



Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet¹

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1. Scope

1.1 This specification covers monolithic methacrylate sheets produced by various processes. For this specification, methacrylate sheet shall be composed of polymerized acrylic monomers of which at least 80 % shall be methyl methacrylate.

NOTE 1—This specification is intended to consolidate the requirements of the Cast Methacrylate Plastic Sheets portion of Fed. Spec. L-P-391D, discontinued Specification D 702. Cast Methacrylate Plastic Sheets, Rods, Tubes and Shapes, and discontinued Specification D 1547, Extruded Acrylic Plastic Sheet.

1.2 This specification is intended to cover acrylic sheet for general-purpose applications. For specialty applications consult the appropriate use standards.

1.3 The following safety hazards caveat pertains only to the test methods portion, Section 8, 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.*

NOTE 2—This standard is similar to ISO 7823-1:1987 (E) in title only. The technical content is significantly different.

2. Referenced Documents

2.1 ASTM Standards:

- D 256 Test Method for Impact Resistance of Plastics and Electrical Insulating Materials²
- D 542 Test Methods for Index of Refraction of Transparent Organic Plastic²
- D 570 Test Method for Water Absorption of Plastics²
- D 638 Test Method for Tensile Properties of Plastics²
- D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load²
- D 673 Test Method for Mar Resistance of Plastics²
- D 756 Practice for Determination of Weight and Shape Changes of Plastics Under Accelerated Service Conditions²
- D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement²

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.

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² Annual Book of ASTM Standards, Vol 08.01.

- D 883 Terminology Relating to Plastics²
 - D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics²
 - D 1044 Test Method for Resistance of Transparent Plastics to Surface Abrasion²
 - D 1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes³
 - D 1499 Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics²
 - D 2565 Practice for Operating Xenon Arc-Type Light Exposure Apparatus With and Without Water for Exposure of Plastics⁴
 - D 3002 Recommended Practice for Evaluation of Coatings for Plastics³
 - D 3359 Test Method for Measuring Adhesion by Tape⁵
 - D 3892 Practice for Packaging/Packing of Plastics⁴
 - E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁶
- 2.2 ISO Standard:
ISO 7823-1:1987 (E) Plastics—Poly(Methyl Methacrylate) Sheets—Types, Dimensions, and Characteristics⁷

3. Terminology

3.1 Definitions:

3.1.1 *General*—The definitions given in Terminology D 883 are applicable to this specification.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *bow warp, n*—distortion in the form of a simple curve or arc extending across the sheet and displaced from the horizontal when the sheet is laying flat.

3.2.2 *edge kink warpage, n*—distortion in the form of a twist, wrinkle, or scallop occurring along the perimeter of the sheet.

3.2.3 *letgoes, n*—an area on the sheet over which the initial adhesion between the polymer and the mold glass has been lost before polymerization, causing an uneven surface.

3.2.4 *“S” warp, n*—distortion in the form of a compound curve or “S” shape caused by a nonuniform change in internal stresses.

³ Annual Book of ASTM Standards, Vol 06.02.

⁴ Annual Book of ASTM Standards, Vol 08.02.

⁵ Annual Book of ASTM Standards, Vol 06.01.

⁶ Annual Book of ASTM Standards, Vol 14.02.

⁷ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

4. Classification

4.1 Categories:

4.1.1 *Category A-1*—Methacrylate sheet typically manufactured by the cell-casting process. This category represents the best optical-quality sheet. It is characterized by the highest long-term design stress and the highest degree of chemical resistance found in methacrylate sheet.

4.1.2 *Category A-2*—Methacrylate sheet typically manufactured by the continuous-casting method. The physical, chemical, and thermal properties are similar to Category A-1 sheet. The optical quality is lower than Category A-1 sheet. This category has better thickness control than that of Category A-1 sheet.

4.1.3 *Category B-1*—Methacrylate sheet manufactured by any of several processes (typically described as continuously manufactured sheet). This sheet possesses lower heat, chemical, and stress-craze resistance than Category A-1 and Category A-2 sheet. It has equivalent or better optical quality and thickness tolerances than Category A-2 sheet.

4.1.4 *Category B-2*—Methacrylate sheet typically manufactured by conventional extrusion processes. This sheet is characterized by excellent thickness control similar to Category A-2 and Category B-1 sheet. This sheet has reduced long-term design stress, chemical resistance, optical quality, and thermal stability.

4.2 *Finish*—The following finishes of methacrylate sheet may be specified. The physical and optical properties in this specification are based on Finish 1 material unless otherwise noted.

4.2.1 *Finish 1*—Smooth or polished.

4.2.2 *Finish 2*—Patterned, including textures and frosting.

4.2.3 *Finish 3*—Abrasion-resistant coated.

4.2.3.1 Finish 3 material can be of any category provided it meets the requirements of that category plus the additional requirements listed in Table 1.

