Designation: D 1834 – 90 (Reapproved 2000)

An American National Standard

Standard Test Method for 20° Specular Gloss of Waxed Paper[1]

This standard is issued under the fixed designation D 1834; 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 is primarily intended to measure the gloss of waxed papers.

NOTE 1—For determining the gloss of book paper reference should be made to Test Method D 1223. For very high gloss paper see Wink et al **(1)**.[2]

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:*

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, or Related Product[3]

D 1223 Test Method for Specular Gloss of Paper and Paperboard at 75°[4]

3. Terminology

3.1 *Definition:*

3.1.1 *specular gloss*—the degree to which a surface simulates a mirror in its capacity to reflect incident light.

4. Summary of Test Method

4.1 This test method involves the measurement of specular reflectance on a scale on which a polished black glass with a refractive index of 1.540 measures 100 units. The angles of incidence and reflection are each 20°, and the receptor or viewing window is round and its diameter subtends an angle of 5° with respect to an apex at the center of the illuminated area in the plane of the sample opening.

NOTE 2—These geometric conditions and measurement scale are recommended by Hunter and Lofland **(2)** for the gloss measurement of waxed papers.

5. Significance and Use

5.1 This test method gives good correlation with visual gloss or shininess provided the sample is flat. The degree of correlation decreases as the sample deviates from being flat.

6. Apparatus

6.1 The apparatus shall consist of a concentrated-filament lamp and lens projecting an incident beam of rays, means for locating the specimen surface to receive this beam, and a light-sensitive receptor located to receive certain rays reflected from this surface. These three parts shall be combined in a rugged instrument in which relative positions shall be as shown in Fig. 1. The actual dimensions of these parts shall be left to the designer of the apparatus, so long as the rays of light passed through the instrument satisfy the geometric and spectral conditions prescribed in 6.2-6.6.

NOTE 3—A suitable instrument has been built by using the following parts and dimensions (refer to Fig. 1):

Lamp[5]—6 V (requires adjustable voltage for standardization)
Lens in lamp beam[6]—Diameter 39 mm, focal length 63 mm
Lens at receptor window[7]—Double convex, diameter 19 mm, focal length 47 mm
Photocell[8]
Meter[9]—0 to 50 μA (90-mm (3½-in.) round flush phenolic plastic case)

Dimensions, mm:	
Lamp filament to center lens	92
Center lens to center specimen	70
Center specimen to center receptor window	126
Center window to center photocell	79
Window diameters, mm:	
Lamp beam lens	37
Specimen	more than 25
Receptor window	11

The cell-meter combination must be calibrated for linearity.

6.2 *Geometric Conditions*—The axis of the incident beam shall be 20 ± 1° from a line perpendicular to the plane to the

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.10.0A on Physical aand Chemical Properties. This test method was prepared jointly by the Technical Association of Pulp and Paper Industry and the American Society for Testing and Materials.

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[2] The boldface numbers in parentheses refer to references listed at the end of this test method.

[3] *Annual Book of ASTM Standards*, Vol 15.09.

[4] Discontinued; see *1979 Annual Book of ASTM Standards.*

[5] A General Electric instrument lamp No. 1630 has been found satisfactory for this purpose.

[6] Available from the Edmund Scientific Corp., 101 E. Gloucester Pike, Barrington, NJ 08007-1380, achromat stock No. 6246.

[7] Available from the Edmund Scientific Corp.

[8] A General Electric No. 8PV1AAB photovoltaic cell has been found satisfactory for this purpose.

[9] A Weston Model 301 has been found satisfactory for this purpose.

