



Standard Classification System for Nylon Injection and Extrusion Materials (PA)¹

This standard is issued under the fixed designation D 4066; 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.

This standard has been approved for use by agencies of the Department of Defense.

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

NOTE 1—This classification system is similar to ISO 1874-1/-2 1993, although the technical content is significantly different.

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 callouts against this classification system.

¹ 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 (Section D20.15.09).

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2. Referenced Documents

2.1 ASTM Standards:

- D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²
- D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials²
- D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics³
- D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials²
- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³
- D 638 Test Method for Tensile Properties of Plastics³
- D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load³
- D 789 Test Methods for Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)³
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials³
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement³
- D 883 Terminology Relating to Plastics⁴
- D 1600 Terminology for Abbreviated Terms Relating to Plastics³
- D 1898 Practice for Sampling of Plastics³
- D 1999 Guide for Selection of Specimens and Test Parameters for International Commerce³
- D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis⁵
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials⁵
- D 3892 Practice for Packaging/Packing of Plastics⁵
- D 4000 Classification System for Specifying Plastic Materials⁵

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Discontinued; see 1997 Annual Book of ASTM Standards, Vol 08.01.

⁵ Annual Book of ASTM Standards, Vol 08.02.

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

- D 5630 Test Method for Ash Content in Thermoplastics⁶
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁷
- 2.2 *Military and Federal Specifications and Standards*:⁸
- 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*:⁹
- 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 1874-1:1992 Plastics—Polyamide (PA) Homopolymers and Copolymers for Moulding and Extrusion Part 1: Designation
- ISO/DIS 1874-2.2:1995 Plastics—Polyamide (PA) Homopolymers for Moulding and Extrusion—Part 2: Preparation of Test Specimens and Determination of Properties
- ISO 3146: 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 D 883 and D 1600.

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 D 1600,
- 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 D 1600,
- 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 callout 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 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 D 1600,
- 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 D 5630.

⁶ Annual Book of ASTM Standards, Vol 08.03.
⁷ Annual Book of ASTM Standards, Vol 14.02.
⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
⁹ Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

TABLE PA Requirements for Nylons Dry-as-Molded^{A,B}

Group	Description	Class	Description	Grade	Description ^C	Viscosity Number, ISO 307, min, mL/g	Density, ISO 1183, g/cm ³	Tensile Strength, ^D ISO 527-1 and ISO 527-2, min, MPa	Flexural Modulus, ISO 178, min, MPa	Izod Impact Resistance, ISO 180/1A, min, kJ/m ²	Deflection Temperature at 1.82 MPa, ^E 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										
		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			
8	Toughened, heat-stabilized	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			

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				G35	35 % glass	...	1.28–1.38	110	5 500	11	220
				G45	45 % glass	...	1.39–1.49	130	8 000	10	230
				M35	35 % mineral	...	1.37–1.47	70	3 800	6.0	...
		9	Weather-stabilized ^F	1		135	1.13–1.17	80	2 400	2.5	60
				2	recycled	115	1.13–1.17	65	2 200	2.0	60
				0	other						
		0	Other	0	other						
02	6 Nylon	1	General-purpose	1		135	1.12–1.14				
				2		175	1.12–1.14	70	2 200	3	50
				3		200	1.12–1.15	70	2 200	3	50
				4		230	1.12–1.15				
				0	other						
				G15	15 % glass		1.20–1.28	110	4 500	4.5	170
				G25	25 % glass		1.28–1.36	140	6 500	6.5	180
				G30	30 % glass		1.32–1.40	150	7 000	7.5	180
				G35	35 % glass		1.38–1.44	155	7 500	8	180
				M30	30 % mineral		1.30–1.40	70	3 200	2.4	50
				R40	40 % glass/mineral		1.42–1.50	100	6 000	3	180
		2	Heat-stabilized	1		135	1.12–1.14				
				2		175	1.12–1.14	70	2 200	3	50
				3		200	1.12–1.15	70	2 200	3	50
				4		230	1.12–1.15				
				0	other						
				G15	15 % glass		1.20–1.28	110	4 500	4.5	180
				G25	25 % glass		1.28–1.36	140	6 500	6.5	190
				G30	30 % glass		1.32–1.40	150	7 000	7.5	190
				G35	35 % glass		1.38–1.44	155	7 500	8	190
				M30	30 % mineral		1.30–1.40	70	3 200	2.4	60
				M40	40 % mineral		1.44–1.52	75	4 500	4.5	70
				R40	40 % glass/mineral		1.42–1.50	100	6 000	3	190
		3	Nucleated and lubricated	1		135	1.12–1.14				
				2		175	1.12–1.14	70	2 300	2.5	50
				3		200	1.12–1.15	75	2 300	2.5	50
				4		230	1.12–1.15	80	2 300	2.5	50
				0	other						
		4	Nucleated and heat-stabilized	1		135					
				2		175	1.12–1.14	70	2 300	2.5	55
				3		200	1.12–1.15	75	2 300	2.5	55
				4		230	1.12–1.15	80	2 300	2.5	55
				0	other						
		5	Impact-modified	1			1.05–1.12	45	1 700	30	45
				2			1.05–1.18	60	2 000	6	50
				3			1.05–1.18	60	2 000	6	50
				0	other						
				G30	30 % glass		1.32–1.40	135	6 500	15	180
		6	Impact-modified, heat-stabilized	1			1.05–1.12	45	1 700	30	45
				2			1.05–1.18	60	2 000	6	50
				3			1.05–1.18	60	2 000	6	50
				0	other						
				G30	30 % glass		1.32–1.40	135	6 500	15	190
		8	Flexural-modified, heat-stabilized	2	injection molding		1.05–1.16	55	2 375max	10	45
				3	extrusion		1.05–1.16	30	2 000max	70	25
				4	blends		1.05–1.10	35	1 700max	4.5	35
				0	other						
		0	Other	0	other						
03 ^G	11 Nylon	1	General purpose	1		221	1.03–1.06				
				2		234	1.03–1.06	45	1000	4.0	35
				3		252	1.03–1.06				

