



Designation: ~~D 3935-02~~ Designation: D3935 - 09

## Standard Specification for Polycarbonate (PC) Unfilled and Reinforced Material<sup>1</sup>

This standard is issued under the fixed designation D3935; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope\*

1.1 This specification covers unfilled and reinforced polycarbonate and polycarbonate copolymer materials suitable for injection molding, blow molding, and extrusion. Some of these compositions may also find use for compression molding or application from solution.

1.2 The properties in this specification are those required for identifying the compositions covered. There may be other requirements necessary for identifying particular characteristics important to specific applications. Those may be specified by using the suffixes in accordance with Section 5.

1.3 The values stated in SI units are to be regarded as the standard.

~~NOTE 1—This specification is similar to ISO 7391-1987 in title only. The technical content is significantly different. 1—This specification and ISO 7391-1 and ISO 7391-2 address the same subject matter, but differ in technical content.~~

1.4 The following hazards caveat pertains only to the test methods portion, Section 12, of this specification. *This standard does not purport to address all 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 or regulatory limitations prior to use.*

### 2. Referenced Documents

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

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

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) and Density of Plastics by Displacement

D883 Terminology Relating to Plastics

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D1600 Terminology for Abbreviated Terms Relating to Plastics

D2584 Test Method for Ignition Loss of Cured Reinforced Resins

D3892 Practice for Packaging/Packing of Plastics

D4000 Classification System for Specifying Plastic Materials

D5630 Test Method for Ash Content in Plastics

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E169 Practices for General Techniques of Ultraviolet-Visible Quantitative Analysis

#### 2.2 ISO Standard:<sup>3</sup>

~~ISO 7391-1987 Plastics—Polycarbonate Molding and Extrusion Materials (Part 1: Designation—1987) (Part 2: Preparation of Test Specimens and Determination of Properties)~~

ISO 7391-1 Plastics—Polycarbonate Molding and Extrusion Materials (Part 1: Designation—2006)

ISO 7391-2 Plastics—Polycarbonate Molding and Extrusion Materials (Part 2: Preparation of Test Specimens and Determination of Properties)

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials. Current edition approved March 10, 2002. Published May 2002. Originally published as D 3935-80. Last previous edition D 3935-94 (2001). Current edition approved April 15, 2009. Published June 2009. Originally approved in 1980. Last previous edition approved in 2002 as D3935-02. DOI: 10.1520/D3935-09.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards Vol 08.01 volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.02.

<sup>3</sup> 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.

**3. Terminology**

3.1 ~~Definitions—The Definitions—The terminology used in this specification is in accordance with Terminologies D 883 and D 1600D883 and D1600. The polycarbonate materials will be designated PC as specified in Terminology D 1600D1600.~~

**4. Classification**

4.1 Unfilled polycarbonate materials are classified into groups according to their composition. These groups are subdivided into classes and grades as shown in Table PC

**TABLE PC Polycarbonate Materials and Detail Requirements**

Note— The values are for naturals; colors may be different.

