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Test Method for Rub Abrasion Mar Resistance of High Gloss Coatings[1]

This standard is issued under the fixed designation D 6279; 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.

ε[1] NOTE—Research report was added editorially July 2000.

1. Scope

1.1 This test method covers procedures for evaluating the relative mar resistance of a series of high gloss coatings applied to a flat, rigid surface. Wet rub and dry rub abrasion tests are described. To fully characterize a coating's mar resistance, both tests should be run.

NOTE 1—Dry abrasion mar resistance can also be evaluated by using Test Method D 6037. If a series of very highly mar resistant coatings is being evaluated, Test Method D 6037 will generally provide the better performance discrimination than the dry rub test described here. However, if the equipment described in Test Method D 6037 is not available, the dry rub test described in this test method affords a reasonable alternative. The dry rub test is also useful for evaluating coatings that are not highly mar resistant.

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

NOTE 2—The mar resistance values obtained by this test method 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 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 823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]

D 1005 Test Methods 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 3924 Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer and Related Materials[2]

D 6037 Test Method for Dry Abrasion Mar Resistance of High Gloss Coatings[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.

3.1.1.1 *Discussion*—This test method measures resistance to visible damage caused by mild abrasion.

4. Summary of Test Method

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, panels are marred by the action of dry abrasion media or wet abrasion media, or both, under a reciprocating weighted pad. 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 of a wide variety of conditions (for example, wiping, cleaning and exposure) during manufacture and service that can mar their surface. The ability of high gloss coatings to maintain their appearance is an important product attribute. This test method provides a way to estimate the ability of high gloss coatings to resist mar damage.

6. Apparatus

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

6.2 *Film Thickness Measuring Apparatus*, as described in

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

Test Methods D 1005, D 1186 or D 1400.

6.3 *Abrader*—The mar tester[3] is so designed that the 16 mm, ±1 mm diameter, friction element with a downward force of 9 N, ±10 %, moves back and forth in a straight line over a 4 in ± 0.4 in. (100 mm ± 10 mm) track on the test panel. It has a uniform stroke rate of 60 r/min. One revolution is a complete back and forth motion.

6.4 *Friction Pad*— Cover the instrument's friction element with a pad made of felt or paper. Felt pads can be attached by wrapping the felt around the friction element and holding it in place with a suitable spring clip or clamp. Paper pads must be cut to fit to cover the area of the friction element that contacts the coating. They can be attached to the friction element with two-sided tape or paper pads that can be purchased with an adhesive backing. The type of pad affects the abrasion and so must be defined for the test. It has been found that generally a thicker felt pad works best for dry abrasion and a thinner pad is best for wet abrasion.

6.5 *Dry Abrasion Media*—Feldspar/calcite, non-silicate cleaning powder.

6.6 *Wet Abrasion Media*—Prepare an aluminum oxide (grit) slurry as follows:

aluminum oxide (220 mesh)	10.0 (by weight)
polyacrylic acid	6.0
distilled water	83.3
2-aminopropanol	0.7
Total	100.0

6.6.1 The slurry ingredients can be combined by using a mixer or spatula. The slurry gets very thick, but is easy to mix.

6.6.2 The slurry prepared by this formula should have a pH of 7.9 to 8.0 and a viscosity of 190 to 210 P (as measured on a Brookfield Viscometer, No. 4 spindle, 10 r/min). If the pH and viscosity are low, add 2-aminopropanol until the pH is 7.9 to 8.0. If the pH is on target but the viscosity is low, add more polyacrylic acid.

7. Preparation of Specimens

7.1 Prepare a minimum of two (*2*) 4 by 6-in. (101.6 by 152.4-mm) panels for each coating that is being tested. Alternatively, if the abrasion apparatus can accommodate them, 4 by 12 in.-823(101.6 by 304.8-mm) panels may be used. Prepare the coated panels as described in Practices D 823.

7.2 Gloss measurements are color dependent. Abraded areas on dark colored panels tend to give lower gloss readings than similarly abraded areas on light colored panels. For consistent results, it is recommended that testing be done using black coatings. Clearcoats can be applied over a black basecoat. If it is necessary to use other colors, a black panel should be included as a control.

8. Conditioning

8.1 Condition the test specimens at 23°C ± 2° (74°F ± 4°) and 50 ± 5 % relative humidity in accordanace with Specification D 3924 unless otherwise specified in the test methods or the standard.