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				4		291	1.03–1.06				
				5	hydrolysis-resistant		1.03–1.06				
				0	other						
		2	Heat-stabilized	1		234	1.03–1.06	45	900	2.0	35
				2		252	1.03–1.06				
				3		291	1.03–1.06				
				4	hydrolysis-resistant		1.03–1.06				
				0	other						
			Highly plasticized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				0	other						
		4	Highly plasticized, heat stabilized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				0	other						
		5	Moderately plasticized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				5			1.03–1.06				
				0	other						
		6	Moderately plasticized, heat-stabilized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				5			1.03–1.06				
				0	other						
		0	Other	0	other						
04	12 Nylon		General purpose	1		100–210	1.00–1.06	30	800	2.5	35
				2		100–210	1.00–1.06	35	1 000	2.5	35
				3		211–270	1.00–1.06	35	1 000	2.5	35
				4		271–340	1.00–1.06	35	1 000	2.5	35
				0	other						
		2	Heat-stabilized	1		100–150	1.00–1.06	35	800	2.5	35
				2		151–210	1.00–1.06	35	800	2.5	35
				3		211–280	1.00–1.06	35	1 000	2.5	35
				0	other						
				G15	15 % glass		1.10–1.20	75	3 000	10	160
				G25	25 % glass		1.10–1.25	90	3 000	15	160
				G30	30 % glass		1.15–1.30	95	4 000	15	160
				G40	40 % glass		1.30–1.45	100	4 500	15	160
				R30	30 % filler		1.22–1.28	55	3 500	5.0	100
		3	Nucleated	1		100–180	1.00–1.06	35	800	1.0	35
				2		181–250	1.00–1.06	35	800	1.0	35
				0	other						
		4	Plasticized	1		100–280	1.00–1.06	30	300–550	15	...
				2		100–280	1.00–1.06	30	450–750	10	...
				0	other						
		5	Plasticized, heat-stabilized	1		100–280	1.00–1.06	20	200–350	20	...
				2		100–280	1.00–1.06	30	300–550	15	...
				3		100–280	1.00–1.06	30	450–750	10	...
				4		100–280	1.00–1.06	35	550–950	5.0	...
				0	other						
		0	Other	0	other						
05	69 Nylon	1	General purpose	1			1.07–1.09				

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					2		1.07–1.09				
					3		1.07–1.09				
					0 other						
		2	Heat-stabilized		1		1.07–1.09				
					2		1.07–1.09				
					3		1.07–1.09				
					0 other						
		0	Other		0 other						
06	612 Nylon	1	General purpose		1	100–139	1.05–1.07	50	1 800	2.0	45
					2	140–199	1.05–1.07	50	1 800	2.5	45
					3	200	1.05–1.07	50	1 800	3.0	45
					0 other						
					G35 35 % glass	...	1.28–1.38	140	7 000	9.0	175
					G45 45 % glass	...	1.38–1.48	150	8 500	11	180
		2	Heat-stabilized		1	140	1.05–1.07	50	1 800	2.0	45
					0 other						
					G30 30 % glass	...	1.25–1.33	120	5 500	5.0	170
					G35 35 % glass	...	1.28–1.38	140	7 000	9.0	175
		3	Weather-stabilized ^F		1	140	1.05–1.07	50	1 800	1.5	45
					0 other						
		0	Other		0 other						
07	610 Nylon	1	General purpose		1		1.05–1.09				
					2		1.05–1.09				
					3		1.05–1.09				
					0 other						
		2	Heat-stabilized		1		1.05–1.09				
					2		1.05–1.09				
					0 other						
		0	Other		0 other						
08	Special	1	n-alkoxy-alkyl 6:6		1		1.09–1.12				
					0 other						
09	46 Nylon	0	Other		0 other						
		1	General-purpose		1						
					2	170	1.16–1.20	85	2 300	6.0	140
					3	195	1.16–1.20	85	2 300	6.0	140
					0 other						
		2	Heat-stabilized		1						
					2	165	1.16–1.20	85	2 300	6.0	140
					3	195	1.16–1.20	85	2 300	6.0	140
					0 other						
					G15 15 % glass	...	1.25–1.31	125	5 000	3.6	240
					G30 30 % glass	...	1.38–1.42	175	8 000	7.5	280
					G40 40 % glass	...	1.48–1.53	195	10 000	10.0	280
					G50 50 % glass	...	1.58–1.63	210	12 000	12.0	280
					R50 50 % filler	...	1.60–1.67	140	9 000	4.0	280
		3	Flame-retardant, ^G heat-stabilized		1						
					2		1.32–1.36	45	2 250	4.0	140
					0 other						
					G15 15 % glass	...	1.55–1.59	115	6 000	4.5	270
					G30 30 % glass	...	1.63–1.69	155	10 000	7.5	280
					G40 40 % glass	...	1.76–1.80	145	11 000	8.0	280
					G45 45 % glass	...	1.75–1.79	165	12 000	8.0	280
		4	Impact-modified, heat-stabilized		1						
					2		1.08–1.12	40	1 500	50	70
					0 other						
		5	Wear-resistant heat-stabilized		1						
					2		1.16–1.20	75	2 200	3.0	140
					0 other						