



Designation: D8033 – 16

Standard Classification System for Poly(Ether Ether Ketone) (PEEK) Molding and Extrusion Materials¹

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1. Scope

1.1 This classification system covers poly(ether ether ketone) materials suitable for injection molding and extrusion. This classification system allows for the use of recycled materials provided that all specification requirements are met.

1.2 The properties included in this standard are those required to identify the compositions covered. Other requirements necessary to identify particular characteristics important to specialized applications are to be specified by using the suffixes in Section 5.

1.3 This classification system and subsequent line callout (specification) are intended to provide means of calling out poly(ether ether ketone) materials used in the fabrication of end items or parts. It is not intended for the selection of materials. It is recommended that material selection be made by those having expertise in the plastics field only 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 cost involved, and the inherent properties of the material other than those covered by this specification.

1.4 Poly(ether ether ketone), commonly referred to as PEEK, is a member of the poly(aryl ether ketone) or PAEK family. Specification D6262 covers properties of PAEK shapes and includes shapes produced from PEEK.

NOTE 1—There is no known ISO equivalent to this standard.

1.5 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.*

¹ This test method 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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2. Referenced Documents

2.1 ASTM Standards:²

- D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
- D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- D257 Test Methods for DC Resistance or Conductance of Insulating Materials
- D570 Test Method for Water Absorption of Plastics
- D618 Practice for Conditioning Plastics for Testing
- D638 Test Method for Tensile Properties of Plastics
- D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
- D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D883 Terminology Relating to Plastics
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
- D3171 Test Methods for Constituent Content of Composite Materials
- D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials
- D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
- D3801 Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position
- D3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer
- D3892 Practice for Packaging/Packing of Plastics

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.

- D4000 Classification System for Specifying Plastic Materials
- D4812 Test Method for Unnotched Cantilever Beam Impact Resistance of Plastics
- D5630 Test Method for Ash Content in Plastics
- D5740 Guide for Writing Material Standards in the Classification Format
- D6262 Specification for Extruded, Compression Molded, and Injection Molded Basic Shapes of Poly(aryl ether ketone) (PAEK)
- D6869 Test Method for Coulometric and Volumetric Determination of Moisture in Plastics Using the Karl Fischer Reaction (the Reaction of Iodine with Water)
- D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)³
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- 2.2 *Underwriters' Laboratories Standards*.⁴
- UL94 Standard for Tests for Flammability of Plastic Materials

3. Terminology

3.1 Except for terms defined below, the terminology used in this classification system is in accordance with Terminologies D883 and D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *poly(ether ether ketone), n*—a polymer in which the repeated structural unit contains an aromatic ketone and two aromatic ether linkages. (C₁₉H₁₂O₃)

4. Classification

4.1 Poly(ether ether ketone) materials are classified into groups that are subdivided into classes and grades as shown in the Basic Property Table (Table PEEK).

NOTE 2—An example of a specification based on this classification system is given below. The specification PEEK012GF30 indicates the following:

PEEK	= Poly(ether ether Ketone) as found in Terminology D1600
01 (Group)	= General Purpose
2 (Class)	= Low Flow
GF30 (Grade)	= 30 % Glass-Filled, with corresponding requirements shown in Table PEEK.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.

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 PEEK. The basic properties for these materials are obtained from Table A as they apply.

4.2 Table A shall be used to specify the physical property requirements that shall be shown by a six-character designation. The designation shall consist 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.

4.2.1 Reinforced filled and lubricated variations of the basic materials are identified by a single letter from Table 1 that indicates the filler and/or reinforcement used and two digits that indicate the nominal quantity in percent by weight. A second letter, from Table 1a, when desired, is used to indicate the form or structure of the reinforcement and/or filler, but is not used for functional mixtures. Thus, the letter designation G for glass, E for beads or spheres or balls, and 33 for percent by weight, specifies a reinforced or filled material with 33 percent by weight in the form of glass beads, spheres, or balls. The reinforcement letter designations and associated tolerance levels are shown in Table 1. Form and structure letter designations are shown in Table 1a.

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 are often shown on the supplier’s technical data sheet unless they are proprietary in nature. If necessary, additional callout of these reinforcement and additives is accomplished by use of the suffix part of the system (see Section 5).

4.2.2 Although the values listed in Table A are necessary to include the range of properties available in existing materials, this does not imply 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 “0” grade shall be used for the reinforced materials in this system.

NOTE 4—An example of the use of this classification system for specifying a special poly(ether ether ketone) plastics material is given as follows. The specification PEEK0120GF30A43460 would have the following material requirements:

PEEK0120	= poly(ether ether ketone) from Table PEEK,
GF30	= glass reinforced at the 30 % nominal level,
A	= Table A property requirements,
4	= tensile strength, 130 MPa min,
3	= flexural modulus, 4.5 GPa min,
4	= Izod impact, 60 J/m min,
6	= deflection temperature, 275°C min, and
0	= unspecified.

If no properties are specified, the designation would be: PEEK0120GF30A00000.

