



Designation: D 5990 – 9900

## Standard Classification System for Polyketone Injection Molding and Extrusion Materials (PK) <sup>1</sup>

This standard is issued under the fixed designation D 5990; 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 This classification system covers polyketone materials suitable for injection molding and extrusion. This classification system does not address recycled polyketone materials.

1.2 The properties included in this classification system are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications. These will be agreed upon between the user and the supplier.

1.3 This classification system and subsequent line call out (specification) 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 plastic field 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 system.

1.4 The following precautionary caveat pertains only to the test method portion, Section 11, of this classification system: *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—There is no similar or equivalent ISO standard available.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

<sup>1</sup> 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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\*A Summary of Changes section appears at the end of this standard.

- D 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics<sup>2</sup>
- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing<sup>2</sup>
- D 638 Test Method for Tensile Properties of Plastics<sup>2</sup>
- D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load<sup>2</sup>
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials<sup>2</sup>
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement<sup>2</sup>
- D 883 Terminology Relating to Plastics<sup>2</sup>
- D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer<sup>2</sup>
- D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>
- D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis<sup>3</sup>
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials<sup>3</sup>
- D 3892 Practice for Packaging/Packing of Plastics<sup>3</sup>
- D 4000 Classification System for Specifying Plastic Materials<sup>3</sup>
- D 5630 Test Method for Ash Content in Thermoplastics<sup>4</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance to with Specifications<sup>5</sup>

### 3. Terminology

3.1 Except for the term defined as follows, the terminology used in this classification system is in accordance with Terminologies D 883 and D 1600.

#### 3.2 Definition:

3.2.1 *polyketone (PK)*, *n*—a linear alternating polymer of carbon monoxide and at least one ethylenically unsaturated hydrocarbon.

### 4. Classification

4.1 Unreinforced polyketone materials are classified into groups according to their composition. These groups are subdivided into classes and grades as shown in Table PK.

NOTE 2—An example of this classification system is given as follows. The designation PK0112 indicates the following:

PK	=	Polyketone as found in Terminology D 1600,
01	=	Ethylene-propylene copolymer (group),
1	=	General purpose (class), and
2	=	Requirements given in Table PK (grade).

4.1.1 To facilitate incorporation of future or special materials the “other” category for group (00), class (0), and grade (0) is shown in Table PK. The basic properties of these materials can be obtained from Table A as they apply.

4.2 Reinforced, filled, and lubricated versions of polyketone materials that are not in Table PK are classified in accordance with Tables PK and A. Table PK is used to specify the group of polyketone materials and Table A is used to specify the property requirements after the addition of reinforcements, 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 fiber 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 tabulated as follows:

Symbol	Material	Tolerance
C	Carbon and graphite fiber reinforced	±3 %
G	Glass fiber reinforced	±3 %
L	Lubricants (such as PTFE and silicone)	Depends upon material and process—to be specified.
M	Mineral-reinforced	±3 %
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 call-out 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 call-out of these reinforcements and additives can be accomplished by use of the suffix part of the system (see Section 3). Ash content of filled or reinforced materials may be determined using Test Method D 5630 where applicable.

<sup>2</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 08.03.

<sup>5</sup> Annual Book of ASTM Standards, Vol 14.02.

4.2.2 Specific requirements for reinforced, filled, or lubricated polyketone materials shall be shown by a six-character designation. The designation consists of the letter “A” and the five digits comprising the cell numbers for the property requirements in the order as they appear in Table A.

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 basis material is not known, or is not important, the use of the “0”-grade classification shall be used for the reinforced materials in this system.

NOTE 4—An example of this classification for a reinforced polyketone material is given as follows: The designation PK0120G30A76360 would indicate the following material requirements:

PK0120	=	High flow ethylene-propylene copolymer polyketone from Table PK,
G 30	=	Glass reinforcement at 30 % nominal level
A	=	Table A property requirements
7	=	Tensile strength 170 MPa min
6	=	Flexural modulus 7.5 GPa min
3	=	Izod impact strength 120 J/m min
6	=	Deflection temperature 220°C min, and
0	=	Unspecified.

