Designation: D 6037 – 96 (Reapproved 2002)

Standard Test Methods for Dry Abrasion Mar Resistance of High Gloss Coatings[1]

This standard is issued under the fixed designation D 6037; 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 Two test methods are included. Test Method A uses a device that contains an abrasive wheel. Test Method B uses a device that contains a wheel that has been fitted with abrasive paper. Either method can be used to evaluate the dry abrasion mar resistance of coatings applied to planar, rigid surfaces. Each test method provides good discrimination between highly mar resistant coatings.

1.2 Mar resistance is assessed by measuring the gloss of abraded and unabraded areas. Mar resistance is directly related to the coating's ability to retain gloss in abraded areas.

NOTE 1—The mar resistance values obtained by these test methods have no absolute significance. They should only be used to derive relative performance rankings for test panels that have been prepared from the series of coatings that are currently being evaluated. If mar resistance values are quoted between laboratories, it is essential that a common standard be measured and that the values be compared to that standard. Even then, the values should be used with caution.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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 523 Test Method for Specular Gloss[2]

D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products[2]

D 823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]

D 1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers[2]

D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base[2]

D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base[2]

D 2240 Test Method for Rubber Property—Durometer Hardness[3]

D 3924 Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer and Related Materials[2]

D 4449 Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance[2]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *mar resistance*—the ability of a coating to resist permanent deformation or fracture, resulting from the application of a dynamic mechanical force. These test methods measure resistance to visible damage caused by mild abrasion.

4. Summary of Test Methods

4.1 The coatings that are being evaluated are applied at uniform dry film thickness to planar panels of uniform surface texture. After drying or curing, or both, the panels are marred. Mar resistance is assessed by measuring the coating's gloss within the abraded and unabraded areas of test panels. Mar resistance is directly related to the coating's ability to retain gloss in abraded areas.

5. Significance and Use

5.1 Coatings, particularly the high gloss coatings used on automobiles, boats, toys, etc., are subject to a wide variety of conditions (for example, wiping, cleaning, and exposure) that can mar their surface. The ability of these coatings to maintain their appearance is an important product attribute. These test methods provide a way to estimate the ability of high gloss coatings to resist mar damage.

5.2 These test methods do not provide fundamental values. However they are suitable for estimating the ability of high

[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.23 on Physical Properties of Applied Paint Films.

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[2] *Annual Book of ASTM Standards*, Vol 06.01.

[3] *Annual Book of ASTM Standards*, Vol 09.01.

gloss coatings to resist mar.

5.3 Since the susceptibility of coatings to marring varies widely, the number of cycles that are needed to cause "relevant" mar damage also varies. Usually, 2 to 50 cycles are sufficient.

TEST METHOD A

6. Apparatus

6.1 *Application Equipment*, as described in Practices D 609, and D 823.

6.2 *Film Thickness Measuring Apparatus*, as described in Test Methods D 1005, D 1186 or D 1400.

6.3 *Abrader*[4]—The abraser so constructed that wheels of several degrees of abrasiveness may be readily used. In this method only the 500-g load is used unless otherwise specified.

6.4 *Refacing Disc*—An S-11 refacing disc[4] for resurfacing the abrasive wheels. The load selected is the same as the test load.

6.5 *Abrasive Wheels*—"Calibrase" wheels CS-10[4], unless otherwise specified or agreed. Wheels that have worn to the diameter of the wheel label should not be used. If the time of the test is not within one year from date of purchase, the following test may provide an indication of the degree of hardening which has occurred.

6.5.1 If required, measure hardness in accordance with Test Method D 2240 on at least four points equally spaced on the center of the abrading surface and one point on each side surface of the wheel. The test on the abrading surface shall be made with pressure applied vertically along the diameter of the wheel, and the reading taken 10 s after full pressure is applied. If any reading on a wheel exceeds the equivalent of 90 units on a Shore A scale, the wheel should be considered suspect for this method.

NOTE 2—The abrasive quality of a "Calibrase" wheel may change with hardness. Hardness can change with time and storage conditions. However, abrasive quality can't be inferred from hardness measurements alone. Many other factors can also affect abrasive quality.

6.6 *Glossmeter*, with 20° geometry complying with Test Method D 523 but with an opening no larger than 1 by 3 in. (25 by 75 mm) to accommodate 4 by 4-in. (100 by 100-mm) test panels. In addition, geometry that places the panel with the test surface facing upwards tends to minimize the chance of stray light affecting the measurement when complete coverage of the opening is not attained.

