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Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials[1]

This standard is issued under the fixed designation D3222; 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 U.S. Department of Defense.

1. Scope

1.1 This specification covers melt processable molding and extrusion materials, as well as coating materials of poly(vinylidene fluoride) fluoroplastic, commonly abbreviated PVDF (or PVF_2 in scientific literature). This specification covers thermoplastic resin materials supplied in pellet or powder form.

1.2 This specification applies only to the virgin homopolymer prepared from vinylidene fluoride, not copolymers, reinforced, filled grades or special grades with additives or treatments for modification of attributes.

1.3 The tests involved are intended to provide information for specification of unmodified PVDF homopolymer resins. It is not the purpose of this specification to provide engineering data for design purposes.

1.4 PVDF fluoroplastics melt between 156 and 180°C (312 and 356°F) and are thermally stable up to about 370°C (698°F). (**Warning—**Evolution of corrosive and toxic hydrogen fluoride can occur under certain conditions.)

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

NOTE 1—PVDF exhibits polymorphism.[2] The type and extent of crystalline structure varies with the thermomechanical history of the sample. Specimens prepared by techniques different than prescribed in this specification can have properties that vary from the values specified.

1.6 *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.* Specific precautionary statements are given in Section 10.

NOTE 2—There is no equivalent ISO standard for this specification. Information in this specification is technically equivalent to related information in ISO 12086-1 and ISO 12086-2.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
D257 Test Methods for DC Resistance or Conductance of Insulating Materials
D542 Test Method for Index of Refraction of Transparent Organic Plastics
D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

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[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. Current edition approved ~~Nov. 1, 2010~~May 1, 2015. Published ~~March 2011~~June 2015. Originally approved in 1973. Last previous edition approved in ~~2005~~2010 as ~~D3222 - 05.~~D3222 - 05(2010). DOI: ~~10.1520/D3222-05R10.~~10.1520/D3222-05R15.

[2] Lovinger, A. J., "Poly(Vinylidene Fluoride)" *Developments in Crystalline Polymers*, Vol 1, Chapter 5, D. C. Bassett, Ed., Applied Science, London, 1982.

[3] 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.

TABLE 1 Classification of PVDF Resins

Property		Typical Values or Ranges		
		Type I		Type II
		Grade 1	Grade 2	
Specific Gravity	Gms/cc	1.75-1.79	1.75-1.79	1.76-1.79
Peak Melting Endotherm	°C	156-162	162-170	164-180
Melt Flow Rate	g/10 min (wt in Kg)			
	Ultra High Viscosity	...	...	0.5-10[A]
	High Viscosity	0.5-8[A]	5-8[B]	0.5-10[C]
	Medium Viscosity	4-18[A]	5-36[B]	0.5-30[D]
	Low Viscosity	...	3.5-45[E]	0.5-60[F]
Apparent Melt Viscosity	Pa's:[G]			
	High Viscosity	2800-3800	2800-3700	2500-4000
	Medium Viscosity	2300-2800	1300-2800	1300-2500
	Low Viscosity	...	350-1300	250-1300

Note: For measuring MFR values of PVDF, the load must be selected based on the viscosity as follows:

[A] = 21.6 Kg
[B] = 12.5 Kg
[C] = 10.0 Kg
[D] = 5 Kg
[E] = 3.8 Kg
[F] = 2.16 Kg
[G] Reported for a shear rate of 100 s^{-1} determined by capillary rheometry at 232°C (450°F) using 0.027 radian (60°) entrance angle die with L/D of 15 and in accordance with procedures of Test Method D3835. Multiply the pascal second values by ten to obtain poise values.

D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
D3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer
D3892 Practice for Packaging/Packing of Plastics
IEEE/ASTM S-10 Use of the International System of Units (SI): The Modern Metric System

2.2 *IEC and ISO Standards:*

ISO 12086-1 Plastics—Fluoropolymer Dispersion and Moulding and Extrusion Materials—Part 1: Designation and Basis for Specification[4]
ISO 12086-2 Plastics—Fluoropolymer Dispersion and Molding and Extrusion Materials—Part 2: Preparation of Test Specimens and Determination of Properties[4]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of plastics terms used in this specification, see Terminology D883.

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

4. Classification

4.1 This specification covers two types[5] of natural, unmodified PVDF fluoroplastics supplied in pellet form for molding and extrusion, and in powder form for solutions, dispersions, or coatings.

4.1.1 *Type I*—PVDF fluoroplastics are polymerized in emulsion. Depending upon the polymerization conditions, the peak melting point of the resin can be varied between 156 and 170°C. The diameter of the primary particle isolated from the emulsion is typically less than 1 µm; the dried powder has an average agglomerate diameter range of 3 to 15 µm.

4.1.1.1 Two distinctly different Type I emulsion PVDF resins are available commercially. These are differentiated by peak melting endotherm values, as shown in Table 1, and this difference is the basis for subdividing Type I resins into Grades 1 and 2. Table 1 shows the melt viscosity ranges encompassing resin grades available from several sources and are provided for information purposes only.

4.1.2 *Type II*—PVDF fluoroplastics are polymerized in suspension. Peak melting temperatures of these resins range from 164 to 180°C. The particles isolated from suspension are spherical and range typically from 20 to 150 µm in diameter.

4.1.2.1 Type II resins are available commercially, and the data of Table 1 reflect ranges encompassing values typical for the properties of available grades.

4.2 The system uses predefined cells to refer to specific aspects of this specification, as illustrated below.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[5] Dohany, J. E., and Robb, L. E., "Poly(Vinylidene Fluoride)" *Kirk-Othmer Encyclopedia of Chemical Technology*, Vol 11, 3rd Edition, 1980, pp. 64–74.