This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D2985/D2985M – 92 (Reapproved 2019)

Standard Test Method for Color of Asbestos[1]

This standard is issued under the fixed designation D2985/D2985M; 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 determination of color, whiteness, and yellowness of asbestos by means of a photoelectric reflectometer.

1.2 The test method is applicable to all grades and varieties of homogeneous milled asbestos.

1.3 This test method may be applied to samples that are not dry or homogeneous, or that contain impurities or adulterants. However, in such cases, results may not be comparable with those obtained on clean dry samples.

1.4 To obtain similar results from spectrophotometers, see Test Method E308.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.6 **Warning—**Breathing of asbestos dust is hazardous. Asbestos and asbestos products present demonstrated health risks for users and for those with whom they come into contact. In addition to other precautions, when working with asbestos-cement products, minimize the dust that results. For information on the safe use of chrysotile asbestos, refer to "Safe Use of Chrysotile: A Manual of Preventive and Control Measures."[2]

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D2590 Test Method for Sampling Chrysotile Asbestos

D2946 Terminology for Asbestos and Asbestos–Cement Products

D3879 Test Method for Sampling Amphibole Asbestos (Withdrawn 2009)[4]

E3 Guide for Preparation of Metallographic Specimens

E259 Practice for Preparation of Pressed Powder White Reflectance Factor Transfer Standards for Hemispherical and Bi-Directional Geometries

E308 Practice for Computing the Colors of Objects by Using the CIE System

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *black, adj*—color name applied to opaque objects that are highly absorbing throughout the visible spectrum.

3.1.2 *CIE, n*—acronym for International Commission on Illumination, which in French is Commission Internationale de l'Eclairage.

3.1.3 *CIE observer, n*—See **observer, standard, CIE 1931** and **observer, supplementary, CIE 1964.**

3.1.4 *CIE source C, n*—See **standard source**.

3.1.5 *color, psychophysical, n*—characteristics of a color stimulus (that is, light producing a sensation of color) denoted by three dimension values such as three tristimulus values.

3.1.6 *daylight 0.785 rad, 0 rad (45°, 0°) luminous directional reflectance*—daylight 0.785 rad, 0 rad (45°, 0°) luminous

[1] This test method is under the jurisdiction of ASTM Committee C17 on Fiber-Reinforced Cement Products and is the direct responsibility of Subcommittee C17.03 on Asbestos - Cement Sheet Products and Accessories.

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[2] Available from The Asbestos Institute, http://www.chrysotile.com/en/sr_use/manual.htm.

[3] 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.

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

[5] Taken in part from Procedure No. B5-9 of Socíeté Asbestos Ltée, with permission.

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directional reflectance (for brevity called reflectance) is the ratio of the luminous flux from a specimen illuminated at an angle of 0.785 rad (45°) by CIE standard source C[6] (average daylight) and viewed perpendicularly by the CIE standard observer, to the luminous flux from the standard magnesium oxide layer, similarly illuminated and viewed (Note 1). The combination of illumination at 0.785 rad (45°) and viewing at 0 rad (0°) (perpendicularly) has been selected as being representative of average conditions of illuminating and viewing. The property of reflectance determines which of two specimens will appear lighter when viewed in average daylight at an angle at which the observation of highlights is avoided.

NOTE 1—These conditions of illumination and observation may be interchanged without affecting the results.

3.1.7 *glos, n*—angular selectivity of reflectance of surface-reflected light responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on a surface.

3.1.8 *gloss, specular, n*—ratio of flux reflected in a specular direction to incident flux for specific source and receptor apertures (usually measured relative to a standard of specified index of refraction).

3.1.9 *gray, n*—color name applied to achromatic stimuli of moderate relative luminance.

3.1.10 *green, adj*—hue name applied to light of wavelengths from 495 to 550 nm.

3.1.11 *hue, n*—attribute of color perception by means of which objects are judged to be red, yellow, blue or intermediate between some adjacent pair of these. Hue is a matter of social consensus as opposed to an assigned frequency range.

3.1.12 *ideal black, n*—object or material that absorbs all light impinging on it.

