

INTERNATIONAL STANDARD

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Plastics — Polycarbonate (PC) moulding and extrusion materials —

Part 2:

Preparation of test specimens and
determination of properties

Plastiques — Polycarbonate (PC) pour moulage et extrusion —

Partie 2: Préparation des éprouvettes et détermination des propriétés



Reference number
ISO 7391-2:1996(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 7391-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

This second edition cancels and replaces the first edition (ISO 7391-2:1986) and includes the following changes:

- the text has been brought into accordance with the standard SC 9 frame text;
- the list of properties and test conditions (table 3) has been revised in accordance with ISO 10350.

ISO 7391 consists of the following parts, under the general title *Plastics — Polycarbonate (PC) moulding and extrusion materials*:

- *Part 1: Designation system and basis for specifications*
- *Part 2: Preparation of test specimens and determination of properties*

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Plastics — Polycarbonate (PC) moulding and extrusion materials —

Part 2:

Preparation of test specimens and determination of properties

1 Scope

This part of ISO 7391 specifies the methods of preparation of test specimens and the test methods to be used in determining the properties of polycarbonate moulding and extrusion materials. Requirements for handling test material and for conditioning both the test material before moulding and the specimens before testing are given here.

Procedures and conditions for the preparation of test specimens and procedures for measuring properties of the materials from which these specimens are made are given. Properties and test methods which are suitable and necessary to characterize polycarbonate moulding and extrusion materials are listed.

The properties have been selected from the general test methods in ISO 10350. Other test methods in wide use for or of particular significance to these moulding and extrusion materials are also included in this part of ISO 7391, as are the designatory properties specified in part 1.

In order to obtain reproducible and comparable test results, it is necessary to use the methods of preparation and conditioning, the specimen dimensions and the test procedures specified herein. Values determined will not necessarily be identical to those obtained using specimens of different dimensions or prepared using different procedures.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7391. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7391 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 62:1980, *Plastics — Determination of water absorption.*

ISO 75-1:1993, *Plastics — Determination of temperature of deflection under load — Part 1: General test method.*

ISO 75-2:1993, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite.*

ISO 178:1993, *Plastics — Determination of flexural properties.*

ISO 179:1993, *Plastics — Determination of Charpy impact strength.*

ISO 180:1993, *Plastics — Determination of Izod impact strength.*

ISO 291:—¹⁾, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 293:1986, *Plastics — Compression moulding test specimens of thermoplastic materials.*

ISO 294-1:—²⁾, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar specimens.*

ISO 306:1994, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST).*

ISO 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles.*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics.*

ISO 899-1:1993, *Plastics — Determination of creep behaviour — Part 1: Tensile creep.*

ISO 1133:—³⁾, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.*

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

ISO 1210:—⁴⁾, *Plastics — Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame ignition source.*

ISO 1628-4:1986, *Plastics — Determination of viscosity number and limiting viscosity number — Part 4: Polycarbonate (PC) moulding and extrusion materials.*

ISO 2818:1994, *Plastics — Preparation of test specimens by machining.*

ISO 3167:1993, *Plastics — Multipurpose test specimens.*

ISO 4589-2:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test.*

ISO 7391-1:1996, *Plastics — Polycarbonate (PC) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 10350:1993, *Plastics — Acquisition and presentation of comparable single-point data.*

IEC 93:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials.*

IEC 112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC 243-1:1988, *Methods of test for electric strength of solid insulating materials — Part 1: Tests at power frequencies.*

IEC 250:1969, *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.*

IEC 296:1982, *Specification for unused mineral insulating oils for transformers and switchgear.*

IEC 1006:1991, *Methods of test for the determination of the glass transition temperature of electrical insulating materials.*

1) To be published. (Revision of ISO 291:1977)

2) To be published. (Revision in part of ISO 294:1995)

3) To be published. (Revision of ISO 1133:1991)

4) To be published. (Revision of ISO 1210:1992)

3 Preparation of test specimens

It is essential that specimens are always prepared by the same procedure (either injection moulding or compression moulding), using the same processing conditions.

