INTERNATIONAL

Designation: D523 − 14 (Reapproved 2018)

Standard Test Method for Specular Gloss[1]

This standard is issued under the fixed designation D523; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the measurement of the specular gloss of nonmetallic specimens for glossmeter geometries of 60, 20, and 85° (**1-7**).[2]

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

1.4 *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]

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

D3964 Practice for Selection of Coating Specimens for Appearance Measurements

D3980 Practice for Interlaboratory Testing of Paint and Related Materials (Withdrawn 1998)[4]

D4039 Test Method for Reflection Haze of High-Gloss Surfaces

E97 Method of Test for Directional Reflectance Factor, 45-Deg 0-Deg, of Opaque Specimens by Broad-Band Filter Reflectometry (Withdrawn 1991)[4]

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

3. Terminology

3.1 *Definitions:*

3.1.1 *relative luminous reflectance factor, n*—the ratio of the luminous flux reflected from a specimen to the luminous flux reflected from a standard surface under the same geometric conditions. For the purpose of measuring specular gloss, the standard surface is polished glass.

3.1.2 *specular gloss, n*—the relative luminous reflectance factor of a specimen in the mirror direction.

4. Summary of Test Method

4.1 Measurements are made with 60, 20, or 85° geometry (**8, 9**). The geometry of angles and apertures is chosen so that these procedures may be used as follows:

4.1.1 The 60° geometry is used for intercomparing most specimens and for determining when the 20° geometry may be more applicable.

4.1.2 The 20° geometry is advantageous for comparing specimens having 60° gloss values higher than 70.

4.1.3 The 85° geometry is used for comparing specimens for sheen or near-grazing shininess. It is most frequently applied when specimens have 60° gloss values lower than 10.

5. Significance and Use

5.1 Gloss is associated with the capacity of a surface to reflect more light in directions close to the specular than in others. Measurements by this test method correlate with visual observations of surface shininess made at roughly the corresponding angles.

5.1.1 Measured gloss ratings by this test method are obtained by comparing the specular reflectance from the specimen to that from a black glass standard. Since specular reflectance depends also on the surface refractive index of the specimen, the measured gloss ratings change as the surface refractive index changes. In obtaining the visual gloss ratings, however, it is customary to compare the specular reflectances of two specimens having similar surface refractive indices.

[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.

Current edition approved May 1, 2018. Published May 2018. Originally approved in 1939. Last previous edition approved in 2014 as D523 – 14. DOI: 10.1520/D0523-14R18.

[2] The 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.

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

5.2 Other visual aspects of surface appearance, such as distinctness of reflected images, reflection haze, and texture, are frequently involved in the assessment of gloss (**1**), (**6**), (**7**). Test Method E430 includes techniques for the measurement of both distinctness-of-image gloss and reflection haze. Test Method D4039 provides an alternative procedure for measuring reflection haze.

5.3 Little information about the relation of numerical-to-perceptual intervals of specular gloss has been published. However, in many applications the gloss scales of this test method have provided instrumental scaling of coated specimens that have agreed well with visual scaling (**10**).

5.4 When specimens differing widely in perceived gloss or color, or both, are compared, nonlinearity may be encountered in the relationship between visual gloss difference ratings and instrumental gloss reading differences.

6. Apparatus

6.1 *Instrumental Components*—The apparatus shall consist of a light source furnishing an incident beam, means for locating the surface of the specimen, and a receptor located to receive the required pyramid of rays reflected by the specimen. The receptor shall be a photosensitive device responding to visible radiation.

