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Plastics — Film and sheeting — Determination of average thickness of a sample, and average thickness and yield of a roll, by gravimetric techniques (gravimetric thickness)

*Plastiques — Film et feuille — Détermination de l'épaisseur moyenne
d'un échantillon, et de l'épaisseur moyenne d'un rouleau, ainsi que de sa
surface par unité de masse, par mesures gravimétriques (épaisseur
gravimétrique)*



Reference number
ISO 4591:1992(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 4591 was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 4591:1979), which has been technically revised.

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Plastics — Film and sheeting — Determination of average thickness of a sample, and average thickness and yield of a roll, by gravimetric techniques (gravimetric thickness)

1 Scope

This International Standard specifies

- a method for the determination of the gravimetric thickness of a sample of plastics film or sheeting (see clause 3);
- a method for the determination of the average gravimetric thickness and, if required, the yield (area per unit mass) of a roll of plastics film or sheeting (see clause 4).

These methods are applicable to all plastics films and sheeting, and have special value when mechanical scanning is not sufficiently precise, particularly for measuring the thickness of embossed sheeting.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics*.

ISO 4592:1992, *Plastics — Film and sheeting — Determination of length and width*.

3 Determination of gravimetric thickness of a sample

3.1 Principle

The gravimetric thickness of a sample is calculated from measurements of its mass, area and density.

3.2 Apparatus

3.2.1 Knife-edged punch, square or circular, having an area of $100 \text{ cm}^2 \pm 0,5 \text{ cm}^2$, or

3.2.2 Square template, having an area of $100 \text{ cm}^2 \pm 0,5 \text{ cm}^2$.

3.2.3 Balance, accurate to 0,000 1 g.

3.3 Specimens

Specimens of area $100 \text{ cm}^2 \pm 0,5 \text{ cm}^2$ shall be cut at positions approximately equally spaced across the width of the sample in each of two bands approximately 1 m apart in the longitudinal direction.

The minimum number of specimens taken from each band across the film or sheeting shall be dependent on the width of the sample as follows:

widths smaller than or equal to 1 000 mm	3
widths greater than 1 000 mm and up to 1 500 mm	5
widths greater than 1 500 mm	10

In the case of very thin film, when the mass of a specimen of area $100 \text{ cm}^2 \pm 0,5 \text{ cm}^2$ is less than 1 g, two specimens located very close together on the film in the longitudinal (extrusion/calender) direction shall be used for one measurement.

3.4 Procedure

3.4.1 Determine the mass, in grams, of the specimen to at least three significant figures, and its density in accordance with ISO 1183, at a temperature of $23\text{ °C} \pm 1\text{ °C}$.

Take care to prevent the formation of static charges which could affect the reproducibility of this determination of mass.

3.4.2 For moisture-sensitive film or sheeting, the conditioning requirements of time and relative humidity shall be agreed between the buyer and seller.

3.5 Expression of results

Calculate the gravimetric thickness, t_s , in micrometres or millimetres, from equation (1) or (2) respectively, when one specimen is used:

$$t_s = \frac{100\ m_s}{\rho} (\mu\text{m}) \quad \dots (1)$$

$$t_s = \frac{m_s}{10\rho} (\text{mm}) \quad \dots (2)$$

where

m_s is the mass, in grams, of the specimen;

ρ is the density, in grams per cubic centimetre, of the specimen.

When two specimens are used, use equation (3) or (4):

$$t_s = \frac{50\ m_s}{\rho} (\mu\text{m}) \quad \dots (3)$$

$$t_s = \frac{m_s}{20\rho} (\text{mm}) \quad \dots (4)$$

3.6 Precision

The precision of this test method is not known because inter-laboratory data are not available. When inter-laboratory data are obtained, a precision statement will be added in the subsequent revision.

3.7 Test report

The test report shall include the following information:

- a reference to this International Standard;
- all information necessary for the complete identification of the sample;

- gravimetric thickness of each specimen, in micrometres or millimetres;
- arithmetic mean of the test results, to the nearest $1\ \mu\text{m}$, or $0,001\ \text{mm}$, reported as the average gravimetric thickness of the sample.

4 Determination of average gravimetric thickness and yield of a roll

4.1 Principle

The average thickness and, if required, the yield of a roll are calculated from measurements of the length, average width and net mass of the roll and of the density of the film or sheeting.

4.2 Apparatus

4.2.1 Weighing device, the accuracy of which is at least 0,5 % of the reading.

4.3 Procedure

4.3.1 Length and average width of film or sheeting in a roll

Determine the length and average width of the roll, in metres, in accordance with ISO 4592.

4.3.2 Net mass of roll

Place the roll of material centrally on the pan or other support of the weighing device. Ensure that the roll of material and the pan are free from contact with other bodies.

Determine the gross mass to an accuracy of 0,5 %. Deduct the mass of the tube, or other object onto which the film or sheeting has been rolled, from the gross mass to give the net roll mass, with the same accuracy.

Determine the net roll mass, in kilograms, to the nearest significant figure corresponding to an accuracy of 0,5 %.

4.3.3 Density

Determine the density of the film or sheeting in accordance with ISO 1183, at $23\text{ °C} \pm 1\text{ °C}$.

4.4 Expression of results

4.4.1 Average gravimetric thickness of roll

Calculate the average gravimetric thickness of the roll, t_r , in micrometres or millimetres, from equation (5) or (6) respectively:

$$t_r = \frac{1\,000\,m_r}{L \times b \times \rho} (\mu\text{m}) \quad \dots (5)$$

$$t_r = \frac{m_r}{L \times b \times \rho} (\text{mm}) \quad \dots (6)$$

where

- m_r is the net mass, in kilograms, of the roll;
- L is the length, in metres, of the roll;
- b is the average width, in metres, of the roll;
- ρ is the density, in grams per cubic centimetre, of the film or sheeting.

Express the result to the nearest 1 μm or 0,001 mm respectively.

4.4.2 Yield (area per unit mass)

If required, calculate the yield, A_m , in square metres per kilogram, from equation (7):

$$A_m = \frac{L \times b}{m_r} \quad \dots (7)$$

where L , b and m_r are as defined in 4.4.1.

4.5 Precision

The precision of this test method is not known because inter-laboratory data are not available. When inter-laboratory data are obtained, a precision statement will be added in the subsequent revision.

4.6 Test report

The test report shall include the following information:

- a) a reference to this International Standard;
- b) all information necessary for the complete identification of the material;
- c) average gravimetric thickness of the tested roll;
- d) yield of the roll (if required).

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