Designation: D 6778 – 03

Standard Classification for Polyoxymethylene (POM, Acetal) Molding and Extrusion Materials[1]

This standard is issued under the fixed designation D 6778; 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 classification covers polyoxymethylene materials suitable for molding and extrusion. This specification allows for the use of polyoxymethylene plastic materials that are recycled, reconstituted, recycled-regrind, recovered, or reprocessed, or combination thereof, provided that the requirements as stated in this specification are met. It is the responsibility of the supplier and the buyer of recycled, reconstituted, recycled-regrind, recovered, or reprocessed polyoxymethylene plastic materials, or combination thereof, to ensure compliance. (See Guide D 5033).

1.2 The properties included in this classification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications. These may be specified by using the suffixes as given in Section 5.

1.3 This classification and subsequent line callout are intended to provide a means of calling out plastic materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection should be made by those having expertise in the field of plastics design after careful consideration of the design and the performance required of the part, the environment to which it will be exposed, the fabrication process to be employed, the costs involved, and the inherent properties of the material other than those covered by this classification.

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

1.5 The following precautionary caveat pertains only to the test method portion, Section 11, of this classification. *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 requirements prior to use.*

NOTE 1—This classification is similar to ISO 9988-1 and 9988-2, although the technical content is significantly different.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 618 Practice for Conditioning Plastics for Testing

D 883 Terminology Relating to Plastics

D 1600 Terminology for Abbreviated Terms Relating to Plastics

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials

D 3892 Practice for Packaging/Packing of Plastics

D 4000 Classification System for Specifying Plastic Materials

D 5033 Guide for the Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *ISO Standards:*[3]

ISO 75-1 Plastics and Ebonite—Determination of Temperature of Deflection under Load—Part 1: General Test Methods

ISO 75-2 Plastics—Determination of Temperature of Deflection under Load—Part 2: Plastics and Ebonite

ISO 179-1 Plastics—Determination of Charpy Impact Properties—Part 1: Non-instrumented Impact Test

ISO 294-1 Plastics—Injection Moulding Of Test Specimens Of Thermoplastic Materials—Part 1: General Principles, and Moulding of Multipurpose and Bar Test Specimens

ISO 527-1 Plastics—Determination of Tensile Properties—Part 1: General Principals

ISO 527-2 Plastics—Determination of Tensile Properties—Part 2: Test Conditions for Moulding and Extrusion Plastics

ISO 1133 Plastics—Determination of the Melt Mass Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics

ISO 11357-3 Plastics—Differential Scanning Calorimetry (DSC)—Part 3: Determination of Temperature and Enthalpy of Melting and Crystallization

[1] This classification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.18).

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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, 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

ISO 1183 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
ISO 3167 Plastics—Multipurpose Test Specimens
ISO 9988-1 Plastics—Polyoxymethylene (POM) Moulding and Extrusion Materials—Part 1: Designation System and Basis for Specifications
ISO 9988-2 Plastics—Polyoxymethylene (POM) Moulding and Extrusion Materials—Part 2: Preparation of Test Specimens and Determination of Properties

TABLE POM Polyoxymethylene Materials, Detail Requirements (Natural and Black Color Only)[A,B,C]

