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).

4.2.2 Specific requirements for reinforced, filled, or lubricated acetal 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 5—An example of this classification for a reinforced acetal material is as follows. The designation POM210G25A65380 indicates the following material requirement:

POM = Polyoxymethylene (acetal) as found in Terminology D 1600,
2 = 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, 95 MPa, min,
5 = Flexural modulus, 5500 MPa, min,
3 = Izod impact, 5.0 kJ/m^2, min,
8 = Deflection temperature, 150°C, min, and
0 = Unspecified.

If no properties are specified, the designation would be POM210G25A00000.

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

NOTE 7—An example of this classification system for a special acetal material is as follows. The designation POM110B44250 indicates:

POM = Polyoxymethylene (acetal) as found in Terminology D 1600,
1 = Homopolymer (group),
1 = General purpose and high flow (class),
0 = Other (grade),
B = Table B property requirements,
4 = Tensile strength, 55 MPa, min,
4 = Flexural modulus, 2400 MPa, min,
2 = Izod impact, 4.0 kJ/m^2, min,
5 = Deflection temperature, 100°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. Conformance or nonconformance is based on this comparison.

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.

Test Piece	Relevant Test Method
ISO 3167 Type 1A Bar	Tensile strength 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	Flexural modulus by ISO 178
	Izod impact resistance by ISO 180/1A
	Deflection temperature by ISO 75/Method Af
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. 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.

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

TABLE 1 Conditions for Injection Molding of Test Specimens

Material	Melt Temperature, °C	Mold Temperature, °C	Average Injection Velocity, mm/s
Holopolymer, MFR ≤7	215	90	140 ± 100
Holopolymer, MFR >7	215	90	300 ± 100
Holopolymer, impact modified, MFR ≤7	210	60	140 ± 100
Copolymer, MFR >4	205	90	200 ± 100
Copolymer impact modified	205	80	200 ± 100
Copolymer, MFR <4	205	90	140 ± 100

11. Test Methods

11.1 Determine the properties enumerated in this classification by means of the test methods in Section 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; polyacetal; polyformaldehyde; polyoxymethylene; POM

APPENDIXES

(Nonmandatory Information)

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

ASTM D 4181	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 213 G25A66360	Type II Grade A Class 25
POM 213 G20A45080	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 4181	L-P-392A
POM 111	Type II Class 1
POM 112/POM 113	Type I Class 1
POM 130 B44240	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 220 B43250	Type I Class 2
POM 221	Type I Class 3
POM 223	Type I Class 3

X2. REFERENCE TO PREVIOUS EDITION

X2.1 Referenced Documents

X2.1.1 *ASTM Standards:*

D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials.[2]

D 638M Test Method for Tensile Properties of Plastics (Metric)[2]

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load[2]

D 790M Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials (Metric)[2]

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

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

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis[4]

TABLE X2.1 Polyoxymethylene (Acetal) Materials, Detail Requirements, Natural Color Only (Table POM, D 4181 – 92)

