



Designation: D5927 – 09

# Standard Classification System for Thermoplastic Polyester (TPES) Injection and Extrusion Materials Based on ISO Test Methods<sup>1</sup>

This standard is issued under the fixed designation D5927; 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.

## INTRODUCTION

This material specification is intended to provide a callout system for thermoplastic polyester materials based on ISO test methods.

### 1. Scope\*

1.1 This specification covers thermoplastic polyester materials suitable for molding or extrusion.

1.2 This specification allows for the use of recycled thermoplastic polyester materials provided that the requirements as stated in this specification are met. The proportions of recycled material used, as well as the nature and amount of any contaminant, however, cannot be covered practically in this specification.

1.3 The properties included in this specification 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.

1.4 This classification system and subsequent line callout (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 performance required of the part, the environment to which it will be exposed, the fabrication process to be used, the costs involved, and the inherent properties of the material other than those covered by this specification.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 The following hazards caveat pertains only to the test methods portion, Section 11, of this specification: *This stan-*

*ard 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 specification is similar to ISO 7792-1:1995 and ISO 7792-2:1988, although the technical content is significantly different.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3892 Practice for Packaging/Packing of Plastics

D4000 Classification System for Specifying Plastic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

#### 2.2 IEC and ISO Standards:<sup>3</sup>

IEC 112 Recommended Method for Determining the Comparative Tracking Index of Solid Insulation Materials

IEC 243 Recommended Methods of Test for Electrical Strength of Solid Insulating Materials at Power Frequencies

ISO 62 Plastics—Determination of Water Absorption

ISO 75-1:1993 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Methods

ISO 75-2:1993 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastics and Ebonite

ISO 179-1:1993 Plastics—Determination of Charpy Impact Strength

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

Current edition approved Feb. 1, 2009. Published February 2009. Originally approved in 1996. Last previous edition approved in 2003 as D5927 – 03. DOI: 10.1520/D5927-09.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

ISO 291:1997 Plastics—Standard Atmospheres for Conditioning and Testing

ISO 294-1:1996 Plastics—Injection Moulding of Test Specimens of Thermoplastic Materials—Part 1: General Principles, Multipurpose-Test Specimens (ISO Mould Type A) and Bars (ISO Mould Type B)

ISO 527-1:1993 Plastics—Determination of Tensile Properties—Part 1: General Principles

ISO 527-2:1993 Plastics—Determination of Tensile Properties—Part 2: Testing Conditions

ISO 604 Plastics—Determination of Compressive Properties

ISO 1133:1997 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics

ISO 1183:1987 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics

ISO 3451-4 Plastics—Determination of Ash—Part 2: Polyalkylene Terephthalates

ISO 7792-1:1995 Plastics—Saturated Polyester (SP) Moulding and Extrusion Materials—Part 1: Designation System and Basis for Specification

ISO 7792-2:1988 Plastics—Polyalkylene Terephthalates—Part 2: Preparation of Test Specimens and Determination of Properties

2.3 *Underwriters Laboratories (UL)*:<sup>4</sup>

UL 94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances

2.4 *National Technical Information Service (NTIS)*:<sup>5</sup>

AD297457 Procedure and Analytical Method for Determining Toxic Gases Produced by Synthetic Compounds

### 3. Terminology

3.1 *Definitions*—The terminology used in this specification is in accordance with Terminologies D883 and D1600.

### 4. Classification

4.1 Thermoplastic polyester materials are classified into groups according to their composition. These groups are subdivided into classes and grades, as indicated in the basic property table (Table TPES).

NOTE 2—An example of this classification system is as follows. The designation TPES 0113 would indicate:

TPES	= thermoplastic polyester as found in Terminology D1600,
01 (group)	= PBT,
1 (class)	= general purpose, and
3 (grade)	= requirements given in Table TPES.

4.1.1 Grades of reinforced or filled versions, or both, of the basic materials are identified by a single letter that indicates the reinforcement or filler used and two digits, in multiples of five, that indicate the nominal quantity in percent by weight. Thus, a letter designation G for glass reinforced and 35 for percent or reinforcement, G35, specifies a material with a nominal glass

level of 35 %. The reinforcement letter designations and associated tolerance levels are shown as tabulated 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 on material and process—to be specified
M	mineral-reinforced	±2 %
R	combinations of reinforcements or fillers, or both	±3 %

NOTE 3—An example of this classification system for reinforced thermoplastic polyester is given as follows. The designation TPES 021G30 indicates the following:

TPES	= thermoplastic polyester as found in Terminology D1600,
02 (group)	= PET,
1 (class)	= unmodified, and
G30 (grade)	= nominal 30 % glass with the requirements given in Table TPES.

