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Standard Test Method for Seal Strength of Flexible Barrier Materials[1]

This standard is issued under the fixed designation F88/F88M; 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 measurement of the strength of seals in flexible barrier materials.

1.2 The test may be conducted on seals between a flexible material and another flexible material, a rigid material, or a semi-rigid material.

1.3 Seals tested in accordance with this test method may be from any source, laboratory or commercial.

1.4 This test method measures the force required to separate a test strip of material containing the seal. It also identifies the mode of specimen failure.

1.5 This test method differs from Test Method F2824. Test Method F2824 measures mechanical seal strength while separating an entire lid (cover/membrane) from a rigid or semi-rigid round container.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

1.8 *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]

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D883 Terminology Relating to Plastics

E171 Practice for Conditioning and Testing Flexible Barrier Packaging

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F17 Terminology Relating to Primary Barrier Packaging

F2824 Test Method for Mechanical Seal Strength Testing for Round Cups and Bowl Containers with Flexible Peelable Lids

F3263 Guide for Packaging Test Method Validation

3. Terminology

3.1 *Definitions:*

3.1.1 *average seal strength, n*—average force per unit width of seal required to fully separate a flexible material from a rigid material, semi-rigid material, or another flexible material, under the conditions of the test.

3.1.1.1 *Discussion*—The average force normally is calculated by the testing machine from the digitized plot of force versus grip travel. The plot starts from zero force after slack has been removed from the test strip. The initial ramp-up from zero to the force level required to peel the seal is not indicative of seal strength, and data from that part of the curve should not be included in the calculation of average strength, nor should the return to zero following complete failure of the specimen. The amount of data actually discarded on each end of the measured seal-profile curve must be the same for all tests within any set of comparisons of average seal strength (see 6.1.1 and 9.9.1).

3.1.2 *maximum seal strength, n*—maximum force per unit width of seal required to fully separate a flexible material from a rigid or semi-rigid material, or another flexible material, under the conditions of the test.

[1] This test method is under the jurisdiction of ASTM Committee F02 on Primary Barrier Packaging and is the direct responsibility of Subcommittee F02.20 on Physical Properties.

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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.

3.1.3 *flange, n*—any geometric feature of a rigid or semi-rigid component, which provides a counterpart surface to which a flexible component can form a seal.

3.1.4 *interferences, n*—conditions that may lead to increased variation or challenges in obtaining consistent measurement of test samples.

4. Significance and Use

4.1 Seal strength is a quantitative measure for use in process validation, capability, and control. Seal strength is not only relevant to opening force and package integrity, but to measuring the packaging processes' ability to produce consistent seals. Seal strength at some minimum level is a necessary package requirement, and at times it is also desirable to have an upper limit to the strength of the seal to facilitate opening.

NOTE 1—Seal strength values are a measurement of the output of the seal separation and may also involve mechanical properties of the materials that form the seal, given the potential for deformation or elongation over the course of the test. This separation is indicative of the area of the package being sampled and does not take into account simulation of a user interfacing with an entire package during the opening process.

NOTE 2—Lower seal strength specifications are typically utilized to provide assurance of package closure, which can contribute to seal integrity.

NOTE 3—Upper seal strength specifications are typically utilized to limit the amount of force required to open a package, ensuring that a user is able to open the design. Upper seal strength specifications are typically limited to seals that are intended to be peeled by the end user.

4.1.1 The maximum seal force is important information, but for some applications, average force to separate the seal may be useful, and in those cases also should be reported.

4.2 A portion of the force measured when testing materials may be a bending component and not seal strength alone. A number of fixtures and techniques have been devised to hold samples at various angles to the pull direction to control this bending force. Because the effect of each of these on test results is varied, consistent use of one technique (Technique A, Technique B, or Technique C) throughout a test series is recommended. Examples of techniques are illustrated in Fig. 1.

4.2.1 *Technique A: Unsupported*—Each tail of the specimen is secured in opposing grips and the seal remains unsupported while the test is being conducted.

4.2.2 *Technique B: Supported 90° (By Hand)*—Each tail of the specimen is secured in opposing grips and the seal remains hand-supported at a 90° perpendicular angle to the tails while the test is being conducted.

NOTE 4—Excessive lateral forces applied via hand may impact results. Actual gripping of samples is not intended and will influence results; contact is intended to be loose, only preventing tail movement up or down.

4.2.3 *Technique C: Supported 180°*—For flexible to flexible applications, the least flexible tail is typically supported flat against a rigid alignment plate held in one grip. The more flexible tail is typically folded 180° over the seal and is held in the opposing grip while the test is being conducted. Alternatively, in rigid and semi-rigid applications, the package structure may be maintained for the least flexible side; with this structure gripped or fixtured.

NOTE 5—Properties of some flexible materials may cause movement or flipping of the tail throughout the course of the test; this has potential to impact the measured strength and should be reported with results.

NOTE 6—Test method validation should account for use of fixtures or alignment plates, as well as determination of which material is placed into which grip as these factors are known to impact results, and feasibility of each approach may vary depending on design features. Examples of optional fixtures and equipment with built in fixturing are included in Appendix X4 for reference. Refer to Guide F3263 for guidance on test method validation.

5. Interferences

5.1 The value obtained for seal strength can be affected by properties of the specimen other than seal strength. Some flexible barrier materials have properties, such as shape and dimension, that may vary or change and need to be taken into consideration when testing for seal strength. Examples include materials that may stretch (elongation), flexing around the perimeter of a seal flange, or the shape/design of the rigid or semi-rigid material flanges (for example, in a tray), or variation in material properties such as caliper. These interferences are discussed in Annex A1.

6. Apparatus

6.1 *Tensile Testing Machine*—A testing machine of the constant rate-of-jaw-separation type. The machine shall be equipped with a device for recording the tensile load and the amount of separation of the grips; both of these measuring systems shall be accurate to ±2 %. The rate of separation of the jaws shall be uniform and capable of adjustment from approximately 8 in. to 12 in. [200 mm to 300 mm]/min. The gripping system shall be capable of minimizing specimen slippage and applying an even stress distribution to the specimen.

NOTE 7—If the tensile testing machine utilizes a spring and hook-based apparatus to extend the sample, it is expected to impart more variation in results as it travels, as compared to modern equipment. When utilizing spring and hook-based apparatus, it is recommended to take this factor into consideration and limit the variation imparted by the weighing system movement to a maximum distance of 2 % of the specimen extension within the range being measured.

NOTE 8—Impact of jaw-separation rate is discussed in Appendix X3.

6.1.1 If calculation of average seal strength is required, the testing machine system shall have the capability to calculate its value over a specified range of grip travel programmable by the operator. Preferably, the machine shall have the capability also to plot the curve of force versus grip travel.

6.2 *Specimen Cutter,* conforming to the requirements of 6.5 of Test Method D882, sized to cut specimens to a width of 0.984 in. [25 mm], 0.591 in. [15 mm], or 1.00 in. [25.4 mm].

NOTE 9—Alternate specimen cutting methods and tools may be utilized if deemed appropriate for the application.

NOTE 10—Any deviation from sample tolerance or width shall be supported through documented rationale and/or supportive data. Recommended tolerance for sample cutting tool is ±0.5 %. Sample cutting method and associated variation that may support to establish alternate tolerances may be assessed in validation of the test method; refer to Guide F3263 for test method validation guidance.

NOTE 11—Seal strength is proportional to sample width under the same test conditions. Impact of variation in sample width is discussed in Appendix X3.