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Standard Classification System for Polyamide Molding and Extrusion Materials (PA)¹

This standard is issued under the fixed designation D 6779; 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.

1. Scope*

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

1.2 This classification system allows for the use of recycled polyamide materials provided that the requirements as stated in this classification system 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 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.

1.4 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 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.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 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 requirements prior to use.*

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

2. Referenced Documents

2.1 ASTM Standards:²

D 257 Test Methods for DC Resistance or Conductance of Insulating Materials

D 789 Test Methods for Determination of Solution Viscosities of Polyamide (PA)

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 3892 Practice for Packaging/Packing of Plastics

D 4000 Classification System for Specifying Plastic Materials

D 6260 Test Method for Gravimetric Determination of Carbon Black in Nylon Materials (PA)

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 IEC/ISO Standards:³

IEC 60243-1 Electrical Strength of Insulating Materials—Test Methods—Part 1: Tests at Power Frequencies

IEC 60250 Recommended Methods for the Determination of the Permittivity and Dielectric Dissipation Factor of Electrical Insulating Materials at Power, Audio and Radio Frequencies Including Metre Wavelengths

ISO 75-1 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Methods

ISO 75-2 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastic and Ebonite

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.

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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.

- ISO 179-1 Plastics—Determination of Charpy Impact Strength—Part 1: Non-instrumented Impact Test
- ISO 294-1 Plastics—Injection Moulding of Test Specimens of Thermoplastic Materials—Part 1: General Principles, Multipurpose-Test Specimens and Bars
- ISO 307 Determination of Viscosity Number of Polyamides In Dilute Solutions
- ISO 527-1 Plastics—Determination of Tensile Properties—Part 1: General Principles
- ISO 527-2 Plastics—Determination of Tensile Properties—Part 2: Testing Conditions
- ISO 1183 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
- ISO 1874-1 Plastics—Polyamide (PA) Homopolymers and Copolymers for Moulding and Extrusion—Part 1: Designation
- ISO 1874-2.2 Plastics—Polyamide (PA) Homopolymers and Copolymers for Moulding and Extrusion—Part 2: Preparation of Test Specimens and Determination of Properties
- ISO 3167 Plastics, Multipurpose Test Specimens
- ISO 3451-4 Plastics—Determination of Ash—Part 4: Polyamides
- ISO 11357-1 Plastics—Differential Scanning Calorimetry—Part 1: General Principles
- ISO 11357-3 Plastics—Differential Scanning Calorimetry—Part 3: Determination of Temperature and Enthalpy of Melting and Crystallization
- ISO 15512 Plastics—Determination of Water Content

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 Polyamide materials are classified into groups in accordance with their composition. These groups are subdivided into classes and grades as shown in the Basic Property Table (Table PA).

NOTE 2—An example of this classification system for unreinforced polyamide is given as follows: The designation PA0123 indicates the following:

- PA = polyamide as found in Terminology D 1600,
- 01 (group) = polyamide 66,
- 2 (class) = heat stabilized, and
- 3 (grade) = with a minimum viscosity number of 210 and 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 3—An example of this classification system for reinforced polyamide is given as follows: The designation PA012G35 indicates the following:

- PA = polyamide as found in Terminology D 1600,
- 01 (group) = polyamide 66,
- 2 (class) = heat stabilized, and
- G35 (grade) = nominal 35 % glass with the requirements given in Table PA.

NOTE 4—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 5—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 glass fiber level of 33 % is included with Grade G35 as shown in Note 4.

NOTE 6—Ash content of filled or reinforced materials may be determined using Test Method ISO 3451-4.

4.2 Variations of polyamide materials that are not in Table PA are classified in accordance with Tables PA and A or B. Table PA is used to specify the group of polyamide and Table A or B is used to specify property requirements.

4.2.1 Specific requirements for variations of polyamide materials shall be shown by a six-character designator. The designation will consist of the letter “A” or “B” and the five digits comprising the cell numbers for the property requirements in the order as they appear in Tables A and B.

