



Standard Test Method for Formability of Zinc-Rich Primer/Chromate Complex Coatings on Steel¹

This standard is issued under the fixed designation D 4146; 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 zinc-rich primer/chromate complex coatings on steel with thicknesses of 0.65 to 1.25 mm (0.025 to 0.05 in.) 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 and health practices and determine the applicability of regulatory limitations prior to use.* For a specific hazard statement, see Section 7.

2. Referenced Documents

2.1 ASTM Standards:

D 3330 Test Method for Peel Adhesion of Pressure-Sensitive Tape²

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*—the height of the dome formed in the test.

3.1.2 *indenting ball diameter*—the diameter of the spherical-ended penetrator (ball) used to deform the specimen.

3.1.2.1 *Discussion*—The 41-mm (1 $\frac{5}{8}$ -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*—the percent elongation of scribed gage lengths after forming. For the draw height of 13 mm (0.512 in.), using a 1 $\frac{5}{8}$ -in. 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 control the manufacturing process or in development work to improve the product.

5.3 It should be recognized that variability in the results persist 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 lbf).

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.)/min maximum.

6.2 *Indenting Ball*, with a diameter of 41 mm (1 $\frac{5}{8}$ in.), a Rockwell hardness number not less than 61 on the Rockwell C scale (HRC), and a smooth surface finish not exceeding 4 μ m

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.

Current edition approved May 10, 2003. Published May 2003. Originally approved in 1983. Last previous edition approved in 1996 as D 4146 - 96.

² *Annual Book of ASTM Standards*, Vol 15.09.

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.