# International Standard 2897/2

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# Plastics — Impact-resistant polystyrenes — Part 2 : Determination of properties

*Plastiques — Polystyrènes résistant au choc — Partie 2 : Détermination des caractéristiques*

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## Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2897/2 was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in March 1979.



It has been approved by the member bodies of the following countries :



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# Plastics — Impact-resistant polystyrenes — Part 2 : Determination of properties

## 1 Scope and field of application

This International Standard specifies procedures for moulding specimens of impact-resistant polystyrenes in a specified state and methods for measuring their properties. Any property listed in Part 2 and referred to in combination with Part 1 shall be determined by the method referred to in Part 2.

No figures are quoted for these properties. Those required for the designation of impact-resistant polystyrenes are given in ISO 2897/1. Other properties shall be determined by the appropriate methods referred to in this International Standard and values may be obtained from manufacturers' literature. They can be directly compared if the procedures described herein for preparing the test specimens and for determining the properties are followed.



## 2 References

ISO 62, *Plastics — Determination of water absorption.*

ISO 75, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 175, *Plastics — Determination of the effects of liquid chemicals including water.*

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

ISO 179, *Rigid plastics — Determination of Charpy impact strength.*[1]

ISO 180, *Plastics — Determination of Izod impact strength.*[2]

ISO 306, *Plastics — Determination of the Vicat softening temperature of thermoplastics.*

ISO 527, *Plastics — Determination of tensile properties.*[3]

ISO 537, *Plastics — Testing with the torsion pendulum.*

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

ISO 1133, *Plastics — Determination of the melt flow rate of thermoplastics.*[4]

ISO/R 1183, *Plastics — Methods for determining the density and relative density (specific gravity) of plastics, excluding cellular plastics.*

ISO/R 1195, *Plastics — Determination of the water vapour transmission rate of plastic films and thin sheets — Dish method.*

ISO 2039, *Plastics and ebonite — Determination of hardness by the ball indentation method.*

ISO 2039/2, *Plastics — Determination of Rockwell hardness.*[5]

ISO 2556, *Plastics — Determination of the gas transmission rate of films and thin sheets under atmospheric pressure — Manometric method.*

ISO 2557, *Plastics — Amorphous thermoplastic moulding materials — Preparation of test specimens with a defined level of shrinkage.*

ISO 2561, *Plastics — Determination of residual styrene monomer in polystyrene by gas chromatography.*

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

1) At present at the stage of draft. (Revision of ISO/R 179.)

2) At present at the stage of draft. (Revision of ISO/R 180.)

3) At present at the stage of draft. (Revision of ISO/R 527.)

4) At present at the stage of draft. (Revision of ISO/R 292 and ISO/R 1133.)

5) At present at the stage of draft.

ISO 3167, *Plastics — Preparation and use of multipurpose test specimens.*

ISO 4600, *Plastics — Determination of environmental stress cracking (ESC) — Ball or pin impression method.*

IEC Publication 93, *Recommended methods of test for volume and surface resistivities of electrical insulating materials.*

IEC Publication 112, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC Publication 243, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

IEC Publication 250, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.*

## 3 Properties

The values determined according to this International Standard 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 or anisotropy. The latter 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.

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.

## 4 Preparation of test specimens

### 4.1 General

The specimens shall be prepared and their state assessed by the methods specified in ISO 2557.[1)]

NOTES

1 Whenever possible, use the multipurpose specimen described in ISO 3167, or parts thereof.

2 Before it is processed, the moulding compound should be at the ambient temperature of the workshop. If it is colder, for example if it has just been brought up from a cold warehouse, moisture may condense on it and thus affect the moulding process.

### 4.2 State of the test specimens

#### 4.2.1 Defined state

Longitudinal oriented specimens shall be injection moulded in a mould with a frontal gate. The diameter of the gate shall be at least equal to the minimum dimension of the specimen. The moulding conditions depend upon the size of the specimens, the moulding machine, and the moulding compound. They should be set so that the maximum shrinkage $S_m$, (170 °C, 15 min, in air), in the trimmed 30 mm central part of the specimen is 60 ± 10 % when determined in air by the method specified in ISO 2557. If this is not possible, a shrinkage level of 40 ± 10 % shall be applied, but this shall be stated in the test report because the results from such specimens usually differ from those obtained with specimens at the 60 % shrinkage level.

