-bound organelle in animal cells that contains digestive enzymes.

**Lytic cycle** The sequence of events in which a bacteriophage infects a bacterial cell, replicates, and eventually causes lysis of the cell.

**Lytic phage** *See virulent phage.*

**Macrolide** A large-ring compound, such as erythromycin, that is antibacterial by affecting protein synthesis.

**Macrophage** Ravenously phagocytic leukocytes found in tissues.

**Mad cow disease** Transmissible spongiform encephalopathy disease of the brain of cattle, caused by prions.

**Madura foot** Tropical disease caused by a variety of soil organisms (fungi and actinomycetes) that often enter the skin through bare feet.

*Known also as maduromycosis.*

**Maduromycosis** *See madura foot.*

**Major histocompatibility complex (MHC)** A group of cell surface proteins that are essential to immune recognition reactions.

**Malaria** A severe parasitic disease caused by several species of the protozoan *Plasmodium* and transmitted by mosquitoes.

**Male reproductive system** The host system consisting of the testes, ducts, specific glands, and the penis.

**Malignant** Relating to a tumor that is cancerous.

**Malta fever** *See brucellosis.*

**Malted** Referring to cereal grains that are partially germinated to increase the concentration of starch-digesting enzymes.

**Mammary gland** A modified sweat gland that produces milk and ducts that carry milk to the nipple.

**Mash** Malted grain that is crushed and mixed with hot water.

**Mass spectrometry** A method for determining the molecular mass from the velocity of motion of ions in a vacuum.

**Mast cell** A leukocyte that releases histamine during an allergic response.

**Mastigophoran** A flagellate protozoan such as *Giardia*.

**Mastoid area** Portion of the temporal bone prominent behind the ear opening.

**Matrix** Fluid-filled inner portion of a mitochondrion.

**Maturation** The process by which complete virions are assembled from newly synthesized components in the replication process.

**Measles** A febrile disease with rash caused by the rubeola virus, which invades lymphatic tissue and blood.
*Known also as rubeola.*

**Measles encephalitis** A serious complication of measles that leaves many survivors with permanent brain damage.

**Mebendazole** An antihelminthic agent that blocks glucose uptake by parasitic roundworms.

**Mechanical stage** Attachment to a microscope stage that holds the slide and allowsprecise control in moving the slide.

**Mechanical vector** A vector in which the parasite does not complete any part of its life cycle during transit.

**Mechanism-based inhibitor** An enzyme inhibitor whose action depends on the enzyme's catalytic mechanism. Typically, it is a substrate analog that irreversibly modifies the enzyme at a particular step in the catalytic cycle.

**Medium** A mixture of nutritional substances on or in which micro-organisms grow.

**Megakaryocyte** Large cell normally present in bone marrow that gives rise to platelets.

**Meiosis** Division process in eukaryotic cells that reduces the chromosome number in half.

**Membrane attack complex** A set of proteins in the complement system that lyses invading bacteria by producing lesions in their cell membranes.

**Membrane electrical potential** With respect to biological membranes, a voltage difference that exists across a membrane owing to differences in the concentrations of ions on either side of the membrane.

**Membrane filter method** Method of testing for coliform bacteria in water in which bacteria are filtered through a membrane and then incubated on the membrane surface in growth medium.

**Memory cell** Long-lived B or T lymphocyte that can carry out an anamestic or secondary response.

**Meninges** Three layers of membrane that protect the brain and spinal cord.

**Merozoite** A malaria trophozoite found in infected red blood or liver cells.

**Mesophile** An organism that grows best at temperatures between 25 and 45°C, including most bacteria.

**Mesophilic spoilage** Spoilage due to improper canning procedures or because the seal has been broken.

**Messenger RNA (mRNA)** (1) A type of RNA that carries the information from DNA to dictate the arrangement of amino acids in a protein. (2) RNA molecules that act as templates for the synthesis of polypeptides by ribosomes.

**Metabolic pathway** A chain of chemical reactions in which the product of one reaction serves as the substrate for the next.

**Metabolism** The totality of the chemical reactions that occur in an organism. *Compare anabolism, catabolism, and intermediary metabolism.*

**Metacercaria** The postcercarial encysted stage in the development of a fluke, prior to transfer to the final host.

**Metachromasia** Property of exhibiting a variety of colors when stained with a simple stain.

**Metachromatic granule** A polyphosphate granule that exhibits metachromasia. *Known also as volutin.*

**Metastability** For a system, the condition of being in a state that does not represent thermodynamic equilibrium but is nearly stable at the time scale of interest because progress toward equilibrium is slow.

**Metastasize** Relating to the spread of malignant tumors to other body tissues.

**Methanogens** One of the groups of the archaeobacteria that produce methane gas.

**Metronidazole** An antiprotozoan agent effective against *Trichomonas* infections.

**Micelles** Tiny droplets that form when an amphipathic substance that has a polar head group and a non-polar tail region (such as a fatty acid) is added to an aqueous medium and shaken. Each droplet consists of a spherical cluster of amphipathic molecules arranged with their polar head groups facing out toward the water and their non-polar tails facing in toward the center.

**Michaelis–Menten equation** An equation that gives the rate of an enzyme-catalyzed reaction in terms of the concentrations of substrate and enzyme as well as two constants that are specific for a particular combination of enzyme and substrate: a rate constant, $k_{cat}$, for the catalytic production of product when the enzyme is saturated, and the Michaelis constant, $K_M$.

**Microaerophile** A bacterium that grows best in the presence of a small amount of free oxygen.

**Microbe** *See micro-organism.*

**Microbial antagonism** The ability of normal microbiota to compete with pathogenic organisms and in some instances to effectively combat their growth.

**Microbial antagonism** The ability of. normal microbiota to compete with pathogenic organisms and in some instances to effectively combat their growth.

**Microbial growth** Increase in the number of cells, due to cell division.

**Microbiology** The study of micro-organisms.

**Micrococci** Aerobes or facultative anerobes that form irregular clusters by dividing in two or more planes.

**Microenvironment** A habitat in which the oxygen, nutrients, and light are stable, including the environment immediately surrounding the microbe.

**Microfilament** A protein fiber that makes up part of the cytoskeleton in eukaryotic cells.

**Microfilaria** An immature microscopic roundworm larva.

**Micrometer** (µm) Unit of measure equal to 0.000001 m or $10^{-6}$ m; formerly called a micron (µ).

**Micro-organism** Organism studied with a microscope; includes the viruses.
*Known also as a microbe.*

**Microscopy** The technology for making very small things visible to the unaided eye.

**Microtubule** A protein tubule that forms the structure of cilia, flagella, and part of the cytoskeleton in eukaryotic cells.

**Microtubule-associated proteins (MAPs)** A class of proteins associated with microtubules that assist in dynamic processes.

**Microtubules** Fiber-like cytoplasmic structures that consist of units of the protein tubulin arranged helically to form a hollow tube. They are involved in various kinds of cellular motility, including the beating of cilia and flagella and the movement of organelles from one part of the cell to another.

**Microvillus** (plural: *Microvilli*). A minute projection from the surface of an animal cell.

**Miliary tuberculosis** Type of tuberculosis that invades all tissues producing tiny lesions.

**Minimum bactericidal concentration (MBC)** The lowest concentration of an antimicrobial agent that kills micro-organisms, as indicated by absence of growth following subculturing in the dilution method.

**Minimum inhibitory concentration (MIC)** The lowest concentration of an antimicrobial agent that prevents growth in the dilution method of determining antibiotic sensitivity.

**Minus strand** In viral genomes, a nucleic acid strand that is complementary to the RNA strand that serves as mRNA. *Compare plus strand.*

**Miracidium** Ciliated, free-swimming first-stage fluke larva that emerges from an egg.

**Mismatch repair** A system for the correction of mismatched nucleotides or single-base insertions or deletions produced during DNA replication; it scans the nearly replicated DNA, and when it finds an error, it removes and replaces a stretch of the strand containing the error.

**Missense mutation** A mutation that alters a DNA codon so as to cause one amino acid in a protein to be replaced by a different one.

**Mitochondria** The organelles whose chief task it is to supply the cell with ATP via oxidative phosphorylation. They contain the enzymes for pyruvate oxidation, the citric acid cycle, the β-oxidation of fatty acids, and oxidative phosphorylation, as well as the electron transport chain.

**Mitochondrion** An organelle in eukaryotic cells that carries out oxidative reactions that capture energy.

**Mitosis** Process by which the cell nucleus in a eukaryotic cell divides to form identical daughter nuclei.

**Mixed-functional oxidase** An oxygenase enzyme that analyzes a reaction in which two different substrates are oxidized, one by the addition of an oxygen atom from $O_2$ and the other by supplying two hydrogen atoms to reduce the remaining oxygen atom to $H_2O$.

**Mixed infection** An infection caused by several species of organisms present at the same time.

**Mixture** Two or more substances combined in any proportion and not chemically bound.

**MMR vaccine** Measles, mumps, and rubella vaccine.

**Mole** The weight of a substance in grams equal to the sum of the atomic weights of the atoms in a molecule of the substance. *Known also as gram molecular weight.*

**Molecular mimicry** Imitation of the behavior of a normal molecule by an antimetabolite.

**Molecule** Two or more atoms chemically bonded together.

**Molluscum contagiosum** A viral infection characterized by flesh-colored, painless lesions.

**Molten globule** A hypothetical intermediate state in the folding of a globular protein, in which the overall tertiary framework has been established but internal side chains (especially hydrophobic ones) are still free to move about.

**Monera** The kingdom of prokaryotic organisms that are unicellular and lack a true cell nucleus.

*Known also as prokaryotae.*

**Moniliasis** *See candidiasis.*

**Monoclonal antibody** A single, pure antibody produced in the laboratory by a clone of cultured hybridoma cells.

**Monocular** Refers to a light microscope having one eyepiece (ocular)

**Monocyte** A ravenously phagocytic leukocyte, called a macrophage after it migrates into tissues.

**Monolayer** A suspension of cells that attach to plastic or glass surfaces as a sheet one cell layer thick.

**Monosaccharide** A simple carbohydrate, consisting of a carbon chain or ring with several alcohol groups and either an aldehyde or ketone group.

**Monotrichous** A bacterial cell with a single flagellum.

**Morbidity rate** The number of persons contracting a specific disease in relation to the total population (cases per 100,000).

**Mordant** A chemical that helps a stain adhere to the cell or cell structure.

**Mortality rate** The number of deaths from a specific disease in relation to the total population.

**Most probable number (MPN)** A statistical method of measuring bacterial growth, used when samples contain too few organisms to give reliable measures by the plate-count method.

**Mother cell** A cell that has approximately doubled in size and is about to divide into two daughter cells.
*Known also as a parent cell.*

**Mucin** A glycoprotein in mucus that coats bacteria and prevents their attaching to surfaces.

**Mucociliary escalator** Mechanism involving ciliated cells that allows materials in the bronchi, trapped in mucus, to be lifted to the pharynx and spit or swallowed.

**Mucopolysaccharides** *See glycosaminoglycans.*

**Mucous membrane** A covering over those tissues and organs of the body cavity that are exposed to the exterior.
*Known also as mucosa.*

**Mucus** A thick but watery secretion of glycoproteins and electrolytes secreted by the mucous membranes.

**Multicatalytic proteinase complex (MPC)** A massive complex of proteolytic enzymes that is found in the cytosol of many eukaryotic cells and seems to function in the programmed destruction of cellular proteins.

**Multiple-tube fermentation method** Three-step method of testing for coliform bacteria in drinking water.

**Mumps** Disease caused by a paramyxovirus that is transmitted by saliva and invades cells of the oropharynx.

**Murine typhus** *See endemic typhus.*

**Muscarinic acetylcholine receptors** A class of receptors for the neurotransmitter acetylcholine that are characterized by an ability to bind the toadstool toxin muscarine. Synapses that have these receptors may be either excitatory or inhibitory. *Compare nicotinic acetylcholine receptors.*

**Mutagen** An agent that increases the rate of mutations.

**Mutation** Any inheritable change in the nucleotide sequence of genomic DNA (or genomic RNA, in the case of an RNA virus).

**Mutualism** A form of symbiosis in which two organisms of different species live in a relationship that benefits both of them.

**Myasthenia gravis** Autoimmune disease specific to skeletal muscle, especially muscles of the limbs and those involved in eye movements, speech, and swallowing.

**Mycelium** (plural: *mycelia*). In fungi, a mass of long, threadlike structures (hyphae) that branch and intertwine.

**Mycobacteria** Slender, acid-fast rods, often filamentous, include organisms that cause tuberculosis, leprosy, and chronic infections.

**Mycology** The study of fungi.

**Mycoplasmas** Very small bacteria with cell membranes, RNA and DNA, but no cell walls.

**Mycosis** (plural: *Mycoses*). A disease caused by a fungus.

**Myiasis** An infestation caused by maggots (fly larvae).

**Mycarditis** An inflammation of the heart muscle.

**Nacardioforms** Gram-positive, non-motile, pheomorphic, aerobic bacteria, often filamentous and acid-fast, include some skin and respiratory pathogens.

**NAD** Nicotinamide dinucleotide, a coenzyme that carries hydrogen atoms and electrons.

**Naked virus** A virus that lacks an envelope.

**Nanometer** (nm). Unit of measure equal to 0.000000001 m or $10^{-9}$; formerly called a millimicron (nμ).

**Narrow spectrum** The range of activity of an antimicrobial agent that attacks only a few kinds of micro-organisms.

**Nasal cavity** Part of the upper respiratory tract where air is warmed and particles are removed by hairs as they pass through.

**Nasal sinus** A hollow cavity within the skull that is lined with mucous membrane.

**Naturally acquired active immunity** When an individual is exposed to an infectious agent, often having the disease, and their own immune system responds in a protective way.

**Naturally acquired immunity** Defense against a specific disease is acquired sometime after birth, without the intervention or use of man-made products such as vaccines or gamma globulin.

**Naturally acquired passive immunity** When antibodies made by another individual are given to a host, e.g., in mother's milk, without intervention by man.

**Natural killer (NK) cell** A lymphocyte that can destroy virus-infected cells, malignant tumor cells, and cells of transplanted tissues.

**Negative (–) sense RNA** An RNA strand made up of bases complementary to those of a positive (+) sense RNA.

**Negative staining** Technique of staining the background around a specimen, leaving the specimen clear and unstained.

**Nematode** *See roundworm.*

**Neonatal herpes** Infection in infants usually with HSV-2, most often acquired during passage through a birth canal contaminated with the virus.

**Neoplasm** A localized tumor.

**Neoplastic transformation** The uncontrollable division of host cells caused by infection with a DNA tumor virus.

**Nephron** A functional unit of the kidney in which fluid from the blood is filtered.

**Nernst equation** An equation that relates the electrical potential across a membrane to the concentrations of ions on either side of the membrane.

**Nerve** A bundle of neuron fibers that relays sensory and motor signals throughout the body.

**Nervous system** The body system, comprising the brain, spinal cord, and nerves, that coordinates the body's activities in relation to the environment.

**Neurohormones** Substances that are released from neurons and modulate the behavior of target cells, which are often other neurons. Unlike neurotransmitters, they do not act strictly across a synapse. Most neurohormones are peptides.

**Neuron** A conducting nerve cell.

**Neurotoxin** A toxin that acts by disrupting nerve cell function. Fast-acting neurotoxins often act by blocking the action of an ion gate necessary for the development of an action potential.

**Neurosyphilis** Neurological damage, including thickening of the meninges, ataxia, paralysis, and insanity, that results from syphilis.

**Neurotoxin** A toxin that acts on nervous system tissues.

**Neurotransmitter** A low-molecular-weight substance that is released from an axon terminal in response to the arrival of an action potential and then diffuses across the synapse to influence the post-synaptic cell, which may be either another neuron or a muscle or gland cell.

**Neutral** Referring to a solution with a pH of 7.

**Neutralization** Inactivation of microbes or their toxins through the formation of antigen–antibody complexes.

**Neutralization reaction** An immunological test used to detect bacterial toxins and antibodies to viruses.

**Neutron** An uncharged subatomic particle in the nucleus of an atom.

**Neutrophil** A phagocytic leukocyte.

*Known also as Polymorphonuclear leukocyte, PMNL.*

**Neutrophile** An organism that grows best in an environment with a pH of 5.4–8.5.

**Nicotinic acetylcholine receptors** A class of receptors for the neurotransmitter acetylcholine that are characterized by their ability to bind nicotine. Synapses with this king of receptor are excitatory. *Compare muscarinic acetylcholine receptors.*

**Nick translation** A process in which nucleotides in one strand of a nucleic acid duplex are replaced one by one with nucleotides complementary to the other strand. The process starts at a nick in the strand and causes the location of the nick to migrate (hence the origin of the term)

**Niclosamide** An antihelminthic agent that interferes with carbohydrate metabolism.

**Nitrification** The process by which ammonia or ammonium ions are oxidized to nitrites or nitrates.

**Nitrofuran** An antibacterial drug that damages cellular respiratory systems.

**Nitrogenase** Enzyme in nitrogen-fixing bacteroids that catalyzes the reaction of nitrogen gas and hydrogen gas to form ammonia.

**Nitrogen cycle** Process by which nitrogen moves from the atmospheric through various organisms and back into the atmosphere.

**Nitrogen fixation** The reduction of atmospheric nitrogen gas to ammonia.

**Nocardiosis** Respiratory disease characterized by tissue lesions and abscesses, caused by the filamentous bacterium *Nocardia asteroids.*

**Nocturia** Nightime urination, often a result of urinary tract infections.

**Nomarski microscopy** Differential interference contrast microscopy; utilizes differences in refractive index to visualize structures producing a nearly three-dimensional image.

**Non-communicable infectious disease** Disease caused by infectious agents but not spread from one host to another.

**Non-competitive inhibitor** A molecule that attaches to an enzyme at an allosteric site (a site other than the active site), distorting the shape of the active site so that the enzyme can no longer function.

**Non-covalent interactions** All kinds of interactions between atoms and molecules that do not involve the actual sharing of electrons in a covalent bond; they include electrostatic interactions, permanent and induced dipole interactions, and hydrogen bonding.

**Non-cyclic photophosphorylation** In photosynthesis, photophosphorylation (light-dependent ATP synthesis) that is linked to a one-way flow of electrons from water through photosystems II and I and finally to NADPH; it is thus coupled to the oxidation of $H_2O$ and the reduction of $NADP^+$. *Compare cyclic photophosphorylation.*

**Non-cyclic photoreduction** The photosynthetic pathway in which excited electrons from chlorophyll are used to generate ATP and reduce NADP with the splitting of water molecules.

**Non-gonococcal urethritis (NGU)** A gonorrhealike sexually transmitted disease most often caused by *Chlamydia trachomatis* and mycoplasmas.

**Non-indigenous organism** An organism temporarily found in a given environment.

**Non-infection disease** Disease caused by any factor other than infectious agents.

**Non-self** Antigens recognized as foreign by an organism.

**Nonsense codon** A set of three bases in a gene (or mRNA) that does not code for an amino acid.

*Known also as terminator codon.*

**Nonsense mutation** A mutation that creates an abnormal stop codon and thus causes translation to terminate prematurely; the resulting truncated protein is usually nonfunctional.

**Non-specific defenses** Those host defenses against pathogens that operate regardless of the invading agent.

**Non-specific immunity** Product by general defenses, such as skin, lysozyme and complement, that protect against many different kinds of organisms rather than a specific one or two.

**Non-synchronous growth** Natural pattern of growth during the log phase in which every cell in a culture divides at some point during the generation time, but not simultaneously.

**Normal microflora** Micro-organisms that live on or in the body but do not usually cause disease.

*Known also as normal flora.*

**Northern blotting** A technique for detecting the presence of a specific RNA sequence in a cell and determining its size. The total RNA of the cell is extracted, resolved by gel electrophoresis, and blotted onto a filter. There it is incubated under annealing conditions with a radiolabeled probe for the sequence in question, and heteroduplexes of the probe with RNA are detected by radioautography.

**Nosocomial infection** An inflection acquired in a hospital or other medical facility.

**Notifiable disease** A disease that a physician is required to report to public health officials.

**N-Terminus** The end of a polypeptide chain that carries an unreacted amino group. A ribosome synthesizes a polypeptide in the direction from the N-terminus to the C-terminus.

*Known also as amino terminus. See also C-terminus.*

**Nuclear envelope** The double membrane surrounding the cell nucleus in a eukaryotic cell. It is pierced by nuclear pores that allow even quite large molecules, such as mRNAs and nuclear proteins, to enter or leave the nucleus.

**Nuclear magnetic resonance (NMR) spectroscopy** A type of spectroscopy that depends on the fact that isotope nuclei having the property of spin will resonate with specific frequencies of microwave radiation when placed in a magnetic field of given strength. The resonance energy is sensitive to the local molecular environment, so NMR spectroscopy can be used to explore molecular structure. Also, different living tissues have characteristic overall NMR spectra, which are sensitive to changes in the tissue environment. NMR can thus be used in the study of tissue metabolism and the diagnosis of disease.

**Nuclear matrix** A protein web that is left in the nucleus when histones and other weakly bound proteins are removed and most of the DNA is digested away. It is presumed to act as an organizing scaffold for the chromatin.

**Nuclear pore** An opening in the nuclear envelope that allows for the transport of materials between nucleus and cytoplasm.

**Nuclear region** Central location of DNA, RNA, and some proteins in bacteria; not a true nucleus.

*Known also as nucleoid.*

**Nuclease** An enzyme that cleaves nucleic acids.

**Nucleic acids** Long polymers of nucleotides that encode genetic information and direct protein synthesis.

**Nucleocapsid** The nucleic acid and capsid of a virus.

**Nucleoid** The large, circular DNA molecule of a prokaryotic cell, along with its associated proteins; also sometimes called the bacterial chromosome. It is supercoiled and forms a dense mass within the cell, and the term Nucleoid is often used for the cell region occupied by this mass.

*See nuclear region.*

**Nucleolus** (plural: *Nucleoli*). Area in the nucleus of a eukaryotic cell that contains RNA and serves as the site for the assembly of ribosomes.

**Nucleoplasm** The semifluid portion of the cell nucleus in eukaryotic cells that is surrounded by the nuclear envelope.

**Nucleoside** A molecule that, upon complete hydrolysis, yields 1 mol per mol of a purine or pyrimidine base and a sugar.

**Nucleotide** An organic compound consisting of a nitrogenous base, a five-carbon sugar, and one or more phosphate groups.

**Nucleosome** The first-order structural unit for the packing of DNA in chromatin, consisting of 146 bp of DNA wrapped 1.75 times around a core octamer of histone proteins. Successive nucleosomes are connected by stretches of “linker” DNA.

**Nucleotide** A molecule that, upon complete hydrolysis, yields at least 1 mol per mol of a Purine or pyrimidine base, a sugar, and inorganic phosphate.

**Nucleus** The membrane-bound structure in a eukaryotic cell that contains the chromosomal genetic material and associated components. It is also the place where RNA molecules are processed and ribosomes are assembled.

**Null cells** Undifferentiated cells that cannot be identified as either B cells or T cells; include the natural killer (NK) cells.

**Numerical aperature** The widest cone of light that can enter a lens.

**Numerical taxonomy** Comparison of organisms based on quantitative assessment of a large number of characteristics.

**Nutritional complexity** The number of nutrients an organism must obtain to grow.

**Nutritional factor** One factor that influences both kinds of organisms found in an environment and their growth.

**Objective lens** Lens in a microscope closest to the specimen that creates an enlarged image of the object viewed.

**Obligate** Requiring a particular environmental condition.

**Obligate aerobe** A bacterium that must have free oxygen to grow.

**Obligate anaerobe** A bacterium that is killed by free oxygen.

**Obligate intracellular parasite** An organism or virus that can live or multiply only inside a living host cell.

**Obligate parasite** A parasite that must spend some or all of its life cycle in or on a host.

**Obligate psychrophile** An organism that cannot grow at temperatures about 20°C.

**Obligate thermophile** An organism that can grow only at temperatures above 37°C.

**Ocular lens** Lens in the microscope that further magnifies the image creased by the objective lens.

**Ocular micrometer** A glass disk with an inscribed scale that is placed inside the eyepiece of a microscope; used to measure the actual size of an object being viewed.

**Okazaki fragment** One of the short, discontinuous DNA segments formed on the lagging strand during DNA replication.

**Okazaki fragments** The discontinuous stretches in which the lagging strand is initially synthesized during DNA replication; these fragments are later joined to form a continuous strand.

**Onchocerciasis** Ana eye disease caused by the filarial larvae of the nematode *Onchocerca volvulus*, transmitted by blackflies, common in Africa and Central America. *Known also as river blindness.*

**Oncogene** A gene that, in a mutated version, can help to transform a normal cell to a cancer cell. Many oncogene codes for mutant proteins that are involved in the reception and transduction of growth factor signals. A cancer-causing gene.

**Oncoprotein** The protein product of an oncogene.

**ONPG and MUG test** Water purity test that relies on the ability of coliform bacteria to secrete enzymes that convert a substrate into a product that can be detected by a color change.

**Oomycota** *see water mold.*

**Open-promoter complex** A complex between RNA polymerase holoenzyme and a promoter that has undergone initial unwinding (has “opened”) preparatory to the start of transcription. It is preceded by a much less stable *closed-promoter complex*, in which the promoter has not unwound, that may either fall apart or proceed to an open-promoter complex.

**Open reading frame** A sequence within a messenger RNA that is bounded by start and stop codons and can be continuously translated. It represents the coding sequence for a polypeptide.

**Operator** A DNA site where a repressor protein binds to block the initiation of transcription from an adjacent promoter.

**Operon** (1) A sequence of a closely associated genes that includes both structural genes and regulatory sites that control transcription. (2) A set of contiguous prokaryotic structural genes that are transcribed as a unit, along with the adjacent regulatory elements that control their expressions.

**Opthalmia neonatorium** Pyrogenic infection of the eyes caused by *Neisseria Gonorrhoeae. Known also as conjunctivitis of the newborn.*

**Opportunist** A species of resident or transient microbiota that does not ordinarily cause disease but can do so under certain conditions.

**Opsonin** An antibody that promotes phagocytosis when bound to the surface of a micro-organism.

**Opsonization** The process by which micro-organisms are rendered more attractive to phagocytes by being coated with antibodies (opsonins) and C3b complement protein. *Known also as immune adherence.*

**Optical isomers** *See enantiomers.*

**Optical microscope** *See compound light microscope.*

**Optimum pH** The pH at which microorganisms grow best.

**Orbivirus** Type of virus that causes colorado tick fever.

**Orchitis** Inflammation of the testes; a symptom of mumps in postpubertal males.

**Organelle** An internal membrane-enclosed structure found in eukaryotic cells.

**Organelles** Membrane-bound compartments in the cytoplasm of eukaryotic cells. Each kind of organelle carries out a specific set of functions. Examples are mitochondria, chloroplasts, and nuclei.

**Organic chemistry** The study of compounds that contain carbon.

**Ornithosis** Disease with pneumonialike symptoms, caused by *Chlamydia psittaci* and acquired from birds (previously called psittacosis and parrot fever).

**Oroyo fever** One form of bartonellosis; an acute fatal fever with severe anemia. *Known also as carrion's disease.*

**Orthomyxovirus** A medium-sized, enveloped RNA virus that varies in shape from spherical to filamentous and has an affinity for mucus.

**Osmosis** A special type of diffusion in which water molecules move from an area of higher concentration to one of lower concentration across a selectively permeable membrane.

**Osmotic pressure** The pressure required to prevent the net flow of water molecules by osmosis.

**Otitis externa** Infection of the external ear canal.

**Otitis media** Infection of the middle ear.

**Outer membrane** A bilayer membrane, forming part of the cell wall of Gram-negative bacteria.

**Ovarian follicle** An aggregation of cells in the ovary containing an ovum.

**Ovary** In the female, one of a pair of glands that produces ovarian follicles, which contain an ovum and hormone-secreting cells.

**Oxidase** An enzyme that catalyzes the oxidation of a substrate with oxygen as the electron acceptor.

**Oxidation** The loss of electrons and hydrogen atoms.

**Oxidative phosphorylation** (1) Process in which the energy of electrons is captured in high-energy bonds as phosphate groups combine with ADP to form ATP. (2) The phosphorylation of ADP to ATP that occurs in conjunction with the transit of electrons down the electron transport chain in the inner mitochondrial membrane.

**Oxygenase** An enzyme that catalyzes the incorporation of oxygen into a substrate.

**Palindrome** With respect to DNA, a segment in which the sequence is the same on one strand read right to left as on the other strand read left to right; thus, a back-to-back pair of inverted repeats.

**Pandemic** An epidemic that has become worldwide.

**Papilloma** *See wart.*

**Papovavirus** A small, naked DNA virus that causes both benign and malignant warts in humans, some types cause cervical cancer.