NOTE 4—This part of the classification system uses the percent of reinforcements or fillers, or both, in the callout of the modified base material. The types and percentages of reinforcements and fillers 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 5).

NOTE 5—Materials containing reinforcements or fillers, or both, at nominal levels not in multiples of five are included in the nearest TPES designation. For example, a material with a nominal glass content of 28 % is included with Grade G30.

NOTE 6—The ash content of filled or reinforced materials may be determined using ISO 3451-4.

4.2 Variations of thermoplastic polyester materials that are not included in Table TPES are classified in accordance with Table TPES and Table A or B. Table TPES is used to specify the group of thermoplastic polyester, and Table A or B is used to specify property requirements.

4.2.1 Specific requirements for variations of thermoplastic polyester materials shall be indicated by a six-character designator. 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 Table A or B.

4.2.1.1 Although the values listed are necessary to include the range of properties available in existing material, users should not infer that every possible combination of the properties exists or can be obtained.

4.2.2 When the grade of the basic material is not known or is not important, the use of "0" grade classification shall be used for materials in this system (see Note 7).

<sup>4</sup> Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

<sup>5</sup> Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, <http://www.ntis.gov>.

**TABLE A Detailed Requirements:<sup>A</sup> Reinforced or Filled Thermoplastic Polyesters**

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527-1:1993 and ISO 527-2:1993, min, MPa <sup>B</sup>	unspecified	35	50	70	95	115	140	175	210	specify value <sup>C</sup>
2	Tensile modulus, ISO 527-1:1993 and ISO 527-2:1993, min, MPa <sup>D</sup>	unspecified	1 400	2 700	4 100	5 500	6 900	8 000	10 000	12 500	specify value <sup>C</sup>
3	Charpy impact, ISO 179:1993, min, kJ/m <sup>2E</sup>	unspecified	1.5	3.0	4.5	6.0	8.5	11.0	13.5	17.5	specify value <sup>C</sup>
4	Deflection temperature under load at 1.8 MPa, ISO 75-1:1993 and ISO 75-2:1993, min, °C <sup>F</sup>	unspecified	50	100	120	150	185	205	220	235	specify value <sup>C</sup>
5	To be determined	...	...	...	...	...	...	...	...	...	...

<sup>A</sup> It is recognized that detailed test values, particularly Charpy impact, may not predict nor even correlate with the performance of parts molded of these materials.

<sup>B</sup> Tensile strength shall be determined using a Type 1A tensile specimen as described in ISO 527-2:1993. Crosshead speed shall be 5 mm/min ± 20 %.

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

<sup>D</sup> Tensile modulus shall be determined using a Type 1A tensile specimen as described in ISO 527-2:1993 at a test speed of 1 mm/min ± 20 %.

<sup>E</sup> The test specimen shall be 80 ± 2 by 10 ± 0.2 by 4 ± 0.2 mm, cut from the center of the Type 1A tensile specimen and tested as described in ISO 179:1993, Method 1eA.

<sup>F</sup> The test specimen size shall be 80 ± 2 by 10 ± 0.2 by 4 ± 0.2 mm, cut from the center of the Type 1A tensile specimen. The requirements are based on unannealed test specimens.

**TABLE B Detailed Requirements:<sup>A</sup> Special Thermoplastic Polyesters**

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527-1:1993 and ISO 527-2:1993, min, MPa <sup>B</sup>	unspecified	10	30	35	40	45	50	60	80	specify value <sup>C</sup>
2	Tensile modulus, ISO 527-1:1993 and ISO 527-2:1993, min, MPa <sup>D</sup>	unspecified	100	350	1000	1500	2000	2500	3000	4000	specify value <sup>C</sup>
3	Charpy impact, ISO 179:1993, min, kJ/m <sup>2E</sup>	unspecified	2.0	3.5	5.0	8.0	13.0	18.0	25.0	50.0	specify value <sup>C</sup>
4	Deflection temperature under load at 1.8 MPa, ISO 75-1:1993 and ISO 75-2:1993, min, °C <sup>F</sup>	unspecified	30	45	60	70	80	90	100	115	specify value <sup>C</sup>
5	To be determined	...	...	...	...	...	...	...	...	...	...

