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Plastics — Poly(methyl methacrylate) sheets — Types, dimensions and characteristics —

Part 3:
Continuous cast sheets

Plastiques — Plaques en poly(méthacrylate de méthyle) — Types, dimensions et caractéristiques —
Partie 3: Plaques coulées continues

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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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 7823:2007), of which it constitutes a minor revision. The changes compared to the previous edition are as follows:

— the normative references clause has been updated.

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 — Poly(methyl methacrylate) sheets — Types, dimensions and characteristics —

Part 3: Continuous cast sheets

1 Scope

This document specifies requirements for non-modified flat poly(methyl methacrylate) (PMMA) continuous cast sheets for general-purpose use. The sheets can be colourless or coloured, and can be transparent, translucent or opaque.

The thickness range of the sheets covered by document is 1 mm to 10 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 62, *Plastics — Determination of water absorption*

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

ISO 178, *Plastics — Determination of flexural properties*

ISO 179-1, *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 489:1999, *Plastics — Determination of refractive index*

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 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 2039-2, *Plastics — Determination of hardness — Part 2: Rockwell hardness*

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

ISO 4582, *Plastics — Determination of changes in colour and variations in properties after exposure to glass-filtered solar radiation, natural weathering or laboratory radiation sources*

ISO 4892-2:2006, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 4892-4, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

ISO 11359-2, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

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

ISO 13468-2, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 2: Double-beam instrument*

ISO 14782, *Plastics — Determination of haze for transparent materials*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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/

3.1
non-modified flat cast poly(methyl methacrylate) sheet
sheet with two plane, substantially parallel surfaces, based on homopolymers of MMA, or copolymers of MMA with acrylic or methacrylic monomers, produced by bulk polymerization in the presence of suitable initiators

4 Composition

The amounts of plasticizing ingredients (materials that do not undergo chemical reaction to become a part of the polymer), other monomers and crosslinking agents (materials that produce the links between the chains of polymers) present shall be such that the basic properties are not changed from the values given in Table 3. These amounts are in most cases less than a mass fraction of 5 %.

Other additives, such as colorants, UV absorbers and pigments, may be included to give specific properties.

Requirements regarding additives are given in national environmental legislation and regulations.

5 General requirements

5.1 Protective coverings

Unless otherwise agreed upon by the interested parties, the surfaces of the sheet, as delivered, shall be protected by suitable materials, for example kraft paper secured with a water-soluble or pressure-sensitive adhesive, or a polyethylene film, which are readily removable without causing surface contamination or damage.

5.2 Appearance

5.2.1 Surface defects

The sheet shall have a smooth surface. There shall be no scratches, marks or other surface defects larger than 3 mm^2 each anywhere in the sheet.

5.2.2 Inclusion defects

There shall be no bubbles, inclusions, cracks or other defects that could adversely affect the performance of the sheet in its intended application which are larger than 3 mm^2 each anywhere in the sheet.

5.2.3 Classification of defects

The area of any defect found in the sheets shall be classified as specified in Table 1. Each defect shall be considered separately.

Table 1 — Classification of defects

Classification	Area of surface defect	Area of inclusion defect
Negligible	Less than 1 mm^2	Less than 1 mm^2
Acceptable	1 mm^2 to 3 mm^2	1 mm^2 to 3 mm^2

5.2.4 Distribution of defects

5.2.4.1 There shall be no significant number (for the application) of small defects, each of which is defined as negligible in Table 1, within 1 m^2 anywhere in the sheet. What constitutes a significant number shall be agreed between the interested parties.

5.2.4.2 No defect defined as acceptable in Table 1 shall be within 500 mm of another acceptable defect anywhere in or on the sheet.

5.3 Colour

The colour distribution shall be homogeneous, unless otherwise specified. Variations in colour shall be agreed upon between the interested parties.

5.4 Dimensions

5.4.1 Length and width

The length and width of the sheet shall be agreed upon between the interested parties. For cut sheets, the tolerances for each sheet shall be as specified in Table 2.

Table 2 — Tolerances on length and width of cut sheets

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	$^{+0,3}_{0}$ %

5.4.2 Thickness

The thickness tolerance for sheets in the range from 1 mm to 10 mm and up to 6 m^2 in area shall be ± 0,1*h*, where *h* is the nominal sheet thickness in millimetres.

The tolerances apply within each sheet and from sheet to sheet.

5.4.3 Tolerances for other sheet sizes

Tolerances for sheet sizes and thicknesses outside the above ranges shall be agreed upon between the interested parties.

5.4.4 Conditions of measurement

Measurements of dimensions shall be made at room temperature, except that, in cases of dispute, measurements shall be made under standard conditions, as specified in ISO 291. For measurements made under ambient conditions, due allowance shall be made for dimensional changes due to the differences in temperature and relative humidity between test locations.

5.5 Basic and other properties

5.5.1 Basic properties

The basic mechanical, thermal and optical properties of sheets shall be as specified in Table 3.