Group	Description	Class	Description	Grade	Description	Flow Rate ISO 1133,[D,E] G/10 min	Melting Point, ISO 11357-3[F] °C, min	Density, ISO 1183, g/cm^3	Tensile Strength, ISO 527,[G] MPa, min	Tensile Modulus, ISO 527[H] MPa, min	Charpy Impact Resistance, ISO 179[I]/ 1eA, kJ/m^2, min	Deflection Temperature, ISO 75/ Method A_f[J] 1.82 MPa, °C, min
01	Homopolymer	1	general purpose and high flow	1		<4	170	1.39 to 1.44	65	2400	7.0	80
				2		4 to 10	170	1.39 to 1.44	65	2500	6.0	80
				3		8 to 19	170	1.39 to 1.44	65	2700	4.5	80
				4		19 to 30	170	1.39 to 1.44	65	2700	4.5	85
				5		30 to 55	170	1.39 to 1.44	65	2700	4.0	85
				G10	10 % glass		170	1.45 to 1.53	80	3500	3.0	150
				G25	25 % glass		170	1.55 to 1.63	125	7000	6.0	160
				0	other							
		3	UV stabilized	1		<8	170	1.39 to 1.44	65	2400	7.0	75
				2		8 to 19	170	1.39 to 1.44	65	2700	4.5	75
				3		19 to 30	170	1.39 to 1.44	65	2700	4.5	75
				4		30 to 55	170	1.39 to 1.44	65	2700	4.5	75
				0	other							
		4	impact modified	1		<4	170	1.31 to 1.37	35	800	50.0	50
				2		8 to 17	170	1.36 to 1.42	45	1800	8.0	65
				3			170	1.32 to 1.38	35	1100	12.0	55
		0	other	0	other							
02	Copolymer	1	general purpose and high flow	1		<4	160	1.38 to 1.43	58	2000	4.0	80
				2		4 to 7	160	1.38 to 1.43	58	2200	3.5	80
				3		7 to 11	160	1.38 to 1.43	58	2200	3.5	80
				4		11 to 16	160	1.38 to 1.43	58	2000	3.0	80
				5		16 to 35	160	1.38 to 1.43	60	2300	3.0	80
				6		35 to 60	160	1.38 to 1.43	60	2500	2.5	80
				7		60+	160	1.38 to 1.43	60	2500	2.0	80
				G10	10 % glass		160	1.40 to 1.52	70	4000	3.0	150
				G15	15 % glass		160	1.45 to 1.55	80	5500	3.0	150
				G20	20 % glass		160	1.50 to 1.60	80	6500	3.0	150
				G25	25 % glass		160	1.54 to 1.65	80	7300	3.0	150
				GE25	25 % glass beads		160	1.50 to 1.70	36	3000	1.0	80
				M30	30 % Mineral		160	1.55 to 1.65	40	3500	2.5	80
				0	other							
		2	UV stabilized	1		<4	160	1.38 to 1.43	56	2000	4.0	80
				2		4 to 7	160	1.38 to 1.43	56	2000	3.5	80
				3		7 to 11	160	1.38 to 1.43	57	2000	3.5	80
				4		11 to 16	160	1.38 to 1.43	57	2000	3.0	80
				5		16 to 35	160	1.38 to 1.43	58	2100	3.0	80
				6		35 to 60	160	1.38 to 1.43	58	2100	2.5	80
				7		60+	160	1.38 to 1.43	58	2100	2.0	80
				0	other							
		3	impact modified	1		11 to 28	155	1.34 to 1.40	46	1800	4.5	70
				2		11 to 28	155	1.30 to 1.38	40	1400	4.5	60
				3		4 to 12	155	1.34 to 1.40	44	1500	5.0	70
				4		4 to 12	155	1.30 to 1.40	35	1300	5.0	60
				0	other							
		4	high modulus	4		11 to 16	165	1.38 to 1.43	64	2700	4.0	80
				0	other							
03	Terpolymer	1	high melt strength	1		<2	160	1.38 to 1.43	56	2250	3.5	80
				0	other							
00	Other	0	other	0	other							

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

[B] Refer to 9.1 under Specimen Preparation for source of test pieces.

[C] Data on 4 mm test specimens may be limited and the minimum values may be changed in a later revision after a statistical database of sufficient size is generated.

[D] Flow rate: 190/2.16 (T/M).

[E] Flow rate, g/10 min (MFR) can be converted to flow rate, cc/10 min (MVR) by the relationship MVR = (MFR/density of the melt at 190°C).

[F] Melting point rate 10°C/min. T_M second melting curve.

[G] Crosshead speed shall be 50 mm/min ± 10 % unless the specimen exhibits brittle failure (no yield point) and strain at break of <10 % in which case crosshead speed shall be 5 mm/min ± 25 %.

[H] Crosshead speed shall be 1 mm/min.