**Parainfluenza** Viral disease characterized by nasal inflammation, pharyngitis, Bronchitis, and sometimes pneumonia, mainly in children.

**Parainfluenza virus** Virus that initially attacks the mucous membranes of the nose and throat.

**Paramyxovirus** A medium-sized, enveloped RNA virus that has an affinity for mucus.

**Parasite** An organism that lives in or on, and at the expense of, another organism, the host.

**Parasitism** A symbiotic relationship in which one organism, the parasite, benefits from the relationship, whereas the other organism, the host, is harmed by it.

**Parasitology** The study of parasites.

**Parfocal** For a microscope, remaining in approximate focus when minor focus adjustments are made.

**Paroxysmal stage** State of whooping cough in which mucus and masses of bacterial fill the airway, causing violet coughing.

**Partial molar free energy** *See chemical potential.*

**Partition coefficient (*K*)** A coefficient that indicates how a particular substance will distribute itself between two media if allowed to diffuse to equilibrium between them; it is equal to the ratio of the solubilities of the substance in the two media.

**Parvovirus** A small, naked DNA virus.

**Passive immunity** Immunity created when ready-made antibodies are introduced into, rather than created by, an organism.

**Passive immunization** The process of inducing immunity by introducing ready-made antibodies into a host.

**Passive transport** With respect to membrane transport, the movement of a substance across a biological membrane by molecular diffusion through the lipid bilayer. *Compare active transport, facilitated transport.*

*Known also as Passive Diffusion.*

**Pasteur Effect** The inhibition of glycolysis by oxygen; discovered by Pasteur when he found that aerobic yeast cultures metabolize glucose relatively slowly.

**Pasteurella-Haemophilus Group** Very small Gram-negative bacilli and coccobacilli that lack flagella and are nutritionally fastidious.

**Pasteurization** Mild heating to destroy pathogens and other organisms that cause spoilage.

**Pathogen** An organism capable of causing disease in its host.

**Pathogenicity** The capacity to produce disease.

**Pediculosis** Lice infestation, resulting in reddened areas at bites, dermatitis, and itch.

**Pellicle** (1) A thin layer of bacteria adhering to the air-water interface of a broth culture by their attachment pili (2) A strengthened plasma membrane of a protozoan cell (3) Film over the surface of a tooth at the beginning of plaque formation.

**Pelvic Inflammatory Disease (PID)** An infection of the pelvic cavity in females, caused by any of several organisms including *Neisseria Gonorrhoeae* and *Chlamydia.*

**Penetration** The entry of the virus (or its nucleic acid) into the host cell in the replication process.

**Penicillin** An antibacterial agent that inhibits cell wall synthesis.

**Penis** Part of the male reproductive system used to deliver semen to the female reproductive tract during sexual intercourse.

**Peptide bond** A covalent bond joining the amino group of one amino acid and the carboxyl group of another amino acid. It consists of an amide bond between the $\alpha$-carboxyl group of one amino acid and the $\alpha$-amino group of the next.

**Peptidoglycan** A structural polymer in the bacterial cell wall that forms a supporting net. *Known also as murein.*

**Peptidyltransferase** During ribosomal polypeptide synthesis, the enzyme complex that transfers the polypeptide chain from the tRNA in the P site to the amino acid carried by the tRNA in the A site, thereby adding another amino acid to the chain, the complex is an integral part of the large ribosomal subunit.

**Peptococci** Anerobes that form pairs, tetrads, or irregular clusters, they lac both catalase and the enzyme to ferment lactic acid.

**Peptone** A product of enzyme digestion of proteins that contains many small peptides; a common ingredient of a complex medium.

**Perforin** A cytotoxin produced by cytotoxic T cells that bores holes in the plasma membrane of infection host cells.

**Pericarditis** An inflammation of the protective membrane around the heart.

**Periodontal disease** A combination of gum inflammation, decay of cementum, and erosion of periodontal ligaments and bone that support teeth.

**Periodontitis** A chronic periodontal disease that affects the bone and tissue that supports the teeth and gums.

**Peripheral nervous system** All nerves outside the central nervous system.

**Periplasm** Those substances (enzymes, transport proteins) located in the periplasmic space of Gram-negative bacteria or in the older cell wall of Gram-positive bacteria.

**Periplasmic enzyme** An exoenzyme produced by Gram-negative organisms, which acts in the periplasmic space.

**Periplasmic space** The space between the cell membrane and the outer membrane in Gram-negative bacteria that is filled with periplasm.

**Peritrichous** Having flagella distributed all over the surface of a bacterial cell.

**Permanent dipole** In chemistry, a molecule that has a permanent, asymmetric distribution of charge such that one end is negative and the other end positive. The water molecule is an example. The oxygen end has a partial negative charge, and the hydrogen end has a partial positive charge.

**Permanent parasite** A parasite that remains in or on a host once it has invaded the host.

**Permease** An enzyme complex involved in active transport through the cell membrane.

**Peroxisome** (1) An organelle filled with enzymes that in animal cells oxidate amino acids and in plant cells oxidize fats. (2) A small vesicular organelle that specializes in carrying out cellular reactions involving the transfer of hydrogen from a substrate to $O_2$. These reactions produce the by-product $H_2O_2$, which is split to $H_2O$ and $O_2$ by the peroxisomal enzyme catalase.

**Persistent viral infection** The continued production of viruses within the host over many months or years.

**Pertussis** *See whooping cough.*

**PEST sequences** A family of amino acid sequences that have been found on cellular proteins that undergo rapid turnover; they may target proteins for rapid proteolysis. They consist of a region about 12–60 residues long that is rich in praline, glutamate, serine, and threonine (P, E, E, and T in the one-letter abbreviation system).

**Petechia** (plural: *petechiae*). A pinpoint-size hemorrhage, most common in skin folds, that often occurs in rickettsial diseases.

**pH** A means of expressing the hydrogen-ion concentration, and thus the acidity, of a solution.

**Phage** *See bacteriophage.*

**Phage typing** Use of bacteriophages to determine similarities or differences among different bacteria.

**Phagocyte** A cell that ingests and digests foreign particles.

**Phagocytosis** Ingestion of solids into cells by means of the formation of vacuoles.

**Phagolysosome** A structure resulting from the fusion of lysosomes and a phagosome.

**Phagosome** A vacuole that forms around a microbe within the phagocyte that engulfed it.

**Pharmaceutical microbiology** A special branch of industrial microbiology concerned with the manufacture of products used in treating or preventing disease.

**Pharyngitis** An infection of the pharynx, usually caused by a virus but sometimes bacterial in origin, a sore throat.

**Pharnyx** The throat, a common passageway for the respiratory and digestive systems with tubes connecting to the middle ear.

**Phase-contrast microscopy** Use of microscope having a condenser that accentuates small differences in the refractive index of various structures within the cell.

**Phenol coefficient** A numerical expression for the effectiveness of a disinfectant relative to that of phenol.

**Phenotype** The specific observable characteristics displayed by an organism. It results from the interaction of the organism's genetic makeup with the environment. *Compare genotype.*

**Pheromones** Intercellular mediator compounds that are released from one organism and influence the metabolism or behavior of another organism, usually of the same species. Sex attractants, which elicit reproductive behavior in suitable recipients, are the examples.

**Phlebovirus** Bunyavirus that is carried by the sandfly *Phlebotomus papatsii.*

**Phorbol esters** A group of natural substances that resemble *sn*-1,2-diacyglycerol (DAG) in part of their structure and can act as tumor promoters. This effect suggests that the DAG second-messenger system may be involved in growth factor action.

**Phosphodiester link** The linkage that connects the nucleotide monomers in a nucleic acid. It consists of a phosphate residue that links the sugar moieties of successive monomers by forming an ester bond with the 5′ carbon of one sugar and the 3′ carbon of the next.

**Phospholipid** A lipid composed of glycerol, two fatty acids, and a polar head group; found in all membranes.

**Phosphorescence** Continued emission of light by an object when light rays no longer strike it.

**Phosphorus cycle** The cyclic movement of phosphorous between inorganic and organic forms.

**Phosphorylation** The addition of a phosphate group to a molecule, often from ATP, generally increasing the molecule's energy.

**Phosphotransferase system** A mechanism that uses energy from phosphorenolyruvate to move sugar molecules into cells by active transport.

**Photoautotroph** An autotroph that obtains energy from light.

**Photoheterrotroph** A heterotroph that obtains energy from light.

**Photolysis** Process in which light energy is used to split water molecules into protons, electrons, and oxygen molecule.

**Photophosphorylation** Phosphorylation of ADP to ATP that depends directly on energy from sunlight. The light energy is captured by a pigment such as chlorophyll and is passed in the form of excited electrons to an electron transport chain; the electron transport chain uses energy from the electrons to create a proton gradient across a membrane, which drives the synthesis of ATP.

**Photoproducts** The products that result when light energy causes a chemical reaction to occur in a substance. With respect to DNA, the term refers to the types of damaged DNA that can be caused by UV irradiation.

**Photoreactivation** A DNA repair process in which an enzyme uses light energy to break cyclobutane pyrimidine dimers created by UV irradiation and to restore the correct bonding.

*See light repair.*

**Photorespiration** The cycle of reactions that occurs in place of the Calvin cycle when the photosynthetic enzyme rubisco adds $O_2$ rather than $CO_2$ to ribulose bisphosphate carboxylase. It takes place partly in chloroplasts, partly in peroxisomes, and partly in mitochondria; it expends ATP energy and loses a previously fixed $CO_2$ molecule in the process of regenerating the Calvin cycle intermediate 3-phosphoglycerate.

**Photosynthesis** The capture of energy from light and use of this energy to manufacture carbohydrates from carbon dioxide.

**Photosystem** A structural unit in a cellular membrane that captures light energy and converts a portion of it to chemical energy. The photosynthesis practiced by plants, algae and cyanobacteria involves two types of photosystem, both of which capture energy in the form of high-energy electrons and transduce it via an electron transport chain.

**Phototaxis** A non-random movement of an organism toward or away from light.

**Phylogenetic** Pertaining to evolutionary relationships.

**Physical factor** Factor in the environment, such as temperature, moisture, pressure, or radiation, that influences the kinds of organisms found and their growth.

**Picornavirus** A small, naked RNA virus; different genera are responsible for polio, the common cold, and hepatitis.

**Pilus** (plural: *pili*). A tiny hollow projection used to attach bacteria to surfaces (attachment pilus) or for conjugation (conjugation pilus).

**Pimple** *See folliculitis.*

**Pinna** Flap-like external structure of the ear.

**Pinworm** A small roundworm, *Enterobius vermicularis*, that causes gastrointestinal disease.

**Placebo** An unmedicated, usually harmless substance given to a recipient as a substitute for or to test the efficacy of a medication or treatment.

**Plantae** The kingdom of organisms to which all plants belong.

**Plaque** (1) A clean area in a bacterial lawn culture where viruses have lysed cells. (2) A clear area that is formed by a local phage infection in a lawn of cultured bacteria in a Petri dish; for purposes of experimentation, it is the phage equivalent of a bacterial colony.

**Plaque assay** A viral assay used to determine viral yield by culturing viruses on a bacterial lawn and counting plaques.

**Plaque-forming unit** A plaque counted on a bacterial lawn that gives only an approximate number of phages present, because a given plaque may have been due to more than one phage.

**Plasma** Liquid portion of the blood, excluding the formed elements.

**Plasma cell** A large lymphocyte differentiated from a B cell that synthesizes and releases antibodies like those on the B cell surface.

**Plasma membrane** A selectively permeable lipoprotein bilayer that forms the boundary between the cytoplasm of a eukaryotic cell and its environment.

*Known also as cell membrane.*

**Plasmid** A small, circular, independent replicating piece of DNA in a cell that is not part of its chromosome and can be transferred to another cell.

*Known also as extrachromosomal DNA.*

**Plasmids** Small, extrachromosomal circular DNA molecules found in many bacteria, they replicate independently of the main chromosome and may occur in multiple copies per cell.

**Plasmodial slime mold** Funguslike protest consisting of a multinucleate amoeboid mass, or plasmodium, that moves about slowly and phagocytizes dead matter.

**Plasmodium** A multinucleate mass of cytoplasm that forms one of the stages in the life cycle of a plasmodial slime mold.

**Plasmogamy** Sexual reproduction in fungi in which haploid gametes unite and their cytoplasm mingles.

**Plasmolysis** Shrinking of a cell, with separation of the cell membrane from the cell wall, resulting from loss of water in a hypertonic solution.

**Platelet** A short-lived fragment of large cells called megakaryocytes, important component of the blood-clotting mechanism.

**Pleomorphism** Phenomenon in which bacteria vary widely in form, even within a single culture under optimal conditions.

**Pleura** Serious membrane covering the surfaces of the lungs and the cavities they occupy.

**Pleurisy** Inflammation of pleural membranes that causes painful breathing often accompanies lobar pneumonia.

**Plus strand** In viral genomes, a nucleic acid strand that can serve as mRNA or (for DNA strand) that is homologous to one that can; as distinct from the complementary (minus) strand. Most viruses with single-strand genomes package only the plus or minus strand in virions; the other strand is made transiently during replication. *Compare minus strand.*

**Pneumocystis pneumonia** A fungal respiratory disease caused by *Pneumocystis carinii.*

**Pneumonia** An inflammation of lung tissue caused by bacteria, viruses, or fungi.

**Pneumonic plague** Usually fatal form of plague transmitted by aerosol droplets from a coughing patient.

**Point mutation** Mutation in which one base is substituted for another at a specific location in a gene.

**Polar compound** A molecule with an unequal distribution of charge due to an unequal sharing of electrons from between atoms.

**Poliomyelitis** Disease caused by any of several strains of polioviruses that attack motor neutrons of the spinal cord and brain.

**Polyacrylamide gel electrophoresis (PAGE)** A technique for separating proteins from a cell based in their molecular size.

**Polyene** An antifungal agent that increases membrane permeability.

**Polymer** (1) A large molecule that is made by linking together prefabricated molecular units (monomers) that are similar or identical to each other. The number of monomers in a polymer may range up to millions. (2) A long chain of repeating subunits.

**Polymerase chain reaction (PCR)** A technique that rapidly produces a billion or more identical copies of a DNA fragment without needing a cell.

**Polymyxin** An antibacterial agent that disrupts the cell membrane.

**Polynucleotide** A chain of many nucleotides.

**Polypeptide** A chain of many amino acids.

**Polyribosome** A long chain of ribosomes attached at different points along an mRNA molecule.
*Known also as polysome.*

**Polysaccharide** A carbohydrate formed when many monosaccharides are linked together by glycosidic bonds.

**Polytene chromosome** An extra-thick chromosome that includes many parallel copies of the original DNA molecule; it is produced by repeated rounds of DNA replication without separation of the resulting copies. Polytene chromosomes are found in various cell types, notably *Drosophilia* salivary gland cells; they are useful in chromosome mapping because they are large and because the genes on the strands are arranged in strict register.

**Pontiac fever** A mild variety of legionellosis.

**Porin** A protein in the outer membrane of Gram-negative bacteria that non-selectively transports polar molecules into the periplasmic space.

**Portal of entry** A site at which micro-organisms an gain access to body tissues.

**Portal of exit** A site at which micro-organisms can leave the body.

**Positive chemotaxis** Movement of an organism toward a chemical.

**Positive (+) sense RNA** An RNA strand that encodes information for making proteins needed by a virus.

**Potable water** Water that is fit for human consumption.

**Pour plate** A plate containing separate colonies and used to prepare a pure culture.

**Pour plate method** Method used to prepare pure cultures using serial dilutions, each of which is mixed with melted agar and poured into a sterile Petri plate.

**Poxvirus** DNA virus that is the largest and most complex of all viruses.

**Precipitation reaction** Immunological test in which antibodies called precipitans react with antigens to form latticelike networks of molecules that precipitate from solution.

**Precipitin test** Immunological test used to detect antibodies that is based on the precipitation reaction.

**Prediction** The expected outcome if a hypothesis is correct.

**Preserved culture** A culture in which organisms are maintained in a dormant state.

**Presumptive test** First stage of testing in multiple-tube fermentation in which gas production in lactose broth provides presumptive evidence that coliform bacteria are present.

**Prevalence rate** The number of people infected with a particular disease at any one time.

**Primaquine** An antiprotozoan agent that interferes with a protein synthesis.

**Primary atypical pneumonia** A mild form of pneumonia with insidious onset. *Known also as mycoplasma pneumonia and walking pneumonia.*

**Primary cell culture** A culture that comes directly from an animal and is not subcultured.

**Primary immunodeficiency disease** A genetic or developmental defect in which T cells or B cells are lacking or non-functional.

**Primary infection** An initial infection in a previously healthy person.

**Primary response** Humoral immune response that occurs when an antigen is first recognized by host B cells.

**Primary structure** For a nucleic acid or a protein, the sequence of the bases or amino acids in the polynucleotide or polypeptide. *Compare quaternary structure second structure tertiary structure.*

**Primary treatment** Physical treatment to remove solid wastes from sewage.

**Primer** A short piece of DNA or RNA that is base-paired with a DNA template strand and provide a free 3′ –OH end from which a DNA polymerase can extend a DNA strand. Also refers to DNA oligomers used in the polymerase chain reaction.

**Primosome** An enzyme complex that is located in the replication fork during DNA replication; it synthesizes the RNA primers on the lagging strand and also participates in unwinding the parental DNA helix.

**Prion** An exceedingly small infectious particle consisting of protein without any nucleic acid.

**Probe** A single-stranded DNA fragment that has a sequence of bases that can be used to identify complementary DNA base sequences.

**Processivity** For a DNA or an RNA polymerase, the average number of nucleotides incorporated per event of binding between the polymerase and a 3′ primer terminus. It describes the tendency of a polymerase to remain bound to a template.

**Prodromal phase** In an infectious disease, the short period during which non-specific symptoms such as malaise and headache sometimes appear.

**Prodrome** A symptom indicating the onset of a disease.

**Producer** Organism that captures energy from the sun and synthesizes food.
*Known also as autotroph.*

**Product** The material resulting from an enzymatic reaction.

**Productive infection** Viral infection in which viruses enter a cell and produce infectious progeny.

**Proglottid** One of the segments of a tapeworm, containing the reproductive organs.

**Progressive multifocal leukoencephalopathy** Disease caused by the JC polyomavirus with symptoms including mental deterioration, limb paralysis, and blindness.

**Prokaryote** Micro-organism that lacks a cell nucleus and membrane-enclosed internal structures, all bacteria in the kingdom Monera (Prokaryotae) are prokaryotes.

**Prokaryotes** Primitive single-celled organism that are not compartmentalized by internal cellular membranes; the eubacteria and archaebacteria. *Compare eukaryotes.*

**Prokaryotic cell** A cell that lacks a cell nucleus; includes all bacteria.

**Promoter** A DNA sequence that can bind RNA polymerase, resulting in the initiation of transcription.

**Propagated epidemic** An epidemic that arises from person-to-person contacts.

**Prophage** An inactive phage genome that is present in a bacterial cell and its progeny. It is integrated into the host chromosome.

**Propionibacteria** Pleomorphic, irregular, non-sporing, Gram-positive rods.

**Prostaglandin** A reaction mediator that acts as a cellular regulator, often intensifying pain.

**Prostaglandins** A family of compounds that are derived from certain long-chain unsaturated fatty acids (particularly arachidonic acid) by a cyclooxygenase pathway and that function as local hormones.

**Prostate gland** The gland located at the beginning of the male urethra whose milky fluid discharge forms a component of semen.

**Prostatitis** Inflammation of the prostate gland.

**Prosthetic group** A metal ion or small molecule (other than an amino acid) that forms part of a protein in the protein's native state and is essential to the protein's functioning; its attachment to the protein may be either covalent or non-covalent.

**Proteases** Enzymes that cleave peptide bonds in a polypeptide. Many show specificity for a particular amino acid sequence.

**Proteasome** A large, ATP-dependent protease complex that is found in the cytosol of cells and is involved in the selective degradation of short-lived cytoplasmic proteins.

**Protein** A polymer of amino acids joined by peptide bonds.

**Protein profile** A technique for visualizing the proteins contained in a cell; obtained by the use of polyacrylamide gel electrophoresis.

**Proteoglycans** Glycoproteins in which carbohydrate is the dominant element. The carbohydrate is in the form of glycosamminoglycan polysaccharides, which are connected to extended core polypeptides to form huge, feathery molecules. Proteoglycans are important components of the intercellular. matrix.

**Protista** The kingdom of organisms that are unicellular but contain internal organelles typical of the eukaryotes.

**Protist** A unicellular eukaryotic organism that is a member of the kingdom Protista.

**Protofilaments** The 13 linear columns of tubulin units that can be visualized in the structure of a microtubule; they result because each turn of the microtubule helix contains exactly 13 tubulin units. Each protofilament consists of alternating $\alpha$ and $\beta$ tubulin subunits.

**Proton** A positively charged subatomic particle located in the nucleus of an atom.

**Proton motive force (pmf)** An electrochemical $H^+$ gradient that is set up across a cellular membrane by membrane-bound proton pumps, such as the ones in the inner mitochondrial membrane or thylakoid membrane. As the protons flow back down their gradient across the membrane, they can drive processes such as ATP synthesis.

**Proton pumping** The active pumping of protons across a cellular membrane to form a proton gradient. For example, the electron transport chains of the inner mitochondrial and thylakoid membranes incorporate proton pumps, which create the proton gradient that powers the ATP synthases of these membranes.

**Proto-oncogene** A normal gene that can cause cancer in uncontrolled situations; often the normal gene comes under the control of a virus.

**Protoplast** A Gram-positive bacterium from which the cell wall has been removed.

**Protoplast fusion** A technique of genetic engineering in which genetic material is combined by removing the cell walls of two different types of cells and allowing the resulting protoplasts to fuse.

**Prototroph** A normal, non-mutant organism.

*Known also as wild type.*

**Protozoa** (singular: *protozoan*). Single-celled, microscopic, animallike protests in the kingdom Protista.

**Provirus** Viral DNA that is incorporated into a host-cell chromosome.

**Pseudocoelom** A primitive body cavity, typical of nematodes, that lacks the complete lining found in higher animals.

**Pseudocyst** An aggregate of trypanosome protozoa that forms in lymph nodes in Chagas' disease.

**Pseudogenes** Non-transcribed stretches of DNA that bear a strong sequence similarity to functioning genes and obviously arose from them during evolution. Many gene families contain pseudogene members.

**Pseudomembrane** A combination of bacilli, damaged epithelial cells, fibrin, and blood cells resulting from infection with diphtheria that can block the airway, causing suffocation.

**Pseudomonads** Aerobic motile rods with polar flagella.

**Paeudoplasmodium** A multicellular mass composed of individual cellular slime mold cells that have aggregated.

**Pseudopodium** A temporary footlike projection of cytoplasm associated with amoeboid movement.

**Psittacosis** *See ornithosis.*

**Psychrophile** A cold-loving organism that grows best at temperatures of 15–20°C.

**Puerperal fever** Disease caused by β-hemolytic streptococci, which are normal vaginal and respiratory microbiota that can be introduced during child delivery by medical personnel.

*Known also as childbed fever or puerperal sepsis.*

**Pulsed field gel electrophoresis** A type of gel electrophoresis in which the orientation of the electric field is charged periodically. This technique makes it possible to separate very large DNA molecules, up to the size of whole chromosomes.

**Pure culture** A culture that contains only a single species of organism.

**Purine** The nucleic acid bases adenine and guanine.

**Pus** Fluid formed by the accumulation of dead phagocytes, the material they have ingested, and tissue debris.

**Pustule** *See folliculitis.*

**Pyelonephritis** Inflammation of the kidneys.

**Pyoderma** A pus-producing skin infection caused by staphylococci, streptococci, and corynebacteria, singly or in combination.

**Pyrimidine** Any of the nucleic acid bases thymine, cytosine, and uracil.

**Pyrogen** A substance that acts on the hypothalamus to set the body's "thermostat" to a higher-than-normal temperature.

**Q Fever** Pneumonialike disease caused by *Coxiella burnetii*, a rickettsia that survives long periods outside cells and can be transmitted aerially as well as by ticks.

**Quantum efficiency (*Q*)** With respect to photosynthesis, the ratio of oxygen molecules released to photons absorbed.

**Quarantine** The separation of human or animals from the general population when they have a communicable disease or have been exposed to one.

**Quaternary ammonium compound (quat)** A cationic detergent that has four organic groups attached to a nitrogen atom.

**Quaternary structure** (1) The three-dimensional structure of a protein molecule formed by the association of two or more polypeptide chains. (2) For a protein, the level of structure that results when separate, folded polypeptide chains (subunits) associate in a specific way to produce a complete protein. *Compare primary structure, secondary structure tertiary structure.*

**Quinine** An antiprotozoan agent used to treat malaria.

**Quinolone** A bactericidal agent that inhibits DNA replication.

**Quinone** A non-protein, lipid-soluble electron carrier in oxidative phosphorylation. *Known also as coenzyme Q.*

**Rabies** A viral disease that affects the brain and nervous system with symptoms including hydrophobia and aerophobia; transmitted by animal bites.

**Rabies virus** An RNA-containing rhabdovirus that is transmitted through animal bites.

**Rad** A unit of radiation energy absorbed per gram of tissue.

**Radial immunodiffusion** Serological test used to provide a quantitative measure of antigen or antibody concentration by measuring the diameter of the ring of precipitation around an antigen.

**Radiation** Light rays, such as X-rays and ultraviolet rays, that can act as mutagens.

**Radioautography** A technique in which an item containing radioactively labeled elements (for example, a tissue slice or a chromatography gel) is laid against a photographic film; the radioactivity exposes the film to form an image of the labeled elements. Also called autoradiography.

**Radioimmunoassay (RIA)** Technique that uses a radioactive anti-antibody to detect very small quantities of antigens or antibodies.

**Radioisotope** Isotope with unstable nuclei that tends to emit subatomic particles and radiation.

**Ramachandran plot** A plot that constitutes a map of all possible backbone configurations for an amino acid in a polypeptide. The axes of the plot consist of the rotation angles of the two backbone bonds that are free to rotate ($\phi$ and $\psi$, respectively); each point $\phi, \psi$ on the plot thus represents a conceivable amino acid backbone configuration.

**Random coil** Refers to a linear polymer that has no secondary or tertiary structure but instead is wholly flexible with a randomly varying geometry. This is the state of a denatured protein or nucleic acid.

**Rat bite fever** A disease caused by *Streptobacillus moniliformis* transmitted by bites from wild and laboratory rats.

**Rate constant** With respect to chemical reactions, a constant that relates the reaction rate for a particular reaction to substrate concentrations.

**Rate equation** An equation, such as the Michaelis–Menten equation that relates velocity of an enzyme-catalyzed reaction to measurable parameters.

**Reactant** Substance that takes part in a chemical (enzymatic) reaction.

**Reaction center** In photosynthesis, a specific pair of chlorophyll molecules in a photosystem that collect light energy absorbed by other chlorophyll molecules and pass it to an electron acceptor, normally the first compound of an electron transport chain.

**Reactive oxygen species (ROS)** Oxygen species intermediate in oxidation level between $O_2$ and $H_2O$, which are more reactive than $O_2$; ROS includes superoxide, peroxide, peroxynitrite, and hydroxyl radical.

**Reagin** Older name for immunoglobulin E (IgE); very important in allergies.

**Receptor** A protein that binds selectively to a specific molecule (such as an intercellular mediator or antigen) and initiates a biological response.

**Recognition helix** In a helix-turn-helix DNA binding motif, the $\alpha$-3 helix, which fits deep in the major groove and is responsible for the sequence specificity of binding.

**Recombinant DNA** DNA combined from two different species by restriction enzymes and ligases.

**Recombinant DNA molecule** A DNA molecule that includes segments from two or more precursor DNA molecules.

**Recombination** (1) The combining of DNA from two different cells, resulting in a recombinant cell. (2) A process in an organism in which two parent DNA molecules give rise to daughter DNA that combines segments from both parent molecules. It may involve the integration of one DNA molecule into another, the substitution of a DNA segment for a homologous segment on another DNA molecule, or the exchange of homologous segments between two DNA molecules.

**Redia** The development stage of the fluke immediately following the sporocyst stage.

**Reducing equivalent** An amount of a reducing compound that donates the equivalent of 1 mol of electrons in an oxidation–reduction reaction. The electrons may be expressed in the form of hydrogen atoms.

**Reduction** The gain of electrons and hydrogen atoms.

**Reference culture** A preserved culture used to maintain an organism with its characteristics ad originally defined.

**Reflection** The bouncing of light off an object.

**Refraction** The bending of light as it passes from one medium to another medium of different density.

**Regulator gene** Gene that controls the expression of structural genes of an operon through the synthesis of a repressor protein.

