



Designation: ~~D3294~~—15 D3294 – 22

Standard Specification for Polytetrafluoroethylene (PTFE) Resin Molded Sheet and Molded Basic Shapes¹

This standard is issued under the fixed designation D3294; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification establishes requirements and methods of test for the material, dimensions, and workmanship, and the physical and electrical properties of molded sheet in minimum thicknesses of 0.794 mm ($1/32$ in.) manufactured from PTFE resin molding materials defined in Specification [D4894](#).

1.2 This specification also establishes requirements for molded basic shapes made from molding materials. This specification is for products 300 mm (12 in.) or less in a dimension parallel to and 12.7 mm (0.5 in.) or greater in the dimension perpendicular to the direction of the applied molding pressure.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 The following precautionary caveat pertains only to the test method portion, Section 7, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Special attention is called to [13.2](#), [13.3](#), [13.6](#), [13.8](#), and A1.

NOTE 1—There is no known ISO equivalent to this standard.

1.5 *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

- [D149](#) Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
- ~~D374~~[D374/D374M](#) Test Methods for Thickness of Solid Electrical Insulation—(Metric) ~~D0374~~ [D0374M](#)
- [D618](#) Practice for Conditioning Plastics for Testing
- [D638](#) Test Method for Tensile Properties of Plastics
- [D792](#) Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- [D883](#) Terminology Relating to Plastics

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 (Section D20.15.12).

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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.

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

- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
- D3892 Practice for Packaging/Packing of Plastics
- D4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry
- D4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials
- D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
- E94E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film
- IEEE/ASTM SI-10 American National Standard for Use of the International System of Units (SI): The Modern Metric System

3. Terminology

3.1 *Definitions:*

- 3.1.1 Definitions are in accordance with Terminology D883 unless otherwise specified.
- 3.1.2 *lot, n*—one continuous production run or a uniform blend of two or more production runs of one size sheet or molded basic shape.

3.2 *Abbreviations:*

- 3.2.1 Abbreviations are in accordance with Terminology D1600.

4. Classification

4.1 This specification covers the following four types of molded basic sheets and shapes:

- 4.1.1 *Type I*—Premium; normally used for exacting electrical, mechanical, or chemical applications.
- 4.1.2 *Type II*—General purpose; for electrical, mechanical, and chemical applications not requiring premium material.
- 4.1.3 *Type III*—Mechanical Grade; for non-critical chemical, electrical, and mechanical applications.
- 4.1.4 *Type IV*—Utility; having no electrical requirements and with mechanical properties at a lower level.

4.2 Types I, II, and III shall be subdivided into two grades as follows:

- 4.2.1 *Grade 1*—made only from virgin resin.
- 4.2.2 *Grade 2*—made using reprocessed resin.

4.3 The grades shall be further subdivided into ~~three~~four classes as follows:

- 4.3.1 *Class A*—resistant to thermal dimensional change not exceeding 0.5 %.
- 4.3.2 *Class B*—thermal dimensional change not exceeding 5.0 %.
- 4.3.3 *Class C*—no requirement for thermal dimensional change.
- 4.3.4 *Class D*—as agreed by the processor and customer.

4.4 A one-line system shall be used to specify materials covered by this specification. The system uses predefined cells to refer to specific aspects of this specification, as illustrated below.

| Specification | | | | | | |
|------------------------------------|---|------|---|-------|---|---------------|
| Standard Number | : | Type | : | Grade | : | Class |
| Block | : | | : | | : | Special Notes |
| : | : | : | : | : | : | : |
| Example: Specification D3294 – 03, | | I | | I | | A |

For this example, the line callout would be Specification D3294 – 03, 11A and would specify premium virgin form of polytetrafluoroethylene that has all of the properties listed for that Type, Grade, and Class in the appropriate specified properties, tables, or both, in the specification identified. A comma is used as the separator between the standard Number and the Type. Separators are not needed between the Type, Grade, and Class.³ Provision for Special Notes is included so that other information shall be provided when required. An example would be in Specification D3295 where dimensions and tolerances are specified for each AWG size within Type and Class. When Special Notes are used, they shall be preceded by a comma.

5. Ordering Information

5.1 The molded sheet or basic shapes covered in this specification shall be ordered stating the type, grade, and class and that they meet the requirements of this specification.

6. Materials

6.1 The sheet or molded basic shape from Types I, II, III, or IV shall be made from unpigmented PTFE as free of foreign matter as commercially practical.

7. Requirements

7.1 The sheet covered by this specification shall meet the physical and electrical requirements specified in **Table 1** when tested by the methods given in Section 13.

7.2 The molded basic shapes covered by this specification shall meet the physical and electrical requirements specified in **Table 2** when tested by the test methods given in Section 13.

