



Standard Specification for Extruded and Compression Molded Shapes Made from Poly(Vinylidene Fluoride) (PVDF)¹

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1. Scope

1.1 This specification covers the requirements and test methods for the material, dimensions, and workmanship, and the properties of extruded sheet, rod and tubular bar manufactured from PVDF.

1.2 The properties included in this specification are those required for the compositions covered. Requirements necessary to identify particular characteristics important to specialized applications may be described by using the classification system given in Section 4.

1.3 This specification allows for the use of recycled plastics (as defined in Guide D 5033).

1.4 The values stated in English units are to be regarded as the standard in all property and dimensional tables. For reference purposes, SI units are also included in Tables X and S-PVDF only.

1.5 The following precautionary caveat pertains only to the test method portions 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 requirements prior to use.*

NOTE 1—There is no similar or equivalent ISO standard. ISO 12086-1 and ISO 12086-2 have pertinent information.

2. Referenced Documents

2.1 ASTM Standards:

D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics²

D 638 Test Method for Tensile Properties of Plastics²

D 790 Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials²

D 883 Terminology Relating to Plastics²

D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding and Extrusion and Coating Materials³

D 3892 Practice for Packaging/Packing of Plastics³

D 4000 Classification System for Specifying Plastics Materials³

D 5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics⁴

2.2 ANSI Standard:⁵

Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes

3. Terminology

3.1 Definitions:

3.1.1 *regrind (plastic), n*—a product or scrap such as sprues and runners that have been reclaimed by shredding and granulating for use in-house. **D 5033**

3.1.2 For definitions of other technical terms pertaining to plastics used in this specification, see Terminology D 883 or Guide D 5033.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *recycled-plastic shape, n*—a product made from up to 100 % post-consumer material.

3.2.2 *rod, n*—an extruded solid cylindrical shape with a minimum diameter of $\frac{1}{16}$ in.

3.2.3 *sheet, n*—flat stock greater than and including 0.010 in. thickness.

3.2.4 *tubular bar, n*—extruded annular shapes with minimum inside diameter of $\frac{1}{16}$ in., and a minimum wall of $\frac{1}{4}$ in.

3.2.5 *unmodified virgin plastic shape, n*—a product produced from virgin plastic, as furnished by a manufacturer, with no additives or processing aids.

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.20 on Plastic Products (Section D20.20.02).

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² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 08.02.

⁴ *Annual Book of ASTM Standards*, Vol 08.03.

⁵ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

4. Classification and Material

4.1 Product shape and size as defined in the applicable purchase order.

4.2 This specification covers product extruded and compression molded as listed in Table S-PVDF. Products included in the designations reference Specification D 3222 callouts where applicable.

4.2.1 The type of PVDF shape product may be categorized by type, grade and class depending on resin and filler compositions as defined in Table S-PVDF.

4.2.2 Each type of shape may be categorized into one of several grades as follows:

4.2.2.1 *Grade 1—Unmodified Virgin*—Extruded or compression molded product made using only 100 % virgin PVDF material.

4.2.2.2 *Grade 2—General Purpose*—Extruded or compression molded product made using up to 20 % PVDF regrind developed during internal processing steps may be used.

4.2.2.3 *Grade 3—Recycled*—Extruded or compression molded product made using up to 100 % recycled PVDF resin.

4.3 The type, class and grade is further differentiated based on dimensional stability (elevated temperature excursion test), Table S-PVDF, and dimensional requirements, Tables A and B.

4.4 Property Tables:

4.4.1 Table S-PVDF may be used to describe both extruded or compression molded products.

4.4.2 Table X may also be used to describe both extruded or compression molded products not included in Table S-PVDF via a cell callout that includes the applicable Table S-PVDF type and specific properties (Designations 1-7).

4.4.3 To facilitate the incorporation of future or special materials not covered by Table S-PVDF, the “as specified” category (00) for type, class and grade is shown in the table with the basic properties to be obtained from Table X, as they apply.

4.4.4 *Reinforcements and Additive Materials*—A symbol (single-letter) will be used for the major reinforcement or combination, or both, along with two numbers that indicate the percentage of addition by mass with the tolerance as tabulated below. This must be included in all Table X callouts.

