Designation: D 5436 – ~~99~~03

Standard Specification for Cast Poly(Methyl Methacrylate) Plastic Rods, Tubes, and Shapes[1]

This standard is issued under the fixed designation D 5436; 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.

1. Scope*

1.1 This specification covers poly(methyl methacrylate) rods, tubes, and other shapes produced by casting or machining cast blanks. This specification does not apply to heat-formed and molded or extruded parts and shapes, or sections that are made by assembling or joining two or more pieces.

NOTE 1—The properties included in this specification are those required to identify the types and grades of materials covered. There may be other requirements necessary to identify particular characteristics.

1.2 *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 2—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*

[1] This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

Current edition approved ~~Nov.~~ June 10, ~~1999.~~ 2003. Published ~~February 2000.~~ August 2003. Originally ~~published as D 5436 – 93.~~ approved in 1993. Last previous edition approved in 1999 as D 5436 – ~~93~~9.

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

D 542 Test Method for Index of Refraction of Transparent Organic Plastics[2]
D 570 Test Method for Water Absorption of Plastics[2]
D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]
D 638 Test Method for Tensile Properties of Plastics[2]
D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load[2]
D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement[2]
D 883 Terminology Relating to Plastics[2]
D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics[2]
D 1600 Terminology of Abbreviated Terms Relating to Plastics[2]
D 3892 Practice for Packaging/Packing of Plastics[3]
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

3. Terminology

3.1 The terminology used in this specification is in accordance with Terminology D 883 and Terminology D 1600.

4. Classification

4.1 *Types*—This specification covers two types of cast methacrylate plastics:
4.1.1 *Type UVA*—Material having ultraviolet-lightabsorbing properties as shown in Table 1.
4.1.2 *Type UVT*—Material not subject to the light-absorbing properties shown in Table 1.
4.2 *Finish*—Castings may be specified with the following finishes:
4.2.1 *Finish 1*—Rods, tubes, and shapes having a smooth surface finish obtained either in the casting process or by highly polishing the surface.
4.2.2 *Finish 2*—Rods, tubes, and shapes having a rough, unfinished surface which may be frosted, abraded, sanded, machined, or as-cast.

[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 14.02.

TABLE 1 Detail Requirements for Cast Methacrylate Rods, Tubes, and Shapes

	Type UVA	Type UVT
Index of refraction, n_D, 23°C		
min:	1.48	1.48
max:	1.50	1.50
~~Specific gravity, 23/23°C (73.4/73.4°F)~~		
Specific gravity, 23/23°C [73.4/73.4°F]		
min:	1.18	1.18
max:	1.20	1.20
Spectral transmittance, %, max		
270 nm:	5	...
280 nm:	5	...
290 nm:	5	...
310 nm:	5	...
340 nm:	5	...
Luminous transmittance, %, min		
up to 4.7 mm (0.187 in.) thickness:	91	91
25.4 mm (1.00 in.) thickness:	89	89
greater than 25.4 mm (1.00 in.) thickness:	87	87
Haze, %, max	3.0	3.0
~~Deflection temperature under load at 1820 kPa (264 psi), °C~~	~~see Fig. 1~~	~~see Fig. 1~~
Deflection temperature under load at 1820 kPa (264 psi), °C		
<12.0 mm [0.472 in.]	87 [188.6]	87 [188.6]
>12.0 mm [0.472 in.]–24.0 mm [0.944 in.]	88 [190.4]	88 [190.4]
>24.0 mm [0.944 in.]–100 mm [3.937 in.]	93 [199.4]	93 [199.4]
Water absorption at 23°C		
Gain in weight, 3.2 mm (0.125 in.) thick, %, max	0.8	0.8
~~Tensile strength at 23°C (73.4°F), min, MPa (psi)~~	~~55 (8000)~~	~~55 (8000)~~
Tensile strength at 23°C [73.4°F], min, MPa [psi]	55 [8000]	55 [8000]
Elongation at break, %, min	2	2

NOTE 3—The sawed ends of Finish 1 and Finish 2 rods, tubes, and shapes are not polished.

5. General Requirements

5.1 Finish 1 and Finish 2 cast tubes are subject to the following permissible variations from the specified dimensions:

5.1.1 Cast tubes may be specified with either Type A or Type B wall thickness tolerances as listed in Table 2. Type A tolerances are specified for applications where wall thickness is critical to performance, otherwise Type B is generally specified.

5.1.2 Cast tubes are subject to the outside-diameter tolerances listed in Table 3.

5.1.3 Cut-to-size lengths of cast tube are subject to the length tolerances listed in Table 4.

5.2 Finish 1 and Finish 2 cast rods are subject to the following dimensions and tolerances.

5.2.1 Cast rods are subject to the diameter tolerances listed in Table 5.

5.2.2 Cut-to-size lengths of cast rod are subject to the length tolerances listed in Table 4.

5.3 Tolerances for shapes other than simple rods and tubes depend upon the shapes themselves. Tolerances for these cast shapes are to be specified independently.