Group	Description	Class	Description	Grade	Description <sup>A</sup>	Flow Rate, <sup>B</sup>	Specific Gravity, Test	Izod Impact, <sup>C</sup>	Tensile Yield Strength <sup>D</sup>	Elongation at Break <sup>D</sup>	Flexural Modulus, <sup>E</sup>	Deflection Temperature, Test		
						Test Method D 1238, g/10 min	Method D 792, D 792-2, D 792-3, D 792-4, D 792-5, D 792-6, D 792-7, D 792-8, D 792-9, D 792-10, D 792-11, D 792-12, D 792-13, D 792-14, D 792-15, D 792-16, D 792-17, D 792-18, D 792-19, D 792-20, D 792-21, D 792-22, D 792-23, D 792-24, D 792-25, D 792-26, D 792-27, D 792-28, D 792-29, D 792-30, D 792-31, D 792-32, D 792-33, D 792-34, D 792-35, D 792-36, D 792-37, D 792-38, D 792-39, D 792-40, D 792-41, D 792-42, D 792-43, D 792-44, D 792-45, D 792-46, D 792-47, D 792-48, D 792-49, D 792-50, D 792-51, D 792-52, D 792-53, D 792-54, D 792-55, D 792-56, D 792-57, D 792-58, D 792-59, D 792-60, D 792-61, D 792-62, D 792-63, D 792-64, D 792-65, D 792-66, D 792-67, D 792-68, D 792-69, D 792-70, D 792-71, D 792-72, D 792-73, D 792-74, D 792-75, D 792-76, D 792-77, D 792-78, D 792-79, D 792-80, D 792-81, D 792-82, D 792-83, D 792-84, D 792-85, D 792-86, D 792-87, D 792-88, D 792-89, D 792-90, D 792-91, D 792-92, D 792-93, D 792-94, D 792-95, D 792-96, D 792-97, D 792-98, D 792-99, D 792-100	Methods D 256, J/m, min	Test Method D 638, MPa, min	Test Method D 790, MPa, min	Test Method D 648, °C, min			
01	PC	1	general purpose	1		>24	1.19–1.22			use Table B				
				2		15 to 30	1.19–1.22			use Table B				
				3		12 to 20	1.19–1.22	640	55	100	2000	126		
				4		9 to 18	1.19–1.22	750	60	105	2100	126		
				5		6 to 13	1.19–1.22	750	60	110	2200	128		
				6		4 to 8	1.19–1.22	750	60	110	2200	128		
				7		<5	1.19–1.22	780	60	110	2200	130		
				0	other	...	...	...	...	...	...	...	...	
				2	flame-retarded <sup>G</sup>	1		>24	1.19–1.22			use Table B		
						2		15 to 30	1.19–1.22			use Table B		
		3				12 to 20	1.19–1.22	640	55	100	2000	126		
		4				9 to 18	1.19–1.22	640	60	100	2100	126		
		5				6 to 13	1.19–1.22	640	60	105	2200	128		
		6				4 to 8	1.19–1.22	640	60	110	2200	128		
		7				<5	1.19–1.22	640	60	110	2200	130		
		0	other			...	...	...	...	...	...	...	...	
		3	UV <sup>H</sup> stabilized			1		>24	1.19–1.22			use Table B		
						2		15 to 30	1.19–1.22			use Table B		
				3		12 to 20	1.19–1.22	640	55	100	2000	124		
				4		9 to 18	1.19–1.22	750	60	105	2100	124		
				5		6 to 13	1.19–1.22	750	60	110	2100	126		
				6		4 to 8	1.19–1.22	750	60	110	2200	126		
				7		<5	1.19–1.22	750	60	110	2200	128		
				0	other	...	...	...	...	...	...	...	...	
				4	impact-modified	1		6 to 15	1.18–1.22	375 <sup>I</sup>	50	90	1900	121
						0	other	...	...	...	...	...	...	...
		5	FDA <sup>J</sup> compliant formulations			1		>24	1.19–1.22			use Table B		
						2		15 to 30	1.19–1.22			use Table B		
						3		12 to 20	1.19–1.22	640	55	100	2000	126
						4		9 to 18	1.19–1.22	750	60	105	2100	126
5						6 to 13	1.19–1.22	750	60	110	2200	128		
6						4 to 8	1.19–1.22	750	60	110	2200	128		
7						<5	1.19–1.22	780	60	110	2200	130		
0	other					...	...	...	...	...	...	...		
0	other	...	...	...	...	...	...	...						
02	PC copolymer-flame retarded	1	general purpose	1		>24	1.22–1.26			use Table B				
				2		15 to 30	1.22–1.26			use Table B				
				3		12 to 20	1.22–1.26	80	60	100	2100	128		
				4		9 to 18	1.22–1.26	80	60	110	2200	128		
				5		6 to 13	1.22–1.26	90	60	110	2200	130		
				6		4 to 8	1.22–1.26	90	60	110	2200	130		
				7		<5	1.22–1.26	90	60	110	2200	132		
				0	other	...	...	...	...	...	...	...		
				2	UV <sup>H</sup> stabilized	1		>24	1.22–1.26			use Table B		
						2		15 to 30	1.22–1.26			use Table B		
		3				12 to 20	1.22–1.26	80	60	100	2100	126		
		4				9 to 18	1.22–1.26	80	60	110	2200	126		
		5				6 to 13	1.22–1.26	90	60	110	2200	128		
		6				4 to 8	1.22–1.26	90	60	110	2200	130		
		7				<5	1.22–1.26	90	60	110	2200	130		
		0	other			...	...	...	...	...	...	...		
		0	other			...	...	...	...	...	...	...		

TABLE Continued

Note— The values are for naturals; colors may be different.