**Regulatory site** The promotor and operator regions of an operon.

**Regulon** A group of unlinked (nonadjacent) genes that are all regulated by a common mechanism.

**Relapsing fever** Disease caused by various species of *Borrelia*, most commonly by *B recurrentis*; transmitted by lice.

**Release** The exit from the host cell of new virions, which usually kills the host cell.

**Release factors** Independent protein factors that are necessary participants in the release of a finished polypeptide chain from a ribosome.

**Rennin** An enzyme from calves' stomachs used in cheese manufacture.

**Reovirus** A medium-sized RNA virus that has a double-capsid with no envelope; causes upper respiratory and gastrointestinal infections in humans.

**Replica plating** A technique used to transfer colonies from one medium to another.

**Replication** Process by which an organism or structure (especially a DNA molecule) duplicates itself.

**Replication cycle** The series of steps of virus replication in a host cell.

**Replication fork** A site at which the two strands of the DNA double helix separate during replication and new complementary DNA strands form.

**Replicon** A unit in the genome that consists of an origin of replication and all the DNA that is replicated from that origin.

**Repressor** In an operon it is the protein that binds to the operator, thereby preventing transcription of adjacent genes.

**Repressor protein** Substance produced by host cells that keeps a virus in an inactive state and prevents the infections of the cell by another phage.

**Reservoir host** An infected organism that makes parasites available for transmission to other hosts.

**Reservoir of infection** Site where micro-organisms can persist and maintain their ability to infect.

**Resident microflora** Species of micro-organisms that are always present on or in an organism.

**Resistance** The ability of a micro-organism to remain unharmed by an antimicrobial agent.

**Resistance (R) gene** A component of a resistance plasmid that confers resistance to a specific antibiotic or to a toxic metal.

**Resistance (R) plasmid** A plasmid that carries genes that provide resistance to various antibiotics or toxic metals.

*Known also as R factor.*

**Resistance transfer factor (RTF)** A component of a resistance plasmid that implements transfer by conjugation of the plasmid.

**Resolution** The ability of an optical device to show two items as separate and discrete entities rather than a fuzzily overlapping image.

**Resolving power** A numerical measure of the resolution of an optical instrument.

**Respiration** With respect to energy metabolism, the process in which cellular energy is generated through the oxidation of nutrient molecules with $O_2$ as the ultimate electron acceptor. This type of respiration is also called *cellular respiration* to distinguish it from respiration in the sense of breathing.

**Respiratory anaphylaxis** Life-threatening allergy in which airways become constructed and filled with mucous secretions.

**Respiratory bronchiole** Microscopic channel in the lower respiratory system that ends in a series of alveoli.

**Respiratory chain** The electron transport chain that is employed during cellular respiration and has $O_2$ as the ultimate electron acceptor.

**Respiratory syncytial virus (RSV)** Cause of lower respiratory infections affecting children under 1 year old causes cells in culture to fuse their plasma membranes and become multinucleate masses (syncytia).

**Respiratory system** Body system that moves oxygen from the atmosphere to the blood and removes carbon dioxide and other wastes from the blood.

**Resting potential** The voltage difference that exists across the membrane of an excitable cell, such as a nerve cell, except in places when an action potential is in progress. It is a consequence of the ion gradients that are maintained across the membrane.

**Restriction endonuclease** Enzymes that catalyze the double-strand cleavage of DNA at specific base sequences. Many restriction endonucleases with different sequence specificities have been found in bacteria; they are used extensively in molecular genetics.

**Restriction enzyme** Another term for restriction endonuclease.

**Restriction fragment length polymophism (RFLP)** (1) A short piece of DNA snipped out by restriction enzymes. (2) A type of genetic polymorphism that is readily detected by Southern blotting and can be used to screen for genetic diseases. It is based on the fact that alleles often have different restriction endonuclease cleavage sites and therefore produce different arrays of fragments upon cleavage with appropriate endonucleases.

**Reticulate body** An intracellular stage in the life cycle of chlamydias.

**Retinoids** Substances that are derived from retinoic acid (a form of vitamin A) and act as intercellular mediators; they are particularly important in regulating development.

**Retrovirus** An enveloped RNA virus that uses its own reverse transcriptase to transcribe its RNA into DNA in the cytoplasm of the host cell.

**Retroviruses** A family of RNA viruses that possess reverse transcriptase. After the virus infects a cell, this enzyme transcribes the RNA genome into a double-strand DNA version, which integrates into a host chromosome. Human immunodeficiency virus (HIV) is a retrovirus.

**Reverse transcriptase** An enzyme found in retroviruses that synthesizes a double-strand DNA molecule from a single-strand RNA template. It is an important tool in molecular genetics.

**Reverse transcription** An enzyme found in retroviruses that copies RNA into DNA.

**R factor** *See resistance (R) plasmid.*

**R group** An organic chemical group attached to the central carbon atom in an amino acid.

**Rhabdovirus** A rod-shaped, enveloped RNA virus that infects insects, fish, various other animals, and some plants.

**Rh antigen** An antigen found on some red blood cells, discovered in the cells of rhesus monkeys. Rheumatic fever. A multisystem disorder following infection by $\beta$-hemolytic *Streptococcus pyogenes* that can cause heart damage.

**Rheumatoid arthritis** Autoimmune disease that affects mainly the joints but can extend to other tissues.

**Rheumatoid factor** IgM found in the blood of patients with rheumatoid arthritis, and their relatives.

**Rhinovirus** A virus that replicates in cells of the upper respiratory tract and causes the common cold.

**Ribonucleic acid (RNA)** Nucleic acid that carries information from DNA to sites where proteins are manufactured in cells and that directs and participates in the assembly of proteins.

**Ribosomal RNA (rRNA)** A type of RNA that, together with specific proteins, makes up the ribosomes.

**Ribosome** Site for protein synthesis consisting of RNA and protein, located in the cytoplasm.

**Ribosomes** Large protein – RNA complexes that are responsible for synthesizing polypeptides under the direction of mRNA templates.

**Rickettsialpox** Mild rickettsial disease with symptoms resembling those of chickenpox; caused by *Rickettsia akari* and carried by mites found on house mice.

**Rickettsias** Small, non-motile, Gram-negative organisms, obligate intercellular parasites of mammalian and anthropod cells.

**Rifamycin** An antibacterial agent that inhibits ribonucleic and (RNA) synthesis.

**Rift valley fever** Disease caused by bunyaviruses that occurs in epidemics.

**Ringworm** A highly contagious fungal skin disease that can cause ringlike lesions.

**River blindness** *See onchocerciasis.*

**RNA editing** A type of RNA processing that has been found in the mitochondrial mRNAs of certain eukaryotes, in which the RNA sequence is altered by the insertion of uridine residues at specific sites.

**RNA polymerase** An enzyme that binds to one strand of exposed DNA during transcription and catalyzes the synthesis of RNA from the DNA template.

**RNA primer** During DNA replication, the short stretch of RNA nucleotides that is laid down at the beginning of each Okazaki fragment; it provides a $3'$ –OH end from which DNA polymerase can extend the fragment. It is later replaced with DNA.

**RNA tumor virus** Any retrovirus that causes tumors and cancer.

**Rocky mountain spotted fever** Disease caused by *Rickettsia rickettsia* and transmitted by ticks.

**Rotavirus** Virus transmitted by the fecal-oral route that replicates in the intestine, causing diarrhea and enteritis.

**Roundworm** A worm with a long, cylindrical, unsegmented body and a heavy cuticle. *Known also as a nematode.*

**Rubella** Viral disease characterized by a skin rash; can cause severe congenital damage. *Known also as German measles.*

**Rubeola** *See measles.*

**Rubisco (ribulose bisphosphate carboxylase–oxygenase)** The enzyme that accomplishes carbon fixation in photosynthesis by adding $CO_2$ to ribulose-1,5-bisphosphate. It can also add $O_2$ in place of $CO_2$, initiating photorespiration.

**Rule of octets** Principle that an element is chemically stable if it contains eight electrons in its outer shell.

**Sac fungus** A member of a diverse group of fungi that produces saclike asci during sexual reproduction.
*Known also as ascomycota.*

**St. Anthony's fire** *See erysipelas.*

**St. Louis encephalitis** Type of viral encephalitis most often seen in humans in the central United States.

**Salmonellosis** A common enteritis characterized by abdominal pain, fever, and diarrhea with blood and mucus; caused by *Salmonella* species.

**Sapremia** A condition caused when saprophytes release metabolic products into the blood.

**Saprophyte** An organism that feeds on dead or decaying organic matter.

**Sarcina** A group of eight cocci in a cubicle packet.

**Sarcodine** An amoeboid protozoan.

**Sarcoplasmic reticulum** A network of membranous tubules that surrounds each myofibril in a skeletal muscle cell. It is a specialized region of endoplasmic reticulum; its main function is to sequester and then release the $Ca^{2+}$ that triggers myofibril contraction.

**Sarcoptic manage** *See scabies.*

**Satellite DNA** DNA consisting of multiple tandem repeats of very short, simple nucleotide sequences. It typically makes up 10–20% of the genome of higher eukaryotes; at least some of it may play a role in chromosome structure.

**Saturated fatty acid** A fatty acid containing only carbon–hydrogen single bonds.

**Scabies** Highly contagious skin disease caused by the itch mite *Sarcoptes scabiei.*
*Known also as Sarcoptic mange.*

**Scalded skin syndrome** Infection caused by staphylococci consisting of large, soft vesicles over the whole body.

**Scanning electron microscope (SEM)** A type of electron microscopy in which a beam of electrons is scanned across an object, and the pattern of reflected electrons is analyzed to crease an image of the object's surface. This type of microscope is used to study the surfaces of specimens. *Compare transmission electron microscopy.*

**Scanning tunneling microscope (STM)** Also called scanning probe microscope; type of microscope in which electron tunnel into each other's clouds, can show individual molecules, live specimens, and work underwater.

**Scarlet fever (sometimes called scarlatina)** Infection caused by *Streptococcus pyogenes* that produces an erythrogenic toxin.

**Schaeffer–Fulton fpore staining** A differential stain used to make endospores easier to visualize.

**Schick test** Test to determine immunity to diphtheria.

**Schistosomiasis** Disease of the blood and lymph caused by blood fluke of the genus *Schistosoma.*
*Known also as Bilharzia.*

**Schizogony** Multiple fission, in which one cell gives rise to many cells.

**Scolex** Head end of a tapeworm, with suckers and sometimes hooks that attach to the intestinal wall.

**Scrapie** Transmissible spongiform encephalopathy disease of the brain of sheep, causing extreme itching so that the sheep repeatedly scrape themselves against posts, trees, etc.

**Scrub typhus** A typhus caused by *Rickettsia tsutsugamushi*, transmitted by mites that feed on rats.
*Known also as tsutsugamushi.*

**Sebaceous gland** Epidermal structure, associated with hair follicles, that secretes an oily substance called sebum.

**Sebum** Oily substance secreted by the sebaceous glands.

**Secondary immunodeficiency disease** Result of damage to T cells or B cells after they have developed normally.

**Secondary infection** Infection that follows a primary infection, especially in patients weakened by the primary infection.

**Secondary response** The folding or coiling of a polypeptide chain into a particular pattern, such as a helix or pleated sheet.

**Secondary structure** (1) Local folding of the backbone of a linear polymer to form a regular, repeating structure. The B- and Z-forms of the DNA helix and the α-helix and β-sheet structures of polypeptides are examples. *Compare primary structure, quaternary structure, tertiary structure.* (2) The folding or coiling of a polypeptide chain into a particular pattern such as a helix or pleated sheet.

**Secondary treatment** Treatment of sewage by biological means to remove remaining solid wastes after primary treatment.

**Second law of thermodynamics** The law that states that the entropy in a closed system never decreases. An alternative statement is that processes that are thermodynamically favored at constant temperature and pressure involve a decrease in free energy.

**Second messenger** An intercellular substance that relays an extracellular signal (such as a hormonal signal) from the cell membrane to intracellular effector proteins.

**Second-order reaction** A reaction in which two reactant molecules must come together for the reaction to occur. The reaction is called second-order because the reaction rate depends on the square of reactant concentration (for two molecules of the same reactant) or on the product of two reactant concentrations (for two different reactants) *Compare first-order reaction.*

**Secretory piece** A part of the IgA antibody that protects the immunoglobulin from degradation and helps in the secretion of the antibody.

**Secretory vesicle** Small membrane-enclosed structure that stores substances coming from the Golgi apparatus.

**Sedimentation coefficient (*S*)** A coefficient that determines the velocity at which a particular particle will sediment during centrifugation; it depends on the density of the medium, the specific density of the particle, and the size, shape, and mass of the particle.

**Sedimentation equilibrium** A technique for using centrifugation to measure the mass of a large molecule such as a protein. A solution of the substance is centrifuged at low speed until the tendency of the substance to sediment is balanced by its tendency to diffuse to uniform concentration; the resulting concentration gradient is used to measure the molecular mass.

**Selectively permeable** Able to prevent the passage of certain specific molecules and ions while allowing others through.

**Selective medium** A medium that encourages growth of some organisms and suppresses growth of others.

**Selective toxicity** The ability of an antimicrobial agent to harm microbes without causing significant damage to the host.

**Self** Molecules that are not recognized as antigenic or foreign by an organism.

**Semen** The male fluid discharge at the time of ejaculation, containing sperm and various glandular and other secretions.

**Semiconservative replication** Replication in which a new DNA double helix is synthesized from one strand of parent DNA and one strand of new DNA.

**Seminal vesicle** A saclike structure whose secretions form a component of semen.

**Semisynthetic drug** An antimicrobial agent made partly by laboratory synthesis and partly by micro-organisms.

**Sense codon** A set of three DNA (or mRNA) bases that code for an amino acid.

**Sense strand** For a gene, the DNA strand that is homologous to an RNA transcript of the gene – that is, it carries the same sequence as the transcript, except with T in place of U. It is thus complementary to the strand that served as a template for the RNA.

**Sensitization** Initial exposure to an antigen, which causes the host to mount an immune response against it.

**Septicemia** An infection caused y rapid multiplication of pathogens in the blood. *Known also as blood poisoning.*

**Septicemic plague** Fatal form of plague that occurs when bubonic plague bacteria move from the lymphatics to the circulatory system.

**Septic shock** A life-threatening septicemia with low blood pressure and blood-vessel collapse, caused by endotoxins.

**Septic tank** An underground tank for receiving sewage, where solid material settle out as sludge, which must be pumped periodically.

**Septum** (plural: *septa*). A cross-wall separating two fungal cells.

**Sequela** (plural: *sequelae*). The aftereffect of a disease; after recovery from it.

**Serial dilution** A method of measurement in which successive 1:10 dilutions are made from the original sample.

**Seroconversion** The identification of a specific antibody in serum as a result of an infection.

**Serology** The branch of immunology dealing with laboratory tests to detect antigens and antibodies.

**Serovar** Strain; a subspecies category.

**Serum** The liquid part of blood after cells and clotting factors have been removed.

**Serum hepatitis** *See hepatitis B.*

**Serum killing power** Test used to determine effectiveness of an antimicrobial agent in which a bacterial suspension is added to the serum of a patient whose is receiving an antibiotic; and incubated.

**Serum sickness** Immune complex disorder that occurs when foreign antigens in seta cause immune complexes to be deposited in tissues.

**Severe combined immunodeficiency (SCID)** Primary immunodeficiency disease caused by failure of stem cells to develop properly, resulting in deficiency of both B and T cells.

**Sewage** Used water and the wastes it contains.

**Sex factors** Plasmids that specify gene products that enable bacteria to engage in conjugation (bacterial mating).

**Sexually transmitted disease (STD)** An infectious disease spread by sexual activities.

**Shadow casting** The coating of electron microscopy specimens with a heavy metal, such as gold or palladium, to create a three-dimensional effect.

**Shigellosis** Gastrointestinal disease caused by several strains of *Shigella* that invade intestinal lining cells.
*Known also as bacillary dysentery.*

**Shinbone fever** *See trench fever.*

**Shingles** Sporadic disease caused by reactivation of varicella-zoster herpesvirus that appears most frequently in older and immunocompromised individuals.

**Shrub of life** A diagram that represents our current understanding of the early evolution of life. There are many roots rather than a single ancestral line, and the branches criss-cross and merge again and again.

**Sickle-cell disease** A genetic disease resulting from a hemoglobin mutation. It produces fragile erythrocytes, leading to anemia.

**Sign** A disease characteristic that can be observed by examining the patient, such as swelling or redness.

**Signal recognition particles (SRPs)** Cytoplasmic particles that dock ribosomes on the surface of the endoplasmic reticulum (ER) if the nascent polypeptide is destined to be processed by the ER. The SRP recognizes and binds to a specific N-terminal signal sequence on the nascent polypeptide.

**Simple diffusion** The net movement of particles from a region of higher to one of lower concentration; does not require energy from a cell.

**Signal sequence** *See leader sequence.*

**Simple stain** A single dye used to reveal basic cell shapes and arrangements.

**Single-cell protein (SCP)** Animal feed consisting of micro-organisms.

**Sinus** A large passageway in tissues, lined with phagocytic cells.

**Sinusitis** An infection of the sinus cavities.

**Sinusoid** An enlarged capillary.

**Site-directed mutagenesis** A technique by which a specific mutation is introduced at a specific site in a cloned gene. The gene can then be introduced into an organism and expressed.

**6-4 Photoproduct** A type of DNA damage caused by UV irradiation in which a bond forms between carbon-6 of one pyrimidine base and carbon-4 of an adjacent pyrimidine base. This type of photoproduct appears to be the chief cause of UV-induced mutations.

**Skin** The largest single organ of the body that presents a physical barrier to infection by micro-organisms.

**Slime layer** A thin protective structure loosely bound to the cell wall that protects the cell against drying, helps trap nutrients, and sometimes binds cells together.

**Slime mold** A funguslike protist.

**Sludge** Solid matter remaining from water treatment that contains aerobic organisms that digest organic matter.

**Sludge digester** Large fermentation tank in which sludge is digested by anerobic bacteria into simple organic molecules, carbon dioxide, and methane gas.

**Small intestine** The upper area of the intestine where digestion is completed.

**Smallpox** A formerly worldwide and serious viral disease that has now been eradicated.

**Smear** A thin layer of liquid specimen spread out on a microscopic slide.

**Solute** The substance dissolved in a solvent to form a solution.

**Solution** A mixture of two or more substances in which the molecules are evenly distributed and will not separate out on standing.

**Solvent** The medium in which substances are dissolved to form a solution.

**Somatic mutation** A mutation that occurs in a cell of an organism other than a germ-like cell; it may affect the organism in which it occurs, but it cannot be passed on to progeny.

**Sonication** The disruption of cells by sound waves.

**SOS response** A bacterial response to various potentially lethal stresses, including severe UV irradiation. It involves the coordinated expression of a set of proteins that carry out survival maneuvers, including an error-prone type of repair for thymine dimers in DNA.

**Southern blotting** A technique for detecting the presence of a specific DNA sequence in a genome. The DNA is extracted, cleaved into fragments, separated by gel electrophoresis, denatured, and blotted onto a nitrocellulose filter. There it is incubated under annealing conditions with a radiolabeled probe for the sequence in question, and heteroduplexes of the probe with genomic DNA are detected by radioautography.

**Specialized transduction** Type of transduction in which the bacterial DNA transduced is limited to one or a few genes lying adjacent to a prophage that are accidentally included when the prophage is excised from the bacterial chromosome.

**Species** A group of organisms wit many common characteristics; the narrowest taxon.

**Species immunity** Innate or inborn genetic immunity.

**Specific defense** A host defense that operates in response to a particular invading pathogen.

**Specific epithet** The second name of an organism in the binomial system of nomenclature, following that of the genus – for example, *coli* in *Escherichia coli*.

**Specific immunity** Defense against a particular microbe.

**Specificity** (1) The property of an enzyme that allows it to accept only certain substrates and catalyze only one particular reaction. (2) The property of a virus that restricts it to certain specific types of host cells (3) The ability of the immune system to mount a unique immune response to each antigen it encounters.

**Spectrophotometer** An instrument that exposes a sample to light of defined wavelengths and measures the absorbance. Different types of spectrophotometers operate in different wavelength ranges, such as ultraviolet, visible, and infrared.

**Spectrum of ctivity** Refers to the range of different microbes against which are antimicrobial agent is effective.

**Spheroplast** A Gram-negative bacterium that lacks the cell wall but had not lysed.

**Spike** A glycoprotein projection that extend to form the viral capsid or envelope and is used to attach to or fuse with host cells.

**Spindle apparatus** A system of microtubules in the cytoplasm of a eukaryotic cell that guides the movement of chromosomes during mitosis and meiosis.

**Spin label** A substance that has an unpaired electron detectable by electron spin resonance and that is used as a chemical label.

**Spirillar fever** A form of rat bite fever, caused by *Spirillum minor*, first described as sodoku in Japan.

**Spirillum** (plural: *spirilla*). A flexible, wavy-shaped bacterium.

**Spirochetes** Corkscrew-shaped motile bacteria.

**Spleen** The largest lymphatic organ; acts as a blood filter.

**Spliceosome** A protein–RNA complex in the nucleus that is responsible for splicing introns out of RNA transcripts.

**Spontaneous generation** The theory that living organisms can arise from non-living things.

**Spontaneous mutation** A mutation that occurs in the absence of any agent known to cause changes in DNA; usually caused by errors during DNA replication.

**Sporadic disease** A disease that is limited to a small number of isolated case posing no great threat to a large population.

**Spore** A resistant reproductive structure formed by fungi and actinomycetes; different from a bacterial endospore.

**Spore coat** A keratinlike protein material that is lad down around the cortex of an endospore by the mother cell.

**Sporocyst** Larval form of a fluke that develops in the body of its snail or mollusk host.

**Sporotrichosis** Fungal skin disease caused by *Sporothrix schenckii* that often enters the body from plants.

**Sporozoite** A malaria trophozoite present in the salivary glands of infected mosquitoes.

**Sporulation** The formation of spores such as endospores.

**Spread plate method** A technique used to prepare pure cultures by placing a diluted sample of cells on the surface of an agar plate and then spreading the sample evenly over the surface.

**Stain** A molecule that can bind to a structure and give it color.

*Known also as a dye.*

**Standard bacterial growth curve** A graph plotting the number of bacteria versus time and showing the phases of bacterial growth.

**Standard reduction potential ($E_0$)** For a given pair consisting of an electron donor and its conjugate acceptor, the reduction potential under standard conditions (25°C; donor and acceptor both at 1 m concentration).

**Standard state** A reference state, with respect to which thermodynamic quantities (such as chemical potentials) are defined. For substances in solution, standard state indicates 1 m concentration at 1 atm pressure and 25°C.

**Start codon** The first codon in a molecule of mRNA, which begins the sequence of amino acids in protein synthesis; in bacteria it always codes for methionine.

**Stationary phase** The third of four major phases of the bacterial growth curve in which new cells are produced at the same rate that old cells die, leaving the number of live cells constant.

**Sterility** The state in which there are no living organisms in or on a material.

**Sterilization** The killing or removal of all micro-organisms in a material or on an object.

**Steroid** A lip having a four-ring structure, includes cholesterol, steroid hormones, and vitamin D.

**Stock culture** A reserve culture used to store an isolated organism in pure condition for use in the laboratory.

**Stop codon** (1) The last codon to be translated in a molecule of mRNA, causing the ribosome to release from the mRNA. (2) RNA codons that signal a ribosome to stop translating an mRNA and to release the polypeptide. In the normal genetic code, they are UAG, UGA, and UAA.

**Strain** A subgroup of a species with one or more characteristics that distinguish it from other subgroups of that species.

**Streak plate method** Method used to prepare pure cultures in which bacterial are lightly spread over the surface of agar plates, resulting in isolated colonies.

**Streptococci** Aerotolerant anerobes that form pairs, tetrads, or chains by dividing in one or two planes; most lack the enzyme catalase.

**Streptokinase** A bacterially produced enzyme that digests (dissolves) blood clots.

**Streptolysin** Toxin produced by streptococci that kills phagocytes.

**Streptomycetes** Gram-positive, filamentous, sporing, soil-dwelling bacteria, produces of many antibiotics.

**Streptomycin** An antibacterial agent that blocks protein synthesis.

**Stringent response** A mechanism that inhibits the expression of all structural genes in bacteria under conditions of amino acid starvation. It involves inhibition of the synthesis of ribosomal and transfer RNAs.

**Stroma** The fluid-filled inner portion of a chloroplast.

**Stromatolite** Live or fossilized layered mats of photosynthetic prokaryotes associated with warm lagoons or hot springs.

**Strongyloidiasis** Parasitic disease caused by the roundworm *Stongyloides stercoralis* and a few closely related species.

**Structural gene** A gene that carries information for the synthesis of a specific polypeptide.

**Structural protein** A protein that contributes to the structure of cells, cell parts, and membranes.

**Sty** An infection at the base of an eyelash.

**Subacute disease** A disease that is intermediate between an acute and a chronic disease.

**Subacute sclerosing panencephalitis (SSPE)** A complication of measles, nearly always fatal, that is due to the persistence of measles viruses in brain tissue.

**Subclinical infection** *See inapparent infection.*

**Subculturing** The process by which cells from an existing culture are transferred to fresh medium in new containers.

**Substrate** (1) The substance on which an enzyme acts. (2) A surface or food source on which a cell can grow or a spore can germinate.

**Substrate-level phosphorylation** Synthesis of a nucleoside triphosphate (usually ATP) driven by the breakdown of a compound with higher phosphate transfer potential.

**Suicide inhibitor** An enzyme inhibitor on which the enzyme can act catalytically but which irreversibly alters the active site of the enzyme in the process. (It is called a suicide inhibitor because the enzyme "commits suicide" by acting on it.)

**Sulfate reduction** The reduction of sulfate ions to hydrogen sulfide.

**Sulfonamide** A synthetic, bacteriostatic agent that blocks the synthesis of folic acid. *Known also as sulfa drugs.*

**Sulfur cycle** The cyclic movement of sulfur through an ecosystem.

**Sulfur oxidation** The oxidation of various forms of sulfur to sulfate.

**Sulfur reduction** The reduction of elemental sulfur to hydrogen sulfide.

**Superantigens** Powerful antigens, such as bacterial toxins, that activate large numbers of T cells, causing a large immune response that can cause diseases such as toxic shock.

**Supercoiling** For a DNA double helix, turns of the two strands around each other that either exceed or are fewer than the number of turns in the most stable helical conformation. Only a helix that is circular or else fixed at both ends can support supercoiling. *See twist, writhe.*

**Superhelix density ($\sigma$)** A measure of the superhelicity of a DNA molecule. It is equal to the change in linking number caused by the introduction of supercoiling divided by the linking number the DNA molecule would have in its relaxed state.

**Superinfection** A secondary infection from the removal of normal microbiota, allowing colonization by pathogenic, and often antibiotic-resistant, microbes.

**Superoxide** A highly reactive form of oxygen that kills obligate anaerobes.

**Superoxide dismutase** An enzyme that converts superoxide to molecular oxygen and hydrogen peroxide.

**Suppression** With respect to mutations, a mutation that occurs at a different site from that of an existing mutation in a gene but restores the wild-type phenotype.

**Suppressor T cell ($T_5$)** Possibly a type of cytotoxic or helper T cells that inhibits immune responses.

**Surface tension** A phenomenon in which the surface of water behaves like a thin invisible elastic membrane.

**Surfactant** A substance that reduces surface tension.

**Susceptibility** The vulnerability of an organism to harm by infectious agents.

**Svedberg unit (S)** In ultracentrifugation, a unit used for the sedimentation coefficient; it is equal to $10^{-13}$ s.

**Swarmer cell** Spherical, flagellated *Rhizobium* cell that invades the root hairs of leguminous plants, eventually to form nodules.

**Sweat gland** Epidermal structure that empties a watery secretion through pores in the skin.

**Swimmer's itch** Skin reaction to cercariae of some species of the helminth *Schistosoma*.

**Symbiosis** The living together of two different kinds of organisms.

**Symport** A membrane transport process that couples the transport of a substrate in one direction across a membrane to the transport of a different substrate in the same direction. *Compare antiport.*

**Symptom** A disease characteristic that can be observed or felt only by the patient, such as pain or nausea.

**Synchronous growth** Hypothetical pattern of growth during the log phase in which all the cells in a culture divide at the same time.

**Syncytium** (plural: *syncytia*). A multinucleate mass in a cell culture, for example, caused by the respiratory syncytial virus.

**Syndrome** A combination of signs and symptoms that occur together.

**Synergism** Referring to an inhibitory effect produced by two antibiotics working together that is greater than either can achieve alone.

**Synthesis** The step of viral replication during which new nucleic acids and viral proteins are made.

**Synthetic drug** An antimicrobial agent synthesized chemically in the laboratory.

**Synthetic medium** A growth medium prepared in the laboratory from materials of precise or reasonably well-defined composition.