<sup>A</sup> It is recognized that detailed test values, particularly Charpy impact, may not predict nor even correlate with the performance of parts molded of these materials.

<sup>B</sup> Tensile strength shall be determined using a Type 1A tensile specimen as described in ISO 527-2:1993. Crosshead speed shall be 50 mm/min ± 10 %.

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

<sup>D</sup> Tensile modulus shall be determined using a Type 1A tensile specimen as described in ISO 527-2:1993 at a test speed of 1 mm/min ± 20 %.

<sup>E</sup> The test specimen shall be 80 ± 2 by 10 ± 0.2 by 4 ± 0.2 mm, cut from the center of the Type 1A tensile specimen and tested as described in ISO 179:1993, Method 1eA.

<sup>F</sup> The test specimen size shall be 80 ± 2 by 10 ± 0.2 by 4 ± 0.2 mm, cut from the center of the Type 1A tensile specimen. The requirements are based on unannealed test specimens.

**TABLE 1 Recommended Processing Conditions**

Material	Melt Temperature, °C	Mold Temperature, °C	Average Injection Velocity, mm/s	Hold Pressure Time, s	Total Cycle Time, s
PBT, unfilled semicrystalline	260 ± 3	80 ± 5	200 ± 100	20 ± 5	40 ± 5
PBT, filled semicrystalline	260 ± 3	80 ± 5	200 ± 100	20 ± 5	40 ± 5
PET, unfilled amorphous	285 ± 3	20 ± 5	200 ± 100	20 ± 5	40 ± 5
PET, unfilled semicrystalline	275 ± 3	135 ± 5	200 ± 100	20 ± 5	40 ± 5
PET, filled semicrystalline	285 ± 3	135 ± 5	200 ± 100	20 ± 5	40 ± 5
PET, filled semicrystalline, nucleated	285 ± 3	110 ± 5	200 ± 100	20 ± 5	40 ± 5
PET, filled semicrystalline, flame-retarded	275 ± 3	135 ± 5	200 ± 100	20 ± 5	40 ± 5
PET, filled semicrystalline, flame-retarded, nucleated	275 ± 3	110 ± 5	200 ± 100	20 ± 5	40 ± 5
PCT, unfilled amorphous	300 ± 3	20 ± 3	200 ± 100	20 ± 5	40 ± 5
PCT, unfilled semicrystalline	300 ± 3	120 ± 5	200 ± 100	20 ± 5	40 ± 5
PCT, filled semicrystalline	300 ± 3	120 ± 5	200 ± 100	20 ± 5	40 ± 5
PEN, unfilled amorphous	300 ± 3	20 ± 3	200 ± 100	20 ± 5	40 ± 5

NOTE 7—An example of a reinforced thermoplastic polyester of this classification system is as follows. The designation TPES 0310G30A22450 would indicate the following material requirements from Table A:

- TPES0310 = PET copolymer, from Table TPES,
- G30 = glass-reinforced at 30 % nominal glass content,
- A = Table A for property requirements,
- 2 = tensile strength, 50 MPa, min,
- 2 = tensile modulus, 2700 MPa, min,
- 4 = Charpy impact, 6.0 kJ/m<sup>2</sup>, min,
- 5 = deflection temperature, 185°C, at 1.8 MPa, min, and
- 0 = unspecified.

If no properties are specified, the designation would be TPES 0310G30A00000.

4.3 Table B has been incorporated into this specification to facilitate the classification of special materials for which Table TPES or Table A do not reflect the required properties. Table B shall be used in the same manner as Table A.

NOTE 8—The mechanical properties of pigmented or colored thermoplastic polyester materials can differ from the mechanical properties of natural thermoplastic polyester 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 and tensile elongation values. If specific properties of pigmented thermoplastic polyester materials are necessary, prior testing between the materials supplier and end user should be initiated. Once these agreements are reached, a classification using Table B should be used to ensure proper property compliance.

NOTE 9—An example of a special material using this classification system is as follows. The designation TPES0210B54220 would indicate the following material requirements from Table B:

- TPES0210 = PET, unmodified, from Table TPES,
- B = Table B for property requirements,
- 5 = tensile strength, 45 MPa, min,
- 4 = tensile modulus, 1500 MPa, min,
- 2 = Charpy impact, 3.5 kJ/m<sup>2</sup>, min,
- 2 = deflection temperature, 45°C, at 1.8 MPa, min, and
- 0 = unspecified.

