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Standard Terminology Relating to Rubber[1]

This standard is issued under the fixed designation D1566; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This terminology covers definitions of technical terms used in the rubber industry. Terms that are generally understood or adequately defined in other readily available sources are not included.

1.2 Definitions for terms that have been established by other bodies recognized as expert in the field will, after ballot approval, be inserted in this terminology without change, and the source of the definition will be identified. Exceptions to this rule will be where the meaning of the term as used in the rubber industry is different from the common meaning of the term.

1.3 Users of this terminology who require mathematical expressions for the time and temperature dependent physical properties of some terms found in this standard should refer to Guide D5992 and other standards listed under referenced documents. Selected terms from Guide D5992 may be found in Annex A1.

1.4 Although this terminology standard avoids the inclusion of jargon and archaic terms as much as possible, some terms have been retained for historical reasons.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D925 Test Methods for Rubber Property—Staining of Surfaces (Contact, Migration, and Diffusion)

D1076 Specification for Rubber—Concentrated, Ammonia Preserved, Creamed, and Centrifuged Natural Latex

D1148 Test Method for Rubber Deterioration—Discoloration from Ultraviolet (UV) and Heat Exposure of Light-Colored Surfaces

D1415 Test Method for Rubber Property—International Hardness

D1646 Test Methods for Rubber—Viscosity, Stress Relaxation, and Pre-Vulcanization Characteristics (Mooney Viscometer)

D1765 Classification System for Carbon Blacks Used in Rubber Products

D3053 Terminology Relating to Carbon Black

D5992 Guide for Dynamic Testing of Vulcanized Rubber and Rubber-Like Materials Using Vibratory Methods

D6085 Practice for Sampling in Rubber Testing—Terminology and Basic Concepts

E6 Terminology Relating to Methods of Mechanical Testing

E20 Practice for Particle Size Analysis of Particulate Substances in the Range of 0.2 to 75 UM by Optical Microscopy[3]

E28 Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus

E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus

E126 Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers

2.2 *ISO Standards:*[4]

1382-82 Rubber-Vocabulary Second Edition (Addendum 16-18-1998)

3. Terminology

abrasion, *n*—surface loss of a material due to frictional forces.

abrasion resistance index, *n*—measure of the abrasion resistance of a rubber relative to that of a standard rubber under the same specified conditions, expressed as a percentage.

accelerated life test, *n*—test method designed to approximate in a short time, the deteriorating effect of normal long-term service conditions.

accelerator, delayed action, *n*—accelerator that, in conjunction with other curing agent(s), produces, at vulcanizing temperatures, a period of no significant cross-linking, followed by a period of rapid cross-link formation.

accelerator (rubber), *n*—compounding material used in small amounts with a vulcanizing agent to increase the speed of vulcanization.

[1] This terminology is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.08 on Terminology.

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The boldface designations refer to the original source of the definition and the ASTM technical committee having jurisdiction. DOI: 10.1520/D1566-09.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

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DISCUSSION—Properties of a vulcanizate are changed by the type or amount of accelerator used.

activator, *n*—compounding material used in small proportions to increase the effectiveness of an accelerator.

adhesion, *n*—condition in which surfaces are held together by chemical or physical forces or both.

adhesion failure, *n*—loss of structural integrity due to the separation of two bonded surfaces at the bond interface.

adhesion value, *n*—force required to cause adhesion failure.

DISCUSSION—Any separation occurring at any other point, for example, inside either component under test, is a failure of the component material, and such separation should not be considered as indicating adhesion strength.

adhesive failure, *n*—separation of two bonded surfaces that occurs within the bonding material.

DISCUSSION—Adhesive failure occurs when the adhesive strength of a bonding material is greater than its cohesive strength.

aftercure, *n*—continuation of the process of vulcanization after the energy source has been removed.

age resistance, *n*—ability of a material to resist deterioration caused by ageing.

agglomerate, compounding material, *n*—cluster of particles of one or more compounding materials loosely held together.

agglomerate, latex, *n*—cluster of rubber particles in a colloidal aqueous suspension of such particles.

agglomerates, *n*—clusters of particles of compounding materials contained in a continuous rubber phase.

agglomeration (latex), *n*—reversible or irreversible joining together of latex particles.

ageing (act of), *n*—exposure of materials to a deteriorating environment for a specified time interval.