Symbol	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber reinforced	±2 %
G	Glass-reinforced	
	<15 % glass content	±2 %
	>15 % glass content	±3 %
L	Lubricants (for example, PTFE, graphite, and silicone)	by agreement between the supplier and the user
M	Mineral	±2 %
R	Combinations of reinforcements or fillers, or both	±3 % for the total reinforcement

4.5 *Callout Designation*—A one-line system shall be used to specify PVDF materials covered by this specification. The system uses predefined cells to refer to specific aspects of this specification as illustrated below:

4.5.1 Examples:

4.5.1.1 *Example 1*—Product made from unfilled virgin PVDF:

CELL CALLOUT: S-PVDF0111

where:

S-PVDF01 = product made from PVDF in accordance with Table S-PVDF,

1 = unfilled virgin class, and

1 = general purpose grade product.

4.5.1.2 *Example 2*—Product made from 10 % carbon fiber blended with unmodified virgin PVDF resin:

CELL CALLOUT: S-PVDF0100C10X3454430

where:

S-PVDF0100 = product made from PVDF in accordance with Table S-PVDF,

C10 = 10 % carbon fiber,

X = Table X properties,

3 = tensile strength (10,000 psi),

4 = elongation at break (10 %),

5 = tensile modulus (500,000 psi),

4 = dimensional stability (0.4 %),

4 = flexural modulus (550,000 psi),

3 = Izod impact (1.0 ft-lb/in of notch), and

0 = unspecified.

4.5.2 These two examples illustrate how an on-line, alphanumeric sequence can identify the product composition, commercial parameters and physical characteristics of extruded or compression molded product. A space must be used as a separator between the specification number and the type designation. No separators are needed between type, class and grade. When special notes are to be included, such information should be preceded by a comma. Special tolerances must be noted at the time of order and are inserted after the grade in parenthesis and preceded by a comma.

5. Property Requirements

5.1 The physical property values listed within this specification’s tables are to be considered minimum specification values. Any requirement for specific test data for a given production lot should be specified at the time of order. Physical properties for products not yet included in Table S-PVDF may be specified using Table X for extruded or compression molded products.

6. Dimensional Requirements

6.1 The type, class and grade is differentiated based on dimensional stability (elevated temperature excursion test), Table S-PVDF and dimensional requirements, Tables A and B. Products shall be produced within commercial tolerances and with the lowest stress levels for machined parts as delineated in Tables A and B for extruded and compression molded products.

6.2 Tubular bar dimensions shall be supplied in the unfinished condition, unless otherwise specified at time of order sufficient to finish to the nominal dimension ordered.

6.3 The maximum allowable camber or bow, or both, shall be within the limits referenced in Tables A and B.

7. Workmanship, Finish and Appearance

7.1 *Appearance*—The color of products shall be as published by the shapes manufacturer. They shall be uniform in color throughout the thickness. Specific colors and color-matching only agreed to by order. Physical properties may be affected by colors.

7.2 *Finish*—All products shall be free of blisters, wrinkles, cracks, gouges and defects that restrict commercial use of the product. A special surface finish shall be supplied only when specified in the purchase order or contact.

7.3 *Defects*—All products shall be free of voids, dirt, foreign material and embedded particles exceeding $\frac{1}{32}$ in. maximum diameter as defined in 7.3.1.

7.3.1 The criteria for determining internal cleanliness shall be external visual inspection. A maximum number of two internal defects per square foot of sheet and one foot length of rod and tubular bar shall be allowed. Clusters of defects less than $\frac{1}{32}$ in. diameter are to be counted as a single defect.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of this specification as applicable (see ANSI Z1.4-1993).

8.2 For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same type, class, grade, and nominal size submitted for inspection at one time.

9. Number of Tests

9.1 Routine lot inspection shall consist of all criteria specified in the applicable product tables.

9.2 The criteria listed in these product tables and definitions are sufficient to establish conformity of the sheet, rod or tubular bars to this specification. When the number of test specimens is not stated in the test method, a single determination may be made. If more than single determinations and separate portions of the same sample are made, the results shall be averaged. The final result shall conform to the requirements prescribed in this specification.

10. Test Conditions

10.1 *Conditioning of Specimens*—The specification values and dimensions are based on conditioning techniques outlined in Procedure A of Practice D 618.

10.2 *Standard Temperature*—The tests shall be conducted at the standard laboratory temperature of $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity.

