



Designation: **D5336 – 09 D5336 – 15**

Standard Classification System and Basis for Specification for Polyphthalamide (PPA) Injection Molding Materials¹

This standard is issued under the fixed designation D5336; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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. Other requirements necessary to identify particular characteristics important to specialized applications are to be specified by using suffixes as given in Section 5. See Guide [D5740](#).
- 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 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.
- 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 known ISO equivalent to this specification.

2. Referenced Documents

2.1 ASTM Standards:²

- [D256 Test Methods for Determining the Izod Pendulum Impact Resistance 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](#)
- [D2857 Practice for Dilute Solution Viscosity of Polymers](#)
- [D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry](#)
- [D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials](#)
- [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](#)

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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.

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

- ~~D4000 Classification System for Specifying Plastic Materials~~
- ~~D5225 Test Method for Measuring Solution Viscosity of Polymers with a Differential Viscometer~~
- ~~D5630 Test Method for Ash Content in Plastics~~
- ~~D5740 Guide for Writing Material Standards in the Classification Format~~
- ~~D6869 Test Method for Coulometric and Volumetric Determination of Moisture in Plastics Using the Karl Fischer Reaction (the Reaction of Iodine with Water)~~
- ~~E29 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 Materials³~~
- ~~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 ~~D883~~ and ~~D1600~~.

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 ~~D1600~~.

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:

The designation PPA0121 would indicate from Table PPA:

PPA	= Polyphthalamide as found in Terminology D1600
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

³ Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

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

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
0†	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		0.80-1.05	320-335	90-105
				2		0.85-0.95	290-305	85-95
				3		0.85-1.05	300-315	85-95
		0	Other		Other			
00	Other	0	Other	0	Other			

^APractice D2857 or Test Method D5225 with conditions as specified in 12.7 of this specification.

^BTest Method D3418 using a heating rate of 10°C/min.

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 D2857, dL/g, min	^B	0.60	0.7	0.75	0.8	0.85	0.9	0.95	†	‡
Tensile strength, Test Method D638 ^D , MPa ^E (psi), min	^B	45 (6500)	75 (10 900)	90 (13 000)	100 (14 500)	135 (19 600)	200 (29 000)	230 (33 400)	255 (37 000)	‡
Flexural modulus, Test Method D790 ^F , GPa (kpsi), min	^B	1.5 (218)	2.5 (363)	3.0 (435)	5.5 (798)	6.5 (943)	10.0 (1450)	13.5 (1958)	15.0 (2175)	‡
Charpy impact, Test Method D256 ^G J/m ^H (ft-lb/in), min	^B	20 (0.38)	40 (0.75)	60 (1.1)	90 (1.6)	100 (1.9)	350 (6.6)	500 (9.4)	650 (12.1)	‡
Deflection Temperature Test Method D648 ^I , °C, min	^B	100	125	160	185	210	235	260	285	‡

^ASee 12.7 of this specification for specific conditions.

^BUnspecified requirement.

^CSpecific value must be given in call-out.

^DTest Method D638, Type I tensile bar. The speed of testing shall be as described in 12.2 of this specification.

^EMPa × 145 = psi.

^FTest Method D790 with a 1-mm (0.05-in.)/min testing speed.

^GTest Methods D256, Test Method A.

^HJ/m × 0.01873 = ft-lb/in.

^ITest Method D648, using 1820-kPa (264-psi) stress.

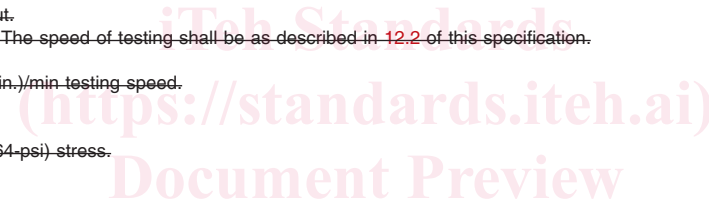


TABLE B—Detail Requirements of Special Reinforced PPAs Using ISO Methods

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	^B	45	75	90	100	135	200	230	255	‡
Tensile modulus, ISO 527 GPa min ^D	^B	1.5	2.5	3.0	5.5	6.5	10.0	13.5	15.0	‡
Charpy, ISO 179-1, J/m ² , min ^E	^B	20	40	60	90	100	350	500	650	‡
Deflection Temperature Under Load, ISO 75-2 method Af, °C, min ^F	^B	100	125	160	185	210	235	260	285	‡
To be determined	^B									

^AISO 527, Type 1A 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, this does not imply that every possible combination of the properties exists or can be obtained.