ageing (rubber), *n*—irreversible change of material properties during exposure to a deteriorating environment, for a specified time interval.

ageing, accelerated, *n*—exposure of rubber to a test environment with the intent of producing, in a shorter time period, effects similar to normal ageing.

ageing, air bomb, *n*—process of exposing materials to the action of air at an elevated temperature and pressure.

ageing, air oven, *n*—process of exposing materials to the action of air at an elevated temperature at atmospheric pressure.

ageing, natural, *n*—ageing under normal service conditions.

ageing, oxygen bomb, *n*—process of exposing materials to the action of oxygen at an elevated temperature and pressure.

ageing, shelf, *n*—ageing during storage.

alloy, *n*—unique composition of two or more polymers that has one or more of the polymers treated or processed in a special way to confer enhanced performance characteristics on the resulting material.

anticoagulant (natural rubber latex), *n*—substance added to field latex from *Havea brasiliensis* or to guayule latex to retard bacterial action which would otherwise cause rapid coagulation of the latex.

DISCUSSION—The word "stabilizer" is often used in place of "anticoagulant" in latex terminology.

antidegradant, *n*—compounding material used to retard deterioration caused by oxidation, ozone, light, and combinations of these.

DISCUSSION—"Antidegradant" is a generic term for such additives as antioxidants, antiozonants, and waxes.

antiflex cracking agent, *n*—compounding material used to retard cracking caused by cyclic deformations.

antifoaming agent, *n*—agent that inhibits bubble formation in an agitated liquid, usually by reducing the surface tension.

antioxidant, *n*—compounding material used to retard deterioration caused by oxidation.

antiozonant, *n*—compounding material used to retard deterioration caused by ozone.

antistatic agent, *n*—material which reduces the tendency for accumulation of electric charge on the surface of an article.

apparent density, *n*—See **density, bulk**, the preferred term.

aromatic oil, *n*—hydrocarbon process oil containing at least 35 %, by mass, of aromatic hydrocarbons.

ash, *n*—residue from incineration of a material under specified conditions.

autoclave (rubber), *n*—pressure vessel used for vulcanizing rubber products by means of steam under pressure.

backrinding, *n*—molding defect in which the rubber adjacent to the spew line shrinks below the surface of the molded product, with the spew line often being ragged and torn.

bag cure, *n*—method of vulcanization in which an inflated flexible bag is used to impart positive internal pressure on the article being vulcanized.

balata, *n*—hard thermoplastic consisting of approximately equal proportions of trans-polyisoprene and resin, obtained from trees of the *Sapotaceae* family.

bale coating, *n*—coating applied to surfaces of rubber bales that inhibits adhesion to other surfaces.

ball mill, *n*—closed rotating cylinder containing hard balls (or other shaped members) that serves to grind coarse materials to a finer particle size.

bank (mill, calender, or spreader), *n*—reservoir of material at the opening between rolls (mill or calender), or at the spreader bar.

batch, *n*—product of one mixing operation.

bench marks, *n*—two marks of known separation applied to a specimen to measure the strain of the specimen during extension.

blank, *n*—portion of a rubber compound of suitable volume to fill the cavity of a mold.

bleeding, *n*—exuding of a liquid compounding material from the surface of a vulcanized or unvulcanized rubber.

blister(s), *n*—surface or internal imperfection(s), produced by entrapped gases or other volatiles, during the manufacture of rubber articles.

bloom (rubber), *n*—liquid or solid material that has migrated to the surface of a rubber and generally changes the surface appearance.

blow, *n*—volume expansion that occurs during the production of cellular or sponge rubber.

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blowing agent, *n*—compounding material used to produce gas by chemical or physical action, or both, in the manufacture of hollow or cellular articles.

booster, *n*—synonym for **secondary accelerator**, which is the preferred term.

bound monomer, *n*—monomer that is combined or reacted with itself or other types of monomers in a polymerization reaction to form a polymer.

DISCUSSION—This term is used in synthetic rubber production, and the bound monomer is normally expressed as a percentage of total polymer.

bound rubber, *n*—nonvulcanized polymer attached to a filler through any combination of absorption, chemisxorption, physical entrapment, or crosslinking of free molecules; the polymer-filler combination is insoluble in solvents that normally dissolve the polymer.

branched polymer, *n*—polymer that has side chains of the same monomer composition as the main chain attached at points along the main chain.

buffing rubber, *n*—particulate rubber produced as a byproduct of the buffing operation in the carcass preparation stage of a tire retreading; characterized by a wide range of particle sizes that are predominately elongated or acicular in shape. See **particulate rubber**.

