



Designation: D 5205 – 96

Standard Classification System for Polyetherimide (PEI) Materials¹

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1. Scope

1.1 This classification system covers unfilled, filled, and reinforced polyetherimide materials suitable for injection molding and extrusion.

1.2 This classification system is not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials is to be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered.

1.3 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 specific applications. These may be specified by using suffixes as described in Section 5.

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 methods portion, Section 12, 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.* Specific precautionary statements are given in Note 4.

2. Referenced Documents

2.1 ASTM Standards:

- D 149 Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²
- D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials²
- D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials²
- D 618 Practice for Conditioning Plastics and Electrical

Insulating Materials for Testing³

- D 638 Test Method for Tensile Properties of Plastics³
 - D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load³
 - D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials³
 - D 792 Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement³
 - D 883 Terminology Relating to Plastics³
 - D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer³
 - D 1600 Terminology for Abbreviated Terms Relating to Plastics³
 - D 1897 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials⁴
 - D 2584 Test Method for Ignition Loss of Cured Reinforced Resins⁵
 - D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)⁵
 - D 3892 Practice for Packaging/Packing of Plastics⁵
 - D 4000 Classification System for Specifying Plastic Materials⁵
 - E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁶
 - E 662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials⁷
- #### 2.2 Military Standards:⁸
- MIL-P-46184 Plastic Molding and Extrusion Materials, Polyetherimide (PEI).
 - MIL-M-24519 Molding Plastics, Electrical, Thermoplastic
- #### 2.3 Underwriters Laboratories Standards:
- UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances⁹

¹ This classification system is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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² *Annual Book of ASTM Standards*, Vol 10.01.

³ *Annual Book of ASTM Standards*, Vol 08.01.

⁴ *Discontinued*—See 1991 *Annual Book of ASTM Standards*, Vol 08.02.

⁵ *Annual Book of ASTM Standards*, Vol 08.02.

⁶ *Annual Book of ASTM Standards*, Vol 14.02.

⁷ *Annual Book of ASTM Standards*, Vol 04.07.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁹ Available from Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60066.



3. Terminology

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

3.2 *Abbreviations: Abbreviation*—The polyetherimide materials will be designated “PEI” as specified in Terminology D 1600.

4. Classification

4.1 Unfilled polyetherimide materials are classified into groups according to their composition. These groups are subdivided into classes and grades as shown in Table PEI.

NOTE 1—An example of this classification system is given as follows. The designation PEI 0114 indicates the following:

- PEI = polyetherimide as found in Terminology D 1600,
- 01 = polyetherimide (group),
- 1 = general purpose (class), and
- 4 = requirements given in Table PEI (grade).

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

4.2 Reinforced, pigmented, filled, and lubricated versions of polyetherimide materials are classified in accordance with Tables PEI and A or B. Table PEI is used to specify the unreinforced material and Table A or B 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 A single letter shall be used to indicate the major category of the reinforcement, along with two numbers that indicate the percentage of additive(s) by mass, with the tolerances as tabulated as follows:

Category	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber-reinforced	±2 percentage points
G	Glass-reinforced	
	< 15 % glass content	±2 percentage points
	> 15 % glass content	±3 percentage points
L	Lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide)	Variable. To be specified by user.
M	Mineral-reinforced	±2 percentage points
R	Reinforced-combination/mixtures of reinforcements or other fillers/ reinforcements	±3 percentage points based on the total reinforcement

NOTE 2—If necessary, additional requirements may be specified using suffixes as described in Section 5. Special agreements on tolerances may be required when levels are below 5 %. Ash content of filled or reinforced materials may be determined using Test Method D 2584 where applicable.

4.2.2 Specific requirements for reinforced, filled, or lubricated polyetherimide 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 PEI or 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 basic materials is not shown, or is not important, the use of “O”-grade classification shall be used for reinforced materials in this system.

NOTE 3—An example of this classification for a polyetherimide material is given as follows. The designation PEI0110G10A48266 would indicate the following material requirements:

- PEI 0110 = general-purpose polyetherimide from Table PEI,
- G10 = glass reinforced at nominal 10 % level,
- A = Table A property requirements,
- 4 = 110-MPa tensile strength, min,
- 8 = 13790-MPa flexural modulus, min,
- 2 = 4 g/10 min; melt flow, min,
- 6 = 205-MPa flexural strength, min, and
- 6 = 230°C deflection temperature, min.

If no properties are specified, the designation would be PEI0110G10A00000.

5. Suffixes

5.1 When requirements not covered by the basic cell tables need to be specified, suffixes shall be used. The following suffixes shall be used when appropriate. Additional suffixes may also be defined according to Classification System D 4000 when needed.

5.1.1 *E* = Electrical requirements as designated by the following digits:

- | | |
|---|---|
| | First Digit |
| 0 | = specimen to be specified by user |
| 1 | = specimens as appropriate for test methods as defined in Table 1 |
| | Second Digit |
| 0 | = to be specified by user |
| 1 | = meets requirements of Table 1, Column A |
| 2 | = meets requirements of Table 1, Column B |
| 3 | = meets requirements of Table 1, Column C |
| 4 | = meets requirements of Table 1, Column D |
| 5 | = meets requirements of Table 1, Column E |

5.1.2 *F* = Flammability requirements as designated by the following digits:

NOTE 4—**Precaution:** By publication of this classification system and its use of flammability ratings, ASTM does not intend that their use in any way reflects hazards presented under actual fire conditions.

