Designation: ~~D7093 – 13~~ D7093 – 19

Standard Test Method for Formability of Thin Film Organic Coatings on Steel Over a Biaxially Stretched Dome[1]

This standard is issued under the fixed designation D7093; 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 covers the evaluation of the formability and adhesion of factory applied thin film organic coatings on steel ~~with~~ having coating thicknesses of 2.5 to 10 microns (0.10 to 0.40 mils) typical of those used in the coil coating industry.

1.2 The degree of oil removal prior to forming, the techniques of taping, and differences in adhesive strength of the tape can affect the adhesion rating.

1.3 The values stated in SI 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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.* For a specific hazard statement, see Section 7.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D3330/D3330M Test Method for Peel Adhesion of Pressure-Sensitive Tape
2.2 *Other Document:*
Pictorial Standards of Coating Defects[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*
3.1.1 *dome height, n*—the height of the dome formed in the test.
3.1.2 *indenting ball diameter, n*—the diameter of the spherical-ended penetrator (ball) used to deform the specimen.

3.1.2.1 *Discussion*—

The 41 mm ~~(1~~(1.625~~5/8~~ in.) diameter ball was selected because it minimizes the variability in the localized peak strain. This size ball is commercially available and is as large as most testing machines can accommodate.

3.1.3 *percent strain, n*—the percent elongation of scribed ~~gage~~gauge lengths after forming.

3.1.3.1 *Discussion*—

[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 D01.53 on Coil Coated Metal.

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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.

[3] Copies of the pictorial photographic reference standard are contained in the publication Pictorial Standards of Coatings Defects and may be obtained from the Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422. The silver halide gelatin photographs are intended to be the only primary reference standards for this test method. The reproductions of them in this test method are for the purpose of illustration only.

For the draw height of 13 mm (0.512 in.), using a 41 mm diameter ball, the localized peak strain is about 19 % (see Fig. 1).

4. Summary of Test Method

4.1 A coated specimen is biaxially stretched a given distance in an appropriate machine, adhesive tape is applied to the deformed area (dome) and then pulled off, and the amount of coating removed is compared with a photographic standard to determine the coating adhesion rating.

5. Significance and Use

5.1 The results of the combined deformation and tape test are related to the ability of the coated metal to withstand stamping in factory applications.

5.2 This test can be used to determine or control the manufacturing process or ~~in~~ for coatings development work to improve the product.

5.3 It should be recognized that variability in the results ~~persist~~persists due to the test conditions and forming machine variations.

6. Apparatus and Materials (see Fig. 2)

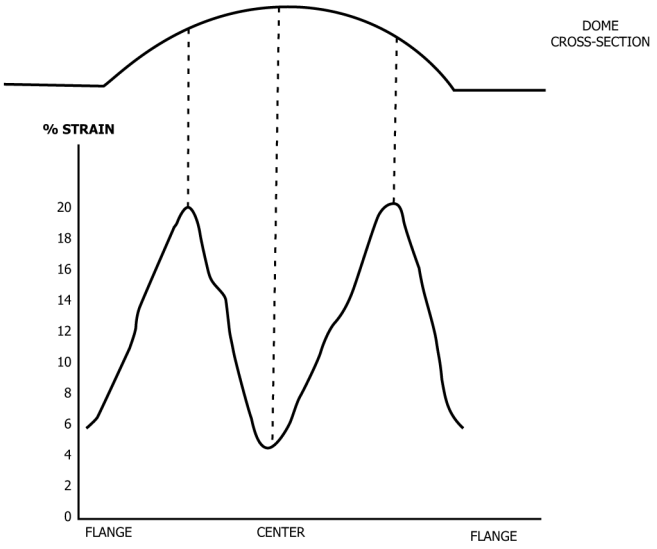
6.1 *Forming Machine,* equipped with a spherical-ended penetrator to deform the specimen with appropriate dies, until the required height is obtained, and clamping arrangement to hold the specimen with a minimum pressure of 8.9 kN (2000 lb).

6.1.1 The speed of forming shall be between 4.8 and 25 mm/min (0.2 and 1.0 in./min). The speed is usually slowed to measure more accurately the final height as shown on the dial indicator, but the final punch speed shall be controlled at 6 mm (0.24 in.) per min maximum.

6.2 *Indenting Ball,* with a diameter of 41 mm (~~1~~(1.625~~⅝~~ in.), a Rockwell hardness number not less than 61 on the Rockwell C scale (HRC), and a smooth surface finish not exceeding 4 µm (160 µin.). The indenting ball shall not deform during the test. The ball and holder shall move through the centerline of the top and bottom dies. The ball shall be clean and free of oil, grease, oxide buildup, rust, dirt, nicks, or other damage.

6.3 *Ball Holder,* to hold the ball in its seat during the test. Most ball holders are removable so that other ball punch deformation tests can be done in the same machine.

6.4 *Upper and Lower Dies,* with a hardness of 56 HRC or higher. The upper die shall have an approach radius of 1.6 ± 0.05 mm (0.0625 ± 0.002 in.) for steel thicknesses less than 1.50 mm (0.059 in.) and an approach radius of 4.8 ± 0.15 mm (0.1875



Draw distance = 0.512 in. (13 mm)
Ball diameter = ~~1~~1.625~~⅝~~ in. (41 mm)

FIG. 1 Survey of Strain Over Biaxially Stretched Dome