DISCUSSION—The appearance of the unique shape of the particles of this material is only apparent in finished goods or products that contain particles having a dimension greater in size than 600 µm (30 mesh).

bulk density, *n*—mass per unit volume of a material, including any voids present.

bumping, molding process, *n*—application, release, and re-application of pressure prior to the start of vulcanization to vent entrapped gases, thereby facilitating complete filling of the mold.

calender, *n*—machine with two or more parallel, counter-rotating rolls with a controllable, roll-to-roll spacing, rotating at selected surface speeds and controlled temperatures, used for sheeting, laminating, skim coating (topping) and friction coating, to a controlled thickness and/or surface condition.

carbon black, *n*—material consisting essentially of elemental carbon in the form of near-spherical colloidal particles and coalesced particle aggregates of colloidal size, obtained by partial combustion or thermal decomposition of hydrocarbons. **D3053**

carbon black, thermal, *n*—type of carbon black produced under controlled conditions by the thermal decomposition of hydrocarbons in the absence of air or flames.

DISCUSSION—These grades are designated with an "N" first character and a second character of "8 or 9" in Table 1 of Classification D1765. **D3053**

carbon black, thermal, acetylenic, *n*—thermal black produced from acetylene gas **D3053**

carbon gel (carbon-rubber-gel), *n*—portion of rubber that is not leached by a solvent under specified conditions, from an intimate mixture of carbon black and unvulcanized rubber.

carcass, *n*—fabric, cord, or metal reinforced section, or all three, of a rubber product as distinguished from the rubber tube, cover, or tread.

cell, *n*—single small cavity surrounded partially or completely by walls.

cell, closed, *n*—cell totally enclosed by its walls, hence not interconnecting with other cells.

cell, open, *n*—cell not totally enclosed by its walls and hence interconnecting with other cells.

cellular material, *n*—generic term for materials containing many cells (either open, closed, or both) dispersed throughout the mass.

cellular material, collapse, *n*—undesirable densification of a cellular material resulting from the breakdown of its cellular structure.

cellular material, cored, *n*—cellular material containing a multiplicity of holes (usually, but not necessarily, cylindrical in shape), molded or cut into the material in some pattern normally perpendicular to the largest surface, and extending part or all the way through the piece.

cellular material, flexible, *n*—cellular organic polymeric material that will not rupture when a specimen 200 by 25 by 25 mm (8 by 1 by 1 in.) is bent around a 25-mm (1-in.) diameter mandrel at a uniform rate of one lap in 5 s at a temperature between 18 and 29°C.

cellular rubber, *n*—rubber products containing cells or hollow receptacles which may be open, interconnecting, or closed and not interconnecting.

cellular striation, *n*—condition characterized by a layer within a cellular material that differs greatly from the characteristic cell structure.

cement, rubber, *n*—adhesive that is either a liquid dispersion or solution of raw or compounded rubber, or both.

centrifuged rubber latex, *n*—latex, the rubber concentration of which has been increased by the removal of water by centrifugal force.

chalking (rubber), *n*—formation of a powdery residue on the surface of a rubber, commonly resulting from surface degradation.

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chatter marks, *n*—defect on calendered sheeting consisting of transverse narrow bands of alternately thicker and thinner material.

coagent, *n*—compounding ingredient used in small amounts to increase the crosslinking efficiency of certain non-sulfur vulcanizing systems, or to modify the properties given by such systems.

DISCUSSION—The term is usually identified with additives used to modify vulcanization by organic peroxides.

coagulant dipping (latex), *n*—dipping process in which the product form is first immersed in a coagulant solution, withdrawn, dried, and then immersed in the latex.

coagulating agent, *n*—any material used to transform a liquid or colloid system into a curdlike, semisolid, or solid-state system.

