



Standard Specification for Extruded and Compression Molded Polytetrafluoroethylene (PTFE) Rod and Heavy Walled Tubing¹

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1. Scope *

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

1.2 The specification covers rod 200-mm (8-in.) nominal diameter or under and heavy-walled tubing 100-mm outside diameter and with a wall thickness of 1.6 mm ($\frac{1}{16}$ in.) or greater. These materials must be made wholly from PTFE and produced in accordance with good commercial practice.

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

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:

- D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²
- D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials²
- D 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics³
- D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials²

- D 374 Test Methods for Thickness of Solid Electrical Insulation²
- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³
- D 621 Test Methods for Deformation of Plastics Under Load⁴
- D 638 Test Method for Tensile Properties of Plastics³
- D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 and 30°C ³
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials³
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement³
- D 883 Terminology Relating to Plastics³
- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique³
- D 1600 Terminology for Abbreviated Terms Relating to Plastics³
- D 2240 Test Method for Rubber Property-Durometer Hardness⁵
- D 3295 Specification for PTFE Tubing⁶
- D 3892 Practice for Packaging/Packing of Plastics⁶
- D 4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry⁷
- D 4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials⁷
- D 4895 Specification for Polytetrafluoroethylene (PTFE) Resins Produced from Dispersion⁷
- D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁷
- D 5740 Guide for Writing Material Standards in the Classification D 4000 Format⁷
- E 94 Guide for Radiographic Testing⁸
- F 36 Test Method for Compressibility and Recovery of Gasket Materials⁹
- IEEE/ASTM SI 10 Standard for the Use of the International

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.12).

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² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Discontinued; see 1994 Annual Book of ASTM Standards, Vol 08.01.

⁵ Annual Book of ASTM Standards, Vol 09.01.

⁶ Annual Book of ASTM Standards, Vol 08.02.

⁷ Annual Book of ASTM Standards, Vol 08.03.

⁸ Annual Book of ASTM Standards, Vol 03.03.

⁹ Annual Book of ASTM Standards, Vol 09.02.

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

System of Units (SI): The Modern Metric System¹⁰

2.2 ISO Standards:¹¹

ISO 13000-1 (1997) Plastics—Polytetrafluoroethylene (PTFE) Semi-Finished Products, Part 1: Basis for Specification

ISO 13000-2 (1997) 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. (D 4895)

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-fluorocarbon rod and heavy-walled tubing. They are as follows:

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

4.1.2 Type II, General Purpose—A type of rod or heavy-walled tubing having properties required of general electrical, mechanical, and chemical applications.

4.1.3 Type III—A type of rod or heavy-walled tubing for noncritical chemical, electrical, and mechanical applications.

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

| Standard Number Block | Specification | | | | Special notes |
|-----------------------|---------------|-------|-------|--|---------------|
| | Type | Grade | Class | | |

Example: Specification D 1710-XX 1 1 A

4.2.1 For this example, the line callout would be Specification D 1710-XX, 11 A, and would specify that a rod or

heavy-walled tubing 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 or heavy-walled tubing. When special notes are used, they should 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 or heavy-walled tubing having normal dimensional stability.

4.4.2 Class B—Rod or heavy-walled tubing 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 or heavy-walled tubing from Types I, II, and III shall be made from unpigmented PTFE as free of foreign matter as commercially practical.

6. General Requirements

6.1 The rod covered by this specification shall meet the mechanical and electrical requirements specified in Table 1 and 6.1.1 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 and 6.1.1 when tested by the methods given in Section 12.

6.1.1 Melting Point—The melting point of all types of rod and heavy walled tubing shall be 327 ± 10°C when tested in accordance with 12.7.

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 may be necessary to center-less-grind the outside diameter for rod and heavy-walled tubing to meet the tolerances given in Table 3.

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 1/2 | 1/2 to 1 1/2 | over 1 1/2 | under 1/2 | 1/2 to 1 1/2 | over 1 1/2 | under 1/2 | 1/2 to 1 1/2 | over 1 1/2 |
| Specific gravity, min | 2.14 | 2.15 | 2.15 | 2.12 | 2.13 | 2.14 | 2.12 | 2.13 | 2.14 |
| Tensile strength, min, MPa (psi) | 13.8 (2000) | 14.5 (2100) | 15.2 (2200) | 11.7 (1700) | 12.4 (1800) | 13.1 (1900) | 9.7 (1400) | 10.3 (1500) | 11.0 (1600) |
| Elongation at Break, min, % | 150 | 175 | 200 | 100 | 125 | 150 | 50 | 75 | 75 |
| Dielectric strength, min, V/mil | 700 | 750 | 800 | 600 | 650 | 700 | 250 | 250 | 250 |
| 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.

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 (psi) | 13.8 (2000) | 10.4 (1500) | 12.4 (1800) | 9.7 (1400) | 11.0 (1600) | 9.0 (1300) |
| Elongation at break, min, % | 150 | 140 | 130 | 120 | 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) |
| 50.8 (2) | 0.89 (0.035) |
| 57.2 (2 1/4) | 1.02 (0.040) |
| 63.5 (2 1/2) | 1.14 (0.045) |
| 76.2 (3) | 1.14 (0.045) |
| 101.6 (4) | 1.14 (0.045) |
| 203.2 (8) | 1.14 (0.045) |

^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.

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 and III typically are white but may vary to light gray or light brown. For Types II and III 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 may 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 $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$). 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 should be interpreted as not affecting the physical and electrical properties; however, if