3.1.13 *illuminant, n*—incident luminous flux specified only by its spectral distribution. (The spectral composition of an illuminant may differ from the source because of spectral modification by such means as absorption or refraction by mediae enclosing the source or by reflection from other objects. See definition of **source**. The CIE standard illuminants are Illuminant C and Illuminant D6500, each representing average daylight, and Illuminant A, 2854K).

3.1.14 *light, n*—electromagnetic radiation in the spectral range detectable by the normal human eye (approximately 380 to 760 nm).

3.1.15 *light, n*—radiant energy evaluated according to the CIE photopic spectral luminous efficiency function.

3.1.16 *light, adj*—highly reflecting, as in the term light green.

3.1.16.1 *Discussion*—For given conditions of illumination and surface texture, a more reflective surface is perceived as lighter in color than a less reflective but otherwise identical surface.

3.1.17 *luminous, adj*—indicates that the radiant flux is evaluated by weighting according to the luminous efficiency function of the CIE 1931 standard observer.

3.1.18 *luminous reflectance, n*—See **reflectance, luminous**.

3.1.19 *observer, standard,* CIE 1931, *n*—hypothetical observer based on color mixture data obtained for a 2° field of view for 17 observers, adopted by the CIE in 1931.

3.1.20 *observer, supplementary, CIE 1964, n*—hypothetical observer based on color mixture data obtained for a 10° field of view for 76 observers, adopted by the CIE in 1964.

3.1.21 *photoelectric color meter, n*—color-stimulus-measuring instrument using photoelectric detectors in which source-filter-detector response characteristics are adjusted so that the instruments read directly the tristimulus values or related quantities.

3.1.22 *preferred white, n*—the white color, usually bluish, that is judged by a given group of observers looking at a given series of specimens to be the whitest color attainable.

3.1.23 *reflectance, luminous, n*—ratio of luminous flux reflected by a specimen to that incident on it.

3.1.24 *reflection, n*—processes by which incident flux leaves a surface or a medium from the incident side.

3.1.25 *reflection, diffuse, n*—process by which incident flux is distributed by reflection over a wide range of angles.

3.1.26 *regular, adj*—used to indicate flux transmitted or reflected in the image-forming state (the adjective specular is usually used to indicate regular mirror-reflected flux).

3.1.27 *source, n*—that which furnishes light or other radiation; real device by which radiant flux is produced. (See **illuminant**.)

3.1.28 *source, CIE standard, n*—See **standard source**.

3.1.29 *spectral, adj*—indicates either a function of wavelength as in spectral transmittance, or spectral concentration, as in spectral flux.

3.1.30 *specular, adj*—same as regular when applied to reflection.

3.1.31 *specular gloss, n*—See **gloss, specular**.

3.1.32 *standard observer, n*—See **observer, standard**.

3.1.33 *standard, primary, n*—one whose calibration is determined by measurement according to specified parameters.

3.1.34 *standard, secondary, n*—standard calibrated by reference to another standard such as a primary, reference, laboratory or working standard.

3.1.35 *standard source, n*—light source whose spectral energy distribution is known or defined. (The CIE standard sources to represent incandescent-lamp light, sunlight, and daylight, are designated A, B, and C, respectively.)

3.1.36 *texture, adj*—in evaluating the color of a surface, structural quality of a surface determined by the topography of its constituents.

3.1.37 *viewing conditions, n*—the conditions under which a visual observation is made, including the angular substance of the specimen at the eye; the geometric relationship of source,

[6] CIE standard sources and functions are defined in Test Method E308.

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specimen and eye; the photometric and spectral character of the field of view surrounding the specimen; and the state of adaptation of the eye.

3.1.38 *white, adj*—color name most usually applied to opaque, highly reflecting, highly diffusing, visually hueless specimens.

3.1.39 *whiteness*—the term "whiteness" is widely used to designate the degree to which a near-white surface approaches "perfect white," defined as a 100 % reflectance over the whole visible spectrum. Other terms used for this property are "lightness" or " luminous apparent reflectance." The concept of whiteness is not only applicable to near-white surfaces but also to dark and colored surfaces. Whiteness may be defined as the grading which an observer would assign to the surface, irrespective of its color or hue, when compared under daylight conditions against a scale of grays ranging from white to black.

3.1.40 *yellow, adj*—hue name applied to light wavelengths from 572 to 783 nm and to visually similar stimuli.

