Designation: D3111 – 10

Standard Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method[1]

This standard is issued under the fixed designation D3111; 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 determination of the flexibility of a hot-melt adhesive in sheet form under specific test conditions. This is a working test. Its results are useful for comparing adhesives, 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 for information 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]

D907 Terminology of Adhesives

E171 Practice for Conditioning and Testing Flexible Barrier Packaging

3. Terminology

3.1 *Definitions*—Many of the terms found in this test method are defined in Terminology D907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flexibility, n*—that property of a material by virtue of which it may be flexed or bowed repeatedly without undergoing rupture.

4. Summary of Test Method

4.1 Test strips of a hot-melt adhesive properly sized and conditioned, are bent 180° over a mandrel (rod). Using a fresh specimen for each test, the test is repeated with smaller diameter mandrels until the adhesive fails on bending. The flexibility 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 hot-melt adhesive meets flexibility requirements. This test is also useful for comparing flexibility of several 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 specimens at the desired temperature and performing the test under these temperature conditions.

6. Apparatus

6.1 The test apparatus consists of a series of different diameter cylindrical rods or mandrels supported at each end. There shall be enough space 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, 3.2 mm (~⅛ in.), 6.4 mm (~¼ in.), and 12.8 mm (~½ in.) diameter by 75 to 150-mm (~3 to 6-in.) long rods made of brass or stainless steel are satisfactory. Fig. 1 describes two simple test frames, one with fixed mandrels and the other designed to take any diameter mandrel.

7. Test Specimen

7.1 The test specimen dimensions can be varied depending on the end use requirements of the hot-melt adhesive. Fig. 2 describes a recommended specimen size. It is 10 mm (~0.4 in.) wide, 75 mm (~3 in.) long and 1.25 ± 0.01 mm (~0.05 in.) thick. The thickness dimension is critical and must be accurately measured. The test specimens shall be cut from molded or extruded sheets or film. Plying of several thinner samples shall not be permitted. No flaws visible anywhere in the sample to the naked eye shall be permitted.

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.14 on Tape and Labels.

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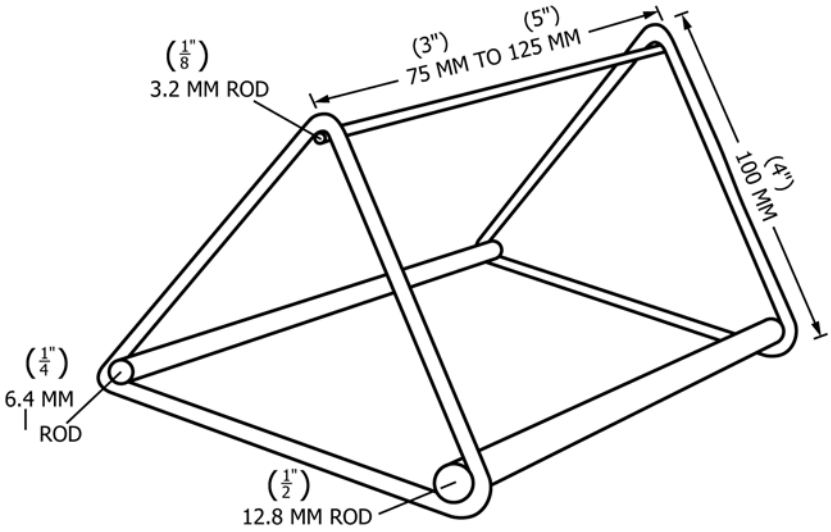
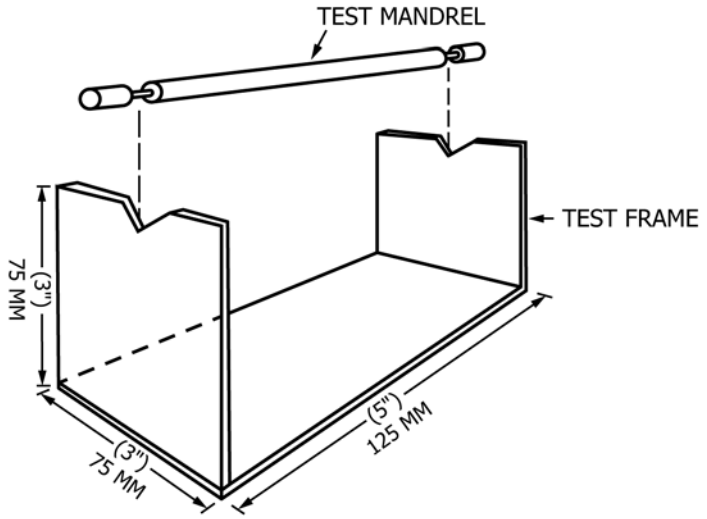
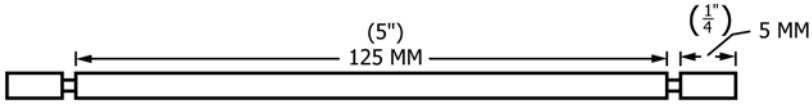
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



