INTERNATIONAL STANDARD

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Plastics — Poly(methyl methacrylate) (PMMA) moulding and extrusion materials —

Part 2: **Preparation of test specimens and determination of properties**

Plastiques — Poly(méthacrylate de méthyle) (PMMA) pour moulage et extrusion —

Partie 2: Préparation des éprouvettes et détermination des propriétés

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO 8257 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8257-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

This second edition cancels and replaces the first edition (ISO 8257-2:1990), which has been technically revised.

ISO 8257 consists of the following parts, under the general title *Plastics — Poly(methyl methacrylate) (PMMA) moulding and extrusion materials*:

— *Part 1: Designation system and basis for specifications*

— *Part 2: Preparation of test specimens and determination of properties*

In this corrected version of ISO 8257-2:2001, Table 3 has been amended to remove the meaningless “less than” (<) signs in the dimensions of the specimens for Charpy unnotched impact strength, Charpy notched impact strength and temperature of deflection under load (sixth, seventh and eighth properties in table).

Plastics — Poly(methyl methacrylate) (PMMA) moulding and extrusion materials —

Part 2:
Preparation of test specimens and determination of properties

1 Scope

1.1 This part of ISO 8257 specifies procedures for moulding test specimens of PMMA materials in a specified state, and methods for measuring their properties. Any property listed in this part of ISO 8257 and referred to in combination with ISO 8257-1 shall be determined by the method referred to in this part of ISO 8257.

1.2 No values are quoted for these properties. Those required for the designation of PMMA materials for moulding and extrusion are given in ISO 8257-1. Other properties shall be determined by the appropriate methods referred to in this part of ISO 8257.

1.3 The values determined in accordance with this part of ISO 8257 will not necessarily be identical to those obtained using specimens of different dimensions and/or prepared by different procedures. They may also be influenced by colorants and other additives. The values obtained for the properties of a moulding depend on the moulding compound, the shape of test specimen, the test method and the state of anisotropy. The last-mentioned depends on the gating and the moulding conditions, for example temperature, pressure or injection rate. Any subsequent treatment must also be considered, for example conditioning or annealing.

1.4 The thermal history and the internal stresses of the specimens may strongly influence thermal and mechanical properties and resistance to environmental stress cracking, but exert less effect on the electrical properties, which mainly depend on the chemical composition of the moulding compound.

2 Conformance

In clause 3, the year of publication of each normative reference has been specifically stated. In order to be able to claim conformity with this part of ISO 8257, it is essential that the user use only those editions given, and not earlier or more recent editions.

3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8257. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 62:1999, *Plastics — Determination of water absorption*

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

ISO 175:1999, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals*

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 294-1:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

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

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

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

ISO 604:1993, *Plastics — Determination of compressive properties*

ISO 1133:1997, *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 1628-6:1990, *Plastics — Determination of viscosity number and limiting viscosity number — Part 6: Methyl methacrylate polymers*

ISO 2039-1:1993, *Plastics — Determination of hardness — Part 1: Ball indentation method*

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

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

ISO 6721-2:1994, *Plastics — Determination of dynamic mechanical properties — Part 2: Torsion-pendulum method*

ISO 8257-1:1998, *Plastics — Poly(methyl methacrylate) (PMMA) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 10350-1:1998, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

ISO 13468-1:1996, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 1: Single-beam instrument*

4 Preparation of test specimens

4.1 General

It is essential that specimens are always prepared by the same procedure, using the same processing conditions. The procedures to be used depend on the PMMA material concerned and are indicated in the following subclauses.

4.2 Treatment of the material before moulding

Before processing, the moulding compound shall be predried for 24 h in an oven at 80 °C. In cases of dispute, the manufacturer's instructions shall be followed.

4.3 Moulding of specimens

4.3.1 General requirements

The specimens shall be prepared by injection moulding in accordance with ISO 294-1, using the conditions specified in 4.3.2 to 4.3.6.

4.3.2 Melt temperature

4.3.2.1 General

PMMA moulding compounds are designated using a code-number representing the value of the Vicat softening temperature (VST), a code-number representing the value of the melt mass-flow rate (MFR) and, optionally, a code-number representing the value of the viscosity number (VN). For details of this designation system, in particular the code-numbers used, see ISO 8257-1. In those cases where the designation only includes code-numbers for VST and MFR, the melt temperature used for moulding test specimens may be determined from the MFR code-number (see 4.3.2.2). If the code-number for VN is also used in the designation, the melt temperature may also be determined from the VST and VN code-numbers (see 4.3.2.3). It should be noted that, for moulding compounds with MFR values lying between 1 g/10 min (code-number 015) and 16 g/10 min (code-number 120), there is little difference in the melt temperatures calculated from the MFR code-number and those calculated from the VST and VN code-numbers. However, for moulding compounds outside this range, the melt temperature shall be determined only from the VST and VN code-numbers.

