Designation: D7293 – 12

Standard Specification for Extruded and Compression-Molded Shapes Made from Polyetherimide (PEI)[1]

This standard is issued under the fixed designation D7293; 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.

INTRODUCTION

This specification is intended to be a means of calling out plastic shapes used in the fabrication of end items or parts.

1. Scope*

1.1 This specification covers requirements and test methods for the dimensions, workmanship, and the properties of extruded and compression-molded sheet, plate, rod and tubular bar manufactured from polyetherimide (PEI) resins.

1.2 The properties included in this specification are those required for the compositions covered. It is possible that other requirements will be necessary to identify particular characteristics important to specialized applications. These shall be specified by using the suffixes as given in Section 5.

1.3 This specification does not allow for the use of recycled plastics (as defined in Guide D7209).

1.4 The values stated in English units are regarded as standard in all property and dimensional tables. For reference purposes, SI units are also included in Table 1 and Table S-PEI.

1.5 *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.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of 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

D883 Terminology Relating to Plastics

D3892 Practice for Packaging/Packing of Plastics

D4000 Classification System for Specifying Plastic Materials

D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products

D5205 Classification System and Basis for Specification for Polyetherimide (PEI) Materials

IEEE/ASTM SI-10 American National Standard for Use of the International System of Units (SI): The Modern Metric System

2.2 *ANSI Standard:*[3]

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

3. Terminology

3.1 *Definitions*—For definitions of other technical terms pertaining to plastics used in this specification, see Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *rod, n*—extruded solid cylindrical shape with a minimum diameter of 1/16 in. (1.6 mm).

3.2.2 *sheet, n*—flat stock with thickness greater than 1/4-in. (6.4-mm).

3.2.3 *tubular bar, n*—extruded annular shapes with minimum inside diameter of 3/8 in. (0.5 mm) and minimum wall thickness of 1/16 in. (1.6 mm).

[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.

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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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

4. Classification

4.1 This specification covers shapes extruded and compression molded from polyetherimide (PEI) resins as listed in Table S-PEI. The PEI resin is included in the designation using Specification D5205 callout.

4.1.1 The type of PEI extruded shape shall be categorized by composition.

4.1.2 There shall be only one class of PEI shape, for virgin products.

4.1.2.1 *Class 1*—General purpose product made using 100 % virgin resin.

4.2 The type and class shall be further differentiated based on dimensional tolerances and dimensional stability (based on elevated temperature excursion testing). Grades 1 and 2 shapes are produced with the closest commercial tolerances and lowest stress levels for machined parts as delineated in Table A and Table B. Any additional or custom tolerance requirements are to be specified. Custom tolerances shall be noted following the grade designation.

TABLE S-PEI Requirements for PEI Shapes, Dry-as-Manufactured (<0.2 % Moisture)

Type	Description	Class	Description	Grade	Applicable D5205 Callout[A]	Description	Ultimate Tensile Strength, min, psi (MPa)	Tensile Elongation, % at Break, min	Tensile Modulus, min, psi (MPa)	Dimensional Stability, %, max
01		1	Unfilled	1	D5205 PEI 0113	General purpose	14 000 (97)	50	425 000 (2930)	0.4
		1	Unfilled	0		Other				
02	Glass filled	1	10 % glass reinforced	1	...	General purpose	14 500 (100)	2	500 000 (3447)	0.4
	Glass filled	1	20 % glass reinforced	2	...	General purpose	15 000 (103)	2	600 000 (4137)	0.4
	Glass filled	1	30 % glass reinforced	3	D5205 PEI0110[B]	General purpose	16 000 (110)	2	800 000 (5516)	0.4
	Glass filled	1	Glass reinforced	0		Other				
00	Other	1	Other	0		Other				

[A] Applicable Classification System D5205 resin type to be specified on purchase order.
[B] G30A99169

TABLE A Dimensional Requirements for Natural and Glass-Filled Extruded PEI Rod[A]

