Designation: D4039 – 09 (Reapproved 2015)

Standard Test Method for Reflection Haze of High-Gloss Surfaces[1]

This standard is issued under the fixed designation D4039; 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 describes a procedure for using two specular gloss measurements to obtain a haze index for high-gloss nonmetallic specimens (1-4).[2] It is particularly useful for evaluating the haze in clear finishes on nonglossy substrates, and the haze in reflected images produced by the surfaces of opaque glossy pigmented finishes.

1.2 *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:*[3]

D523 Test Method for Specular Gloss

D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels

D3964 Practice for Selection of Coating Specimens for Appearance Measurements

E284 Terminology of Appearance

E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry

3. Terminology

3.1 *Definitions:*

3.1.1 *specular gloss, n*—ratio of flux reflected in specular direction to incident flux for a specified angle of incidence and source and receptor angular apertures.

3.1.2 *haze, n—in reflection*—scattering of light at the glossy surface of a specimen responsible for the apparent reduction of contrast of objects viewed by reflection at the surface.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *60° specular gloss G_{60}, n*—specular gloss measured with the 60° geometry specified in Test Method D523.

3.2.2 *20° specular gloss G_{20}, n*—specular gloss measured with the 20° geometry specified in Test Method D523.

3.2.3 *haze index, H, n*—a measure of reflection haze, where $H = G_{60} - G_{20}$.

3.3 Appearance terms used in this standard are defined in Terminology E284.

4. Summary of Test Method

4.1 Measurements of 60° and 20° specular gloss are made on a specimen. The haze index is computed as the difference between the two measurements.

4.2 This test method is applicable to nonmetallic specimens having a 60° specular gloss value greater than 70 in accordance with Test Method D523.

4.3 Both 60° and 20° specular gloss depend upon the refractive index of the material being measured. Because 20° gloss changes much more rapidly with index than 60° gloss, the reflection haze value of a specimen also depends on the index of refraction of the material. To establish a correction for the effect of refractive index would require its measurement for each material, which is inconvenient. Comparisons of reflection haze evaluated by this test method are therefore limited to specimens of essentially the same refractive index.

5. Significance and Use

5.1 Measured gloss values of specimens depend on the angle of illumination, refractive index of the material, and the geometric distribution of the reflected light.

5.2 Haze is produced by irregularities in the reflecting surface that affect the distribution of flux reflected around the specular angle. The procedures specified in Test Method D523 are not designed to measure reflected-flux scattering characteristics of high-gloss finishes, particularly where specimens having different surface refractive indexes are being compared.

5.3 In this test method, values for reflection haze are obtained from two measurements of specular gloss, one made with a large receptor aperture and the other made with a small receptor aperture. The geometric conditions have been chosen to permit the use of glossmeters that provide 60° specular gloss

[1] This test method is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.03 on Geometry.

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[2] Boldface numbers in parentheses refer to the list of references at the end of this test method.

[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.

measurements (large receptor aperture) and 20° specular gloss measurements (small receptor aperture) as specified in Test Method D523.

5.4 An additional method for the measurement of reflection haze is given in Test Method E430.

6. Apparatus

6.1 *Glossmeter(s),* capable of measuring 60° and 20° specular gloss in accordance with the specifications given in Test Method D523.

7. Preparation and Selection of Test Specimens

7.1 This test method does not cover preparation techniques. When a test requires the preparation of specimens from a liquid coating, specify the techniques of specimen preparation.

7.2 Select test specimens in accordance with Practice D3964.

7.2.1 To determine the maximum gloss obtainable from a material, such as a paint or a varnish, use methods in Practices D823 to produce a film of uniform thickness on a smooth, planar substrate.

7.2.2 Use surfaces of good planarity, because surface warpage, waviness, or curvature may affect test results significantly. The directions of brush marks or similar texture effects should be parallel to the plane of the axis of the two beams.

8. Calibration and Standardization

8.1 Calibrate the glossmeters with primary and secondary working standards in accordance with the procedures given in Test Method D523.

8.2 The gloss scales in Test Method D523 are defined by adopting the scale value of 100 for polished black glass with a refractive index of 1.567. However, the polished black glass standards used in this test method usually have a lower refractive index (approximately 1.527). The appropriate scale values of such standards have been calculated in Test Method D523; they are 93.6 for the 60° geometry and 89.2 for the 20° geometry.

NOTE 1—Because of the difference in scale values for the two geometries, the haze-free standard or a haze-free specimen of refractive index 1.527 will have a haze index H = 93.6 – 89.2 = 4.4.

9. Procedure

9.1 Select an area near the center of the test specimen and determine the 60° specular gloss.

9.2 Determine the 20° specular gloss on the same area of the specimen.

10. Calculation

10.1 Compute the haze index, *H*, as follows:

$$H = G_{60} - G_{20} \quad (1)$$

where:

G_{60} = value of 60° specular gloss and
G_{20} = value of 20° specular gloss.

11. Report

11.1 Report the following information:

11.1.1 For each specimen, the measured G_{60} and G_{20} values and the computed haze index, *H*.

11.1.2 Where preparation of the test specimen has been necessary, describe or otherwise identify the method of preparation.

11.1.3 Identify the glossmeter used by make and model.

11.1.4 Identify the gloss standards used.

12. Precision

12.1 On the basis of interlaboratory studies of this procedure in which six laboratories conducted single determinations on eight high-gloss coatings differing in visually perceived reflection haze, the within-laboratory standard deviation for haze index values was found to be 2.5.

12.2 Based on these standard deviations, the following criteria should be used for judging the acceptability of single determinations at the 95 % confidence level.

12.2.1 *Repeatability*—Two results obtained by a single operator should be considered suspect if they differ by more than 2 units of haze index.

12.2.2 *Reproducibility*—Two results obtained by operators in different laboratories should be considered suspect if they differ by more than 7 units of haze index.

13. Keywords

13.1 haze; high gloss; reflection haze

REFERENCES

(1) Nimeroff, I., "Two-Parameter Gloss Methods," *Journal of Research*, National Bureau of Standards, Vol 58, No. 3, March 1957, pp. 127–135.

(2) Hammond, III, H. K., and Nimeroff, I., "Measurement of Sixty-Degree Specular Gloss," *Journal of Research*, National Bureau of Standards, Vol 44, No. 6, June 1950, p. 585.

(3) Horning, S. C., and Morse, M. P., "The Measurement of the Gloss of Paint Panels," *Official Digest*, Federation of Paint and Varnish Production Clubs, Vol 19, No. 266, March 1947, p. 153.

(4) Hunter, R. S., "Gloss Evaluation of Materials," *ASTM Bulletin*, No. 186, December 1952, p. 48.