INTERNATIONAL

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Standard Test Method for Tensile Properties of Thin Plastic Sheeting[1]

This standard is issued under the fixed designation D882; 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.
These test methods have been approved for use by agencies of the Department of Defense to replace Method 1013 of Federal Test Method Standard 406.

1. Scope*

1.1 This test method covers the determination of tensile properties of plastics in the form of thin sheeting and films (less than 1.0 mm (0.04 in.) in thickness).

NOTE 1—Film is defined in Terminology D883 as an optional term for sheeting having a nominal thickness no greater than 0.25 mm (0.010 in.).

NOTE 2—Tensile properties of plastics 1.0 mm (0.04 in.) or greater in thickness shall be determined according to Test Method D638.

1.2 This test method can be used to test all plastics within the thickness range described and the capacity of the machine employed.

1.3 Specimen extension can be measured by grip separation, extension indicators, or displacement of gage marks.

1.4 The procedure for determining the tensile modulus of elasticity is included at one strain rate.

NOTE 3—The modulus determination is generally based on the use of grip separation as a measure of extension; however, the desirability of using extensometers, as described in 6.2, is recognized and provision for the use of such instrumentation is incorporated in the procedure.

1.5 Test data obtained by this test method is relevant and appropriate for use in engineering design.

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

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.*

NOTE 4—This test method is similar to ISO 527-3, but is not considered technically equivalent. ISO 527-3 allows for additional specimen configurations, specifies different test speeds, and requires an extensometer or gage marks on the specimen.

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]

D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D883 Terminology Relating to Plastics
D4000 Classification System for Specifying Plastic Materials
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
D6287 Practice for Cutting Film and Sheeting Test Specimens
D6988 Guide for Determination of Thickness of Plastic Film Test Specimens
E4 Practices for Force Verification of Testing Machines
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2935 Practice for Conducting Equivalence Testing in Laboratory Applications

2.2 *ISO Standard:*

ISO 527-3 Plastics—Determination of Tensile Properties—Part 3: Test Conditions for Films and Sheets[3]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms that appear in this test method relating to plastics, refer to Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

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[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.19 on Film, Sheeting, and Molded Products.

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**

3.2.1 Definitions of terms and symbols relating to tension testing of plastics appear in the Annex to Test Method D638.

3.2.2 *line grips*—grips having faces designed to concentrate the entire gripping force along a single line perpendicular to the direction of testing stress. This is usually done by combining one standard flat face and an opposing face from which protrudes a half-round.

3.2.3 *flat grips*—grips having flat faces and lined with thin rubber, crocus-cloth, emery cloth, or pressure-sensitive tape.

3.2.4 *tear failure*—a tensile failure characterized by fracture initiating at one edge of the specimen and progressing across the specimen at a rate slow enough to produce an anomalous force-deformation curve.

4. Summary of Test Method

4.1 A specimen of uniform cross-section is loaded in tension via means of a mechanical testing machine. Force and or extension are recorded during the test. Various techniques for specimen gripping and extension measurement are addressed. Depending on the elongation of the material and the desired properties to be gained from the testing, various combinations of grip separation and test speed are utilized. Properties such as tensile stress, elongation and modulus can be calculated.

5. Significance and Use

5.1 Tensile properties determined by this test method are of value for the identification and characterization of materials for control and specification purposes. Tensile properties can vary with specimen thickness, method of preparation, speed of testing, type of grips used, and manner of measuring extension. Consequently, where precise comparative results are desired, these factors must be carefully controlled. This test method shall be used for referee purposes, unless otherwise indicated in particular material specifications. For many materials, there can be a specification that requires the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 in Classification D4000 lists the ASTM materials standards that currently exist.

5.2 Tensile properties can be utilized to provide data for research and development and engineering design as well as quality control and specification. However, data from such tests cannot be considered significant for applications differing widely from the force-time scale of the test employed.

5.3 The tensile modulus of elasticity is an index of the stiffness of thin plastic sheeting. The reproducibility of test results is good when precise control is maintained over all test conditions. When different materials are being compared for stiffness, specimens of identical dimensions must be employed.

