Designation: D 1710 – 08

Standard Specification for Extruded Polytetrafluoroethylene (PTFE) Rod, Heavy Walled Tubing and Basic Shapes[1]

This standard is issued under the fixed designation D 1710; 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.

1. Scope*

1.1 This specification covers extruded polytetrafluoroethylene (PTFE) rod, heavy-walled tubing, and basic shapes manufactured from the PTFE resin of Specification D 4894 and reprocessed PTFE resin (as defined in Guides D 5033 and D 7209).

1.2 The specification covers all sizes of rod, tubing, and basic shapes with a wall thickness of 1.6 mm (1/16 in.) or greater. These materials must be made wholly from PTFE and produced in accordance with good commercial ram extrusion practices.

NOTE 1—This specification and ISO/DIS 13000-1 (1997) and ISO/DIS 13000-2 (1997) differ in approach, however, data obtained using either are technically equivalent.

NOTE 2—For compression molded PTFE materials, see Specification D 3294. Material that can be certified to Specification D 3294 may be substituted for Specification D 1710, however the reverse in not true.

1.3 The values stated in SI units, as detailed in IEEE/ASTM SI 10 are to be regarded as the standard. The inch-pound units given in parentheses are provided for information only.

1.4 The following precautionary caveat pertains to the test methods portion, Section 12, only of this specification: *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.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D 374 Test Methods for Thickness of Solid Electrical Insulation

D 618 Practice for Conditioning Plastics for Testing

D 638 Test Method for Tensile Properties of Plastics

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D 883 Terminology Relating to Plastics

D 1600 Terminology for Abbreviated Terms Relating to Plastics

D 3892 Practice for Packaging/Packing of Plastics

D 4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials

D 5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics[3]

D 5740 Guide for Writing Material Standards in the Classification D 4000 Format

D 5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

D 7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products

E 94 Guide for Radiographic Examination

IEEE/ASTM SI 10 Standard for the Use of the International System of Units (SI): The Modern Metric System[4]

2.2 *ISO Standards:*[5]

ISO 13000-1 (2005) Plastics—Polytetrafluoroethylene (PTFE) Semi-Finished Products, Part 1: Basis for Specification

ISO 13000-2 (2005) Plastics—Polytetrafluoroethylene (PTFE) Semi-Finished Products, Part 2: Preparation of Test Specimen and Determination of Properties

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D 883 unless otherwise specified.

3.1.1 *lot*, *n*—one production run or a uniform blend of two or more production runs.

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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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] Withdrawn.

[4] Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

[5] 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.**

TABLE 1 Detail Requirements of Extruded Rod

Properties	Type I			Type II			Type III		
	Rod Diameter, in.[A]			Rod Diameter, in.[A]			Rod Diameter, in.[A]		
	under ½	½ to 1½	over 1½	under ½	½ to 1½	over 1½	under ½	½ to 1½	over 1½
Specific gravity, min	2.14	2.15	2.15	2.14	2.15	2.15	2.12	2.13	2.14
Tensile strength, min, MPa	13.8	14.5	15.2	13.8	14.5	15.2	9.7	10.3	11.0
(psi)	(2000)	(2100)	(2200)	(2000)	(2100)	(2200)	(1400)	(1500)	(1600)
Elongation at Break, min,%	150	175	200	100	125	150	50	75	75
Dielectric strength, min, V/mil	700	750	750	...	...	...	...	...	...
Dimensional stability,[B] max, %									
Length	1.5	1.5	...	1.5	1.5	...	3.0	3.0	...
Diameter	0.5	0.5	...	0.5	0.5	...	1.0	1.0	...

[A] 1 in. = 25.4 mm.
[B] This requirement applies only to rod of Classes B and D that is under 25.4 mm (1 in.) in diameter. Values for larger sizes shall be as agreed upon by manufacture and buyer or manufacture stating material was stress relieved after manufacture of extruded rod.

3.2 *Abbreviations*—Abbreviations are in accordance with Terminology D 1600. PTFE is the acronym for polytetrafluoroethylene.

