INTERNATIONAL STANDARD

ISO 7823-1

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

Part 1:
Cast sheets

Plaques en poly(méthacrylate de méthyle) — Types, dimensions et caractéristiques —

Partie 1: Plaques coulées

Reference number
ISO 7823-1:1991(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 7823-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 7823-1:1987), of which it constitutes a technical revision.

ISO 7823 consists of the following parts, under the general title *Poly(methyl methacrylate) sheets — Types, dimensions and characteristics*:

— *Part 1: Cast sheets*

— *Part 2: Melt-calendered extruded sheets*

Annex A forms an integral part of this part of ISO 7823.

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

Part 1:
Cast sheets

1 Scope

1.1 This part of ISO 7823 specifies requirements for non-modified flat poly(methyl methacrylate) (PMMA) cast sheets (plates and continuous) for general-purpose use. The sheets may be colourless or coloured, and transparent, translucent or opaque.

1.2 The thickness range of the sheets covered by this part of ISO 7823 is 1,5 mm to 25 mm.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7823. 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 7823 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 75:1987, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 178:1975, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179:1982, *Plastics — Determination of Charpy impact strength of rigid materials.*

ISO 291:1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 306:1987, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature.*

ISO 489:1983, *Plastics — Determination of the refractive index of transparent plastics.*

ISO/R 527:1966, *Plastics — Determination of tensile properties.*

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

ISO 2039-2:1987, *Plastics — Determination of hardness — Part 2: Rockwell hardness.*

ISO 2818:1980, *Plastics — Preparation of test specimens by machining.*

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.*

ISO 4582:1980, *Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or artificial light.*

ISO 4607:1978, *Plastics — Methods of exposure to natural weathering.*

ISO 4892:1981, *Plastics — Methods of exposure to laboratory light sources.*

EN 2155-5:1989, *Aerospace series — Test methods for transparent materials for aircraft glazing — Part 5: Determination of visible light transmission.*

EN 2155-9:1989, *Aerospace series — Test methods for transparent materials for aircraft glazing — Part 9: Determination of haze.*

EN 2155-12:—,[1] *Aerospace series — Test methods for transparent materials for aircraft glazing — Part 12: Determination of coefficient of linear thermal expansion.*

3 Definitions

For the purposes of this part of ISO 7823, the following definitions apply.

3.1 non-modified cast PMMA sheets: Sheets based on homopolymers of MMA, or copolymers of MMA with acrylic or methacrylic monomers, produced by bulk polymerization in the presence of suitable initiators.

3.2 flat PMMA sheets: Sheets with substantially parallel plane surfaces.

4 Composition

4.1 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) shall be present in amounts that do not change the basic properties from the values given in table 3. These amounts are in most cases less than 3 % (*m*/*m*).

4.2 Other additives, e.g. colorants, UV absorbers, pigments, may be included to achieve specific properties.

5 General requirements

5.1 Protective coverings

Unless otherwise agreed between the interested parties, the surfaces of the sheet, as delivered, shall be protected by a suitable material, for example kraft paper secured with a water-soluble or pressure-sensitive adhesive which allows the protective material to be readily removed without surface contamination or damage, or polyethylene film.

1) To be published.

5.2 Appearance

5.2.1 Surface defects

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

5.2.3 Classification

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

Table 1 — Classification of defects

Areas in square millimetres

Classification	Area of surface defects	Area of inclusion defects
Negligible	Less than 1	Less than 1
Acceptable	1 to 3	1 to 3

5.2.4 Defect distribution

5.2.4.1 There shall not be a significant number (for the application) of small defects, each particle of which is defined as "negligible" in table 1, within 1 m^2 anywhere in the sheet.

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

Unless otherwise specified, colour distribution shall be homogeneous. Admissible variation shall be agreed between the interested parties.

5.4 Dimensions

5.4.1 Length and width

The length and width of the sheets shall be agreed between the interested parties. The tolerances shall be as specified in table 2.