**Syphilis** A sexually transmitted disease, caused by the spirochete *Treponema pallidum*, characterized by a chancre at the site of entry and often eventual neurological damage.

**Systemic blastomycosis** Disease resulting from invasion by *Blastomyces dermatitides* of internal organs, especially the lungs.

**Systemic infection** An infection that affects the entire body.

*Known also as a generalized infection.*

**Systemic lupus erythematosus** A widely disseminated, systemic autoimmune disease resulting from production of antibodies against DNA and other body components.

**Tapeworm** Flatworm that lives in the adult stage as a parasite in the small intestine of animals.

**Tartar** Calcium deposition on dental plaque forming a very rough, hard crust.

**Tautomers** Structural isomers that differ in the location of their hydrogen and double bonds.

**Taxon** (plural: *taxa*). A category used in classification, such as species, genus, order, family.

**Taxonomy** The science of classification.

**Tay-sachs disease** A genetic disease caused by a deficiency of the lysosomal enzyme N-acetylhexosaminidase A, which is involved in sphingolipid degradation. The deficiency results in accumulation of the ganglioside sphingolipid $GM_2$, particularly in the brain.

**T Cell** *See t lymphocyte.*

**T-Dependent antigen** Antigen requiring helper T cell ($T_H2$) activity to activate B cells.

**Teichoic acid** A polymer attached to peptidoglycan in Gram-positive cell walls.

**Telomerase** A DNA polymerase that adds a short repeating sequence to the $3'$ strand at either end of a chromosomal DNA molecule, thus creating a single-strand overhand. This overhand gives room for priming the origin of a final Okazaki fragment during DNA replication so that the full length of the chromosome can be copied.

**Telomeres** Special DNA sequences at the ends of eukaryotic chromosomes.

**Temperate phage** A bacteriophage that does not cause a virulent infection; rather, its DNA is incorporated into the host cell chromosome, as a prophage, and replicated with the chromosome.

**Temperate phages** Bacterial phages that can establish a condition of lysogeny.

*See also lysogeny.*

**Template** DNA used as a pattern for the synthesis of a new nucleotide polymer in replication or transcription.

**Template strand** A DNA or an RNA strand that directs the synthesis of a complementary nucleic acid strand.

**Temporary parasite** A parasite that feeds on and then leaves its host (such as a biting insect).

**Teratogen** An agent that induces defects during embryonic development.

**Teratogenesis** The induction of defects during embryonic development.

**Terminator** *See stop codon.*

**Terminator codon** A codon that signals the end of the information for a particular protein.

*Known also as nonsense codon or stop codon.*

**Tertiary structure** (1) The folding of a protein molecule into globular shapes. (2) Large-scale folding structure in a linear polymer that is at a higher order than secondary structure. For proteins and RNA molecules, the tertiary structure is the specific three-dimensional shape into which the entire chain is folded. *Compare primary structure, quaternary structure, and secondary structure.*

**Tertiary treatment** Chemical and physical treatment of sewage to produce an effluent of water pure enough to drink.

**Test** A shell made of calcium carbonate and common to some protists.

*See also diagnostic procedures and tests; specific tests.*

**Testis** (plural: *testes*). One of a pair of male reproductive glands that produce testosterone and sperm.

**Tetanus** Disease caused by *Clostridium tetani* in which muscle stiffness progresses to eventual paralysis and death.

*Known also as lockjaw.*

**Tetanus neonatorum** Type of tetanus acquired through the raw stump of the umbilical cord.

**Tetracycline** An antibacterial agent that inhibits protein synthesis.

**Tetrad** Cuboidal groups of four cocci.

**Thallus** The body of a fungus.

**Theca** A tightly affixed, secreted outer layer of dinoflagellates that often contains cellulose.

**Therapeutic dosage lLevel** Level of drug dosage that successfully eliminates a pathogenic organism if maintained over a period of time.

**Thermal death point** The temperature that kills all the bacteria in a 24-hour-old broth culture at neutral pH in 10 min.

**Thermal death time** The time required to kill all the bacteria in a particular culture at a specified temperature.

**Thermoacidophile** A member of one of the groups of the archaeobacteria that live in extremely hot, acidic environments.

**Thermophile** A heat-loving organism that grows best at temperatures from 50 to 60°C.

**Thermophilic anaerobic spoilage** Spoilage due to endospore germination and growth in which gas and acid are produced, making cans bulge.

**Thrush** Milky patches of inflammation on oral mucous membranes; a symptom Candidiasis, caused by *Candida albicans.*

**Thylakoid** An internal membrane of chloroplasts that contains chlorophyll.

**Thymus gland** Multilobed lymphatic organ located beneath the sternum that posses lymphocytes into T cells.

**Tick paralysis** A disease characterized by fever and paralysis due to anticoagulants and toxins secreted into a tick's bite via the ectoparasite's saliva.

**Tincture** An alcoholic solution.

**T-Independent antigen** Antigen not requiring helper T cells ($T_H2$) activity to activate B cells.

**Tinea barbae** Barber's itch; a type of ringworm that causes lesions in the beard.

**Tinea capitis** Scalp ringworm, a form of ringworm in which hyphae grow in hair follicles, often leaving circular patterns of baldness.

**Tinea corporis** Body ringworm, a form of ringworm that causes ringlike lesions with a central scaly area.

**Tinea cruris** Groin ringworm, a form of ringworm that occurs in skin folds in the pubic region.
*Known also as jock itch.*

**Tinea pedis** *See athlete's foot.*

**Tinea unguium** A form of ringworm that causes hardening and discoloration of fingernails and toenails.

**Tissue culture** Culture made from a single tissue, assuring a reasonably homogenous set of cultures in which to test the effects of a virus or to culture an organism.

**Titer** The quantity of a substance needed to produce a given reaction.

**T-Lymphocyte** Thymus-derived cell of the immune system and agent of cellular immune responses.
*Known also as T cell.*

**Togavirus** A small, enveloped RNA virus that multiplies in many mammalian and anthropod cells.

**Tolerance** A state in which antigens no longer elicit an immune response.

**Tonsilitis** A bacterial infection of the tonsils.

**Tonsil** Lymphoid tissue that contributes immune defenses in the form of B cells and T cells.

**Topoisomerases** Enzymes that change the supercoiling of DNA helices by either allowing the superhelical torsion to relax (thus reducing the supercoiling) or adding more twists (thus increasing the supercoiling)

**Topoisomers** With respect to DNA, closed circular DNA molecules that are identical except in their sense or degree of supercoiling. DNA topoisomers can be interchanged only by cutting one or both strands using topoisomerases.

**TORCH series** A group of blood tests used to identify teratogenic diseases in pregnant women and newborn infants.

**Total magnification** Obtained by multiplying the magnifying power of the objective lens by the magnifying power of the ocular lens.

**Toxemia** The presence and spread of exotoxins in the blood.

**Toxic dosage level** Amount of a drug necessary to cause host damage.

**Toxic shock syndrome (TSS)** Condition caused by infection with certain toxigenic strains of *Staphylococcus aureus*; often associated with the use of super absorbent but abrasive tampons.

**Toxin** Any substance that is poisonous to other organisms.

**Toxoid** An exotoxin inactivated by chemical treatment but which retains its antigenicity and therefore can be used to immunize against the toxin.

**Toxoplasmosis** Disease caused by the protozoan *Toxoplasma gondii* that can cause congenital defects in newborns.

**Trace element** Minerals, such as copper, iron, zinc, and cobalt ions, that are required in minute amounts for growth.

**Trachea** The windpipe.

**Trachoma** Eye disease caused by *Chlamydia trachomatis* that can result in blindness.

**Transamination** In the cell, the enzymatic transfer of an amino group from an amino group a keto acid. The keto acid becomes an amino acid and vice versa.

**Transcription** The synthesis of an RNA molecule complementary to a DNA strand; the information encoded in the base sequence of the DNA is thus "transcribed" into the RNA version of the same code. *Compare translation.*

**Transcription factors** Proteins that influence the transcription of particular genes, usually by binding to specific promoter sites.

**Transduction** The transfer of genetic material from one bacterium to another by a bacteriophage.

**Transfer RNA (tRNA)** Type of RNA that transfers amino acids from the cytoplasm to the ribosomes for placement in a protein molecule.

**Transformation** A change in an organism's characteristics through the transfer of naked DNA.

**Transfusion reaction** Reaction that occurs when matching antigens and antibodies are present in the blood at the same time.

**Transgenic** (1) State of permanently changing an organism's characteristics by integrating foreign DNA (genes) into the organism. (2) Refers to an organism whose genome contains one or more DNA sequences from a different species (transgenes). Genetic engineering can be used to create transgenic animals.

**Transient microflora** Micro-organisms that may be present in or on an organism under certain conditions and for certain lengths of time *t* sites where resident microbiota.

**Transition state** In any chemical reaction, the high-energy or unlikely state that must be achieved by the reacting molecule(s) for the reaction to occur.

**Translation** The synthesis of a polypeptide under the direction of an mRNA, so that the nucleotide sequence of the mRNA is "translated" into the amino acid sequence of the protein. *Compare transcription.*

**Transmissible spongiform encephalopathies** Prion-caused diseases resulting in brain tissue developing multiple holds such that it resembles a sponge, includes Creutzfeldt–Jakob disease, mad cow disease, kuru, scrapie and others.

**Transmission** The passage of light through an object.

**Transmission electron microscope (TEM)** A type of electron microscopy in which a beam of electrons passes through the object to be viewed and creates an image on a photographic plate or screen. Very thin slices of specimens are used. *Compare scanning electron microscopy.*

**Transovarian transmission** Passing of pathogen from one generation of ticks to the next as eggs leave the ovaries.

**Transplantation** The moving of tissue from one site to another.

**Transplant rejection** Destruction of grafted tissue or of a transplanted organ by the host immune system.

**Transposable element** A mobile genetic sequence that can move from one plasmid to another plasmid or chromosome.

**Transposable genetic elements** Genetic elements that are able to move from place to place within a genome. A Transposon is one type of transposable element.

**Transposal of virulence** A laboratory technique in which a pathogen is passed from its normal host sequentially through many individual members of a new host species, resulting in a lessening or even total loss of its virulence in the original host.

**Transposase** An enzyme that is involved in the insertion of a bacterial Transposon into a target site.

**Transposition** The process whereby certain genetic sequences in bacteria or eukaryotes can move from one location to another.

**Transposon** A mobile genetic sequence that contains the genes for transposition as well as one or more other genes not related to transposition.

**Traumatic herpes** Type of herpes infection in which the virus enters traumatized skin in the area of a burn or other injury.

**Traveler's diarrhea** Gastrointestinal disorder generally caused by pathogenic strains of *Escherichia coli.*

**Trench fever** Rickettsial disease, caused by *Rochalimaea quintana*, resembling epidemic typhus in that is transmitted by lice and is prevalent during wars and under unsanitary conditions.

*Known also as shinbone fever.*

**Treponemes** Spirochetes belonging to the genus *Treponema.*

**Triacylglycerol** A molecule formed from three fatty acids bonded to glycerol.

**Tricarboxylic acid cycle** *See citric acid cycle and krebs cycle.*

**Trichinosis** A disease caused by a small nematode, *Trichinella spiralis*, that enters the digestive tract as encysted larvae in poorly cooked meat, usually pork.

**Trichocyst** Tentaclelike structure on ciliates for catching prey for attachment.

**Trichomoniasis** A parasitic urogenital disease, transmitted primarily by sexual intercourse, that causes intense itching and a copious white discharge, especially in females.

**Trichuriasis** Parasitic disease caused by the whipworm, *Trichuris trichiura*, that damages intestinal mucosa and causes chronic bleeding.

**Trickling filter system** Procedure in which sewage is spread over a bed of rocks coated with aerobic organisms that decompose the organic matter in it.

**Trophozoite** Vegetative form of a protozoan such as *Plasmodium.*

**Trypanosomiasis** *See african sleeping sickness.*

**Tube agglutination test** Serologic test that measures antibody titers by comparing various dilutions of the patient's serum against known quantities of an antigen.

**Tubercle** A solidified lesion or chronic granuloma that forms in the lungs in patients with tuberculosis.

**Tuberculin hypersensitivity** Cell-mediated hypersensitivity reaction that occurs in sensitized individuals when they are exposed to tuberculin.

**Tuberculin skin test** An immunological test for tuberculosis in which a purified protein derivative from the *Mycobacterium tuberculosis* is injected subcutaneously, resulting in an induration if there was previous exposure to the bacterium.

**Tuberculoid** Referring to the anesthetic form of Hansen's disease leprosy in which areas of skin lose pigment and sensation.

**Tuberculosis** Disease caused mainly by *Mycobacterium tuberculosis.*

**Tularemia** Zoonosis caused by *Francisella tularensis*, most often associated with cottontail rabbits.

**Tumor** An uncontrolled division of cells, often caused by viral infection.

**Turbidity** A cloudy appearance in a culture tube indicating the presence of organisms.

**Turnover number** With respect to an enzyme-catalyzed reaction, the number of substrate molecules one enzyme molecule can process (turn over) per second when saturated with substrate. It is equivalent to the catalytic rate constant, $k_{cat}$.

**Twist (*T*)** With respect to a DNA double helix, the total number of times the two strands of the helix cross over each other, excluding writhing. It is a measure of how tightly the helix is wound.

*See also linking number, writhe.*

**Tympanic membrane** Membrane separating the outer and middle ear.

*Known also as the eardrum.*

**Type strain** Original reference strain of a bacterial species, descendants of a single isolation in pure culture.

**Typhoidal tularemia** Septicemia that resembles typhoid fever, caused by bacteremia from tularemia lesions.

**Typhoid fever** An epidemic enteric infection caused by *Salmonella typhi*, uncommon in areas with good sanitation.

**Typhus fever** Rickettsial disease that occurs in a variety of forms including epidemic, endemic (murine), and scrub typhus.

**Tyrocidin** An antibacterial agent that disrupts cell membranes.

**Ulceroglandular** Referring to the form of tularemia caused by entry of *Francisella tularensis* through the skin and characterized by ulcers on the skin and enlarged regional lymph nodes.

**Ultrafiltration** The technique of filtering a solution under pressure through a Semipermeable membrane, which allows water and small solutes to pass through but retains macromolecules.

**Ultra-high temperature (UHT) processing** A method of sterilizing milk and dairy products by raising the temperature to 87.8°C for 3 s.

**Uncoating** Process in which protein coats of animal viruses that have entered ells are removed by proteolytic enzymes.

**Undulant fever** *See brucellosis.*

**Universal precautions** A set of guidelines established by the CDC to reduce the risks of disease transmission in hospital and medical laboratory settings.

**Unsaturated fatty acid** A fatty acid that contains at least one double bond between adjacent carbon atoms.

**Upper respiratory tract** The nasal cavity, pharynx, larynx, trachea, bronchi, and larger bronchioles.

**Ureaplasmas** Bacteria with unusual cell walls, require sterols as a nutrient.

**Ureter** Tube that carries urine from the kidney to the urinary bladder.

**Urethra** Tube through which urine passes from the bladder to the outside during micturition (urination)

**Urethritis** Inflammation of the urethra.

**Urethrocystitis** Common term used to describe urinary tract infections involving the urethra and the bladder.

**Urinalysis** The laboratory analysis of urine specimens.

**Urinary bladder** Storage area for urine.

**Urinary system** Body system that regulates the composition of body fluids and removes nitrogenous and other wastes from the body.

**Urinary tract infection (UTI)** A bacterial urogenital infection that causes urethritis or cystitis.

**Urine** Water collected in the kidney tubules.

**Urogenital system** Body system that (1) regulates the composition of body fluids and removes certain wastes from the body and (2) enables the body to participate in sexual reproduction.

**Use-dilution test** A method of evaluating the antimicrobial properties of a chemical agent using standard preparations of certain test bacteria.

**Uterine tube** A tube that conveys ova from the ovaries to the uterus.
*Known also as fallopian tubes or oviducts.*

**Uterus** The pear-shaped organ in which a fertilized ovum implants and develops.

**Vaccine** A substance that contains an antigen to which the immune system responds. *See also immunization*, specific types of vaccines.

**Vacuole** A membrane-bound structure that stores materials such as food or gas in the cytoplasm or eukaryotic cells.

**Vagina** The female genital canal, extending from the cervix to the outside of the body.

**Vaginitis** Vaginal infection, often caused by opportunistic organisms that multiply when the normal vaginal microflora are disturbed by antibiotics or other factors.

**van der Waals radius (*r*)** The effective radius of an atom or a molecule that defines how close other atoms or molecules can approach; it is thus the effective radius for closest molecular packing.

**Variable** Anything that can change in an experiment.

**Varicella–Zoster virus** A herpesvirus that causes both chickenpox and shingles.

**Vasodilation** Dilation of the capillary and venule walls during an acute inflammation.

**Vector** (1) A self-replicating carrier of DNA; usually a plasmid, bacteriophage, or eukaryotic virus. (2) An organism that transmits a disease-causing organism from one host to another. (3) In genetic engineering, a DNA molecule that can be used to introduce a DNA sequence into a cell where it will be replicated and maintained. Usually a plasmid or a viral genome.

**Vegetation** A growth that forms on damaged heart valve surfaces in bacterial endocarditis, exposed collagen fibers elicit fibrin deposits, and transient bacteria attach to the fibrin.

**Vegetative cell** A cell that is actively metabolizing nutrients.

**Vehicle** A non-living carrier of an infectious agent from its reservoir to a susceptible host.

**Venezuelan equine encephalitis** Type of viral encephalitis seen in Florida, Texas, Mexico, and South America; infects horses more frequently than humans.

**Verminous intoxication** An allergic reaction to toxins in the metabolic wastes of liver flukes.

**Verruga peruana** One form of bartonellosis; a chronic non-fatal skin disease.

**Vertical gene transfer** Genes that pass from parents to offspring.

**Vertical transmission** Direct contact transmission of disease in which pathogens are passed from parent to offspring in an egg or sperm, across the placenta, or while traversing the birth canal.

**Very low-density lipoprotein (VLDL)** A type of lipoprotein particle that is manufactured in the liver and functions mainly to carry triacylglycerols from the liver to adipose and other tissues.

**Vesicle** A membrane-bound inclusion in cells.

**Vibrio** A comma-shaped bacterium.

**Vibriosis** An enteritis caused by *Vibrio parahaemolyticus*, acquired from eating contaminated fish and shellfish that have not been thoroughly cooked.

**Virion** A single virus particle.

**Villus** (plural: *villi*). A multicellular projection from the surface of a mucous membrane, functioning in absorption.

**Viral enteritis** Gastrointestinal disease caused by rotaviruses, characterized by diarrhea.

**Viral hemagglutination** Hemagglutination caused by binding of viruses, such as those that cause measles and influenza, to red blood cells.

**Viral meningitis** Usually self-lining and non-fatal form of meningitis.

**Viral neutralization** The binding of antibodies to viruses, which is used in an immunological test to determine if a patient's serum contains viruses.

**Viral pneumonia** Disease caused by viruses such as respiratory syncytial virus.

**Viral specificity** Refers to the specific types of cells within an organism that a virus can infect.

**Viral yield** *See burst size.*

**Viremia** An infection in which viruses are transported in the blood but do not multiply in transit.

**Viridans group** A group of streptococci that often infect the valves and lining of the heart and cause incomplete (alpha) hemolysis of red blood cells in laboratory cultures.

**Virion** A complete virus particle, including its envelope if it has one.

**Viroid** An infectious RNA particle, smaller than a virus and lacking a capsid, that causes various plant diseases.

**Virulence** The degree of intensity of the disease produced by a pathogen.

**Virulence factor** A structural or physiological characteristic that helps a pathogen cause infection and disease.

**Virulent phage** A bacteriophage that enters the lytic cycle when it infects a bacterial cell, causing eventual lysis and death of the host cell.

*Known also as lytic phage.*

**Virus** A submicroscopic, parasitic, acellular micro-organism composed of a nucleic acid (DNA or RNA) core inside a protein coat.

**Viruses** Infectious entities that contain the nucleic acid to code for their own structure but that lack the enzymatic machinery of a cell; they replicate by invading a cell and using its machinery to express the viral genome. Most viruses consist of little but nucleic acid enclosed in a protein coat; some viruses also have an outer lipid-bilayer envelope.

**Visceral larva migrans** The migration of larvae of *Toxocara* species in human tissues, where they cause damage and allergic reactions.

**Vitamin** A substance required for growth that the organism cannot make.

**Volutin** Polyphosphate granules.

*Known also as metachromatic granule.*

**Walking pneumonia** *See primary atypical pneumonia.*

**Wandering macrophages** Phagocytic cells that circulate in the blood or move into tissues when microbes and other foreign material are present.

**Wart** A growth on the skin and mucous membranes caused by infection with human papillonavirus.

*Known also as papilloma.*

**Water cycle** Process by which water is recycled through precipitation, ingestion by organisms, respiration, and evaporation.

*Known also as the hydrologic cCycle.*

**Water mold** A funguslike protist that produces flagellated asexual spores (zoospores) and large, motile gametes.

*Known also as oomycota.*

**Wavelength** The distance between successive crests or troughs of a light wave.

**Western blotting** A technique for identifying proteins or protein fragments in a mixture that react with a particular antibody. The mixture is first resolved into bands by one-dimensional denaturing gel electrophoresis. The protein bands are then "blotted" onto a nitrocellulose sheet, the sheet is treated with the antibody and any bands that bind the antibody are identified. More accurately called immunoblotting.

**Western equine encephalitis** Type of viral encephalitis seen most often in the western United States; infects horses more frequently than humans.

**West nile fever** Emerging viral disease new to the USA, transmitted by mosquitoes, causing seizures and encephalitis; lethal to crows.

**Wet mount** Microscopy technique in which a drop of fluid containing the organisms (often living) is placed on a slide.

**Wetting agent** A detergent solution often used with other chemical agents to penetrate fatty substances.

**Whey** The liquid portion (waste product) of milk resulting from bacterial enzyme addition.

**Whipworm** *Trichuris trichiura*, a worm that causes trichuriasis infestation of the intestine.

**Whitlow** A herpetic lesion on a finger that can result from exposure to oral, ocular and probably genital herpes.

**Whooping cough** A highly contagious respiratory disease caused primarily by *Bordetella pertussis.*

*Known also as pertussis.*

**Wild-type** Refers to the normal genotype found in free-living, natural members of a group of organisms.

**Wort** The liquid extract from mash.

**Wound botulism** Rare form of botulism that occurs in deep wounds when tissue damage impairs circulation and creates anerobic conditions in which *Clostridium botulinum* can multiply.

**Writhe (*W*)** With respect to a supercoiled DNA helix, the number of times the helix as a whole crosses over itself – that is, the number of superhelical turns that are present.

*See also linking number, twist.*

**Xenobiotic** An organic compound that is not produced by the organism in which it is found.

**Xenograph** A graft between individuals of different species.

**X-ray diffraction** A technique that is used to determine the three-dimensional structure of molecules, including macromolecules. A crystal or fiber of the substance is illuminated with a beam of X-rays, and the repeating elements of the structure scatter the X-rays to form a diffraction pattern that gives information on the molecule's structure.

*See also diffraction pattern.*

**Yeast artificial chromosomes (YACs)** Artificial chromosomes used for cloning and maintaining large fragments of genomic

DNA for investigational purposes. A YAC is constructed by recombinant DNA techniques from a year centromere, two telomeres (chromosome ends), selectable markers, and cloned DNA in the megabase range.

**Yeast extract** Substance from yeast containing vitamins, coenzymes, and nucleosides; used to enrich media.

**Yellow fever** Viral systemic disease found in tropical areas, carried by the mosquito *Aedes aegypti.*

**Yersiniosis** Severe enteritis caused by *Yersinia enterocolitica.*

**Z-DNA** A DNA duplex with a specific left-hand helical structure. In vitro, it tends to be the most stable form from DNA duplexes that have alternating purines and pyrimidines, especially under conditions of cytosine methylation or negative supercoiling.

**Ziehl–Neelsen acid-fast stain** A differential stain for organisms that are not decolorized by acid in alcohol, such as the bacteria that cause Hansen's disease (leprosy) and tuberculosis.

**Zone of inhibition** A clear area that appears on agar in the disk diffusion method, indicating where the agent has inhibited growth of the organism.

**Zoonosis** (plural: *zoomoses*). A disease that can be transmitted from animals to humans.

**Zygomycosis** Disease in which certain fungi of the genera *Mucor* and *Rhizopus* invade lungs, the central nervous system, and tissues of the eye orbit.

**Zygomycota** *See bread mold.*

**Zygospore** In bread molds, a thick-walled, resistant, spore-producing structure enclosing a zygote.

**Zygote** A cell formed by the union of gametes (egg and sperm).

## 2. Bacteria

The classification below is based on that in the 3rd edition of Microbiology (Bernard D David, Harper & Row, New York, pp. 27–28). The extent of classification is to the genus and, in selected cases families, but the species are listed in the text.

## a. Main groups of bacteria*

### I. Gram-positive eubacteria

Motility: Nearly all permanently immotile
Cell shape: Straight rods

| Other distinguishing characteristics | Genera | Families |
|---|---|---|
| Cell shape: cocci | Sarcina | |
| Cells in cubical packets | | Micrococcaceae |
| | Micrococus | |
| Cells irregularly arranged | Staphylooccus | |
| Cells in chains | Streptoccoccus | Streptococcaceae |
| Lactic fermentation of sugars | Leuconostoc | |
| Cell shape: straight rods | | |
| Lactic fermentation of sugars | Lactobacillus | Lactobacillaceae |
| Propionic fermentation of sugars | Propionibacterium<br>Corynebacterium<br>Listeria | Propionibacteriaceae |
| Oxidative, weakly fermentative | Erysipelothrix | |

Motility: Motile with pertrichous flagella, and related immotile forms

| Other distinguishing characteristics | Genera | | |
|---|---|---|---|
| | Aerobic | Bacillus | Families |
| Endospores produced | Anaerobic | Clostridum | Bacillaceae |

### II. Gram-negative bacteria, excluding photosynthetic forms

Cell shape: Cocci
Motility: Permanently immotile

| Other distinguishing characteristics | Genera | Families |
|---|---|---|
| Aerobic | Neisseria<br>Veillonella<br>Brucella<br>Bordetella<br>Pasteurella | Neisseriaceae |
| Anerobic | Hamophilus | Brucellacease |

Cell shape: Straight rods
Motility: Motile with peritrichous flagella, and related immotile forms

| Other distinguishing characteristics | Genera | | |
|---|---|---|---|
| | Aerobic | Bacillus | Families |
| | | Escherichia<br>Erwinia<br>Shigella | |
| | Mixed acid<br>Fermentation<br>of sugars | Salmonella<br>Proteus<br>Yersinia | Enterobacteriaceae |
| Facultative—<br>anerobic | Butylene glycol<br>fermentation | Enterobacter<br>Serrati | Azotobacteraceae |
| | Free-living nitrogen fixers | Azotobacter | |
| Aerobic | Symbiotic nitrogen fixers | Rhizobium | Rhizobiaceae |

Cell shape: Straight rods
Motility: Motile with polar flagella
Cell shape: Curved rods

| Other distinguishing characteristics | Genera | | |
|---|---|---|---|
| | Aerobic | Bacillus | Families |
| | Oxide inorganic compounds | Nitrosomonas<br>Nitrobacter | Nitrobacteraceae<br>Thiobacillus |
| Aerobic | Oxidize organic compounds | Pseudomonas<br>Acetobacter | Pseudomonadaceae |
| Facultative aneobic | | Photobacterium<br>Zymomonas<br>Aeromonas | |

Motility: Motile with polar flagella

| Other distinguishing characteristics | Genera | | |
|---|---|---|---|
| | Aerobic | Bacillus | Families |
| Comma-shaped | Aerobic | Vibro | Spirllaceae |
| | | Desulfovibrio | |
| Spiral | Anaerobic | Spirillum | |

## III. Other major groups

| Other distinguishing characteristics | Genera | Families |
|---|---|---|
| Acid-fast rods | Mycobacterium | Actinomycetales |
| | Nocardia | |
| Ray-forming rods (actinomycetes) | Streptomyces | Actinomyces |
| | Treponema | |
| | Borrelia | |
| | Leptospira | |
| Spiral organisms, motile | Spirocheta | Spirochetales |
| Small, pleomorphic; lack rigid wall | Mycoplasma | Mycoplasmataceae |
| | Rickettsia | |
| Small intracellular parasites | Coxiella | Rickettsiaceae |
| Small intracellular parasites, readily filterable | Chlamydia | Chlamydiaceae |
| Intracellular parasites; borderline with protoza | Bartonella | Bartonellaceae |

*Some of these traditional names have been officially replaced. (Modified from Stanier RY et al: The microbial world. Prentice Hall, Englewood Clifffs, NJ, 1963).

