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Standard Terminology Relating to Carbon Black[1]

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ε[1] NOTE—Section 2 was editorially updated in February 2003.

[1] These definitions are under the jurisdiction of ASTM Committee D24 on Carbon Black and are the direct responsibility of Subcommittee D24.41 on Carbon Black Nomenclature and Terminology.

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1. Scope

1.1 This terminology is a compilation of definitions of technical terms used in the carbon black and rubber industries. Terms that are generally understood or adequately defined in other readily available sources are not included.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1508 Test Method for Carbon Black, Pelleted—Fines Content[2] and Attrition

[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*, Vol 09.01. volume information, refer to the standard's Document Summary page on the ASTM website.

D 1509 Test Methods for Carbon Black—Heating Loss
D 1510 Test Method for Carbon Black—Iodine Adsorption Number
D 1511 Test Method for Carbon Black—Pellet Size Distribution
D 1513 Test Method for Carbon Black, Pelleted—Pour Density
D 1514 Test Method for Carbon Black—Sieve Residue
D 1566 Terminology Relating to Rubber
D 1618 Test Method for Carbon Black ~~Extractables—Toluene Discoloration[2]~~ Extractables—Transmittance of Toluene Extract
D 1765 Classification System for Carbon Blacks Used in Rubber Products
D 1937 Test Method for Carbon Black, Pelleted—Mass Strength
D 2414 Test Method for Carbon Black—Oil Absorption Number (OAN)
D 3265 Test Method for Carbon Black—Tint Strength
D 3313 Test Method for Carbon Black—Individual Pellet ~~Crush Strength[2]~~ Hardness
D 3493 Test Method for Carbon Black—Oil Absorption Number of Compressed Sample
D 3849 Test Method for Carbon ~~Black—Primary Aggregate Dimensions from~~ Black—Morphological Characterization of Carbon Black Using Electron ~~Microscope Image Analysis[2]~~ Microscopy
D 5230 Test Method for Carbon Black—Automated Individual Pellet ~~Crush Strength[2]~~ Hardness
D 6556 Test Method for Carbon Black—Total and External Surface Area by Nitrogen Adsorption

3. Terminology

3.1 *Definitions:*

aciniform, *adj*—shaped like a cluster of grapes.

DISCUSSION—The spheroidal primary particles of carbon black are fused into aggregates of colloidal dimension forming an aciniform morphology.

carbon black, *n*—~~material consisting essentially~~ an engineered material, primarily composed of elemental carbon, obtained from the partial combustion or thermal decomposition of hydrocarbons, existing in the form of ~~n~~ aggregates of acinifor-m morphology which are composed of spheroiedal primary particles, uniformity of primary particle sizes within a given aggregate and turbostratic layering within the primary particles.

DISCUSSION—Particle size and ~~a~~aggregate size (number of particles per aggregate) are distributional properties and vary depending on the carbon black grade. Transmission electron micrographs shown in Annex 1 of Practice D 6602 demonstrate that while particle and aggregate sizes vary greatly within a given grade of ~~colloidal size, obtained by partial combustion or thermal decomposition of hydrocarbons.~~ carbon black, the primary particle size is essentially uniform within an individual aggregate.

carbon black agglomerate, *n*—a cluster of physically bound and entangled aggregates.

DISCUSSION—See Test Method D 3849.

carbon black aggregate, *n*—a discrete, rigid, colloidal mass of extensively coalesced particles; it is the smallest dispersible unit.
carbon black, carcass grade, *n*—a type of furnace carbon black having an average particle size in the range from 31 to 200 nm.

DISCUSSION—Carcass-grade carbon blacks are produced by the oil furnace process. The use of these grades in the rubber industry is not limited to the carcass portion of the tire. These grades are designated with an "N" first character and a second character of "4, 5, 6, or 7" in Table 1 of Classification D 1765. See Terminology D 1566 for the definition of carcass.

carbon black, furnace, *n*—a type of carbon black produced by the decomposition reaction of hydrocarbons when injected into a high-velocity stream of combustion gases under controlled conditions.
carbon black, hard, *n*—See **carbon black, tread grade**, the preferred term.

DISCUSSION—All carbon blacks provide some level of reinforcement when mixed in rubber. The amount of reinforcement is a function of the carbon black grade and amount used. See Terminology D 1566 for the definition of reinforcement.

carbon black microstructure, *n*—arrangement of carbon atoms within a carbon black particle.
carbon black particle, *n*—a small spheroidally shaped (paracrystalline, non-discrete) component of a carbon black aggregate; it is separable from the aggregate only by fracturing.
carbon black particle diameter, *n*— arithmetic average of the diameters of particles within a carbon black aggregate as measured by electron microscopy.

DISCUSSION—See Test Method D 3849.

carbon black pellet, *n*—a relatively large agglomerate mass that has been densified in spheroidal form to facilitate handling and processing.

DISCUSSION—See Test Method D 1511.

carbon black reinforcing, *n*—See **carbon black, tread grade**, the preferred term.

DISCUSSION—All carbon blacks provide some level of reinforcement when mixed in rubber. The amount of reinforcement is a function of the carbon black grade and amount used. See Terminology D 1566 for the definition of reinforcement.

carbon black, semi-reinforcing, *n*— See **carbon black, carcass grade**, the preferred term.

DISCUSSION—All carbon blacks provide some level of reinforcement when mixed in rubber. The amount of reinforcement is a function of the carbon black grade and amount used. See Terminology D 1566 for the definition of reinforcement.

carbon black, soft, *n*—See **carbon black, carcass grade**, the preferred term.