4. Classification

4.1 This specification covers three types of PTFE rod, heavy-walled tubing, and basic shapes. They are as follows:

4.1.1 *Type I, Premium*—A type of rod, heavy-walled tubing, or basic shape requiring both maximum physical and electrical properties to meet rigid requirements.

4.1.2 *Type II, Non-electrical Premium*—A type of rod, heavy-walled tubing, or basic shape requiring physical properties, but no electrical requirements.

4.1.3 *Type III*—A type of rod, heavy-walled tubing, or basic shape for non-critical chemical, electrical, and mechanical applications.

4.1.4 *Type IV*—A type of rod, heavy-walled tubing, or basic shape for chemical, electrical, and mechanical applications, not requiring physical property testing as described for Types I, II, and III, in Tables 1 and 2.

4.2 A one-line system is used to specify materials covered by this specification. The system uses predefined cells to refer to specific aspects of this specification, illustrated as follows:

	Specification Standard Number Block	Type	Grade	Class	Special notes
Example:	Specification D 1710–08	1	1	A	

4.2.1 For this example, the line callout would be Specification D 1710–08, 11 A, and would specify that a rod, heavy-walled tubing, or basic shape has all of the properties listed for that type, grade, and class. A comma is used as the separator between the standard number and the type. Separators are not needed between the type, grade, and class. A provision for special notes is included so that other information can be provided when required. An example would be to specify the dimension tolerances for each size of rod, heavy-walled tubing, or basic shape. When special notes are used, they shall be preceded by a comma.

4.3 The types are further subdivided into two grades:

4.3.1 *Grade 1*—Made only from virgin resin.

4.3.2 *Grade 2*—Made using reprocessed resin.

4.4 The grades are further subdivided into four classes:

4.4.1 *Class A*—Rod, heavy-walled tubing, or basic shape having normal dimensional stability.

4.4.2 *Class B*—Rod, heavy-walled tubing, or basic shape meeting the dimensional stability requirements of Table 1.

4.4.3 *Class C*—Same as Class A, but, in addition, completely examined for internal defects.

4.4.4 *Class D*—Same as Class B, but, in addition, completely examined for internal defects.

5. Materials and Manufacture

5.1 The rod, heavy-walled tubing, or basic shapes from Types I, II, III, and IV shall be made from non-pigmented PTFE as free of foreign matter as commercially practical.

6. *General Requirements* General Requirements

6.1 The rod, heavy-walled tubing, or basic shapes covered by this specification shall meet the mechanical and electrical requirements specified in Table 1 when tested by the methods given in Section 12. The heavy-walled tubing covered by this specification shall meet the mechanical and electrical requirements in Table 2 when tested by the methods given in Section 12.

7. Dimensions, Mass, and Permissible Variations

7.1 The dimensions and tolerances of heavy-walled tubing shall be in accordance with Table 3. Measurements shall be made in accordance with Method A of Test Methods D 374.

7.2 For rod and heavy-walled tubing, it is necessary to center-less-grind the outside diameter for rod and heavy-walled tubing to meet the tolerances given in Table 3. Tolerances for sizes of rod 50.8 mm (2.0 in.) and above shall be agreed upon be manufacturer and buyer.

7.2.1 *Eccentricity*—The eccentricity of the heavy-walled tubing, when measured as one half of the difference between the maximum and minimum wall thickness at either end of the tube, shall not exceed 10 % of the nominal wall thickness. Nominal wall thickness is one half the difference between the nominal outside diameter and the nominal inside diameter.