6. Detail Requirements

6.1 The following applies to all specified limits in this specification: For purposes of determining conformance with this specification an observed value or a calculated value shall be rounded to the nearest 1 MPa ~~([100 psi)]~~ for tensile strength, and for all other properties shall be rounded to the nearest unit in the last righthand place of figures used in expressing the limiting value, in accordance with the rounding method of Practice E 29.

6.2 The physical and optical properties in this specification are based on Finish 1 material unless otherwise specified.

6.3 Rods, tubes, and shapes shall conform to the detail requirements prescribed in Table 1 and, in addition, shall be so prepared as to conform to the following properties:

6.3.1 Bubbles or inclusions in cast rods, tubes, and shapes shall not exceed 3.96 mm ~~([0.156 in.)]~~ in any dimension. No more than three such defects are permissible in any standard length greater than 122 cm ~~([48 in.)]~~, or an outside diameter greater than 76.2 mm ~~(3 in.).~~ [3 in.]. Bubbles or inclusions are not permitted in rods, tubes, or shapes less than 122 cm ~~(48 in.)~~ [48 in.] in length and less than 76.2 mm ~~(3 in.)~~ [3 in.] in outside diameter. Defects less than 1 mm ~~([0.039 in.)]~~ shall be disregarded, unless grouped to form an objectionable pattern.

7. Number of Tests

7.1 The number of tests shall be consistent with the requirements of Sections 8 and 10.

8. Sampling and Specimen Preparation

8.1 Sampling shall be statistically adequate to satisfy the requirements of Section 10.

8.2 In the case of rods, tubes, or special shapes from which the required test specimens cannot be cut, the test specimens shall be prepared specially from the same raw materials and under conditions simulating the manufacture of the special size or shape. Otherwise a unit of the manufactured product shall be used for testing.

8.3 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment, and may consist of product from two or more production runs.

9. Test Methods

9.1 The properties enumerated in this specification shall be determined in accordance with the following test methods:

TABLE 2 Sizes and Permissible Tolerances for Wall Thickness of Cast Tube

Nominal Wall Thickness, mm ~~([in.)]~~	Permissible Wall Thickness Tolerances, ±, mm ~~([in.)]~~	
	Type A	Type B
~~up to 4.7 (0.187)~~	~~0.5 (0.020)~~	~~not applicable~~
up to 4.7 [0.187]	0.5 [0.020]	not applicable
~~up to 6.4 (0.250)~~	~~0.6 (0.025)~~	~~1.1 (0.045)~~
up to 6.4 [0.250]	0.6 [0.025]	1.1 [0.045]
~~up to 9.5 (0.375)~~	~~0.9 (0.035)~~	~~1.4 (0.055)~~
up to 9.5 [0.375]	0.9 [0.035]	1.4 [0.055]
~~up to 12.7 (0.550)~~	~~1.1 (0.045)~~	~~1.5 (0.060)~~
up to 12.7 [0.550]	1.1 [0.045]	1.5 [0.060]
~~up to 19.0 (0.750)~~	~~1.5 (0.060)~~	~~2.3 (0.090)~~
up to 19.0 [0.750]	1.5 [0.060]	2.3 [0.090]
~~up to 25.4 (1.00)~~	~~3.8 (0.150)~~	~~not applicable~~
up to 25.4 [1.00]	3.8 [0.150]	not applicable
~~greater than 25.4 (1.00)~~	~~6.4 (0.250)~~	~~not applicable~~
greater than 25.4 [1.00]	6.4 [0.250]	not applicable

TABLE 3 Sizes and Permissible Tolerances for Outside Diameter of Cast Tubes

Nominal Outside Diameter, mm [in.]	Outside Diameter Tolerances, ±, mm [in.]	Difference Between Maximum and Minimum Outside Diameter (One Tube), Not to Exceed, mm [in.]
~~up to 76.2 (3.0)~~	~~0.5 (0.020)~~	~~0.6 (0.025)~~
up to 76.2 [3.0]	0.5 [0.020]	0.6 (0.025)
~~up to 98.4 (3.875)~~	~~0.8 (0.030)~~	~~1.0 (0.040)~~
up to 98.4 [3.875]	0.8 [0.030]	1.0 (0.040)
~~up to 152.4 (6.00)~~	~~1.1 (0.045)~~	~~1.5 (0.060)~~
up to 152.4 [6.00]	1.1 [0.045]	1.5 (0.060)
~~up to 304.8 (12.00)~~	~~1.6 (0.065)~~	~~2.0 (0.080)~~
up to 304.8 [12.00]	1.6 [0.065]	2.0 (0.080)
~~greater than 304.8 (12.00)~~	~~3.2 (0.125)~~	~~not applicable~~
greater than 304.8 [12.00]	3.2 [0.125]	not applicable

