



Designation: D 3849 – 95a (Reapproved 2000)

Standard Test Method for Carbon Black — Primary Aggregate Dimensions from Electron Microscope Image Analysis¹

This standard is issued under the fixed designation D 3849; 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 test method covers the morphological characterization of carbon black primary aggregates from transmission electron microscope images. The measurements are applicable to carbon blacks in the dry (as manufactured) state, extracted from unvulcanized rubber compounds and in a cellulose acetate butyrate paint chip dispersion.

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 297 Test Methods for Rubber Products—Chemical Analysis²

D 1416 Test Methods for Rubber from Synthetic Sources—Chemical Analysis²

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

3. Terminology

3.1 Definitions:

3.1.1 *Aggregate Dimensional Properties from Image Analysis:*

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

3.1.1.2 *chord*—the length of a scanning intercept across an

aggregate in a given direction. The *mean chord* ($\pi A/P$) is the average width of an aggregate in all directions.

3.1.1.3 *Feret's diameter*—the maximum spacing between parallel tangents to an aggregate in a given direction. The average Feret (L) is derived from an average of multiple measurements at specific angular increments.

3.1.1.4 *length (L_1)*—the longest Feret's diameter of an aggregate.

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

3.1.1.6 *projected length (L_2)*—the total length of an aggregate in a given direction, including the contribution of multiple entrants. The projected length is equal to the number of scan lines multiplied by a calibration factor that is equal to the scan line spacing in the proper dimensional units (usually nanometres for carbon blacks).

3.1.1.7 *volume*—the volume of carbon black aggregates may be measured directly by well-calibrated scanning microdensitometry (V) or geometrically (V_1) as follows:

$$V_1 = 8A^2/3P \quad (1)$$

3.1.1.8 *width*—the width of a carbon black aggregate may be described in terms of either the mean chord or Feret's diameter. The average width (W) is defined as the mean chord measured in a direction that is perpendicular to the longest projection. W is equal to the projected area divided by the longest projection. The average nondirectional width (W_1) is equal to the mean chord ($\pi A/P$). The shortest width (W_2) is equal to the shortest chord length and is derived from chord sizing. The longest width (W_3) is the shortest Feret's diameter from multiple measurements in different directions.

3.1.2 Aggregate Nondimensional Shape Parameters

3.1.2.1 *circularity factor ($C.F.$)*—the amount of deviation of the two-dimensional projected aggregate area from a circle expressed as follows:

$$C.F. = P^2/4\pi A \quad (2)$$

3.1.2.2 *form factor*—the length/width ratio of the aggregate. Some of the more commonly used ratios are as follows:

$$F_1 = L_1/W_1 \quad (3)$$

$$F_2 = L/W_1 \quad (4)$$

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.

Current edition approved Oct. 10, 1995. Published December 1995. Originally published as D 3849 – 80. Last previous edition D 3849 – 95.

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