FIXED TEST MANDREL



VARIABLE TEST MANDREL



NOTE 1—(Recess to fit test frame) Figures in parentheses are approximate.

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

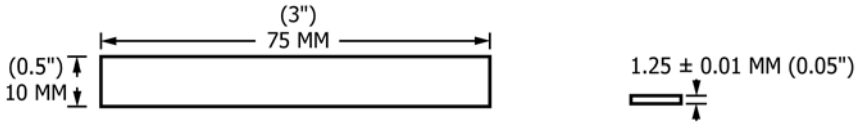


FIG. 2 Test Specimen

8. Conditioning

8.1 Store the test specimens and test apparatus at the test conditions for 24 h. Perform the test under these same conditions. For rapid screening, particularly at low temperatures, a minimum of 4 h conditioning can be used. Note this change when recording data. If other conditions are not specified, the storage and test conditions will be 23 ± 2°C and

50 ± 5 % relative humidity. Specification E171, details these and other tests conditions.

9. Failure

9.1 Failure is a visible fracture, crazing, or cracking of the hot-melt adhesive. This can occur at any time during the bending of the adhesive test specimen over the mandrel. Color changes or blushing not affecting the tensile properties of the material is not a failure, but should be reported.

10. Procedure

10.1 Run the tests in the same environment used to condition the test specimens and test apparatus.

10.2 Put the largest diameter mandrel in the horizontal operating position in the test frame.

10.3 Grasp the test specimen between the thumb and forefinger of one hand with the longest dimension between the fingers. For low temperature testing, use ordinary cotton work gloves to insulate the test specimens from the warm fingers.

10.4 Lay the flat-side of the test specimen tangentially at right angles to the longitudinal axis of the test mandrel.

10.5 Within 1 s, fold the test specimen 180° to form an inverted "U" shaped angle over the mandrel maintaining intimate contact with the mandrel.

10.6 If no failure occurs, fold a fresh specimen over the next smaller diameter mandrel. Repeat the test using a fresh sample each time until failure occurs.

10.7 Now repeat the test five times using five fresh test specimens on the smallest diameter mandrel at which failure had not occurred. To be significant, at least four out of five test specimens must pass. Follow this procedure with smaller or larger diameter mandrels until four out of five test specimens pass.

10.8 Record the flexibility of the hot-melt adhesive as the smallest diameter mandrel over which four out of five test specimens passed.

11. Report

11.1 Report the following information:

11.1.1 Method of specimen preparation, molded, extruded, or other method.

11.1.2 Specimen dimensions, especially thickness to within 0.01 mm (½ in.).

11.1.3 Conditioning and test conditions, temperature and, if important, relative humidity.

11.1.4 Smallest diameter mandrel over which four out of five specimens did not fail.

11.1.5 Color changes or blushing of nonfailing test specimens after bending.

12. Precision and Bias

12.1 No information about either the precision or bias of Test Method D3111 for measuring flexibility of hot-melt adhesives is available since the test result is non-quantitative.

13. Keywords

13.1 flexibility; hot melt; mandrel