Bacteria are classified as follows:
Kingdom: Monera (Prokaryotae)
Division/Phylum: Gracillcutes
Subphylum:
Class: Scotobacteria
Order: Spirochaetales
Family: Spirochaetaceae
Genus: Treonema
Specific Epithet: pallidum
Subspecies(strain):

### Sources

1. Bergey's manual of systematic bacteriology, 2nd edn. Springer-Verlag, New York, April 2001.
2. The web page "www/bacterio.cict.fr/" is a source for the complete identification of all bacteria and viruses using Bergey's classification of bacteria.

## b. Classification of bacteria

### *Domain "Archaea"*

Phylum A1. *Crenarchaeota phy. nov.*
Class I. *Thermoprotei class. mov.*
Order I. *Thermoproteales*
*Family I. Thermoproteaceae*
*Genus I. Thermoproteus*
*Genus II. Caldivirga*
*Genus III. Pyrobaculum*
*Genus IV. Thermocladium*
*Family II. Thermofilaceae*
*Genus I. Thermofilum*
Order II. *Desulfurococcales ord. nov.*
*Family I. Desulfurococcaceae*
*Genus I. Desulfurococcus*
*Genus II. Acidolobus*
*Genus III. Aeropyrum*
*Genus IV. Ignicoccus*
*Genus V. Staphylothermus*
*Genus VI. Stetteria*
*Genus VII. Sulfophobococcus*
*Genus VIII. Thermodiscus gen. nov.*
*Genus IX. Thermosphaera*
*Family II. Pyrodictiaceae*
*Genus I. Pyrodictium*
*Genus II. Hyperthermus*
*Genus III. Pyrolobus*
Order III. *Sulfolobales*
*Family I. Sulfolobaceae*
*Genus I. Sulfolobus*
*Genus II. Acidianus*
*Genus III. Metallosphaera*
*Genus IV. Stygiolobus*
*Genus V. Sulfurisphaera*
*Genus VI. Sulfurococcus*

- Phylum AII. *Euryarchaeota phy. nov.*
  - Class I. *Methanobacteria class. nov.*
    - Order I. *Methanobacteriales*
      - *Family I. Methanobacteriaceae*
        - *Genus I. Methanobacterium*
        - *Genus II. Methanobrevibacter*
        - *Genus III. Methanosphaera*
        - *Genus IV. Methanothermobacter*
      - *Family II. Methanothermaceae*
        - *Genus I. Methanothermus*
  - Class II. *Methanococci class. nov.*
    - Order I. *Methanococcales*
      - *Family I. Methanococcaceae*
        - *Genus I. Methanococcus*
        - *Genus II. Methanothermococcus gen. nov.*
      - *Family II. Methanocaldococcacae fam. nov.*
        - *Genus I. Methanocaldococus gen. nov.*
        - *Genus II. Methanotorris gen. nov.*
    - Order II. *Methanomicrobiales*
      - *Family I. Methanomicrobiaceae*
        - *Genus I. Methanomicrobium*
        - *Genus II. Methanoculleus*
        - *Genus III. Methanofollis*
        - *Genus IV. Methanogenium*
        - *Genus V. Methanolacinia*
        - *Genus VI. Methanoplanus*
      - *Family II. Methanocorpusculaceae*
        - *Genus I. Methanocorpusculum*
      - *Family III. Methanospirillaceae fam. nov.*
        - *Genus I. Methanospirillum*
      - *Genera incertae sedis*
        - *Genus I. Methanocalculus*
    - Order III. *Methanosarcinales ord. nov.*
      - *Family I. Methanosarcinaceae*
        - *Genus I. Methanosarcina*
        - *Genus II. Methanococcoides*
        - *Genus III. Methanohalobium*
        - *Genus IV. Methanohalophilus*
        - *Genus V. Methanolobus*
        - *Genus VI. Methanomicrococcus*
        - *Genus VII. Methanosalsum gen. nov.*
      - *Family II. Methanosaetaceae fam. nov.*
        - *Genus I. Methanosaeta*
  - Class III. *Halobacteria class. nov.*
    - Order I. *Halobacteriales*
      - *Family I. Halobacteriaceae*
        - *Genus I. Halobacterium*
        - *Genus II. Haloarcula*
        - *Genus III. Halobaculum*
        - *Genus IV. Halococcus*
        - *Genus V. Haloferax*
        - *Genus VI. Halogeometricum*
        - *Genus VII. Halorhabdus*
        - *Genus VIII. Halorubrum*
        - *Genus IX. Haloterrigena*
        - *Genus X. Natrialba*
        - *Genus XI. Natrinema*
        - *Genus XII. Natronobacterium*
        - *Genus XIII. Natronococcus*
        - *Genus XIV. Natronomonas*
        - *Genus XV. Natronorubrum*
  - Class IV. *Thermoplasmata class. nov.*
    - Order I. *Thermoplasmatales ord. nov.*
      - *Family I. Thermoplasmataceae fam. nov.*
        - *Genus I. Thermoplasma*
      - *Family II. Picrophilaceae*
        - *Genus I. Picrophilus*
      - *Family III. Ferroplasmatacaea*
        - *Genus I. Ferroplasma*
  - Class V. *Thermococci class. nov.*
    - Order I. *Thermococcales*
      - *Family I. Thermococcaceae*
        - *Genus I. Thermococcus*
        - *Genus II. Palaeococcus*
        - *Genus III. Pyrococcus*
  - Class VI. *Archaeoglobi class. nov.*
    - Order I. *Archaeoglobales ord. nov.*

- *Family I. Archaeoglobaceae fam. nov.*
  - *Genus I. Archaeoglobus*
  - *Genus II. Ferroglobus*
- Class VII. *Methanopyri class. nov.*
  - Order I. *Methanopyrales ord. nov.*
    - *Family I. Methanopyraceae fam. nov.*
      - *Genus I. Methanopyrus*

***Domain "Bacteria"***

- Phylum BI. *Aquificae phy. nov.*
  - Class I. *Aquificae class. nov.*
    - Order I. *Aquificales ord. nov.*
      - *Family I. Aquificaceae fam. nov.*
        - *Genus I. Aquifex*
        - *Genus II. Calderobacterium*
        - *Genus III. Hydrogenobacter*
        - *Genus IV. Thermocrinis*
      - *Genera incertae sedis*
        - *Genus I. Desulfurobacterium*
- Phylum BII. *Thermotogae phy. nov.*
  - Class I. *Thermotogae class. nov.*
    - Order I. *Thermotogales ord. nov.*
      - *Family I. Thermotogaceae fam. nov.*
        - *Genus I. Thermotoga*
        - *Genus II. Fervidobacterium*
        - *Genus III. Geotoga*
        - *Genus IV. Petrotoga*
        - *Genus V. Thermosipho*
- Phylum BIII. *Thermodesulfobacteria phy. nov.*
  - Class I. *Thermodesulfobacteria class. nov.*
    - Order I. *Thermodesulfobacteriales ord. nov.*
      - *Family I. Thermodesulfobacteriaceae fam. nov.*
        - *Genus I. Thermodesulfobacterium*
- Phylum BIV. *"Deinococcus-Thermus"*
  - Class I. *Deinococci class. nov.*
    - Order I. *Deionococcales*
      - *Family I. Deinococcaceae*
        - *Genus I. Deinococcus*
    - Order II. *Thermales ord. nov.*
      - *Family I. Thermaceae fam. nov.*
        - *Genus I. Thermus*
        - *Genus II. Meiothermus*
- Phylum BV. *Chrysiogenetes phy. nov.*
  - Class I. *Chrysiogenetes class. nov.*
    - Order I. *Chrysiogenales ord. nov.*
      - *Family I. Chrysiogenaceae fam. nov.*
        - *Genus I. Chrysiogenes*
- Phylum BVI. *Chloroflexi phy. nov.*
  - Class I. *"Chloroflexi"*
    - Order I. *"Chloroflexales"*
      - *Family I. "Chloroflexaceae"*
        - *Genus I. Chloroflexus*
        - *Genus II. Chloronema*
        - *Genus III. Heliothrix*
      - *Family II. Oscillochloridaceae*
        - *Genus I. Oscillochloris (moved)*
    - Order II. *"Herpetosiphonales"*
      - *Family I. "Herpetosiphonaceae"*
        - *Genus I. Herpetosiphon*
- Phylum BVII. *Thermomicrobia phy. nov.*
  - Class I. *Thermomicrobia class. nov.*
    - Order I. *Thermomicrobiales ord. nov.*
      - *Family I. Thermomicrobiaceae fam. nov.*
        - *Genus I. Thermomicrobium*
- Phylum BVIII. *Nitrospira phy. nov.*
  - Class I. *"Nitrospira"*
    - Order I. *"Nitrospirales"*
      - *Family I. "Nitrospiraceae"*
        - *Genus I. Nitrospira*
        - *Genus II. Leptospirillum*
        - *Genus III. Magnetobacterium*
        - *Genus IV. Thermodesulfovibrio*
- Phylum BIX. *Deferribacteres phy. nov.*
  - Class I. *Deferribacteres class. nov.*
    - Order I. *Deferribacterales ord. nov.*
      - *Family I. Deferribacteraceae fam. nov.*
        - *Genus I. Deferribacter*
        - *Genus II. Denitrovibrio*

- *Genus III. Flexistipes*
- *Genus IV. Geovibrio*
- *Genera incertae sedis*
  - *Genus I. Synergistes*

Phylum BX. *Cyanobacteria*
- Class I. *"Cyanobacteria"*
  - Subsection I.
    - *Family I.*
      - *Form genus I. Chamaesiphon*
      - *Form genus II. Chroococcus*
      - *Form genus III. Cyanobacterium*
      - *Form genus IV. Cyanobium*
      - *Form genus V. Cyanothece*
      - *Form genus VI. Dactylococcopsis*
      - *Form genus VII. Gloeobacter*
      - *Form genus VIII. Gloeocapsa*
      - *Form genus IX. Gloeothece*
      - *Form genus X. Microcystis*
      - *Form genus XI. Prochlorococcus*
      - *Form genus XII. Prochloron*
      - *Form genus XIII. Synechococcus*
      - *Form genus XIV. Synechocystis*
  - Subsection II.
    - *Family I.*
      - *Form genus I. Cyanocystis*
      - *Form genus II. Dermocarpella*
      - *Form genus III. Stanieria*
      - *Form genus IV. Xenococcus*
    - *Family II.*
      - *Form genus I. Chroococcidiopsis*
      - *Form genus II. Myxosarcina*
      - *Form genus III. Pleurocapsa*
  - Subsection III.
    - *Family I.*
      - *Form genus I. Arthrospira*
      - *Form genus II. Borzia*
      - *Form genus III. Crinalium*
      - *Form genus IV. Geitlerinema*
      - *Genus V. Halospirulina*
      - *Form genus VI. Leptolyngbya*
      - *Form genus VII. Limnothrix*
      - *Form genus VIII. Lyngbya*
      - *Form genus IX. Microcoleus*
      - *Form genus X. Oscillatoria*
      - *Form genus XI. Planktothrix*
      - *Form genus XII. Prochlorothrix*
      - *Form genus XIII. Psuedanabaena*
      - *Form genus XIV. Spirulina*
      - *Form genus XV. Starria*
      - *Form genus XVI. Symploca*
      - *Genus XVII. Trichodesmium*
      - *Form genus XVIII. Tychonema*
  - Subsection IV.
    - *Family I.*
      - *Form genus I. Anabaena*
      - *Form genus II. Anabaenopsis*
      - *Form genus III. Aphanizomenon*
      - *Form genus IV. Cyanospira*
      - *Form genus V. Cylindrospermopsis*
      - *Form genus VI. Cylindrospermum*
      - *Form genus VII. Nodularia*
      - *Form genus VIII. Nostoc*
      - *Form genus IX. Scytonema*
    - *Family II.*
      - *Form genus I. Calothrix*
      - *Form genus II. Rivularia*
      - *Form genus III. Tolypothrix*
  - Subsection V.
    - *Family I.*
      - *Form genus I. Chlorogloeopsis*
      - *Form genus II. Fischerella*
      - *Form genus III. Geitleria*
      - *Form genus IV. Iyengariella*
      - *Form genus V. Nostochopsis*
      - *Form genus VI. Stigonema*

Phylum BXI. *Chlorobi phy. nov.*
- Class I. *"Chlorobia"*
  - Order I. *Chlorobiales*
    - *Family I. Chlorobiaceae*
      - *Genus I. Chlorobium*
      - *Genus II. Ancalochloris*
      - *Genus III. Chloroherpeton*

            - *Genus IV. Pelodictyon*
            - *Genus V. Prosthecochloris*

- Phylum BXII. *Proteobacteria phy. nov.*
    - Class I. *"Alphaproteobacteria"*
        - Order I. *Rhodospirillales*
            - *Family I. Rhodospirillaceae*
                - *Genus I. Rhodospirillum*
                - *Genus II. Azospirillum*
                - *Genus III. Magnetospirillum*
                - *Genus IV. Phaeospirillum*
                - *Genus V. Rhodocista*
                - *Genus VI. Rhodospira*
                - *Genus VII. Rhodothalassium*
                - *Genus VIII. Rhodovibrio*
                - *Genus IX. Roseospira*
                - *Genus X. Skermanella*
            - *Family II. Acetobacteraceae*
                - *Genus I. Acetobacter*
                - *Genus II. Acidiphilium*
                - *Genus III. Acidisphaera*
                - *Genus IV. Acidocella*
                - *Genus V. Acidomonas*
                - *Genus VI. Asaia*
                - *Genus VII. Craurococcus*
                - *Genus VIII. Gluconacetobacter*
                - *Genus IX. Gluconobacter*
                - *Genus X. Paracraurococcus*
                - *Genus XI. Rhodopila*
                - *Genus XII. Roseococcus*
                - *Genus XIII. Stella*
                - *Genus XIV. Zavarzinia*
        - Order II. *Rickettsiales*
            - *Family I. Rickettsiaceae*
                - *Genus I. Rickettsia*
                - *Genus II. Orientia*
                - *Genus III. Wolbachia*
            - *Family II. Ehrlichiaceae*
                - *Genus I. Ehrlichia*
                - *Genus II. Aegyptianella*
                - *Genus III. Anaplasma*
                - *Genus IV. Cowdria*
                - *Genus V. Neorickettsia*
                - *Genus VI. Xenohaliotis*
            - *Family III. "Holosporaceae"*
                - *Genus I. Holospora*
                - *Genus II. Caedibacter*
                - *Genus III. Lyticum*
                - *Genus IV. Polynucleobacter*
                - *Genus V. Pseudocaedibacter*
                - *Genus VI. Symbiotes*
                - *Genus VII. Tectibacter*
                - *Genus VIII. Odyssella*
        - Order III. *"Rhodobacterales"*
            - *Family I. "Rhodobacteraceae"*
                - *Genus I. Rhodobacter*
                - *Genus II. Ahrensia*
                - *Genus III. Amaricoccus*
                - *Genus IV. Antarctobacter*
                - *Genus V. Gemmobacter*
                - *Genus VI. Hirschia*
                - *Genus VII. Hyphomonas*
                - *Genus VIII. Maricaulis*
                - *Genus IX. Methylarcula*
                - *Genus X. Octadecabacter*
                - *Genus XI. Paracoccus*
                - *Genus XII. Rhodovulum*
                - *Genus XIII. Roseibium*
                - *Genus XIV. Roseinatronobacter*
                - *Genus XV. Roseivivax*
                - *Genus XVI. Roseobacter*
                - *Genus XVII. Roseovarius*
                - *Genus XVIII. Rubrimonas*
                - *Genus XIX. Ruegaria*
                - *Genus XX. Sagittula*
                - *Genus XXI. Staleya*
                - *Genus XXII. Stappia*
                - *Genus XXIII. Sulfitobacter*
        - Order IV. *"Sphingomonadales"*
            - *Family I. Sphingomonadaceae*
                - *Genus I. Sphingomonas*
                - *Genus II. Blastomonas*
                - *Genus III. Erythrobacter*
                - *Genus IV. Erythromicrobium*
                - *Genus V. Erythromonas*
                - *Genus VI. Porphyrobacter*

- *Genus VII. Rhizomonas*
- *Genus VIII. Sandaracinobacter*
- *Genus IX. Zymomonas*

Order V. *Caulobacterales*
- *Family I. Caulobacteraceae*
  - *Genus I. Caulobacter*
  - *Genus II. Asticcacaulis*
  - *Genus III. Brevundimonas*
  - *Genus IV. Phenylobacterium*

Order VI. *"Rhizobiales"*
- *Family I. Rhizobiaceae*
  - *Genus I. Rhizobium*
  - *Genus II. Agrobacterium*
  - *Genus III. Carbophilus*
  - *Genus IV. Chelatobacter*
  - *Genus V. Ensifer*
  - *Genus VI. Sinorhizobium*
- *Family II. Bartonellaceae*
  - *Genus I. Bartonella*
- *Family III. Brucellaceae*
  - *Genus I. Brucella*
  - *Genus II. Mycoplana*
  - *Genus III. Ochrobactrum*
- *Family IV. "Phyllobacteriaceae"*
  - *Genus I. Phyllobacterium*
  - *Genus II. Allorhizobium*
  - *Genus III. Aminobacter*
  - *Genus IV. Aquamicrobium*
  - *Genus V. Defluvibacter*
  - *Genus VI. Mesorhizobium*
  - *Genus VII. Pseudaminobacter*
- *Family V. "Methylocystaceae"*
  - *Genus I. Methylocystis*
  - *Genus II. Methylopila*
  - *Genus III. Methylosinus*
- *Family VI. "Beijerinckiaceae"*
  - *Genus I. Beijerinckia*
  - *Genus II. Chelatococcus*
  - *Genus III. Derxia*
  - *Genus IV. Methylocella*
- *Family VII. "Bradyrhizobiaceae"*
  - *Genus I. Bradyrhizobium*
  - *Genus II. Afipia*
  - *Genus III. Agromonas*
  - *Genus IV. Blastobacter*
  - *Genus V. Bosea*
  - *Genus VI. Nitrobacter*
  - *Genus VII. Oligotropha*
  - *Genus VIII. Rhodopseudomonas*
- *Family VIII. Hyphomicrobiaceae*
  - *Genus I. Hyphomicrobium*
  - *Genus II. Ancalomicrobium*
  - *Genus III. Ancylobacter*
  - *Genus IV. Angulomicrobium*
  - *Genus V. Aquabacter*
  - *Genus VI. Azorhizobium*
  - *Genus VII. Blastochloris*
  - *Genus VIII. Devosia*
  - *Genus IX. Dichotomicrobium*
  - *Genus X. Filomicrobium*
  - *Genus XI. Gemmiger*
  - *Genus XII. Labrys*
  - *Genus XIII. Methylorhabdus*
  - *Genus XIV. Pedomicrobium*
  - *Genus XV. Prosthecomicrobium*
  - *Genus XVI. Rhodomicrobium*
  - *Genus XVII. Rhodoplanes*
  - *Genus XVIII. Seliberia*
  - *Genus XIX. Starkeya*
  - *Genus XX. Xanthobacter*
- *Family IX. "Methylobacteriaceae"*
  - *Genus I. Methylobacterium*
  - *Genus II. Protomonas*
  - *Genus III. Roseomonas*
- *Family X. "Rhodobiaceae"*
  - *Genus I. Rhodobium*

Class II. *"Betaproteobacteria"*

Order I. *"Burkholderiales"*
- *Family I. "Burkholderiaceae"*
  - *Genus I. Burkholderia*
  - *Genus II. Cupriavidus*
  - *Genus III. Lautropia*
  - *Genus IV. Pandoraea*
  - *Genus V. Thermothrix*
- *Family II. "Ralstoniaceae"*
  - *Genus I. Ralstonia*

*Family III. "Oxalobacteraceae"*
*Genus I. Oxalobacter*
*Genus II. Duganella*
*Genus III. Herbaspirillum*
*Genus IV. Janthinobacterium*
*Genus V. Massilia*
*Genus VI. Telluria*
*Family IV. Alcaligenaceae*
*Genus I. Alcaligenes*
*Genus II. Achromobacter*
*Genus III. Bordetella*
*Genus IV. Pelistega*
*Genus V. Sutterella*
*Genus VI. Taylorella*
*Family V. Comamonadaceae*
*Genus I. Comamonas*
*Genus II. Acidovorax*
*Genus III. Aquabacterium*
*Genus IV. Brachymonas*
*Genus V. Delftia*
*Genus VI. Hydrogenophaga*
*Genus VII. Ideonella*
*Genus VIII. Leptothrix*
*Genus IX. Polaromonas*
*Genus X. Rhodoferax*
*Genus XI. Roseateles*
*Genus XII. Rubrivivax*
*Genus XIII. Sphaerotilus*
*Genus XIV. Tepidimonas*
*Genus XV. Thiomonas*
*Genus XVI. Variovorax*
Order II. *"Hydrogenophilales"*
*Family I. "Hydrogenophilaceae"*
*Genus I. Hydrogenophilus*
*Genus II. Thiobacillus*
Order III. *"Methylophilales"*
*Family I. "Methylophilaceae"*
*Genus I. Methylophilus*
*Genus II. Methylobacillus*
*Genus III. Methylovorus*
Order IV. *"Neisseriales"*
*Family I. Neisseriaceae*
*Genus I. Neisseria*
*Genus II. Alysiella*
*Genus III. Aquaspirillum*
*Genus IV. Catenococcus*
*Genus V. Chromobacterium*
*Genus VI. Eikenella*
*Genus VII. Formivibrio*
*Genus VIII. Iodobacter*
*Genus IX. Kingella*
*Genus X. Microvirgula*
*Genus XI. Prolinoborus*
*Genus XII. Simonsiella*
*Genus XIII. Vitreoscilla*
*Genus XIV. Vogesella*
Order V. *"Nitrosomonadales"*
*Family I. "Nitrosomonadaceae"*
*Genus I. Nitrosomonas*
*Genus II. Nitrosospira*
*Family II. Spirillaceae*
*Genus I. Spirillum*
*Family III. Gallionellaceae*
*Genus I. Gallionella*
Order VI. *"Rhodocyclales"*
*Family I. "Rhodocyclaceae"*
*Genus I. Rhodocyclus*
*Genus II. Azoarcus*
*Genus III. Azonexus*
*Genus IV. Azospira*
*Genus V. Azovibrio*
*Genus VI. Ferribacterium*
*Genus VII. Propionibacter*
*Genus VIII. Propionivibrio*
*Genus IX. Thauera*
*Genus X. Zoogloea*
Class III. *"Gammaproteobacteria"*
Order I. *"Chromatiales"*
*Family I. Chromatiaceae*
*Genus I. Chromatium*
*Genus II. Allochromatium*
*Genus III. Amoebobacter*
*Genus IV. Halochromatium*
*Genus V. Halothiobacillus*
*Genus VI. Isochromatium*
*Genus VII. Lamprobacter*

*Genus VIII. Lamprocystis*
*Genus IX. Marichromatium*
*Genus X. Nitrosococcus*
*Genus XI. Pfennigia*
*Genus XII. Rhabdochromatium*
*Genus XIII. Thermochromatium*
*Genus XIV. Thioalkalicoccus*
*Genus XV. Thiocapsa*
*Genus XVI. Thiococcus*
*Genus XVII. Thiocystis*
*Genus XVIII. Thiodictyon*
*Genus XIX.*
*Genus XX. Thiohalocapsa*
*Genus XXI. Thiolamprovum*
*Genus XXII. Thiopedia*
*Genus XXIII. Thiorhodococcus*
*Genus XXIV. Thiorhodovibrio*
*Genus XXV. Thiospirillum*
*Family II. Ectothiorhodospiraceae*
*Genus I. Ectothiorhodospira*
*Genus II. Arhodomonas*
*Genus III. Halorhodospira*
*Genus IV. Nitrococcus*
*Genus V. Thiorhodospira*
Order II. *Acidithiobacillales*
*Family I. Acidithiobacillaceae*
*Genus I. Acidithiobacillus*
*Family II. Thermithiobacillaceae*
*Genus I. Thermithiobacillus*
Order III. “*Xanthomonadales*”
*Family I. “Xanthomonadaceae”*
*Genus I. Xanthomonas*
*Genus II. Frateuria*
*Genus III. Luteimonas*
*Genus IV. Lysobacter*
*Genus V. Nevskia*
*Genus VI. Pseudoxanthomonas*
*Genus VII. Rhodanobacter*
*Genus VIII. Stenotrophomonas*
*Genus IX. Xylella*
Order IV. “*Cardiobacteriales*”
*Family I. Cardiobacteriaceae*
*Genus I. Cardiobacterium*
*Genus II. Dichelobacter*
*Genus III. Suttonella*
Order V. “*Thiotrichales*”
*Family I. “Thiotrichaceae”*
*Genus I. Thiothrix*
*Genus II. Achromatium*
*Genus III. Beggiatoa*
*Genus IV. Leucothrix*
*Genus V. Macromonas*
*Genus VI. Thiobacterium*
*Genus VII. Thiomargarita*
*Genus VIII. Thioploca*
*Genus IX. Thiospira*
*Family II. “Piscirickettsiaceae”*
*Genus I. Piscirickettsia*
*Genus II. Cycloclasticus*
*Genus III. Hydrogenovibrio*
*Genus IV. Methylophaga*
*Genus V. Thiomicrospira*
*Family III. “Francisellaceae”*
*Genus I. Francisella*
Order VI. “*Legionellales*”
*Family I. Legionellaceae*
*Genus I. Leionella*
*Family II. “Coxiellaceae”*
*Genus I. Coxiella*
*Genus II. Rickettsiella*
Order VII. “*Methylococcales*”
*Family I. Methylocaccaceae*
*Genus I. Methylococcus*
*Genus II. Methylobacter*
*Genus III. Methylocaldum*
*Genus IV. Methylomicrobium*
*Genus V. Methylomonas*
*Genus VI. Methylosphaera*
Order VIII. “*Oceanspirillales*”
*Family I. “Oceanospirillaceae”*
*Genus I. Oceanospirillum*
*Genus II. Balneatrix*
*Genus III. Fundibacter*
*Genus IV. Marinomonas*
*Genus V. Marinospirillum*
*Genus VI. Neptunomonas*

  - *Family II. Halomonadaceae*
    - *Genus I. Halomonas*
    - *Genus II. Alcanivorax*
    - *Genus III. Carnimonas*
    - *Genus IV. Chromohalobacter*
    - *Genus V. Deleya*
    - *Genus VI. Zymobacter*
- Order IX. *Pseudomonadales*
  - *Family I. Pseudomonadaceae*
    - *Genus I. Pseudomonas*
    - *Genus II. Azomonas*
    - *Genus III. Azotobacter*
    - *Genus IV. Cellvibrio*
    - *Genus V. Chryseomonas*
    - *Genus VI. Flaviomonas*
    - *Genus VII. Lampropedia*
    - *Genus VIII. Mesophilobacter*
    - *Genus IX. Morococcus*
    - *Genus X. Oligella*
    - *‘Genus XI. Rhizobacter*
    - *Genus XII. Rugamonas*
    - *Genus XIII. Serpens*
    - *Genus XIV. Thermoleophilum*
    - *Genus XV. Xylophilus*
  - *Family II. Moraxellaceae*
    - *Genus I. Moraxella*
    - *Genus II. Acinetobacter*
    - *Genus III. Psychrobacter*
- Order X. *“Alteromonadales”*
  - *Family I. “Alteromonadaceae”*
    - *Genus I. Alteromonas*
    - *Genus II. Allishewanella*
    - *Genus III. Colwellia*
    - *Genus IV. Ferrimonas*
    - *Genus V. Glaciecola*
    - *Genus VI. Idiomarina*
    - *Genus VII. Marinobacter*
    - *Genus VIII. Marinobacterium*
    - *Genus IX. Microbulbifer*
    - *Genus X. Moritella*
    - *Genus XI. Pseudoalteromonas*
    - *Genus XII. Shewanella*
- Order XI. *“Vibrionales”*
  - *Family I. Vibrionaceae*
    - *Genus I. Vibrio*
    - *Genus II. Allomonas*
    - *Genus III. Enhydrobacter*
    - *Genus IV. Listonella*
    - *Genus V. Photobacterium*
    - *Genus VI. Salinivibrio*
- Order XII. *“Aeromonadales”*
  - *Family I. Aeromonadaceae*
    - *Genus I. Aeromonas*
    - *Genus II. Oceanomonas*
    - *Genus III. Tolumonas*
  - *Family II. Succinivibrionaeae*
    - *Genus I. Succinivibrio*
    - *Genus II. Anaerobiospirillum*
    - *Genus III. Ruminobacter*
    - *Genus IV. Succinimonas*
- Order XIII. *“Enterobacteriales”*
  - *Family I. Enterobacteriaceae*
    - *Genus I. Enterobacter*
    - *Genus II. Alterococcus*
    - *Genus III. Arsenophonus*
    - *Genus IV. Brenneria*
    - *Genus V. Buchnera*
    - *Genus VI. Budvicia*
    - *Genus VII. Buttiauxella*
    - *Genus VIII. Calymmatobacterium*
    - *Genus IX. Cedecea*
    - *Genus X. Citrobacter*
    - *Genus XI. Edwardsiella*
    - *Genus XII. Erwinia*
    - *Genus XIII. Escherichia*
    - *Genus XIV. Ewingella*
    - *Genus XV. Hafnia*
    - *Genus XVI. Klebsiella*
    - *Genus XVII. Kluyvera*
    - *Genus XVIII. Leclercia*
    - *Genus XIX. Leminorela*
    - *Genus XX. Moellerella*
    - *Genus XXI. Morganella*
    - *Genus XXII. Obesumbacterium*
    - *Genus XXIII. Pantoea*
    - *Genus XXIV. Pectobacterium*

