Designation: ~~D788 – 14~~ D788 – 16

Standard Classification System for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds[1]

This standard is issued under the fixed designation D788; 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 The purpose of this classification system is to provide a method of adequately identifying PMMA materials using a system consistent with that of Classification System D4000. It further provides a means for specifying these materials by the use of a simple line callout designation.

1.2 This classification system covers poly(methyl methacrylate) molding and extrusion compounds. These compounds are polymers based on methyl methacrylate, and at least 70 % of the polymer shall be polymerized from methyl methacrylate.

1.3 The properties in this classification system are those required to identify the compositions covered. Other requirements necessary to identify particular characteristics important to specific applications shall be described by using the suffixes as given in Section 5.

1.4 Acrylic molding and extrusion compounds are used frequently in applications where extreme clarity and the ability to retain that clarity and color under severe weathering and other environmental exposures are of primary significance. While the test specimen properties of this document extend to the evaluation of nonvirgin materials, the user must take precautions to ensure that parts made from these materials meet the desired end-use requirements. Accordingly, this specification allows for the use of those acrylic plastic materials that can be recycled, reconstituted, and reground provided the following:

1.4.1 The requirements as stated in this specification are met, and

~~1.4.2 The material has not been modified in any way to alter its conformance to food contact regulations or similar requirements, and~~

1.4.2 The requirements of the particular end-use application are met.

1.5 This classification system and subsequent line callout (specification) are not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials is to be made by personnel with expertise in the plastics field in which the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered.

NOTE 1—This classification system is similar to ISO 8257-1:1987 in title only. The technical content is significantly different.

1.6 The values stated in SI units are to be regarded as standard.

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

[1] This classification system 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.

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

TABLE 1 Transmission of Grade 2 Materials at Various Wavelengths[A,B]

Wavelength, nm	Transmission, min, %
400	86
340	85
310	70
290	50
280	26
270	12

[A] Measured with UV spectrophotometer using an integrating sphere and a sample thickness of 3.2 mm.
[B] These requirements are in addition to the luminous transmittance requirements given in Table 3.

D257 Test Methods for DC Resistance or Conductance of Insulating Materials
D618 Practice for Conditioning Plastics for Testing
D883 Terminology Relating to Plastics
D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1600 Terminology for Abbreviated Terms Relating to Plastics
D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials
D3892 Practice for Packaging/Packing of Plastics
D4000 Classification System for Specifying Plastic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *ISO Standards and Recommendations:*[3]
ISO 179 Plastics—Determination of Charpy Impact Properties—Part 1: Non-Instrumented Impact Test
ISO 294 Plastics—Injection Moulding of Test Specimens of Thermoplastic Materials—Part 1: General Principles, and Moulding of Multipurpose and Bar Test Specimens
ISO 306 Plastics—Thermoplastic Materials—Determination of Vicat Softening Temperature
ISO 489 Plastics—Determination of the Refractive Index of Transparent Plastics
ISO 527 Plastics—Determination of Tensile Properties
ISO 1133 Plastics—Determination of the Melt Flow Rate of Thermoplastics
ISO 3167 Plastics—Preparation and Use of Multipurpose Test Specimens
ISO 8257-1 Plastics—Poly(Methyl Methacrylate) (PMMA) Moulding and Extrusion Materials—Part 1

2.3 *SAE Standards:*[4]
SAE J576 ~~SEP86—SAE~~SAE Recommended Practice for Plastic Materials for Use in Optical Parts such as Lenses and Reflectors for Motor Vehicle Lighting Devices
~~SAE J1885~~SAE J2412 ~~AUG87—SAE Recommended Practice~~ SAE Standard for Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance ~~Water Cooled Xenon Arc~~ Xenon-Arc Apparatus
~~SAE J1960~~SAE J2527 ~~JUN89—SAE~~ SAE Performance Based Standard for Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance ~~Water Cooled Xenon Arc~~ Xenon-Arc Apparatus

3. Terminology

3.1 *Definitions*—The terminology used in this classification system is in accordance with Terminologies D883 and D1600.

