



Designation: D 3159 – 04

Standard Specification for Modified ETFE-Fluoropolymer Molding and Extrusion Materials¹

This standard is issued under the fixed designation D 3159; 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 melt processible molding and extrusion materials of modified ETFE-fluoropolymer. The ETFE resin is a copolymer of ethylene containing approximately 75 mass % of tetrafluoroethylene.

1.2 The values stated in SI units as detailed in IEEE/ASTM SI-10 are to be regarded as the standard. The values given in brackets are for information only.

NOTE 1—Although this specification and ISO 12086-1 (1994) and ISO 12086-2 (1994) differ in approach or detail, data obtained using either are technically equivalent.

1.3 The following safety hazards caveat pertains only to the test method portion, Section 11, 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.*

1.4 Recycled material is not appropriate for this specification because performance requirements cannot be met with recycled material. Therefore, this specification is for virgin material only.

2. Referenced Documents

2.1 ASTM Standards:²

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D 618 Practice for Conditioning Plastics for Testing

D 638 Test Method for Tensile Properties of 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.

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

D 883 Terminology Relating to Plastics

D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D 1600 Terminology for Abbreviated Terms Relating to Plastics

D 3418 Test Method for Transition Temperatures of Polymers by Differential Scanning Calorimetry

D 3892 Practice for Packaging/Packing of Plastics

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

SI 10 Use of the International System of Units (SI): The Modern Metric System

2.2 ISO Standards:

ISO 12086-1 (1994) Plastics—Fluoropolymer Dispersions and Moulding and Extrusion Materials—Part 1

ISO 12086-2 (1994) Plastics—Fluoropolymer Dispersions and Moulding and Extrusion Materials—Part 2

3. Terminology

3.1 Definitions:

3.1.1 *General*—The terminology given in Terminology D 883 is applicable to this specification.

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

3.1.3 Abbreviated Terms:

3.1.4 *General*—The abbreviated terms given in Terminology D 1600 are applicable to this specification.

4. Classification

4.1 This specification covers four types of modified ETFE-fluoropolymer supplied in pellet form classified according to their specific gravity. The resins of each type are divided into one to three grades according to their melt flow rate.

4.2 An 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 as follows:

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

Specification				
Standard Number	Type	Grade	Special Block	Notes
:	:	:	:	:

Example: Specification D 3159 – 95, I 2

For this example, the line callout would be, Specification D 3159 – 95,I2 and would specify a modified ETFE-fluoropolymer that has all of the properties listed for that type and grade in the appropriate specified properties, or 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 and grade.³ Provision for special notes is included so that other information can be provided when required. An example would be in Specification D 3295 where dimensions and tolerances are specified for each AWG size within the type and class. When special notes are used, they shall be preceded by a comma.

TABLE 1 Specific Gravity, Melting Point, and Flow Rate Requirements

Type Grade	I			II		III		IV
	1	2	3	1	2	1	2	1
Specific gravity, min:	1.69	1.69	1.69	1.75	1.75	1.83	1.83	1.74
Specific gravity, max:	1.76	1.76	1.76	1.84	1.84	1.88	1.88	1.78
Melting point, °C, min:	255	255	250	220	220	220	220	220
Melting point, °C, max:	280	280	280	255	255	230	230	240
Flow rate, g/10 min, min:	2.0	8.0	25	2.0	10.1	9.0	25.0	10
Flow rate, g/10 min, max:	16.0	28.0 ^A	45	10.0	19.0	18.0	35.0	40

^A Measured with 1.588-mm [0.0625-in.] orifice; other values measured with 2.095-mm [0.0825-in.] orifice.

TABLE 2 Detail Requirements for Molded Test Specimens for All Resins in This Specification

Type Grade	I			II		III		IV
	1	2	3	1	2	1	2	1
Tensile strength, min, psi:	5500	4400	5500	4500	4500	4000	4000	5000
Elongation, min, %:	275	200	300	300	300	350	350	350
Dielectric constant, 10 ³ Hz, max:	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Dielectric constant, 10 ⁶ Hz, max:	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Dissipation factor, 10 ³ Hz, max:	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
Dissipation factor, 10 ⁶ Hz, max:	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009

5. General Requirements

5.1 The material shall be of uniform composition and so prepared as to conform to the requirements of this specification.

5.2 The material described in this specification shall be free of foreign matter to such a contamination level as shall be agreed upon between the purchaser and the seller.

6. Performance Requirements

6.1 The average test result of the lot shall conform to the requirements prescribed in Tables 1 and 2 when tested by the

procedures specified herein. Table 2 lists those tests requiring a specimen molded as described in Section 8.

7. Sampling

7.1 The materials shall be sampled in accordance with an adequate statistical sampling program.

8. Specimen Preparation

8.1 Prepare a molded sheet 1.5 ± 0.3 mm [0.06 ± 0.01 in.] thick. Use a picture-frame-type chase having a suitable blanked-out section and thickness to produce the desired sheet. Use clean aluminum foil, 0.13 to 0.18 mm [0.005 to 0.007 in.] thick, in contact with the resin. A high-temperature mold release agent may be sprayed on the aluminum foil to help prevent the foil from sticking to the sheet. Use steel molding plates at least 1.0 mm [0.040 in.] thick and of an area adequate to cover the chase.

8.2 Lay down and smoothly cover one plate with a sheet of aluminum foil. Place the mold chase on top of this assembly. Place within the mold chase sufficient molding material to produce the required sheet in such manner that the polymer charge is a mound in the middle of the chase. Place a second sheet of aluminum foil on top of the granules and add the top mold plate. Place the assembly in a compression molding press having platens that have been heated to $300 \pm 5^\circ\text{C}$ [$572 \pm 10^\circ\text{F}$].

8.3 Bring the press platens to incipient contact with the mold assembly. Hold for 2 to 4 min without pressure. Apply approximately 1 MPa [145 psi] and hold for 1 to 1.5 min. Then apply 2 to 4 MPa [290 to 580 psi] and hold for 1 to 1.5 min. Maintain the press at $300 \pm 5^\circ\text{C}$ [$572 \pm 10^\circ\text{F}$] during these steps. Remove the assembly from the press and place between

two 20 ± 7 -mm [0.75 ± 0.25 -in.] steel plates whose temperature is less than 40°C [104°F].

8.4 When the sheet is cool enough to touch (about 50 to 60°C [122 to 140°F]), remove aluminum foil from the sheet. (If the sheet is allowed to cool to room temperature, the aluminum foil cannot be pulled free.)

9. Conditioning

9.1 For tests of specific gravity, tensile properties, and electrical properties, condition the molded test specimen in accordance with Practice D 618, Condition 4/23/50. The other tests require no conditioning.

9.2 Conduct tests at the standard laboratory temperature of $23 \pm 2^\circ\text{C}$ [$73.4 \pm 3.6^\circ\text{F}$] for determination of specific gravity,

³ See the ASTM *Form and Style Manual*, available from ASTM Headquarters.