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Standard Specification for Polyphthalamide (PPA) Injection Molding Materials¹

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1. Scope*

1.1 This specification covers polyphthalamide materials suitable for injection molding.

1.2 The properties included in this specification are those required to identify the compositions covered. ~~There may be other~~ Other requirements necessary to identify particular characteristics important to specialized applications. These may applications are to be specified by using suffixes as given in Section 5. See Guide D 5740.

~~1.3~~ 1.3 This specification allows for the use of recycled materials provided that all specification requirements are met.

1.4 This specification is intended to be a means of calling out plastics materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection ~~should~~ can 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 costs involved, and the inherent properties of the material other than those covered by this specification, and the economics. ~~specification.~~

1.5 The values stated in SI units are to be regarded as the standard (see IEEE/ASTM SI-10). The values given in parentheses are for information only.

1.6 The following precautionary caveat pertains only to the test methods portion, Section 12, 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.* Specific precautionary statements are given in Note 6.

~~NOTE 1—There is no similar or equivalent ISO standard.~~ 1—There is no known ISO equivalent to this specification.

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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 (Section D20.15.09).

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

2. Referenced Documents

2.1 ASTM Standards:²

- D 256 [Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics](#)
- D 618 [Practice for Conditioning Plastics for Testing](#)
- D 638 [Test Method for Tensile Properties of Plastics](#)
- D 648 [Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position](#)
- D 790 [Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials](#)
- D 792 [Test Methods for Density and Specific Gravity \(Relative Density\) of Plastics by Displacement](#)
- D 883 [Terminology Relating to Plastics](#)
- D 1600 [Terminology for Abbreviated Terms Relating to Plastics](#)
- D 2857 [Practice for Dilute Solution Viscosity of Polymers](#)
- D 3418 [Test Method for Transition Temperatures of Polymers by Differential Scanning Calorimetry](#)—[Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry](#)
- D 3641 [Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials](#)
- D 3801 [Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position](#)
- D 3835 [Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer](#)
- D 3892 [Practice for Packaging/Packing of Plastics](#)
- D 4000 [Classification System for Specifying Plastic Materials](#) ~~D 4019 Test Method for Moisture in Plastics by Coulometric Regeneration of Phosphorus Pentoxide~~
- D 5225 [Test Method for Measuring Solution Viscosity of Polymers with a Differential Viscometer](#)
- D 5630 [Test Method for Ash Content in Thermoplastics](#)
- ~~D 5740 Guide for Writing Material Standards in the D 4000 Format~~—[Test Method for Ash Content in Plastics](#)
- D 5740 [Guide for Writing Material Standards in the Classification D 4000 Format](#)
- D 6869 [Test Method for Coulometric and Volumetric Determination of Moisture in Plastics Using the Karl Fischer Reaction \(the Reaction of Iodine with Water\)](#)
- E 29 [Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)
- IEEE/ASTM SI-10 [Standard for Use of the International System of Units \(SI\): The Modern Metric System](#)

2.2 Underwriters Laboratories Standard:

- UL94 [Standard for Tests for Flammability of Plastic Materials](#)³

2.3 ISO Standards:⁴

- [ISO 75-1 Determination of Temperature of Deflection Under Load – Part 1: General Test Methods](#)
- [ISO 75-2 Determination of Temperature of Deflection Under Load – Part 2: Plastics and Ebonite](#)
- [ISO 179-1 Determination of Charpy Impact Strength—Part 1: Non-Instrumented Impact Test](#)
- [ISO 294-1 Injection Moulding of Test Specimens of Thermoplastic Materials—Part 1: General Principles, Multipurpose-Test Specimens and Bars](#)
- [ISO 527-1 Determination of Tensile Properties—Part 1: General Principles](#)
- [ISO 527-2 Determination of Tensile Properties—Part 2: Testing Conditions](#)
- [ISO 3451-1 Determination of Ash General Methods](#)
- [ISO 3451-4 Determination of Ash, Polyamides](#)
- [ISO 15512 Determination of Water Content](#)

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *polyphthalamide, PPA, n*—a polyamide in which residues of terephthalic acid or isophthalic acid or a combination of the two comprise at least 55 molar percentage of the dicarboxylic acid portion of the repeating structural units in the polymer chain.

4. Classification

4.1 The polyphthalamide materials will be designated “PPA,” as specified in Terminology D 1600.

4.2 Unreinforced polyphthalamide materials are classified into groups according to crystallinity. These groups are subdivided into classes and grades as shown in Table PPA.

NOTE 2—An example of this classification system is as follows:

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 Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

⁴ Available from Mitsubishi Kasei America, Inc., 81 Main St., Suite 401, White Plains, NY 10601.

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

The designation PPA0121 would indicate from Table PPA:

PPA	= Polyphthalamide as found in Terminology D 1600
01 (Group)	= Semicrystalline PPA
2 (Class)	= Low-temperature molding material
1 (Grade)	= With the corresponding requirements shown in Table PPA

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

4.3 Reinforced and lubricated versions of the polyphthalamide materials are classified in accordance with Tables PPA and A, where Table PPA specifies the unreinforced material and Table A the properties after the addition of reinforcements or lubricants at the nominal level indicated (see 4.3.1).

