Designation: D 4181 – 00

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

This standard is issued under the fixed designation D 4181; 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 Department of Defense.

1. Scope *

1.1 This classification covers acetal materials suitable for molding and extrusion. This specification allows for the use of acetal 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 acetal 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 limitations prior to use.*

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

NOTE 2—This classification was revised in 1992 to include international 4-mm specimens and test procedures as the standard for compliance. The 3.2-mm specimens, test methods, and Tables POM, A, and B that were superceded by the revision are included in Appendix X2, as a reference for those wishing to use them. It is recommended that the material manufacturer be consulted on all callouts against this classification.

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 792 Test Methods for Specific Gravity (Relative Density) of Plastics by Displacement[2]

D 883 Terminology Relating to Plastics[2]

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis[3]

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials[3]

D 3892 Practice for Packaging/Packing of Plastics[3]

D 4000 Classification System for Specifying Plastic Materials[3]

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[4]

D 5630 Test Method for Ash Content in Thermoplastics[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

2.2 *ISO Standards:*[6]

ISO 75 Plastics and Ebonite—Determination of Temperature of Deflection under Load

ISO 178 Plastics—Determination of Flexural Properties of Rigid Materials

ISO 180/1A Plastics—Determination of Izod Impact Strength of Rigid Materials

[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] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.02.

[4] *Annual Book of ASTM Standards*, Vol 08.03.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

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

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

ISO 527 Plastics—Determination of Tensile Properties
ISO 1133 Plastics—Determination of Melt Flow Rate of Thermoplastics
ISO 1183 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
ISO 3146 Plastics—Determination of Melting Behavior (Melting Temperature or Melting Range) of Semi-Crystalline Polymers
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 (Acetal) Materials, Detail Requirements[A,B,C] (Natural and Black Color Only)

Group	Description	Class	Description	Grade	Description	Flow Rate ISO 1133,[D] g/10 min	Melting Point, ISO 3146/ Method C2,[E] °C, min	Density, ISO 1183,[F] g/cm³	Tensile Strength ISO 527,[G] MPa, min	Flexural Modulus, ISO 178, MPa, min	Izod Impact Resistance, ISO 180/1A, kJ/m², min	Deflection Temperature, ISO 75/ Method A,[H] 1.82 MPa, °C, min
1	Homopolymer	1	general purpose and high flow	1		<8	170	1.39 to 1.44	65	2400	7.0	80
				2		8 to 19	170	1.39 to 1.44	65	2700	4.5	80
				3		19 to 30	170	1.39 to 1.44	65	2700	4.5	85
				4		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							
2	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
				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	flexural modified	1		<20	155	1.26 to 1.32	20	800	12.0	50
				4		11 to 16	155	1.38 to 1.43	64	2700	4.0	80
				0	other							
3	Terpolymer	1	high melt strength	1		<2	160	1.38 to 1.43	56	2250	3.5	80
				0	other							
0	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 data base of sufficient size is generated.
[D] Flow rate: 190/2.16 (T/M).
[E] Melting point rate 10°C/min. T_M second melting curve. See Test Method D 3418 for a similar method.
[F] See Test Method D 792 for a similar method.
[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] Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

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

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	80	95	110	125	specify value[D]
2	Flexural modulus, ISO 178, min, MPa	unspecified	1500	2500	3500	4500	5500	6500	7500	8500	specify value[D]
3	Izod impact, ISO 180/1A, min, kJ/m^2	unspecified	2.5	4.0	5.0	7.5	10.0	15.0	20.0	25.0	specify value[D]
4	Deflection temperature, ISO 75, Method A_f, 1.82 MPa, min, °C[E]	unspecified	80	90	100	110	120	130	140	150	specify value[D]
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	

[A] It is recognized that detailed test values, particularly Izod 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] Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

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

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527, min, MPa[C]	unspecified	10	25	40	55	70	85	100	115	specify value[D]
2	Flexural modulus, ISO 178, min, MPa	unspecified	300	1000	1700	2400	3100	3800	4500	5200	specify value[D]
3	Izod impact, ISO 180/1A, min, kJ/m^2	unspecified	2.0	4.0	6.0	10.0	14.0	18.0	24.0	30.0	specify value[D]
4	Deflection temperature, ISO 75, Method A_f, 1.82 MPa, min, °C[E]	unspecified	40	55	70	85	100	115	130	145	specify value[D]
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	

[A] It is recognized that detailed test values, particularly Izod 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] 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 acetal materials are classified into groups according to their composition. These groups are subdivided into classes and grades, as shown in Table POM.

NOTE 3—An example of this classification system is as follows. The designation POM112 indicates the following: POM = polyoxymethylene (acetal) as found in Terminology D 1600, 1 = 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, and lubricated versions of the acetal 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 acetal 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 4—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 Section 1.5).