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Plastics — Polycarbonate sheets — Types, dimensions and characteristics

Plastiques — Plaques en polycarbonate — Types, dimensions et caractéristiques

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This third edition cancels and replaces the second edition (ISO 11963:2012), which has been technically revised. The main changes compared to the previous edition are as follows.

— Relative humidity rule (50 ± 10) % was deleted from 5.4.1. Dimension change by the moisture absorption is very small, and the polycarbonate materials do not need to state adjustment of the relative humidity in the dimensional measurement.

— Relative humidity rule was changed from (65 ± 5) % to (50 ± 10) % in 6.7.2. Polycarbonate materials are not humidity sensitive material in weathering.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plastics — Polycarbonate sheets — Types, dimensions and characteristics

1 Scope

This document specifies the requirements for solid, flat extruded sheets of polycarbonate (PC) for general applications. It applies specifically to sheets made of poly(*p,p′*-isopropylidene-diphenyl carbonate). The sheets can be coloured or colourless, and they can be transparent, translucent or opaque. The sheets can also be those that have a special weather-protective layer on one or both surfaces.

This document applies only to thicknesses equal to or greater than 1,5 mm.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 75-2:2013, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 179-1:2010, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 306:2013, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

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

ISO 877-1, *Plastics — Methods of exposure to solar radiation — Part 1: General guidance*

ISO 877-2, *Plastics — Methods of exposure to solar radiation — Part 2: Direct weathering and exposure behind window glass*

ISO 877-3, *Plastics — Methods of exposure to solar radiation — Part 3: Intensified weathering using concentrated solar radiation*

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

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 8256:2004, *Plastics — Determination of tensile-impact strength*

ISO 13468-1, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 1: Single-beam instrument*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Composition

4.1 The following type of PC is preferred for PC sheet extrusion:

Thermoplastics ISO 21305-PC, E, 61-09

(see ISO 21305-1 for explanation of designation system for PC)

4.2 The sheet may contain colorants, additives, processing aids and stabilizers (e.g. UV-absorbers) up to a total mass content of 5 %.

4.3 Sheets of the type specified in Clause 5 may have a protective layer (on one or both surfaces) with a UV-absorber content higher than that of the substrate. The composition of the protective layer (e.g. polycarbonate and UV-absorber, or PMMA and UV-absorber, or other materials) and the application techniques (e.g. co-extrusion, coating, lamination, flow-coating, dipping) are not specified by this document.

5 Requirements

5.1 Masking

The surface of the sheet as delivered shall be protected by plastic film or paper or a combination of both.

5.2 Appearance

Requirements concerning defects and optical quality shall be agreed upon between the interested parties.

5.3 Colour

The colorant(s) shall be homogeneously and uniformly distributed throughout the material, unless otherwise specified. For critical requirements, the degree of homogeneity shall be specified by the interested parties.

5.4 Dimensions

5.4.1 Conditions of measurement

Measurements should preferably be made under the standard conditions 23 °C ± 2 °C. For measurements made under ambient conditions, allowance shall be made for dimensional changes due to the differences in temperature at the place of measurement from the preferred temperature.

5.4.2 Length and width

The length and width of the sheets shall be agreed upon between the interested parties. The tolerances on length and width shall be as specified in Table 1.

Table 1 — Tolerances on length and width

Length or width mm	Tolerance
Up to 1 000	$^{+3}_{0}$ mm
From 1 001 to 2 000	$^{+6}_{0}$ mm
From 2 001 to 3 000	$^{+9}_{0}$ mm
3 001 and over	$^{+0,3}_{0}$ %

5.4.3 Deviation of shape from rectangular

The difference Δl between the lengths of the two diagonals of the rectangular sheet shall be less than $3,5 \times 10^{-3} \times b$ (where b is the width, in millimetres, of the sheet, measured perpendicular to the direction of extrusion), but need not be less than 2 mm.

5.4.4 Thickness

The tolerance on the thickness, d, of the sheets shall be as specified in Table 2.

Table 2 — Tolerances on thickness

Thickness, d mm	Tolerance %
$1,5 \leq d \leq 5$	±10
$5 < d$	±5

5.5 Shrinkage

The maximum shrinkage (see 6.5.3) shall be as specified in Table 3.

Table 3 — Maximum shrinkage

Thickness, d mm	Maximum shrinkage %
$1,5 \leq d \leq 5$	10
$5 < d$	5

5.6 Basic properties

The basic mechanical, thermal and optical properties of transparent, colourless sheets shall be as specified in Table 5. For other grades, the required properties shall be agreed upon between the interested parties.

5.7 Weathering behaviour

Any requirements on natural- or artificial-weathering behaviour shall be agreed upon between the interested parties, as required.

5.8 Other properties

Other properties of transparent, colourless sheets, needed for specific applications, shall be agreed upon between the interested parties. Examples of, and test methods for, such properties are presented in Table 4.