4.2.1.1 Although the values listed are necessary to include the range of properties available in existing material, users should not infer that every possible combination of the properties exists or can be obtained.

4.2.2 When the grade of the basic material is not known, is not important or does not meet the Table PA requirements, the use of “0” grade classification shall be used for reinforced materials in this classification system.

NOTE 7—An example of this classification system for a reinforced polyamide material is given as follows. The designation PA0110G30A42270 would indicate the following material requirements:

- PA0110 = Polyamide 66, from Table PA,
- G30 = Glass reinforced at 30 % nominal,
- A = Table A property requirements,
- 4 = Tensile strength, 140 MPa, min,
- 2 = Tensile modulus, 4500 MPa, min,
- 2 = Charpy impact, 5.0 kJ/m², min,
- 7 = Deflection temperature at 1.8 MPa, 200°C, min, and
- 0 = Unspecified.

If no properties are specified, the designation would be PA0110G30A00000.

NOTE 8—When a grade of polyamide is not fully identified by a standard callout, it is possible to specify all table properties by the use of an addition of Classification D 4000 suffixes. Suffix values will override the PA table values. An example of an unreinforced polyamide material is given as follows: PA0212KN023. This example is a general purpose, low viscosity PA6 material where K denotes tensile properties, N denotes tensile modulus with ISO 527 as the test method, and 023 denotes a value of 2300 MPa. This value for tensile modulus overrides the normal table value. This example can be applied to replace all table values, that is, tensile stress, notched Charpy impact, and heat deflection temperature.

4.3 To facilitate the specification of special materials where the basic property table does not reflect the properties required, Table B has been incorporated into this classification system. This table will be used in a manner similar to Table A.

NOTE 9—Pigmented or colored polyamides can differ significantly from the natural polymers in mechanical properties depending on the choice of colorants and concentrations. The main property affected is ductility, as illustrated by a reduction in Charpy impact and elongation values. In a typical white pigmented polyamide, elongation losses of up to 50 % and Charpy impact losses of up to 30 % are common. If specific properties of pigmented materials are necessary, Table B may be employed to specify property requirements.

NOTE 10—An example of a special material using this classification system is as follows: The designation PA0220B54220 would indicate the following material requirements from Table B:

- PA0220 = Polyamide 6, heat stabilized, from Table PA,
- B = Table B property requirements,
- 5 = Tensile strength, 70 MPa, min,
- 4 = Tensile modulus, 2400 MPa, min,
- 2 = Charpy impact, 4.0 kJ/m², min,
- 2 = Deflection temperature at 1.8 MPa, 55°C, min, and
- 0 = unspecified.

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

Group	Description	Class	Description	Grade	Description ^C	Viscosity Number, ISO 307, min, mL/g	Density, ^D ISO 1183 g/cm ³	Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min	Tensile Modulus, ^E ISO 527-1 and ISO 527-2, MPa, min	Charpy Impact Resistance, ISO 179/1eA, kJ/m ² , min	Deflection Temperature, ^F ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min
01	PA66	1	General-purpose	1		135	1.13 to 1.15	70	2300	3.3	60
				2		165	1.13 to 1.15	70	2300	3.3	60
				3		210	1.13 to 1.15	70	2300	3.3	60
				4		270	1.13 to 1.15	70	2300	3.3	60
				5	recycled	115	1.13 to 1.15	70	2300	3.3	60
				6	recycled	135	1.13 to 1.15	70	2300	3.3	60
				G15	15 % glass	...	1.20 to 1.26	100	4000	3.0	215
				G20	20 % glass	...	1.25 to 1.33	115	5000	4.0	220
				G25	25 % glass	...	1.29 to 1.37	140	6000	5.0	225
				G35	35 % glass	...	1.35 to 1.45	170	8000	7.0	235
				G40	40 % glass	...	1.42 to 1.52	175	9000	8.0	235
				G45	45 % glass	...	1.45 to 1.55	180	10 000	9.0	240
				G50	50 % glass	...	1.51 to 1.61	190	11 000	10.0	245
				M40	40 % mineral	...	1.45 to 1.55	80	5000	2.0	100
		0	other								
		2	Heat-stabilized	1		135	1.13 to 1.15	70	2300	3.0	60
				2		165	1.13 to 1.15	70	2300	3.0	60
3				210	1.13 to 1.15	70	2300	3.0	60		