The procedure to be used for each test method is indicated in tables 3 and 4 (M = injection moulding, Q = compression moulding).

The material shall be kept in moisture-proof containers until it is required for use.

Moisture content of filled or reinforced materials shall be expressed as a percentage of the total mass of the compound.

3.1 Treatment of the material before moulding

Before processing, the material sample shall be dried for $5 \text{ h} \pm 1 \text{ h}$ at $120 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$. The moisture content shall not exceed 0,02 %.

To ensure that the moisture content remains low, it is recommended that the sample material in the feed hopper of the injection-moulding machine be blanketed with dried air or nitrogen at a temperature of $110 \text{ }^{\circ}\text{C} \pm 10 \text{ }^{\circ}\text{C}$. Better results may be obtained using a dehumidifier hopper drier.

3.2 Injection moulding

Injection-moulded specimens shall be prepared in accordance with ISO 294-1, using the conditions specified in table 1.

Table 1 — Conditions for injection moulding of test specimens

Material	Melt temperature $^{\circ}\text{C}$	Mould temperature $^{\circ}\text{C}$	Average injection velocity mm/s
Non-reinforced grades			
MFR > 15 g/10 min	280	80	200 ± 100
$10 \text{ g/10 min} < \text{MFR} \leq 15 \text{ g/10 min}$	290	80	200 ± 100
$5 \text{ g/10 min} < \text{MFR} \leq 10 \text{ g/10 min}$	300	80	200 ± 100
$\text{MFR} \leq 5 \text{ g/10 min}$	310	90	200 ± 100
Glass-fibre-reinforced grades	300	110	200 ± 100

3.3 Compression moulding

Compression-moulded sheets shall be prepared in accordance with ISO 293, using the conditions specified in table 2.

Table 2 — Conditions for compression moulding of test specimens

Material	Moulding temperature $^{\circ}\text{C}$	Full pressure MPa	Full-pressure time min
All grades	300	5	2

After moulding, cool the specimens for 4 min by putting a water-cooled board between the core and the removable bottom plate at a (moulding) pressure of 1 MPa.

The test specimens required for the determination of the properties shall be machined from the compression-moulded sheets in accordance with ISO 2818 or stamped.

4 Conditioning of test specimens

Test specimens for the determination of electrical properties shall be conditioned in accordance with ISO 291 for at least 24 h at $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity.

Test specimens for the determination of mechanical properties shall be conditioned in accordance with ISO 291 for at least 4 h at $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity.

5 Determination of properties

In the determination of properties and the presentation of data, the standards, supplementary instructions and notes given in ISO 10350 shall be applied. All tests shall be carried out in the standard atmosphere of $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity unless specifically stated otherwise in tables 3 and 4.

Table 3 is compiled from ISO 10350, and the properties listed are those which are appropriate to polycarbonate moulding and extrusion materials. These properties are those considered useful for comparisons of data generated for different thermoplastics.

Table 4 contains those properties, not found specifically in table 3, which are in wide use or of particular significance in the practical characterization of polycarbonate moulding and extrusion materials.

Table 3 — General properties and test conditions (selected from ISO 10350)

Property	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation ¹⁾	Test conditions and supplementary instructions
Rheological properties					
Melt mass-flow rate	g/10 min	ISO 1133	Moulding compound	—	Temperature 300 °C, load 1,2 kg
Melt volume-flow rate	cm ³ /10 min				
Mechanical properties					
Tensile modulus	MPa	ISO 527-1, ISO 527-2	See ISO 3167	M	Test speed 1 mm/min
Yield stress	MPa				Test speed 50 mm/min
Yield strain	%				Test speed 50 mm/min
Nominal strain at break	%				Test speed 50 mm/min
Stress at 50 % strain	MPa				Test speed 50 mm/min
Stress at break	MPa				Test speed 5 mm/min. Only to be quoted if strain at break is < 10 %
Strain at break	%	ISO 899-1	See ISO 3167	M	at 1 h } Strain at 1 000 h } ≤ 0,5 %
Tensile creep modulus	MPa				
Flexural modulus	MPa	ISO 178	See ISO 3167	M	Test speed 2 mm/min
Flexural strength	MPa				
Charpy unnotched impact strength	kJ/m ²	ISO 179	80 × 10 × 4	M	Method 1e (edgewise impact)