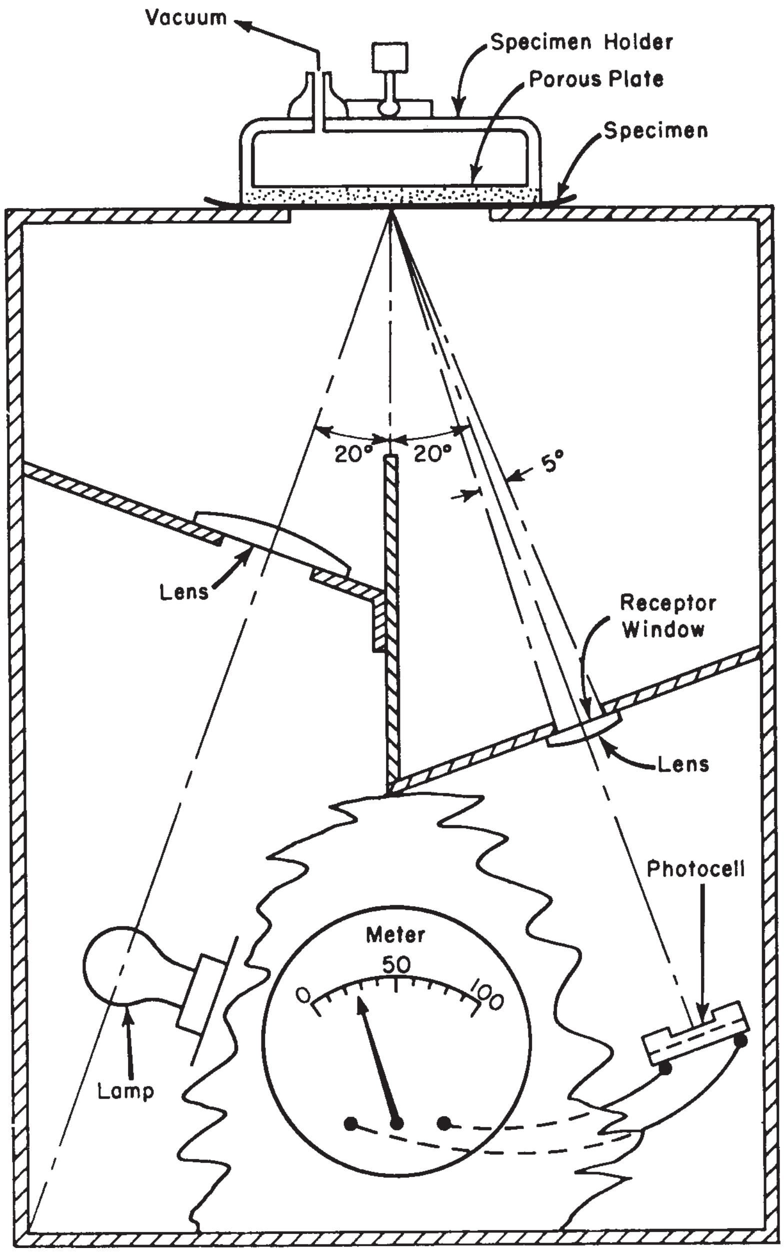

FIG. 1 Diagram of Relative Positions of Essential Elements of Glossmeter

test surface. The receptor window, the lens adjacent to this window, and the photoreceptor shall be centered about an axis which is the mirror image of the axis of the incident beam. With a piece of polished black glass or other front-surface mirror in sample position, an image of the source shall be formed at the center at the receptor window. No diameter of the illuminated area of the specimen shall be more than one quarter the distance from the center of this area to the center of the receptor window. The receptor window shall be round in shape and measure 5 ± 0.05° in diameter from the center of the illuminated area in the plane of the sample opening. An image of the source shall be formed in the center of the receptor window when a front-surface mirror is placed in the specimen position. Diameters of the image shall subtend angles at the center of the illuminated area in the specimen plane of no more than 2.5° nor less than 1.0°.

NOTE 4—It is advantageous, though not essential that there be means by which the operator may observe the specimen area under test.

NOTE 5—The geometric dimensions of glossmeters and the relations of these dimensions to instrument accuracy have been analyzed by Hammond and Nimeroff **(3)**.

6.3 *Stray Light and Vignetting*—There shall be diaphragms and light shields to keep all light from reaching the receptor except that in the beams described in 6.2, but there shall be no vignetting nor interception by stops or diaphragms of rays projected in the directions specified in 6.2. The interior of the instrument shall be finished in matt black. Lamp, lenses, photoreceptor, and interior surfaces shall be kept clean and free of dust.

6.4 *Spectral Conditions*—The instrument shall have as its source Standard Illuminant C defined by the International Commission on Illumination (CIE), and its receptor shall have the spectral response of the CIE luminosity function. Any departure from these conditions shall be less than that introduced by a 500 K change in color temperature of source.