6.2 *Geometric Conditions*—The axis of the incident beam shall be at one of the specified angles from the perpendicular to the specimen surface. The axis of the receptor shall be at the mirror reflection of the axis of the incident beam. The axis of the incident beam and the axis of the receptor shall be within 0.1° of the nominal value indicated by the geometry. With a flat piece of polished black glass or other front-surface mirror in the specimen position, an image of the source shall be formed at the center of the receptor field stop (receptor window). The length of the illuminated area of the specimen shall be not more than one third of the distance from the center of this area to the receptor field stop. The dimensions and tolerance of the source and receptor shall be as indicated in Table 1. The angular dimensions of the receptor field stop are measured from the receptor lens in a collimated-beam-type instrument, as illustrated in Fig. 1, and from the test surface in a converging-beam-type instrument, as illustrated in Fig. 2. See Fig. 1 and Fig. 2 for a generalized illustration of the dimensions. The tolerances are chosen so that errors in the source and receptor apertures do not produce an error of more than one gloss unit at any point on the scale (**5**). The relative dimension is the calculated dimension related to the 60° receptor (=1.0000).

6.2.1 The important geometric dimensions of any specular-gloss measurement are:

6.2.1.1 Beam axis angle(s), usually 60, 20, or 85°.

6.2.1.2 Accepted angular divergences from principal rays (degree of spreading or diffusion of the reflected beam).

TABLE 1 Angles and Relative Dimensions of Source Image and Receptors

	In Plane of Measurement			Perpendicular to Plane of Measurement		
	θ,°	2 tan θ/2	Relative Dimension	θ,°	2 tan θ/2	Relative Dimension
Source image	0.75	0.0131	0.171	2.5	0.0436	0.568
Tolerance ±	0.25	0.0044	0.057	0.5	0.0087	0.114
60° receptor	4.4	0.0768	1.000	11.7	0.2049	2.668
Tolerance ±	0.1	0.0018	0.023	0.2	0.0035	0.046
20° receptor	1.8	0.0314	0.409	3.6	0.0629	0.819
Tolerance ±	0.05	0.0009	0.012	0.1	0.0018	0.023
85° receptor	4.0	0.0698	0.909	6.0	0.1048	1.365
Tolerance ±	0.3	0.0052	0.068	0.3	0.0052	0.068

NOTE 1—The parallel-beam glossmeters possess the better uniformity of principle-ray angle of reflection, but the converging-beam glossmeters possess the better uniformity in extent of angular divergence accepted for measurement.

NOTE 2—*Polarization*—An evaluation of the impact of polarization on gloss measurement has been reported (**11**). The magnitude of the polarization error depends on the difference between the refractive indices of specimen and standard, the angle of incidence, and the degree of polarization. Because the specimen and standard are generally quite similar optically, measured gloss values are little affected by polarization.

6.3 *Vignetting*—There shall be no vignetting of rays that lie within the field angles specified in Table 1.

6.4 *Spectral Conditions*—Results should not differ significantly from those obtained with a source-filter photocell combination that is spectrally corrected to yield CIE luminous efficiency with CIE source C. Since specular reflection is, in general, spectrally nonselective, spectral corrections need to be applied only to highly chromatic, low-gloss specimens upon agreement of users of this test method.

6.5 *Measurement Mechanism*—The receptor-measurement mechanism shall give a numerical indication that is proportional to the light flux passing the receptor field stop with ±1 % of full-scale reading.

7. Reference Standards

7.1 *Primary Standards*—Highly polished, plane, black glass with a refractive index of 1.567 for the sodium D line shall be assigned a specular gloss value of 100 for each geometry. The gloss value for glass of any other refractive index can be computed from the Fresnel equation (**5**). For small differences in refractive index, however, the gloss value is a linear function of index, but the rate of change of gloss with index is different for each geometry. Each 0.001 increment in refractive index produces a change of 0.27, 0.16, and 0.016 in the gloss value assigned to a polished standard for the 20, 60, and 85° geometries, respectively. For example, glass of index 1.527 would be assigned values of 89.2, 93.6, and 99.4, in order of increasing geometry.

7.2 *Working Standards*—Ceramic tile, depolished ground opaque glass, emery paper, and other semigloss materials having hard and uniform surfaces are suitable when calibrated against a primary standard on a glossmeter known to meet the requirements of this test method. Such standards should be checked periodically for constancy by comparing with primary standards.

7.3 Store standards in a closed container when not in use. Keep them clean and away from any dirt that might scratch or mar their surfaces. *Never* place standards face down on a surface that may be dirty or abrasive. Always hold standards at