9. Procedure

9.1 Securely fasten the friction element to the reciprocating arm.

9.2 Set the number of cycles at 10, unless otherwise specified. Set fewer cycles for easily marred panels and more cycles for more mar resistant materials.

9.3 Attach a new pad to the friction element. If an adhesive backed pad is used, attach the pad to the bottom of the friction element. For nonadhesive backed pads, cover the friction element by cupping the cloth around the bottom. Attach the material with a spring clip or clamp, such that a flat, unwrinkled cloth surface comes into contact with the coated panel.

9.4 *Dry Abrasion*— Sprinkle a liberal amount of dry abrasion media over approximately one half of the panel. Holding the panel so its plane is vertical, tap its bottom edge firmly on a hard surface so that an even, thin layer of dry adhesion media remains on the panel. Place the test panel in the apparatus.

9.5 *Wet Abrasion*— Place the test panel on the test area and secure. Spread wet abrasion media on the pad using a spatula to cover the pad well. Lower the friction element to the panel. Excess media should be visible on all sides of the friction element. This indicates full coverage of the friction pad. Ensure that the friction pad lies flat on the panel.

9.6 For both wet and dry abrasion start the test and run the selected number of cycles.

9.7 Lift the arm from the panel and discard the pad.

9.8 Repeat the mar test at least once. The dry test can be repeated by replacing the pad and using an unmarred area of the cleanser-coated panel. The wet test can be repeated by replacing the pad, applying the slurry, and then moving the panel so that the friction element is on an unmarred area.

9.9 Remove the panel, rinse with water, and pat dry with a soft cloth or paper towel.

9.10 Using a glossmeter with 20° geometry that has been properly adjusted, in accordance with Test Method D 523, measure the gloss at four (*4*) places within the unabraded areas of the coated panel. Measure the gloss in the same direction that will be used in 9.11. Record the mean of these four readings as "Unabraded Gloss".

9.11 Measure the 20° gloss at four (*4*) places within the abraded areas of the coated panel (measure the gloss perpendicular to the abrasion grooves). To compensate for unevenness in the abrasion pattern, it is desirable to adjust the measurement position to get the four lowest gloss readings within the abraded area. Record the mean of the four readings as the "Abraded Gloss".

NOTE 3—Subjective comparisons may be made by visually comparing abraded panels with a previously prepared abraded standard. Do not use areas at the ends or edges of the abrasion pattern since they are not representative of the average abrasion. Optical imaging measurements can also be used to obtain quantitative evaluation of the abrasion.

NOTE 4—Small differences in performance between highly abrasion resistant materials are more likely to detected with 20° gloss measurements than with 60° gloss measurements.

[3] The sole source of supply of the apparatus known to the committee at this time is the Atlas Model CM-5 Crockmeter, available from Atlas Electrical Devices, 4114 North Ravenswood Ave., Chicago IL 60613. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

10. Calculation

10.1 Calculate the percent gloss retention for each panel as follows:

$$\% \text{ Gloss Retention} = 100 \times (\text{Abraded Gloss/Unabraded Gloss}) \quad (1)$$

NOTE 5—Abraded and unabraded gloss is the grand mean calculated from the means obtained (in accordance with 9.10 and 9.11) for each of the panels used to test a particular coating.

11. Report

11.1 Report the following information:

11.1.1 The identity of the monocoat or the basecoat/clearcoat that was used, the bake schedule, film thickness and color,

11.1.2 A description of the type of friction pad used, the type of abrading media used, and the number of abrasion cycles,

11.1.3 The type of mar test that was used, that is, wet or dry abrasion,

11.1.4 The percent gloss retention mar resistance values that were obtained for each coating in the series,

11.1.5 The number of mar tests that were run on each panel,

11.1.6 The number of panels that were tested, and

11.1.7 A plot of the percent gloss retention values that were obtained versus the number of abrasion cycles, if more than one abrasion cycle was used.

12. Precision and Bias [4]

12.1 *Precision*—It is not practical to specify precision because, as stated in Note 2, the values obtained by this test method have no absolute value and should only be used to derive relative performance rankings for test panels. Because of this, no statements on *Repeatability* and *Reproducibility* are being made.

12.2 *Bias*—Since there is no accepted reference procedure suitable for determining the bias for this test method, no statement on bias is being made.

13. Keywords

13.1 abrasion; aluminum; coatings; gloss; grit; mar; powder; rub test; scratch

[4] Supporting data are available from ASTM Headquarters. Request RR: D01-1117.