



## Standard Test Method for Mar Resistance of Organic Coatings<sup>1</sup>

This standard is issued under the fixed designation D 5178; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the determination of the mar resistance on smooth, flat surfaces. Results are expressed in terms of force-to-mar films of organic coatings such as paint, varnish, and lacquer when applied to smooth, flat planar panel surfaces.

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

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

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

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

**D 1005** Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

**D 1186** Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base<sup>3</sup>

**D 1400** Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base<sup>3</sup>

**D 2691** Method for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products<sup>3</sup>

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Withdrawn.

### 3. Terminology

3.1 *Definitions:*

3.1.1 *mar resistance, n*—the ability of a coating to resist damage caused by light abrasion. As just defined, it is a resistance of the surface of the coating to permanent deformation, resulting from the application of a dynamic mechanical force.

### 4. Summary of Test Method

4.1 The materials under test are applied at uniform thickness to flat panels of uniform surface texture. After drying/curing, the mar resistance is determined by pushing the panels beneath a rounded stylus or loop that is loaded in increasing amounts until the coating is marred.

### 5. Significance and Use

5.1 In some situations, marring of coatings applied to substrates under typical use conditions is unacceptable. This test method has been found useful in differentiating the degree of marring of coatings on substrates. It is most useful in providing relative ratings for a series of coated panels exhibiting significant differences in marring.

5.2 In a limited laboratory study, meaningful mar results were impossible when powder coatings were tested. The mar marking, that is, scratches, became less perceptible with time. Therefore, powder coatings may not be applicable coatings for this test method.

### 6. Apparatus

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

6.2 *Film-Thickness Measuring Apparatus*, as described in Test Methods **D 1005**, **D 1186**, **D 1400**, or **D 2691**.

6.3 *Balanced Beam Scrape Adhesion and Mar Tester* (**Fig. 1** and **Fig. 2**), consisting of a balanced beam to which is secured a platform for supporting weights, and a rod at an angle of 45° that holds the scraping loop. The rod shall be set so that the scraping loop contacts test surfaces directly below the weights. The loop shall be 1/16-in. (1.6 mm) diameter rod, bent into a “U” shape with an outside radius of  $0.128 \pm 0.002$  in. ( $3.25 \pm 0.05$  mm) and hardened to Rockwell HRC 56 to 58, and shall be a smooth finish. The loop can be either chromium plated, nickel plated, or heat treated polished steel as agreed upon between the purchaser and the supplier. These testers are

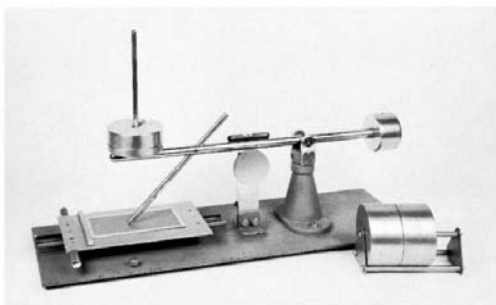


FIG. 1 Balanced Beam Scrape Adhesion and Mar Tester

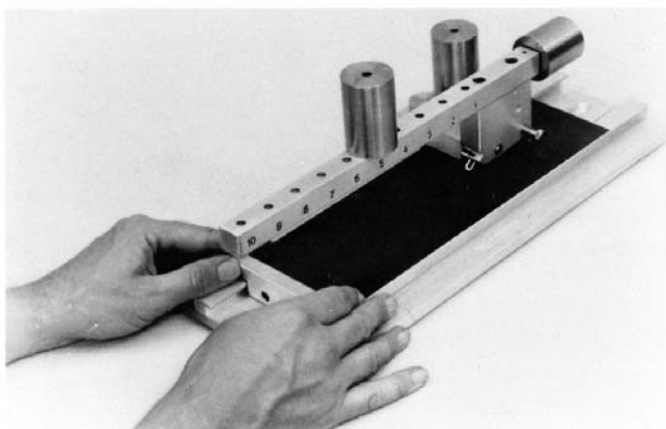


FIG. 2 Balanced Beam Scrape Adhesion and Mar Tester

adjustable to accommodate flat, metallic, and nonmetallic specimens to 0.5-in. (12-mm) thick and 4 to 16 in. (100 to 400 mm) wide and long; the specimen should be at least ½-in. (12-mm) wide.