DISCUSSION—All carbon blacks provide some level of reinforcement when mixed in rubber. The amount of reinforcement is a function of the carbon black grade and amount used. See Terminology D 1566 for the definition of reinforcement.

carbon black structure, *n*—the quality of irregularity and deviation from sphericity of the shape of a carbon black aggregate.

carbon black, surface activity, *n*— the inherent ability of the carbon black surface to interact physically or chemically, or both, with rubber or other molecules.

carbon black, target value, *n*—a consensus value for selected primary properties on which producers center their manufacturing process and users center their specification.

DISCUSSION—Target values for carbon black properties are shown in Classification D 1765 for most rubber grade carbon blacks currently in commerce.

carbon black, thermal, *n*—a 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 D 1765.

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

carbon black, tread grade, *n*—a type of furnace carbon black having an average particle size in the range from 1 to 30 nm.

DISCUSSION—Tread grade carbon blacks are produced by the oil furnace process. The use of these grades in the rubber industry is not limited to the tread portion of the tire. These grades are designated with an "N" first character and a second character of "0, 1, 2, or 3" in Table 1 of Classification D 1765.

carbon black, typical value, *n*—a consensus value for those carbon black properties which are not specifically targeted for control in the manufacturing process and which are somewhat dependent upon the targeted properties.

DISCUSSION—Typical values for carbon black properties are shown in Classification D 1765 for most rubber grade carbon blacks currently in commerce. These are consensus values based upon the range in values supplied by the manufacturers. Typical values are useful in making comparisons between grades but they are not the set-point targets for the process and may be expected to differ significantly between producers.

carbon black weight mean particle size, *n*—ratio equal to the sum of individual particle diameters, each raised to the fourth power, divided by the sum of the individual particle diameters, raised to the third power,

~~**dibutyl phthalate (DBP)**~~**compressed oil absorption number (COAN),** *n*~~—the~~—See **oil absorption number of ~~cubic centimetres of DBP absorbed by 100 g of carbon black under specified test conditions.~~**

~~DISCUSSION—See Test Methods D 2414 and D 3493.~~ compressed sample, the preferred term.

fines, *n*—that portion of pelleted carbon black that passes through a specified sieve under standard conditions.

DISCUSSION—See Test Methods D 1508 and D 1514.

heating loss, *n*—mass loss, in percent, when carbon black is heated at 125°C for 1 h; the heating loss is primarily attributed to moisture content.

DISCUSSION—See Test Method D 1509.

individual pellet hardness, *n*—the force required to fracture or crush a carbon black pellet.

DISCUSSION—See Test Methods D 3313 and D 5230.

iodine adsorption number, *n*—the number of grams of iodine adsorbed per kilogram of carbon black under specified conditions.

DISCUSSION——See Test Method D 1510.

lot, *n*—a quantity of carbon black that is essentially uniform in composition and characteristics.

lot sample, *n*—a quantity of carbon black selected to represent a lot for testing purposes and taken in accordance with Practice D 1799 or D 1900.

mass strength, *n*—a measure of the tendency for carbon black pellets to pack together and to influence flow in a bulk handling system.

DISCUSSION—See Test Method D 1937.

material, *n*—a quantity of carbon black with unique composition and characteristics.

moisture content, *n*—the percentage, by mass, of water absorbed and adsorbed by carbon black.

DISCUSSION—See definition of **carbon black heating loss.**

nitrogen surface area (NSA), *n*—the total surface area of carbon black that is calculated from nitrogen adsorption data using the B.E.T. theory.

DISCUSSION—See Test Methods D 3037 and D 4820.

oil absorption number (OAN), *n*—the number of cubic centimeters of dibutyl phthalate (DBP) or paraffin oil absorbed by 100 g of carbon black under specified conditions.

DISCUSSION—The OAN value is proportional to the degree of aggregation of structure level of the carbon black. See Test Methods D 2414 and D 3493.

oil absorption number of compressed sample (COAN), *n*—the number of cubic centimeters of dibutyl phthalate (DBP) or paraffin oil absorbed by 100 g of carbon black after being compressed four times in a compression cylinder at 165 MPa (24 000 psi) under specified conditions.

DISCUSSION—The COAN value gives some measure of the stability of the structure of the carbon black. See Test Methods D 2414 and D 3493.

oil furnace process, *n*—a process for producing furnace carbon blacks that uses oil as the source of hydrocarbons for decomposition by injection into a high-velocity stream of combustion gases.

DISCUSSION—Oil or natural gas are typically used as combustion fuel to create the high-velocity stream of combustion gases, although other fuels may be used.

pellet size distribution, *n*—the percentage, by mass, of carbon black retained on each of a specified series of sieve screens arranged with progressively smaller openings.

DISCUSSION—See Test Method D 1511.

pour density, *n*—the mass per unit volume of pelleted carbon black.

DISCUSSION—See Test Method D 1513.

sample, *n*—a portion of carbon black selected for use in obtaining a test result.

statistical thickness surface area (STSA), *n*—the external surface area of carbon black that is calculated from nitrogen adsorption data using the de Boer theory and a carbon black model.

DISCUSSION—see Test Methods D 5816.

tint strength, *n*—the ratio, expressed as tint units, of the reflectance of a standard paste to a sample paste, both prepared and tested under specified conditions.

DISCUSSION—See Test Method D 3265.

toluene discoloration, *n*—the transmittance, at 425 nm, of the filtrate obtained from the toluene extract of carbon black, compared to that of pure toluene.

DISCUSSION—See Test Method D 1618.

vacuum, *n*—pressure below atmospheric pressure.