Designation: D3826 – 18

Standard Practice for Determining Degradation End Point in Degradable Polyethylene and Polypropylene Using a Tensile Test[1]

This standard is issued under the fixed designation D3826; 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 practice covers the determination of a degradation-end point *(a brittle point)* for degradable polyethylene/polypropylene films and sheeting less than 1.0 mm (0.04 in.) thick. This practice is not intended for determination of the rate or degree of degradation of a polyethylene/polypropylene film or sheet, but rather, to assess when in the course of its degradation under some condition, a brittle point is reached. If one wishes to monitor tensile elongation during the degradation process (such as when the tensile elongation is significantly greater than 5 %), Test Method D882 is recommended. This practice is not to be considered the only way of determining a degradation-end point.

1.2 Tensile properties of plastics 1.0 mm (0.04 in.) or greater in thickness shall be determined in accordance with Test Method D638.

1.3 Use a static weighing-constant rate of grip separation test. This procedure employs a constant rate of separation of the grips holding the sample and a static load cell.

NOTE 1—This procedure is based on the use of grip separation as a measure of extension; however, the desirability of using extension indicators accurate to ±1.0 % or better as specified in Test Method D638 is recognized, and a provision for the use of such instrumentation is incorporated in the procedure.

1.4 This procedure has been successful for determining the degradation end point of ethylene-carbon-monoxide copolymers and has screened successfully two other additive-type polyethylenes in a round robin test.

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

1.6 *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.*

1.7 There is no equivalent ISO standard.

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]

D374/D374M Test Methods for Thickness of Solid Electrical Insulation

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D883 Terminology Relating to Plastics

D5208 Practice for Fluorescent Ultraviolet (UV) Exposure of Photodegradable Plastics

D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

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

3. Terminology

3.1 *Definitions of Terms*—For definitions of terms used in this specification associated with plastics issues refer to the terminology contained in Terminology D883.

3.2 *Definitions:*

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, n*—in tensile testing machines, grips having faces designed to concentrate the entire gripping force along a single line perpendicular to the direction of testing stress.

3.2.3 *tear failure, n*—in tensile testing of films, a failure characterized by fracture initiating at one edge of the specimen

[1] This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.96 on Environmentally Degradable Plastics and Biobased 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.

and progressing across the specimen at a rate slow enough to produce an anomalous load-deformation curve.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *film, n*—for the purpose of this practice, a piece of material not exceeding 0.250 mm (0.01 in.) in thickness.

3.3.2 *brittle point, n*—in degradable polyethylene/polypropylene film, that point in the history of a material when 75 % of the specimens tested have a tensile elongation at break of 5 % or less.

4. Significance and Use

4.1 The tensile elongation property determined by this practice is of value for the characterization of degradable materials. It is possible that the tensile elongation property will vary with specimen thickness, method of preparation, speed of testing, type of grips used, and manner of measuring test extension. Consequently, where precise comparative results are desired, these factors must be carefully controlled.

4.2 It is acceptable to use the tensile elongation property to provide data for research and development and engineering design as well as quality control specifications. However, data from such tests cannot be considered significant for applications differing widely from the load-time scale of the test employed.

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

4.4 Before proceeding with this test method, reference needs to be made to the specifications of the material being tested. Any test specimen preparation, conditioning, dimensions, or testing parameters or a combination thereof, covered in the material specifications shall take precedence over those mentioned in this test method. If there are no material specifications, then the default conditions apply.

5. Apparatus

5.1 *Testing Machines:*

5.1.1 Use a testing machine of the constant rate-of-jaw-separation type. The machine shall be equipped with a weighing system that moves a maximum distance of 2 % of the specimen extension within the range being measured. Also, there needs to be 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 grips shall be uniform and capable of adjustment from approximately 1.3 to 500 mm/min (0.05 to 20 in./min) in increments necessary to produce the strain rates specified in 9.2.

5.2 *Grips*—Use a gripping system that minimizes both slippage and uneven stress distribution with the test specimen.

NOTE 2—Grips lined with thin rubber, crocus-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 depends on the material tested and thickness. More recently, line grips padded on the round face with 1.0 mm (40 mil) blotting 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. In cases where samples frequently fail at the edge of the grips, it is likely to be advantageous to increase slightly the radius of curvature of the edges where the grips come in contact with the test area of the specimen.

5.3 *Thickness Gage*—A dead-weight dial micrometer as prescribed in Method C of Test Methods D374/D374M, reading to 0.0025 mm (0.0001 in.) or less.

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

5.5 *Specimen Cutter*—Fixtures incorporating razor blades, suitable paper cutters, or other devices capable of safely cutting the specimens to the proper width and producing straight, clean, parallel edges with no visible imperfections. A device consisting of two parallel knives mounted firmly against a precision-ground base shear-block (similar to a paper cutter) has proved satisfactory. The use of striking dies is not recommended because poor and it is possible that inconsistent specimen edges will be produced. It is imperative that the cutting edges be kept sharp and free from visible scratches or nicks.

5.6 *Extension Indicators*—If employed, extension indicators shall conform to requirements specified in Test Method D638. In addition, such apparatus shall be so designed as to minimize stress on the specimen at the contact points of the specimen and the indicator.

NOTE 3—A high-response speed in the recording system is desirable, particularly when relatively high strain rates are employed for rigid materials. The speed of pen response for recorders is supplied by manufacturers of this equipment. Take care to conduct tests at conditions such that response time (ability of recorder to follow actual load) produces less than 2 % error.

6. Test Specimen

6.1 Cut test specimens prior to exposure. Take utmost care in cutting specimens to prevent nicks and tears that are likely to cause premature failures (see Note 4). The edges shall be parallel to within 5 % of the width over the length of the specimen between the grips.

NOTE 4—A microscopic examination of the specimen is a potential way to detect flaws due to sample or specimen preparation.

6.2 Prepare the test specimen with uniform width and length. Examples of typical lengths and widths are:

Width, mm	Length, mm
13 (0.5 in.)	152 (6 in.)
25 (1.0 in.)	102 (4 in.)

6.2.1 The test specimen thickness is contingent upon the thickness of the end-use application. The test specimen thickness needs to be the same as that for the specific end-use application.

6.3 Wherever possible, select test specimen so that thickness is uniform to within 10 % of the thickness over the length of the specimen between the grips in the case of materials 0.25 mm/in. (0.010 in.) or less in thickness, and to within 5 % in the case of materials greater than 0.25 mm (0.010 in.) in thickness but less than 1.00 mm (0.040 in.) in thickness.