



Designation: D 788 – 02

## Standard Classification System for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds<sup>1</sup>

This standard is issued under the fixed designation D 788; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 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 D 4000. 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. There may be other requirements necessary to identify particular characteristics important to specific applications. These 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 may be used to evaluate nonvirgin materials, the user should 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 regrounded provided the following:

1.4.1 The requirements as stated in this specification are met,

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

1.4.3 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 the 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:

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies<sup>2</sup>

D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation<sup>2</sup>

D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics<sup>3</sup>

D 257 Test Methods for DC Resistance or Conductance of Insulating Materials<sup>2</sup>

D 542 Test Methods for Index of Refraction of Transparent Organic Plastics<sup>3</sup>

D 618 Practice for Conditioning Plastics for Testing<sup>3</sup>

D 638 Test Method for Tensile Properties of Plastics<sup>3</sup>

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials<sup>3</sup>

D 883 Terminology Relating to Plastics<sup>3</sup>

D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics<sup>3</sup>

D 1238 Test Method for Flow Rates of Thermoplastics by

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<sup>2</sup> Annual Book of ASTM Standards, Vol 10.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.01.

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

- Extrusion Plastometer<sup>3</sup>
- D 1525 Test Method for Vicat Softening Temperature of Plastics<sup>3</sup>
- D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>3</sup>
- D 1897 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials<sup>4</sup>
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials<sup>5</sup>
- D 3892 Practice for Packaging/Packing of Plastics<sup>5</sup>
- D 4000 Classification System for Specifying Plastic Materials<sup>5</sup>
- D 5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics<sup>6</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>7</sup>
- 2.2 *ISO Standards and Recommendations*:<sup>8</sup>
- ISO 178-1975 Plastics—Determination of Flexural Properties of Rigid Plastics
- ISO 180-1982 Plastics—Determination of Izod Impact Strength of Rigid Materials
- ISO 294
- ISO 306-1987 Plastics—Thermoplastic Materials—Determination of Vicat Softening Temperature
- ISO 489-1983 Plastics—Determination of the Refractive Index of Transparent Plastics
- ISO R 527 November 1966 Plastics—Determination of Tensile Properties
- ISO 1133-1981 Plastics—Determination of the Melt Flow Rate of Thermoplastics
- ISO 3167-1983 Plastics—Preparation and Use of Multipurpose Test Specimens
- ISO 8257-1:1987 Plastics—Poly(Methyl Methacrylate) (PMMA) Moulding and Extrusion Materials—Part 1
- 2.3 *SAE Standards*:<sup>9</sup>
- SAE J576 SEP86—SAE Recommended Practice for Plastic Materials for Use in Optical Parts such as Lenses and Reflectors for Motor Vehicle Lighting Devices
- SAE J1885 AUG87—SAE Recommended Practice for Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Water Cooled Xenon Arc Apparatus
- SAE J1960 JUN89—SAE Standard for Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Water Cooled Xenon Arc Apparatus

### 3. Terminology

3.1 *Definitions*—The terminology used in this classification system is in accordance with Terminologies D 883 and D 1600.

### 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.

4.2.1 Although the values listed in Suffix V are necessary to include the range of properties available in existing materials, users should 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 D 1600,
  - 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 may 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

**TABLE 1 Transmission of Grade 2 Materials at Various Wavelengths<sup>A,B</sup>**

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

<sup>A</sup> Measured with UV spectrophotometer using an integrating sphere and a sample thickness of 3.2 mm.

<sup>B</sup> These requirements are in addition to the luminous transmittance requirements given in Table 3.

<sup>4</sup> Discontinued; see 1990 Annual Book of ASTM Standards, Vol 08.02.  
<sup>5</sup> Annual Book of ASTM Standards, Vol 08.02.  
<sup>6</sup> Annual Book of ASTM Standards, Vol 08.03.  
<sup>7</sup> Annual Book of ASTM Standards, Vol 14.02.  
<sup>8</sup> Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.  
<sup>9</sup> Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001.