11. Test Methods

11.1 Test tensile strength at break, and tensile modulus (tangent) in accordance with Test Method D 638, at the rate of 0.2 in./min.

11.1.1 Test all plate specimens in accordance with Type I of Test Method D 638.

11.1.2 Test all rod specimens in accordance with Test Method D 638.

11.2 *Dimensional Stability:*

11.2.1 *Specimen Preparation (A Minimum of Three Test Samples Required).*

11.2.1.1 *Rods and Tubular Bar*—Prepare each specimen by cutting a 1.5 in. long slice using a coolant and good machining practices to a length of 1.000 ± 0.005 in. Each end of the specimen shall have machined surfaces.

11.2.1.2 *Plate*—Each specimen shall consist of a 2 in. diameter disc machined from the flat (diameter shall equal test

specimen thickness with a minimum of 2.0 in.). The same care shall be used in the machining as described in 11.2.1.1. The thickness of the specimen shall be that of the original flat from which it was cut, no machining being done on the top or bottom faces.

11.2.2 *Testing Procedure*—Measure the outside diameter and thickness of the specimen as applicable at $73.4 \pm 1.8^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$) to the nearest 0.0001 in. All measurements shall be done on the centerline and 90 degrees from the centerline for plate. Also take measurements for thickness halfway to center, and for diameter at mid-point. Place the specimen in a bath consisting of polyalkene glycol or an air circulating oven heated to $280 \pm 5^\circ\text{F}$ ($121 \pm 3^\circ\text{C}$). After 6 h, allow the specimen to slowly cool to room temperature at a rate not to exceed 40°F (22°C)/h. Measure the specimen at $73.4 \pm 1.8^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$) and calculate the percent change in each dimension.

11.3 *Lengthwise Camber and Widthwise Bow:*

11.3.1 Make all measurements for camber and bow using the maximum distance rod, sheet or plate deviates from the straight line extended from edge to edge when measured in accordance with 11.3.2. The shape shall be oriented such that the weight of the product does not influence the results.

11.3.2 *Rod and Plate:*

11.3.2.1 *Rod*—Lay rod on its side and measure it with concave side facing a straight edge. Measure camber from the straight edge to the maximum concave point on the rod. Camber may not exceed the values of Table A.

11.3.2.2 *Plate*—Plate shall not exceed the requirements of Table B on the lengthwise ends and widthwise edges when laid on a flat surface (crown side up).

11.4 *Squareness (Based on a 4 ft Nominal Length):*

11.4.1 Measure and compare diagonal lengths (corner to corner). Accept the product if the difference is $\frac{1}{16}$ in. or less and the measured minimums diagonal meets the following requirements:

11.4.1.1 1 ft wide is $49\frac{1}{2}$ in. minimum.

11.4.1.2 2 ft wide is $53\frac{3}{4}$ in. minimum.

11.4.1.3 4 ft wide is 68 in. minimum.

11.4.2 If the diagonal difference exceeds $\frac{1}{16}$ in., proceed to measure the gap (that is, the deviation from a 2 ft square). The maximum allowable gap shall not exceed $\frac{1}{8}$ in. except for the 1 ft wide sizes of sheet and plate which should not exceed $\frac{1}{16}$ in.

11.5 Test flexural modulus in accordance with Test Method D 790, specimen $\frac{1}{4}$ in. thick maximum, testing speed 0.11 in./min.

11.6 Test Izod impact in accordance with Test Method D 256, Method A, Fig 4, notched, $\frac{1}{4}$ in. thick maximum specimen.

12. Certification

12.1 When requested at the time of order, the purchaser shall be furnished a certification that the lot is made from the required PVDF plastic (percent recycle, if applicable) and meets the requirements of this specification.