[I] Notched specimen tested edgewise (method 1eA).

[J] Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

TABLE A Detail Requirements: Filled or Reinforced Polyoxymethylene[A,B]

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527, min, MPa[C]	unspecified	20	35	50	65	90	110	130	150	specify value[D]
2	Tensile modulus, ISO 527, min, MPa[E]	unspecified	1500	2500	3500	4500	5500	6500	7500	8500	specify value[D]
3	Charpy impact, ISO 179/1eA, min, kJ/m^2	unspecified	1.0	2.0	3.0	4.0	6.0	10.0	20.0	40.0	specify value[D]
4	Deflection temperature, ISO 75, Method A_f, 1.82 MPa, min, °C[F]	unspecified	50	70	90	110	120	130	140	150	specify value[D]
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[A] It is recognized that detailed test values, particularly Charpy impact, may not predict nor even correlate with the performance of parts molded of these materials.
[B] Refer to 9.1 under Specimen Preparation for source of test specimens.
[C] Crosshead speed shall be 50 mm/min ± 10 % unless the specimen exhibits brittle failure (no yield point) and a strain at break of <10 % in which case crosshead speed shall be 5 mm/min ± 25 %.
[D] If specific value is required, it must appear on the drawing or contract, or both.
[E] Crosshead speed shall be 1 mm/min-(method 1eA).
[F] Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

TABLE B Detail Requirements: Special Polyoxymethylene[A,B]

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527, min, MPa[C]	unspecified	10	20	30	40	50	60	70	80	specify value[D]
2	Tensile modulus, ISO 527 min, MPa[E]	unspecified	200	600	1000	1400	1800	2200	2600	3000	specify value[D]
3	Charpy impact, ISO 179/1eA, min, kJ/m^2	unspecified	1.0	2.0	3.0	4.0	6.0	10.0	20.0	50.0	specify value[D]
4	Deflection temperature, ISO 75, Method A_f, 1.82 MPa, min, °C[F]	unspecified	40	55	70	80	90	100	110	120	specify value[D]
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[A] It is recognized that detailed test values, particularly Charpy impact, may not predict nor even correlate with the performance of parts molded of these materials.
[B] Refer to 9.1 under Specimen Preparation for source of test specimens.
[C] Crosshead speed shall be 50 mm/min ± 10 % unless the specimen exhibits brittle failure (no yield point) and a strain at break of <10 % in which case crosshead speed shall be 5 mm/min ± 25 %.
[D] If specific value is required, it must appear on the drawing or contract, or both.
[E] Crosshead speed shall be 1 mm/min (method 1eA).
[F] Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

3. Terminology

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

4. Classification

4.1 Unreinforced polyoxymethylene materials are classified into groups in accordance with their composition. These groups are subdivided into classes and grades, as shown in Table POM.

NOTE 2—An example of this classification system is as follows. The designation POM0112 indicates the following: POM = polyoxymethylene (acetal) as found in Terminology D 1600, 01 = homopolymer (group), 1 = general purpose and high flow (class), and 2 = requirements given in Table POM (grade).

4.1.1 To facilitate the incorporation of future or special materials, the "other/unspecified" category (0) for group, class, and grade is shown in Table POM. The basic properties can be obtained from Tables A or B, as they apply (see 4.3).

4.2 Reinforced, filled, lubricated and special versions of the polyoxymethylene materials that are not in Table POM are classified in accordance with Table POM and Tables A or B. Table POM is used to specify the group of polyoxymethylene and Table A or B is used to specify the property requirements after the addition of reinforcement, pigments, fillers, or lubricants at the nominal level indicated (see 4.2.1).

