



Designation: D4338 – 97(Reapproved 2011)^{ε1}

Standard Test Method for Flexibility Determination of Supported Adhesive Films by Mandrel Bend¹

This standard is issued under the fixed designation D4338; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

^{ε1} NOTE—Units of measure were editorially changed from hard to soft conversions in Section 7 and a typo was corrected in Footnote 3 in April 2011.

1. Scope

1.1 This test method covers the determination of the flexibility of an adhesive film bonded to a flexible substrate. The results are useful for comparing flexibility of adhesives and not for absolute characterization of adhesives.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

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

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

D907 Terminology of Adhesives

D3111 Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method

E171 Practice for Conditioning and Testing Flexible Barrier Packaging

¹ This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.10 on Working Properties.

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This test method is intended to replace Method 1081 of Federal Test Method 175A. Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

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. Terminology

3.1 *Definitions*—For terms used in this standard, refer to Terminology D907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *mandrel, n*—cylindrical rod.

4. Summary of Test Method

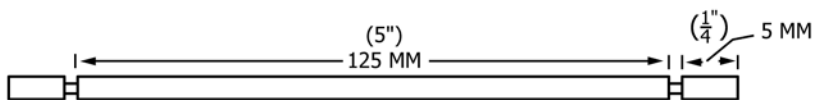
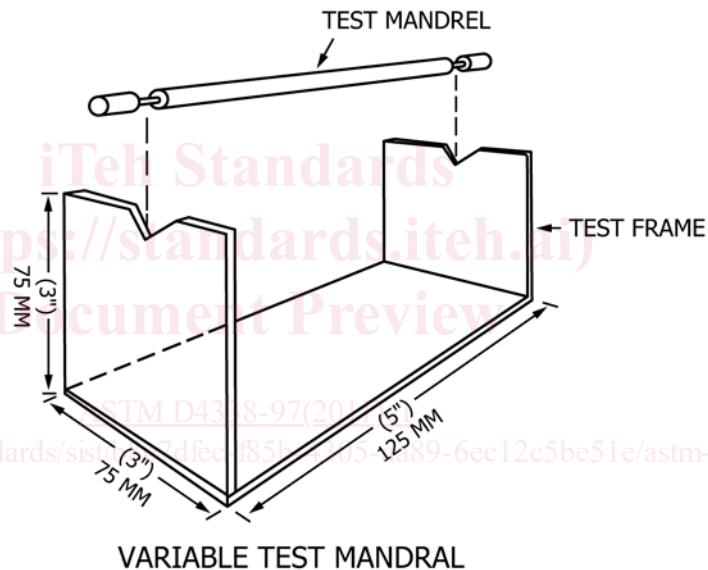
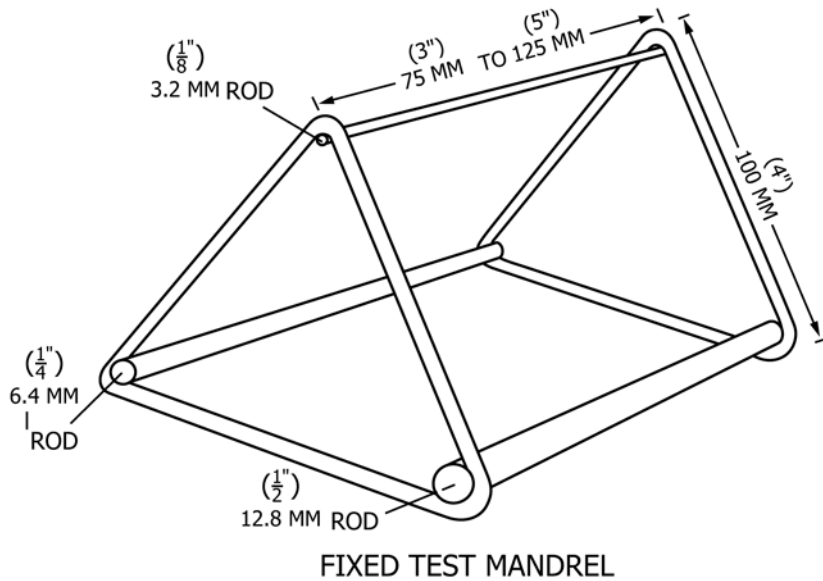
4.1 A test substrate coated with a film of adhesive, properly sized and conditioned, is folded to form an inverted U-shaped angle over the mandrel maintaining intimate contact with the non-adhesive side. Using a fresh specimen for each test, the test is repeated with progressively smaller diameter mandrels until the adhesive fails (cracks) on bending. The flexibility value of the adhesive is the smallest diameter mandrel over which four out of five test specimens do not break.

5. Significance and Use

5.1 The mandrel bend test is simple and fast. It requires little investment in equipment and little operator training. The prime purpose is to determine whether a film of adhesive coated on a substrate meets flexibility requirements. The test is also useful for comparing flexibility of adhesives. It can be used to design adhesives by comparing the flexibility of various formulations to meet specific end-use parameters. The adhesive flexibility can be determined at temperatures other than ambient by conditioning the test apparatus and test specimen at the desired temperature and performing the test under those conditions.

6. Apparatus

6.1 The test apparatus consists of a series of different diameter cylindrical rods or mandrels supported at each end. These should be long enough to permit placement of the flat side of a test specimen tangentially at right angles to the longitudinal axis of the test mandrel. Individual requirements determine the diameter and lengths of the rods needed. For most tests, rods 3.2 mm ($1/8$ in.), 6.4 mm ($1/4$ in.), and 12.8 mm ($1/2$ in.) in diameter, by 75 to 150 mm (3 to 6 in.) in length, made of brass or stainless steel, are satisfactory. Two simple



NOTE 1—Figures in parentheses are approximate.

FIG. 1 Test Mandrel (Various Diameters) for Test Frame

test frames are shown in Fig. 1, one with fixed mandrels, and the other designed to take any diameter mandrel.³

6.2 *Test Support Panels*, unless otherwise specified, are made of steel, not thinner than 0.25 mm (0.010 in.) nor thicker than 0.40 mm (0.016 in.).

6.2.1 The steel test panels are to be free of rust, corrosion, and contamination. Prepare one face of each panel to a clean surface according to Methods D609 to allow better adhesion of

the adhesive to be tested. An alternative to these steel test panels can be bonderized steel panels as available commercially.

6.2.2 Although steel is used in this test method, other flexible support substrates can be used, including other metals, plastics, and paper. Special surface preparation, for example, priming, corona discharge, and etching, can be defined for these substrates before coating the adhesive.

6.3 *Device*, capable of producing adhesive coatings of uniform thickness within (± 1 -mL) tolerances, such as a doctor blade.

³ Available from Paul N. Gardner Company, Inc., 313 NE 1st St. Pompano Beach, FL 33060.