When preparing specimens, the melt temperature shall be kept constant to within $\pm$ 3 °C.

4.3.2.2 Melt temperature determined from MFR code-number

Select the appropriate melt temperature from Table 1.

Table 1 — Melt temperature as a function of MFR code-number

MFR code-number	Melt temperature °C
005	270
015	260
030	250
060	240
120	230
240	220

EXAMPLE

Moulding-compound designation: ISO 8257-PMMA,MLN,108-030

Melt temperature = 250 °C

4.3.2.3 Melt temperature determined from VST and VN code-numbers

Calculate the melt temperature, in degrees Celsius, from the equation

Melt temperature = VST code-number + 130 + a_{VN}

where a_{VN} is a number which depends on the VN code-number as shown in Table 3.

Table 2 — Value of a_{VN} as a function of VN code-number

VN code-number	a_{VN}
43	0
53	10
63	20
73	30
83	40
93	50

EXAMPLE

Moulding-compound designation: ISO 8257-PMMA,MLN,108-030-53

Melt temperature = 108 + 130 + 10 = 248 °C

4.3.3 Mould temperature

Calculate the mould temperature, in degrees Celsius, from the equation

Mould temperature = VST code-number – 40

The mould temperature shall be kept constant to within ± 3 °C.

EXAMPLE

Moulding-compound designation: ISO 8257-PMMA,MLN,108-030-53

Mould temperature = 68 °C

4.3.4 Average melt velocity

Set the injection pressure to give an average melt velocity of 200 mm/s ± 100 mm/s.

4.3.5 Hold pressure

Set the hold pressure to a value such that test specimens with only very slight sink marks are obtained.

4.3.6 Cooling time

Use a cooling time of 50 s ± 5 s.

5 Conditioning

Test specimens shall be conditioned in an oven for 16 h at a temperature of (VST code-number − 25) °C. The conditioning temperature shall be kept constant to within ± 3 °C.

After conditioning in the oven, the specimens shall be further conditioned for at least 24 h at (23 ± 2) °C and (50 ± 5) % relative humidity, except for specimens to be used for the determination of certain thermal and "other" properties, as given in Tables 3 and 4, which, after conditioning in the oven, shall be allowed to cool for at least 1 h at (23 ± 2) °C in a desiccator. Testing shall be performed immediately after the specimens are removed from the desiccator.

6 Determination of properties

In the determination of properties and the presentation of data, the standards, supplementary instructions and notes given in ISO 10350-1 shall be applied. All tests shall be carried out in the standard atmosphere of (23 ± 2) °C and (50 ± 5) % relative humidity unless specifically stated otherwise in Tables 3 and 4.

Table 3 is compiled from ISO 10350-1, and the properties listed are those which are appropriate to PMMA 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 PMMA moulding and extrusion materials.

Table 3 — General properties and test conditions (selected from ISO 10350-1)

Property	Unit	Test method	Specimen type (dimensions in mm)	Test conditions and supplementary instructions
Rheological properties				
Melt mass-flow rate (MFR)[a]	g/10 min	ISO 1133	Moulding compound	Load 3,8 kg Temp. 230 °C[b]
Melt volume-flow rate (MVR)	cm^3/10 min	ISO 1133	Moulding compound	Load 3,8 kg Temp. 230 °C[b]
Mechanical properties				
Tensile modulus	MPa	ISO 527-2/1A/1	Type 1A	Test speed 1 mm/min
Tensile strength at break	MPa	ISO 527-2/1A/5	Type 1A	Test speed 5 mm/min
Tensile strain at break	%	ISO 527-2/1A/5	Type 1A	Test speed 5 mm/min
Charpy unnotched impact strength	kJ/m^2	ISO 179-1eU	80 × 10 × 4[c]	Edgewise
Charpy notched impact strength	kJ/m^2	ISO 179-1eA	80 × 10 × 4[c]	V-notch, $r = 0{,}25$ mm
Thermal properties				
Temperature of deflection under load	°C	ISO 75-2	120 × 10 × 4	120 °C/h 1,8 MPa[c]
Vicat softening temperature[a]	°C	ISO 306/B50	> 10 × > 10 × 4	50 °C/h, 50 N[d]
Other properties				
Water absorption at 23 °C	%	ISO 62, method 1	50 × 50 × 3	After 24 h[d]
Density	kg/dm^3	ISO 1183	> 10 × > 10 × 4	See note d

[a] Property used to designate the material in accordance with ISO 8257-1.

[b] Moulding compound to be dried for at least 4 h in a oven at 80 °C beforehand.

[c] Specimens may be obtained by cutting out the central part of an ISO 3167 type A multipurpose test specimen.

[d] Specimens shall be cooled for at least 1 h in a desiccator at 23 °C ± 2 °C after conditioning in an oven (see clause 5).