NOTE — The 40 ± 10 % level has proved to be useful for products with a high percentage of impact modifier.

#### 4.2.2 Basic state

Specimens in the basic state, i.e., nearly free of internal stresses and orientations, shall be prepared by compression moulding or by thermal relaxation of injection-moulded specimens.

The specimens shall be considered to be in their basic state if, after 15 min at 170 °C in air :

a) the appearance of their surface does not change;

b) the values of their properties are known not to change as a result of heat treatment;

c) their maximum shrinkage is 5 % or less (see 4.2.1)

$S_m$ = 0 to 5 % (170 °C, 15 min, in air).



##### 4.2.2.1 Compression moulding

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

Temperature : 180 °C

Pre-heating time : 5 min

Moulding pressure : 4 MPa (per square millimetre of area of test specimen)

Moulding time : 5 min

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

Demoulding at ⩽ 60 °C

1) Test specimens with longitudinal orientation should be injection moulded separately and not machined from injection-moulded plates.

**4.2.2.2** Thermal relaxation

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

Temperature : 180 °C

Pressure : 1,5 MPa

Relaxation time : 15 min

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

Demoulding at < 60 °C

NOTE — If a longer relaxation time is necessary, it should be verified that no thermal degradation has taken place, for example by measurement of the swelling index.[1)]

## 5 Test methods

The properties quoted shall be determined using the specimens and methods referred to in the table. All measurements shall be made at 23 ± 2 °C and 50 ± 5 % relative humidity unless otherwise stated in the relevant International Standard.

If the values for the properties have been determined on specimens with defined longitudinal shrinkage, this shall be stated.

For example,

a) for Charpy impact strength unnotched determined on specimens with a longitudinal shrinkage of 60 % :

Charpy impact strength (unnotched, $S_m$ = 60 %)

= 50 kJ/m$^2$;

b) for Charpy impact strength unnotched determined on specimens in the basic state i.e., with a longitudinal shrinkage of 0 to 5 % :

Charpy impact strength (unnotched, $S_m$ = 0 to 5 %)

= 20 kJ/m$^2$.



1) Described by Stein, D. J., Fahrbach, G. and Adler, H., *Angewandte Makromolekulare Chemie* **38** (1974) pp. 67 to 69.