7.2.1 *Melting Point*—the melting point of all types of sheet and molded basic shapes shall be $327 \pm 10^\circ\text{C}$ when tested in accordance with paragraph 13.8.

8. Dimensions

8.1 The size, shape, dimensional tolerances, and dimensional stability shall be as specified in the contract or order.

8.2 The tolerance on length and width shall be plus 6.3 mm ($\frac{1}{4}$ in.), minus 0 mm (0 in.).

9. Workmanship, Finish, and Appearance

9.1 *Color*—Type I shall be white to translucent. Types II, III, and IV are typically white, but vary to off white or light gray. For Types II, III, and IV occasional small gray, brown, or black spots shall not be considered as cause for rejection.

9.2 *Finish*—The material shall be as free as is commercially practical from surface blisters, wrinkles, cracks and other surface defects that might affect its serviceability. It shall also be commercially free of macroscopic voids, cracks, and foreign inclusions.

TABLE 1 Physical and Electrical Requirements for PTFE Sheets^A

| Types | Tensile Strength ^A (min) psi | Elongation ^A (min) Percent | Dielectric Strength ^B (min) Volts Per Mill | Specific Gravity ^C | Porosity ^D |
|-------|--|--|---|-------------------------------|-----------------------|
| I | 4500 | 300 | 600 | 2.15 to 2.18 ^E | Zero penetration |
| II | 3000 | 225 | 500 | 2.14 to 2.19 | Not required |
| III | 2000 | 150 | 300 | 2.13 to 2.19 | Not required |
| IV | 1300 | 75 | Not required | 2.13 to 2.20 | Not required |

^ASee 13.2.

^BSee 13.3.

^CSee 13.4.

^DSee 13.6.

^EPTFE sheet used for tank lining shall be Type I but shall have a specific gravity of 2.19 to 2.22.

³ See the ASTM *Form and Style Manual*. Available from ASTM International Headquarters.

TABLE 2 Physical and Electrical Requirements for Basic Shapes

| Types | Tensile Strength psi (min) | Elongation % (min) | Dielectric Strength Volts per mil (min) | Specific Gravity |
|-------|-------------------------------|-----------------------|---|------------------|
| I | 4800 | 325 | 1200 | 2.14 to 2.18 |
| II | 3200 | 240 | 850 | 2.14 to 2.19 |
| III | 1500 | 75 | 250 | 2.13 to 2.20 |
| IV | 1500 | 75 | Not required | 2.13 to 2.20 |

9.3 *Internal Defects*—The moldings shall be as free as is commercially practical of microscopic voids, cracks, and foreign inclusions.

10. Sampling

10.1 Sampling shall be statistically adequate to satisfy the requirements of 15.1

11. Number of Tests

11.1 Routine lot inspection tests shall consist of all the tests specified in Table 1, Table 2, or Table 3.

11.2 The tests listed in Table 1 and Table 2, as they apply, are sufficient to establish conformity of the PTFE sheet or basic shapes 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 and 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.

11.3 The properties listed in the Appendix X1 provide additional information. The data shown are informational only and shall not be used for specification purposes.

12. Test Conditions

12.1 *Conditioning of Specimens*—Unless otherwise specified in this specification, the test specimens shall be conditioned in accordance with Procedure A of Practice D618 for a period of at least four h prior to test.

12.2 *Standard Temperature*—Unless otherwise specified, the tests shall be conducted at the standard laboratory temperature of 23°C ± 2°C (73.4°F ± 3.6°F). Since the sheet or molded basic shape does not absorb water, the maintenance of constant humidity during testing is not important.

13. Test Methods

13.1 *Visual and Dimensional Inspection*—Each of the sample PTFE sheets or molded basic shapes selected in accordance with Section 10 shall be visually and dimensionally inspected to verify their compliance with the requirements of the standard.

TABLE 3 Nominal Thickness and Tolerances for PTFE Sheets

| Thickness Inch | Tolerance Inch | Thickness Inch | Tolerance Inch | Thickness Inch | Tolerance Inch |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 1/32 | +0.015 −0.005 | 1/4 | +0.030 −0.015 | 1 1/4 | +0.102 −0.051 |
| 1/16 | +0.015 −0.005 | 3/8 | +0.038 −0.019 | 1 1/2 | +0.118 −0.059 |
| 3/32 | +0.020 −0.005 | 1/2 | +0.046 −0.022 | 1 3/4 | +0.134 −0.067 |
| 1/8 | +0.016 −0.008 | 5/8 | +0.054 −0.027 | 2 | +0.150 −0.075 |
| 5/32 | +0.018 −0.009 | 3/4 | +0.070 −0.035 | Over 2 | +10 % −10 % |
| 3/16 | +0.022 −0.011 | 1 | +0.087 −0.043 | | |

Occasional superficial flaws in PTFE sheet or molded basic shapes shall be interpreted as neither affecting the porosity nor soundness of the molding. Such flaws are scratches, edge cracks, and the adherence of resin flakes. Such indications shall not be cause for rejection.