6.5 *Measurement Mechanism*—The receptor-measurement mechanism, such as photocell and microammeter, shall give a numerical indication that is proportional to the amount of light passing through the receptor window to ±1 unit. It shall read zero when a black-lined cavity is placed over the specimen opening. To achieve linear response to all rays passing through the receptor window, it is necessary that all such rays shall have the same effect on the light receptor, and that the receptor and indicator be linear in their response to light. The linearity of a photocellmeter combination such as is shown in Fig. 1 must be established by calibration. When a lens is used to provide equal weighting of rays upon the light receptor, as is shown in Fig. 1, this lens shall be located immediately adjacent to the receptor window; and it shall form an image on the surface of the photoreceptor of the illuminated area of the specimen. The focal length of this lens shall be such that the image formed on the photoreceptor surface covers an area equivalent to at least one quarter the total area of the photoreceptor surface.

6.6 *Vacuum Plate Specimen Holder*—The specimen holder shall be provided with means to evacuate air from behind the specimen. See Wink et al **(1)**. The surface of the plate shall be matte black in color and so smooth that waxed paper mounted on it shall not reveal details of the plate texture when a vacuum is applied. The surface of the mounting plate shall be flat to within ±0.03 mm (0.001 in.).

NOTE 6—Ring-type vacuum holders in which the vacuum is supplied through a ring indentation surrounding the central test area are also acceptable. Other methods may also be acceptable.

7. Reference Standards

7.1 *High Gloss Standard*—A high gloss standard shall consist of polished black glass having an index of refraction of 1.540. The gloss value of a plane polished black glass standard having an index of refraction of 1.540 is defined to be 100 units. A standard that does not have an index of refraction of 1.540 may be used if its specular reflectance, R_s, is computed from the refractive index by means of the following (Fresnel) equation:

$$R_s = 1/2\,[\sin^2(i-r)/\sin^2(i+r) + \tan^2(i-r)/\tan^2(i+r)] \quad (1)$$

where:

i = angle of incidence (20°),
r = angle of refraction = $[\sin^{-1}(i/n)]$, and
n = refractive index.

It can be computed from the foregoing that a black glass working standard having a refractive index of 1.507 will have a specular reflectance of 0.04117. Similarly, the specular reflectance of the 100-unit primary standard black glass ($n = 1.54$) computes to 0.04548. Thus, the value of the working standard on the present scale would be $(0.04117/0.04548) \times 100 = 90.5$

7.1.1 Alternatively, when the standard has an index differing from 1.540, the appropriate instrumental glass value can be obtained by adding or subtracting 0.29 gloss units for each 0.001 in index that the standard is higher or lower than 1.540.

7.2 *Intermediate Standard*—An intermediate standard shall be of satin or diffuse-finish wall tile, glass, or porcelain enamel, and shall be carefully calibrated in terms of a black glass standard on an instrument known to comply with the requirements prescribed in 7.1.

NOTE 7—For any test, it is advantageous to have an intermediate standard of about the same gloss as the specimens to be measured.

8. Test Specimens

8.1 The test specimens shall consist of not less than five pieces about 75 mm square cut from different portions of the test sample, taken in accordance with Practice D 585. The test pieces shall be touched only on the edges. They must not come in contact with abrasives, oils, or dusty materials, nor be exposed to sunlight or heat.

9. Procedure

9.1 Operate the glossmeter in accordance with the manufacturer's instructions as to power supply, warm-up time, etc.

9.2 Place the clean polished black glass standard in the sample position and adjust the instrument to give a reading corresponding to the calculated gloss value for this standard. Then place the intermediate standard in the sample position. If the correct reading is not obtained on the intermediate standard, check the interior of the instrument for cleanliness and compliance with geometric requirements. Repeat the checks often enough to ensure the stability of the instrument.

9.3 Place the test specimen in the sample position and under the specimen holder, and apply vacuum to the holder. Unless otherwise noted, expose plain areas of the specimen having no printing (Note 8). Make two tests on the specimen, one test in the machine direction and one test in the cross direction. Repeat the test for each of the five specimens and compute the average of the ten readings.