8. Workmanship, Finish and Appearance

8.1 *Color*—Type I shall be white to translucent but may have occasional spots. Types II, III, and IV typically are white

TABLE 2 Properties of PTFE Heavy-Walled Tubing

Grade	Type I		Type II		Type III	
	Grade 1	Grade 2	Grade 1	Grade 2	Grade 1	Grade 2
Specific Gravity, min	2.15	2.14	2.15	2.14	2.14	2.13
Tensile Strength, min, MPA	13.8	10.4	13.8	10.4	11.0	9.0
(psi)	(2000)	(1500)	(2000)	(1500)	(1600)	(1300)
Elongation at break, min, %	150	140	150	140	100	80
Dielectric Strength, min						
1 mm (0.040 in.) kV/mm	29.5	27.5	25.6	23.6	12	10
Short Time (V/mil)	(750)	(700)	(650)	(600)	(325)	(250)
Dimensional Stability max, Classes B and D, %						
Length	1.5	1.5	2.0	2.0	2.5	2.5
Diameter	0.5	0.5	0.75	0.75	1.0	1.0

TABLE 3 Diameter and Tolerances for PTFE Rod and Heavy-Walled Tubing

Nominal Inside or Outside Diameter,[A] mm (in.)	Tolerance,[B] mm (in.)
1.6 (1/16)	0.13 (0.005)
3.2 (1/8)	0.18 (0.007)
4.8 (3/16)	0.23 (0.009)
6.3 (1/4)	0.30 (0.012)
9.5 (3/8)	0.30 (0.012)
12.7 (1/2)	0.36 (0.014)
15.8 (5/8)	0.41 (0.016)
19.1 (3/4)	0.43 (0.017)
25.4 (1)	0.51 (0.020)
31.8 (1 1/4)	0.64 (0.025)
38.1 (1 1/2)	0.76 (0.030)
44.4 (1 3/4)	0.89 (0.035)

[A] Intermediate diameters shall conform to the tolerances of the next larger diameter in the table.

[B] The tolerance is plus for outside diameters and minus for inside diameters.

but may vary to light gray or light brown. For Types II, III, and IV occasional small gray, brown, or black spots shall not be considered cause for rejection.

8.2 *Finish*—The rod or heavy-walled tubing shall be free from surface blisters, cracks, wrinkles, and other surface defects that might impair it for general use.

8.3 *Internal Defects*—Classes C and D shall be free of all macroscopic voids, cracks, and foreign inclusions, or the location of such defects shall be clearly marked or identified. The examination for internal defects shall be made in accordance with Guide E 94.

9. Sampling

9.1 Sampling shall be statistically adequate to satisfy the requirements of 13.4.

10. Number of Tests and Retests

10.1 The tests listed in Table 1 and Table 2, as they apply, are sufficient to establish conformity of the PTFE rod or heavy-walled tubing to this specification. When the number of test specimens is not stated in the test method, single determination shall be made. If more than single determinations on separate portions of the same sample are made, the results shall be averaged. The single or average result shall conform to the requirements prescribed in this specification.

11. Test Conditions

11.1 *Conditioning of Specimens*—The test specimens shall be conditioned in accordance with Procedure A of Practice D 618 for a period of at least 4 h prior to test.

11.2 *Standard Temperature*—The tests shall be conducted at the standard laboratory temperature of 23 ± 1°C (73.4 ± 1.8°F). Since the rod or heavy-walled tubing does not absorb water, the maintenance of constant humidity during testing is not important.

12. Test Methods

12.1 *Visual Inspection*—Visually inspect each of the samples of PTFE rod or heavy-walled tubing selected in accordance with Section 9 to verify its compliance with the requirements of this specification. Occasional superficial flaws in PTFE rod or heavy-walled tubing shall be interpreted as not affecting the physical and electrical properties; however, if there is an appearance of a transverse discontinuity or "poker chip," testing for tensile strength and elongation is imperative.

12.2 *Specific Gravity*—Determine the specific gravity of the rod or heavy-walled tubing in accordance with Method A of Test Methods D 792. Two drops of wetting agent shall be added to the water in order to reduce the surface tension and ensure complete wetting of the specimens. Test two specimens representative of the cross section of the rod or heavy-walled tubing and average the results.

12.3 *Tensile Strength and Elongation*:

12.3.1 Determine the tensile strength and elongation of rods with a diameter equal to or greater than 15.8 mm (0.625 in.) diameter in accordance with Specification D 4894 modified as described below. Prepare the micro tensile specimens from 1.27- 2.54 mm (0.05-0.10 in.) thick wafers cut from the center portion of the rod in a plane parallel to the direction of extrusion.

