Designation: ~~D6037 – 96 (Reapproved 2008)~~ D6037 – 13

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

This standard is issued under the fixed designation D6037; 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~~ Scope*

1.1 This test method covers procedures for evaluating the relative mar resistance of high gloss coatings. Two test methods are included. Test Method A uses a device that contains ~~an abrasive wheel.~~a rotating specimen holder and two abrasive wheels. Test Method B uses a device that contains a reciprocating specimen holder and a single 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.~~

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1.2 The values stated in ~~inch-pound~~SI 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~~ No other units of measurement are included in this 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D523 Test Method for Specular Gloss

D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products

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

D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

~~D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)[3]~~

~~D1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base (Withdrawn 2006)[3]~~

~~D2240 Test Method for Rubber Property—Durometer Hardness~~

D3924 Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials

D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

D4449 Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance

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

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[2] 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.

***A Summary of Changes section appears at the end of this standard**

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *mar resistance, n*—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 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, 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 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 D609~~,~~ and D823.

6.2 *Film Thickness Measuring ~~Apparatus ,~~ Apparatus,* as described in Test Methods D1005~~,~~ ~~D1186~~or ~~D1400~~D7091.

6.3 *Abrader* (Fig. 1)[3] ~~—The abraser so constructed that wheels of several degrees~~An abrasion tester as described in Test Method D4060 ~~of abrasiveness may be readily~~ shall be used. In this method only the 500-g load per wheel is used unless otherwise specified.

~~[3] The last approved version of this historical standard is referenced on www.astm.org.~~

[3] 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.

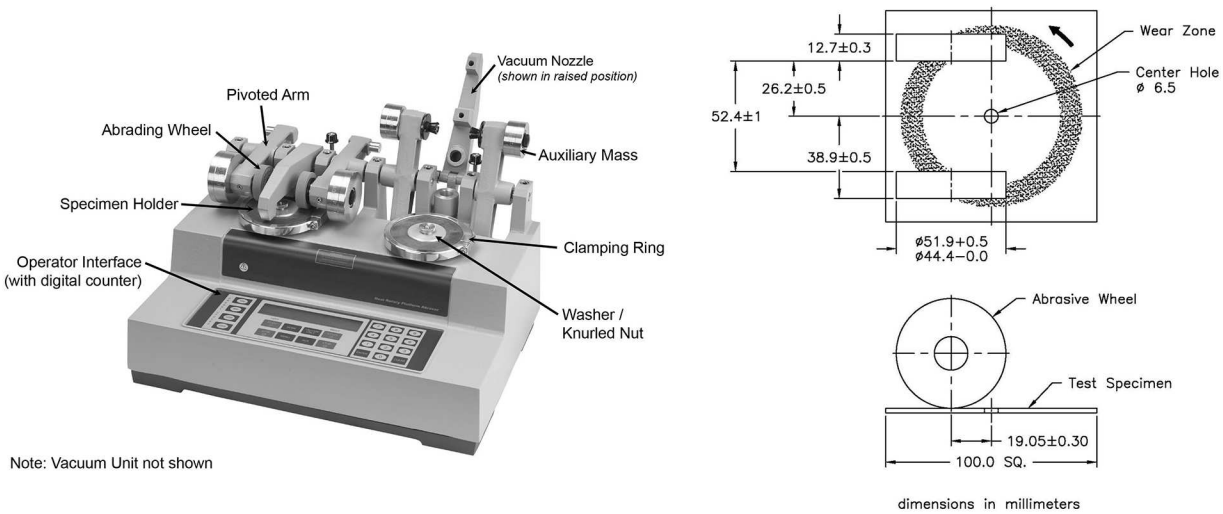

FIG. 1 Abrader for Method A

6.4 *Refacing Disc*—~~A~~an S-11 refacing disc[3] for resurfacing the abrasive wheels. The load selected is the same as the test load.

6.5 *Abrasive Wheels*—"Calibrase" wheels CS-10,[3] 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.~~ Prior to testing, ensure the expiration date has not passed.