Table 2 — Tolerances on length and width

Dimensions in millimetres (unless stated otherwise)

Length or width	Tolerance
⩽ 1 000	$^{+3}_{0}$
From 1 001 to 2 000	$^{+6}_{0}$
From 2 001 to 3 000	$^{+9}_{0}$
⩾ 3 001	$^{+0,3}_{0}$ %

5.4.2 Thickness

The thickness tolerances for sheets of thickness 2 mm to 25 mm and up to 6 m^2 in area shall be $\pm (0,4 + 0,1\ h)$, where h is the nominal sheet thickness in millimetres.

Tolerances apply within each sheet and from sheet to sheet.

5.4.3 Tolerances for other sizes

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

5.4.4 Conditions of measurement

Measurement of the dimensions of the sheets shall be made at room temperature, except that in case of dispute measurement shall be made under standard conditions, as specified in ISO 291. For measurements made under local 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 properties

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

Table 3 — Requirements for basic properties

Property	Unit	Test method	Value	Sub-clause
Tensile strength, min.	MPa	ISO/R 527, type 1 specimen, speed B	70	6.5.2
Modulus of elasticity in tension, min.	MPa	ISO/R 527, type 1 specimen, speed B	3 000	6.5.2
Elongation at break, min.	%	ISO/R 527, type 1 specimen, speed B	4	6.5.2
Impact strength (Charpy), min.	kJ/m^2	ISO 179/1D or ISO 179/2D	13 10	6.5.3
Vicat softening temperature, min.	°C	ISO 306, method B (5 kg)	105	6.6.1
Dimensional change on heating (shrinkage), max.	%	Annex A	2,5	6.6.3
Light transmittance, min.	%	EN 2155-5	90[1)]	6.8.1
Light transmittance at 420 nm, min.	%	EN 2155-5	90[1)]	6.8.3
Light transmittance at 420 nm after exposure to xenon lamp for 1 000 h, min.	%	EN 2155-5	88[1)]	6.8.3

1) For transparent, colourless material.

Table 4 — Typical values for special properties

Property	Unit	Test method	Typical value	Sub-clause
Flexural strength	MPa	ISO 178	110	6.5.1
Rockwell hardness (M scale)		ISO 2039-2	100	6.5.4
Coefficient of linear expansion	$°C^{-1}$	EN 2155-12	7×10^{-8}	6.6.4
Deflection temperature under load	°C	ISO 75, method A (1,8 MPa)	98	6.6.2
Haze	%	EN 2155-9	1	6.8.2
Refractive index, n_D^{20}	—	ISO 489, method A	1,49	6.8.4
Density (colourless sheet)	g/cm^3	ISO 1183, method A	1,19	6.9.1
Water absorption	%	ISO 62, method 1	0,5	6.9.2

5.6 Special properties

Requirements may be agreed between the interested parties for special properties needed for particular applications. Examples of such properties are presented in table 4.

6 Test methods

6.1 General

6.1.1 Sampling

A sample sufficient to determine the compliance of the material to this specification shall be selected in accordance with ISO 2859-1 at random from each lot of material.

6.1.2 Conditioning and testing of specimens

Conditioning of the specimens (48 h) and the tests shall be carried out in accordance with ISO 291 at 23 °C ± 2 °C and (50 ± 5) % R.H., except for Vicat softening temperature and deflection temperature under load (see 6.6.1 and 6.6.2).

6.1.3 Preparation of specimens

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

6.2 Appearance

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

6.3 Colour

Colour differences between a reference material and the test samples shall be determined using a differential colorimetric instrument, as agreed between the interested parties.

6.4 Dimensions

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

6.4.2 The thickness of the sheets shall be measured, using a gauge, a calibrated micrometer or dial-gauge or an ultrasonic probe, to the nearest 0,05 mm in accordance with 5.4.4, excluding the surface protective covering and without damaging the surface. Measurements shall be carried out at not less than 100 mm from the sheet edge.

6.5 Mechanical properties

6.5.1 Flexural properties shall be determined in accordance with ISO 178. The original surface shall be placed under tension whenever the specimen has been machined to conform with the specified dimensions.

