



Designation: D 3379 – 75 (Reapproved 1989)^{ε1}

Standard Test Method for Tensile Strength and Young's Modulus for High-Modulus Single-Filament Materials¹

This standard is issued under the fixed designation D 3379; 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 Department of Defense.

^{ε1} NOTE—Editorial changes were made throughout in May 1989.

1. Scope

1.1 This test method covers the preparation, mounting, and testing of high-modulus single-filament materials [over $> 21 \times 10^9$ Pa ($> 3 \times 10^6$ psi)] for the determination of tensile strength and Young's modulus, at room temperature.

1.2 This test method is limited to single filaments utilizing a fixed gage length at least 2000 times longer than the nominal filament diameter.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns 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:*

D 638 Test Method for Tensile Properties of Plastics²

E 4 Practices for Force Verification of Testing Machines³

E 6 Terminology Relating to Methods of Mechanical Testing³

3. Terminology

3.1 *Definitions:*

3.1.1 *mounting tab*—a thin paper, compliant metal, or plastic strip with a longitudinal slot of fixed gage length. The mounting tab should be as thin as practicable to minimize filament misalignment.

3.1.2 *system compliance*—that portion of the indicated elongation contributed by the load train system and the specimen gripping system. This compliance must be deter-

mined experimentally for a given combination of test machine conditions, grip system and mounted specimen. It must be subtracted from the indicated elongation to yield true specimen elongation in the gage length (Note 1). System compliance correction will not apply when elongation in the specimen gage length is determined by direct measurement.

NOTE 1—The magnitude of the system compliance can be a significant portion of the indicated compliance. Extreme care must be exercised in the determination of this correction as outlined in 8.2.

3.2 Definitions of terms and symbols relating to this test method appear in Terminology E 6, and the Appendix to Test Method D 638.

4. Summary of Test Method

4.1 A random selection of single filaments is made from the material to be tested. The filaments are center-line mounted on special slotted tabs. The tabs are gripped so that the test specimen is aligned axially in the jaws of a constant-speed movable-crosshead test machine. The filaments are then stressed to failure at a constant strain rate.

4.2 For this test method, filament cross-sectional areas are determined by planimeter measurements of a representative number of filament cross sections as displayed on highly magnified photomicrographs. Alternative methods of area determination such as optical gages, image-splitting microscope, linear weight-density method, etc, may also be used.

4.3 Tensile strength and Young's modulus are calculated from the load-elongation records and the cross-sectional area measurements.

5. Significance and Use

5.1 Properties determined by this test method are very useful in the evaluation of new materials at the research and development levels. Very short filaments, such as whiskers of nonuniform cross section, call for highly specialized test techniques not covered by this test method.

¹ This test method is under the jurisdiction of ASTM Committee C-28 on Advanced Ceramics and is the direct responsibility of Subcommittee C28.07 on Ceramic Matrix Composites.

Current edition approved Feb. 28, 1975. Published April 1975.

² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 03.01.

6. Apparatus

6.1 Tensile strength and Young's modulus properties of single-filament specimens may be determined by several established testing procedures. The apparatus described herein shall use a constant-strain-rate tensile testing machine with a test specimen bonded to a suitable tab.

test specimens are gently separated from the strand bundle. Selection should be random. The critical considerations are that the filament be not visibly damaged or attached to another filament, and have sufficient length.

7.2 Segments used for area determinations shall represent the same population as those used for tensile testing.

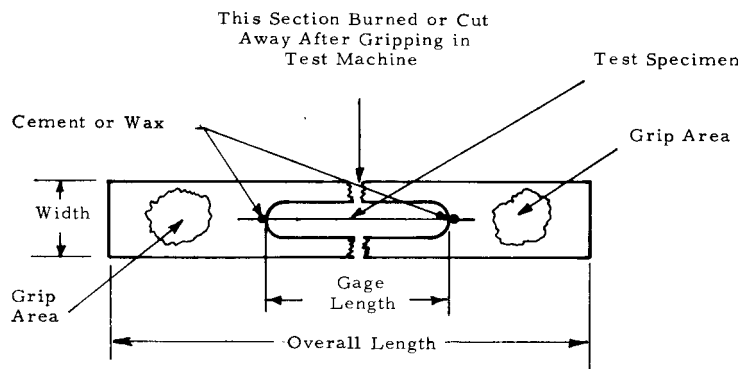


FIG. 1 Tab Showing Typical Specimen Mounting Method

6.2 *Stationary Member*—This member shall be rigidly fixed to the test machine frame and shall contain a housing, located on the machine centerline, for a load cell and part of the specimen grip assembly.

6.3 *Movable Member*—This member, also called the crosshead, shall be driven at a constant preset strain rate. It shall contain an adaptor, on the machine centerline, for the other part of the specimen grip assembly.

6.4 *Load Cell*—The load-sensing device shall have sufficient capacity to accept and transmit load signals above the highest anticipated loads. Its accuracy shall be verified in accordance with Practices E 4.

6.5 *Grips*—The gripping system shall be of a design such that axial alignment may be easily accomplished without damaging the specimens.

6.6 *Load- and Elongation-Measuring System*—A record of test load to failure, with corresponding indicated elongation, shall be provided. For this test method, chart and crosshead speeds shall be provided to produce acceptable data.

6.7 *Mounting Tabs*—A typical test specimen mounting tab is shown in Fig. 1. Alternative methods of specimen mounting may be used.

6.8 *Metallographic Capability*—This test area should have the following capabilities:

6.8.1 *Sample Preparation and Encapsulation in Potting Compound*.

6.8.2 *Metallographic Polishing Units*.

6.8.3 *Metallograph Unit*, with high magnification capabilities (to 3000×).

6.9 *Area Planimeter*.

6.10 Other methods of measuring specimen cross-sectional areas may be used (see 4.1).

8. Procedure

8.1 Test Specimen Mounting:

8.1.1 Loosely place a strand bundle from the material to be tested on a suitable work surface.

8.1.2 Randomly choose and carefully separate a suitable single-filament specimen from the strand bundle.

8.1.3 The specimen gage length shall be the same for a given test group. Determine the length to the nearest ± 0.1 mm.

NOTE 2—For this test method, the specimen gage length shall be between 20 and 30 mm. The tab shape should be proportioned as shown in Fig. 1, with an overall length about three times the specimen gage length and a width of about one half the gage length.

8.1.4 Use a tab (Fig. 1) for specimen mounting. Center the specimen over the tab slot with one end taped to the tab.

8.1.5 Lightly stretch the filament and tape its opposite end to the tab.

8.1.6 Carefully place a small amount of suitable adhesive⁴ on the filament at each edge of the slot and bond the filament to the mounting tab.

8.1.7 Repeat 8.1.2-8.1.6 to complete the test group.

8.2 Filament Specimen Testing:

8.2.1 Stabilize the tensile test machine in accordance with the manufacturer's instructions.

8.2.2 Calibrate the test machine before testing begins and at 4-h intervals throughout the work period.

8.2.3 Set the crosshead and chart recorder speeds to provide a test time to specimen fracture of about 1 min. Make load scale range selection such that specimen fracture occurs above 25 % of full scale.

8.2.4 Grasp a mounted test specimen in one tab grip area by the faces of the stationary jaws.

⁴ H. Courtwright No. 70 cement crystals, melted by a microtorch flame, have been found satisfactory for this test method. Ordinary sealing wax has proven equally effective.

7. Test Specimens

7.1 *Selection of Test Specimens*—Special care shall be taken to assure obtaining representative strand or single-filament segments. A statistically significant number of single-filament