4.3.3 An example of this classification system for a 33 % glass-reinforced polyphthalamide material, using ASTM test methods (Table A) is as follows:

PPA0121G33A56577

PPA0121	=	Semicrystalline, low-temperature molding grade polyphthalamide from Table PPA;
G33	=	Glass reinforced at 33 % nominal;
A	=	Table A property requirements;
5	=	Inherent viscosity, min 0.85 dL/g;

6	=	Tensile strength, min 200 MPa;
5	=	Flexural modulus, min 6.5 GPa;
7	=	Izod impact, min 500 J/m;
7	=	Deflection temperature, min 260°C, and

If no properties are specified, the designation would be PPA0121G33.

5. Suffixes

5.1 When additional requirements are needed for the materials covered in this specification that are not covered in Tables PPA, A, or B, then those requirements shall be designated through the use of suffixes:

5.1.1 A list of suffixes found in Classification System **D4000** (Table 3) is useful for additional requirements as appropriate.

5.2 Flammability callouts were changed in 2007. Therefore callouts written before 2007 are different from those written in 2007 and later:

5.2.1 If the requirements for the polyphthalamide material in **4.3.3** also included flammability requirements, the following example illustrates the call-out based on ASTM **D4000-04**:

PPA0121G33A06577FL34	
PPA0121G33A06577 = Same as 4.3.3	
F	= Flammability requirements
L	= UL94 recognition required
3	= UL recognition at 0.80 mm min thickness
4	= UL rating 94V-0

5.2.2 The following example illustrates the call-out based on ASTM **D4000-07**:

PPA0121G33A06577FF003	
PPA0121G33A065770 = Same as 4.3.3	
F	= Flammability requirements
F	= Vertical burn rate by ASTM D3801 or UL 94V
0	= Rating of designation V-0
03	= 0.80 mm minimum specimen thickness

6. Basic Requirements

6.1 Basic requirements from Tables PPA and A or B, as they apply, are always in effect unless these requirements are superseded by specific suffix requirements, which always take precedence. Properties in Tables A and B supersede properties in Table PPA when reinforced or filled materials are specified.

7. General Requirements

7.1 The material compositions shall be uniform and shall conform to the requirements specified herein.

8. Detail Requirements

8.1 Test specimens for the various materials shall conform to the requirements prescribed in Tables PPA and A or B, and the suffix requirements as they apply.

8.2 For the purpose of determining conformance, all specified limits in this specification are absolute limits, as defined in Practice **E29**.

8.2.1 With the absolute method, an observed value or a calculated value is not rounded, but is to be compared directly to the specified limiting value. Conformance or nonconformance with this specification is based on this comparison.

9. Sampling

9.1 Sampling shall be statistically adequate to satisfy the requirements of **13.4**. A lot of material shall be considered as a unit of manufacture as prepared for shipment, and is permitted to consist of two or more “production runs” or batches.

10. Specimen Preparation

10.1 Mold test specimens by an injection molding process (see Practice **D3641** or ISO 294). Use the following conditions:

Class	Grade	Melt Temperature °C (°F)	Mold Temperature min., °C (°F)
1	1	325-335 (620-635)	135 (275)
	2	335-345 (635-650)	135 (275)
2	1 and 3	330-345 (625-650)	65 (150)
2	2	320-330 (605-625)	65 (150)

10.2 Materials used in the preparation of test specimens shall contain no more than 0.2 % moisture.

NOTE 3—If the moisture content exceeds the limits previously stated, drying the material by methods such as at a temperature of 80–100°C in vacuum or in a stream, of nitrogen or in a desiccant bed dryer, or both, until the moisture content is within the stated limits have been found to be satisfactory.

11. Conditioning

11.1 Obtain test data using dry-as-molded specimens, defined as those that upon removal from the mold are immediately sealed in containers that are impermeable to water vapor. Condition specimens a minimum of 2 h in sealed containers at $23 \pm 2^\circ\text{C}$ prior to testing.

NOTE 4—Physical properties of polyphthalamides are dependent upon the moisture content of the molded item. Refer to the manufacturers' literature for details.

11.2 Conduct tests in the standard laboratory atmosphere (see Practice D618) of $23 \pm 2^\circ\text{C}$ and $50 \pm 10\%$ relative humidity. Do not remove individual specimens from sealed containers until immediately before testing.