DISCUSSION—The transformation permits a separation of the solid from the remaining liquid by a chemical reaction and interaction, but not by evaporation or freezing.

coagulation (rubber latex), *n*—irreversible agglomeration of particles originally dispersed in a rubber latex.

coagulum (latex), *n*—undesirable, irreversible, agglomeration of rubber particles retained on a 180-µm mesh screen. **D1076**

coated fabric, *n*—flexible product composed of a textile fabric and an adherent polymeric material applied to one or both surfaces.

cohesive failure (bonded assembly), *n*—rupture occurring entirely within any single uniform layer of the assembly.

cold checks, *n*—defect on calendered sheeting consisting of surface roughness.

cold flow (unvulcanized rubber), *n*—slow deformation, under gravitational force, at or below room temperature.

colorfast, rubber, *n*—ability of a rubber compound to resist changes in color.

colorfast rubber, *n*—a rubber compound that resists changes in color.

comonomer, *n*—one of two or more monomer species that polymerize to form a copolymer.

complex shear modulus, G*, *n*—ratio of shear stress to shear strain, where both may include elastic and viscous components.

complex Young's modulus, E*, *n*—ratio of normal stress to normal strain, where both may include elastic and viscous components, typically measured at low strains.

compound, *n*—intimate admixture of a polymer(s) with all the materials necessary for the finished article.

compound, standard, *n*—control or reference compound prepared according to a prescribed formula and mixing procedure.

compounding ingredient, *n*—See **compounding material**, the preferred term.

compounding material, *n*—substance used as part of a rubber mix.

compression molding, *n*—molding process in which the material is placed directly in the mold cavity and compressed to shape by closure of the mold.

compression set, *n*—residual deformation of a material after removal of the compressive stress.

conditioning (environmental), *n*—storage of a rubber, under specified conditions (time, temperature, humidity) prior to testing.

conditioning (mechanical), *n*—prescribed program of deformation of a specimen prior to testing.

continuous vulcanization, *n*—process where a shaped article passes without pause through conditions designed to create a vulcanization reaction.

conventional sulfur vulcanizing system, *n*—as applied to natural and isoprene rubbers and butadiene-based synthetic rubbers, a vulcanizing system using a relatively high proportion of sulfur in which the combined sulfur exists predominantly in the polysulfidic cross links chain modifications.

DISCUSSION—The amount of free sulfur and the ratio of free sulfur to accelerator will vary from rubber to rubber.

copolymer, *n*—polymer formed from two different monomers.

copolymerization, *n*—polymerization of two or more different monomers into a single polymer.

coupling agent, *n*—a material that promotes a bond between a polymer and a filler, or between a polymer and an additive.

cracker, *n*—heavy-duty mill having two deeply corrugated or pyramid-cut rolls for breaking down a rubber or a mix, or for cutting rubber or a mix into pieces.

cracks, *n*—fissure(s) originating in the surface of a rubber vulcanizate or product as a result of natural weathering.

cracks, flex, *n*—fissures originating in the surface of a rubber vulcanizate, resulting from cyclic deformation (usually bending).

crack(s), ozone, *n*—fissure(s) originating in the surface of a rubber vulcanizate, caused by exposure to an ozone-containing environment; these fissures are perpendicular to the direction of strain, and usually occur in rubbers having main chain unsaturation.

crazing, *n*—formation of a random pattern of shallow cracks on a rubber surface usually due to ageing by light.

DISCUSSION—Unlike ozone cracking, crazing does not depend on the presence of a tensile strain in the rubber.

creaming (rubber latex), *n*—reversible process of concentration by gravitational force of rubber particles near the bottom or top of the latex.

creep, *n*—time-dependent part of a strain resulting from stress.

crosslink, *n*—chemical bond bridging one polymer chain to another.

crosslink density, *n*—number of crosslinks per unit mass or volume of vulcanizate.

DISCUSSION—The units of crosslink density will indicate whether it is per unit mass or per unit volume.

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crosslinking (the act of), *n*—formation of chemical bonds between polymer chains to give a network structure.

crowsfeet, *n*—small flowmarks of V-shape on calendered sheeting.

crystallization, polymer, *n*—arrangement of previously disordered polymer segments of repeating patterns into geometric symmetry.

cure, *n*—See **vulcanization**, the preferred term.

cure meter, *n*—testing device that measures the progress of vulcanization at a vulcanizing temperature.