- | | |
|---|--|
| | First Digit |
| 0 | = to be specified by user, |
| 1 | = product is tested according to UL94 at 3.05-mm minimum thickness, |
| 2 | = product is tested according to UL94 at 1.47-mm minimum thickness, |
| 3 | = product is tested according to UL94 at 0.71-mm minimum thickness, |
| 4 | = product is tested according to Test Method D 2863, |
| 5 | = product is tested according to Test Method E 662. |
| | Second Digit |
| 0 | = To be specified by user |
| 1 | = 94V-0 flammability class |
| 2 | = 94V-1 flammability class |
| 3 | = 94V-2 flammability class |
| 4 | = 94-5V flammability class |
| 5 | = Oxygen index 44 % minimum |
| 6 | = Specific optical density, flaming mode, $D_4 \leq 2$, $D_{max} \leq 50$. |

6. General Requirements

6.1 The plastic compositions shall be uniform and shall conform to the requirements specified herein.



TABLE PEI Polyetherimide Materials Detail Requirements

NOTE 1—The values listed were developed for “natural colors.” Pigments or other additives, or both, may alter these properties.

Group	Description	Class	Description ^A	Grade	Description	Flow-Rate, ^B Test Method D 1238, g/10, min	Specific Gravity, Test Method D 792	Deflection ^A Temperature (DTUL), min, Test Method D 648, °C, min	Tensile ^B Strength, Test Method D 638, MPa, min	Flexural ^C Strength, Test Methods D 790, MPa, min	Flexural ^E Modulus, Test Methods D 790, MPa, min		
01	Polyetherimide	1	General-Purpose	1		< 2	1.25–1.30	194	103	152	3030		
				2		2–8	1.25–1.30	194	103	152	3030		
				3		6–12	1.25–1.30	194	103	152	3030		
				4		10–16	1.25–1.30	194	103	152	3030		
				5		15–22	1.25–1.30	194	103	152	3030		
				6		20–30	1.25–1.30	192	90	138	2900		
				7		> 30	1.25–1.30	190	83	138	2900		
		2	Impact-Modified	0	Other	1		< 2	1.22–1.28	180	83	117	2410
				2		2–8	1.22–1.28	180	83	117	2410		
				3		6–12	1.22–1.28	180	83	117	2410		
				4		10–16	1.22–1.28	180	83	117	2410		
				5		15–22	1.22–1.28	180	83	117	2410		
				6		20–30	1.22–1.28	180	69	103	2280		
				7		> 30	1.22–1.28	180	69	103	2280		
02	PEI Chemical Resistant	0	Other	0	Other		
				1	General-Purpose	<2	1.25–1.30	198	93	128	2760		
		2	Impact-Modified	2		2–8	1.25–1.30	198	93	128	2760		
				3		6–12	1.25–1.30	198	93	128	2760		
				4		10–16	1.25–1.30	198	93	128	2760		
				5		15–22	1.25–1.30	198	93	128	2760		
				6		20–30	1.25–1.30	196	90	124	2760		
				7		> 30	1.25–1.30	196	90	124	2760		
				0	Other	1		< 2	1.22–1.28	184	69	90	2070
		03	PEI Heat-Resistant	3	High-Heat Resistant	2		2–8	1.22–1.28	184	69	90	2070
						3		6–12	1.22–1.28	184	69	90	2070
						4		10–16	1.22–1.28	184	69	90	2070
						5		15–22	1.22–1.28	184	69	90	2070
						6		20–30	1.22–1.28	184	69	90	2070
7						> 30	1.22–1.28	184	69	90	2070		
0	Other					1		< 2	1.27–1.32	215	97	145	2760
4	High-Heat Impact-Modified			2		2–8	1.27–1.32	215	97	145	2760		
				3		6–12	1.27–1.32	215	97	145	2760		
				4		10–16	1.27–1.32	215	97	145	2760		
				5		15–22	1.27–1.32	215	97	145	2760		
				6		20–30	1.27–1.32	215	97	145	2760		
				7		> 30	1.27–1.32	215	97	145	2760		
				0	Other	1		< 2	1.23–1.30	200	69	103	2070
03	PEI Heat-Resistant	1	General-Purpose	2		2–8	1.23–1.30	200	69	103	2070		
				3		6–12	1.23–1.30	200	69	103	2070		
		2	Impact-Modified	4		10–16	1.23–1.30	200	69	103	2070		
				5		15–22	1.23–1.30	200	69	103	2070		
				6		20–30	1.23–1.30	200	69	103	2070		
				7		> 30	1.23–1.30	200	69	103	2070		
				0	Other	1		< 2	1.27–1.31	210	103	145	2760
				3	High-Heat Resistant	2		2–8	1.27–1.31	210	103	145	2760
						3		6–12	1.27–1.31	210	103	145	2760
		4				10–16	1.27–1.31	210	103	145	2760		
		5				15–22	1.27–1.31	210	103	145	2760		
		6				20–30	1.27–1.31	210	90	131	2760		
		7				> 30	1.27–1.31	210	90	131	2760		
		0	Other			1		< 2	1.27–1.31	210	103	145	2760