Size, in.[B]	Diameter Tolerance, in.	Roundness TIR, in.	Camber, in./ft
1/16	+0.002–0.001	0.002	2½ /8
1/8	+0.002–0.001	0.002	2½ /8
3/16	+0.002–0.001	0.002	2½ /8
1/4	+0.003–0.001	0.002	2½ /8
3/8	+0.003–0.001	0.002	2½ /8
1/2	+0.003–0.001	0.002	2½ /8
5/8	+0.003–0.001	0.002	2½ /8
3/4	+0.003–0.001	0.002	2½ /8
7/8	+0.003–0.001	0.002	2½ /8
1	+0.003–0.001	0.002	1¼ /8
1 1/8	+0.005–0.000	0.005	1¼ /8
1 1/4	+0.005–0.000	0.005	1¼ /8
1 3/8	+0.005–0.000	0.005	1¼ /8
1 1/2	+0.005–0.000	0.005	1¼ /8
1 5/8	+0.005–0.000	0.005	1¼ /8
1 3/4	+0.005–0.000	0.005	1¼ /8
1 7/8	+0.005–0.000	0.005	1¼ /8
2	+0.005–0.000	0.010	1¼ /8
2 1/8 –2 3/4	+0.005–0.000	0.030	1¼ /8
3	+0.250–0.000	0.060	1/4/4

[A] Based on dry-as-manufactured condition and proper product storage and handling.
[B] To convert inches to millimetres, multiply by 25.40.

TABLE B Dimensional Requirements for Natural and Glass-Filled Extruded and Compression-Molded PEI Sheets and Plates (Squareness Requirement Listed in 11.4)[A]

Size, in.[B,C]	Thickness Tolerances, in.	Length Camber, in./ft	Width Bow, in./ft
1/16	±0.005	3/4 /4	3/16 /2
3/32	±0.005	3/4 /4	3/16 /2
1/8	+0.025–0.000	3/4 /4	3/16 /2
3/16	+0.025–0.000	3/4 /4	3/16 /2
1/4	+0.025–0.000	3/4 /4	3/16 /2
5/16	+0.025–0.000	3/4 /4	3/16 /2
3/8	+0.025–0.000	3/4 /4	3/16 /2
7/16	+0.025–0.000	3/4 /4	3/16 /2
1/2	+0.025–0.000	3/4 /4	3/16 /2
5/8	+0.025–0.000	3/4 /4	3/16 /2
3/4	+0.025–0.000	3/4 /4	3/16 /2
7/8	+0.025–0.000	3/4 /4	3/16 /2
1	+0.025–0.000	1/4 /4	1/16 /2
1 1/8	+0.025–0.000	1/4 /4	1/16 /2
1 1/4	+0.025–0.000	1/4 /4	1/16 /2
1 3/8	+0.025–0.000	1/4 /4	1/16 /2
1 1/2	+0.025–0.000	1/4 /4	1/16 /2
1 5/8	+0.025–0.000	1/4 /4	1/16 /2
1 3/4	+0.025–0.000	1/4 /4	1/16 /2
1 7/8	+0.250–0.000	1/4 /4	1/16 /2
2	+0.025–0.000	1/4 /4	1/16 /2
Over 2	+0.125–0.000	1/4 /4	1/16 /2

[A]Based on dry-as-manufactured condition and proper product storage and handling.
[B]To convert inches to millimetres, multiply by 25.40.
[C]Width 24–in. sheet (+0.5 in.-0). Length 48-in. sheet (+1.0 in.-0).

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

4.4 *Property Tables*

4.4.1 Table S-PEI shall be used to describe both extruded or compression-molded products.

4.4.2 Table 1 shall be used to describe extruded or compression-molded products not included in Table S-PEI by way of a cell callout that includes the applicable Table S-PEI type and specific properties (Designations 1-7).

4.4.3 To facilitate the incorporation of future or special materials not covered by Table S-PEI, the other category for type, class, and grade (0010) is shown on the table with the basic properties to be obtained from Table 1, as they apply (see 4.5).

4.4.4 *Reinforcements and Additive Materials*—A symbol (single letter) shall be used for the major reinforcement or combination or both along with two numbers that indicate the percentage of addition by mass with the tolerances as tabulated below. This shall be included in all Table 1 callouts (see 4.5, Example 5).