Table 4 — Typical values of other properties of transparent, colourless sheets

Properties	Unit	Test method	Typical value
Density	g/cm^3	ISO 1183-1	1,2
Coefficient of linear thermal expansion	K^{-1}	ISO 11359-2	65×10^{-6}
Refractive index, n_D^{20}	—	ISO 489:1999, method A	1,59
Haze (3 mm)	%	ISO 14782	1
Surface resistivity	Ω	IEC 60093	10^{15}
Water absorption (pre-conditioning: 50 °C/24 h; immersion time in water: 24 h)	mg	ISO 62:2008, method 1	16

Refractive index n_D^{20} is define by ISO 489.

For other grades, the required properties shall be agreed upon between the interested parties.

6 Test methods

6.1 General

6.1.1 Sampling

The sampling procedure shall be agreed upon between the interested parties. The procedures described in ISO 2859-1 and ISO 28590 are widely accepted and frequently used. Hence these are recommended for sampling.

6.1.2 Conditioning and testing of specimens

Conditioning (48 h) and testing of specimens shall be carried out at 23 °C ± 2 °C and (50 ± 10) % relative humidity, in accordance with ISO 291, except for the Vicat softening temperature and the temperature of deflection under load (see 6.5.1 and 6.5.2).

6.1.3 Preparation of specimens

Specimens shall be prepared, wherever applicable, in accordance with the procedures described in ISO 2818. When it is necessary to machine the sheet to reduce its thickness to the dimension required for a particular test method, one original surface shall be left intact.

With PC sheets coated on one side, the coated side shall remain unmachined. With PC sheets coated on both sides, two groups of specimens shall be prepared. One group shall retain one of the original coated sides and the other group, the other original coated side. The two groups shall be tested separately.

6.2 Colour

Colour differences between a reference material (standard) and the specimens shall be determined using a differential colorimetric instrument, as agreed between the parties concerned: e.g. CIELAB data (CIE 15) may be used.

6.3 Dimensions

6.3.1 The length and width of the sheets shall be measured to the nearest 1 mm.

Table 5 — Requirements on basic properties

Properties		Unit	Test method	Type of specimen	Required value	Subclause
Mechanical properties						
Tensile stress at yield, σ_y		MPa	ISO 527-2/1A/50 ISO 527-2/1B/50	1A 1B	≥55	6.4.1
Modulus of elasticity in tension, E_t		MPa	ISO 527-2/1A/1 ISO 527-2/1B/1	1A 1B	≥2 200	6.4.1
Nominal tensile strain at break, ε_{tB}		%	ISO 527-2/1A/50 ISO 527-2/1B/50	1A 1B	≥60	6.4.1
Charpy impact strength (notched, notch radius 0,25 mm; thickness ≥ 4 mm)		kJ/m^2	ISO 179-1/1eA	1	≥6	6.4.2
Tensile impact strength (double-notched; thickness < 4 mm)		kJ/m^2	ISO 8256:2004, method A	1	≥150	6.4.2
Thermal properties						
Vicat softening temperature		°C	ISO 306:2013, method B50	—	≥145	6.5.1
Temperature of deflection under load (thickness ≥ 3 mm)		°C	ISO 75-2:2013, method A	—	≥130	6.5.2
Optical properties						
Light transmittance, τ_t (380 nm to 780 nm)		—	ISO 13468-1			6.6
Thickness, t	1,5 mm ≤ t < 4 mm 4 mm ≤ t < 6 mm 6 mm ≤ t < 12 mm 12 mm ≤ t			—	≥85 ≥82 ≥80 ≥75	

6.3.2 The thickness of the sheets shall be measured to the nearest 0,05 mm, excluding the masking film or paper, and without damaging the surface. Measurements shall be made at points not less than 100 mm from the sheet edge.

6.4 Mechanical properties

6.4.1 Tensile properties shall be determined in accordance with ISO 527-2, using specimen type 1A or 1B. The test speed for tensile stress at yield and nominal strain at break shall be 50 mm/min and for the modulus of elasticity in tension, 1 mm/min.

6.4.2 When the sheet thickness is greater than or equal to 4 mm, the Charpy notched impact strength shall be determined in accordance with ISO 179-1:2010, method 1eA (edgewise), using a notched bar (80 mm × 10 mm × d mm, V-notch, radius 0,25 mm), where d is equal to the sheet thickness.

If the thickness is less than 4 mm, the tensile impact strength shall be determined using a double V-notch (notch radius 1 mm) in accordance with ISO 8256:2004 (specimen type 1, method A).

The notched impact strength shall be measured with specimens taken parallel and perpendicular to the extrusion direction.

These two different tests are required because, when determining the notched impact strength to ISO 179-1 (Charpy), extruded PC shows a tough/brittle transition in the range between approximately 2,5 mm and 3,5 mm thickness, which gives rise to large deviations in measurements made in this range.