~~6.5.1 If required, measure hardness in accordance with Test Method D2240 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.~~

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6.6 *Glossmeter,* with 20° geometry complying with Test Method D523 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)~~ 25 by 75 mm to accommodate 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—For coatings that are semi- to high-gloss, a glossmeter with a 60° geometry may be better suited.

NOTE 4—Subjective evaluations may be made visually by comparing abraded panels with a measured abraded standard using one of the procedures in Test Method D4449.

7. Preparation of Specimens

7.1 Prepare a minimum of two ~~4~~100 by ~~4-in.~~100-mm panels for each coating that is being tested. Prepare and coat panels in accordance with Practices D609 and D823.

7.1.1 Panels,[4] that is, metal panels with a ~~¼-in. (6-mm)~~ 6.5-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,[4] other planar, distortion-free substrates can be used by substituting a "Drive Pin Type" specimen holder for the standard panel holder.

NOTE 5—It is important that the panels be planar for reproducible results. Cutting and drilling of painted panels has not been satisfactory.

NOTE 6—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)~~ 23° ± 2°C and 50 ± 5 % relative humidity in accordance with Specification D3924. Conduct the test in the same environment or immediately after removal therefrom.

9. Procedure

9.1 Using a glossmeter that ~~has been properly adjusted,~~ is calibrated and verified for accuracy, measure the 20° gloss at four positions within the test area that will be ~~abraded.~~ abraded, approximately 38 mm from the center of the specimen and 90° apart. Record the mean of these four readings as "Unabraded Gloss."

NOTE 7—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"~~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~~25 cycles before abrading each specimen. In each case lightly 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.~~ area immediately following the abrasion test unless otherwise agreed upon by the interested parties. Record the mean of these four readings as "Abraded Gloss."

[4] The sole source of supply of primed Taber panels known to the committee at this time is ACT ~~Laboratories,~~ Test Panels, LLC, 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.

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 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 34).

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[5]

11.1 *Precision*—~~Precision statements~~ The precision of this test method is based on an interlaboratory study of ASTM D6037~~for both~~, Test Methods for Dry Abrasion Mar Resistance of High Gloss Coatings — Method A, conducted in 2012. Each of eight laboratories tested three or four different materials. Every "test result" represents an individual determination, and all participants were asked to report five test results. Unabraded and abraded gloss were measured and reported with both 20° and 60° geometry for all samples. Practice E691~~the entire method and for the glossmeter measuring system are being developed.~~ was followed for the design and analysis of the data; the details are given in ASTM Research Report RR:D01-1170.

11.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

11.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions that are accepted as plausible due to random causes under normal and correct operation of the test method.

11.1.1.2 Repeatability limits are listed in Tables 1 and 2.

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1170. Contact ASTM Customer Service at service@astm.org.

TABLE 1 Mar Resistance (measured with 20 degree geometry)

Material	Number of Abrasion Cycles	Average[A] $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation S_R	Repeatability Limit r	Reproducibility Limit R
A	10	40.500	3.773	9.523	10.565	26.665
A	50	10.729	0.694	3.132	1.942	8.770
A	100	7.100	0.626	2.204	1.752	6.171
B	10	30.492	2.494	8.108	6.982	22.703
B	50	5.267	0.674	1.668	1.887	4.672
B	100	2.292	0.369	1.226	1.032	3.432
C	10	24.950	2.199	7.113	6.156	19.915
C	50	4.965	0.828	1.698	2.317	4.754
C	100	3.230	0.490	1.131	1.371	3.168
D	10	30.745	4.893	5.332	13.701	14.930
D	50	8.460	1.655	2.383	4.635	6.673
D	100	5.945	1.948	2.744	5.455	7.684
E	20	80.057	16.100	16.950	45.081	47.459
E	40	75.315	1.087	2.006	3.045	5.618
E	60	72.550	1.090	1.842	3.053	5.159
F	20	80.927	16.529	17.243	46.280	48.279
F	40	78.125	2.917	3.554	8.167	9.951
F	60	76.055	2.836	4.011	7.940	11.231
G	20	63.473	4.836	9.615	13.541	26.923
G	40	51.073	4.138	11.022	11.586	30.861
G	60	42.653	5.415	11.758	15.161	32.921

[A] The average of the laboratories' calculated averages.