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

Group	Description	Class	Description	Grade	Description ^C	Viscosity Number, ISO 307, min, mL/g	Density, ^D ISO 1183 g/cm ³	Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min	Tensile Modulus, ^E ISO 527-1 and ISO 527-2, MPa, min	Charpy Impact Resistance, ISO 179/1eA, kJ/m ² , min	Deflection Temperature, ^F ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min
				4		270	1.13 to 1.15	70	2300	3.0	60
				5	recycled	115	1.13 to 1.15	70	2300	3.0	60
				6	recycled	135	1.13 to 1.15	70	2300	3.0	60
				G15	15 % glass	...	1.20 to 1.26	100	4000	3.0	220
				G25	25 % glass	...	1.29 to 1.37	140	6000	5.0	225
				G30	30 % glass	...	1.32 to 1.42	160	7000	6.0	230
				G35	35 % glass	...	1.35 to 1.45	170	8000	7.0	235
				G40	40 % glass	...	1.43 to 1.53	175	9000	8.0	235
				G45	45 % glass	...	1.45 to 1.55	180	10 000	9.0	240
				G50	50 % glass	...	1.51 to 1.61	190	11 000	10.0	245
				M40	40 % mineral	...	1.45 to 1.55	80	5000	2.0	100
				R20	20 % filler	...	1.23 to 1.31	70	3200	1.5	...
				R40	40 % filler	...	1.43 to 1.53	100	5500	2.5	200
				0	other						
		3	Nucleated	1		135	1.13 to 1.15	80	2500	2.8	60
				2		165	1.13 to 1.15	80	2500	2.8	60
				3		210	1.13 to 1.15	80	2500	2.8	60
				4		270	1.13 to 1.15	80	2500	2.8	60
				5	recycled	115	1.13 to 1.15	80	2500	2.8	60
				6	recycled	135	1.13 to 1.15	80	2500	2.8	60
				0	other						
		4	Nucleated, heat-stabilized	1		Requirements the same as corresponding grades under Group 01, Class 3					
				2							
				3							
				4							
				5							
				0	other						
		5	Impact-modified	1		...	1.06 to 1.12	52	1700	9.0	50
				2	recycled	...	1.06 to 1.12	50	1600	8.0	50
				G15	15 % glass	...	1.15 to 1.23	85	3000	6.0	210
				G35	35 % glass	...	1.31 to 1.41	110	5500	6.0	225
				0	other						
		6	Impact-modified, heat-stabilized	1		...	1.08 to 1.12	52	1700	9.0	50
				2	recycled	...	1.08 to 1.12	50	1600	8.0	50
				G15	15 % glass	...	1.15 to 1.23	85	3000	6.0	210
				G35	35 % glass	...	1.31 to 1.41	110	5500	6.0	225
				M40	40 % mineral	...	1.45 to 1.55	75	4500	4.0	...
				R35	35 % filler	...	1.38 to 1.48	80	5500	3.0	200
				0	other						
		7	Toughened	1		...	1.06 to 1.10	42	1500	40	45
				2	recycled	...	1.05 to 1.11	40	1300	35	45
				G15	15 % glass	...	1.15 to 1.23	70	2800	9.0	180
				G35	35 % glass	...	1.28 to 1.38	110	5500	11	220
				0	other						
		8	Toughened, heat-stabilized	1		...	1.06 to 1.10	42	1500	40	45
				2	recycled	...	1.05 to 1.11	40	1300	35	45
				G15	15 % glass	...	1.15 to 1.23	70	2800	9.0	180
				G35	35 % glass	...	1.28 to 1.38	110	5500	11	220
				G45	45 % glass	...	1.39 to 1.49	130	8000	10	230
				M35	35 % mineral	...	1.37 to 1.47	70	3800	6.0	...
				0	other						
		9	Weather-stabilized ^G	1		135	1.13 to 1.17	80	2400	2.5	60
				2	recycled	115	1.13 to 1.17	65	2200	2.0	60
				0	other						
				0	Other						
02	PA6	1	General-purpose	1		100	1.12 to 1.14	75	2400	4.0	50
				2		135	1.12 to 1.14	70	2200	3.0	50
				3		150	1.12 to 1.15	70	2200	3.0	50
				4		200	1.12 to 1.15	70	2200	3.0	50
				G15	15 % glass	...	1.20 to 1.28	110	4200	4.0	170
				G25	25 % glass	...	1.28 to 1.36	135	5000	6.5	180
				G30	30 % glass	...	1.32 to 1.40	150	7000	7.5	180
				G35	35 % glass	...	1.38 to 1.44	155	7500	8.0	180
				G40	40 % glass	...	1.41 to 1.48	175	10 000	9.0	190
				M30	30 % mineral	...	1.30 to 1.40	70	3200	2.4	50
				M40	40 % mineral	...	1.44 to 1.52	75	4500	4.0	70
				R40	40 % glass/mineral	...	1.42 to 1.50	100	6000	3.0	180

