Designation: D1938 – 14

Standard Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by a Single-Tear Method[1]

This standard is issued under the fixed designation D1938; 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 force necessary to propagate a tear in plastic film and thin sheeting (thickness of 1 mm (0.04 in.) or less) by a single-tear method. The method is not applicable for film or sheeting material where brittle failures occur during testing.

NOTE 1—Film has been arbitrarily defined as sheeting having nominal thickness not greater than 0.25 mm (0.010 in.).

1.2 *Constant-Rate-of-Grip Separation Test*— This test method employs a constant rate of separation of the grips holding the test specimen.

1.2.1 Specimen extension may be measured in this test method by grip separation.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are provided 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.*

NOTE 2—This standard is similar to ISO 6383-1, but is not considered technically equivalent. The specimen size for ISO 6383-1 is larger, and the method specifies different test speeds.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D883 Terminology Relating to Plastics

D4000 Classification System for Specifying Plastic Materials

D5947 Test Methods for Physical Dimensions of Solid Plastics 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

2.2 *ISO Standard:*

ISO 6383-1 Film and Sheeting—Determination of Tear Resistance Part 1 Trouser Tear Method[3]

3. Terminology

3.1 *Definitions:* For definitions of terms used in this test method, refer to Terminology D883.

4. Summary of Test Method

4.1 The force to propagate a tear across a film or sheeting specimen is measured using a constant-rate-of-grip separation machine as described in Test Methods D882 and is calculated from the load-time chart.

5. Significance and Use

5.1 This test method is of value in rating the tear-propagation resistance of various plastic films and thin sheeting of comparable thickness. For highly extensible film or sheeting the deformation energy of the specimen legs is significantly greater than the tearing energy. The tear-propagation resistance in slightly extensible or non-extensible film or sheeting is distinguished from the tear-propagation resistance in highly extensible film or sheeting by the load-time or load-displacement data, (Fig. 1 and Fig. 2). The tear-propagation force for slightly extensible or non-extensible material is determined from the average tear force versus the initial and peak force for a highly extensible material.

5.2 This test method shall be used for specification acceptance testing only after it has been demonstrated that the data for the particular material are acceptably reproducible.

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is 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**

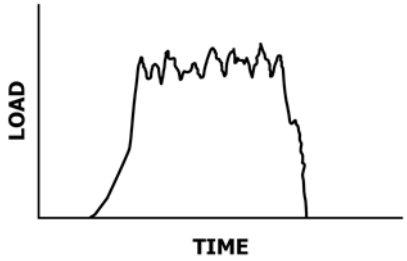

FIG. 1 Load-Time Chart for Low-Extensible Film

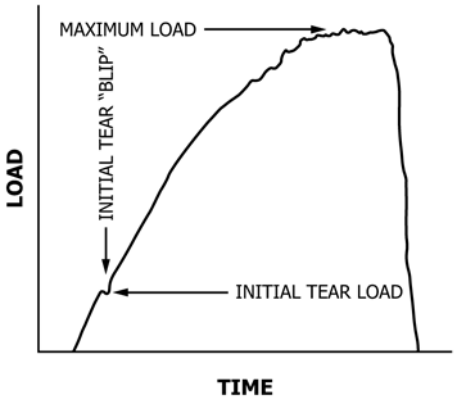

FIG. 2 Load-Time Chart for Highly Extensible Film

5.3 The data obtained by this test method furnish information for ranking the tear-propagation resistance of plastic films and sheeting of similar composition. Actual use performance may not necessarily correlate with data from this test method. Sets of data from specimens of dissimilar thickness are usually not comparable.

5.4 Before proceeding with this test method, reference should be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, or testing parameters, or combination thereof, covered in the relevant ASTM material specification shall take precedence over those mentioned in this test method. If there are no relevant ASTM material specifications, then the default conditions apply. Table 1 of Classification Systems D4000 lists the ASTM materials standards that currently exist.

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*—Preferably, a set of self-aligning grips for holding the test specimen between the fixed member and the movable member of the testing machine. The grips should 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. Fixed grips are to be used only if alignment can be verified when the test specimen

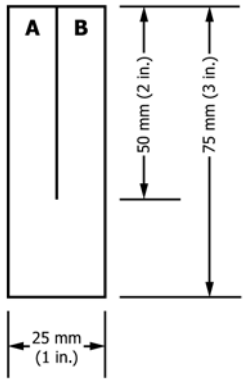

FIG. 3 Single-Tear Specimen

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 member of the testing machine in such a manner that they will move freely into alignment as soon as any load 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 shall be aligned with the direction of pull so that no rotary motion that may induce slippage will occur in the grips.