Group	Description	Class	Description	Grade	Description <sup>A</sup>	Flow Rate, <sup>B</sup>	Specific	Izod	Tensile	Elongation	Flexural	Deflection	
						Test Method D 1238, g/10 min	Gravity, Test Method D 792	Impact, <sup>C</sup> Test Methods D 256	Yield Strength <sup>D</sup>	at Break <sup>D</sup>	Modulus, <sup>E</sup> Test Methods D 790	Temperature, Test Method D 648, <sup>F</sup> °C, min	
03	PC copolymer high-heat resin	1	general purpose	1		TBD	1.18–1.22	80	63	40	1700	150	
		0	other	0		...	...	...	...	...	...	...	
	2	UV <sup>H</sup> stabilized	1			TBD	1.18–1.22	80	63	40	1700	148	
		0	other	0		...	...	...	...	...	...	...	
		3	impact-modified	1		TBD	...	...	...	use Table B	...	...	
		0	other	0		...	...	...	...	...	...	...	
4	FDA <sup>J</sup> compliant formulation	1			TBD	1.18–1.22	80	63	40	1700	150		
	0	other	0		...	...	...	...	...	...	...		
04	PC copolymer homopolymer intermediate heat blends	1	general purpose	1		TBD	1.18–1.22	480	65	60	1900	138	
		0	other	0		...	...	...	...	...	...	...	
	2	UV <sup>H</sup> stabilized	1			TBD	1.18–1.22	480	65	60	1900	136	
		0	other	0		...	...	...	...	...	...	...	
		3	impact-modified	1		TBD	...	...	...	use Table B	...	...	
		0	other	0		...	...	...	...	...	...	...	
4	FDA <sup>J</sup> compliant formulation	1			TBD	1.18–1.22	480	65	60	1900	138		
	0	other	0		...	...	...	...	...	...	...		
0	other	0	other	0		...	...	...	...	...	...		
						...	...	...	...	...	...		
05	PC copolymer low-heat standard flow	1	general purpose	1		>50	1.18–1.22	...	...	use Table B	...	...	
				2		nominal 45	1.18–1.22	570	50	100	2070	104	
		3	UV <sup>H</sup> stabilized	1		nominal 29	1.18–1.22	620	50	100	2070	106	
				0	other	0		...	...	...	...	...	...
				4		nominal 18	1.18–1.22	770	50	100	2160	107	
				5		nominal 10	1.18–1.22	810	50	100	2200	108	
	2	impact-modified	1		>50	1.18–1.22	...	...	...	use Table B	...	...	
			2		nominal 45	1.18–1.22	570	50	100	2070	102		
			3		nominal 29	1.18–1.22	620	50	100	2070	104		
			4		nominal 18	1.18–1.22	770	50	100	2160	105		
			5		nominal 10	1.18–1.22	810	50	100	2200	106		
			0	other	0		...	...	...	...	...	...	
	3	FDA <sup>J</sup> compliant formulations	1		>50	1.18–1.22	...	...	...	use Table B	...	...	
			2		nominal 45	1.18–1.22	570	50	100	2070	104		
			3		nominal 29	1.18–1.22	620	50	100	2070	106		
			4		nominal 18	1.18–1.22	770	50	100	2160	107		
			5		nominal 10	1.18–1.22	810	50	100	2200	108		
			0	other	0		...	...	...	...	...	...	
5	flame-retarded <sup>G</sup>	1		TBD	1.18–1.22	...	...	...	use Table B	...	...		
		0	other	0		...	...	...	...	...	...		
0	other	0	other	0		...	...	...	...	...			
06	PC copolymer low-heat easy flow	1	general purpose	1		TBD	1.18–1.22	...	...	use Table B	...	...	
				0	other	0		...	...	...	...	...	...
	2	UV stabilized <sup>H</sup>	1		TBD	1.18–1.22	...	...	...	use Table B	...	...	
			0	other	0		...	...	...	...	...	...	
	3	impact-modified	1		TBD	1.17–1.22	...	...	...	use Table B	...	...	
			0	other	0		...	...	...	...	...	...	
	4	FDA <sup>J</sup> compliant formulations	1		TBD	1.18–1.22	...	...	...	use Table B	...	...	
			0	other	0		...	...	...	...	...	...	
	5	flame-retarded <sup>G</sup>	1		TBD	1.18–1.22	...	...	...	use Table B	...	...	
			0	other	0		...	...	...	...	...	...	
0	other	0	other	0		...	...	...	...	...			
99	PC other <sup>I</sup>	0	other	0	other	...	...	...	...	...	...		

<sup>A</sup> All grades are listed by performance requirements.

<sup>B</sup> Use condition 300/1.2 for Groups 01, 02, and 05. Define the conditions for other groups in the suffixes as needed.

<sup>C</sup> Test specimens are 3.2 mm thick, with a notch radius of 0.25 mm, tested by Method A.

<sup>D</sup> Test specimens are Type I tensile bars, 3.2 mm thick, tested at a crosshead speed of 50 mm/min.

<sup>E</sup> Test specimens are 3.2 by 12.7 mm, tested by Method I, Procedure A (Tangent), at a crosshead speed of 1.3 mm/min and a span-to-depth ratio of 16 to 1.