4.2.1 Reinforced versions of the basic materials are identified by a single letter that indicates the reinforcement used and two digits that indicate the nominal quantity in percent by weight. Thus, a letter designation G for glass-reinforced and 33 for percent of reinforcement, G33, specifies a filled material with a nominal glass level of 33 %. The reinforcement letter designations and associated tolerance levels are shown as follows:

Symbol	Material	Tolerance
C	carbon and graphite fiber-reinforced	±2 %
G	glass-reinforced	±2 %
L	lubricants (such as, PTFE, graphite, silicone, and molybdenum disulfide)	depends upon material and process to be specified
M	mineral-reinforced	±2 %
R	combinations of reinforcements or fillers, or both	±3 %

NOTE 3—This part of the classification system uses the percent of reinforcements or additives, or both, in the callout of the modified basic material. The types and percentages of reinforcements and additives

should be shown on the supplier's technical data sheet, unless they are proprietary in nature. If necessary, additional callout of these reinforcements and additives can be accomplished by use of the suffix part of the system (see 1.2).

4.2.2 Specific requirements for reinforced, filled, lubricated or special polyoxymethylene materials shall be shown by a six-character designation. The designation will consist of the letter A or B and the five digits comprising the cell numbers for the property requirements in the order as they appear in Tables A or B.

4.2.2.1 Although the values listed are necessary to include the range of properties available in existing materials, users should not infer that every possible combination of the properties exists or can be obtained.

4.2.3 When the grade of the basic material is not known or is not important, the use of "0" grade classification will be used for reinforced materials in this system.

NOTE 4—An example of this classification for a reinforced polyoxymethylene material is as follows. The designation POM0210G25A65380 indicates the following material requirement:

POM	=	Polyoxymethylene (acetal) as found in Terminology D 1600,
02	=	Copolymer (group),
1	=	General purpose and high flow (class),
0	=	Other (grade),
G 25	=	Glass-reinforced at 25 % nominal level,
A	=	Table A property requirements,
6	=	Tensile strength, 110 MPa, min,
5	=	Tensile modulus, 5500 MPa, min,
3	=	Charpy impact, 3.0 kJ/m^2, min,
8	=	Deflection temperature, 150°C, min, and
0	=	Unspecified.

If no properties are specified, the designation would be POM0210G25A00000.

4.3 Table B has been incorporated into this classification to facilitate the classification of special materials where Table POM or Table A does not reflect the required properties. Table B shall be used in the same manner as Table A.

NOTE 5—The mechanical properties of pigmented or colored polyoxymethylene materials can differ from the mechanical properties of natural and black polyoxymethylene material, depending on the choice of colorants and the concentration. The main property affected is ductility, as illustrated by a reduction in impact strength. If specific properties of pigmented materials are necessary, Table B should be employed to specify property requirements.

NOTE 6—An example of this classification system for a special polyoxymethylene material is as follows. The designation POM0110B44250 indicates:

POM	=	Polyoxymethylene (acetal) as found in Terminology D 1600,
01	=	Homopolymer (group),
1	=	General purpose and high flow (class),
0	=	Other (grade),
B	=	Table B property requirements,
4	=	Tensile strength, 40 MPa, min,
4	=	Tensile modulus, 1400 MPa, min,
2	=	Charpy impact, 2.0 kJ/m^2, min,
5	=	Deflection temperature, 90°C, min, and
0	=	Unspecified.

5. Suffix Requirements

5.1 When additional requirements are needed that are not covered by the basic requirements or cell-table requirements, they shall be indicated through the use of suffixes.

5.2 A list of suffixes can be found in Classification System D 4000 (Table 3) and may be used for additional requirements as appropriate. Additional suffixes will be added to that standard as test methods and requirements are developed and requested.

6. General Requirements

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

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

7. Detail Requirements

7.1 The materials shall conform to the requirements in Tables POM, A, and B and suffix requirements, as they apply.

7.2 For the purposes of determining conformance, all specified limits for a specification (line callout) based on this classification system are absolute limits, as defined in Practice E 29.

7.3 With the absolute method, an observed value or a calculated value is not rounded, but is to be compared directly with the limiting value.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of 12.4.

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

9. Specimen Preparation

9.1 Test pieces for relevant test methods shall be based on the injection molded ISO 3167 Type 1A multipurpose test specimen. The following pieces are to be used for the listed relevant test methods. All test pieces are to be tested as molded and conditioned. Annealing is not allowed.