**TABLE 2 Electrical Properties of Unmodified PMMA**

| Property                                    | Test Method | Requirement     |
|---|-------------|-----------------|
| Insulation resistance, min, Mohm            | D 257       | $1 \times 10^7$ |
| Dielectric strength min, kV/mm <sup>A</sup> | D 149       | 13.8            |
| Dielectric constant at 1 MHz, max           | D 150       | 4.5             |
| Dissipation factor at 1 MHz, max            | D 150       | 0.05            |

<sup>A</sup> kV/mm  $\times$  25.4 = V/mil.

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:

### 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 strength, dielectric constant, and dissipation factor meet property limits as given in Table 2.

5.1.2 Suffix H = Heat-stability requirements, as designated by the following digits:

### First Digit

- 0 = to be specified by the user.
- 1 = 1000 h at 70  $\pm$  2°C.
- 2 = 1000 h at 80  $\pm$  2°C.
- 3 = 1000 h at 90  $\pm$  2°C.

### Second Digit

- 0 = to be specified by the user.
- 1 = change in tensile strength and impact strength not to exceed limits as given in Table 4A after aging in an air-circulating oven at the conditions indicated by the first digit and subsequent conditioning according to Section 12.
- 2 = change in tensile strength, tensile elongation, and impact strength not to exceed limits as given in Table 4B after aging in an air-circulating oven at the conditions indicated by the first digit and subsequent conditioning according to Section 12.

5.1.3 Suffix T = Light Transmission and Haze, Modification, as designated by the following digits:

### First Digit

- 0 = unspecified
- 1 = light diffusing polymer modified, minimum transmission 80 %
- 2 = light diffusing polymer modified, minimum transmission 70 %

T1 and T2 materials diffuse light without significant loss of light transmission. They contain either unmodified polymer from Group 1 or impact modified polymer from Group 2 of Table PMMA and acrylic based light diffusing modifier main-

taining the requirement of paragraph 1.2. The overall composition shall have a minimum of 70 % methyl methacrylate units in the various polymers.

T1 materials shall meet the requirements of the appropriate category in Table PMMA except:

- Luminous Transmittance- 80 % min. at 3.2 mm thickness.
- Haze- not applicable.

Refractive Index- 1.49–1.53.

T2 materials shall meet the requirements of the appropriate category in Table PMMA except:

- Luminous Transmittance- 70 % min. at 3.2 mm thickness.
- Haze- not applicable.

Refractive Index- 1.49–1.53.

5.1.4 Suffix V = Melt-flow property requirements as designated by the following digits, determined in accordance with ISO 1133-1981, Condition 13 (equivalent to Test Method D 1238 at Conditions 230/3.8):

### First Digit

- 0 = unspecified.
- 1 = greater than 0 g/10 min.
- 2 = greater than 2 g/10 min.
- 3 = greater than 3 g/10 min.
- 4 = greater than 6 g/10 min.
- 5 = greater than 11 g/10 min.
- 6 = greater than 17 g/10 min.
- 7 = greater than 23 g/10 min.

NOTE 4—An example of this classification system for a PMMA resin with specified melt-flow rate properties is as follows:

The designation PMMA0112V5 indicates:

- PMMA0112 = Unmodified, minimum 77°C Vicat, etc., ultraviolet transmitting material from Table 3,
- V = Melt-flow property requirements, from V suffix requirements above,
- 5 = Greater than 11 g/10 min. Melt-flow rate from V suffix requirements above.

5.1.5 Suffix W = Resistance to weathering as designated by the following digits:

### First Digit

- 0 = to be specified by the user.
- 1 = exposure as defined in SAE J576.
- 2 = exposure as defined in SAE J1885.
- 3 = exposure as defined in SAE J1960.

### Second Digit

- 0 = to be specified by the user.
- 1 = meets the requirements of SAE J576.

5.2 An additional list of suffixes can be found in Classification System D 4000 and may be used for additional requirements, as appropriate.

## 6. Basic Requirements

6.1 Basic requirements from property tables or cell tables, as they apply, are always in effect unless superseded by specific suffix requirements, which always take precedence.

## 7. General Requirements

7.1 The plastics composition shall be uniform and shall conform to the requirements specified herein.