- *Genus XXV. Photorhabdus*
- *Genus XXVI. Plesiomonas*
- *Genus XXVII. Pragia*
- *Genus XXVIII. Proteus*
- *Genus XXIX. Providencia*
- *Genus XXX. Rahnella*
- *Genus XXXI. Saccharobacter*
- *Genus XXXII. Salmonella*
- *Genus XXXIII. Serratia*
- *Genus XXXIV. Shigella*
- *Genus XXXV. Sodalis*
- *Genus XXXVI. Tatumella*
- *Genus XXXVII. Trabulsiella*
- *Genus XXXVIII. Wigglesworthia*
- *Genus XXXIX. Xenorhabdus*
- *Genus XL. Yersinia*
- *Genus XLI. Yokenella*
- Order XIV. *"Pasteurellales"*
  - *Family I. Pasteurellaceae*
    - *Genus I. Pasteurella*
    - *Genus II. Actinobacillus*
    - *Genus III. Hamemorphilus*
    - *Genus IV. Lonepinella*
    - *Genus V. Mannheimia*
    - *Genus VI. Phocoenobacter*
- Class IV. *"Deltaproteobacteria"*
  - Order I. *"Desulfurellales"*
    - *Family I. "Desulfurellaceae"*
      - *Genus I. Desulfurella*
      - *Genus II. Hippea*
  - Order II. *"Desulfovibrionales"*
    - *Family I. "Desulfovibrionacea"*
      - *Genus I. Desulfovibrio*
      - *Genus II. Bilophila*
      - *Genus III. Lawsonia*
    - *Family II. "Desulfomicrobiacea"*
      - *Genus I. Desulfomicrobium*
    - Family III. ***"Desullfohalobiaceae"***
      - *Genus I. Desulfohalobium*
      - *Genus II. Desulfomonas*
      - *Genus III. Desulfonatronovibrio*
    - *Family IV. "Desulfonatronumaceae"*
      - *Genus I.* ***Desullfonatronum***
  - Order III. *"Desulfobacterales"*
    - *Family I. "Desulfobacteraceae"*
      - *Genus I. Desulfobacter*
      - *Genus II. Desulfobacerium*
      - *Genus III. Desulfobacula*
      - *Genus IV. Desulfocella*
      - *Genus V. Desulfococcus*
      - *Genus VI. Desulfofaba*
      - *Genus VII. Desulfofrigus*
      - *Genus VIII. Desulfonema*
      - *Genus IX. Desulfosarcina*
      - *Genus X. Desulfospira*
      - *Genus XI.* ***Desullfotalea***
      - *Genus XII. Desulfotignum*
    - *Family II. "Desulfobulbaceae"*
      - *Genus I. Desulfobulbus*
      - *Genus II. Desulfocapsa*
      - *Genus III. Desulfofustus*
      - *Genus IV. Desulforhopalus*
    - *Family III. "Nitrospinaceae"*
      - *Genus I. Nitrospina*
      - *Genus II. Desulfobacca*
      - *Genus III. Desulfomonile*
  - Order IV. *"Desulfuromonadales"*
    - *Family I. "Desulfuromonadaceae"*
      - *Genus I. Desulfuromonas*
      - *Genus II. Desulfuromusa*
    - *Family II. "Geobacteraceae"*
      - *Genus I. Geobacter*
    - *Family III. "Pelobacteraceae"*
      - *Genus I. Pelobacter*
      - *Genus II. Malonomonas*
      - *Genus III. Trichlorobacter*
  - Order V. *"Syntrohobacterales"*
    - *Family I. "Syntrophobacteraceae"*
      - *Genus I. Syntrophobacter*
      - *Genus II. Desulfacinum*
      - *Genus III. Desulforhabdus*
      - *Genus IV. Desulfovirga*
      - *Genus V. Thermodesulforhabdus*
    - *Family II. "Syntrophaceae"*
      - *Genus I. Syntroiphus*
      - *Genus II. Smithella*

- Order VI. “*Bdelloovibrionales*”
  - *Family I. “Bdellovibrionaceae”*
    - *Genus I. Bdellovibrio*
    - *Genus II. Bacteriovorax*
    - *Genus III. Micavibrio*
    - *Genus IV. Vampirovibrio*
- Order VII. *Myxococcales*
  - *Family I. Myxococcaceae*
    - *Genus I. Myxococcus*
    - *Genus II. Angiococcus*
  - *Family II. Archangiaceae*
    - *Genus Archangium*
  - *Family III. Cystobacteraceae*
    - *Genus I. Cystobacter*
    - *Genus II. Melittangium*
    - *Genus III. Stigmatella*
  - *Family IV. Polyangiaceae*
    - *Genus I. Polyangium*
    - *Genus II. Chondromyces*
    - *Genus III. Nannocystis*

Class V. “*Epsilonproteobacteria*”
- Order I. “*Campylobacterales*”
  - *Family I. Campylobacteraceae*
    - *Genus I. Campylobacter*
    - *Genus II. Arobacter*
    - *Genus III. Sulfurospirillum*
    - *Genus IV. Thiovulum*
  - *Family II. “Helicobavteraceae”*
    - *Genus I. Helicobacter*
    - *Genus II. Wolinella*

Phylum BXIII. *Firmicutes*

Class I. “*Clostridia*”
- Order I. *Clostridiales*
  - *Family I. Clostridiaceae*
    - *Genus I. Clostridium*
    - *Genus II. Acetivibrio*
    - *Genus III. Acidaminobacter*
    - *Genus IV. Anaerobacter*
    - *Genus V. Caloramator*
    - *Genus VI. Coprobacillus*
    - *Genus VII. Natronincola*
    - *Genus VIII. Oxobacter*
    - *Genus IX. Sarcina*
    - *Genus X. Sporobacter*
    - *Genus XI. Thermobrachium*
    - *Genus XII. Thermohalobacter*
    - *Genus XIII. Tindallia*
  - *Family II. “Lachnospiraceae”*
    - *Genus I. Lachnospira*
    - *Genus II. Acetitomaculum*
    - *Genus III. Anaerofilum*
    - *Genus IV. Butyrivibrio*
    - *Genus V. Catenibacterium*
    - *Genus VI. Catonella*
    - *Genus VII. Coprococcus*
    - *Genus VIII. Johnsonella*
    - *Genus IX. Pseudobutyrivibrio*
    - *Genus X. Roseburia*
    - *Genus XI. Ruminococcus*
    - *Genus XII. Sporobacterium*
  - *Family III. “Peptostreptococcaceae”*
    - *Genus I. Peptostreptococcus*
    - *Genus II. Filifactor*
    - *Genus III. Finegoldia*
    - *Genus IV. Fusibacter*
    - *Genus V. Helcococcus*
    - *Genus VI. Micromonas*
    - *Genus VII. Tissierella*
  - *Family IV. “Eubacteriaceae”*
    - *Genus I. Eubacterium*
    - *Genus II. Acetobacterium*
    - *Genus III. Anaerovorax*
    - *Genus IV. Mogibacterium*
    - *Genus V. Pseudoramibacter*
  - *Family V. Peptococcaceae*
    - *Genus I. Peptococcus*
    - *Genus II. Anaeroarcus*
    - *Genus III. Anaerosinus*
    - *Genus IV. Anaerovibrio*
    - *Genus V. Carboxydothermus*
    - *Genus VI. Centipeda*
    - *Genus VII. Dehalobacter*
    - *Genus VIII. Dendrosporobacter*
    - *Genus IX. Desulfitobacterium*
    - *Genus X. Desulfonispora*

- *Genus XI. Desulfosporosinus*
- *Genus XII. Desulfotomaculum*
- *Genus XIII. Mitsuokella*
- *Genus XIV. Propionispira*
- *Genus XV. Succinispira*
- *Genus XVI. Syntrophobotulus*
- *Genus XVII. Thermoterrabacterium*

*Family VI. "Heliobacteriaceae"*
- *Genus I. Heliobacterium*
- *Genus II. Heliobacillus*
- *Genus III. Heliophilum*
- *Genus IV. Heliorestis*

*Family VII. "Acidaminococcaceae"*
- *Genus I. Acidaminococcus*
- *Genus II. Acetonema*
- *Genus III. Anaeromusa*
- *Genus IV. Dialister*
- *Genus V. Megasphaera*
- *Genus VI. Papillibacter*
- *Genus VII. Pectinatus*
- *Genus VIII. Phascolarctobacterium*
- *Genus IX. Quinella*
- *Genus X. Schwartzia*
- *Genus XI. Selenomonas*
- *Genus XII. Sporomusa*
- *Genus XIII. Succiniclasticum*
- *Genus XIV. Veillonella*
- *Genus XV. Zymophilus*

*Family VIII. Syntrophomonadaceae*
- *Genus I. Syntrophomonas*
- *Genus II. Acetogenium*
- *Genus III. Aminobacterium*
- *Genus IV. Aminomonas*
- *Genus V. Anaerobaculum*
- *Genus VI. Anaerobranca*
- *Genus VII. Caldicellulosiruptor*
- *Genus VIII. Dethiosulfovibrio*
- *Genus IX. Pelospora*
- *Genus X. Syntrophospora*
- *Genus XI. Syntrophothermus*
- *Genus XII. Thermaerobacter*
- *Genus XIII. Thermanaerovibrio*
- *Genus XIV. Thermohydrogenium*
- *Genus XV. Thermosyntropha*

Order II. *"Thermoanaerobacteriales"*
- *Family I. "Thermoanaerobacteriacea"*
  - *Genus I. Thermoanerobacterium*
  - *Genus II. Ammonifex*
  - *Genus III. Carboxydobrachium*
  - *Genus IV. Coprothermobacter*
  - *Genus V. Moorella*
  - *Genus VI. Sporotomaculum*
  - *Genus VII. Thermacetogenium*
  - *Genus VIII. Thermoanaerobacter*
  - *Genus IX. Theremoanaerobium*

Order III. *Haloanaerobiales*
- *Family I. Haloanaerobiaceae*
  - *Genus I. Haloanaerobium*
  - *Genus II. Halocella*
  - *Genus III. Halothermothrix*
  - *Genus IV. Natroniella*
- *Family II. Halobacteroidaceae*
  - *Genus I. Halobacteroides*
  - *Genus II. Acetohalobium*
  - *Genus III. Haloanaerobacter*
  - *Genus IV. Orenia*
  - *Genus V. Sporohalobacter*

Class II. *Mollicutes*
- Order I. *Mycoplasmatales*
  - *Family I. Mycoplasmataceae*
    - *Genus I. Mycoplasma*
    - *Genus II. Eperythrozoon*
    - *Genus III. Haemobartonella*
    - *Genus IV. Ureaplasma*
- Order II. *Entomoplasmatales*
  - *Family I. Entomoplasmataceae*
    - *Genus I. Entomoplasma*
    - *Genus II. Mesoplasma*
  - *Family II. Spiroplasmataceae*
    - *Genus I. Spiroplasma*
- Order III. *Acholeplasmatales*
  - *Family I. Acholeplasmataceae*
    - *Genus I. Acholeplasma*

- Order IV. *Anaeroplasmatales*
  - *Family I. Anaeroplasmataceae*
    - *Genus I. Anaeroplasma*
    - *Genus II. Asteroleplasma*
- Order V. *Incertae sedis*
  - *Family I. "Erysipelotrichaceae"*
    - *Genus I. Erysipelothrix*
    - *Genus II. Bulleidia*
    - *Genus III. Holdermania*
    - *Genus IV. Solobacterium*

Class III. *"Bacilli"*

- Order I. *Bacillales*
  - *Family I. Bacillaceae*
    - *Genus I. Bacillus*
    - *Genus II. Amphibacillus*
    - *Genus III. Anoxybacillus*
    - *Genus IV. Exiguobacterium*
    - *Genus V. Gracilibacillus*
    - *Genus VI. Halobacillus*
    - *Genus VII. Saccharococus*
    - *Genus VIII. Salibacillus*
    - *Genus IX. Virgibacillus*
  - *Family II. Planococcaceae*
    - *Genus I. Planococcus*
    - *Genus II. Filibacter*
    - *Genus III. Kurthia*
    - *Genus IV. Sporosarcina*
  - *Family III. Caryophanaceae*
    - *Genus I. Caryophanon*
  - *Family IV. "Listeriaceae"*
    - *Genus I. Listeria*
    - *Genus II. Brochothrix*
  - *Family V. "Staphylococcaceae"*
    - *Genus I. Staphylococcus*
    - *Genus II. Gemella*
    - *Genus III. Macrococcus*
    - *Genus IV. Salinicoccus*
  - *Family VI. "Sporolactobacillaceae"*
    - *Genus I. Sporolactobacillus*
    - *Genus II. Marinococcus*
  - *Family VII. "Paenibacillaceae"*
    - *Genus I. Paenibacillus*
    - *Genus II. Ammoniphilus*
    - *Genus III. Aneurinibacillus*
    - *Genus IV. Brevibacillus*
    - *Genus V. Oxalophagus*
    - *Genus VI. Thermicanus*
    - *Genus VII. Thermobacillus*
  - *Family VIII. "Alicyclobacillaceae"*
    - *Genus I. Alicyclobacillus*
    - *Genus II. Pasteuria*
    - *Genus III. Sulfobacillus*
  - *Family IX. "Thermoactinomycetaceae"*
    - *Genus I. Thermoactinomyces*
- Order II. *"Lactobacillales"*
  - *Family I. Lactobacillaceae*
    - *Genus I. Lactobacillus*
    - *Genus II. Paralactobacillus*
    - *Genus III. Pediococcus*
  - *Family II. "Aerococcaceae"*
    - *Genus I. Aerococcus*
    - *Genus II. Abiotrophia*
    - *Genus III. Dolosicoccus*
    - *Genus IV. Eremococcus*
    - *Genus V. Facklamia*
    - *Genus VI. Globicatella*
    - *Genus VII. Ignavigranum*
  - *Family III. "Carnobacteriaceae"*
    - *Genus I. Carnobacterium*
    - *Genus II. Agitococcus*
    - *Genus III. Alloiococcus*
    - *Genus IV. Desemzia*
    - *Genus V. Dolosigranulum*
    - *Genus VI. Granulicatella*
    - *Genus VII. Lactosphaera*
    - *Genus VIII. Trichococcus*
  - *Family IV. "Enterococcaceae"*
    - *Genus I. Enterococcus*
    - *Genus II. Atopobacter*
    - *Genus III. Melissococcus*
    - *Genus IV. Tetragenococcus*
    - *Genus V. Vagococcus*
  - *Family V. "Leuconostocaceae"*
    - *Genus I. Leuconostoc*
    - *Genus II. Oenococcus*

- *Genus III. Weissella*
- *Family VI. Streptococcaceae*
  - *Genus I. Streptococcus*
  - *Genus II. Lactococcus*
- *Family VII. Incertae sedis*
  - *Genus I. Acetoanaerobium*
  - *Genus II. Oscillospira*
  - *Genus III. Syntrophococcus*

- Phylum BXIV. *Actinobacteria phy. nov.*
  - Class I. *Actinobacteria*
    - Subclass I. *Acidimicrobidae*
      - Order I. *Acidimicrobiales*
        - Suborder I. *"Acidimicrobineae"*
          - *Family I. Acidimicrobiaceae*
            - *Genus I. Acidimicrobium*
    - Subclass II. *Rubrobacteridae*
      - Order I. *Rubrobacterales*
        - Suborder II. *"Rubrobacterineae"*
          - *Family I. Rubrobacteraceae*
            - *Genus I. Rubrobacter*
    - Subclass III. *Coriobacteridae*
      - Order I. *Coriobacteriales*
        - Suborder III. *"Coriobacterineae"*
          - *Family I. Coriobacteriaceae*
            - *Genus I. Coriobacterium*
            - *Genus II. Atopobium*
            - *Genus III. Collinsella*
            - *Genus IV. Cryptobacterium*
            - *Genus V. Denitrobacterium*
            - *Genus VI. Eggerthella*
            - *Genus VII. Slackia*
    - Subclass IV. *Sphaerobacteridae*
      - Order I. *Sphaerobacterales*
        - Suborder IV. *"Sphaerobacterineae"*
          - *Family I. Sphaerobacteraceae*
            - *Genus I. Sphaerobacter*
    - Subclass V. *Actinobacteridae*
      - Order I. *Actinomycetales*
        - Suborder V. *Actinomycineae*
          - *Family I. Actinomycetaceae*
            - *Genus I. Actinomyces*
            - *Genus II. Actinobaculum*
            - *Genus III. Arcanobacterium*
            - *Genus IV. Mobiluncus*
        - Suborder VI. *Micrococcineae*
          - *Family I. Micrococcanceae*
            - *Genus I. Micrococcus*
            - *Genus II. Arthrobacter*
            - *Genus III. Kocuria*
            - *Genus IV. Nesterenkonia*
            - *Genus V. Renibacterium (moved)*
            - *Genus VI. Rothia*
            - *Genus VII. Stomatococcus*
          - *Family II. Bogoriellaceae*
            - *Genus I. Bogoriella (moved)*
          - *Family III. Rarobacteraceae*
            - *Genus I. Rarobacter (moved)*
          - *Family IV. Sanguibacteraceae*
            - *Genus I. Sanguibacter*
          - *Family V. Brevibacteriaceae*
            - *Genus I. Brevibacterium*
          - *Family VI. Cellulomonadaceae*
            - *Genus I. Cellulomonas*
            - *Genus II. Oerskovia*
          - *Family VII. Dermabacteraceae*
            - *Genus I. Dermabacter*
            - *Genus II. Brachybacterium*
          - *Family VIII. Dermatophilaceae*
            - *Genus I. Dermatophilus*
          - *Family IX. Dermacoccaceae*
            - *Genus I. Dermacoccus (moved)*
            - *Genus II. Demetria (moved)*
            - *Genus III, Kytococcus (moved)*
          - *Family X. Intrasporangiaceae*
            - *Genus I. Intrasporangiun*
            - *Genus II. Janibacter*
            - *Genus III. Ornithinicoccus*
            - *Genus IV. Ornithinimicrobium*
            - *Genus V. Nostocoidia*
            - *Genus VI. Terrabacter*
            - *Genus VII. Terracoccus*
            - *Genus VIII. Tetrasphaera*
          - *Family XI. Jonesiaceae*
            - *Genus I. Jonesia*
          - *Family XII. Microbacteriaceae*

- 
  - 
    - *Genus I. Microbacterium*
    - *Genus II. Agrococcus*
    - *Genus III. Agromyces*
    - *Genus IV. Aureobacterium*
    - *Genus V. Clavibacter*
    - *Genus VI. Cryobacterium*
    - *Genus VII. Curtobacterium*
    - *Genus VIII. Frigoribavterium*
    - *Genus IX. Leifsonia*
    - *Genus X. Leucobacter (moved)*
    - *Genus XI. Rathayibacter*
    - *Genus XII. Subtercola*
  - *Family XIII. "Beutenbergiaceae"*
    - *Genus I. Beutenbergia*
  - *Family XIV. Promicromonosporaceae*
    - *Genus I. Promicromonospora*
- Suborder VII. *Corynebacterineae*
  - *Family I. Corynebacteriaceae*
    - *Genus I. Corynebacterium*
  - *Family II. Dietziaceae*
    - *Genus I. Dietzia*
  - *Family III. Gordoniaceae*
    - *Genus I. Gordonia*
    - *Genus II. Skermania*
  - *Family IV. Mycobacteriaceae*
    - *Genus I. Mycobacterium*
  - *Family V. Nocardiaceae*
    - *Genus I. Nocardia*
    - *Genus II. Rhodococcus*
  - *Family VI. Tsukamurellaceae*
    - *Genus I. Tsukamurella*
  - *Family VII. "Williamsiaceae"*
    - *Genus I. Williamsia*
- Suborder VIII. *MKicromonosporineae*
  - *Family I. Micromonosporaceae*
    - *Genus I. Micromonospora*
    - *Genus II. Acinoplanes*
    - *Genus III. Catallatospora*
    - *Genus IV. Catenuloplanes*
    - *Genus V. Couchinoplanes*
    - *Genus VI. Dactylosporangium*
    - *Genus VII. Pilimelia*
    - *Genus VIII. Spirilliplanes*
    - *Genus IX. Verrucosispora*
- Suborder IX. *Propionibacterineae*
  - *Family I. Propionibacteriaceae*
    - *Genus I. Propionibacterium*
    - *Genus II. Luteococcus*
    - *Genus III. Microlunatus*
    - *Genus IV. Propioniferax*
    - *Genus V. Tessaracoccus*
  - *Family II. Nocardioidaceae*
    - *Genus I. Nocardioides*
    - *Genus II. Aeromicrobium*
    - *Genus III. Friedmanniella*
    - *Genus IV. Hongia*
    - *Genus V. Kribella*
    - *Genus VI. Micropruina*
    - *Genus VII. Marmoricola*
- Suborder X. *Pseudonocardineae*
  - *Family I. Pseudonocardiaceae*
    - *Genus I. Pseudonocardia*
    - *Genus II. Actinoalloteichus*
    - *Genus III. Actinopolyspora*
    - *Genus IV. Amycolatopsis*
    - *Genus V. Kibdelosporangium*
    - *'Genus VI. Kutzneria*
    - *Genus VII. Prauserella*
    - *Genus VIII. Saccharomonospora*
    - *Genus IX. Saccharopolyspora*
    - *Genus X. Streptoalloteichus*
    - *Genus XI. Thermobispora*
    - *Genus XII. Thermocrispum*
  - *Family II. Actinosynnemataceae*
    - *Genus I. Actinosynnema*
    - *Genus II. Actinokineospora*
    - *Genus III. Lentzea*
    - *Genus IV. Saccharothrix*
- Suborder XI. *Streptomycineae*
  - *Family I. Streptomycetaceae*
    - *Genus I. Strepstomyces*
    - *Genus II. Kitasatospora*
    - *Genus III. Streptoverticillium*
- Suborder XII. *Streptosporangineae*
  - *Family I. Streptosporangiaceae*
    - *Genus I. Streptosporangium*

    - *Genus II. Acrocarpospora*
    - *Genus III. Herbidospora*
    - *Genus IV. Microbispora*
    - *Genus V. Microtetraspora*
    - *Genus VI. Nonomuraea*
    - *Genus VII. Planobispora*
    - *Genus VIII. Planomonospora*
    - *Genus IX. Planopolyspora*
    - *Genus X. Planotetraspora*
  - *Family II. Nocardiopsaceae*
    - *Genus I. Nocardiopsis*
    - *Genus II. Thermobifida*
  - *Family III. Thermomonosporaceae*
    - *Genus I. Thermomonospora*
    - *Genus II. Actinomadura*
    - *Genus III. Spirillospora*
- Suborder XIII. *Frankineae*
  - *Family I. Frankiaceae*
    - *Genus I. Frankia*
  - *Family II. Geodermatophilaceae*
    - *Genus I. Geodermatophilus*
    - *Genus II. Blastococcus*
    - *Genus III. Modestobacter*
  - *Family III. Microsp0haeraceae*
    - *Genus I. Microsphaera*
  - *Family IV. Sporichthyaceae*
    - *Genus I. Sporichthya*
  - *Family V. Acidothermaceae*
    - *Genus I. Acidothermus*
  - *Family VI. "Kineosporiaceae"*
    - *Genus I. Kineosporia*
    - *Genus II. Cryptosporangium*
    - *Genus III. Kineococcus*
- Suborder XIV. *Glycomycineae*
  - *Family I. Glycomycetaceae*
    - *Genus I. Glycomyes*
- Order II. *Bifidobacteriales*
  - *Family I. Bifidobacteriaceae*
    - *Genus I. Bifidobacterium*
    - *Genus II. Falcivibrio*
    - *Genus III. Gardnerella*
  - *Family II. Unknown Affiliation*
    - *Genus I. Actinobispora*

        - *Genus II. Actinocorallia*
        - *Genus III. Excellospora*
        - *Genus IV. Pelczaria*
        - *Genus V. Turicella*

- Phylum BXV. *Planctomycetes phy. nov.*
  - Class I. *"Planctomycetacia"*
    - Order I. *Planctomycetales*
      - *Family I. Planctomycetaceae*
        - *Genus I. Planctomyces*
        - *Genus II. Gemmata*
        - *Genus III. Isophaera*
        - *Genus IV. Pirellula*

- Phylum BXVI. *Chlamydiae phy. nov.*
  - Class I. *"Chlamydiae"*
    - Order I. *Chlamydiales*
      - *Family I. Chlamydiaceae*
        - *Genus I. Chlamydia*
        - *Genus II. Chlamydophila*
      - *Family II. Parachlamydiaceae*
        - *Genus I. Parachlamydia*
      - *Family III. Simkaniaceae*
        - *Genus I. Simkania*
      - *Family IV. Waddliaceae*
        - *Genus I. Waddlia*

- Phylum BXVII. *Spirochaetes phy. nov.*
  - Class I. *"Spirochaetes"*
    - Order I. *Spirochaetales*
      - *Family I. Spirochaetaceae*
        - *Genus I. Spirochaeta*
        - *Genus II. Borrelia*
        - *Genus III. Brevinema*
        - *Genus IV. Clevelandina*
        - *Genus V. Cristispira*
        - *Genus VI. Diplocalyx*
        - *Genus VII. Hollandina*
        - *Genus VIII. Pillotina*
        - *Genus IX. Treponema*
      - *Family II. "Serpulinaceae"*
        - *Genus I. Serpulina*
        - *Genus II. Brachyspira*
      - *Family III. Leptospiraceae*

- *Genus I. Leptonema*
- *Genus II. Leptospira*

- Phylum BXVIII. *Fibrobacteres phy. nov.*
  - Class I. *"Fibrobacteres"*
    - Order I. *"Fibrobacterales"*
      - *Family I. "Fibrobacteraceae"*
        - *Genus I. Fibrobacter*

- Phylum BXIX. *Acidobacteria phy. nov.*
  - Class I. *"Acidobacteria"*
    - Order I. *"Acidobacteriales"*
      - *Family I. "Acidobacteriaceae"*
        - *Genus I. Acidobacterium*
        - *Genus II. Geothrix*
        - *Genus III. Holophaga*

- Phylum BXX. *Bacteroidetes phy. nov.*
  - Class I. *"Bacteroidetes"*
    - Order I. *"Bacteroidales"*
      - *Family I. Bacteroidaceae*
        - *Genus I. Bacteroides*
        - *Genus II. Acetofilamentum*
        - *Genus III. Acetomicrobium*
        - *Genus IV. Acetothermus*
        - *Genus V. Anaerorhabdus*
        - *Genus VI. Megamonas*
      - *Family II. "Rikenellaceae"*
        - *Genus I. Rikenella*
        - *Genus II. Marinilabilia*
      - *Family III. "Porphyromonadaceae"*
        - *Genus I. Porphyromonas*
        - *Genus II. Dysgonomonas*
      - *Family IV. "Prevotellaceae"*
        - *Genus I. Prevotella*
  - Class II. *"Flavobacteria"*
    - Order I. *"Flavobacteriales"*
      - *Family I. Flavobacteriaceae*
        - *Genus I. Flavobacterium*
        - *Genus II. Bergeyella*
        - *Genus III. Capnocytophaga*
        - *Genus IV. Cellulophaga*
        - *Genus V. Chryseobacterium*
        - *Genus VI. Coenonia*
        - *Genus VII. Empedobacter*
        - *Genus VIII. Gelidibacter*
        - *Genus IX. Ornithobacterium*
        - *Genus X. Polaribacter*
        - *Genus XI. Psychroflexus*
        - *Genus XII. Psychroserpens*
        - *Genus XIII. Riemerella*
        - *Genus XIV. Saligentibacter*
        - *Genus XV. Weeksella*
      - *Family II. "Myroidaceae"*
        - *Genus I. Myroides*
        - *Genus II. Psychromonas*
      - *Family III. "Blattabacteriaceae"*
        - *Genus I. Blattabacterium*
  - Class III. *"Sphingobacteria"*
    - Order I. *"Sphingobacteriales"*
      - *Family I. Sphingobacteriaceae*
        - *Genus I. Sphingobacterium*
        - *Genus II. Pedobacter*
      - *Family II. "Saprospiraceae"*
        - *Genus I. Saprospira*
        - *Genus II. Haliscomenobacter*
        - *Genus III. Lewinella*
      - *Family III. "Flexibacteraceae"*
        - *Genus I. Flexibacter*
        - *Genus II. Cyclobacterium*
        - *Genus III. Cytophaga*
        - *Genus IV. Dyadobacter*
        - *Genus V. Flectobacillus*
        - *Genus VI. Hymenobacter*
        - *Genus VII. Meniscus*
        - *Genus VIII. Microscilla*
        - *Genus IX. Runella*
        - *Genus X. Spirosoma*
        - *Genus XI. Sporocytophaga*
      - *Family IV. "Flammeovirgaceae"*
        - *Genus I. Flammeovirga*
        - *Genus II. Flexithrix*
        - *Genus III. Persicobacter*
        - *Genus IV. Thermonema*
      - *Family V. Crenotrichaceae*
        - *Genus I. Crenothrix*
        - *Genus II. Chitinophaga*

- *Genus III. Rhodothermus*
- *Genus IV. Toxothrix*

Phylum BXXI. *Fusobacteria phy. nov.*
- Class I. *"Fusobacteria"*
  - Order I. *"Fusobacteriales"*
    - *Family I. "Fusobacteriaceae"*
      - *Genus I. Fusobacterium*
      - *Genus II. Ilyobacter*
      - *Genus III. Leptrotrichia*
      - *Genus IV. Propionigenium*
      - *Genus V. Sebaldella*
      - *Genus VI. Streptobacillus*
    - *Family II. Incertae sedis*
      - *Genus I. Cetobacterium*

Phylum BXXII. *Verrucomicrobia phy. nov.*
- Class I. *Verrucomicrobiae*
  - Order I. *Verrucomicrobiales*
    - *Family I. Verrucomicrobiaceae*
      - *Genus I. Verrucomicrobium*
      - *Genus II. Prosthecobacter*
    - *Family II. "Xipinematobacteriaceae"*
      - *Genus I. Xiphinematobacter*

Phylum BXXIII. *Dictyoglomus phy. nov.*
- Class I. *"Dictyoglomi"*
  - Order I. *"Dictyoglomales"*
    - *Family I. "Dictyoglomaceae"*
      - *Genus I. Dictyoglomus*

## c. Classification of viruses

The classification of viruses has undergone great change, as has bacterial taxonomy. Most viruses have not even been classified due to a lack of data concerning their reproduction and molecular biology. Estimates suggest that more than 30,000 viruses are being studies in laboratories and reference centers worldwide. The classification and viral information presented here follows the outline given in Chapter 10 (Tables 10.1 and 10.2) of G Garrity, M Winters, D Searles (2001) Bergey's Manual® of systematic bacteriology, 2nd edn. Springer-Verlag, New York. Information can also be found in L Collier, J Oxford (1993) Human virology: a test for students of medicine, dentistry, and microbiology. Oxford University Press, Oxford, and in J Levy, H Fraenkel-Conrat, R Owens (1994) Virology, 2nd edn. Prentice-Hall, NJ.