4.2.4 *Type UVA (UV-Absorbing)*—Materials that contain an ultraviolet absorber to limit the transmission of UV radiation through the sheet especially for protection of items sensitive to sunlight or UV radiation.

4.2.5 *Type UVT (UV-Transmitting)*—Materials that do not contain any UV absorbers and are used where there is a need to transmit a greater portion of UV radiation.

4.2.6 For general-purpose applications neither type need be specified. If not specified, materials will usually contain UV absorbers only sufficient to protect the polymer from degradation from exposure to direct sunlight or UV radiation. There are

no specific UV-transmission requirements for material of unspecified type.

5. Detail Requirements

5.1 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.

5.2 Sheet shall conform to the requirements prescribed in Table 2. In addition, Category A-1 sheet shall conform to the permissible-thickness variations listed in Table 3.

5.3 *Shrinkage*—Test in accordance with 8.1.7.

5.4 *Thermal Stability*—Sheet shall show no evidence of bubbling or blistering when tested in accordance with 8.1.8.

5.5 *Abrasion-Resistant Material*—Finish 3 material (abrasion-resistant coated material) shall meet the requirements of the substrate material it is designated as and the properties shown in Table 1.

5.6 *Workmanship*—Sheet, as delivered, shall be free from warpage, cracks, scratches, blisters, voids, foreign matter, die lines, and other defects that may affect appearance or serviceability.

5.6.1 *Flatness of Sheet*—Sheet shall be free from edge kink warpage and from edge “S” warp when lying on a flat surface. Overall bow warp is permitted for all types of sheet to a maximum of 6.3 mm (0.250 in.) displacement from the horizontal for each 4-ft length, or fraction thereof, of a sheet under its own weight when laying in the horizontal position on a flat continuous surface. “S” warp that disappears or becomes bow warp when turned over is permitted.

5.6.2 *Corner Letgoes for Sheet (Applicable to Category A-1 and A-2 Sheet Only)*—Masked sheet in thicknesses equal to or less than 51 mm (2.008 in.) shall be free of corner letgoes. Unmasked sheet in thicknesses no greater than 6.00 mm (0.236 in.) may have letgoes within any or all of the corner areas that are defined as isosceles triangles with 76.0 mm (3.0 in.) sides. Corner letgoes in unmasked sheets that are thicker than 6.00 mm (0.236) up to and including 51 mm (2.008 in.) are permitted within any or all of the corner areas that are defined as isosceles triangles with 150 mm (5.91 in.) sides. For unmasked sheets, out-of-tolerance corner letgoes, within an isosceles triangle that has no more than twice the allowable length for sides, shall be accepted if removed. For masked and unmasked sheets in thicknesses greater than 51 mm (2.008 in.), letgoes may exist provided they do not extend more than 0.4 mm (0.016 in.) below the surface. For Category A-2 sheet only, edge letgoes less than 0.4 mm (0.016 in.) in depth may exist within 25 mm (0.984 in.) of the sheet edges, provided physical integrity is not impaired.

5.6.3 *Chips and Dirt in Sheet:*

5.6.3.1 *Chips in Sheet of Thickness Equal to or Less Than 51 mm (2.008 in.)*—The maximum permissible chip size shall be 3.2 mm (0.125 in.). Chips that are approximately the maximum permissible size shall not have a frequency greater than 1 chip per 0.4 m² (4.3 ft²) of sheet area. Chips less than 0.8

TABLE 1 Finish 3 Abrasion Resistant Material

Property	Test Method	Requirement
Abrasion resistance, 100 cycles at 500 g load	D 1044	
Haze, max, %		4.0 ^A
Mar resistance, 1000 g No. 80 grit	D 673	
Haze, max, %		4.0 ^A
Coating adhesion, percent retention, min	see 8.1.13.5	Minimum Classification 4B, ^A Fig. 1, Test Methods D 3359
Chemical resistance, visual examination	see 8.1.14	no change

^A Tests are to be performed before and after the simulated weathering resistance and the accelerated-service conditions described in 8.1.13.