DISCUSSION—The measured property, normally proportional to the complex dynamic modulus, is recorded at closely spaced time intervals to produce a quasi-continuous measured property versus time curve.

cure rate, *n*—time-dependent progress of vulcanization, measured as a change in vulcanizate properties per unit time, where this rate varies over the time period.

curing agent, *n*—synonym for **vulcanizing agent**, the preferred term.

delta Mooney value, *n*—measure of the processability of a non-pigmented emulsion SBR based on the difference in viscosity recorded at specific times by a Mooney viscometer.

density, *n*—mass per unit volume of a material. **E126, E20**

density, bulk, *n*—mass per unit volume of a material, including any voids present.

desiccant, *n*—compounding material used to irreversibly absorb moisture present (in a rubber mix) particularly for the purpose of minimizing risk of porosity during vulcanization.

devulcanization, *n*—destruction of the chemical crosslinks in a vulcanized rubber.

die, cutting, *n*—single planar form having sharpened edges that is forced, in a fixed or rotating fashion, upon a material, thus resulting in a desired shape.

die, extruder, *n*—orifice with a specific geometry through which material is forced, causing the extrudate to have a specific profile.

die swell, *n*—difference between the dimensions of the cross section of an extrudate and the corresponding dimensions of the die orifice by which the extrudate is formed.

DISCUSSION—It is usually quantified as the percentage increases in the cross-sectional area.

diene polymer, *n*—polymer formed from one or more monomer species, at least one of which is a diolefin.

diene rubber, *n*—polymer having unsaturated carbon in the main chain, derived from butadiene or a substituted butadiene.

dipping (latex), *n*—process in which a layer of rubber is deposited on a mold or form as a result of immersion in a bath of compounded latex.

dispersing agent (latex), *n*—surface-active substance used to facilitate the suspension of solid compounding materials in a liquid medium and to stabilize the dispersion thereby produced.

dispersion (the act of), *n*—application of shearing forces to distribute one or more compounding materials uniformly throughout the mass of a continuum of material.

dough (rubber), *n*—paste-like mass of smooth texture, consisting of a rubber mix and solvent; it is used for spreading.

dumbbell specimen (rubber), *n*—flat specimen having a narrow straight central portion of essentially uniform cross section with enlarged ends. **D412**

durometer, *n*—instrument for measuring the indentation hardness of rubber.

dusting, *n*—application of a powder to a rubber surface, generally to prevent adhesion to another surface.

dynamic vulcanizate, *n*—See **thermoplastic vulcanizate**, the preferred term.

dynamic vulcanization, *n*—process of intimate melt mixing a thermoplastic polymer and a suitable reactive rubbery polymer to generate a thermoplastic elastomer with a chemically cross-linked rubbery phase resulting in properties close to those of a thermoset rubber when compared to the same cross-linked composition.

ebonite, *n*—hard material made by sulfur vulcanization of rubber, in which the hardness is substantially obtained by the action of the sulfur.

efficient vulcanizing (EV) systems, *n*—as applied to natural rubbers and isoprene- and butadiene-based synthetic rubbers, a vulcanizing system making efficient use of sulfur and producing at optimum cure a network containing a preponderance of thermally stable monosulfidic crosslinks.

DISCUSSION—EV systems are comprised of a sulfur donor or a combination of low concentration of free sulfur (for example, <0.5 parts per hundred parts of rubber), or both, at a comparatively high concentration of accelerator(s).

elastic, *adj*—of or pertaining to elasticity.

elastic limit, *n*—greatest stress that a material is capable of sustaining, without any permanent strain remaining, upon complete release of the stress. **E6, E28**

elastic (storage) shear modulus, G', *n*—ratio of the shear stress component in phase with the shear strain, to the shear strain.

elastic Young's modulus, E', *n*—ratio of the normal stress component in phase with the normal strain, to the normal strain, typically measured at low strains.

elasticity, *n*—rapid recovery of a material to its approximate initial shape and dimensions after substantial deformation by force and subsequent release of that force.

elastomer, *n*—an elastic polymer.

elongation, *n*—extension produced by a tensile stress.

elongation, percent, *n*—extension of a uniform section of a specimen expressed as percent of the original length.

DISCUSSION—Elongation, % =

$$\frac{(\text{final length} - \text{original length})}{\text{original length}} \times 100$$

elongation, ultimate, *n*—elongation at the time of rupture.

emulsifying agent (latex), *n*—surface-active substance used to facilitate the dispersion of an immiscible liquid compounding material in another liquid and to stabilize the emulsion thereby produced.

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