13. Packing, Packaging and Package Materials

13.1 All packing, packaging and marking provisions of Practice D 3892 shall apply to this specification.

14. Ordering Information

14.1 All shapes covered by this specification shall be ordered using the proper callout designation (see 4.5).

15. Keywords

15.1 fluoropolymers, poly(vinylidene fluoride); plates; poly(vinylidene fluoride); PVDF; recycled plastic, poly(vinylidene fluoride); rod; shapes, poly(vinylidene fluoride); tubular bar, poly(vinylidene fluoride)

TABLE S-PVDF Requirements for Poly(Vinylidene Fluoride) (PVDF) Shapes

Type	Description	Class	Description	Grade	Resin Type ^A	Description	Ultimate Tensile Strength, min, psi (MPa)	Tensile Elongation % at break, min	Tensile Modulus, min, psi (MPa)	Dimensional Stability, max, %	
01	PVDF	1	Unfilled	1	Type I Class 1	Unmodified virgin	6500 (45)	25	240 000 (1655)	0.4	
					2	As specified ^B	General purpose	...	...	...	...
					3	As specified ^B	Recycled	...	...	...	...
					0	As specified ^B	As specified	...	...	...	...
					0	As specified ^C	As specified	...	...	...	...
00	Other PVDFs	0	As specified	0	As specified ^C	As specified	...	...	...	...
					1	As specified ^B	General purpose	...	...	...	...
					2	As specified ^B	Recycled	...	...	...	...
					0	As specified ^C	As specified	...	...	...	...
					0	As specified ^C	As specified	...	...	...	...

^A In accordance with Specification D 3222.

^B Applicable Specification D 3222 resin type to be specified on purchase order.

^C Alphanumeric sequence indicating filler type and quantity must precede Table X callouts for modified products (see 4.4.4).

TABLE A Dimensional Requirements for Poly(Vinylidene Fluoride) (PVDF) Rods^A

Size, in.	Diameter Tolerance, in.	Roundness TIR, in.	Camber, in./ft
1/8 to 7/8	+0.002/-0.001	0.002	2 1/2 / 8
1	+0.005/-0	0.002	1 1/4 / 8
1 1/8 to 1 1/4	+0.005/-0	0.004	1 1/4 / 8
1 3/8 to 1 7/8	+0.005/-0	0.005	1 1/4 / 8
2	+0.005/-0	0.010	1 1/4 / 8
2 1/8 to 2 1/2	+0.030/-0	0.025	1 1/4 / 8
2 5/8 to 6	+0.250/-0	0.050	1/4 / 4

^A To convert inches to millimetres multiply by 25.4.

TABLE B Dimensional Requirements for Poly(Vinylidene Fluoride) (PVDF) Sheets and Plates^A

Size, in.	Thickness Tolerances, in.	Length Camber, in./ft	Width Bow, in./ft
0.010 to 0.188	± 10%	3/4 / 4	3/16 / 2
1/4 to 2	+0.025/-0	3/4 / 4	3/16 / 2
2 1/8 to 3	+0.050/-0	1/4 / 4	1/16 / 2
3 1/8 and over	+0.050/-0	1/4 / 4	1/16 / 1

^A To convert inches to millimetres multiply by 25.4.

TABLE X Additional Detail Requirements—Reinforced/Unreinforced Extruded and Compression Molded Poly(Vinylidene Fluoride)

NOTE—The applicable table polycarbonate type (including fillers in accordance with 4.4.4) must precede this table designation.

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, Test Method D 638, min, psi (MPa)	Unspecified	6000 (41)	8000 (55)	10 000 (69)	12 000 (83)	14 000 (97)	16 000 (110)	20 000 (138)	25 000 (172)	Specify value
2	Elongation at Break Test Method D 638, %, min	Unspecified	1	3	5	10	20	50	100	200	Specify value
3	Tensile Modulus, min, Test Method D 638 min, psi (MPa)	Unspecified	100 000 (690)	200 000 (1379)	300 000 (2073)	400 000 (2760)	500 000 (3448)	600 000 (4137)	800 000 (5516)	1 000 000 (6895)	Specify value
4	Dimensional Stability, % max, per 11.2	Unspecified	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.5	Specify value
5	Flexural Modulus, Test Method D 790, min, psi (MPa)	Unspecified	250 000 (1649)	350 000 (2400)	450 000 (3100)	550 000 (3792)	650 000 (4482)	750 000 (5171)	1 000 000 (6895)	1 500 000 (10 343)	Specify value
6	Izod impact, Test Method D 256, min ft-lb/in. of notch (J/m of notch)	Unspecified	0.5 (27)	0.75 (40)	1.0 (53)	2.5 (133)	5.0 (266)	10.0 (533)	15.0 (800)	18.0 (960)	Specify value

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
7	To be determined	Unspecified

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