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

6.5.2 Tensile properties shall be determined in accordance with ISO/R 527, using a type 1 specimen and at speed B (5 mm/min ± 1 mm/min).

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

6.5.3 The impact strength (Charpy) shall be determined in accordance with ISO 179, using the standard unnotched bar measuring

80 mm × 10 mm × 4 mm (ISO 179/1D) or

50 mm × 6 mm × 4 mm (ISO 179/2D).

The pendulum shall strike the surface opposite the original one whenever the specimen has been machined to conform with the specified dimensions.

Other types of specimen, in accordance with ISO 179, may be used, as agreed between the interested parties.

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

6.6 Thermal properties

6.6.1 The Vicat softening temperature shall be determined in accordance with ISO 306, method B, using the original cast surface. The rate of heating shall be 50 °C/h ± 5 °C/h.

Prior to the test, the specimens shall be conditioned at 80 °C ± 2 °C for 16 h and cooled down to room temperature in a desiccator.

6.6.2 The deflection temperature under load shall be determined in accordance with ISO 75, method A. Prior to the test, the specimens shall be conditioned at 80 °C ± 2 °C for 16 h and cooled down to room temperature in a desiccator.

This test shall not be used for sheets thinner than 3 mm.

6.6.3 The dimensional change at elevated temperature (shrinkage) shall be determined in accordance with the method described in annex A.

6.6.4 The coefficient of linear expansion shall be determined in accordance with EN 2155-12.

6.7 Flammability

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

6.8 Optical properties

6.8.1 The light transmittance shall be determined with light source D 65 in accordance with EN 2155-5, using an integrating sphere, on specimens 1,5 mm to 5 mm thick.

6.8.2 Haze shall be determined in accordance with EN 2155-9 in the range 380 nm to 780 nm on specimens 1,5 mm to 5 mm thick.

6.8.3 The light transmittance at 420 nm, before and after exposure for 1 000 h to a xenon lamp in accordance with ISO 4892, shall be determined with a spectrometric system using a specimen 1,5 mm to 5 mm thick. By agreement between the interested parties, light transmittance may alternatively be determined after exposure to a carbon arc lamp.

6.8.4 The refractive index shall be determined in accordance with ISO 489, method A.

6.9 Special properties

6.9.1 The density shall be determined in accordance with ISO 1183, method A.

6.9.2 The water absorption shall be determined in accordance with ISO 62, method 1 (24 h at 23 °C).

6.9.3 The natural weathering performance shall be determined in accordance with ISO 4607; the resistance to exposure to artificial light shall be determined in accordance with ISO 4892; changes in colour and properties after exposure shall be determined in accordance with ISO 4582. The details of these tests shall be agreed upon between the interested parties.

7 Retest and rejection

If any failure occurs, the material may be retested by agreement between the interested parties.

Annex A
(normative)

Determination of dimensional change at elevated temperature (shrinkage)

A.1 Cut three or more square specimens of side 100 mm ± 2 mm from the sample sheet at positions approximately equally spaced across the width of the sample. Dry the specimens at 70 °C ± 2 °C for 48 h and then cool them down to room temperature in a desiccator (18 °C to 28 °C; in case of dispute 23 °C ± 2 °C). Mark the four sides and measure these to the nearest 0,02 mm.

A.2 Place the specimens horizontally on a plane plate on a shelf in an oven maintained at 160 °C ± 2 °C. To avoid sticking of the specimens, cover the supporting plate with a 3 mm thick layer of talc. The time of heating, depending on the thickness of the sheet, shall be as follows:

Thickness (mm)	**Time** (min)
1,5 to 5	60
> 5	75

A.3 Cool the specimens to room temperature in a desiccator (18 °C to 28 °C; in case of dispute 23 °C ± 2 °C) and measure the four sides again to the nearest 0,02 mm.

A.4 Calculate the change in the length of each side of each specimen as a percentage of the initial value. Calculate the average percentage change for the four sides of each specimen and the average value for the set of three or more specimens.

A.5 Report the presence of bubbles and cracks, and any other change in appearance of the specimens.