TABLE TPES Detail Requirements for Thermoplastic Polyesters<sup>A</sup>

Group	Description	Class	Description	Grade	Description <sup>B</sup>	Flow Rate, ISO 1133:1997, g/10 min	Density, ISO 1183:1987, g/cm <sup>3</sup>	Tensile Strength, ISO 527-1:1993 and ISO 527-2:1993, <sup>C</sup> min, MPa	Tensile Modulus, ISO 527-1:1993 and ISO 527-2:1993, <sup>D</sup> min, MPa	Charpy Impact ISO 179:1993, <sup>E</sup> min, kJ/m <sup>2</sup>	Deflection Temperature at 1.8 MPa, ISO 75-1:1993 and ISO 75-2:1993, <sup>F</sup> min, °C						
01	Polybutylene terephthalate (PBT)	1	general purpose	1	<6 250/2.16 <sup>G</sup>	1.28 to 1.34	45	1 800	3.0	...							
				2	<12 250/2.16 <sup>G</sup>	1.28 to 1.34	45	1 800	3.0	...							
				3	<20 250/2.16 <sup>G</sup>	1.28 to 1.34	45	1 800	3.0	...							
				4	<35 250/2.16 <sup>G</sup>	1.28 to 1.34	45	1 800	3.0	...							
				5	<60 250/2.16 <sup>G</sup>	1.28 to 1.34	45	1 800	3.0	...							
				6	<100 250/2.16 <sup>G</sup>	1.28 to 1.34	45	1 800	3.0	...							
				G10	10 % glass	...	1.34 to 1.38	70	4 000	3.0	145						
				G15	15 % glass	...	1.36 to 1.47	75	4 500	3.0	160						
				G20	20 % glass	...	...	80	6 000	4.5	...						
				G30	30 % glass	...	1.50 to 1.59	85	7 000	6.0	190						
				G40	40 % glass	...	1.58 to 1.65	115	10 000	6.0	190						
		R40	40 % filler	...	1.54 to 1.64	85	9 000	3.0	180								
		0	other	...	...	...	...	...	...								
		2	impact modified	1	unfilled	1	<20 250/5.0 <sup>G</sup>	1.16 to 1.32	20	1 000	45	...					
						G05	5 % glass	...	1.26 to 1.36	35	2 300	7.0	55				
						G10	10 % glass	...	1.25 to 1.35	35	3 500	3.3	85				
						G15	15 % glass	...	1.31 to 1.37	45	3 000	7.0	130				
						G30	30 % glass	...	1.42 to 1.53	70	7 000	7.0	145				
						R40	40 % filler	...	1.49 to 1.59	60	5 000	7.0	150				
						0	other	...	...	...	...	...	...				
						3	flame-retarded	1	unfilled	1	unfilled	1.38 to 1.52	40	2 000	0.7	40	
										G10	10 % glass	...	1.45 to 1.55	60	...	...	130
										G15	15 % glass	...	1.48 to 1.60	62	5 000	3.0	180
G30	30 % glass	...	1.58 to 1.75	85	7 000					4.0	165						
R30	30 % filler	...	1.71 to 1.77	80	8 000					4.0	185						
R35	35 % filler	...	1.60 to 1.77	60	8 000	2.0	175										
0	other	...	...	...	...	...	...										
4	flame-retarded, impact-modified	1	unfilled	1	...	1.26 to 1.36	25	1 200	20	45							
				0	other	...	...	...	...	...							
0	other	0	other	0	other	...	...	...	...								
02	Polyethylene terephthalate (PET)	1	unmodified	1	<20.0 285/2.16 <sup>H</sup>	1.26 to 1.43	50	...	...	60							
				G15	15 % glass	...	1.26 to 1.52	75	4 000	3.0	160						
				G20	20 % glass	...	1.43 to 1.60	80	...	...	190						
				G30	30 % glass	...	1.46 to 1.65	115	7 500	7.0	200						
				G40	40 % glass	...	1.59 to 1.75	120	11 000	5.0	200						
				G45	45 % glass	...	1.64 to 1.85	120	12 000	7.0	210						
				G55	55 % glass	...	1.76 to 1.86	160	15 000	5.0	220						
				R15	15 % filler	...	1.35 to 1.45	70	4 000	1.0	90						
				R35	35 % filler	...	1.53 to 1.65	70	8 500	3.0	165						
				R40	40 % filler	...	1.54 to 1.70	85	10 000	4.0	185						