If no properties are specified, the designation would be PK0120-G30A00000.

### 5. Suffixes

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 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.

**TABLE PK Requirements for Unreinforced Polyketone Plastics**

Group	Description	Class	Description	Grade	Description	Flow Rate, D 1238, <sup>A</sup> min, g/10 min	Melt Point, D 3418, <sup>B</sup> °C	Specific Gravity, <sup>D</sup> D 792	Tensile Strength at Yield, <sup>C</sup> D 638, <sup>C</sup> min, MPa	Elongation (Ultimate) Yield, <sup>C</sup> D 638, <sup>C</sup> min, %	Flexural Modulus, <sup>D</sup> D 790 D 638 min, GPa	Izod Impact <sup>E</sup> Resistance D 256, <sup>E</sup> min, J/m	Deflection Temperature D 648, <sup>E</sup> min, °C
04	Ethylene-propylene copolymer	4	General purpose	4	<4	219–229	1.22–1.24	56	200	4.5	214	90	
01	Ethylene-propylene copolymer	1	General purpose	1	<4	215–225	1.20–1.26	55	20	1.4	180	85	
				2	4 to 8	219–229	1.22–1.24	56	200	1.4	214	90	
				2	4 to 8	215–225	1.20–1.26	55	20	1.4	180	85	
				3	>8	219–229	1.22–1.24	56	200	1.4	200	90	
				3	>8	215–225	1.20–1.26	55	20	1.4	170	85	
			0 Other										
			0 other										
		2	High-flow	4	>60	219–229	1.22–1.24	56	180	1.4	85	90	
		2	high flow	1	>60	215–225	1.20–1.26	55	18	1.4	80	85	
				0 Other									
			0 other										
00	Other	0	Other										
00	Other	0	other										

<sup>A</sup>Test conditions: 240°C/2.16 Kg, kg; Charging time: 30-s; s; Preheat time: 240-s; s; Degas time: 60-s; s; Melt flow measurement less than 7 measurement: <7 min.

<sup>B</sup>Measured by DSC. Heating rate 10°C/min.

<sup>C</sup>Test specimens are Test Method D 638 Type-4, 1 tensile bars and shall be tested at 50-8 50 mm/min.

<sup>D</sup>Test specimens are center of Test Method D 638 Type-4, 1 tensile bars with nominal 3.2 by 12.7 mm cross section. Span is a nominal tested at 50-mm. Rate of crosshead is 1.3 mm/min mm/min, using Method 1. Report 1 % secant modulus based on strain, an extensometer (gage length: 50 mm).

<sup>E</sup>Test specimens are nominal 3.2 by 12.7-mm cross section.

**TABLE A Detail Requirements:<sup>A</sup> Special and Reinforced Polyketone Plastics**

Designation Order Number	Property	0	1	2	3	4	5	6	7	8
4	Tensile strength at yield, <sup>B</sup> D 638, min, MPa	unspecified	30	50	70	90	110	140	170	Specify value <sup>C</sup>
1	Tensile strength at yield, <sup>B</sup> D 638, min, MPa	unspecified	30	50	70	90	110	140	170	specify value <sup>C</sup>
2	Flexural modulus, <sup>D</sup> D 790, min, GPa	unspecified	0.5	1.0	1.5	3.0	5.0	7.5	10.0	S14.0
2	Tensile modulus, <sup>D</sup> D 790, min, GPa	unspecified	0.5	1.0	2.0	3.0	5.0	7.0	10.0	14.0
3	Izod impact resistance <sup>E</sup> at 23°C, D 256, min J/m	unspecified	80	100	120	150	200	260	320	Specify value <sup>C</sup>
3	Izod impact resistance <sup>E</sup> at 23°C, D 256, min, J/m	unspecified	80	100	120	150	200	260	320	specify value <sup>C</sup>
4	Deflection temperature at 1.82 MPa, D 648, min, °C	unspecified	70	100	130	160	190	220	250	Specify value <sup>C</sup>
4	Deflection temperature at 1.82 MPa, D 648, min, °C	unspecified	70	100	130	160	190	220	250	specify value <sup>C</sup>
5	To be determined	unspecified								Specify value <sup>C</sup>
5	To be determined	unspecified								specify value <sup>C</sup>

<sup>A</sup>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.