13.2 *Tensile Strength and Elongation*—Determine the ultimate tensile strength and elongation in accordance with Test Method D638 except as follows:

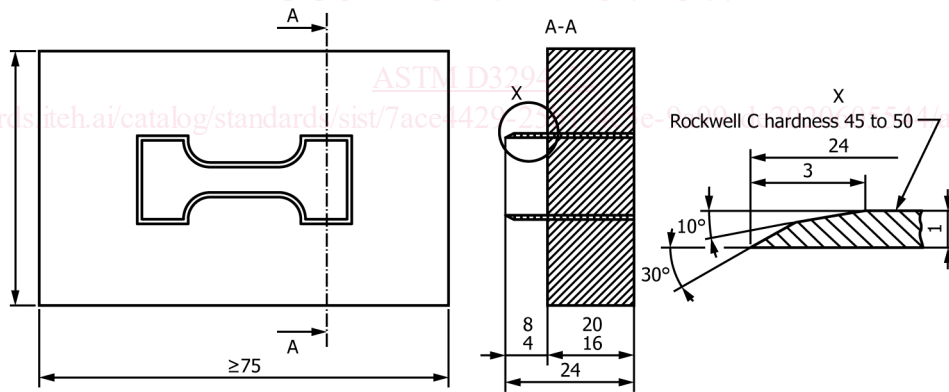
13.2.1 Cut five micro-specimens with the steel rule die and the dimensions shown in Fig. 1 using a hydraulic or mechanical press. When cutting a specimen, back it by a hard surface board such as masonite or equal with a piece of thin cardboard between said hard surface and sample.

13.2.2 Testing shall be at a speed of 50.8 mm (2 in.)/min.

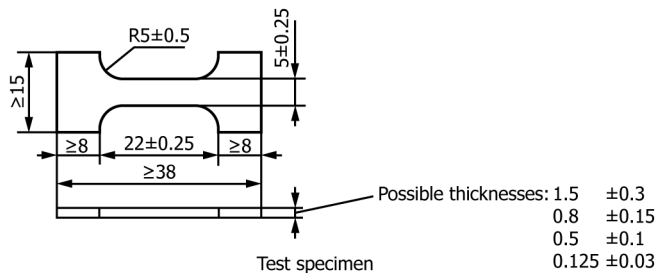
13.2.3 Determine elongation by using an initial jaw separation of 22.2 mm (0.875 in.) and expressed as a percentage of the initial jaw separation.

13.2.4 *Alternative Specimens*—When the shape of the sample does not permit making the micro-specimen as specified in 13.2.1 prepare specimens by turning a 0.8-mm ($\frac{1}{32}$ -in.) thick-walled tube from the shape, and cutting dumbbells from the tube wall in a direction perpendicular to the applied molding pressure, that is, with the long axis of the dumbbell parallel to the circumference of the tube. Lathe-turn the tube in such a manner that the specimen is taken from the center of the original wall thickness. In the case of a rod, remove the outer 1.6 mm ($\frac{1}{16}$ in.) before finish turning the outer diameter of the tube. Turn both inside and outside surfaces with a fine lathe feed and sharp tools to permit the smoothest possible finish.

13.2.5 Cut sheets 1.6 mm ($\frac{1}{16}$ in.) or under in thickness, five micro-specimens with the steel rule die and the dimensions shown in Fig. 1 using a hydraulic or mechanical press. Machine sheets thicker than 1.6 mm ($\frac{1}{16}$ in.) and thinner than 15.9 mm ($\frac{5}{8}$ in.) to a thickness of 1.6 ± 0.25 mm ($\frac{1}{16} \pm 0.010$ in.) and five specimens from these reduced portions. From sheets 15.9 mm ($\frac{5}{8}$ in.) and over in thickness, a slice somewhat thicker than 1.6 mm ($\frac{1}{16}$ in.) shall be cut from one edge but not less than 12.7 mm ($\frac{1}{2}$ in.) distance from that edge and both faces machined to a thickness of 1.6 ± 0.25 mm ($\frac{1}{16} \pm 0.010$ in.). In all cases of specimens reduced to 1.6 mm ($\frac{1}{16}$ in.) by machining, tool marks shall be removed by light sanding in a longitudinal direction.



Steel-rule die
(inside dimensions for die are the same as test specimen)
Die to be sharpened on outside edge only (as shown in A-A)



NOTE 1—Dimensions in millimetres.

FIG. 1 Microtensile Die—ISO