TABLE PEEK Requirements for Poly(Ether Ether Ketone) Plastics

Group	Description	Class	Description	Grade	Description	Melt Viscosity, ^A Pa·s	Deflection Temperature, ^B °C, min	Tensile Strength, ^C MPa, min	Flexural Modulus, ^D GPa, min	Izod Impact, ^E J/m, min	Specific Gravity ^F		
01	General Purpose	1	Very Low Flow	1	Unfilled	400-650	149	80	3.4	80	1.27-1.32		
				0	Other								
		2	Low Flow	1	Unfilled	300-500	149	90	3.4	53	1.28-1.32		
				CF20	20 % Carbon Fiber	475-930	300	164	10.0	6.4	1.34-1.39		
				CF30	30 % Carbon Fiber	480-1360	300	194	13.1	80	1.38-1.43		
				CF40	40 % Carbon Fiber	550-1280	300	190	20.0	80	1.43-1.47		
				GF15	15 % Glass Fiber	270-900	300	100	4.5	50	1.34-1.42		
				GF20	20 % Glass Fiber	310-1000	300	120	5.0	60	1.40-1.46		
				GF30	30 % Glass Fiber	425-1200	300	155	9.0	88	1.48-1.54		
				0	Other								
				3	Intermediate Flow	1	Unfilled	275-410	149	93	3.4	53	1.28-1.32
						2	Unfilled	220-330	149	93	3.4	43	1.28-1.32
		0	Other										
		4	High Flow	1	Unfilled	105-180	149	93	3.4	37	1.28-1.32		
				CF30	30 % Carbon Fiber	200-700	300	217	18.9	59	1.37-1.43		
				GF15	15 % Glass Fiber	120-390	300	90	5.0	40	1.37-1.43		
				GF20	20 % Glass Fiber	140-390	300	120	5.0	55	1.40-1.48		
				GF30	30 % Glass Fiber	175-500	300	155	9.0	75	1.48-1.55		
				0	Other								
				5	Very High Flow	1	Unfilled	70-120	149	85	3.1	25	1.25-1.32
CF30	30 % Carbon Fiber					90-400	300	200	15.0	50	1.37-1.43		
GF30	30 % Glass Fiber	90-320	300			165	9.5	65	1.47-1.56				
GF60	60 % Glass Fiber	315-690	300			180	15.0	65	1.70-1.90				
0	Other												
02	Wear Resistant	1	Low Flow	L10	Reduced Friction	140-625	145	85	3.1	130	1.33-1.37		
				L20	Reduced Friction	280-625	145	70	2.8	50	1.37-1.43		
				R30	Reduced Friction	210-720	270	125	6.2	53	1.42-1.48		
				R45	Reduced Friction	180-650	280	145	17.0	53	1.48-1.52		
				0	Other								
		2	High Flow	R30	Reduced Friction	160-400	270	115	6.5	40	1.41-1.48		
				0	Other								
		3	High Flow, High Modulus	R30	Reduced Friction	160-400	270	140	11.5	35	1.37-1.47		
				0	Other								
				0	Other								
00	Other	0	0	Other									

Physical properties, other than melt viscosity, were determined using injection molded specimens.

^ATest Method D3835 conditions 400°C and 1000/s.

^BTest Method D648 Method A at 264 psi, measured on 3.2 mm specimens annealed for 2 hours at 200°C.

^CTest Method D638 Unreinforced tested at 50 mm/min. Reinforced tested at 5.0 mm/min. For unreinforced materials tensile strength is reported as stress at yield; for reinforced materials tensile strength is reported as stress at break.

^DTest Method D790.

^ETest Method D256.

^FTest Method D792.

TABLE A Detail Requirements of Special Poly(Ether Ether Ketone) Plastics Using ASTM Methods

Designation or Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ^A D638, min, MPa ^B	unspecified	70	90	110	130	150	170	190	210	specify value
2	Flexural modulus, ^C D790, (A), min, GPa ^B	unspecified	3.0	3.5	4.5	5.5	7.0	9.0	11.0	13.0	specify value
3	Izod impact resistance, ^D D256, min, J/m ^E	unspecified	30	40	50	60	80	100	120	150	specify value
4	Deflection temperature at 1.8 MPa, ^F D648, min, °C	unspecified	140	150	200	245	260	275	290	305	specify value
5	To be determined	unspecified

^AType I D638 test specimens, unreinforced tested at 50 mm/min, Reinforced tested at 5.0 mm/min.

^BMPa × 145 = psi.

^CTest specimens are nominal 3.2 mm in depth by 12.7 mm wide. Span is a nominal 50 mm. Rate of crosshead is 0.05 mm/min using Method 1.

^DTest specimens are nominal 3.2 mm wide with a depth of 12.7 mm.

^EJ/m × (1.873 × 10⁻²) = ft lb/in. or ft lb/in. × 53.38 = J/m.

^FTest specimens are nominal 3.2 mm deep by 12.7 mm wide. Measured on specimens annealed for 2 hours at 200°C.