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

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				0	other						
		2	Heat-stabilized	1		100	1.12 to 1.14	75	2400	4.0	50
				2		135	1.12 to 1.14	70	2200	3.0	50
				3		150	1.12 to 1.15	70	2200	3.0	50
				4		200	1.12 to 1.15	70	2200	3.0	50
				5	recycled	135	1.12 to 1.14	70	2000	3.0	50
				G5	5 % glass		1.16 to 1.22	85	2500	2.5	110
				G15	15 % glass		1.20 to 1.28	110	4200	4.0	180
				G25	25 % glass		1.28 to 1.36	135	5000	6.5	190
				G30	30 % glass		1.32 to 1.40	150	7000	7.5	190
				G35	35 % glass		1.38 to 1.44	155	7500	8.0	190
				G40	40 % glass		1.41 to 1.48	175	10 000	9.0	190
				G45	45 % glass		1.46 to 1.54	175	10 000	10	190
				G50	50 % glass		1.52 to 1.60	175	10 000	10	190
				G65	65 % glass		1.70 to 1.78	175	13 000	10	200
				M30	30 % mineral		1.30 to 1.40	70	3200	2.4	50
				M35	35 % mineral		1.39 to 1.47	70	3500	3.0	60
				M40	40 % mineral		1.44 to 1.52	75	4500	4.0	70
			R20	20 % glass/ mineral		1.25 to 1.33	80	3200	2.5	120	
			R40	40 % glass/ mineral		1.42 to 1.50	100	6000	3.0	180	
				0	other						
		3	Nucleated and lubricated	1		100	1.12 to 1.14	70	2300	2.5	50
				2		135	1.12 to 1.14	70	2300	2.5	50
				3		150	1.12 to 1.15	75	2300	2.5	50
				4		200	1.12 to 1.15	80	2300	2.5	50
				0	other						
		4	Nucleated and heat-stabilized	1		100	1.12 to 1.14	70	2300	2.5	50
				2		135	1.12 to 1.14	70	2300	2.5	50
				3		150	1.12 to 1.15	75	2300	2.5	50
				4		200	1.12 to 1.15	80	2300	2.5	50
				5	recycled	135	1.12 to 1.14	70	2100	2.5	50
				0	other						
		5	Impact-modified	1			1.05 to 1.12	45	1700	30	45
				2			1.05 to 1.18	55	2000	6.0	45
				3			1.05 to 1.18	40	1000	6.0	35
				G15	15 % glass		1.15 to 1.24	75	3300	9.0	130
				G30	30 % glass		1.30 to 1.40	135	6500	15	180
				G35	35 % glass		1.32 to 1.42	135	6800	15	190
				G40	40 % glass		1.39 to 1.47	135	8000	10	200
				0	other						
		6	Impact-modified, heat-stabilized	1			1.05 to 1.12	45	1700	30	45
				2			1.05 to 1.18	55	2000	6.0	45
				3			1.05 to 1.18	40	1000	6.0	35
				4			1.05 to 1.18	25	1000	30	30
				G15	15 % glass		1.15 to 1.24	75	3300	9.0	130
				G30	30 % glass		1.30 to 1.40	135	6500	15	180
				G35	35 % glass		1.32 to 1.42	135	6800	10	190
				G40	40 % glass		1.39 to 1.47	135	8000	10	200
				M35	35 % mineral		1.35 to 1.45	65	3200	3.0	50
			M40	40 % mineral		1.39 to 1.47	65	3200	3.0	50	
				0	other						
		7	Flexural-modified, heat-stabilized	1	injection molding		1.05 to 1.16	55	2375 max	10	45
				2	extrusion		1.05 to 1.16	30	2000 max	7.0	25
				3	blends		1.05 to 1.10	35	1700 max	4.5	35
				0	other						
03 ^H	PA11	0	Other	0	other						
		1	General purpose	1		115 to 140	1.01 to 1.06	35	900	4.0	36
				2		160 to 190	1.01 to 1.06	35	900	6.0	36
				0	other						