## 7. Preparation of Specimens

7.1 Apply the materials under test to panels of the composition and surface condition on which it is desired to determine mar resistance of the coating. The panel material (7.1.1), surface preparation, thickness, and number of coats shall be specified or agreed upon between the seller and the purchaser. Apply coatings and air dry or bake under conditions of humidity and temperature mutually agreeable to the seller and the purchaser.

7.1.1 The surface of the coating must be hard enough to resist damage by the scraping loop at a load agreed upon between the producer and the user. If no panel material is specified, use 0.032-in. (0.8-mm) cold-rolled carbon steel prepared in accordance with Methods B or C of Practice D 609.

## 8. Conditioning and Number of Tests

8.1 Condition the test panels for at least 48 h at  $23 \pm 2^\circ\text{C}$  ( $73.5 \pm 3.5^\circ\text{F}$ ) and  $50 \pm 5\%$  relative humidity, and test in the same environment, or immediately on removal therefrom, unless otherwise specified or agreed upon by the seller and the purchaser. Test at least two replicate specimens of each material.

## 9. Procedure

9.1 In preparation for using the apparatus, ensure that it is reasonably level and place it so that the weight holder is toward the operator. This places the beam release on the operator's right and allows freedom to move the test specimen manually under the weighted scraping element (loop). Insert the loop into the holder as far as it will go and tighten the clamping screw. Adjust the main bearing support so that the beam is balanced in the horizontal plane when the loop is just touching the specimen surface. The alignment of the beam should be such that the end of the loop is over the midline of the movable table.

9.2 Raise the beam and lock it in the raised position. Wipe the loop with a clean cloth or chamois. Locate the specimen on the sliding platform against the stop so that the specimen can be moved away from the operator and there is an area at least 3 in. (75 mm) long by ½ in. (12 mm) wide on the sample parallel to the horizontal plane through the beam. Place weights on the weight support using an initial amount that is estimated to be appropriate for the particular coating. Release the beam and carefully lower it until the loop rests on the coated test specimen and the full load is applied, then slowly push the sliding platform away from the operator at a rate of ¼ in. (6 mm)/s for a distance of at least 3 in. (75 mm). If the coating is marred, continue the testing using successively smaller loads (0.5-kg increments) until the coating is not marred. If the coating is not marred by the initial scrape, continue the test using successively larger loads (0.5-kg increments) until the coating is marred or until the maximum load of 10 kg has been applied. Use a new area of the test surface each time a scrape is made.

9.3 When the critical load has been approximately located, repeat the test five times at each of three loadings: above, below and at the load determined in the first trial. Apply different loads in random fashion so that all scrapes at one load are not made in succession or on one panel.

9.3.1 Periodically examine the loop to ensure that the original smooth surface is intact. If the contacting surface is worn, reverse the loop. When both sides are worn, replace with a new loop.

9.4 For each applied load, tabulate the number of times the coating was marred.

## 10. Report

10.1 Report the following information:

- 10.1.1 Load in kilograms at the mar failure end point,
- 10.1.2 Panel material and surface preparation,
- 10.1.3 "U" shape loop surface finish,
- 10.1.4 Dry-film thickness, and
- 10.1.5 Any deviation from the specified procedure.

## 11. Precision

11.1 *Precision*—If sufficient cooperators can be obtained, an interlaboratory study will be conducted to establish precision.

11.2 *Bias*—No information can be provided on the bias of this test method for measuring mar because no material having an accepted reference value is available.



## 12. Keywords

12.1 balanced beam scrape adhesion and mar tester; balanced beam tester; coatings; mar or organic mar resistance

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