5.4 The tensile energy to break (TEB) is the total energy absorbed per unit volume of the specimen up to the point of rupture. In some texts this property has been referred to as *toughness*. It is used to evaluate materials that are subjected to heavy abuse or that can stall web transport equipment in the event of a machine malfunction in end-use applications. However, the rate of strain, specimen parameters, and especially flaws can cause large variations in the results. In that sense, caution is advised in utilizing TEB test results for end-use design applications.

5.5 Materials that fail by tearing give anomalous data which cannot be compared with those from normal failure.

6. Apparatus

6.1 *Testing Machine*—A testing machine of the constant rate-of-crosshead-movement type and comprising essentially the following:

6.1.1 *Fixed Member*—A fixed or essentially stationary member carrying one grip.

6.1.2 *Movable Member*—A movable member carrying a second grip.

6.1.3 *Grips*—A set of grips for holding the test specimen between the fixed member and the movable member of the testing machine; grips can be either the fixed or self-aligning type. In either case, the gripping system must minimize both slippage and uneven stress distribution.

6.1.3.1 Fixed grips are rigidly attached to the fixed and movable members of the testing machine. When this type of grip is used, care must be taken to ensure that the test specimen is inserted and clamped so that the long axis of the test specimen coincides with the direction of pull through the center line of the grip assembly.

6.1.3.2 Self-aligning grips are attached to the fixed and movable members of the testing machine in such a manner that they will move freely into alignment as soon as a force is applied so that the long axis of the test specimen will coincide with the direction of the applied pull through the center line of the grip assembly. The specimens must be aligned as perfectly as possible with the direction of pull so that no rotary motion will cause slippage to occur in the grips; there is a limit to the amount of misalignment self-aligning grips will accommodate.

6.1.3.3 The test specimen shall be held in such a way that slippage relative to the grips is prevented insofar as possible. Grips lined with thin rubber, crocus-cloth, emery cloth, or pressure-sensitive tape as well as file-faced or serrated grips have been successfully used for many materials. The choice of grip surface will depend on the material tested, thickness, etc. Line grips padded on the round face with 0.75-1.00 mm (0.030-0.040 in.) blotting paper or filter paper have been found superior. Air-actuated grips have been found advantageous, particularly in the case of materials that tend to "neck" into the grips, since pressure is maintained at all times (see Notes 5-7). In cases where samples frequently fail at the edge of the grips, it could be advantageous to slightly increase the radius of curvature of the edges where the grips come in contact with the test area of the specimen.

NOTE 5—Caution needs to be taken when choosing the type of grips and the type of grip surfaces to use for testing specimens films composed of high strength LLDPE and VLDPE resins. Test results tend to differ more when comparing these types of specimens films tested with the grips lined with different materials.

NOTE 6—The gage of pressure sensitive tape, thin rubber, crocus-cloth, and emery cloth needs to be adequate enough to prevent slipping and premature failures of the test specimens (for example, pressure sensitive tape is used on the surface of the grips: the test specimen can may begin to tear at the edge of the grips during the test if the tape is too thin.).

NOTE 7—The grit size of crocus-cloth and emery cloth is suggested to be at least 800. The use of these materials helps to prevent test specimens from slipping in the grips. One must be cautious when using these materials so that premature failures of the test specimens do not occur.

6.1.4 *Drive Mechanism*—A drive mechanism for imparting to the movable member a uniform, controlled velocity with respect to the stationary member. The velocity shall be regulated as specified in Section 10.

6.1.5 *Force Indicator*—A suitable force-indicating mechanism capable of showing the total tensile force carried by the test specimen held by the grips. This mechanism shall be essentially free of inertial lag at the specified rate of testing (see Note 8). Unless a suitable extensometer is used (see 6.2), the motion of the weighing system shall not exceed 2 % of the specimen extension within the range being measured. The force indicator shall determine the tensile force applied to the specimen with an accuracy of ±1 % of the indicated value, or better. The accuracy of the testing machine shall be verified in accordance with Practices E4.