Table 3 — General properties and test conditions (selected from ISO 10350) (*concluded*)

Property	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation ¹⁾	Test conditions and supplementary instructions
Thermal properties					
Glass transition temperature	°C	IEC 1006	Moulding compound	—	Method A (DSC or DTA). Use 10 °C/min
Temperature of deflection under load	°C	ISO 75-1, ISO 75-2	110 × 10 × 4 edgewise or 80 × 10 × 4 flatwise	M	0,45 MPa and 1,8 MPa
Vicat softening temperature	°C	ISO 306	10 × 10 × 4	M	Heating rate 50 °C/h, load 50 N
Coefficient of linear thermal expansion	°C ⁻¹	TMA (see ISO 10350)	Prepared from ISO 3167	M	Parallel } Quote the secant } value over the Normal } temperature range } 23 °C to 55 °C
Flammability	s	ISO 1210	125 × 13 × 3 (or thicker by agreement)	M	Method B — afterflame/after- glow times of vertical specimens
Ignitability	%	ISO 4589-2	80 × 10 × 4	M	Procedure A — top surface ignition
Electrical properties					
Relative permittivity	—	IEC 250	$\geq 80 \times \geq 80 \times 1$	Q	Frequency 100 Hz and 1 MHz (compensate for electrode edge effect)
Dissipation factor	—				
Volume resistivity	$\Omega \cdot m$	IEC 93	$\geq 80 \times \geq 80 \times 1$	Q	Voltage 100 V
Surface resistivity	Ω				
Electric strength	kV/mm	IEC 243-1	$\geq 80 \times \geq 80 \times 1$	Q	Use 25 mm/75 mm coaxial- cylinder electrode configuration. Immerse in IEC 296 transformer oil. Use short time (rapid rise) test
Comparative tracking index	—	IEC 112	$\geq 15 \times \geq 15 \times 4$	M	Use solution A
Other properties					
Water absorption	%	ISO 62	50 × 50 × 3 or Ø 50 × 3 disc	M	Saturation value in water at 23 °C Saturation value at 23 °C and 50 % relative humidity
Density	kg/m ³	ISO 1183	10 × 10 × 4	M	—
¹⁾ M = Injection moulding. Q = Compression moulding (compression-moulded sheets are used if injection-moulded specimens cannot be manufactured due to insufficient flowability to fill the mould).					

Table 4 — Additional properties and test conditions of particular utility to polycarbonate moulding and extrusion materials

Property	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation ¹⁾	Test conditions and supplementary instructions
Mechanical properties					
Yield stress (at slower test speed)	MPa	ISO 527-1, ISO 527-2	ISO 3167	M	Test speed 5 mm/min. Only to be quoted if strain at break is < 10 %
Yield strain (at slower test speed)	%				
Izod impact strength	kJ/m ²	ISO 180	63,5 × 12,7 × 3,2	M	Method 4A
Electrical properties (with thicker specimens)					
Relative permittivity	—	IEC 250	≥ 80 × ≥ 80 × 3	M	Frequency 100 Hz and 1 MHz (compensate for electrode edge effect)
Dissipation factor	—				
Volume resistivity	Ω·m	IEC 93	≥ 80 × ≥ 80 × 3	M	Voltage 100 V
Surface resistivity	Ω				
Electric strength	kV/mm	IEC 243-1	≥ 80 × ≥ 80 × 3	M	Use 25 mm/75 mm coaxial-cylinder electrode configuration. Immerse in IEC 296 transformer oil. Use short time (rapid rise) test
Other properties					
Viscosity number	ml/g	ISO 1628-4	Moulding compound	—	Determine the average for two separate solutions
1) M = Injection moulding.					

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