The 21 families of viruses listed here are primarily those that infect vertebrates. Thus, these families represent only a small part of the 71 families and more than 3000 viruses recognized in *Virus Taxonomy: Seventh Report of the International Committee on Taxonomy of Viruses,* Van Regenmortel HV, Bishop DHL, Van Reenmortel MH, and Fauquet CM eds., Academic Press, San Diego, CA 2000 (ISBN 0123702003).

### 1. Family: Picornaviridae

**Genera**

- *Enterovirus* (gastrointestinal viruses, poliovirus, coxsackie viruses A and B, and echoviruses.
- *Hapatovirus* (hepatitis A virus).
- *Cardiovirus* (encephalomyocarditis virus of mice and other rodents).
- *Rhinovirus* (upper respiratory tract viruses, common cold viruses).
- *Aphthovirus* (foot-and-mouth disease virus).

Naked, polyhedral, positive-sense, and ssRNA. Synthesis and maturation take place in the host cell cytoplasm. Viruses are released via cell lysis.

### 2. Family: Caliciviridae

**Genus**

- *Calicivirus* (Norwalk viruses and similar viruses causing gastroenteritis, hepatitis E virus).

Naked, polyhedral, positive-sense, and ssRNA. Synthesis and maturation takes place in the host cell cytoplasm. Viruses are released via cell lysis.

## 3. Family: Togaviridae

**Genera**

*Alphavirus* (eastern, western, and Venezuelan equine encephalitis viruses, and Semliki forest virus).

*Rubivirus* (rubella virus).

*Arterivirus* (equine arteritis virus and simian hemorrhagic fever virus).

Enveloped, polyhedral, positive-sense, and ssRNA. Synthesis occurs in the host cell cytoplasm; maturation involves budding of nucleocapsids through the host cell plasma membrane. Viruses are released via cell lysis (*Arterivirus*). Many replicates in arthropods and vertebrates.

## 4. Family: Flaviviridae

**Genera**

*Flavivirus* (yellow-fever virus, dengue fever virus, St. Louis and Japanese encephalitis viruses, and tickborne encephalitis virus).

*Pestivirus* (bovine diarrhea virus, hop cholera virus) Hapatitis C virus.

Enveloped, polyhedral, positive-sense, and ssRNA. Synthesis occurs in the host cell cytoplasm; maturation involves budding through host cell endoplasmic reticulum and Golgi apparatus membranes. Most replicate in arthropods.

## 5. Family: Coronavirdae

**Genus**

*Coronavirus* (common cold viruses, avian infectious bronchitis virus, feline infectious peritonitis virus, and mouse hepatitis virus).

Enveloped, helical, positive-sense, and ssRNA. Synthesis occurs in the host cell cytoplasm; maturation involves budding through membranes and the endoplasmic reticulum, and Golgi apparatus. Viruses are released via cell lysis.

## 6. Family: Rhabdoviridae

**Genera**

*Vesiculovirus* (vesicular stomatitis-like virus).

*Lyssavirus* (rabies and rabieslike viruses).

*[Unnamed]* (proposed, for bovine ephemeral feverlike viruses).

Enveloped, helical, negative-sense, and ssRNA. Synthesis occurs in the host cell nucleus; maturation occurs via budding from the host cell plasma membrane. Many replicate in arthropods.

## 7. Family: Filoviridae

**Genus**

*Filovirus* (Marburg and Ebola viruses).

Enveloped; long, filamentous forms, sometimes with branching, and sometimes U-shaped, 6-shaped, or circular; negative-sense, and ssRNA. Synthesis occurs in the host cell cytoplasm; maturation involves budding from the host cell plasma membrane. Viruses are released via cell lysis. These viruses are "Biosafety Level 4" pathogens – they must be handled in the laboratory under maximum containment conditions.

## 8. Family: Paramyxoviridae

**Genera**

*Paramyxovirus* (parainfluenza viruses 1-4, mumps virus, and Newcastle disease virus).

*Morbillivirus* (measles and measleslike viruses, canine distemper virus).

*Pneumovirus* (respiratory syncytial virus).

Enveloped, helical, negative-sense, and ssRNA. Synthesis occurs in the host cell cytoplasm; maturation involves budding through the host cell plasma membrane. viruses are released via cell lysis. Morbilliviruses can cause persistent infections.

## 9. Family: Orthomyxoviridae

**Genera**

*Influenzavirus* A and B (influenza viruses A and B).

*Influenzavirus* C (influenza C virus).

Enveloped, helical, negative-sense, and ssRNA (eight segments). Synthesis occurs in the host cell nucleus; maturation takes place in the host cell cytoplasm. Viruses are released through budding from the host cell's plasma membrane. These viruses can reassort genes curing mixed infections.

## 10. Family Bunyaviridae

**Genera**

*Bunyavirus* (Bunyamwera supergroup).

*Phlebovirus* (sandfly fever viruses).

*Nairovirus* (Nairobi sheep diseaselike viruses).

*Uukuvirus* (Uukuniemi-like viruses).

*Hantavirus* (hemorrhagic fever viruses, Korean hemorrhagic fever, Sin Nombre hantavirus).

Enveloped, spherical, negative-sense, and ssRNA (three segments; *Phlebovirus* ambisense ssRNA). Synthesis occurs in the host cell cytoplasm; maturation occurs within the Golgi apparatus. Viruses are released via cell lysis. Closely related viruses can reassort genes during mixed infections.

## 11. Family: Arenaviridae

**Genus**

*Arenavirus* (Lassa fever virus, lymphocytic choriomeningitis virus, Machupo virus, and Junin virus).

Enveloped, helical, ambisense, and ssRNA (two segments). Synthesis occurs in the host cell cytoplasm; maturation involves budding from the host cell plasma membrane. Virions contain ribosomes. The human pathogens Lassa, Machuppo, and Junin viruses are "Biosafety Level 4" pathogens – they must be handled in the laboratory under maximum containment conditions.

## 12. Family: Reoviridae

**Genera**

*Orthoreovirus* (reoviruses 1–3).

*Orbivirus* (Orungo virus).

*Rotavirus* (human rotaviruses).

*Cypovirus* (cytoplasmic polyhidrosis viruses).

*Coltivirus* (Colorado tick fever virus).

*Plant Reovirus* 1/3 (plant reoviruses subgroups 1–3).

Each genus differs in morphology and physiochemical details. In general, virions are naked, polyhedral, dsRNA (10–12 segments). Synthesis and maturation take place in the host cell cytoplasm. Viruses are released via cell lysis. Virions contain ribosomes.

## 13. Family: Birnaviridae

**Genera**

*Birnavirus* (infectious pancreatic necrosis virus of fish and infections bursal disease virus of fowl).

Naked, polyhedral, dsRNA (two segments). Synthesis and maturation take place in the host cell cytoplasm. Viruses are released via cell lysis.

## 14. Family: Retroviridae

**Genera**

MLV-related virus (spleen necrosis virus, mouse, and feline leukemia viruses).
Mammalian type-B (mouse mammary tumor virus).
Type D (squirrel monkey retrovirus).
ALV-related virus (avian leukemia virus, rous sarcoma virus).
HTL-BLV group (human T-cell leukemia virus HTLV-1, HTLV-II, and bovine leukemia virus).
*Spumavirus* (the foamy viruses)
*Lentivirus* (human, feline, simian, and bovine immunodeficiency viruses).

Enveloped, spherical, negative-sense, and ssRNA (two identical strands). Synthesis occurs in the host cell cytoplasm; maturation involves budding through the host cell plasma membrane. These viruses contain the enzyme reverse transcriptase. The retroviruses (except the *Spumavirus* and *Lentivirus* genera) represent the RNA tumor viruses, causing leukemias, carcinomas, and sarcomas.

## 15. Family: Hepadnaviridae

**Genera**

*Orthohepadnavirus* (hepatitis B virus).
*Avihepadnavirus* (duck hepatitis virus).

Enveloped, polyhedral, and partially dsDNA. Synthesis and maturation take place in the host cell nucleus. Surface antigen production occurs in the cytoplasm. Persistence is common and is associated with chronic disease and neoplasia.

## 16. Family: Parvoviridae

**Genera**

*Parvovirus* (feline leucopenia virus, canine parvovirus).
*Dependovirus* (adeno-associated viruses).
*Densovirus* (insect parvoviruses).
*Erythrovirus* (human erythrovirus B19).

Naked, polyhedral, negative-sense, and ssDNA (*Parvovirus*) or positive-sense and negative-sense, and ssDNA (other genera). Synthesis and maturation occur in rapidly dividing host cells, specifically in the host cell nucleus. Viruses are released via cell lysis.

## 17. Family: Papovaviridae

**Genera**

*Papillomarirus* (wart viruses, genital condylomas, and DNA tumor viruses).
*Polyomavirus* (human polyoma-like viruses, SV-40).

Naked, polyhedral, and dsDNA. Synthesis and maturation take place in the host cell nucleus. Viruses are released via cell lysis.

## 18. Family: Adenoviridae

**Genera**

*Mastadenovirus* (human adenoviruses A-F, infectious canine hepatitis virus).
*Aviadenovirus* (avian adenoviruses).

Naked, polyhedral, and dsDNA. Synthesis and maturation take place in the host cell nucleus. Viruses are released via cell lysis.

## 19. Family: Herpesviridae

**Subfamily: Alphaherpesvirinae**
**Genera**

*Simplexvirus* (herpes simplex viruses 1 and 2).
*Varicellovirus* (varicella-zoster virus).

**Subfamily: Betaherpesvirinae**

**Genera**

*Cytomegalovirus* (human cytomegalovirus).

*Muromegalovirus* (murine cytomegalovirus).

**Subfamily: Gammaherpesvirinae**

**Genera**

*Lymphocryptovirus* (Epstein-Barr viruses).

*Rhadinovirus* (saimiri-ateles-like virus).

Enveloped, polyhedral, and dsDNA. Synthesis and maturation occur in the host cell nucleus, with budding through the nuclear envelope. Although most herpesviruses cause persistent infections, virions can be released by rupture of the host cell plasma membrane.

### 20. Family: Poxviridae

**Subfamily: Chordopoxvirinae**

**Genera**

*Orthopoxvirus* (vaccinia and variola viruses, cowpox virus).

*Parapoxvirus* (orf virus, pseudocowpox virus).

*Avipoxvirus* (fowlpox virus).

*Capripoxvirus* (sheep pox virus).

*Leporipoxvirus* (myxoma virus).

*Suipoxvirus* (swinepox virus).

*Yatapoxvirus* (yabapox virus and tanapox virus).

*Molluscipoxvirus* (mollescum contagiosum virus).

**Subfamily: Entomopoxvirinae**

**Genus**

*Entomopoxvirus A/B/C* (poxviruses of insects).

External envelope, large, brick-shaped (or ovoid), and dsDNA. Synthesis and maturation take place in the portion of the host cell cytoplasm called viroplasm ("viral factories"). Viruses are released via cell lysis.

### 21. Family: Irdoviridae

**Genera**

*Iridovirus* (small iridescent insect viruses).

*Chloriridovirus* (large iridescent insect viruses).

*Ranavirus* (frog viruses).

*Lymphocystivirus* (lymphocystis viruses of fish).

Enveloped (missing on some insect viruses), polyhedral, dsDNA. Synthesis occurs in both the host cell nucleus and cytoplasm. Most virions remain cell-associated.

## d. Word roots commonly encountered in microbiology

**a-, an** *not, without absence* abiotic, not living; anaerobic, in the absence of air.

**acantho** *thorn or spinelike Acanthamoeba*, an amoeba with spinelike projections.

**action** *having rays Actinomyces*, a bacterium forming colonies that look like sunbursts.

**aero** a*ir.* aerobic, in the presence of air.

**agglutino** *clumping or sticking together* hemagglutinatin, clumping of blood cells.

**albo** *white Candida albicans*, a white fungus.

**amphi** *around, doubly, both* Amphitrichous describes flagella found at both ends of a bacterial cell.

**ant-, anti-** *against, versus* Antibacterial compounds kill bacteria.

**archaeo-** *ancient.* Archaeobacteria are thought to resemble ancient forms of life.

**artho-** *joint* arthritis, inflammation of joints.

**asco-** *sac, bag* Ascospores are held in a saclike container, the ascus.

**-ase** *denotes enzyme* lipase, an enzyme attacking lipids.

**aureo-** *golden Staphylococcus aureus* has gold-colored colonies.

**Auto-** *self.* Autotrophs, self-feeding organisms.

**bacillo-** *rod.* bacillus, rod-shaped bacterium.

**basid-** *base, foundation* basidium, fungal cell bearing spores at its end.

**bio-** *life* biology, the study of living things.

**blast-** *bud* bladstospore, spore formed by budding.

**bovi-** *cow Mycobacterium bovis*, bacterium causing tuberculosis in cattle.

**brevi-** *short Lactobacillus brevis*, a bacterium with short rod-shaped cells.

**butyr-** *butter* Butyric acid gives rancid butters its unpleasant odor.

**campylo-** *curved Campylobaccter*, a curved bacterium.

**carcino-** *cancer* a carcinogen causes cancer.

**caryo-, karyo-** *center, kernel* Prokaryotic cells lack a true, discrete nucleus.

**caseo-** *cheese* caseous, cheeselike lesions.

**caul-** *stalk, stem Caulobacter*, a stalked bacterium.

**ceph-, cephalo-** *of the head or brain* encephalitis, inflammation of the brain.

**chlamydo-** *cloaked hidden Chlamydia* are difficult bacteria to detect.

**chloro-** *green* chlorophyll, a green pigment.

**chromo-** *colored* Metachromatic granules stain various colors within a cell.

**chryso-** *golden Streptomyces chryseus*, a bacterium forming golden colonies.

**-cide** *to kill* fungicide kills fungi.

**co-, con-** *with, together.* congenital, existing from birth.

**cocc-** *berry Streptococcus*, spherical bacteria in chains.

**coeno-**. *shared in common* coenocytic, many nuclei not separated by septa.

**col-, colo-** *colon* coliform bacteria, found in the colon large intestine.

**conidio-** *dust* conidiam tiny dustlike spores produced by fungi.

**coryne-** *club Corynebacterium diphtheriae*, club-shaped bacterium

**-cul** *little, tiny* molecule, a tiny mass.

**cut-, -cut** *skin* cutaneous, of the skin.

**cyan-** *blue* cyanobacteria, formerly called the blue-green algae.

**cyst, -cyst** *bladder* cystitis, inflammation of the urinary bladder.

**cyt, -cyte** *cell* leukocyte, white blood cell.

**de-** *lack of removal* decolorize, to remove color.

**dermato-** *skin* dermatitis, inflammation of the skin.

**di-, diplo-** *two, double.* diplocci, pairs of spherical cells.

**dys-** *bad, faulty, painful* dysentery, a disease of the enteric system.

**ec-, ecto-, ex** *outside, outer* Ectoparasite, found on the outside of the body.

**em-, en-** *in, inside* encapsulated, inside a capsule.

**-emia** *of the blood* pyemia, pus in the blood.

**endo-** *inside* endospore, spore found inside a cell.

**entero-** *intestine* enteric, bacteria found in the intestine.

**epi-** *atop, over* epidemic, a disease spreading over an entire population at one time.

**erythro-** *red* lupus erythematosus, disease with a red rash.

**etio-** *cause* etiology, study of the causes of disease.

**eu-** *true, good, normal* eukaryote cell with a true nucleus.

**exo-** *outside* exotoxion, toxin released outside of a cell.

**extra-** *outside, beyond* extracellular, outside of a cell.

**fil-** *thread* filament, thin chain of cells.

**flav-** *yellow* flavivirus, cause of yellow fever.

**-fy** *to become, make* solidify, to become solid.

**galacto-** *milk* galactose, monosaccharide from milk sugar.

**gamet-** *marriage* gamete, a reproductive cell, such as egg or sperm.

**gastro-** *stomach* gastroenteritis, inflammation of the stomach and intestines.

**gel-** *to stiffen, congeal* gelatinous, jellylike.

**gen-, -gen** *to give rise to* pathogen, microbe that causes disease.

**-genesis** *origin, development* pathogenesis, development of disease.

**germ, germin-** *bud* germination, process of growing from a spore.

**-globulin** *protein* immunoglobulins, proteins of the immune system.

**haem-, hem-** *blood* hemmagglutinatin, clumping of blood cells.

**halo-** *salt* halophilic, organisms that thrive in salty environments.

**hepat-** *liver* hepatitis, inflammation of the liver.

**hetero-** *different, other* heterotroph, organism deriving nutrition from other sources.

**histo-** *tissue* histology, the study of tissues.

**homo-** *same* homologous, having the same structure.

**hydro-** *water* hydrologic cycle, water cycle.

**hyper-** *over, above* hyperbaric oxygen, higher than atmospheric pressure oxygen.

**hypo-** *under, below* hypodermic, going beneath the skin.

**im-, in-** *not* insoluble, cannot be dissolved.

**inter-** *between* intercellular, between cells.

**intra-** *inside* intracellular, inside a cell.

**io-** *violet* iodine, element that is purple in gaseous state.

**iso-** *same, equal* isotonic, having the same osmotic pressure.

**-it is** *inflammation of* meningitis, inflammation of the meninges.

**kin-** *moving* kinetic energy, energy of movement.

**leuko-** *white* leukocyte, white blood cell.

**lip-. lipo-** *fat, lipid* lipoprotein, molecule having both fatty and proteinaceous parts.

**-logy, -ology** *study of* microbiology, study of microbes.

**lopho-** *tuft* lophotrihous, having a tuft or group of flagella.

**luc-, luci-** *light* luciferase, enzyme that catalyzes a light-producing reaction.

**luteo-** *yellow Micrococcus luteus*, bacterium producing yellow colonies.

**lys-, lysis** *slitting* cytolysis, rupture of a cell .

**macro-** *large* macroconidia, large spores.

**meningo-** *membrane* meninges, membranes of the brain.

**meso-** *middle* Mesophile, organism growing best a medium temperatures.

**micro-** *small, tiny* microbiology, study of tiny forms of life.

**mono-** *one, single* monosaccharide, a single sugar unit.

**morph-** *shape, form* pleionorphic, having many different shapes.

**multi-** *many* mutticellular, having many cells.

**mur-** *wall* muramic acid, a component of cell walls.

**muri-, mus-** *mouse* murine, in or of mice.

**mut-, mute** *to change* mutagen, agent that causes genetic change.

**myc-, myces** *fungus Actinomyces*, a bacterium that resembles a fungus.

**myxo-** *slime, mucus* myxomycetes, slime molds.

**necro-** *dead, corpse* necrotizing toxin, causes death of tissue.

**nema-, -nema** *thread Treponema*, nematode, threadlike organisms.

**nigr-** *black Rhizopus nigricans*, a black mold.

**oculo-** *eye* binocular, microscope with two eyepieces.

**-oid** *like, resembling* Toxoid, harmless molecule that resembles a toxin.

**-oma** *tumor* carcinoma, tumor of opithelial cells.

**onco-** *mass, tumor* oncogenes, genes that cause tumors.

**-osis** *condition of* brucellosis, condition of being infected with Brucella.

**patho-** *abnormal* pathology, study of abnormal diseased states.

**peri-** *around* peritrichous flagella located all around an organism.

**phago-** *eating* phagocytosis, cell eating by engulfing.

**philo-, -phil, -phile** *loving, preferring* Capnophile, organism needing higher than normal levels of carbon dioxide.

**-phob, -phobe** *hating, fearing* hydrophobic, water-repelling.

**-phore** *bearing, carrying* electrophoresis, technique in which ions are carried by an electric current.

**-phyte** *plant* Dermatophyte, fungus that attacks skin.

**pil-** *hair* pilus, hairlike tube on bacterial surface.

**-plast** *formed part* chloroplast, green body inside plant cell.

**pod-, -pod** *foot* podocyte, foot cell of kidney.

**poly-** *many* polyribosomes, many ribosomes on the same piece of messenger RNA.

**post-** *afterward, behind* post-streptoccal glomerulonephritis, kidney damage following a streptococcal infection.

**pre-, pro-** *before, toward* prepubertal, before puberty.

**pseudo-** *false* pseudopod, projection resembling a foot, false foot.

**psychro-** *cold* psychrophilic, preferring extreme cold.

**pyo-** *pus* pyogenic, producing pus.

**pyro-** *fire, heat* pyrogen, fever-producing compound.

**rhin-** *nose* rhinitis, inflammation of nasal membranes.

**rhizo-** *root* mycorrhiza, symbiotic growth of fungi and roots.

**rhodo-** *red Rhodospirillum*, a large red spiral bacterium.

**-rrhea** *flow* diarrhea, abnormal flow of liquid feces.

**rubric-** *red Rhodospirillum rubrum*, a large red spiral bacterium.

**saccharo-** *sugar* polysaccharide, many sugar units linked together.

**sapro-** *rotten, decaying* saprophyte, organism living on dead matter.

**sarco-** *flesh* sarcoma, tumor made up of muscle or connective tissue.

**schizo-** *to split* schizogony, a type of fission in malarial parasites.

**-scope, -scopy** *to see, examine* microscopy, use of the microscope to examine small things.

**sept-, septo-** *partition, wall* septum, wall between cells.

**septi-** *rotting* septic, exhibiting decomposition due to bacteria.

**soma-, -some** *body* chromosome, colored body (when stained).

**spiro-** *coil* spirochete, spiral-shaped bacterium.

**sporo-** *spore* sporocidal, spore killing.

**staphylo-** *in bunches, like grapes* staphylococci, spherical bacteria growing in clusters.

**-stasism stat-** *stopping, not changing* bacteriostatic, able to stop the growth of bacteria.

**strepto-** *twisted Streptobacillus*, twisted chains of bacilli.

**sub-** *under, below* Subclinical, signs and symptoms not clinically apparent.

**super-** *above, more than* superficial mycosis, fungal infection of the surface tissues.

**sym-, syn-** *together* symbiosis, living together.

**tact-, -taxis** *touch* chemotaxis, orientation or movement in response to chemicals.

**tax-, taxon-** *arrangement* taxonomy, the classification of organisms.

**thermo-** *heat* thermophile, organism preferring or needing high temperatures.

**thio-** *sulfur Thiobacillus*, organism that oxidizes hydrogen sulfide to sulfates.

**tox-** *poison* toxin, a harmful compound.

**trans-** *through, across* transduction, movement of genetic information from one cell to another.

**trich-** *hair* Monotrichous, having a single, hairlike flagellum.

**-troph** *feeding, nutrition* phototroph, organism that makes its on food, using energy from light.

**uni-** *one, singular* unicellular, composed of one cell.

**undul-** *waving* undulant fever disease in which fever rises and falls.

**vac-, vaccine-** *cow* vaccine, disease-preventing product originally produced by inoculating it onto skin of calves.

**vacu-** *empty* vacuole, empty-appearing structure in cytoplasm.

**vesic-** *blister, bladder* vesicle, small blisterlike lesions.

**vitr-** *glass in vitro*, grown in laboratory glassware.

**xantho-** *yellow Xanthomonas oryzae*, bacterium producing yellow colonies.

**zeno-** *strange, foreign* xenograft, graft from a different species.

**zoo-** *animal* protozoan, first animal.

**zygo-** *yoke, joining* zygote, fertilized egg.

**-zyme** *ferment* enzymes, biological catalysts, some of which are involved in fermentation.

Garrity GM, Winters M, and Searles DB (2001) Taxonomic outline of the procaryotic genera, bergey's manual of systematic bacteriology, 2nd edn. Springer-Verlag, New York.