NOTE 3—Grips lined with thin rubber have successfully been used. Grips may be of the self-tightening type. In cases where specimens frequently fail at the edge of the grips, the radius of curvature of the edges of the grips may be increased slightly at the point where they come in contact with the specimen.

6.1.4 *Drive Mechanism*—A drive mechanism capable of separating the movable member (grip) from the stationary member (grip) at a controlled velocity of 250 mm (10 in.) ± 5 %/min.

6.1.5 *Load Indicator*—A suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen held by the grips. The testing machine shall be essentially free from inertia lag at the specified rate of testing and shall indicate the load with an accuracy of ±1 %. 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 (crosshead movement).

6.2 *Thickness*—A micrometer as prescribed in Test Methods D5947 and D6988, or an equivalent measuring device, reading to 0.0025 mm (0.0001 in.) or less. The pressure exerted by the gage on the specimen being measured shall not distort or deform the specimen. For thin films, ≤0.025 mm (0.001 in.), or films which exhibit visual deformation during measurement, a maximum pressure of 70 kPa (10 psi) is recommended. For thicker or stiffer films and thin sheeting, the pressure shall be between 160 and 185 kPa (23 and 27 psi).

6.3 *Die*—A die having the dimensions shown in Fig. 3 shall be used to cut all specimens. The cutting edge of the die shall have a 5° negative rake, and shall be kept sharp and free from nicks to avoid leaving ragged edges on the specimen. The

sample shall rest on a smooth, slightly yielding surface that will not injure the die blade. Care shall be taken that the cut edges of the specimen are parallel and perpendicular to the samples longitudinal and transverse directions.

7. Test Specimens

7.1 The specimens shall conform to the dimensions shown in Fig. 3 and shall not vary by more than 0.5 % from these dimensions.

NOTE 4—The thickness of the test specimens shall be uniform to within 5 % of the thickness over the length of the unslit portion of the specimen.

7.2 Measure the thickness of the specimen below the slit (see Fig. 3) in several places and record it in millimetres to the nearest 0.0025 mm (0.0001 in.).

7.3 Cut enough specimens to provide a minimum of five tear-propagation force determinations each in the machine direction and in the transverse direction of the material being tested.

NOTE 5—This is required because the properties of anisotropic specimens vary with direction.

8. Conditioning

8.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618 unless otherwise specified by agreement or the relevant ASTM material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

8.2 *Test Conditions*—Conduct the tests at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity unless otherwise specified by agreement or the relevant ASTM material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ± 5 % relative humidity.

9. Procedure

9.1 Secure Tongue *A* (see Fig. 3) in one grip and Tongue *B* in the other grip of the constant-rate-of-grip separation-testing machine, using an initial grip separation of 50 mm (2 in.). Align the specimen so that its major axis coincides with an imaginary line joining the centers of the grips.

9.2 Using a grip-separation speed of 250 mm (10 in.)/min, start the instrument, and record the load versus extension.

9.3 Continue the test until the tear has propagated through the entire unslit 25-mm (1-in.) portion.

9.4 If the tear deviates from the center line to such an extent as to reach one of the edges of the specimen, note the deviation in the report.

9.5 Test not less than five specimens in each of the principal film or sheeting directions.

10. Calculation

10.1 For thin films and sheeting that have load-time charts characterized by Fig. 1, calculate the average tear propagation force by averaging the load over a 25.4 mm (1 in.) interval, disregarding the initial and final portions of the curve.

TABLE 1 Tear Propagation Resistance (Trouser Tear) Machine Direction (Values Expressed in Units of Grams-Force)

Material	Average	S_r [A]	S_R [B]	r [C]	R [D]
Polystyrene	5.04	1.54	3.47	4.32	9.72
Polyester	32.75	7.08	7.08	19.81	19.81
Polypropylene	70.77	20.52	38.05	57.45	106.6
HDPE No. 2	127.3	48.04	56.49	134.59	158.2
LDPE—LD 104	228.3	33.98	33.98	95.14	95.14
LLDPE	337.1	30.95	42.74	86.66	119.7
HDPE No. 1	482.9	49.04	106.0	137.3	296.9

[A] S_r = within-laboratory standard deviation for the material stated. It is obtained by pooling the standard deviations of the test results from each laboratory, as follows:
$$S_r = [(\Sigma(S_1)^2 + (S_2)^2 \ldots + (S_n)^2)/n]^{1/2}$$
[B] S_R = between-laboratories standard deviation for the material stated. It is a pooling of the amounts by which the average of the test results for each laboratory deviate from the overall average for that material.
[C] r = within-laboratory repeatability limit = 2.8 × S_r.
[D] R = between-laboratories reproducibility limit = 2.8 × S_R.