6.1.6 *Crosshead Extension Indicator*—A suitable extension-indicating mechanism capable of showing the amount of change in the separation of the grips, that is, crosshead movement. This mechanism shall be essentially free of inertial lag at the specified rate of testing (see Note 8) and shall indicate the crosshead movement with an accuracy of ±1 % of the indicated value, or better.

6.2 *Extensometer (Optional)*—A suitable instrument used for determining the distance between two designated points on the test specimen as the specimen is stretched. The use of this type of instrument is optional and is not required in this test method. This apparatus, if employed, shall be so designed as to minimize stress on the specimen at the contact points of the specimen and the instrument (see 9.3). It is desirable that this instrument automatically record the distance, or any change in it, as a function of the force on the test specimen or of the elapsed time from the start of the test, or both. If only the latter is obtained, force-time data must also be taken. This instrument must be essentially free of inertial lag at the specified speed of testing (see Note 8).

6.2.1 *Modulus of Elasticity and Low-Extension Measurements*—Extensometers used for modulus of elasticity and low-extension (less than 20 % elongation) measurements shall, at a minimum, be accurate to ±1 % and comply with the requirements set forth in Practice E83 for a Class C instrument.

6.2.2 *High-Extension Measurements*—Instrumentation and measuring techniques used for high-extension (20 % elongation or greater) measurements shall be accurate to ±10 % of the indicated value, or better.

NOTE 8—A sufficiently high response speed in the indicating and recording system for the force and extension data is essential. The response speed required of the system will depend in part on the material tested (high or low elongation) and the rate of straining.

6.3 *Thickness Gauge*—A dead-weight dial or digital micrometer as described in Test Methods D5947 or D6988 as appropriate for the material or specimen geometry being tested.

6.4 *Width-Measuring Devices*—Suitable test scales or other width measuring devices capable of measuring 0.25 mm (0.010 in.) or less.

6.5 *Specimen Cutter*—Refer to Practice D6287 for the apparatus and techniques for cutting film and sheeting used in this test method.

6.5.1 Devices that use razor blades have proven especially suitable for materials having an elongation-at-fracture above 10 to 20 %.

6.5.2 The use of a punch press or a striking die is not recommended because of their tendency to produce poor and inconsistent specimen edges.

6.5.3 The use of a cutting template and a single razor blade is not recommended as it will affect the parallelism of the test specimen.

7. Test Specimens

7.1 The test specimens shall consist of strips of uniform width and thickness at least 50 mm (2 in.) longer than the grip separation used.

7.2 The nominal width of the specimens shall be not less than 5.0 mm (0.20 in.) or greater than 25.4 mm (1.0 in.).

7.3 A width-thickness ratio of at least eight shall be used. Narrow specimens magnify effects of edge strains or flaws, or both.

7.4 The utmost care shall be exercised in cutting specimens to prevent nicks and tears that cause premature failures (see Note 9). The edges shall be parallel to within 5 % of the width over the length of the specimen between the grips.

NOTE 9—Microscopical examination of specimens can be used to detect flaws due to sample or specimen preparation.

7.5 Test specimens shall be selected so that thickness is uniform to within 10 % of the average thickness over the length of the specimen between the grips in the case of specimens 0.25 mm (0.010 in.) or less in thickness and to within 5 % in the case of specimens greater than 0.25 mm (0.010 in.) in thickness but less than 1.00 mm (0.040 in.) in thickness.

NOTE 10—In cases where thickness variations are in excess of those recommended in 7.5, results tend not to be characteristic of the material under test.

7.6 If the material is suspected of being anisotropic, two sets of test specimens shall be prepared having their long axes respectively parallel with and normal to the suspected direction of anisotropy.

7.7 For tensile modulus of elasticity determinations, a specimen gage length of 250 mm (10 in.) shall be considered as standard. This length is used in order to minimize the effects of grip slippage on test results. When this length is not feasible, test sections as short as 100 mm (4 in.) can be used if it has been shown that results are not appreciably affected. However, the 250-mm (10-in.) gage length shall be used for referee purposes. The speed of testing of shorter specimens must be adjusted in order for the strain rate to be equivalent to that of the standard specimen.