Symbol	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber	±2 %
G	Glass	±2 %
L	Lubricants (for example, PTFE, graphite, silicone, and molybdenum disulfide)	Depends upon material and process—to be specified
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 materials covered by this specification. The system uses predefined cells to refer to specific aspects of this specification as illustrated in the following examples:

4.5.1 *Description:*

4.5.1.1 *Example 1*—Product made from general purpose PEI 0111:

CELL CALLOUT: D7293 S-PEI0111

4.5.1.2 *Example 2*—Product made from extruded PEI, 30 % glass-reinforced:

CELL CALLOUT: D7293 S-PEI0213

4.5.1.3 *Example 3*—Product made from extruded PEI, 15 % graphite-filled with tensile strength greater than 8000 psi and elongation greater than 5 %:

CELL CALLOUT: D7293 S-PEI0100 C15 23000000

4.5.2 The examples illustrate how a one-line, alphanumeric sequence can identify the product composition, commercial parameters, and physical characteristics of extruded product. A space shall 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 shall be preceded by a comma. Special tolerances shall be noted in parentheses following a comma after the specification.

5. Physical Properties

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 shall be specified at the time of order. Physical properties for products not yet included in Table S-PEI shall be specified using Table 1 for extruded products.

6. Dimensions

6.1 The type, class, and grade shall be further differentiated based on dimensional stability (elevated temperature excursion test), Table S-PEI, and dimensional requirements, Tables A and B. Grade 1 and 2 products shall be produced within commercial tolerances and with the lowest stress levels for machined parts as delineated in Tables A and B for compression-molded and extruded products. The manner in which the tolerances are obtained is not relevant. These shall be designated in each callout as referenced in 4.5.2.

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 as agreed to by order. In some cases, physical properties are 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. Special surface finish shall be supplied only when specified in the purchase order or contract.

7.3 *Defects*—All products shall be free of voids, dirt, foreign material, and embedded particles exceeding 1⁄32-in. (0.8-mm) maximum diameter as defined in 7.3.1.

7.3.1 The criteria for determining the internal cleanliness shall be external visual inspection. A maximum number of two internal defects per square foot of plate/sheet and 1-ft (0.3-m) length of rod and tubular bar. Clusters of defects less than 1⁄32-in. (0.8-mm) diameter shall be counted as a single defect.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of this specification as applicable.

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 the 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, plate, rod, or tubular bars to this specification. When the number of test specimens is not stated in the specification, a 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 final result shall conform to the requirements prescribed in this specification.

10. Test Conditions PEI

10.1 *Conditioning of Specimens*—The specification values and dimensions are based on Practice D618, Procedure A.

10.2 *Standard Temperature*—The tests shall be conducted at the standard laboratory temperature of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 10 % relative humidity (RH).

11. Test Methods

11.1 Tensile strength at break, elongation at break, and tensile modulus (tangent) in accordance with Test Method D638, at the rate of 0.2 in./min:

11.1.1 All plate and sheet specimens in accordance with Test Method D638, Type I.

11.1.2 All rod specimens in accordance with Test Method D638.

11.1.3 All tubular bar specimens in accordance with Test Method D638.

11.2 *Dimensional Stability:*

11.2.1 Specimen Preparation (a minimum of three test samples required).

11.2.1.1 *Rods and Tubular Bar*—Each specimen shall be prepared by cutting a 1.5-in. (4-cm) long slice from the shape to be tested. The slice shall then be machined using a coolant and good machining practices to a length of 1.000 ± 0.005 in. (2.54 ± 0.013 cm). Each end of the specimen shall have a machined surface.

11.2.1.2 *Plate and Sheet*—This test is not applicable to sheet under 3⁄16 in. (0.48 mm) thick. Each specimen shall consist of a 2-in. (5-cm) diameter disk machined from the flat (diameter shall equal test specimen thickness with a minimum of 2.0 in. (5 cm)). 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*—The outside diameter and thickness or length of the specimen as applicable shall be measured at 73.4 ± 1.8°F (23 ± 1°C) to the nearest 0.0001 in. (0.000254 cm). All measurements shall be done on the center line and 90° from the center line for plate. Also, take measurements for thickness halfway to center and for diameter at midpoint. The specimen shall be placed in an oil bath consisting of polyalkylene glycol or an air-circulating oven and heated to 375 ± 5°F (190 ± 3°C). After 6 h, the specimen shall be allowed to cool slowly to room temperature at a rate not to exceed 40°F (22°C)/h. The specimen shall then be measured at 73.4 ± 1.8°F (23 ± 1°C) and the percent change in each dimension calculated.