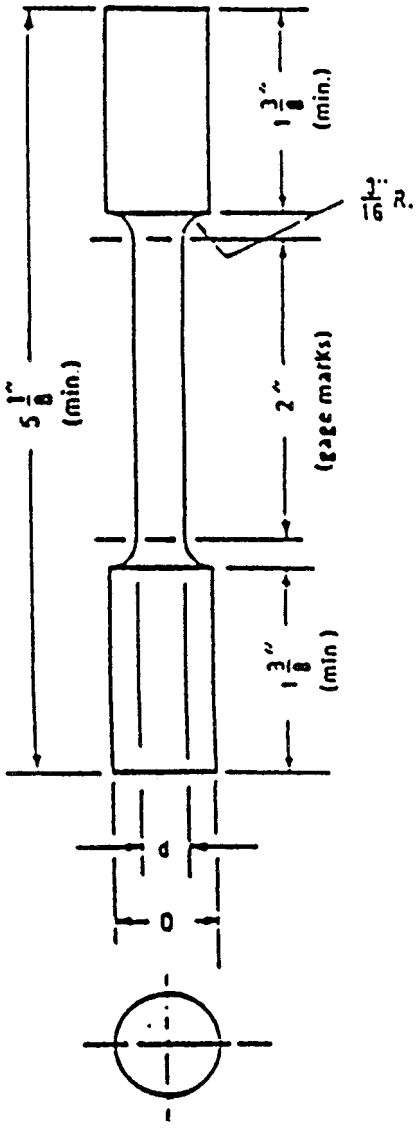

FIG. 1 Turned Dumbbell Specimen for Tensile Testing

12.3.1.1 For rods of less than 15.8 mm (0.625 in.) diameter prepare the test specimens in accordance with Fig. 1.

12.3.1.2 Rods of 6.35 mm (¼ in.) and smaller shall be tested in fill cross-section.

12.3.1.3 For the tensile strength and elongation of heavy-walled tubing, machine a sleeve 1.27-2.54 mm (0.05-0.10 in.) wall thickness approximately 25.4 mm (1 in.) long from the inner area of the tubing. Slit this sleeve using a utility knife (cut parallel to direction of extrusion) to open up and lay flat this tubing. Using steel rule diameter as described in Specification D 4894 stamp samples around perimeter of the tubing.

12.3.2 Test at a speed of 50.8 mm (2 in.)/min, five specimens to be tested and averaged for all specimen types.

12.3.3 *Precision and Bias*—The precision and bias data available is shown in Table 4 .

12.4 *Dielectric Strength*:

TABLE 4 Precision Summary, Tensile Strength and Elongation at Break

NOTE 1—$I_r = 2.8 \times CV_r$; $I_R = 2.8 \times CV_R$

Material	Tensile Strength				
	Mean, psi	CV_r, %	CV_R, %	I_r, %	I_R, %
Granular PTFE	4801	2.79	8.85	7.81	24.78

TABLE 5 Percentage Elongation at Break

NOTE 1—$I_r = 2.8 \times CV_r$; $I_R = 2.8 \times CV_R$

Material	Mean, psi	CV_r, %	CV_R, %	I_r, %	I_R, %
Granular PTFE	337	2.83	16.43	7.92	46.00

12.4.1 Determine the dielectric strength in accordance with the short-timed test of Test Method D 149. Electrode shall be 1/16" diameter pin electrode having beveled edges where they impinge on the specimen. Sample thickness shall be 1 ± 0.02 mm (0.040 ± 0.001 in.). Test five specimens in oil and average results.

12.4.1.1 *Dielectric Strength of Rod Specimens*—For rods of sufficient diameter that prevent flash over (approx 0.5 in.) prepare wafers by cutting specimens perpendicular to the length-wise axis as wafers 1 ± 0.02 mm (0.040 ± 0.001 in.) thick and place between two electrodes that contact the wafer at its center point. The surfaces of the wafer adjacent to the electrodes shall be parallel and as plane and smooth as the material permits.