# References

Adamaon AW, Gast AP (1997) Physical chemistry of surfaces. John Wiley and Sons, New York

Akin RB (1962) Acetal resins. Reinhold Publishing Co., New York

Allcock HR, Mark J, Lampe F (2003) Contemporary polymer chemistry. Prentice-Hall, New York

American Society for Testing and Materials, PA, www.astm.org

Appleman BR, Hower HE (1985) Surface preparation: the state of the art. Steel Structures Paint Council, Pittsburgh, PA

Ash M, Ash I (1982–1983) Encyclopedia of plastics, polymers and resins. vols I–III. Chemical Publishing Co., New York

Ash M, Ash I (1996) Handbook of paint and coating raw materials: trade name products—chemical products dictionary with trade name cross-references. Ashgate Publishing Ltd., New York

Ash M, Ash I (1998) Handbook of fillers, extenders and dilutents. Synapse Information Resources Inc., New York

Ash M, Ash I (2000) Handbook of industrial surfactants. Synapse Information Resources, New York

Ash M, Ash I (2000) Industrial surfactants. Synapse Information Resources, New York

Ashford NA, Miller CS (1997) Chemical exposures: low levels and high stakes. John Wiley and Sons, New York

Atkins PW, De Paula J (2001) Physical chemistry, 7th edn. W. H. Freeman Co., New York

Avrami M (1939–1941) Kinetics of phase change I: general theory. J Chem Phys 7:1103; Kinetics of phase change II: transformation-time relations for random distribution of nuclei 8:212; Kinetics of phase change III: granulation, phase change and microstructures 9:177

Baboian R (2002) Corrosion engineer's handbook, 3rd edn. NACE International–The Corrosion Society, Houston, TX

Babrauskas V (2003) Ignition handbook. Fie Science Publishers, New York

Bar-Cohen Y (ed) (2001) Electroactive polymer (EAP) actuators as artificial muscles. SPIE Press, Bellingham, WA

Bart J (2005) Additives in polymers: industrial analysis and applications. John Wiley and Sons, New York

Barton AFM (1983) Handbook of solubility parameters and other cohesion parameters. CRC Press, Boca Raton, FL

Becher P (1989) Dictionary of colloid and surface science. Marcel Dekker, New York

Becher P (2001) Emulsions: theory and practice. American Chemical Society, Washington, DC

Belfield KD, Crivello JV (eds) (2003) Photoinitiated polymerization. American Chemical Society Publications, Washington, DC

Garrity GM, Winters M, Searles DB (2001) Bergey's manual of systematic bacteriology, 2nd edn. Springer-Verlag, New York

Berne BJ (2000) Dynamic light scattering: applications to chemistry, biology and physics. Dover Publications, New York

Bhushan B (ed) (2004) Springer handbook of nanotechnology. Springer-Verlag, New York

Bhushan B, Fuchs H, Hosaka H (2004) Applied scanning probe methods. Springer-Verlag, New York

Biederman H (2004) Plasma polymer films. Imperial College Press, London

Billmeyer FW, Saltzman M (1966) Principles of color technology. John Wiley and Sons Inc., New York

Billmeyer FW (1984) Textbook of polymer science, 3rd edn. Wiley-Interscience, New York

Bittance JC (ed) (1990) Engineering plastics and composites. ASM International, Materials Park, OH

Black JG (2002) Microbiology, 5th edn. John Wiley and Sons, New York

Black JG (2002) Microbiology, 5th edn. John Wiley and Sons Inc., New York

Bovey FAA, Mirau PA (1996) NMR of polymers. Elsevier Science and Technology Books, New York

Box GE, Hunter WG, Hunter JS (2005) Statistics for experimenters: innovation, and discovery, 2nd edn. John Wiley and Sons, New York

Braga PC, Rici D (2004) Atomic force microscopy: biomedical applications. Humas Press, Italy

Brandrup J, Immergut EH (eds) (1989) Polymer handbook, 3rd edn. Wiley-Interscience, New York

Breitmaier E, Voelter W (1986) Carbon-13 NMR spectroscopy. John Wiley and Sons, New York

Brown R (1999) Handbook of physical polymer testing, vol 50. Marcel Dekker, New York

Brown W (1996) Light scattering: principles and development. Oxford University Press, New York

Bruno TJ, Paris S (2005) CRC handbook of fundamental spectroscopic correlation charts. CRC press, Boca Raton, FL

Burell R, Faires JD (2004) Numerical analysis. Brookes/Cole, New York

Callister WD (2002) Materials science and engineering. John Wiley and Sons, New York

Carley James F (ed) (1993) Whittington's dictionary of plastics. Technomic Publishing Co. Inc., Lancaster, PA

Catalog handbook of fine chemicals (1990) Aldrich Chemical Co., WI

Celanese Acetate LLC (2000) Complete textile glossary. Three Park Avenue, New York

Chung DD (1994) Carbon fiber composites. Elsevier Science and Technology Books, New York

Coleman MM, Strauss S (1998) Fundamentals of polymer science: an introductory text. CRC Press, Boca Raton, FL

Collins EA, Bares J, Billmeyer FW Jr (1973) Experiments in polymer science. Wiley-Interscience, New York

Collins PJ (1997) Introduction to liquid crystals: chemistry and physics, vol 1. Taylor and Francis Inc., New York

Color Photographic Standards for Surface Preparation (SSPC-VIS 1) (1982) Steel Structures Paint Council, Pittsburg, PA, USA, www.sspc.org

Commission Internationale De L'Eclairage (CIE), CIE Central Bureau, Kegelgasse 27, A-1030, Wien, Austria. [English: International Commission on Illumination, Vienna, Austria], www.cie.co.at/headerbasic.html

Connors KA (1990) Chemical kinetics. John Wiley and Sons, New York

Coussot P (2005) Rheometry of pastes, suspensions and granular materials: applications in industry and environment. John Wiley and Sons, New York

Coyard H, Tuck N, Deligny P, Oldring PKT (2001) Resins for surface coatings: acrylics and epoxies, vol 12. John Wiley and Sons, New York

Czeslaw K, Harvey S, Wilusz (1990) Encyclopedia of tribology. Elsevier Science, New York

D'Agostino R, Facassi F (eds) (1997) Plasma processing of polymers. Kluwer Academic Publishers, New York

Dainth J (2004) Dictionary of chemistry. Oxford University Press, UK

DeLevie R (1996) Principles of quantitative analysis. McGraw-Hill Higher Education, New York

Deligny P, Oldring PKT, Tuck N (eds) (2001) Resins for surface coatings, alkyds and polyester, vol 22. John Wiley and Sons, New York

Dissado LA, Fothergill CJ (eds) (1992) Electrical degradation and breakdown of polymers. Institution of Electrical Engineering (IEE), London

Donnet J-B, Wang M-J (1993) Carbon black. Marcel Dekker, New York

Driggers RC, Cox P, Edwards T (1998) Introduction to infrared and electro-optical systems. Artech House Inc., Aylesford, UK

Al-Asser MS, Lovell PA (1997) Emulsion Polymerization and Emulsion Polymers, John Wiley and Sons, New York

Nass LI (ed) (1976) Encyclopedia of PVC, Marcel Dekker, New York

Kroschwitz JA, Mark HF (2003) Encyclopedia of Polymer Science and Technology, John Wiley and Sons, New York

Elias H-G et al (1983) Abbreviations for thermoplastics, thermosets, fibers, elastomers, and additives. Polymer News (9) 101–110

Elias HG (1977) Macromolecules, vols 1–2. Plenum Press, New York

Elias H-G (2003) An introduction to plastics. John Wiley and Sons, New York

Elmas M (1973) Powder technology publication, series No 5: fluidized – bed powder coatings. Powder Advisory Cent, London

Emerson JA, Torkelson JM (eds) (1991) Optical and electrical properties of polymers: materials research society symposium proceedings, vol 24. Materials Research Society, Warrendale, PA

Wells K, Beal S, Woodburn C, Durant J, Brandimane J (1997) Fabric dyeing. Interweave Press Inc., Escondido, California

Finzel WA (1996) Silicones in coatings. Federation of Societies for Coatings Technology, Blue Bell, PA

Flick EW (1975) Water-based paint formulations. Noyes Data Corp., Park Ridge, NJ

Flick EW (1991) Industrial synthetic resins handbook. Williams Andrews Publishing/Noyes, New York

Flick WE (1977) Solvent-based paint formulation. Noyes Data Corp., Park Ridge, NJ

Flory PJ (1953) Principles of polymer science. Cornell University Press, Ithaca, NY

Flory PJ (1960) The statistical thermodynamics of solutions. John Wiley and Sons Inc., New York

Flory PJ (1969) Statistical mechanics of chain molecules. Interscience Publishers Inc., New York

Fouassier J-P (1995) Photoinitiation, photopolymerization and photocuring. Hanser–Gardner Publications, New York

Fox AM (2001) Optical properties of solids. Oxford University Press, UK

Franklin AJ (1976) Cement and mortar additives. Noyes Data Corp., Park Ridge, NJ

Freir GD (1965) University physics. Appleton-Century-Crofts, New York

Froment GF (1990) Chemical reactor analysis and design. John Wiley and Sons, New York

Gair A (1996) Artist's manual. Chronicle Books LLC, San Francisco

Galina H, Spiegel S, Meisel I, Kniep CS, Grieve K (2001) Polymer networks. John Wiley and Sons, New York

Giambattista A, Richardson R, Richardson RC, Richardson B (2003) College physics. McGraw-Hill Science, New York

Glenz W (ed) (2001) A glossary of plastics terminology in 5 languages, 5th edn. Hanser–Gardner Publications Inc., Cinicinnati

Godlly EW (1995) Naming organic compounds: a systematic instruction manual. Pearson Education, New York

Goldberg DE (2003) Fundamentals of chemistry. McGraw-Hill Science/Engineering/Math, New York

Gooch JW (1988) Development of high solids magnetic dispersions and coatings. J Coating Technol 60:757

Gooch JW (1993) Lead-based paint handbook. Plenum Press, New York

Gooch JW (1997) Analysis and deformulation of polymeric materials. Plenum Press, New York

Gooch JW (2002) Emulsification and polymerization of alkyd resins. Kluwer Academic/Plenum Publishers, New York

Goodwin JW, Goodwin J, Hughes RW (2000) Rheology for chemists. Royal Society of Chemistry, UK

Grellman W, Seidler S (eds) (2001) Deformation and fracture behavior of polymers. Springer-Verlag, New York

Groenewoud WM (2001) Characterization of polymers by thermal analysis. Elsevier Science and Technology Books, New York

Hansen CM, Beerbower A (1974) Solubility parameters. Encyclopedia of Chemical Technology. Supplemental Volume

Hare CH (2001) Paint film degradation—mechanisms and control. Steel Structures Paint Council, Pittsburgh, PA

Harper CA (2000) Modern plastics encyclopedia. McGraw-Hill Professional, New York

Harper CA (ed) (2002) Handbook of plastics, elastomers and composites, 4th edn. McGraw-Hill, New York

Harrington BJ (2001) Industrial cleaning technology. Kluwer Academic Publishers, New York

Harris CM (2005) Dictionary of architecture and construction. McGraw-Hill Co., New York

Harris DC (2002) Quantitative chemical analysis. W. H. Freeman Co., New York

Hartland S (ed) (2004) Surface and interfacial tension. CRC Press, Boca Raton, FL

Heeger AJ, Ulrich DR, Orenstein J (eds) (1988) Nonlinear optical properties of polymers. Materials Research Society, Warrendale, PA

Herbst W, Hunger K (2004) Industrial organic pigments. John Wiley and Sons Inc., New York

Hess M, Morgans WM (1979) Paint film defects. John Wiley and Sons Inc., New York

Hibbard MJ (2001) Mineralogy. McGraw-Hill Companies Inc., New York

Higham T, Ramsey B, Owen C (2004) Radiocarbon and archaeology. Oxford University School of Archaeology, UK

Hildebrand JH, Scott RL (1962) Regular solutions. Prentice-Hall Inc., Englewood Cliffs, NJ

Hoadley RB (2000) Understanding wood. The Taunton Press, Newtown, CT

Hollander AP, Hatton PV (2004) Biopolymer methods in tissue engineering. Humana Press, Totowa, NJ

Holst GC (2003) Electro-optical imaging system performance. J. C. D. Publishing, FL

Houston PL (2001) Chemical kinetics and reaction dynamics. McGraw-Hill Co., New York

Houwink R, Salomon G (1967) Adhesion and adhesives, 2nd edn, vol 2. Elsevier Publishing Co., Amsterdam

Huggins ML (1958) Physical chemistry of high polymers. John Wiley and Sons Inc., New York

Hull D (1999) Fractography: observing, measuring and interpreting fracture surface topography. Cambridge University Press, UK

Humphries M (2000) Fabric glossary. Prentice-Hall, Upper-Saddle River, NJ

Iaac MD, Ishal O (2005) Engineering mechanics of composite materials. Oxford University Press, UK

Intelligent macromolecules for smart devices. Springer-Verlag, New York, 2002

Industrial dye: chemistry, properties and applications. John Wiley and Sons, New York, 2003

ISO-472 (1988) Plastics-vocabulary, 2nd edn. International organization for standardization, Geneva, Switzerland

Isobe Y, Okuyama K, Hosaka A, Kubota Y (1983) Effect of the pigment vehicle interaction on the properties of magnetic coatings. J Coating Technol 55 (698):23

IUPAC Handbook, 2000–2001, International Union of Pure and Applied Chemistry, NC, 2000

Jeffrey GA (1997) An introduction to hydrogen bonds, Oxford University Press, New York

Johnson SF (2001) History of light and colour measurement: a science in the shadows. Taylor and Francis, UK

Kadolph SJ, Langford AL (2001) Textiles. Pearson Education, New York

Kakudo M (2005) X-ray diffraction of macromolecules. Springer-Verlag, New York

Kamide K, Dobashi T (2000) Physical chemistry of polymer solutions. Elsevier, New York

Keane JD (ed) (1993) Steel structures painting manual. Steel Structures Paint Council, Pittsburgh, PA

Keane JD (ed) (1993) Steel structures painting manual: good painting practice, vol 1. Steel Structures Painting Council, Pittsburgh, PA

Kemp RB (1999) Handbook of thermal analysis and calorimetry. Elsevier Science and Technology Books, New York

Kidder RC (1994) Handbook of fire retardant coatings and fire testing Services. CRC Press, Boca Raton, FL

Kirk PM, Cannon PF (2001) Fungi, 9th edn. CABI Publishing, Wallingford

Kirk–Othmer encyclopedia of chemical technology, vols 1–19. Wiley-Interscience, New York, 1998

Kirk–Othmer encyclopedia of chemical technology: pigments–powders. John Wiley and Sons, New York, 1996

Klempner D, Frisch KC (2001) Advances in urethane science and technology. Rapra Technology Ltd., Shropshire, UK

Klocek P (ed) (1991) Handbook of infrared materials. Marcel Dekker, New York

Kokhanovsky AA (2004) Light scattering media optics. Springer-Verlag, New York

Krause A, Lange A, Ezrin M (1988) Plastics analysis guide: chemical and instrumental methods. Oxford University Press, UK

Kricheldorf HR, Swift G, Nuyken O, Huang SJ (2004) Handbook of polymer synthesis. CRC Press, Boca Raton, FL

Kroschwitz JI (ed) (1990) Concise dictionary of polymer science and engineering. John Wiley and Sons, New York

Kroschwitz JI (ed) (1990) Polymers: polymer characterization and analysis. John Wiley and Sons, New York

Ku CC, Liepins R (1987) Electrical properties of polymers. Hanser Publishers, New York

Langenheim JH (2003) Plant resins: chemistry, evolution ecology and ethnobotany. Timber Press, Portland, OR

Leach RH, Pierce RJ, Hickman EP, Mackenzie MJ, Smith HG (eds) (1993) Printing ink manual, 5th edn. Blueprint, New York

Lee SM (1989) Dictionary of composite materials technology. Technomic Publishing Co. Inc., Lancaster, PA

Lenz RW (1967) Organic Chemistry of synthetic high polymers. Interscience, Publishers Inc., New York

Leonard EC (ed) (1970–1971) Vinyl and diene monomers (3 vols). Wiley-Interscience, New York

Levenspiel O (1998) Chemical reaction engineering. John Wiley and Sons, New York

Levin HL (2005) The earth through time. John Wiley and Sons, New York

Lewis PA (ed) (1985–1990) Pigment handbook, 2nd edn, vols 1–4. Wiley-Interscience, New York

Licari JJ (2003) Coating materials for electronics applications: polymers, processes, reliability and testing. Noyes Data Corporation/Noyes Publications, New York

Lide DR (ed) (2004) CRC handbook of chemistry and physics. CRC Press, Boca Raton, FL

Loveland RP (1981) Photomicrograsphy. Krieger Publishing Co., New York

Lovell PA, El-Aasser (eds) (1997) Emulsion polymerization and emulsion polymers. John-Wiley and Sons Inc., New York

Lowe JJ (1997) Radiocarbon dating. John Wiley and Sons, New York

Madox DM (1998) Handbook of physical vapor deposition (PVD) processing. Noyes Data Corporation, New York

Magnetic materials – a glossary. Pfizer Corp., Easton, PA, 1981

Mark JE (ed) (1996) Physical properties of polymers handbook. Springer-Verlag, New York

Martens CR (1961) Alkyd resins. Reinhold Publishing Co., New York

Martens CR (1964) Emulsion and water-soluble paints and coatings. Reinhold Publishing Co., New York

Martens CR (1968) Technology of paints, varnishes and lacquers. Reinhold Publishing Co., New York

Mathews CK, van Holde KE, Ahern KG (2000) Biochemistry, 3rd edn. Addison–Wesley–Longman Inc., San Francisco, CA

Mayer R, Sheehan S (1991) Artist's handbook of materials and techniques. Viking Adult, New York

Mayer R, Sheehan S (1991) Artist's handbook of materials and techniques. Viking Adult, New York

McCleverty JA, Connelly NG (2001) Nomenclature of inorganic chemistry II: recommendations 2000. The Royal Society of Chemistry, UK

McCutcheon's emulsifiers and detergents (2000) North American edition, vol 1. McCutcheon Division of McCutcheon Publishing Co.

McDonald R (1997) Colour physics for industry, 2nd edn. Society of Dyers and Colourists, West Yorkshire, England

McGraw-Hill dictionary of geology and mineralogy. McGraw-Hill, New York, 2002

McNutt J Private Correspondence and Conferences, E, I. du Pont de Nemours 7 Co. Inc.

Meeten GH (1986) Optical properties of polymers. Springer-Verlag, New York

Merck index, 13th edn. Merck and Company Inc., Whitehouse Station, NJ, 2001

Merriam-Webster's collegiate dictionary, 11th edn. Merriam-Webster Inc., MA

Microsoft computer dictionary. Microsoft Press, WA, 2002

Miller ML (1966) The Structure of Polymers, Reinhold Publishing Co., New York

Mittal KL (ed) (2004) Silanes and other coupling agents, vol 3. VSP International Science Publishers, New York

Mittal KL (2003) Contact angle, wettability and adhesion, vols 1–3. VPS International Science Publishers, Zeist, The Netherlands

Modern Plastics Encyclopedia, Highstown, New Jersey, 1992

Moller KD (2003) Optics. Springer-Verlag, New York

Morrison GR (2004) X-ray microscopy: techniques and applications. World Scientific Publishing Company Inc., New York

Morrison RT, Boyd RN (1992) Organic chemistry, 6th edn. Prentice-Hall, Englewood Cliffs, NJ

Muizebelt WJ, Donkerbroek MWF, Nielsen JB, Hussem and Biedmond MEF (1998) Oxidative crosslinking of alkyd resins studied with mass spectroscopy and NMR using model compounds. J Coatings Technol 70(876):83–92

Munson BR, Young DF, Okiishi TH (2005) Fundamentals of fluid mechanics. John Wiley and Sons, New York

Murphy J (1998) Reinforced plastics handbook. Elsevier Science and Technology Books, New York

Nelson G (1990) Fire and polymers: hazards identification and prevention. Oxford University Press, UK

Nesse WD (2003) Introduction to optical mineralogy. Oxford University Press, New York

O'Conner DJJ, Smart RS, Sexton BA (2003) Surface analysis methods in materials science. Springer-Verlag, New York

Odian GC (2004) Principles of polymerization. John Wiley and Sons Inc., New York

Oss CJ (1994) Interfacial forces in aqueous media. Marcel Dekker, New York.

Paint and coating testing manual (Gardner–Sward Handbook) MNL 17, 14th edn. ASTM, Conshohocken, PA, 1995

Paint/Coatings dictionary. Compiled by Definitions Committee of the Federation of Societies fro Coatings Technology, Stanley LeSota, Chairman, Philadelphia, Blue Bell, PA, 1978

Paint: pigment, drying oils, polymers, resins, naval stores, cellulosics esters, and ink vehicles, vol 3. American Society for Testing Materials, Washington, DC, 2001

Parfitt CD, Sing KSW (1976) Characterization of powder surfaces. Academic Press, London

Parfitt GD (1969) Dispersion of powders in liquids. Elsevier Publishing Co., New York

Patton TC (1979) Paint flow and pigment dispersion: a rheological approach to coating and ink technology. Wiley, New York

Pauk A (2001) Orbital interaction theory of organic chemistry, 2nd edn. Wiley Interscience, New York

Paul N. Gardner (2006) Company Inc., Pompano Beach, FL, www.gardco.com

Pecora R, Pecora R (1985) Dynamic scattering: applications of photon correlation spectroscopy. Kluwer Academic Publishers, New York

Perkins D (2001) Mineralogy. Prentice-Hall, New York

Perry RH, Green DW (1997) Perry's chemical engineer's handbook, 7th edn. McGraw-Hill, New York

Pethrick RA, Pethrick RA (eds) (1999) Modern techniques for polymer characterization. John Wiley and Sons, New York

Phillip R Watson (1997) Physical chemistry. John Wiley and Sons Inc., New York

Pierson HO (1994) Handbook of carbon, graphite, diamond and fullerenes. Noyes Data Corporation/Noyes Corporation, New York

Pittance JC (ed) (1990) Engineering plastics and composites. SAM International, Materials Park, OH

Leach RH, Pierce RJ (1993) Printing ink handbook, national association of printing ink manufacturers Inc., 5th edn. Kluwer Academic Press, London, UK

Mao Xu, Carrick A, Spiegel S, Meisel I, Kniep CS Progress in polymer science and technology: 2002 IUPAC world polymer congress, Beijing, China, July 7–12, 2002, John Wiley and Sons, New York

Provder T (ed) (1991) Particle size distribution II: assessment and characterization. Oxford University Press, New York

Provder T, Texter J (eds) (2004) Particle sizing and characterization. American Chemical Society, Washington, DC

Prutton M, El Gomati M (eds) (2006) Scanning auger electron microscopy. Wiley, New York

Radiogenic age and isotopic studies: Report 1. Editied by Geologic Survey of Canada Staff, National Research Council of Canada NRC Research, 1987

Ready RG (1996) Thermodynamics. Plenum Publishing Company, New York

Rhodes G (1999) Crystallography made crystal clear: a guide for users of macromolecular models. Elsevier Science and Technology Books, New York

Rosato DV (ed) (1992) Rosato's plastics encyclopedia and dictionary. Hanser–Gardner Publications, New York

Rosin J (1967) Reagent chemicals and standards. Van Nostrand Reinhold Co., New York

Russell JB (1980) General chemistry. McGraw-Hill, New York

Salamone JC (ed) (1996) Polymeric materials encyclopedia. CRC Press, Boca Raton, FL

Saleh BEA, Teich MC (1991) Fundamentals of photonics. John Wiley and Sons, New York

Schoeser M (2003) World textiles: a concise history. Thames and Hudson, NY

Seanor DA (1982) Electrical conduction in polymers. Academic Press, New Academic Press, New York

Sepe MP (1998) Dynamic mechanical analysis. Plastics Design Library, Norwich, New York

Shah V (1998) Handbook of plastics testing technology. Wiley, New York

Shahidi F, Bailey AE (eds) Bailey's industrial oil and fat products. Wiley, New York

Shenoy AV (1996) Thermoplastics melt rheology and processing. Marcel Dekker, New York

Sigma–Aldrich Chemical Co. Catalog, www.sigma-aldrich.com, USA, 2006–2007

Skeist I (ed) (1990) Handbook of adhesives. Van Nostrand Reinhold, New York

Skoog DA, Holler FJ, Nieman TA (1997) Principles of instrumental analysis. Brooks/Coles, New York

Slade PE (2001) Polymer molecular weights, vol 4. Marcel Dekker, New York

Smith E, Dent G (2004) Modern Raman spectroscopy. John Wiley and Sons, New York

Smith JM (1981) Chemical engineering kinetics. McGraw-Hill Co., New York

Smith JM, Abbott MM, Abbot M, Van Ness HC, Van Ness HC (2004) Introduction to chemical engineering thermodynamics. McGraw-Hill Companies, New York

Smith MB, March J (2001) Advanced organic chemistry, 5th edn. John Wiley and Sons, New York

Soderberg GA, Karcher PW (1958) Restoring and maintaining finishes – spot finishing. Bruce Publishing Co., Milwaukee, WI

Solomon DH (1969) Kinetics and mechanisms of polymerization series, vol 2. Ring opening and step growth, vol 3. Marcel Dekker Inc., New York

Solomon DH, Hawthorne DG (1991) Chemistry of pigments and fillers. Krieger Publishing Co., New York

Staniforth M, Goldstein J, Echlin PL, Ifshin E, Newbury DA (2003) Scanning electron microscopy and X-ray microanalysis. Springer-Verlag, New York

Starr TF (1993) Data book of thermoset resins for composites. Elsevier Science and Technology Books, New York

Staudinger H, Heuer WA (1930) Relationship between the viscosity and the molecular weight of polystyrene (German). Ber 63B:222–234

Stedman's medical dictionary, 27th edn. Lippincott Williams and Wilkins, New York, 2000

Strong AB (2000) Plastics materials and processing. Prentice-Hall, Columbus, Ohio

Stuart BH (2002) Polymer analysis. John Wiley and Sons, New York

Stuart BH (2004) Infrared spectroscopy. John Wiley and Sons, New York

Sudduth RD (2003) J Appl Sci 48(1):25–36

Suryanarayana C, Norton MG (2003) X-ray diffraction: a practical approach. Plenum Publishing Company, New York

John D Keane Systems and specifications (1985) Steel Structures Paint Council, Pittsburgh, PA

Tanford C (1961) Physical chemistry of macromolecules. John Wiley and Sons Inc., New York

Tess RW, Poehlein GW (eds) (1985) Applied polymer science, 2nd edn. American Chemical Society, Washington, DC

Tests for comparative flammability of liquids, UI 340. Laboratories Incorporated Underwriters, New York, 1997

Thompson, Michael, Baker MD, Tyson JF, Christie A (1985) Auger electron spectroscopy. John Wiley and Sons Inc., New York

Tooke WR Jr (1963) Film thickness testing: a paint inspection gage. Official Digest 35(462): 691–698

Tortora PG (ed) (1997) Fairchild's dictionary of textiles. Fairchild Books, New York

Tortora PG, Merkel RS (2000) Fairchild's dictionary, 7th edn. Fairchild Publications, New York

Tracton AA (ed) (2005) Coatings technology handbook. Taylor and Francis Inc., New York

Troitzsch J (2004) Plastics flammability handbook: principle, regulations, testing and approval. Hanser–Gardner Publications, New York

Tuck N (2001) Waterborne and solvent based, alkyds and their end user application, vol 6. John Wiley and Sons, New York

Uhlig HH (2000) Corrosion and corrosion control. John Wiley and Sons Inc., New York

Usmani AM (ed) (1997) Asphalt science and technology. Marcel Dekker, New York

Van Wazer JR, Lyons JW, Kim KY, Colwell RE (1963) Viscosity and flow measurement. Interscience Publishers Inc., New York

Vanderhoff JW, Gurnee EF (1956) Motion picture investigation of polymer latex phenomena. TAPPI 39(2):71–77

Vanderhoff JW, Tarkowski HL, Jenkins MC, Bradford EG (1966) Theoretical considerations of the interfacial forces involved in the coalescence of latex particles. J Macromol Chem 1(2):361–397

Vigo TL (1994) Textile processing, dyeing, finishing and performance. Elsevier Science, New York

Vincenti R (ed) (1994) Elsevier's textile dictionary. Elsevier Science and Technology Books, New York

Wallenberger FT, Weston NE (eds) (2003) Natural fibers, plastics and composites. Springer-Verlag, New York

Wang X, Zhou Q (2004) Liquid crystalline polymers. World Scientific Publishing Co. Inc., Singapore

Watt IM (1997) Principles and practice of electron microscopy. Cambridge University Press, UK

Weast RC (ed) Handbook of chemistry and physics, 52nd edn. The CRC Press, Boca Raton, FL

Weismantal GF (1981) Paint handbook. McGraw-Hill Corporation Inc., New York

Weldon DG (2001) Failure Analysis of paints and coatings. John Wiley and Sons, New York

Whistler JN, BeMiller JN (eds) (1992) Industrial gums: polysaccharides and their derivatives. Elsevier Science and Technology Books, New York

Whitten KW, Davis RE, Davis E, Peck LM, Stanley GG (2003) General chemistry. Brookes/Cole, New York

Wicks ZN, Jones FN, Pappas SP (1999) Organic coatings science and technology, 2nd edn. Wiley-Interscience, New York

Wickson EJ (eds) (1993) Handbook of polyvinyl chloride formulating. John Wiley and Sons Inc., New York

Wijnekur FJM (1967) Elsevier's dictionary of the printing and allied industries in four languages. Research Institute for the Graphic and Allied Industries, TNO, Amsterdam, Elsevier Publishing Co., New York

Willard HH, Merritt LL, Dean JA (1974) Instrumental methods of analysis. D.Van Nostrand Company, New York

Witte RSS, Witte JS, Smith GS (2003) Statistics. John Wiley and Sons, New York

Wolf WL, Zeissis GJ (1985) Infrared handbook. SPIE International Society for Optical Engineering, WA

Wray HA (ed) (1991) Manual for flash point standards and their use. American Society for Testing and Materials, PA

Wypych G (ed) (2001) Handbook of solvents. Chemtec Publishing, New York

Wypych G (ed) (2003) Plasticizer's data base. Noyes Publication, New York

Yates M (2002) Fabrics. W. W. Norton and Company, New York

Yau WW, Kirkland JJ, Bly DD (2001) Modern size-exclusion chromatography. John Wiley and Sons, New York

Zaccaria VK, Utracki L (2003) Polymer blends. Springer-Verlag, New York

Zaiko GE (ed) (1995) Degradation and stabilization of polymers. Nova Science Publishers Inc., New York

Zhelyazova B, Kovacheva S (2002) Elsevier's dictionary of plastics and polymer in English–German–French–Spanish–Russian. Elsevier, New York