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

Group	Description	Class	Description	Grade	Description ^C	Viscosity Number, ISO 307, min, mL/g	Density, ^D ISO 1183 g/cm ³	Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min	Tensile Modulus, ^E ISO 527-1 and ISO 527-2, MPa, min	Charpy Impact Resistance, ISO 179/1eA, kJ/m ² , min	Deflection Temperature, ^F ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min			
04	PA12	2	Heat-stabilized	1		115 to 140	1.01 to 1.06	35	900	4.0	36			
				2		160 to 190	1.01 to 1.06	35	900	6.0	36			
				3	black	160 to 190	1.01 to 1.06	35	900	4.0	36			
				4		210 to 255	1.01 to 1.06	35	900	6.0	36			
				3	Plasticized	0	other							
						1		170 to 200	1.01 to 1.06	30	370	25	36	
				4	Plasticized, Heat Stabilized	0	other							
						1		180 to 240	1.01 to 1.06	35	500	25	36	
						2		170 to 200	1.01 to 1.06	35	400	25	36	
						3		115 to 140	1.01 to 1.06	30	350	25	36	
		4	black			175 to 240	1.01 to 1.06	35	400	25	36			
		5				170 to 190	1.01 to 1.06	30	370	25	36			
		6				200 to 230	1.01 to 1.06	35	370	25	36			
		0	Other General purpose	0	other									
				1		100 to 210	1.00 to 1.06	30	800	2.5	35			
				2		100 to 210	1.00 to 1.06	35	1000	2.5	35			
				3		211 to 270	1.00 to 1.06	35	1000	2.5	35			
				4		271 to 340	1.00 to 1.06	35	1000	2.5	35			
				0	other									
				2	Heat-stabilized	1		100 to 150	1.00 to 1.06	35	800	2.5	35	
						2		151 to 210	1.00 to 1.06	35	800	2.5	35	
						3		211 to 280	1.00 to 1.06	35	1000	2.5	35	
						G15	15 % glass		1.10 to 1.20	75	3000	10	160	
		G25	25 % glass		1.10 to 1.25	90	3000	15	160					
		G30	30 % glass		1.15 to 1.30	95	4000	15	160					
		G40	40 % glass		1.30 to 1.45	100	4500	15	160					
		R30	30 % filler		1.18 to 1.32	55	3500	5.0	100					
		3	Nucleated	0	other									
				1		100 to 180	1.00 to 1.06	35	800	1.0	35			
		4	Plasticized	0	other									
1				181 to 250	1.00 to 1.06	35	800	1.0	35					
5	Plasticized, heat-stabilized	0	other											
		1		100 to 280	1.00 to 1.06	30	300 to 550	15						
		2		100 to 280	1.00 to 1.06	30	450 to 750	10						
		3		100 to 280	1.00 to 1.06	30	450 to 750	10						
		4		100 to 280	1.00 to 1.06	35	550 to 950	5.0						
0	Other	0	other											