Designation: D5927 – 14

Standard Classification System for and Basis for Specifications for Thermoplastic Polyester (TPES) Injection and Extrusion Materials Based on ISO Test Methods[1]

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 (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

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

1. Scope*

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

1.2 This classification system allows for the use of recycled thermoplastic polyester materials provided that the requirements as stated in this classification system and subsequent line callout (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 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 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 can be made by those having expertise in the plastic field only 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 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 standard and ISO 7792-1:2012 and ISO 7792-2:2012 address the same subject matter, but differ in technical content.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products

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

2.2 *IEC and ISO Standards:*[3]

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

[1] This specification 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] 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.

[3] 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**

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ISO 75-1:2013 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Methods
ISO 75-2:2013 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastics and Ebonite
ISO 179-1:2010 Plastics—Determination of Charpy Impact Strength
ISO 291:2008 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 527-1:2012 Plastics—Determination of Tensile Properties—Part 1: General Principles
ISO 527-2:2012 Plastics—Determination of Tensile Properties—Part 2: Testing Conditions
ISO 604 Plastics—Determination of Compressive Properties
ISO 1133-2:2011 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics—Part 2: Method for Materials Sensitive to Time-Temperature History and/or Moisture
ISO 1183-1:2012 Plastics—Methods for Determining the Density of Non-Cellular Plastics—Part 1: Immersion Method, Liquid Pyknometer Method, and Titration Method
ISO 1183-2:2012 Plastics—Methods for Determining the Density of Non-Cellular Plastics—Part 2: Density Gradient Column Method
ISO 1183-3:2012 Plastics—Methods for Determining the Density of Non-Cellular Plastics—Part 3: Gas Pyknometer Method
ISO 3451-2 Plastics—Determination of Ash—Part 2: Polyalkylene Terephthalates
ISO 7792-1:2012 Plastics—Saturated Polyester (SP) Moulding and Extrusion Materials—Part 1: Designation System and Basis for Specification
ISO 7792-2:2012 Plastics—Polyalkylene Terephthalates—Part 2: Preparation of Test Specimens and Determination of Properties

2.3 *Underwriters Laboratories (UL):*[4]

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

2.4 *National Technical Information Service (NTIS):*[5]

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:

TABLE Reinforcement-Filler[A] Symbols[B] and Tolerances

Symbol	Material	Tolerance
C	Carbon and graphite	±2 %
E	Clay	±2 %
G	Glass	±2 %
K	Calcium carbonate	±2 %
L	Lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide)	depends on material and process—to be specified
M	Mineral	±2 %
P	Mica	±2 %
R	Combinations of reinforcements and/or fillers	±3 %
S	Synthetic organic	±2 %
T	Talcum	±2 %
X	Not specified	To be specified

[A]Ash content of filled and/or reinforced materials can be determined using ISO 3451-2 where applicable.
[B]Additional symbols can be added to this table as required.

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 are sometimes shown on the supplier's technical data sheet. 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 is 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

[4] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.
[5] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, http://www.ntis.gov.

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TABLE A Detailed Requirements:[A] 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 527-1:2012 and ISO 527-2:2012, min, MPa[B]	unspecified	35	50	70	95	115	140	175	210	specify value[C]
2	Tensile modulus, ISO 527-1:2012 and ISO 527-2:2012, min, MPa[D]	unspecified	1 400	2 700	4 100	5 500	6 900	8 000	10 000	12 500	specify value[C]
3	Charpy impact, ISO 179-1:2010, min, kJ/m^2[E]	unspecified	1.5	3.0	4.5	6.0	8.5	11.0	13.5	17.5	specify value[C]
4	Deflection temperature under load at 1.8 MPa, ISO 75-1:2013 and ISO 75-2:2013, min, °C[F]	unspecified	50	100	120	150	185	205	220	235	specify value[C]
5	To be determined	...	...	...	...	...	...	...	...	...	...

[A] It is recognized that detailed test values, particularly Charpy impact, do not necessarily predict nor even correlate with the performance of parts molded of these materials.
[B] Tensile strength shall be determined using a Type 1A tensile specimen as described in ISO 527-2:2012. Crosshead speed shall be 5 mm/min± 20 %.
[C] If a specific value is required, it must appear on the drawing or contract, or both.
[D] Tensile modulus shall be determined using a Type 1A tensile specimen as described in ISO 527-2:2012 at a test speed of 1 mm/min ± 20 %.
[E] 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 179:2010, Method 1eA.
[F] 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:[A] Special Thermoplastic Polyesters

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527-1:2012 and ISO 527-2:2012, min, MPa[B]	unspecified	10	30	35	40	45	50	60	80	specify value[C]
2	Tensile modulus, ISO 527-1:2012 and ISO 527-2:2012, min, MPa[D]	unspecified	100	350	1000	1500	2000	2500	3000	4000	specify value[C]
3	Charpy impact, ISO 179:2010, min, kJ/m^2[E]	unspecified	2.0	3.5	5.0	8.0	13.0	18.0	25.0	50.0	specify value[C]
4	Deflection temperature under load at 1.8 MPa, ISO 75-1:2013 and ISO 75-2:2013, min,° C[F]	unspecified	30	45	60	70	80	90	100	115	specify value[C]
5	To be determined	...	...	...	...	...	...	...	...	...	...

[A] It is recognized that detailed test values, particularly Charpy impact, do not necessarily predict nor even correlate with the performance of parts molded of these materials.
[B] Tensile strength shall be determined using a Type 1A tensile specimen as described in ISO 527-2:2012. Crosshead speed shall be 50 mm/min± 10 %.
[C] If a specific value is required, it must appear on the drawing or contract, or both.
[D] Tensile modulus shall be determined using a Type 1A tensile specimen as described in ISO 527-2:2012 at a test speed of 1 mm/min ± 20 %.
[E] 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 179:2010, Method 1eA.
[F] 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.

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, not 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).

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:

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