

# International Standard



# 2577

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## Plastics — Thermosetting moulding materials — Determination of shrinkage

*Plastiques — Matières à mouler thermodurcissables — Détermination du retrait*

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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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2577 was prepared by Technical Committee ISO/TC 61, *Plastics*.

ISO 2577 was first published in 1975. This second edition cancels and replaces the first edition, of which it constitutes a technical revision.

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# Plastics — Thermosetting moulding materials — Determination of shrinkage

## 1 Scope and field of application

This International Standard specifies a method of determining the moulding shrinkage and the shrinkage after heat treatment of moulded test specimens of thermosetting moulding materials.

These characteristics are useful for the production control of thermosetting material and for checking uniformity of manufacture. Furthermore, knowledge of the initial shrinkage of thermosetting materials is important for the construction of moulds, and knowledge of post-shrinkage for establishing the suitability of the moulding material for the manufacture of moulded pieces with accurate dimensions.

## 2 Reference

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

ISO 295, *Plastics — Compression moulding test specimens of thermosetting materials*.

## 3 Definitions

For the purpose of this International Standard, the following definitions apply :

**3.1 moulding shrinkage** : The difference in dimensions between a moulding and the mould cavity in which it was moulded, both the mould and the moulding being at normal temperature when measured.

**3.2 post-shrinkage** : Shrinkage of a plastic product after moulding, during post-treatment, storage or use.

## 4 Apparatus

**4.1 Mould, press, etc.**, suitable for moulding the test specimens specified in clause 6. For compression moulding, a positive or a semi-positive mould with single or multiple cavities shall be used. For injection moulding, the type of mould is under study.

If required, marks may be engraved in the mould near opposite ends of the specimen to facilitate the accurate measurement of the length of the cavity and the specimens.

NOTE — If multiple cavities are used with a positive mould, resulting variations in test specimen density may be sufficient to produce inconsistent shrinkage.

**4.2 Equipment**, suitable for measuring the lengths of the test specimen and the corresponding cavity of the mould to within 0,02 mm.

**4.3 Oven** (for post-shrinkage only).

## 5 Sampling

A representative sample shall be taken from the moulding material and be kept at room temperature in airtight containers, without any conditioning, until moulded into test specimens.

## 6 Test specimens

**6.1** The test specimen shall be

- a) for compression moulding — bars of length 120 mm, width 15 mm and thickness 10 mm ;
- b) for injection moulding — flat square plaques approximately 120 mm × 120 mm × 4 mm.

**6.2** The specimens shall be moulded to shape by compression or injection moulding using a mould with single or multiple cavities.

## 7 Procedure

**7.1** If not already known, measure the lengths of the cavities (or the distances between the engraved marks in the mould) to the nearest 0,02 mm at a temperature of  $23 \pm 2$  °C (ISO 291 "atmosphere 23").

Record these measurements for use in the calculation of shrinkage.

NOTE — From time to time, moulds should be checked for wear, etc. As an alternate to measuring directly the lengths of the cold moulds, the gauge for the moulds may be obtained very precisely by cold-moulding specimens from lead and measuring their lengths.

**7.2** Mould at least two specimens from the sample to be tested, under the conditions given below.

a) For compression moulding :

Mould the specimens under the conditions of pressure, temperature, time, etc., specified in ISO 295 or in the relevant specification for the material.

b) For injection moulding :

Under study; to be added later.

NOTE — In the case of those fibrous materials that are to be injection-moulded as a plaque, at least four specimens should be tested.

**7.3** After removal from the mould, allow the test specimens to cool to room temperature by placing them on a material with low thermal conductivity and under an appropriate load to avoid warping. Store them at a temperature of  $23 \pm 2$  °C and a relative humidity of 45 % to 55 % (ISO 291 "atmosphere 23/50") for between 16 and 72 h, or for such shorter time as can be shown to give the same test results.

**7.4** Before measuring the lengths of the test specimens, place them on a flat surface or against a straight edge in order to determine any warp or distortion. Any test specimen that has a warp exceeding 1 % of its length shall be discarded.

**7.5** For the determination of moulding shrinkage, measure, to the nearest 0,02 mm, the lengths of the bar specimens parallel to their major axis between opposite end faces or the distances between the gauge marks, at a temperature of  $23 \pm 2$  °C (ISO 291 "atmosphere 23"). Measurement of plaque specimens shall be made at distance of 20 mm from the corners, two measurements in the same direction.

NOTE — In order to measure the effect of orientation on the shrinkage of an injection-moulded specimen, shrinkages in two directions at right-angles (each of which is calculated from an average of two measurements in the same direction) are measured and calculated independently.

**7.6** For the determination of post-shrinkage, place the test specimens, measured as described in 7.5, in an oven maintained at the temperature given below. Support the specimens to avoid deformation and in such a way that they are separated from each other.

The heating temperatures shall be :

$80 \pm 2$  °C for urea-formaldehyde moulding materials;

$110 \pm 3$  °C for all other thermosetting moulding materials.

The times of exposure shall be :

$48 \pm 1$  h for rapid determination;

$168 \pm 2$  h for normal determination.

NOTE — Post-shrinkage depends strongly on the time of exposure. Therefore the exposure time should be noted [see 8.2 and 9 f)] and should be specified in the specification for the material.

At the end of the heating period, remove the test specimens from the oven and allow them to cool in a standard atmosphere of  $23 \pm 2$  °C and a relative humidity of 45 % to 55 % (ISO 291 "atmosphere 23/50") for at least 3 h.

After the cooling period, measure the test specimens again, at a temperature of  $23 \pm 2$  °C (ISO 291 "atmosphere 23") to the nearest 0,02 mm, as specified in 7.5.

## 8 Expression of results

**8.1** The moulding shrinkage (*MS*) is given, as a percentage, by the formula

$$MS = \frac{L_0 - L_1}{L_0} \times 100$$

where

$L_0$  is the length, in millimetres, of the dimension of the mould, determined as in 7.1;

$L_1$  is the length, in millimetres, of the corresponding dimension measured on the test specimen according to 7.5.

NOTE — When shrinkage is being determined using injection-moulded plaques,  $L_0$  and  $L_1$  are each the averages of two readings, measured in the same direction, taken 20 mm from the corners of the mould and the test specimen respectively.

**8.2** Post-shrinkage (*PS*) is given, as a percentage, by the formula

$$PS_{48 \text{ h or } PS_{168 \text{ h}}} = \frac{L_1 - L_2}{L_1} \times 100$$

where

$L_1$  is as defined in 8.1;

$L_2$  is the length, in millimetres, of the same dimension of the test specimen, measured after heat treatment for 48 or 168 h according to 7.6.

NOTE — When post-shrinkage is being determined using injection-moulded plaques,  $L_2$  is the average of two readings, measured in the same direction, taken 20 mm from the corners of the test specimen.

## 9 Test report

The test report shall include the following particulars :

- reference to this International Standard;
- the grade and designation of the moulding material;
- the type of test specimen used (bar or plaque);

d) the method of moulding the specimens (compression or injection) and the moulding conditions;

e) the number of test specimens discarded because of excessive warping;

f) the conditions of heat treatment for the determination of post-shrinkage;

g) the moulding shrinkage ( $MS$ ) and the post-shrinkage ( $PS_{48\text{ h}}$  and/or  $PS_{168\text{ h}}$ ), as a percentage, including the individual values, the arithmetic mean and, for injection-moulded plaques, the direction of measurement with respect to the direction of injection;

h) the dates of moulding the test specimens, measurement of moulding shrinkage, post-shrinkage heat treatment, and measurement of post-shrinkage.

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