TABLE 4 Sizes and Permissible Length Tolerances for Cut-to-Length Cast Rod and Tube

Nominal Outside Diameter, mm [in.]	Permissible Length Tolerances, ±, mm [in.]
~~up to 76 (3.0)~~	~~2 (0.079)~~
up to 76 [3.0]	2 [0.079]
~~up to 280 (11.0)~~	~~3 (0.118)~~
up to 280 [11.0]	3 [0.118]
~~greater than 280 (11.0)~~	~~6 (0.236)~~
greater than 280 [11.0]	6 [0.236]

TABLE 5 Size and Permissible Tolerances for Diameter of Cast Rods

Size, Diameter, mm [in.]	Diameter Tolerances, ±, mm (in.)
~~up to 9.5 (0.375)~~	~~0.1 (0.005)~~
up to 9.5 [0.375]	0.1 [0.005]
~~up to 25.4 (1.00)~~	~~0.2 (0.010)~~
up to 25.4 [1.00]	0.2 [0.010]
~~up to 50.8 (2.00)~~	~~0.4 (0.015)~~
up to 50.8 [2.00]	0.4 [0.015]
~~up to 76.2 (3.00)~~	~~0.8 (0.030)~~
up to 76.2 [3.00]	0.8 [0.030]
~~up to 152.4 (6.00)~~	~~1.1 (0.045)~~
up to 152.4 [6.00]	1.1 [0.045]
~~up to 304.8 (12.00)~~	~~1.5 (0.060)~~
up to 304.8 [12.00]	1.5 [0.060]
~~greater than 304.8 (12.00)~~	~~2.5 (0.100)~~
greater than 304.8 [12.00]	2.5 [0.100]

9.1.1 *Test Conditions*—Conduct the tests in the standard laboratory atmosphere of 23 ± 1.0°C [73.4 ± 1.8°F] and 50 ± 2 % relative humidity, unless otherwise specified in the test methods or in this specification.

9.1.2 *Index of Refraction*—Test in accordance with Test Methods D 542, using one of the exposed surfaces of the test specimen that has been given any necessary polish without gross removal of material.

9.1.3 *Specific Gravity*—Test in accordance with Method A of Test Methods D 792.

9.1.4 *Water Absorption*—Test in accordance with Test Method D 570, using the 24-h immersion procedure. Before testing and following immersion, condition the test specimens for 24 h at 50 ± 3°C [112 ± 5°F] in accordance with Procedure B of Test Methods D 618.

9.1.5 *Defection Temperature Under Flexural Load*—Test in accordance with Test Method D 648. Any square, rectangular, or cylindrical test specimen may be used, but calculate the test load used on the basis of a center-loaded beam in which the outer fiber stress produced is 1820 kPa [264 psi]. Stack and bind together pieces of thin sheet, 12.7 mm [0.500 in.] in width, to form a test specimen approximately 12.7 by 12.7 mm [0.500 by 0.500 in.]. Load the specimen parallel to the faces containing the original surfaces of the material. Specimens 12.7 by 12.7 mm [0.500 by 0.500 in.] machined from the face of thick material shall be loaded parallel to the face containing the original surface.

9.1.6 *Tensile Strength and Elongation at Break*—Test in accordance with Test Method D 638 using Type I or Type II specimens at a cross-head speed of 5 mm/min [0.2 in./min].

9.1.7 *Spectral Transmittance*—Measure the spectral transmittance at each specified wavelength with a suitable spectrophotometer.

9.1.8 *Light Transmittance*—Test in accordance with Test Method D 1003.

9.1.9 *Haze*—Test in accordance with Test Method D 1003.

10. Certification and Inspection

10.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

10.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of (*1*) thickness and dimensions, (*2*) appearance, and (*3*) deflection temperature.

10.3 Periodic check inspection shall consist of the tests specified for all requirements of the material under this specification. Supplier shall determine and use an inspection frequency which shall be adequate to ensure that the material is certifiable in accordance with 10.4.

10.4 Certification shall be that the material was manufactured, sampled, tested, and inspected in accordance with this specification and that average values meet the requirements at a confidence level of 95 %.

10.5 Any report made in accordance with 10.1 shall consist of the results of the lot-acceptance inspection of the shipment and the results of the most recent periodic-check inspection.

11. Packaging and Marking

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

12. Keywords

12.1 acrylic; acrylic plastic; cast acrylic; clear weatherable plastics; plastic; plastic materials; plastic rods; plastic shapes; plastic tubes; PMMA; poly(methyl methacrylate); rods; shapes; transparent; tubes

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or the reasons for the changes, or both.

D 5436–03:

(*1*) Revised "Deflection Temperature Under Flexural Load" requirements in Table 1 to be consistent with Specification D 4802, Category A-1.

(*2*) Deleted Figure 1 (Deflection Temperature vs. Thickness).

D 5436–99:

(*1*) Revised Note 2.

(*2*) Revised text of Section 10.

(*3*) Added Summary of Changes section.