<sup>B</sup>Test specimens are Test Method D 638 Type 1 tensile bars and shall be tested at 50 ± 5 mm/min.

<sup>C</sup>If specific value is required, it must appear on the drawing or contract, or both.

<sup>D</sup>Test specimens are center of Test Method D 638 Type 1 tensile bars with nominal 3.2 by 12.7 mm cross section. Span is a nominal 100 mm. Rate of crosshead is 1.3 mm/min, using Method 1. Report 1% secant modulus based on strain, an extensometer (gage length: 50 mm).

<sup>E</sup>Test specimens are nominal 3.2 by 12.7 mm cross section.

## 6. General Requirements

6.1 Basic requirements from the property Tables PK and A 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 PK, A, and suffix requirements as they apply.

7.2 For 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.

7.2.1 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 materials from two or more batches separately prepared.

## 9. Specimen Preparation

9.1 Before processing, the moisture content of the material shall not exceed 0.1 %. If the moisture level exceeds this limit, the sample shall be dried as specified by the resin supplier.

9.2 The test specimens shall be prepared by injection molding process in accordance with Practice D 3641. Recommended processing conditions are shown in Table 1.

9.3 Before injection molding, the moisture content of the material shall not exceed 0.2 %. If the moisture level exceeds this limit, the sample shall be dried as specified by the resin supplier.

NOTE 5—The moisture content can be determined by a gravimetric method by allowing 25 g of material to dry for 1 h at 130°C.

## 10. Conditioning

10.1 Test specimens shall be conditioned in the standard laboratory atmosphere in accordance with Procedure A of Practice D 618 before performing the required tests.

10.2 Conduct those tests influenced by ambient conditions 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 system by means of the test methods referenced in Section 1.1.

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

**TABLE 1 Recommended Processing Conditions**

Melt Temperature, °C	Cycle Time, s	Average Injection Velocity Rate, <sup>A</sup> cm <sup>3</sup> /s	Hold Pressure		Cooling Time, s	Back Pressure, MPa	Mold Temperature, °C
			Time, s	Pressure, MPa			
255 ± 5	≤35	200 ± 100	45 ± 5	70 ± 10	10–15	1–2	80 ± 5
245 ± 5	≤35	6–15	15 ± 5	70 ± 10	10–15	1–2	80 ± 5

<sup>A</sup>For each individual test specimen, 3–4 mm in thickness (Type 1 tensile bar).

## 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 therein.

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:

12.2.1 Melt flow rate, and

12.2.2 Reinforcement content.

12.3 Periodic check inspection with reference to a specification based upon 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 test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and the results of the most recent periodic-check inspection.

## 13. Packaging, Packing, and Marking

13.1 The provisions of Practice D 3892 apply to packaging, packing, and marking of containers for plastic materials.

## 14. Keywords

14.1 classification; classification system; line callout; plastic materials; polyketone

## SUMMARY OF CHANGES

This section identifies the location of selected changes to this classification system. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this classification system. This section may also include descriptions of the changes or reasons for the changes, or both.

### D 5990–98:

(1) Added new section 9.2 and Note 5.

(2) Revised Table 1 to make it more consistent with the new version of Practice D 3641.

(3) Revised Note A of Table PK.

### D 5990–99:

(1) Revised 9.1.

(2) Revised Table 1.

### D 5990 – 00:

(1) Revised Tables PK, A, and Table 1.

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