NOTE 8—From an equation given in the "Measurement of Sixty Degree Specular Gloss" **(3)**, it can be computed that the so-called diffuse-reflectance correction is 3.8 R_d, where R_d, the diffuse reflectance, is 1.0 for MgO. Thus an unprinted area of waxed paper with $R_d = 0.6$ (60 %) will measure 2.3 units higher than an area of the same paper printed black.

9.4 Omit diffuse corrections (Note 8) due to background color unless otherwise directed.

10. Report

10.1 Report the average gloss value to the nearest whole unit when the gloss reading is over 10, and to the nearest tenth of a unit when the reading is less than 10. The maximum and minimum reading are reported if it is necessary to show data on surface uniformity.

11. Precision and Bias

11.1 *Precision*—Repeatability and reproducibility data on this 20° gloss method are not available. However, the National Institute of Standards and Technology Collaborative Reference Program for Paper reports similar analyses of 75° gloss measurements of paper from 40 different laboratories. For 35 reports, each involving two paper samples, and for test results each of which consist of 5 replicate measurements, the average values of repeatability and reproducibility were:

	75° gloss of paper (TAPPI T480)
Repeatability (within average laboratory)	1.7
Reproducibility (between laboratories)	5.6

11.1.1 Results for 20° may be similar if performed according to Test Method D 1834.

11.2 *Bias*—The procedure in this test method has no bias because the 20° specular gloss of waxed paper can be defined only in terms of a test method.

12. Keywords

12.1 gloss; specular gloss; waxed paper

APPENDIX

(Nonmandatory Information)

X1. ADDITIONAL INFORMATION

X1.1 The permitted tolerances in geometry and measurement mechanism are estimated to make instrument settings of specular gloss accurate to ±1 unit or ±5 %, whichever is greater. Waxed paper samples may show even greater variation than this from one location to another.

X1.2 An instrument error may be suspected when one cannot obtain the correct setting on an intermediate standard after adjusting the instrument to read correctly on the black glass standard. In this case, the following points should be considered:

X1.2.1 *Cleanliness of Standards*—Be sure that both the black glass and intermediate standards are clean. A semidiffuse intermediate standard of ceramic tile must be oven-dryed after washing.

X1.2.2 *Cleanliness of Instrument*—Dirt on the lenses and walls will affect the accuracy of readings. Be sure all lenses and interior walls are free of dust and dirt.

X1.2.3 *Alignment and Focusing*—An image of the source must be formed in the center of the receptor window with the black glass standard in the sample.

X1.2.4 *Geometric Factors*—Careful measurements are necessary to establish compliance with the specular angle and the receptor window specifications. Deviations from this specifications will affect the accuracy of readings.

X1.2.5 *Spectral Factors*—Change of color response is often suspected as a source of error, but geometric factors are more frequently at fault.

X1.2.6 The following nonuniformities of the test specimen may also contribute to inaccurate readings:

X1.2.6.1 The specimen is not flat, as a result of careless handling, coarse texture of vacuum plate, or other reason.

X1.2.6.2 The specimen does not have a uniform gloss. This may be due to the surface being damaged by abrasion, blocking, etc., or may be inherent in the sample.

X1.2.6.3 The specimen may have a nonuniform opacity, or background color. A white area may read 2 or 3 units higher than a black area where printed papers are tested.

REFERENCES

(**1**) Wink, W. A., Delevanti, C. H., and Van den Akker, J. A., "Instrumentation Studies LXXVII, Study on Gloss I, A Goniophotometric Study of High Gloss Papers," *TAPPI*, Technical Association of the Pulp and Paper Industry, Vol 36, December 1953, p. 163-A.

(**2**) Hunter, R. S., and Lofland, C. A., "A Gloss Test for Waxed Paper," *TAPPI*, Technical Association of the Pulp and Paper Industry, Vol 39, December 1956, pp. 833–41.

(**3**) Hammond, H. K., III, and Nimeroff, I.," Measurement of Sixty-Degree Specular Gloss," *Journal of Research*, Nat. Bureau of Standards, Vol 44, June, 1950, p. 585 (*Research Paper 1205*).

(**4**) Budde, W., "A Reference Instrument for 20°, 60°, and 85° Gloss Measurements," *Metrologia* Vol 16, 1980, p. 1.

(**5**) Budde, W., "Polarization Effects in Gloss Measurements," *Applied Optics*, Vol 16, 1979, p. 2252.