TABLE 2 Detail Requirements for Cast Methacrylate Plastic Sheets

Property	Test Method	Category			
		A-1	A-2	B-1	B-2
Tensile strength, min, MPa (psi)	D 638	62 (9.0 k)	62 (9.0 k)	62 (9.0 k)	62 (9.0 k)
Elongation at break, min, %	D 638	2	2	2	2 ^A
Index of refraction	D 542				
min:		1.48	1.48	1.48	1.48 ^A
max:		1.50	1.50	1.50	1.50
Specific gravity	D 792				
min:		1.18	1.18	1.18	1.18 ^A
max:		1.20	1.20	1.20	1.20
Luminous transmittance, min, %	D 1003				
<4.5 mm (0.177 in.)		91	91	91	91
>4.5 mm (0.177 in.) ≤32 mm (1.259 in.)		89	89	89	89
>32.0 mm (1.259 in.) ≤51.0 mm (2.000 in.)		87	87	87	87
Spectral transmittance, max, %	see 8.1.12				
Type UVA only 290 to 330 nm (6.0 mm, 0.236 in.)					
@290 nm		5	5	5	5
@310 nm		5	5	5	5
@330 nm		5	5	5	5
Type UVT only 290 to 400 nm (3.0 mm, 0.118 in.)					
@290 nm		40	40	40	40
@310 nm		70	70	70	70
@340 nm		85	85	85	85
@400 nm		86	86	86	86
Haze, max, %	D 1003	3	3	3	3
Dimensional tolerance, max:					
Thickness, %		see Table 3	±10	±5	±5
Length and width, mm (in.)		−0.0, +6.4 (−0.0, +0.250)	−0.0, +6.4 (−0.0, +0.250)	−0.0, +6.4 (−0.0, +0.250)	−0.0, +6.4 (−0.0, +0.250)
Shrinkage, max, %	see 8.1.7	2.8	2.8	...	...
Transverse:		...	...	0.0	5.0
Machine:		...	...	3.0	8.0
Water absorption, %	D 570 (24-h method)	...	...	...	^A
Deflection temperature under flexural load, 1820 kPa (264 psi), °C (°F), min	D 648				
<12.0 mm (0.472 in.)		87 (188.6)	87 (188.6)	87 (188.6)	87 (188.6)
>12.0 mm (0.472 in.) ≤24.0 mm (0.944 in.)		88 (190.4)	88 (190.4)	88 (190.4)	N/A ^B
>24.0 mm (0.944 in.) ≤100 mm (3.937 in.)		93 (199.4)	93 (199.4)	N/A ^B	N/A ^B
Thermal stability		see 8.1.8.1	see 8.1.8.1	see 8.1.8.2	see 8.1.8.2
Impact strength, Izod, J/m (ft-lb/in.), min	D 256, Method A	16.0 (0.3)	16.0 (0.3)	16.0 (0.3)	16.0 (0.3) ^A

^A For Category B-2 sheet only, properties noted may be determined on the resin from which the sheet is extruded.

^B Not applicable.

mm (0.031 in.) are to be disregarded unless they form a concentrated pattern that may affect serviceability. Chips from 0.8 mm (0.031 in.) to the maximum permissible size shall not have a frequency greater than 1 per 0.4 m² (4.3 ft²). Chips out of tolerance in size may be knifed off and considered acceptable if the remaining blemish can be removed by polishing, except for Finish 3 sheet which cannot be easily polished. For Finish 3 sheet, the maximum permissible chip size shall be 4.75 mm (0.187 in.); all other requirements above apply except as noted.

5.6.3.2 Chips in Sheet of Thicknesses Greater Than 51 mm (2.008 in.)—Chips may be accepted providing they do not extend more than 0.4 mm (0.016 in.) above the surface.

5.6.3.3 Dirt and Contaminants—The maximum permissible dirt and contamination dimension shall be 3.2 mm (0.125 in.). Dirt and contaminants less than 0.8 mm (0.031 in.) shall be disregarded unless they form a concentrated pattern that may affect the serviceability of the sheet. The maximum permissible frequency for dimensions ranging from 0.8 mm (0.031 in.) to the maximum permissible for each type of sheet shall be 1 per 0.4 m² (4.3 ft²) of sheet area for thickness up to and including 12.0 mm (0.472 in.). For Finish 3 sheet the maximum

permissible dimension for dirt and contaminants shall be 4.8 mm (0.187 in.); all other requirements above apply.

5.6.3.4 Other Defects—Minor defects, such as mold or handling scratches, or die lines that can be removed by polishing, shall be permitted provided these are not objectionable individually or in group patterns. Excluding side letgoes for masked and unmasked sheets in thicknesses greater than 51 mm (2.004 in.) and for unmasked sheets that are thicker than 6.0 mm (0.236 in.) up to and including 51 mm (2.004 in.), defects within 25 mm (0.984 in.) of the untrimmed edge of the sheet, that do not significantly reduce mechanical strength of the sheet, shall be permitted. Side letgoes for sheets thicker than 51 mm (2.004 in.) may exist providing they do not extend more than 0.4 mm (0.016 in.) below the surface. Side letgoes for unmasked sheets thicker than 6.0 mm (0.236 in.) up to and including 51 mm (2.004 in.) shall be allowed within a 50 mm (1.97 in.) band from the untrimmed edge of the sheet. For Finish 3 sheet, the maximum permissible length for mold scratches shall be 25 mm (0.984 in.); the maximum permissible length for medium or heavy handling scratches or abrasions shall be 50 mm (1.97 in.); the maximum permissible length of light-handling scratches or abrasions shall be 153 mm (6.024