



Standard Test Method for Carbon Black—Morphological Characterization of Carbon Black Using Electron Microscopy¹

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1. Scope

1.1 This test method covers the morphological characterization of carbon black primary aggregates from transmission electron microscope images. These measurements are used to derive the mean particle and aggregate size of carbon black in the dry (as manufactured) state, from CAB chip dispersion or removed from a rubber compound.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets²

D 3191 Test Methods for Carbon Black in SBR (Styrene-Butadiene Rubber)—Recipe and Evaluation Procedures²

D 3192 Test Methods for Carbon Black Evaluation in NR (Natural Rubber)²

D 6556 Test Method for Carbon Black—Total and External Surface Area by Nitrogen Adsorption²

3. Terminology

3.1 Definitions:

3.1.1 General

3.1.1.1 *carbon black particle*—a small spheroidally shaped, paracrystalline, non-discrete component of an aggregate; it can only be separated from the aggregate by fracturing. Carbon

black particle size is a distributional property; therefore, the term particle size implies the mean value from multiple measurements.

3.1.1.2 *carbon black aggregate*—a discrete, rigid colloidal entity that is the smallest dispersible unit; it is composed of extensively coalesced particles. Carbon black aggregate size is a distributional property; therefore, the term aggregate size implies the mean value from multiple measurements.

3.1.1.3 *glow discharge*—a plasma of ionized gas that is formed in a high-voltage field at pressures of about 3 to 20 Pa (25 to 150×10^{-3} torr). An alternating current (a-c) glow discharge using air is effective in cleaning and oxidizing the surface of carbon substrates to improve the wetting characteristics of polar vehicles containing pigment dispersions.

3.1.1.4 *substrate*—a thin film that is used to support electron microscope specimens. Evaporated carbon films are commonly used because of relatively good mechanical strength, stability and conductivity.

3.1.2 Aggregate Dimensional Properties from Image Analysis

3.1.2.1 *area (A)*—the two-dimensional projected area of the carbon black aggregate image.

3.1.2.2 *perimeter (P)*—the total boundary length of an aggregate.

3.1.2.3 *volume (V)*—an estimate of the volume of the carbon black aggregate using stereological principles.

3.1.3 Image Analysis

3.1.3.1 *erosion*—the process by which image features are reduced in size by selectively removing pixels from their periphery. It consists of examining each binary pixel and changing it from ON to OFF if it has greater than a preset minimum of neighbors that are OFF. It serves a number of useful functions such as smoothing feature outlines and separating features touching each other.

3.1.3.2 *dilation*—the converse of erosion. This process is accomplished by changing any OFF pixel to ON if it has greater than a preset minimum of ON neighbors. This process causes image features to grow in size, which fills in small breaks in features, internal voids, or small indentations along the feature surface.

¹ This test method is under the jurisdiction of ASTM Committee D24 on Carbon Black and is the direct responsibility of Subcommittee D24.81 on Carbon Black Microscopy and Morphology.

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² *Annual Book of ASTM Standards*, Vol 09.01.