3.1.41 *yellowness*—a yellowed or tan discolored asbestos may have the same degree of whiteness on the gray scale as a gray asbestos. It is thus necessary to measure an index of yellowness for such cases, and this may be calculated arbitrarily from reflectance measurements using tristimulus filters. Use the following relationship for asbestos:

$$\text{yellowness factor} = (A - B)/G \quad (1)$$

where:

A = reflectance with the amber tristimulus filter,[7]
B = reflectance with the blue tristimulus filter, and
G = reflectance with the green tristimulus filter.

3.1.42 For terms relating to asbestos fibers, refer to Terminology D2946.

4. Summary of Test Method

4.1 Specimens are pressed into a pellet and the luminous reflectance is measured by means of a simple reflectometer fitted with an incandescent source, and a photoelectric reflectometer.

4.2 Instructions are included for use of the suppressed zero technique to improve precision.

4.3 The use of tristimulus color filters permitting the determination of whiteness, yellowness, and CIE[8] color-order values, is covered.

5. Significance and Use

5.1 The color of asbestos is of commercial significance when it is to be incorporated into products, the color of which is affected by the color of the asbestos, and for which color specifications must be met.

5.2 Whiteness is required of asbestos for use in white or pale-colored products.

5.3 Yellowness is significant in asbestos for use in pastel-colored products where discolored asbestos may prevent attainment of certain shades and hues detector.

6. Apparatus

6.1 The apparatus shall consist of a photoelectric reflectometer having source, filter, and receptor characteristics such that it will measure reflectance accurately to within 1.0 % of full-scale reading. The reflectometer shall have the following characteristics:

6.1.1 *Spectral Characteristics*—The spectral energy distribution of the illuminator and the spectral sensitivity of the receptor, in combination, shall provide the equivalent of illumination by CIE standard source C and observation by the CIE standard observer.

6.1.2 *Geometric Characteristics*—Illumination shall be within 0.0698 rad (4°) of, and centered about, a direction of 0.785 rad (45°) from the perpendicular to the test surface; viewing shall be within 0.262 rad (15°) of, and centered about, the perpendicular (Note 1).

6.1.3 Any instrument that meets the apparatus specifications and the precision requirements stated in Section 13 may be used. In general, commercial instruments do not conform exactly to the apparatus requirements. The suitability of a given instrument depends in large measure on its response to the spectral selectivity range of asbestos, and on the availability of standards of similar reflectance and spectral character. Instruments that have been found satisfactory include: the Hunter Multi-purpose Reflectometer; the Gardner (Hunter) Photometric Unit with 0.785 rad, 0 rad (45°, 0°) reflectance head; and the General Electric Reflection Meter.

6.2 *Standards:*

6.2.1 *Primary Standard*—The primary standard for reflectance measurements is a layer of MgO freshly prepared in accordance with Practice E259. It is assigned a value of 100 for the conditions of 0.785 rad (45°) illumination and perpendicular view (Note 1).

6.2.2 *Secondary Standards*—Porcelain enameled metal plaques or other materials known to be reasonably permanent in reflectance, and of uniform surface, may be calibrated and used as secondary reflectance standards.

NOTE 2—Secondary standards of porcelain enamel may be obtained from the National Bureau of Standards,[9] the Henry A. Gardner Laboratory,[10] or the Photovolt Corp. Experience has shown that these secondary reflectance standards are reasonably permanent if abrasion is avoided. Plaques stored for a year or more may develop efflorescence (bloom) noticeable on black plaques, which can be removed by washing with mild soluble soap and water.

6.2.3 Standards with reflectance values as close as possible to the values of the unknowns are recommended.

6.3 *Tristimulus Filters,*[7]including amber, blue, and green, to fit the reflectometer source and detector.

6.4 *Piston and Cylinder Mold,* for pressing the asbestos specimens into pellets with a diameter of approximately 28.6

[7] Tristimulus filters are described in the following reference: Lih, M. M., *Chemical Engineering*, Vol 75, No. 17, August 12, 1968, pp. 146–156.

[8] Commission International de l'Eclairage (International Commission on Illumination). The CIE color-order system is the most important of those used in connection with instruments for color measurement. Refer to Test Method E308.

[9] National Bureau of Standards, Washington, DC 20234.

[10] Gardner Laboratory Inc., Box 5728, Bethesda, MD 20014.

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