**Table — Methods of test for impact-resistant polystyrenes**

| Property | Unit | Method | Specimen dimensions, mm | State[1] | Particulars |
|---|---|---|---|---|---|
| **Tests on moulding material** | | | | | |
| Melt flow rate[2] | g/10 min | ISO 1133 | —[3] | — | Load 5 kg, $t$ 200 °C |
| Density | g/cm$^3$ | ISO/R 1183 | —[3] | — | |
| **Tests on standard specimens** | | | | | |
| **Mechanical properties** | | | | | |
| Shear modulus | MPa | ISO 537 | 60 × 10 × 1[4] | A | Frequency 0,1 to 10 Hz |
| Mechanical loss factor | — | ISO 537 | 60 × 10 × 1[4] | A | Frequency 0,1 to 10 Hz |
| Tensile modulus of elasticity | MPa | ISO 527 | 150 × 20/10 × 4 | B | Testing speed 1 mm/min |
| Tensile stress at break or at yield | MPa | ISO 527 | 150 × 20/10 × 4 | B | Testing speed 20 or 25 mm/min |
| Tensile elongation at break or at yield | % | ISO 527 | 150 × 20/10 × 4 | B | Testing speed 20 or 25 mm/min |
| Flexural modulus of elasticity[2] | MPa | ISO 178 | 80 × 10 × 4 | B | Testing speed 1 mm/min |
| Flexural stress at conventional deflection | MPa | ISO 178 | 80 × 10 × 4 | B | Testing speed 2 mm/min |
| Impact strength Charpy[2] | kJ/m$^2$ | ISO 179 | 50 × 6 × 4[4] [5] | B | |
| Impact strength Izod[2] | J/m | ISO 180 | 63,5 × 12,7 × 3,2 or 80 × 10 × 4 | B | |
| Compressive strength | MPa | ISO 604 | 11,6 × 6 × 4 | B | Testing speed 1 mm/min |
| Rockwell-α hardness number | — | ISO 2039/2 | 50 × 50 × 6 | B | |
| Ball indentation hardness | daN/mm$^2$ | ISO 2039 | 10 × 10 × 4[6] | A | Load 35,8 daN, time 30 s |
| **Thermal properties** | | | | | |
| Vicat softening temperature[2] | °C | ISO 306, method B | 10 × 10 × 3/6,4[6] | A | Heating rate 50 °C/h |
| Temperature of deflection under load | °C | ISO 75, method A | 110 × 10 × 4 | B | Heating rate 2 °C/min |
| **Electrical properties** | | | | | |
| Surface resistivity | Ω | IEC 93 | 120 × 120 × 1[4] | A | 1 000 V measuring voltage |
| Volume resistivity | Ω·cm | IEC 93 | 120 × 120 × 1[4] | A | 1 000 V measuring voltage |
| Electric strength | kV/mm | IEC 243 | 120 × 120 × 0,5[4] | A | A C voltage; electrode : sphere diameter 20 mm, against plate under dibutylphthalate, rapidly applied |
| Relative permittivity $\varepsilon_r$ | | IEC 250 | 120 × 120 × 1[4] | A | A C voltage, 1 MHz |
| Dissipation factor, tan δ | | IEC 250 | 120 × 120 × 1[4] | A | A C voltage, 1 MHz |
| Comparative tracking index | | IEC 112 | 50 × 50 × 3[4] | A | A C voltage, 50 Hz |
| **Miscellaneous properties** | | | | | |
| Water vapour transmission rate | g/(m$^2$·24 h) | ISO/R 1195 | Disc $\phi$ 80 × 0,1 | B | Testing atmosphere : 25 °C, 90 % relative humidity |
| Gas transmission rate | cm$^3$/m$^2$·24 h ·1 atm)[7] | ISO 2556 | Sheet 0,1 | B | |
| Water absorption | | ISO 62, method 1 | Disc $\phi$ 50 × 3 | B | |
| Effect of liquid chemicals | | ISO 175 | | B | Immersion time 7 days |
| Environmental-stress-cracking | | ISO 4600 | 80 × 10 × 4 | B | Olive oil : oleic acid (1 : 1 by volume) |
| Residual styrene monomer | % | ISO 2561 | | | |



1) A indicates that specimens can be tested either in the basic state **or** in the oriented state, because 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 orientation affects the values of these properties.

2) Properties used for material designation in ISO 2897/1.

3) Moulding material or fragments of moulded articles.

4) Specimens of other dimensions may be used when they give the same results.

5) To be replaced eventually by a cross section of 10 mm × 4 mm.

6) May be machined (see ISO 2818).

7) 1 cm$^3$/(m$^2$·24 h·1 atm) = 0,114 3 fm/(Pa·s).

# Annex

## Other International Standards for styrene-containing moulding and extrusion materials

(This annex does not form part of the standard.)

ISO 1622, *Plastics — Polystyrene moulding and extrusion materials — Designation.*

ISO 1622/2, *Plastics — Polystyrene moulding and extrusion materials — Part 2 : Determination of properties.*

ISO 2580/1, *Plastics — Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials — Part 1 : Designation.*

ISO 2580/2, *Plastics — Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials — Part 2 : Determination of properties.*[1)]

ISO 2897, *Plastics — Designation of impact-resistant polystyrenes.*

ISO 4894/1, *Plastics — Styrene/acrylonitrile (SAN) copolymer moulding and extrusion materials — Part 1 : Designation.*

ISO 4894/2, *Plastics — Styrene/acrylonitrile (SAN) copolymer moulding and extrusion materials — Part 2 : Determination of properties.*

ISO 6402/1, *Plastics — Impact-resistant acrylonitrile/styrene moulding and extrusion materials (ASA, AES, ACS) excluding butadiene-modified materials — Part 1 : Designation.*[1)]



1) At present at the stage of draft.