4. Basis of Classification

4.1 Poly(methyl methacrylate) molding and extrusion compounds are classified into groups in accordance with their composition. These groups are subdivided into classes and grades as shown in Table 3. A complete classification must include reference to melt-flow rate, as discussed in 4.2 and 5.1.4.

4.1.1 To facilitate the incorporation of future or special materials, the "other/unspecified" category (0) for group, class, and grade is given in Table 3.

4.1.2 When the grade of the basic material is not shown, or is not important, the use of "0" grade classification shall be used in this classification system.

4.2 The melt-flow rate can vary within a given group, class, and grade and can overlap classes or grades. For this reason, the melt-flow rate shall be specified using Suffix V.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[4] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

TABLE 2 Electrical Properties of Unmodified PMMA

Property	Test Method	Requirement
Insulation resistance, min, Mohm	D257	1×10^7
Dielectric strength min, kV/mm[A]	D149	13.8
Dielectric constant at 1 MHz, max	D150	4.5
Dissipation factor at 1 MHz, max	D150	0.05

[A] kV/mm × 25.4 = V ⁄mil.

4.2.1 Although the values listed in Suffix V are necessary to include the range of properties available in existing materials, users must not infer that every melt-flow rate exists for each class or grade.

NOTE 2—An example of this classification system is as follows:
The designation PMMA0112 indicates:

PMMA	=	poly(methyl methacrylate) as found in Terminology D1600,
01	=	unmodified (group),
1	=	minimum 77°C Vicat, etc. (class) and
2	=	ultraviolet transmitting (grade).

(See Note 4 for a more complete example.)

NOTE 3—Major industries using these materials now require internationally accepted test methods for product specifications. For this reason, ISO test methods have been used in Table 3 and elsewhere in this classification system where appropriate. Similar ASTM standards have been listed in Section 2. Many of these ASTM standards are now or soon will be equivalent. In future editions, a note in the ASTM standard will indicate the degree of equivalency with a particular international standard. The corresponding ASTM test method is to be substituted as long as the specimen size and all other conditions of the test method noted in this classification system as applying to the ISO test method are also applied to the ASTM standard.

4.3 Grade 1 materials are used where special ultraviolet transmission, filtering, or stabilization characteristics are not required.

4.4 Grade 2 materials are used for those specialized applications in which the greatest amount of transmission of UV light is required. The transmission properties are given in Table 1.

4.5 Grade 3 materials (transparent UV stabilized or transparent UV absorbing) are used when either special resistance to slight color change over long exposure times or high-intensity UV radiation is required, or when the material is required to filter out ultraviolet light. These applications are varied and require specific light transmission or color-stability properties to be specified by the user.

5. Suffixes

5.1 When additional requirements are needed, based on the application, that are not covered by the basic cell-table requirements, they shall be indicated through the use of suffixes. In general, suffixes consist of a suffix letter, which gives the requirement needed, a first digit, which gives the test condition, and a second digit, which gives the specific requirement.

5.1.1 Suffix E = Electrical requirements, as designated by the following digits:

TABLE 3 PMMA Poly(Methyl Methacrylate) Materials Detail Requirements

Note—The values listed were developed for natural colors. Colorants or other additives, or both, have the potential to alter these properties.