10.2 For thin films and sheeting that have load-time data characterized by Fig. 2, obtain and report the initial force to continue the propagation of the slit, the maximum force, and the extension at maximum force. Report both the initial load, the maximum load, and extension at maximum load.

10.3 For each series of tests, report the mean of all values obtained to three significant figures and as the mean value of the particular property.

10.4 Calculate the estimated standard deviation and report load to three significant figures and extension to two significant figures.

11. Report

11.1 Report the following information:

11.1.1 Complete identification of the material tested, including type, source, manufacturer's code number, form, principal dimensions, previous history, orientation of samples with respect to principal directions of the material, etc.,

11.1.2 Average thickness of test specimens,

11.1.3 Number of samples tested,

11.1.4 Date of test, and

11.1.5 Mean of the five average tear-propagation determinations, usually in newtons (or pounds-force), for the materials described in 10.1; and the mean of the five initial tear-propagation forces, the mean of the five maximum tear-propagation forces, in newtons (or pounds-force), and the extension to maximum force, in mm (in.) for materials described in 10.2. In each case, report the standard deviation of the data. In the cases where the specimens tear to one side, note this together with the values obtained.

12. Precision and Bias

12.1 *Precision:*

12.1.1 Table 1 and Table 2 are based on a round robin[4] conducted between 1986 and 1990 in accordance with Practice E691 – 87, involving seven materials tested by seven laboratories. For each material, all the samples were prepared at one

[4] Supporting data on precision are available from ASTM Headquarters. Request RR:D20-1177.

TABLE 2 Tear Propagation Resistance (Trouser Tear) Transverse Direction (Values Expressed in Units of Grams-Force)

Material	Average	S_r [A]	S_R [B]	r [C]	R [D]
Polystyrene	3.86	0.46	3.08	1.28	8.63
Polyester	32.47	1.74	3.68	4.86	10.31
LDPE—LD 104	278.6	12.21	30.29	34.18	84.40
Polypropylene	326.2	49.67	124.9	139.1	349.7
LLDPE	372.5	26.69	31.68	74.74	88.70
HDPE No. 2	452.6	24.68	31.28	69.10	87.59
HDPE No. 1	549.7	64.10	105.4	179.5	295.0

[A] S_r = within-laboratory standard deviation for the material stated. It is obtained by pooling the standard deviations of the test results from each laboratory, as follows:

$$S_r = [(\Sigma(S_1)^2 + (S_2)^2 \ldots + (S_n)^2)/n]^{1/2}$$

[B] S_R = between-laboratories standard deviation for the material stated. It is a pooling of the amounts by which the average of the test results for each laboratory deviate from the overall average for that material.

[C] r = within-laboratory repeatability limit = 2.8 × S_r.

[D] R = between-laboratories reproducibility limit = 2.8 × S_R.

source, and randomized sections of film were sent to each of the laboratories which prepared the test specimens and tested them. Each test result was the average of five determinations. Each laboratory obtained two test results for each material. (**Warning—**The explanation of *r* and *R* (12.1.2 – 12.1.2.3) are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Table 1 and Table 2 should not be applied to acceptance or rejection of materials, as these data apply only to the materials tested in the round robin and are unlikely to be rigorously representative of other lots, formulations, conditions, materials, or laboratories. Users of this test method should apply the principles outlined in Practice E691 to generate data specific to their materials and laboratories (or between specific laboratories). The principles of 12.1.2 – 12.1.2.3 would then be valid for such data.)

12.1.2 *Concept of r and R in* Table 1 *and* Table 2—If S_r and S_R have been calculated from a large enough body of data and for test results that were averages from testing five specimens for each test result, then:

12.1.2.1 *Repeatability*—Two results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for the material. "*r*" is the interval representing the critical difference between the two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

12.1.2.2 *Reproducibility*—Two test results obtained by different laboratories shall be judged not equivalent if they differ by more than "*R*" value for that material. " *R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

12.1.2.3 Any judgment in accordance with 12.1.2.1 or 12.1.2.2 would have an approximate 95 % (0.95) probability of being correct.

12.2 *Bias*—There are no recognized standards to estimate the bias of this test method.

13. Keywords

13.1 plastic film; single tear; tear; tear-propagation; thin sheeting; trouser

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D1938 - 08) that may impact the use of this standard. (December 1, 2014)

(1) Corrected a figure reference in 7.1.
(2) Corrected a decimal error for a metric conversion in 6.2.
(3) Removed permissive language found in Section 6.