<sup>F</sup> Test specimens are 3.2 mm thick, tested at 1820 kPa, and are not annealed before testing.

<sup>G</sup> Use suffix letter F, with the appropriate digits allowed in Classification D-4000D4000, to define specific requirements.

<sup>H</sup> Refer to Practices E-169E-169 Refer to Practices E169 for testing procedure. Specific requirements shall be stated in the purchase order or contract.

<sup>I</sup> Test specimens for Group 1, Class 4, Grade 1 are 6.4 mm thick with a notch radius of 0.25 mm and are tested by Method A.

<sup>J</sup> Manufactured in compliance with Food Additive Regulation 21CFR177.1580 governing polycarbonate resins for food-contact applications..

NOTE 2—An example of this classification system is as follows: the designation PC0214 indicates:

PC	= polycarbonate as found in Terminology D 1600D1600,
02	= polycarbonate as found in Terminology D1600,
1	= polycarbonate copolymer-flame retarded (group),
4	= general purpose (class), and
	= requirements given in Table PC.

4.1.1 To facilitate the specification of new, special, or recycled materials, the “other” category (0) for class or grade, or both, may be used as indicated in Table PC. The properties of these materials may be specified using Tables A, B, or R as they apply.

4.2 Reinforced, pigmented, filled, and lubricated versions of polycarbonate materials may be classified in accordance with Tables PC and A, B, or R. Table PC is used to specify basic materials, and Tables A or B are used to specify the property requirements after the addition of reinforcement, pigments, fillers, or lubricants at the nominal level indicated (see 4.2.1). Table R is used for recycled materials.

4.2.1 A single letter shall be used to indicate the major category of the reinforcement, along with two numbers indicating the nominal percentage of additive(s) by mass, with the tolerances as tabulated as follows:

Category	Material	Tolerance (Based on the Total Mass)
C	carbon and graphite fiber-reinforced	±2 percentage points
G	glass-reinforced <15 % glass content >15 % glass content	±2 percentage points ±3 percentage points
L	lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide)	depends on material and process—to be specified
M	mineral-reinforced	±2 percentage points
R	combination/mixtures of reinforcements or other fillers/reinforcements	±3 percentage points based on total reinforcement

NOTE 3—If necessary, additional requirements may be specified using suffixes, in accordance with Section 5. Special agreements on tolerances may be required when levels are below 5 %. The ash content of filled or reinforced materials may be determined using Test Method D 2584D2584 where applicable.

4.2.2 Specific requirements for reinforced, filled, or lubricated polycarbonate materials shall be shown by a six-character designation that will consist of the letter A or B and the five digits comprising the cell numbers for the property requirements in the order in which they occur in Tables A or B.

4.2.2.1 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.

4.2.3 When the grade of the basic material is not shown, or is not important, a “0” grade classification shall be used for reinforced materials in this system.

NOTE 4—An example of this classification system for reinforced polycarbonate material is as follows: the designation PC0110G10A22230 indicates:

PC0110	= general-purpose polycarbonate from Table PC,
G10	= glass reinforced at nominal 10 % level,
A	= Table A property requirements,
2	= 60-MPa tensile strength, min,
2	= 3000-MPa flexural modulus, min,
2	= 80-J/m Izod impact strength, min,
3	= 125°C deflection temperature, min, and
0	= unspecified.

If no properties are specified, the designation is PC0110G10A00000.

4.3 Table B has been incorporated into this specification to facilitate the classification of special materials where Table PC or Table A do not reflect the required properties. Table B shall be used in the same manner as Table A.

NOTE 5—The mechanical properties of polycarbonates can be affected by the amounts and types of additives and colorants used. The most often observed effect is a change in the ductility of the material as evidenced in reductions of up to 90 % in Izod impact strength and 25 % or more in tensile elongation. A classification using Table PC and Table B should be used if properties of pigmented or specially formulated polycarbonates need to be specified.

NOTE 6—An example of this classification system for a special polycarbonate material is as follows: the designation PC0110B34720 indicates:

PC0110	= general-purpose polycarbonate from Table PC,
B	= Table B property requirements,
3	= 60-MPa tensile strength, min,
4	= 2100-MPa flexural modulus, min,
7	= 640-J/m Izod impact strength, min,
2	= 105°C deflection temperature, min, and
0	= unspecified.

4.4 The short- and long-term mechanical properties of polycarbonate materials can be affected adversely by their prior processing as well as end-use exposure to chemicals, weathering, and secondary finishing steps. Efforts to reuse materials may include direct feedback into the system from which they are generated, or they could involve isolation for reuse at other times into