12. Test Methods

12.1 Determine the properties enumerated in this specification by means of test methods referenced.

12.2 *Tensile Strength*—Test Method D638, using a Type I test specimen or ISO 527, using Type 1A specimens. A testing speed of 5 mm (0.2 in.)/min or 50 mm (2.0 in.)/min if elongation exceeds 10 %.

12.3 *Flexural Strength*—Test Methods D790, using a testing speed of 1 mm (0.05 in.)/min.

12.4 *Izod Impact*—Test Methods D256, Test Method A.

12.5 *Charpy Impact*—ISO 179-1, Method 1eA

12.6 *Deflection Temperature*—Test Method D648, using a maximum outer fiber stress of 1.82 Mpa (264 psi), or ISO 75-2, Method Af with a specimen height of 4.0 mm.

NOTE 5—Test Method D648 and ISO 75-2 will probably yield different heat distortion temperatures.

12.7 *Inherent Viscosity (IV)*—Test Method D2857 or D5225 with the following modifications:

12.7.1 *Solvent*—Prepare a filtered solution containing a 60/40 weight percent of phenol/tetrachloroethane (TCE). (**Warning**—Phenol/tetrachloroethane is a very dangerous solvent. It is toxic by ingestion, inhalation, and absorption. Refer to the appropriate material safety data sheet for information on the proper handling of this material.)

12.7.2 *Sample Size*—Use a sample size of 0.400 ± 0.003 g of resin/100 mL of solvent. IV determinations are not recommended for materials that contain fillers or reinforcements. However, if the sample does contain filler, select the appropriate sample size from the following table:

% Ash	Sample Size, g
10	0.4444
20	0.5000
25	0.5333
30	0.5714
35	0.6154
40	0.6666
45	0.7273

NOTE 6—A sample size to produce a resin concentration of 0.4 g/100mL shall be used. The sample sizes shown in the table were calculated by the following equation:

$$\text{sample weight} = \frac{0.4}{100 - \% \text{ filler}} \times 100 \quad (1)$$

12.7.3 Dissolve the sample in the inherent viscosity (IV) solvent by heating and stirring on a hot plate. Monitor the temperature with a surface thermometer to be sure that it does not exceed 130°C .

12.7.4 If the sample contains a filler, it must be filtered to remove the filler after all of the resin has dissolved.

12.7.5 *Calculation*:

$$IV = \ln(S_i/B_i)/C \quad (2)$$

where:

IV = inherent viscosity at 30°C , dL/g;

S_i = average sample flow time, s;

B_i = average blank flow time, s, and

C = polymer concentration, g/dL.

12.8 *Moisture*—Test methods D6869 or ISO 15512, Method B.

13. Inspection and Certification

13.1 Inspection and certification of the materials supplied under this specification shall be for conformance to the requirements specified herein.

13.2 Lot acceptance inspection shall be the basis on which acceptance or rejection of a lot is made. The lot acceptance inspection shall consist of the following tests that ensure process control during manufacturing as well as those necessary to ensure certifiability in accordance with ~~13.4~~:

~~13.2.1 Inherent viscosity only for unreinforced or unfilled polymer as described in Table PPA.~~

~~13.2.2 Moisture content, and~~

~~13.2.3 Filler content (see Test Method [D5630](#) or ISO 3451), when applicable.~~

13.3 A periodic check inspection shall consist of the tests specified for all requirements of the materials under this specification. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with ~~13.4~~.

~~13.4 Certification shall be that the material was manufactured, by a process in statistical control, sampled, tested, and inspected in accordance with this classification system, and that the average values for the lot meet the requirements of the specification (line callout).~~

NOTE 7—The ASTM publication, *Manual on Presentation of Data and Control chart Analysis, 7th Edition*, Stock number MNL7A, provides detailed information about statistical process control.

13.5 A report of test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and the results of the most recent periodic-check inspection.

14. Packaging and Package Marking

14.1 For packing, packaging, and practice marking, the provisions of Practice [D3892](#) apply.

15. Keywords

15.1 inherent viscosity; line call-out; moisture analysis; molding material; plastic; polyphthalamide

1. Scope*

1.1 This classification system covers polyphthalamide materials suitable for injection molding.

1.2 The properties included in this classification system 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 suffixes as given in Section 5. See Guide [D5740](#).

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

1.4 This classification system 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 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 classification system.

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