4.3.1 A single letter shall be used to indicate the major reinforcement, or filler, or combinations of reinforcements or fillers, or both, along with two digits that indicate the percentage of additive(s) by total mass, with tolerances as tabulated as follows:

Symbol	Material	Tolerance (Based on the Total Mass)
C	Carbon or graphite fiber	±3 %
G	Glass reinforced	±3 %
L	Lubricants	by agreement between the supplier and the user
M	Mineral	±3 %
R	Combinations of reinforcements or fillers, or both	±3 % for the total reinforcement or filler, or both

TABLE PPA Requirements for Unreinforced Polyphthalamide Resins

Group	Description	Class	Description	Grade	Description	Inherent Viscosity ^A dL/g	Melting Temperature, ^B °C	Glass Transition ^B , T _g , °C
01	semicrystalline	1	high-temperature molding	1		0.80-1.06	305-320	115-130
				2		0.70-1.00	315-330	115-130
	PPA	2	low-temperature molding	0	Other			
				1		0.85-1.05	320-335	90-105
				2		0.80-1.05	320-335	90-105
				3		0.85-0.95	290-305	85-95
		0	Other	0	Other			
00	Other	0	Other	0	Other			

^APractice D 2857 or Test Method D 5225 with conditions as specified in 12.6-12.7 of this specification.

^BTest Method D 3418 using a heating rate of 10°C/min.

TABLE A—Detail Requirements of Special Reinforced PPAs
TABLE A Detail Requirements of Special Reinforced PPAs Using ASTM Methods

NOTE—All mechanical properties are determined on dry-as-molded injection molded specimens.

Property	0	1	2	3	4	5	6	7	8	9
Inherent viscosity, ^A Test Method D 2857, dL/g, min	<i>B</i>	0.60	0.7	0.75	0.8	0.85	0.9	0.95	1	<i>C</i>
Tensile strength, Test Method D 638 ^D , MPa ^E [psi], min	<i>B</i>	45 [6500]	75 [10 900]	90 [13 000]	100 [14 500]	135 [19 600]	200 [29 000]	230 [33 400]	255 [37 000]	<i>C</i>
Tensile strength, Test Method D 638 ^D , MPa ^E (psi), min	<i>B</i>	45 (6500)	75 (10 900)	90 (13 000)	100 (14 500)	135 (19 600)	200 (29 000)	230 (33 400)	255 (37 000)	<i>C</i>
Flexural modulus, Test Method D 790 ^F , GPa [kpsi], min	<i>B</i>	1.5 [218]	2.5 [363]	3.0 [435]	5.5 [798]	6.5 [943]	10.0 [1450]	13.5 [1958]	15.0 [2175]	<i>C</i>
Flexural modulus, Test Method D 790 ^F , GPa (kpsi), min	<i>B</i>	1.5 (218)	2.5 (363)	3.0 (435)	5.5 (798)	6.5 (943)	10.0 (1450)	13.5 (1958)	15.0 (2175)	<i>C</i>
Izod impact, Test Method D 256 ^G J/m ^H [ft-lbf/in], min	<i>B</i>	20 [0.38]	40 [0.75]	60 [1.1]	90 [1.6]	100 [1.9]	350 [6.6]	500 [9.4]	650 [12.1]	<i>C</i>
Izod impact, Test Method D 256 ^G J/m ^H (ft-lbf/in), min	<i>B</i>	20 (0.38)	40 (0.75)	60 (1.1)	90 (1.6)	100 (1.9)	350 (6.6)	500 (9.4)	650 (12.1)	<i>C</i>
Deflection Temperature Test Method D 648 ^I , °C, min	<i>B</i>	100	125	160	185	210	235	260	285	<i>C</i>

^ASee 12.6-12.7 of this specification for specific conditions.

^BUnspecified requirement.

^CSpecific value must be given in call-out.

^DTest Method D 638, Type I tensile bar. The speed of testing shall be as described in 12.2 of this specification.

^EMPa × 145 = psi.

^FTest Method D 790 with a 1-mm [0.05-in./min(0.05-in.)/min] testing speed.

^GTest Methods D 256, Test Method A.

^HJ/m × 0.01873 = ft-lb/in.

^ITest Method D 648, using 1820-kPa [264-psi] stress-, using 1820-kPa (264-psi) stress.

TABLE B Detail Requirements of Special Reinforced PPAs Using ISO Methods

NOTE—All mechanical properties are determined on dry-as-molded injection molded specimens.

Property	0	1	2	3	4	5	6	7	8	9
Tensile strength, ISO 527 MPa min ^A	<i>B</i>	45	75	90	100	135	200	230	255	<i>C</i>
Tensile modulus, ISO 527 GPa min ^D	<i>B</i>	1.5	3.5	5.5	7.5	9.5	12.0	14.0	18.0	<i>C</i>
Charpy, ISO 179-1, J/m ² , min ^E	<i>B</i>	2.0	4.0	5.5	7.5	9.0	11.0	13.0	15.0	<i>C</i>
Deflection Temperature Under Load, ISO 75-2 method Af, °C, min ^F	<i>B</i>	100	125	160	185	210	235	260	285	<i>C</i>
To be determined	<i>B</i>									<i>C</i>

^AISO 527, Type IA tensile bar. The speed of testing shall be as described in 12.2 of this specification.

^BUnspecified requirement.

^CSpecific value must be given in call-out.

^DISO 527, Type 1A tensile bar. The Speed of testing shall be 1 mm/min.

^EISO 179-1, Test specimen shall be taken from the center portion of multipurpose tensile bar.

^FISO 75-2, The test specimen shall be taken from the center portion of the multipurpose tensile bar, 4 mm thick, and tested in the flatwise position.

4.3.1.1 This part of the specification uses the type and percentage of additive to designate the modification of the basic material. To facilitate this designation, the type and percentage of additive can be shown on the supplier's technical data sheet unless it is proprietary in nature. If necessary, additional requirements shall be indicated by use of the suffix part of the system, as given in Section 5.

4.3.2 *Tables A and B Detail Requirements*—An identifying number is made up of the letter “A” or “B,” depending on whether ASTM or ISO test methods are used, and five digits comprising the cell numbers in the order in which the properties appear.

4.3.2.1 Although the values listed in Tables A and B 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.