Group	Description	Class	Description[A]	Grade	Description[A]	Charpy Impact, Test Method ISO 179[B] kJ/m^2, min	Tensile Strength, Test Method ISO 527,[D] MPa, min	Luminous Transmittance, Test Method D1003,[E] %, min	Haze, Test Method D1003,[E] %, max	Index of Refraction, Test Method ISO 489[E]	Tensile Modulus, Test Method ISO 527,[C] MPa, min	Vicat Softening Temperature, Test Method ISO 306,[F] °C, min
01	Unmodified[G]	1	Formerly Grade 5 (D788 - 84)	1	General purpose	...	58	90	2.5	1.48-1.50	2700	77
				2	UV transmitting[H]	...	58	90	2.5	1.48-1.50	2700	77
				3	UV stabilized[I]	...	58	90	2.5	1.48-1.50	2700	77
		2	Formerly Grade 6 (D788 - 84)	1	General purpose	...	62	90	2.5	1.48-1.50	2700	86
				2	UV transmitting[H]	...	62	90	2.5	1.48-1.50	2700	86
				3	UV stabilized[I]	...	62	90	2.5	1.48-1.50	2700	86
		3	Formerly Grade 8 (D788 - 84)	1	General purpose	...	65	90	2.5	1.48-1.50	2700	95
				2	UV transmitting[H]	...	65	90	2.5	1.48-1.50	2700	95
				3	UV stabilized[I]	...	65	90	2.5	1.48-1.50	2700	95
		4	Higher Vicat Softening Point than Former Grade 8	1	General purpose	...	65	90	2.5	1.48-1.50	2700	104
				2	UV transmitting[H]	...	65	90	2.5	1.48-1.50	2700	104
				3	UV stabilized[I]	...	65	90	2.5	1.48-1.50	2700	104
02	Impact modified[J]	1		1		1.2	51	88	4.0	1.48-1.50	2600	95
				0	Other/unspecified	...	...	...	...	...	...	...
		2		1		2.0	38	88	4.0	1.48-1.50	2500	90
		3		1		4.3	31	88	4.0	1.48-1.50	1700	85
		4		1		3.0	31	88	4.0	1.48-1.50	1700	85
03	Heat-Resistance modified[K]	1		1	General purpose	...	65	90	2.5	1.48-1.50	2700	113
				2	UV transmitting[H]	...	65	90	2.5	1.48-1.50	2700	113
				3	UV stabilized[I]	...	65	90	2.5	1.48-1.50	2700	113
				4	Impact modified also	tbd	56	88	4.0	1.48-1.50	tbd	113
		2		1	General purpose	...	65	90	2.5	1.48-1.50	2700	122
				2	UV transmitting[H]	...	65	90	2.5	1.48-1.50	2700	122
				3	UV stabilized[I]	...	65	90	2.5	1.48-1.50	2700	122
		3		1	General purpose	...	58	90	2.5	1.48-1.52	2700	113
		4		1	General purpose	...	58	90	2.5	1.48-1.52	2700	122
00	Other	0		0	Other/unspecified	...	...	...	...	...	...	...

[A] No descriptions are listed unless needed to describe a special grade or class. All other categories are listed by requirements.

[B] Method designation shall be ISO 179/1eA. Specimen shall be type 1 (4 by 10 by 80 mm) with a type A notch radius of 0.25 mm and shall positioned edgewise for impact. Specimens shall be conditioned in an oven for 16 hours at a set temperature that is 25°C below the Vicat softening temperature.

[C] Method designation shall be ISO 527-2/1A/1. Specimens shall be type 1A and tested at 1 mm/min. Specimens shall be conditioned in an oven for 16 hours at a set temperature that is 25°C below the Vicat softening temperature.

[D] Method designation shall be ISO 527-2/1A/5. Specimens shall be type 1A and tested at 5 mm/min. Specimens shall be conditioned in an oven for 16 hours at a set temperature that is 25°C below the Vicat softening temperature.

[E] Test specimens are 3.2-mm thick of colorless material.

[F] Method designation shall be ISO 306/B50. Specimens shall be 4 mm thick and >10 mm long by >10 mm wide. Specimens shall be conditioned in an oven for 16 hours at a set temperature that is 25°C below the Vicat softening temperature. After conditioning, they must be placed in a desiccator at 23 ± 2°C immediately after molding for at least 1 hour to prevent water pickup and kept dry until ready for test. Specimens must be tested at a temperature rate of 50°C/h with a 50 N load.

[G] Unmodified group materials are polymerized from 70 to 100 % methacrylate monomer and 0 to 30 % acrylic comonomers.

[H] See 4.4 for description.

[I] See 4.5 for description.

[J] Impact-modified materials contain 50 to 95 % unmodified polymer and 5 to 50 % of impact modifier(s), maintaining the requirement that the overall composition of these materials is polymers made from monomers, at least 70 % of which are methyl methacrylate.

[K] Heat-resistance modified materials are polymerized from 70 to 95 % methyl methacrylate monomer and 5 to 30 % comonomers.

First Digit

0	=	to be specified by the user.
1	=	specimen thickness, 3.2 mm, nominal.

Second Digit

0	=	to be specified by the user.
1	=	volume resistivity, dielectric constant, and dissipation factor meet property limits as given in Table 2.