5.5.2 Other properties

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

Table 3 — Basic properties of PMMA continuous cast sheets — Required values

Property	Unit	Test method	Required value	Subclause
Tensile strength	MPa	ISO 527-2/1B/5	min. 60	6.5.2
Tensile strain	%	ISO 527-2/1B/5	min. 2	6.5.2
Modulus of elasticity in tension	MPa	ISO 527-2/1B/1	min. 2 700	6.5.2
Charpy impact strength (unnotched)	kJ/m^2	ISO 179-1/1fU	min. 8	6.5.3
Vicat softening temperature	°C	ISO 306, method B50	min. 95	6.6.1
Dimensional change on heating (shrinkage)	%	Annex A	max. 2,8	6.6.3
Total luminous transmittance[a]	%	ISO 13468-1	min. 90	6.8.1
Light transmittance at 420 nm (thickness 3 mm)[a]				
— before exposure to xenon lamp	%	ISO 13468-2	min. 90	6.8.3
— after exposure to xenon lamp for 1 000 h (ISO 4892-2:2006, method A)	%	ISO 13468-2	min. 88	6.8.3

[a] For transparent, colourless material.

Table 4 — Other properties of PMMA continuous cast sheets — Typical values

Property	Unit	Test method	Typical value	Subclause
Flexural strength	MPa	ISO 178	110 to 115	6.5.1
Rockwell hardness	Scale M	ISO 2039-2	95 to 100	6.5.4
Linear expansion coefficient	°C^{-1}	ISO 11359-2	7 × 10^{-5}	6.6.4
Temperature of deflection under load	°C	ISO 75-2:2013, method A	85 to 100	6.6.2
Haze	%	ISO 14782	0,5 to 1	6.8.2
Refractive index, n_D^{23}		ISO 489:1999, method A	1,49	6.8.4
Density[a, b]	g/cm^3	ISO 1183-1:2019, method A or C, or ISO 1183-2	1,19	6.9.1
Water absorption	%	ISO 62, method 1 (24 h, 23 °C)	0,5[c]	6.9.2

a For transparent, colourless material.

b Coloured sheets may have a higher value.

c Value reported refers to a square specimen of edge 50 mm and thickness 3 mm.

6 Test methods

6.1 General

6.1.1 Sampling

The sampling procedure shall be agreed upon between the interested parties. The sampling procedure given in ISO 2859-1 is widely accepted and frequently used. Hence it is recommended.

6.1.2 Conditioning and testing atmospheres

Conditioning of specimens (48 h) and tests shall be carried out in accordance with ISO 291 with class 2 tolerances for temperature and relative humidity, except for the Vicat softening temperature, temperature of deflection under load and dimensional change on heating (shrinkage) (see 6.6.1, 6.6.2 and 6.6.3).

6.1.3 Preparation of test specimens

Specimens shall be prepared in accordance with the procedures specified in ISO 2818, wherever applicable.

When it is necessary to machine the sheet to the thickness required for a particular test method, one original surface shall be left intact.

6.1.4 Specimen thickness

When the sheet has a thickness less than that required for the specimens in a particular test method, specimens having the thickness of the sheet shall be used.

6.2 Appearance

Defects and their distribution shall be evaluated by inspecting the sheet illuminated by daylight or by a daylight-type fluorescent lamp with a colour temperature of 6 500 K ± 650 K and a power rating of not less than 40 W.

6.3 Colour

Colour differences between a reference material (standard) and the test sample shall be determined by methods agreed upon by the interested parties.

6.4 Dimensions

6.4.1 The length and width shall be measured to the nearest 1,0 mm, in accordance with 5.4.4. using a calibrated rule.

6.4.2 The thickness shall be measured to the nearest 0,05 mm, in accordance with 5.4.4, using a calibrated micrometer or dial gauge, or an ultrasonic probe. Measurements shall be carried out at no less than 100 mm from the sheet edge.

6.5 Mechanical properties

6.5.1 The flexural properties shall be determined in accordance with ISO 178, using, when possible, a 4-mm-thick specimen. The original surface shall be put under tension whenever the specimen has been machined to the specified dimensions.

6.5.2 The tensile properties shall be determined in accordance with ISO 527-2, using type 1B specimens. The test speed for tensile strength and for tensile strain at break shall be 5 mm/min ± 1 mm/min and for the modulus of elasticity in tension 1 mm/min ± 0,2 mm/min.

6.5.3 The Charpy impact strength shall be determined in accordance with ISO 179-1/1fU, using the standard unnotched bar (dimensions of the specimen 80 mm × 10 mm × 4 mm). The pendulum shall strike the surface that is opposite to the original one if the specimen has been machined to the specified dimensions.

6.5.4 The Rockwell hardness shall be determined in accordance with ISO 2039-2, scale M, on the original cast surface.

6.6 Thermal properties

6.6.1 The Vicat softening temperature shall be determined in accordance with ISO 306:2013, method B50, using the original cast surface. The rate of heating shall be 50 °C/h ± 5 °C/h. Before the test, the specimens shall be conditioned for 16 h at 80 °C ± 2 °C and cooled to room temperature in a desiccator.

6.6.2 The temperature of deflection under load shall be determined in accordance with ISO 75-2:2013, method A. Before the test, the specimens shall be conditioned for 16 h at 80 °C ± 2 °C and cooled to room temperature in a desiccator. Measurements shall not be carried out on specimens with a thickness below 3 mm.

6.6.3 The dimensional change on heating (shrinkage) shall be determined by the method described in Annex A.

6.6.4 The linear expansion coefficient shall be determined in accordance with ISO 11359-2.

6.7 Flammability

The flammability and burning properties shall be determined in accordance with national fire regulations.