Group	Description	Class	Description	Grade	Description <sup>B</sup>	Flow Rate, ISO 1133:1997, g/10 min	Density, ISO 1183:1987, g/cm <sup>3</sup>	Tensile Strength, ISO 527-1:1993 and ISO 527-2: 1993, <sup>C</sup> min, MPa	Tensile Modulus, ISO 527-1:1993 and ISO 527-2:1993, <sup>D</sup> min, MPa	Charpy Impact ISO 179:1993, <sup>E</sup> min, kJ/m <sup>2</sup>	Deflection Temperature at 1.8 MPa, ISO 75-1: 1993 and ISO 75-2:1993, <sup>F</sup> min, °C
				R45 0	45 % filler other	...	1.65 to 1.76	90	12 000	3.0	200
		2	impact- modified	G15 G30 G35 0	15 % glass 30 % glass 35 % glass other	... ... ... ...	1.35 to 1.45 1.46 to 1.56 1.49 to 1.59	60 100 85	3 000 7 000 6 000	5.0 9.0 15.0	170 205 200
		3	flame- retarded	G15 G20 G30 G40 G45 R45 0	15 % glass 20 % glass 30 % glass 40 % glass 45 % glass 45 % filler other	... ... ... ... ... ... ...	1.50 to 1.67 1.56 to 1.70 1.62 to 1.78 1.71 to 1.83 1.75 to 1.85 1.70 to 1.91	70 80 95 100 140 80	5 000 8 000 12 000 11 000	3.5 4.0 8.0 3.0	175 190 200 200 215 180
		0	other	0	other	...					
03	PET copolymer	1	PETG <sup>I</sup>	1 0	other other	...	1.20 to 1.35	40			50
		0	other	0	other	...					
04	PBT copolymer	1	general purpose	0	other	...		...			...
		2		G30 0	30 % glass other	...	1.55 to 1.75	90	9 000	2.0	150
		0	other	0	other	...					
05	Blend PBT and polycarbonate (PBT + PC)	1	general purpose	1 G10 G30 0	1 10 % glass 30 % glass other	<28 265/5 <sup>G</sup> ... ...	1.20-1.24 1.25-1.36 1.46-1.54	58 50 80	2 500 2 700 7 000	13 2.0 6.0	90 90 125
		2	impact- modified	1 2 G10 0 0	1 2 10 % glass other other	<17 250/5 <sup>G</sup> <13 265/5 <sup>G</sup> ... ...	1.17-1.21 1.17-1.21 1.27-1.31	47 45 50	1 500 1 200 2 700	44 35 6.0	73 77 89
		0	other	0	other	...					
06	Blend (PBT + PET)	1	general purpose	1 G15 G30 G40 R30 R40 0	1 15 % glass 30 % glass 40 % glass 30 % filler 40 % filler other	... ... ... ... ... ...	... 1.36 to 1.48 1.47 to 1.60 1.58 to 1.70 1.50 to 1.60 1.52 to 1.67	... 60 70 80 90 65	... 8 000 7 000 8 000	... 7.0 4.0 2.0	... 170 180 200 190 180
		2	impact- modified	R30 R40 0	30 % filler 40 % filler other	... ... ...	... 1.49 to 1.67	70 60	6 500	3.0	145 150
		0	other	0	other	...					
08	Blend PBT and thermoplastic elastomer ether ester (PBT + TEEE)	1	general purpose	1 2 3 0	1 2 3 other	<25 240/2.16 <sup>J</sup> <25 250/2.16 <sup>J</sup> <25 250/2.16 <sup>J</sup> ...	1.18 to 1.24 1.0 to 1.3 1.16 to 1.32	10 7 20	200 1 000	30 40	... ... 40 ...
		0	other	0	other	...					G,H,I,J
09	Blend PCTG <sup>K</sup> and PC (PCTG + PC)	1	unmodified	1 2 0	chemical and medium heat resistance chemical and low heat resistance other	... ... ...	1.17 to 1.23 1.18 to 1.24	48 45			75 65
		0	other	0	other	...					
10	Poly(1,4-cyclo- hexylene- dimethylene terephthalate) (PCT)	1	unmodified	1 G15 G20 G30 G40	unfilled 15 % glass 20 % glass 30 % glass 40 % glass	... ... ... ... ...	1.18 to 1.33 1.25 to 1.40 1.30 to 1.45 1.37 to 1.52 1.46 to 1.60	55 70 85 100 115	5 000 7 000	5.5 6.0	60 210 235 240 240