Group	Description	Class	Description	Grade	Description[A]	Flow Rate, ASTM D 1238[B] g/10 min	Melting Point, ASTM D 3418 or DTA/DSC, min, °C	Specific Gravity ASTM D 792	Tensile Strength, ASTM D 638M[C], min, MPa	Elongation (Ultimate), ASTM D 638M[C], Min, %	Flexural Modulus, ASTM D 790M, min, MPa	Izod Impact Resistance, ASTM D 256, min, J/m	Deflection Temperature, ASTM D 648, 1.82 MPa, min, °C
1	Homopolymer	1	general purpose and high flow	1		<4	172	1.39 to 1.44	62	60	2400	110	115
				2		4 to 7.5	172	1.39 to 1.44	62	25	2700	59	115
				3		7.5 to 13	172	1.39 to 1.44	62	15	2700	53	115
				4		13 to 25	172	1.39 to 1.44	62	10	2700	45	115
				0	other								
		2	fast cycle	1		5.5 to 8.0	172	1.39 to 1.44	62	20	2400	53	100
				2		9.0 to 15.0	172	1.39 to 1.44	62	15	2400	53	100
				0	other								
		3	UV stabilized[D]	1		<4	172	1.39 to 1.44	62	30	2400	110	115
				2		4 to 7.5	172	1.39 to 1.44	62	15	2700	59	115
				0	other								
		4	impact modified	1		<1.2	170	1.31 to 1.37	38	100	1110	750	70
				2		4.2 to 6.5	170	1.36 to 1.42	52	40	2070	96	80
		0	other	0	other								
2	Copolymer	1	general purpose and high flow	1		<4	160	1.38 to 1.42	55	40	2270	48	105
				2		4 to 7	160	1.38 to 1.42	55	40	2270	48	105
				3		7 to 11	160	1.38 to 1.42	55	40	2270	48	105
				4		11 to 16	160	1.38 to 1.42	55	35	2270	48	105
				5		16 to 35	160	1.38 to 1.42	55	20	2270	40	105
				6		35 to 60	160	1.38 to 1.42	55	15	2270	35	105
				7		60+	160	1.38 to 1.42	55				
				0	other								
		2	UV stabilized	1		<4	160	1.38 to 1.42	58	40	2270	48	105
				2		4 to 7	160	1.38 to 1.42	55	40	2270	48	105
				3		7 to 11	160	1.38 to 1.42	55	40	2270	48	105
				4		11 to 16	160	1.38 to 1.42	55	35	2270	48	105
				5		16 to 35	160	1.38 to 1.42	55	20	2270	35	105
				6		35 to 60	160	1.38 to 1.42	55	15	2270	20	105
				7		60+	160	1.38 to 1.42					
				0	other								
		3	impact modified	1		<24	155	1.36 to 1.42	40	40	1700	40	80
				2		<22	155	1.35 to 1.39	35	55	1320	55	78
				3		<12	155	1.37 to 1.41	40	40	1700	65	80
				4		<11	155	1.35 to 1.39	35	60	1320	95	78
				5		<11	155	1.34 to 1.38	35	60	1500	125	78
				0	other								
		4	flexural modified	1		<20	155	1.27 to 1.31	15	100	680	110	52
				0	other								
3	Terpolymer	1	high melt strength	1		<2	160	1.38 to 1.42	55	25	2065	30	105
				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] Flow rate: Group 1—190/1.05
Group 2—190/2.16

[C] Tensile strength and elongation shall be determined using a Type I tensile specimen as described in Test Method D 638M. Crosshead speed shall be 5 mm/min ±25 %.

[D] Practice G 23, Type E apparatus, 500-h exposure, with 50 % minimum retention of original elongation.

TABLE X2.2 Detail Requirements[A] Filled or Reinforced Acetals (Table A, D 4181 – 92)

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ASTM D 638, min, MPa[B,C]	unspecified	20	35	50	65	80	95	110	125	specify value[D]
2	Flexural modulus, ASTM D 790, min, MPa[B]	unspecified	1500	2500	3500	4500	5500	6500	7500	8500	specify value[D]
3	Izod impact, ASTM D 256, min, J/m[E]	unspecified	25	40	50	75	100	150	200	250	specify value[D]
4	Deflection temperature, ASTM D 648, 1.82 MPa, min, °C	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] MPa × 145 = psi.
[C] Tensile strength shall be determined using a Type I tensile specimen, as described in Test Method D 638. 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] $J/m^2 \times 18.73 \times 10^{-3}$ = ft · lbf/in.

TABLE X2.3 Detail Requirements[A] Special Acetals (Table B, D 4181 – 92)

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ASTM D 638, min, MPa[B,C]	unspecified	10	25	40	55	70	85	100	115	specify value[D]
2	Flexural modulus, ASTM D 790, min, MPa[B]	unspecified	300	1000	1700	2400	3100	3800	4500	5200	specify value[D]
3	Izod impact, ASTM D 256, min, J/m[2D]	unspecified	20	40	60	100	140	180	240	300	specify value[D]
4	Deflection temperature, ASTM D 648, 1.82 MPa, min, °C	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] MPa × 145 = psi.
[C] Tensile strength shall be determined using a Type I tensile specimen, as described in ISO 527. Crosshead speed shall be 50 mm/min ±25 %.
[D] If specific value is required, it must appear on the drawing or contract, or both.

TABLE X2.4 Polyoxymethylene (Acetal) Materials, Detail Requirements,[A] Natural Color Only (Table POM, D 4181 – 97)

