INTERNATIONAL STANDARD

ISO 8257-2

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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 caractéristiques

Reference number
ISO 8257-2:1990(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 8257-2 was prepared by Technical Committee ISO/TC 61, *Plastics*.

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

— *Part 1: Designation*

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

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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 figures 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, 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 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8257. 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 8257 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 175:1981, *Plastics — Determination of the effects of liquid chemicals, including water.*

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

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

ISO 180:1982, *Plastics — Determination of Izod impact strength of rigid materials.*

ISO 294:1975, *Plastics — Injection moulding test specimens of thermoplastic materials.*

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 537:1989, *Plastics — Testing with the torsion pendulum.*

ISO 604:1973, *Plastics — Determination of compressive properties.*

ISO 1133:1981, *Plastics — Determination of the melt flow rate 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 2039-1:1987, *Plastics — Determination of hardness — Part 1: Ball indentation method.*

ISO 2557-1:1989, *Plastics — Amorphous thermoplastics — Preparation of test specimens with a specified maximum reversion — Part 1: Bars.*

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

ISO 8257-1:1987, *Plastics — Poly(methyl methacrylate) (PMMA) moulding and extrusion materials — Part 1: Designation.*

ISO 8328:1989, *Plastics — Amorphous thermoplastic moulding materials — Determination of maximum reversion.*

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

3 Preparation of test specimens

Injection moulding is the referee method for the preparation of test specimens and will become the only method included in the next revision of this part of ISO 8257. Subclauses 3.3 and 3.3.1 on compression moulding are included for information only and will not appear in the next revision.

3.1 Predrying of the moulding compound

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

3.2 Preparation of test specimens by injection moulding

The specimens produced under controlled conditions shall be prepared by injection moulding, in accordance with ISO 294, using the following conditions:

3.2.1 Plastic melt temperature θ_S [see plastic (stock) temperature in ISO 294:1975]

On the basis of the melt flow rate (MFR), as indicated in the designation code (see ISO 8257-1), the plastic melt temperature θ_S (MFR) shall be selected in accordance with table 1.

Table 1 — Plastic melt temperature as a function of melt flow rate

MFR cote-number	θ_S (MFR) ± 3*) °C
005	270
015	260
030	250
060	240
120	230
240	220

*) It is important that θ_S (MFR) is kept constant to within ± 3 °C.

EXAMPLE

Moulding powder ISO 8257-PMMA,MLN,108-030

θ_S(MFR) = 250 °C

For moulding powders also characterized by the viscosity number (VN) in the designation code (see ISO 8257-1), the melt temperature θ_S (VN) may also be obtained, in degrees Celsius, from the relationship

$$\theta_S(VN) = VST + 130 + a$$

where

VST is the Vicat softening temperature, in degrees Celsius, as given in the designation code;

VN is the viscosity number, as given in the designation code;

a is a constant which depends on the viscosity number, as shown in table 2;

θ_S (VN) shall be kept constant to within ± 3 °C.

Table 2 — Dependence of the constant a on viscosity number VN

VN cote-number	43	53	63	73	83	93
a	0	10	20	30	40	50

EXAMPLE

Moulding powder ISO 8257-PMMA,MLN,108- ... -53

$\theta_S(VN) = 108 + 130 + 10 = 248$ °C

θ_S (MFR) and θ_S (VN) are parameters which do not differ noticeably for moulding powders, MFR values generally lying within the range 1 g/10 min (code-number 015) to 16 g/10 min (code-number 120). For moulding powders outside this range, θ_S (VN) shall be used to ensure a comparable quality of the test specimens.

3.2.2 Mould temperature (see ISO 294)

The mould temperature θ_M is given in degrees Celsius, by the equation

$\theta_M = VST - 40$

θ_M shall be kept constant to within ± 3 °C.

EXAMPLE

Moulding powder ISO 8257-PMMA,MLN,108-030-53

$\theta_M = 108 - 40 = 68$ °C

3.2.3 Average injection velocity (see ISO 294)

The injection pressure shall be set in such a way that the average injection velocity is 250 mm/s ± 100 mm/s.

3.2.4 Hold pressure [see injection pressure in ISO 294:1975)

The hold pressure shall be set in such a way that test specimens with only very slight sink marks are obtained.

3.2.5 Cooling time (see ISO 294)

The cooling time shall be 50 s ± 5 s.

3.3 Preparation of test specimens by compression moulding

Specimens in the basic state, i.e. almost free from molecular orientation, shall be prepared in accordance with ISO 2557-1 by compression moulding or by thermal relaxation of injection-moulded specimens.

The specimens shall be considered to be in their basic state if

— the maximum reversion, measured in accordance with ISO 8328 (170 °C, but 15 min, in air), does not exceed 5 %;

— the surface structure of the specimens and/or the values of intrinsic properties do not change as a result of heat treatment.