NOTE 3—Subjective evaluations may be made visually by comparing abraded panels with a measured abraded standard using one of the procedures in Test Method D 4449.

7. Preparation of Specimens

7.1 Prepare a minimum of two 4 by 4-in. panels for each coating that is being tested. Prepare and coat panels in accordance with Practices D 609 and D 823.

7.1.1 Panels,[5] that is, metal panels with a ¼-in. (6-mm) hole drilled in the center to accommodate the mounting spindle, are available.

7.1.2 If it is not convenient to apply test coatings to panels,[5] other planar, distortion-free substrates can be used by substituting a "Drive Pin Type" specimen holder for the standard panel holder.

NOTE 4—It is important that the panels be planar for reproducible results. Cutting and drilling of painted panels has not been satisfactory.

NOTE 5—Measurements are color dependent. Dark colors give lower values of gloss retention. To standardize, it is recommended that testing be done using a black coating. Clearcoats are applied over a black basecoat. For other colors a black panel should be included as a control.

8. Conditioning

8.1 Cure the coated panels under conditions of temperature and humidity as agreed upon between the purchaser and the seller.

8.2 Unless otherwise agreed upon between the purchaser and the seller, condition the coated panels for at least 24 h at 73.5 ±3.5°F (23° ±2°C) and 50 ±5 % relative humidity in accordance with Specification D 3924. Conduct the test in the same environment or immediately after removal therefrom.

9. Procedure

9.1 Using a glossmeter that has been properly adjusted, measure the 20° gloss at four positions within the test area that will be abraded. Record the mean of these four readings as "Unabraded Gloss".

NOTE 6—It is recommended that the panel be marked, or a template be created, to ensure that measurements are taken in the area that will be abraded.

9.2 Mount the pair of "Calibrase" wheels to be used on their respective flange holders, taking care not to handle them by their abrasive surfaces. Select the same load to be used in the test and affix it to the abraser. Mount an S-11 refacing disc on the turntable. Reface new wheels for 100 cycles. Reface previously used wheels for 50 cycles. Reface the wheels for 50 cycles before abrading each specimen. In each case brush the residue from the resurfacing operation off each wheel. Discard the S-11 refacing disc after each use.

9.3 Mount the test panel on the turntable and subject it to abrasion for a selected number of cycles. An abrasion of 10 cycles and 500 g-load are typically used, unless otherwise agreed upon. Use a soft camel's hair brush or compressed air to remove residue from the specimen after abrasion.

9.4 Repeating 9.1, measure the gloss at four positions within the abraded area. Record the mean of these four readings as "Abraded Gloss".

9.4.1 If the panel was marked for measurement of unabraded gloss, it can be easily placed in the correct position for measuring abraded gloss. However, to compensate for any

[4] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant Street, North Tonawanda, NY 14120. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[5] The sole source of supply of primed Taber panels known to the committee at this time is ACT Laboratories, 273 Industrial Drive, Hillsdale, MI. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

abrasion unevenness, it is desirable to make minor adjustments to panel position to get the four lowest gloss readings within the abraded area (see Note 3).

9.5 Calculate the percent gloss retention for each panel from the following equation:

$$\text{percent gloss retention} = 100 \times (\text{abraded gloss/unabraded gloss}) \quad (1)$$

9.6 Calculate the grand mean from the means obtained for each of the panels used to test a particular coating and report as the percent gloss retention for that coating.

10. Report

10.1 Report the following information:

10.1.1 The percent gloss retention values that were obtained for each coating in the series.

10.1.2 The number of panels that were tested for each of the coatings evaluated.

10.1.3 The abrasive wheel, load, and number of cycles used.

10.1.4 A plot of percent gloss retention versus number of abrasion cycles, if more than one number of abrasion cycles was used.

10.1.5 Any deviation from the test procedure.

11. Precision and Bias

11.1 *Precision*—Precision statements for both the entire method and for the glossmeter measuring system are being developed.

11.2 *Bias*—There are no accepted standards for this test so bias cannot be determined.

TEST METHOD B

12. Apparatus

12.1 *Application Equipment*, see 6.1.

12.2 *Film Thickness Measuring Apparatus*, see 6.2.

12.3 *Abrader*, [6] consisting of a pressure plate for holding the test specimen level and rigid, and a 2-in. (50-mm) diameter wheel to the outer circumference of which is attached a ½-in. (12-mm) wide strip of abrasive paper. The force between the wheel and the test specimen shall be capable of being varied from 100 g to 3000 g so that the test specimen slides back and forth in a horizontal plane in parallel contact with the test surface of the wheel. The abraded area is about ½ by 1¼ in. (12 by 30 mm).

