



Designation: D4066 – 13 (Reapproved 2019)

## Standard Classification System for Nylon Injection and Extrusion Materials (PA)<sup>1</sup>

This standard is issued under the fixed designation D4066; 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 standard is maintained in order to support products that must utilize ASTM D4066 in the product definition. This is necessary because there are some differences between the material property test requirements of ASTM D4066 and ASTM D6779, Standard Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA). There are also differences between the two specifications in some of the Group/Class/Grade callouts. Designers of new products are urged to use ASTM D6779 rather than ASTM D4066.

### 1. Scope

1.1 This classification system covers nylon materials suitable for injection molding and extrusion. Some of these compositions are also suitable for compression molding and application from solution.

1.2 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 specialized applications. These may be specified by using the suffixes as given in Section 5.

1.3 This classification system and subsequent line call-out (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 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.

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 11, 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,*

*health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

NOTE 2—This classification system is being revised to include international 4-mm specimens and test procedures as the standard for compliance. The 3.2-mm specimens; test methods; and Tables PA, A, and B are included in Appendix X3 as a reference for those wishing to use them. It is recommended that the material manufacturer be consulted on all call-outs against this classification system.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

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

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

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

<sup>1</sup> This classification system 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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<sup>2</sup> 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

- D789** Test Method for Determination of Relative Viscosity of Concentrated Polyamide (PA) Solutions
- 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
- 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
- D3892** Practice for Packaging/Packing of Plastics
- D4000** Classification System for Specifying Plastic Materials
- D5630** Test Method for Ash Content in Plastics
- D6260** Test Method for Gravimetric Determination of Carbon Black in Nylon Materials (PA) (Withdrawn 2004)<sup>3</sup>
- D6779** Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- 2.2 *Military and Federal Specifications and Standards:*<sup>4</sup>
- L-P-410** Plastic, Polyamide (Nylon) Rigid: Rods, Tubes, Flats, Molded and Cast Parts
- VV-I-530** Insulating Oil, Electrical (for Transformers, Switches, and Circuit Breakers)
- 2.3 *ISO Standards:*<sup>5</sup>
- 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: Plastic and Ebonite
- ISO 178:1993** Plastics—Determination of Flexural Properties
- ISO 180:1993** Plastics—Determination of Izod Impact Strength
- ISO/DIS 294-1:1995** 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 307** Determination of Viscosity Number of Polyamides In Dilute Solutions
- 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 960:1969** Plastics—Determination of the Water Content in Polyamides

- ISO 1183:1987** Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
- ISO/DIS 1874-2:1995** Plastics—Polyamide (PA) Homopolymers for Moulding and Extrusion—Part 2: Preparation of Test Specimens and Determination of Properties
- ISO 3146:1995** Plastics—Determination of Melting Behaviour (Melting Temperature or Melting Range) of Semi-Crystalline Polymers
- ISO 3167** Plastics, Multipurpose Test Specimens
- ISO 3451-4:1994** Plastics—Determination of Ash—Part 4: Polyamides

### 3. Terminology

3.1 The terminology used in this classification system is in accordance with Terminologies **D883** and **D1600**.

### 4. Classification

4.1 Nylon materials are classified into groups according to their composition. These groups are subdivided into classes and grades as shown in the Basic Property Table (Table PA).

NOTE 3—An example of this classification system for unreinforced nylon is given as follows: The designation PA0123 indicates the following:

- PA = polyamide (nylon) as found in Terminology **D1600**,  
 01 (group) = 66 nylon,  
 2 (class) = heat stabilized, and  
 3 (grade) = with a minimum viscosity number of 210 and the requirements given in Table PA.

NOTE 4—An example of this classification system for reinforced nylon is given as follows: The designation PA012G35 indicates the following:

- PA = polyamide (nylon) as found in Terminology **D1600**,  
 01 (group) = 66 nylon,  
 2 (class) = heat stabilized, and  
 G35 (grade) = nominal 35 % glass with the requirements given in Table PA.

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 5, 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 follows:

Symbol	Material	Tolerance (Based on the Total Mass)
C	carbon- and graphite-fiber-reinforced	±2 %
G	glass-reinforced	±2 %
L	lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide)	Depends upon material and process—to be specified.
M	mineral-reinforced	±2 %
R	combinations of reinforcements or fillers, or both	±3 %

NOTE 5—This part of the classification system uses percent of reinforcements or additives, or both, in the call-out of the modified basic material. The types and percentages of reinforcements and additives should be shown on the supplier's technical data sheet unless they are proprietary in nature. If necessary, additional control of these reinforcements and additives can be accomplished by use of the suffix part of the system (see Section 5).

NOTE 6—Materials containing reinforcements or fillers, or both, at

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

<sup>5</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

nominal levels not in multiples of 5 are included in the nearest PA grade designation. For example, a material with a nominal material level of 28 % is included with Grade M30.