11.3 *Lengthwise Camber and Widthwise Bow:*

11.3.1 All measurements for camber and bow shall be made 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, Sheet, and Plate:*

11.3.2.1 *Rod*—Rod shall be laid on side and measured with the concave side facing the straight edge. Camber is measured

from the straight edge to the maximum concave point on the rod. Camber shall not exceed the values of Table A for extruded product.

11.3.2.2 *Sheet and Plate Up to and Including 5/8 in. (16 mm) Thick*—Plate up to and including 5/8 in. (16 mm) in thickness shall meet the requirements of Table B when measured with a straight edge, positioned in a lengthwise and widthwise direction, with the plate standing on its edge.

11.3.2.3 *Sheet and Plate Greater Than 5/8 in. (16 mm) Thick*—Plate above 5/8 in. (16 mm) thick 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 (1.2-m) Nominal Length):*

11.4.1 Measure and compare diagonal lengths (corner to corner). The product shall be accepted if the difference is 1/16 in. (1.6 mm) or less and the measured minimum diagonal meets the following requirements:

11.4.1.1 One foot (0.3 m) wide is 49½ in. (126 cm) minimum.

11.4.1.2 Two feet (0.6 m) wide is 53¾ in. (136.5 cm) minimum.

11.4.1.3 Four feet (1.2 m) wide is 68 in. (173 cm) minimum.

11.4.2 If the diagonal difference exceeds 1/16 in. (1.6 mm), proceed to measure the gap (which is the deviation from a 2-ft (0.6-m) square). The maximum allowable gap shall not exceed 1/8 in. (3.2 cm) except for the 1-ft (0.3-m) wide sizes of sheet and plate that shall not exceed 1/16 in. (1.6 mm).

11.5 *Flexural Modulus*—Test in accordance with Test Methods D790, specimen ¼-in. (0.6-cm) thick maximum, testing speed 0.11 in./min.

11.6 *Izod Impact*—Test in accordance with Test Method D256, Fig. 4, notched, ¼-in. (0.6-cm) 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 plastic and meets the requirements of this specification.

13. Packaging and Package Marking

13.1 All packing, packaging, and marking provisions of Practice D3892 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 PEI; polyetherimide; polyetherimide plates; polyetherimide rod; polyetherimide shapes; polyetherimide tubular bar

TABLE 1 Additional Detail Requirements—Reinforced/Unreinforced[A]

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, Test Method D638, 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 D638, %, min	Unspecified	1	3	5	10	20	50	100	200	Specify Value
3	Tensile modulus min, Test Method D638, 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 Methods for D790, 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 for D256, min, ft lbs/in. J/m) of notch	Unspecified	0.4 (21)	0.6 (32)	0.8 (43)	1.0 (53)	2.0 (107)	3.0 (160)	4.5 (240)	6.0 (320)	Specify Value
7	Table 1 grade, dimensional requirements	Unspecified	A-1	B-1	...	...	...	...	...	...	Specify Value
8	To be determined	Unspecified	...	...	...	...	...	...	...	...	Specify Value

[A]The applicable Practice D5205 resin callout (including resin type, fillers) must precede this table designation.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D7293 – 06) that may impact the use of this standard. (August 1, 2012)

(1) The phrase "Test Method" was replaced with the word "specification" in the title and where appropriate in the text.
(2) "Cast" was replaced by "compression-molded" throughout.
(3) Typographical and other errors were corrected.
(4) Classes for "Other" were added to Table S-PEI where needed.
(5) Example 3 was added to clarify the use of Table 1.
(6) Tolerance on relative humidity was increased to ±10%.
(7) Minor editorial changes were made.