12.4 *Abrasive Wheel*[6]—After each double stroke (complete reciprocal movement), the wheel is advanced through an angle of 0.9° to bring an unused portion of abrasive paper into contact with the surface before making the next double stroke. The angle of rotation is such that after 400 double strokes the wheel will have made one complete revolution. At the completion of one revolution the abrasive paper shall be renewed. The relative speed of movement is 40 ±2 double strokes per minute.

12.5 *Abrasive Paper*[6]—The abrasive paper is coated with 3 µm (4000 mesh) grade aluminum oxide. It shall be used by cutting ½ by 6-in. (12 by 158-mm) strips to cover the circumference of the wheel without overlapping, and shall be bonded into position.

NOTE 7—Other grades of abrasive paper may be used by mutual agreement among the interested parties.

12.6 *Glossmeter*, see 6.6, but the glossmeter opening should be no larger than ½ by ½ in. (12 mm by 12 mm).

13. Preparation of Specimens

13.1 Prepare a minimum of two panels (between 1¼ by 2 in. (30 by 50 mm) and 3 by 12 in. (70 by 300 mm) for each coating that is being tested. Prepare and coat the panels in accordance with Practices D 609 and D 823 (see Note 4 and Note 5).

14. Conditioning

14.1 See 8.1 and 8.2.

15. Procedure

15.1 Using a glossmeter with 20° geometry, complying with Test Method D 523, that has been properly adjusted, measure the gloss at two positions within the test area that will be abraded (see Fig. 1). Record the mean of these two readings as "Unabraded Gloss".

15.2 Place the test specimen into position on the apparatus.

15.3 Attach a new abrasive paper to the circumference of the wheel.

15.4 Set the apparatus to run for 10 double strokes using a 500-g load.

15.5 Repeating 15.1, measure the gloss at two positions within the abraded area. Record the mean of these two readings as "Abraded Gloss" (see Note 3).

NOTE 8—A ⅛-in. (3-mm) length at one end of the abraded area might be subject to extra wear because of the continual wheel rotation that takes place at this point. This end should be ignored when taking the measurements.

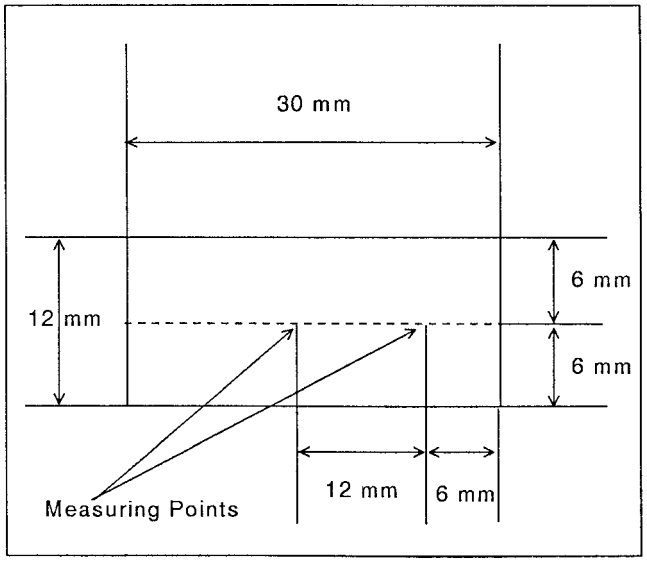

FIG. 1 Plan–to–abrade area 1¼ × ½ in. (30 × 12 mm)

[6] The sole source of supply of the apparatus known to the committee at this time is Suga Test Instruments Co., Ltd., 5-4-14, Shinjuku, Shinjuku-ku, Tokyo, 160, Japan. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

15.6 Calculate results as described in 9.5 and 9.6.

16. Report

16.1 Report the following information:

16.1.1 The percent gloss retention for each coating.

16.1.2 The number of panels tested.

16.1.3 The abrasive wheel, load, and number of double strokes used.

16.1.4 A plot of percent gloss retention versus the number of abrasion cycles used, if more than one number of abrasion cycles was used.

17. Precision and Bias

17.1 *Precision*—Precision statements for both the entire method and for the glossmeter measuring system are being developed.

17.2 *Bias*—Bias statements for both the entire method and for the glossmeter measuring system are being developed.

18. Keywords

18.1 abraser; abrasion tester; coatings; gloss; mar