3.3.1 Compression moulding

The conditions for compression moulding shall be adapted to the presses, moulds and moulding compounds being used. The following initial conditions are recommended:

Temperature: 200 °C

Pre-heating time: 5 min

Moulding pressure: 4 MPa

Moulding time: 5 min

Cooling rate: 10 °C/min ± 5 °C/min (under pressure)

Demoulding at: < 60 °C

3.3.2 Thermal relaxation

The conditions for thermal relaxation shall be adapted to the presses, moulds and moulding materials being used. The following initial conditions are recommended:

Temperature: 180 °C

Pressure: 1,5 MPa

Relaxation time: 15 min

Cooling rate: 10 °C/min ± 5 °C/min (under pressure)

Demoulding at: < 60 °C

4 Conditioning

When measuring the properties given in table 3, the test specimens shall be given one of the following pre-treatments:

Method 1: Annealing for 16 h at 80 °C, followed by at least 24 h storage at 23 °C and 50 % relative humidity.

Method 2: Annealing for 16 h at 80 °C, followed by a cooling period of at least 1 h at 23 °C in a desiccator. Testing shall be performed immediately after the samples are removed from the desiccator.

In either method, if the specimens undergo deformation at 80 °C, a temperature of (VST − 25) °C shall be used. This temperature shall be kept constant to within ± 3 °C.

5 Determination of properties

Properties shall be determined using the specimens and test methods specified in table 3. All measurements shall be made at 23 °C ± 2 °C and (50 ± 5) % relative humidity, unless otherwise specified in the relevant International Standard.

Table 3 — Methods of test for PMMA moulding material and moulded test specimens

Property	Unit	Test method	Specimen dimensions mm	Specimen state[1]	Condition-ing[2]	Remarks
Tests on moulding material						
Melt flow rate[3]	g/10 min	ISO 1133	—[4]	—	C_2	Load 3,8 kg, temperature 230 °C
Viscosity number[3]	cm^3 /g	ISO 1628-6	—[4]	—	—	
Density	g/cm^3	ISO 1183	—[4]	—	C_2	
Tests on standard specimens						
Mechanical properties						
Shear modulus	MPa	ISO 537	60 × 10 × 1[5]	A	C_1	Frequency 0,1 Hz to 10 Hz
Mechanical loss factor	—	ISO 537	60 × 10 × 1[5]	A	C_1	Frequency 0,1 Hz to 10 Hz
Tensile modulus of elasticity	MPa	ISO/R 527	150 × 20/10 × 4[5]	B	C_1	Test speed 1 mm/min
Tensile stress at break or at yield	MPa	ISO/R 527	150 × 20/10 × 4[5]	B	—	Test speed 5 mm/min
Tensile elongation at break or at yield	%	ISO/R 527	150 × 20/10 × 4[5]	B	—	Test speed 5 mm/min
Flexural modulus of elasticity	MPa	ISO 178	80 × 10 × 4	B	C_1	Test speed 1 mm/min
Flexural stress at rupture	MPa	ISO 178	80 × 10 × 4	B	—	Test speed 1 mm/min
Flexural deflection at rupture	mm	ISO 178	80 × 10 × 4	B	—	Test speed 1 mm/min
Impact strength:						
— Charpy	kJ/m^2	ISO 179	80 × 10 × 4 or 50 × 6 × 4[6]	B	C_1	Specimen 1A or 2C
— Izod	kJ/m^2	ISO 180	80 × 10 × 4 or 63,5 × 12,7 × 3,2	B	C_1	Specimen 1A or 4A
Compressive strength	MPa	ISO 604	11,6 × 6 × 4	B	C_1	Test speed 1 mm/min
Ball indentation hardness	N/mm^2	ISO 2039-1	40 × 40 × 4	A	C_1	Load 358 N, time 30 s
Thermal properties						
Vicat softening temperature[3]	°C	ISO 306, method B	10 × 10 × 3/6,4	A	C_2	Heating rate 50 °C/h
Temperature of deflection under load	°C	ISO 75, method A	110 × 10 × 4	B	C_2	Heating rate 120 °C/h
Miscellaneous properties						
Refractive index		ISO 489		—	—	
Light transmission		EN 2155-5	Disc Ø 50 × 3	—	C_1	
Water absorption		ISO 62, method 1	Disc Ø 50 × 3	B	C_2	
Effect of liquid chemicals		ISO 175		B	C_2	Immersion time 7 days
Moulding shrinkage	%	ISO 8328	150 × 20/10 × 4	—	C_1	

1) "A" indicates that specimens can be tested either in the basic state or in the oriented state, because molecular orientation does not affect the values of these properties.

"B" indicates that it is advisable to test specimens both in the basic state and in the oriented state, because molecular orientation affects the value of these properties.

2) C_1: conditioning method 1 (see clause 4).

C_2: conditioning method 2 (see clause 4).

3) Properties used to designate the material in accordance with ISO 8257-1.

4) Use moulding material or fragments of moulded articles.

5) Specimens of other dimensions may be used provided they give the same results.

6) Distance between supports: 40 mm.

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