NOTE 7—An example of this classification system for a 33 % glass-reinforced nylon is given as follows. The designation PA011G35 indicates the following:

PA = polyamide (nylon) as found in Terminology **D1600**,  
 01 (group) = 66 nylon,  
 1 (class) = general purpose, and  
 G35 (grade) = with requirements given in Table PA.

NOTE 8—Ash content of filled or reinforced materials may be determined using Test Method **D5630**.

**TABLE PA Requirements for Nylons Dry-as-Molded<sup>A,B</sup>**

Group	Description	Class	Description	Grade	Description <sup>C</sup>	Viscosity Number, ISO 307, min, mL/g	Density, ISO 1183, g/cm <sup>3</sup>	Tensile Strength, <sup>D</sup> ISO 527-1 and ISO 527-2, min, MPa	Flexural Modulus, ISO 178, min, MPa	Izod Impact Resistance, ISO 180/1A, min, kJ/m <sup>2</sup>	Deflection Temperature at 1.82 MPa, <sup>E</sup> ISO 75-1 and ISO 75-2 min, °C
01	66 Nylon	1	General-purpose	1		135	1.13–1.15	70	2 300	3.3	60
				2		165	1.13–1.15	70	2 300	3.3	60
				3		210	1.13–1.15	70	2 300	3.3	60
				4		270	1.13–1.15	70	2 300	3.3	60
				5	recycled	115	1.13–1.15	70	2 300	3.3	60
				6	recycled	135	1.13–1.15	70	2 300	3.3	60
				0	other						
				G15	15 % glass	...	1.20–1.26	100	4 000	3.0	215
				G20	20 % glass	...	1.25–1.33	115	5 000	4.0	220
				G25	25 % glass	...	1.29–1.37	140	6 000	5.0	225
				G35	35 % glass	...	1.35–1.45	170	8 000	7.0	235
				G40	40 % glass	...	1.42–1.52	175	9 000	8.0	235
				G45	45 % glass	...	1.45–1.55	180	10 000	9.0	240
				M40	40 % mineral	...	1.45–1.55	80	5 000	2.0	150
		2	Heat-stabilized	1		135	1.13–1.15	70	2 300	3.0	60
				2		165	1.13–1.15	70	2 300	3.0	60
				3		210	1.13–1.15	70	2 300	3.0	60
				4		270	1.13–1.15	70	2 300	3.0	60
				5	recycled	115	1.13–1.15	70	2 300	3.0	60
				6	recycled	135	1.13–1.15	70	2 300	3.0	60
				0	other						
				G15	15 % glass	...	1.20–1.26	100	4 000	3.0	220
				G25	25 % glass	...	1.29–1.37	140	6 000	5.0	225
				G30	30 % glass	...	1.32–1.42	160	7 000	6.0	230
				G35	35 % glass	...	1.35–1.45	170	8 000	7.0	235
				G40	40 % glass	...	1.43–1.53	175	9 000	8.0	235
				G45	45 % glass	...	1.45–1.55	180	10 000	9.0	240
				M40	40 % mineral	...	1.45–1.55	80	5 000	2.0	150
R20	20 % filler	...	1.23–1.31	70	3 200	1.5	...				
R40	40 % filler	...	1.43–1.53	100	5 500	2.5	200				
3	Nucleated	1		135	1.13–1.15	80	2 500	2.8	60		
		2		165	1.13–1.15	80	2 500	2.8	60		
		3		210	1.13–1.15	80	2 500	2.8	60		
		4		270	1.13–1.15	80	2 500	2.8	60		
		5	recycled	115	1.13–1.15	80	2 500	2.8	60		
		6	recycled	135	1.13–1.15	80	2 500	2.8	60		
		0	other								
4	Nucleated, heat-stabilized	1		Requirements the same as corresponding grades under Group 01, Class 3.							
		2									
		3									
		4									
		0	other								
5	Impact-modified	1		...	1.06–1.12	52	1 700	9.0	50		
		2	recycled	...	1.06–1.12	50	1 600	8.0	50		
		0	other								
		G15	15 % glass	...	1.15–1.23	85	3 000	6.0	210		
		G35	35 % glass	...	1.31–1.41	110	5 500	6.0	225		
6	Impact-modified, heat-stabilized	1		...	1.08–1.12	52	1 700	9.0	50		
		2	recycled	...	1.08–1.12	50	1 600	8.0	50		
		0	other								
		G15	15 % glass	...	1.15–1.23	85	3 000	6.0	210		
		G35	35 % glass	...	1.31–1.41	110	5 500	6.0	225		
		M40	40 % mineral	...	1.45–1.55	75	4 500	4.0	...		
R35	35 % filler	...	1.38–1.48	80	5 500	3.0	200				
7	Toughened	1		...	1.06–1.10	42	1 500	40	45		
		2	recycled	...	1.05–1.11	40	1 300	35	45		
		0	other								
		G15	15 % glass	...	1.15–1.23	70	2 800	9.0	180		
G35	35 % glass	...	1.28–1.38	110	5 500	11	220				