Test Piece	Relevant Test Method
ISO 3167 Type 1A Bar	Tensile strength and modulus by ISO 527
80 ± 2 mm × 10 ± 0.2 mm × 4 ± 0.2 mm cut from the center portion of ISO 3167 Type 1A Bar	Charpy impact resistance by ISO 179/1eA
	Deflection temperature by ISO 75/Method A_f
Specimen approximately 10 × 10 × 4 mm cut from center of ISO 3167 Type 1A Bar	Density by ISO 1183

9.2 The test specimens shall be molded by injection molding in accordance with Practice D 3641 and ISO 294-1 and ISO 9988-2. Recommended processing conditions are shown in Table 1.

10. Conditioning

10.1 Test specimens shall be conditioned in the standard laboratory atmosphere for a minimum of 16 h (Condition 16/23/50, Practice D 618) before performing the required tests.

TABLE 1 Conditions for Injection Molding of Test Specimens

Material	Melt Temperature, °C	Mold Temperature, °C	Average Injection Velocity, mm/s
Homopolymer, MFR <4	215	90	140 ± 100
Homopolymer, MFR >4	215	90	300 ± 100
Homopolymer, impact modified, MFR <7	205	50	140 ± 100
Copolymer, MFR >4	205	90	200 ± 100
Copolymer impact modified	205	80	200 ± 100
Copolymer, MFR <4	205	90	140 ± 100

10.2 Conduct tests in the standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity in accordance with Practice D 618.

11. Test Methods

11.1 Determine the properties enumerated in this classification by means of the test methods in 1.1.

11.1.1 The number of tests shall be consistent with the requirements of Section 8 and 12.4.

12. Inspection and Certification

12.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of melt flow rate or reinforcement content.

12.3 Periodic check inspection with reference to a specification based on this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with 12.4.

12.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system and that the average values for the lot meet the requirements of the specification (line callout).

12.5 A report of the test results shall be furnished when requested. The report shall consist of the results of the lot-acceptance inspection for the shipment and the results of the most recent periodic-check inspection. If requested, the report shall include that recycled, reconstituted, recycled-regrind, recovered, or reprocessed acetal plastic, or combination thereof, was used and the nominal weight percent.

13. Packaging and Marking

13.1 For packing, packaging, and marking, the provisions of Practice D 3892 apply.

14. Keywords

14.1 acetal; acetal copolymer; acetal homopolymer; acetal terpolymer; classification; classification system; line callout; L-P-392A; MIL-P-46137A (MR); plastic materials; polyformaldehyde; polyoxymethylene; polyoxymethylene copolymer; polyoxymethylene homopolymer; polyoxymethylene terpolymer; POM

APPENDIX

(Nonmandatory Information)

X1. CROSS-REFERENCES TO MIL-P-46137A (MR) AND L-P-392A

ASTM D 6778	MIL-P-46137A (MR)
POM 111 G20A35070	Type I Class 20
POM 111 G30A45080	Type I Class 30
POM 111 G40A46080	Type I Class 40
POM 21 G 25	Type II Grade A Class 25
POM 21 G 20	Type II Grade B Class 20
POM 213 G30A47080	Type II Grade B Class 30
POM 213 G40A48080	Type II Grade B Class 40
ASTM D 6778	**L-P-392A**
POM 111	Type II Class 1
POM 112/POM 113	Type I Class 1
POM 112/POM 113[A]	Type I Class 2
POM 132	Type I Class 3
POM 211/POM 311	Type II Class 1
POM 213/POM 214	Type I Class 1
POM 213/ POM 214[A]	Type I Class 2
POM 221	Type I Class 3
POM 223	Type I Class 3

[A] Shall be black in color.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this classification. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this classification. This section may also include descriptions of the changes or reasons for the changes, or both.

D 6778 - 03:

(*1*) Added two new grades POM021GE25 and POM021M30 to Table POM.

(*2*) Added a new footnote to Flow Rate by ISO 1133 heading in Table POM.

(*3*) Corrected an error in the melting point of Grade 0244 in Table POM.