(1) For rods over 1.000 in. diameter machine OD diameter to 1.000 in. to aid sample preparation of wafers.

(2) When flashover interferes with obtaining satisfactory tests using above method, (less than 0.5 in. diameter) the testing can be done with a modified sample. The specimen is prepared by drilling holes 1/16 in. diameter from opposite ends of a rod section, leaving a 1 ± 0.02 mm (0.040 ± 0.001 in.) thick web section between them. A flat-tipped drill must be used to ensure that a 1 ± 0.02 mm (0.040 ± 0.001 in.) thickness is left. The opposing pin electrodes can then be inserted into the holes.

(3) On rods of diameter that are physically too small to make samples that prevent flashover report flashover occurred and value at which it occurred on the test report.

12.4.1.2 *Dielectric Strength of Tubular Specimens*—Machine a sleeve 1 ± 0.02 mm (0.040 ± 0.001 in.) wall thickness approximately 25.4 mm (1 in.) long from the center area of the tubing. Slit this sleeve using a utility knife (cut parallel to direction of extrusion) to open up and lay flat. Follow above procedures for testing wafers.

12.5 *Dimensional Stability*—Determine the dimensional stability of the rod or heavy-walled tubing by cutting two sections of rod from each end 25.4 ± 0.127 mm (1 ± 0.005 in.) in length. Measure (see 7.1) their length and diameter to the nearest 0.0254 mm (0.001 in.) at the center point. Mark these points of original measurements so that measurement after heating and cooling is made at the same points. Place them in a heating chamber that can be elevated to a temperature of 290 ± 1°C (554 ± 5.4°F). The heating medium shall be either oil or air. Hold the specimens at this temperature for at least 2 h for

each 6.35 mm (0.25 in.) in diameter. Then lower the temperature at a rate not exceeding 30°C (54°F)/h until room temperature is reached. Measure the lengths and diameters of the specimens again to the nearest 0.0254 mm (0.001 in.) at the center point. Calculate the change in dimensions by the following formula and average the results:

$$D = L_n - L_i \times 100 \quad (1)$$

where:

D = Percent dimensional change,
L_n = Initial dimension of sample, and
L_i = Dimension of sample after heating.

12.6 *Examination for Internal Defects*—The examination for internal defects in the rod or heavy-walled tubing shall be in accordance with the method described in Guide E 94. X-ray the specimen in as many views as necessary to give complete coverage of the piece. Identify all film to correspond with the rod section or view, so that any defects may be located later. View the films for defects such as macroscopic voids, cracks, and inclusions. Films showing apparent defects should be checked against the corresponding specimen and position to ensure that such defects are not due to surface damage or surface contamination.

13. Inspection and Certification

13.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

13.2 Lot-acceptance shall be the basis on which acceptance or rejection of the lot is made. Lot-acceptance inspection shall consist of rod diameter, tensile and elongation and specific gravity.

13.3 Periodic check inspection with reference to a specification based on this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to insure the material is certifiable in accordance with 13.4.

13.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system, and that the average values for the lot meet the requirements of the specification (line callout).

13.5 A report of test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and the results of the most recent periodic-check inspection.

14. Packaging and Marking

14.1 The provisions of Practice D 3892 apply to packaging, packing, and marking of containers for plastic materials.

15. Keywords

15.1 fluorocarbon polymer; fluoropolymers; granular PTFE; polytetrafluoroethylene; PTFE; PTFE heavy-walled tubing; PTFE rod

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D 1710 - 02) that may impact the use of this standard. (April 1, 2008.)

(*1*) Removed several old referenced documents.
(*2*) Revised 4.1.2 General Purpose grade to Non-electrical Premium grade.
(*3*) Revised tensile strength procedure to add heavy walled tubing 12.3.1.3.
(*4*) Revised wording in Dielectric section.
(*5*) Added Note 2 for compression molding material reference.
(*6*) Removed non-mandatory language throughout standard.
(*7*) Added Type IV for materials that are PTFE based, but do not require physical tests.