Group	Description	Class	Description	Grade	Description[B]	Flow Rate, ISO 1133,[C] g/10 min	Melting Point, ISO 3146/ Method C2,[D] °C, min	Density, ISO 1183,[E] g/cm^3	Tensile Strength, ISO 527,[F] MPa, min	Flexural Modulus, ISO 178,[G] MPa, min	Izod Impact Resistance, ISO 180/ 1A,[H] kJ/m^2, min	Deflection Temperature, ISO 75/ Method A,[A] 1.82 MPa, °C, min
1	Homopolymer	1	general purpose and high flow	1		<8	170	1.39 to 1.44	65	2400	8.5	100
				2		8 to 16	170	1.39 to 1.44	65	2700	5.0	100
				3		16 to 28	170	1.39 to 1.44	65	2700	4.5	105
				4		28 to 55	170	1.39 to 1.44	65	2700	4.0	105
				0	other							
		2	fast cycle	1		11 to 18	170	1.39 to 1.44	65	2400	4.5	100
				2		19 to 33	170	1.39 to 1.44	65	2400	4.0	100
				0	other							
		3	UV stabilized	1		<8	170	1.39 to 1.44	65	2400	8.5	100
				2		8 to 16	170	1.39 to 1.44	65	2700	5.0	100
				0	other							
		4	impact modified	1		<3	170	1.31 to 1.37	35	1100	70	70
				2		8 to 15	170	1.36 to 1.42	45	1900	9.0	80
				0	other							
		0	other	0	other							
2	Copolymer	1	general purpose and high flow	1		<4	160	1.38 to 1.43	58	2300	5.5	90
				2		4 to 7	160	1.38 to 1.43	58	2300	4.5	90
				3		7 to 11	160	1.38 to 1.43	58	2300	4.0	95
				4		11 to 16	160	1.38 to 1.43	58	2300	4.0	95
				5		16 to 35	160	1.38 to 1.43	58	2300	3.5	95
				6		35 to 60	160	1.38 to 1.43	58	2300	3.0	95
				7		60+	160	1.38 to 1.43	58	2300	2.5	95
				0	other							
		2	UV stabilized	1		<4	160	1.38 to 1.43	58	2300	5.5	90
				2		4 to 7	160	1.38 to 1.43	58	2300	4.5	90
				3		7 to 11	160	1.38 to 1.43	58	2300	4.0	95
				4		11 to 16	160	1.38 to 1.43	58	2300	4.0	95
				5		16 to 35	160	1.38 to 1.43	58	2300	3.5	95
				6		35 to 60	160	1.38 to 1.43	58	2300	3.0	95
				7		60+	160	1.38 to 1.43	58	2300	2.5	95
				0	other							
		3	impact modified	1		11 to 26	155					
				2		11 to 26	155					
				3		4 to 11	155	1.34 to 1.40	40	1500	6.0	70
				4		5 to 11	155					
				5			155					
				0	other							
		4	flexural modified	1		<20	155	1.26 to 1.32	20	800	12.0	50
				0	other							
		0	other	0	other							
3	Terpolymer	1	high melt strength	1		<2	160	1.38 to 1.43	56	2250	3.5	90
				0	other							
		0	other	0	other							
0	Other	0	other	0	other							

[A] Deflection temperature shall be determined by specimen 80 ± 2 mm × 10 ± 0.2 mm × 4 ± 0.2 mm (Method A).
[B] No descriptions are listed unless needed to describe a special grade under the class. All other grades are listed by requirements.
[C] Flow rate: 190/2.16 (T/M).
[D] Melting point rate 10°C/min. TM second melting curve. See Test Method D 3418 for a similar method.
[E] See Test Methods D 792 for a similar method.
[F] Tensile strength shall be determined using a Type I tensile specimen as described in ISO 527. Crosshead speed shall be 50 mm/min ±10 %.
[G] Flexural modulus shall be determined by specimen 80 ± 2 mm × 10 ± 0.2 mm × 4 ± 0.2 mm as described in ISO 178.
[H] Izod shall be determined by specimen 80 ± 2 mm × 10 ± 0.2 mm ×4 ± 0.2 mm (Method A).

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 4181 – 97:
(*1*) Deleted recycle grades in Class 5, 6, 7, and 8 in Groups 1 and 2 and Class 2 in Group 3.
(*2*) Addressed use of acetal plastics that are recycled, reconstituted, recycled-regrind, recovered, or reprocessed, or combination thereof, in Scope and Inspection and Certification sections.
(*3*) Added Guide D 5033 to Referenced Documents.
D 4181 – 98:
(*1*) Include Natural and Black colors to satisfy users of the classification.
(*2*) Update property values on high volume products to reflect a large data base (reference Footnote *H*).
(*3*) Add filled and reinforced grades.
(*4*) Delete group 1, class 2 materials, since they are no longer commercially available.
(*5*) Delete group 2, class 3, grade 5, since the grade cannot be identified as a commercial material.
(*6*) Add the current Table POM from D 4181 – 97 to the Appendix as Table X3.1 for reference.
(*7*) Add ISO 3167, Plastics-Multipurpose test specimens to the referenced documents.
(*8*) Insert new section 9.1 and renumber old 9.1 to 9.2 to detail injection molded test specimens as source of test pieces.
(*9*) Revise footnotes to Tables POM, A and B to refer to specimen preparation section 9.1 for source of test pieces.
D 4181 – 00:
(*1*) Updated injection molding conditions in Table 1.