Group	Description	Class	Description	Grade	Description <sup>B</sup>	Flow Rate, ISO 1133:1997, g/10 min	Density, ISO 1183:1987, g/cm <sup>3</sup>	Tensile Strength, ISO 527-1:1993 and ISO 527-2: 1993, <sup>C</sup> min, MPa	Tensile Modulus, ISO 527-1:1993 and ISO 527-2:1993, <sup>D</sup> min, MPa	Charpy Impact ISO 179:1993, <sup>E</sup> min, kJ/m <sup>2</sup>	Deflection Temperature at 1.8 MPa, ISO 75-1: 1993 and ISO 75-2:1993, <sup>F</sup> min, °C
				R30	30 % filler	...	1.37 to 1.52	80			235
				R40	40 % filler	...	1.49 to 1.63	90			240
				0	other						
		2	flame- retarded	G15	15 % glass	...	1.44 to 1.58	70			185
				G20	20 % glass	...	1.47 to 1.61	80			200
				G30	30 % glass	...	1.54 to 1.68	95			220
				G40	40 % glass	...	1.63 to 1.77	100			225
				R40	40 % filler	...	1.65 to 1.80	80			210
				0	other						
		0	other	0	other						
11	PCT copolymer	1	PCTA <sup>L</sup>	1	unfilled	...	1.20 to 1.30	50			60
				G15	15 % glass	...	1.27 to 1.37	55			190
				G20	20 % glass	...	1.37 to 1.41	60			220
				G30	30 % glass	...	1.38 to 1.48	60			250
				0	other						
		2	PCTG <sup>K</sup>	1	unfilled	...	1.16 to 1.30	40			60
				G10	10 % glass	...	1.22 to 1.36	65			70
				G20	20 % glass	...	1.28 to 1.42	85			70
				G30	30 % glass	...	1.38 to 1.52	95			70
				0	other						
		0	other	0	other						
12	Blend	1	unmodified	1	chemical and high heat resistance	...	1.15 to 1.21	47			85
	(PCT + PC)			0	other						
		0	other	0	other						
13	Blend (PBT + PETG)	1		G30	30 % glass	...	1.43 to 1.53	90			150
		0	other	0	other						
14	Blend	1	heat stabilized	G20	20 % glass	...	1.33 to 1.43	90	6300	4.0	145
	(PBT + ASA)	2	heat stabilized	G30	30 % glass	...	1.40 to 1.50	110	8000	5.5	170
		0	other	0	other						

<sup>A</sup> Data on 4-mm test specimens may be limited, and the minimum values may be changed in a later revision after a statistical database of sufficient size is generated.

<sup>B</sup> No descriptions are listed unless needed to describe a special grade under the class. All other grades are listed by requirements.

<sup>C</sup> Tensile strength shall be determined using a Type 1A tensile specimen as described in ISO 527-2:1993. The 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 %.

<sup>D</sup> Tensile modulus shall be determined using a Type 1A tensile specimen as described in ISO 527-2:1993 at a test speed of 1 mm/min ± 20 %.

<sup>E</sup> Charpy shall be determined on a specimen 80 ± 2 by 10 ± 0.2 by 4 ± 0.2 mm, cut from the center of the Type 1A tensile specimen, as described in ISO 179:1993, Method 1eA.

<sup>F</sup> Deflection temperature shall be determined on an unannealed specimen 80 ± 2 by 10 ± 0.2 by 4 ± 0.2 mm, cut from the center of the Type 1A tensile specimen, as described in ISO 75-2:1993, Method Af.

<sup>G</sup> The moisture content of the specimen shall be below 0.02 %.

<sup>H</sup> The moisture content of the specimen shall be below 0.005 %.

<sup>I</sup> Polyethylene terephthalate, glycol modified (PETG).

<sup>J</sup> The moisture content of the specimen shall be below 0.01 %.

<sup>K</sup> Poly(1,4-cyclohexylenedimethylene terephthalate), glycol modified (PCTG).

<sup>L</sup> Poly(1,4-cyclohexylenedimethylene terephthalate), acid modified (PCTA).

## 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 **D4000** (Table 3) and may be used for additional requirements, as

appropriate. Additional suffixes will be added to that classification system as test methods and requirements are developed and requested.