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Plastics — Determination of linear dimensions of test specimens

Plastiques — Détermination des dimensions linéaires des éprouvettes

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 16012:2004), which has been technically revised. It also incorporates the Technical Corrigendum ISO 16012:2004/Cor.1:2005.

Plastics — Determination of linear dimensions of test specimens

1 Scope

This International Standard specifies measuring equipment and procedures for the determination of the linear dimensions of rigid plastics test specimens. It is applicable to test specimens described in ISO 20753 but can also be used for other test specimens, and to thicknesses typically in the range 0,4 mm ≤ h ≤ 6,4 mm.

NOTE Determination of dimensions of test specimen made of semi-rigid materials (70 MPa ≤ E ≤ 700 MPa) can follow ISO 23529:2010[1].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 463, *Geometrical Product Specifications (GPS) — Dimensional measuring equipment — Design and metrological characteristics of mechanical dial gauges*

ISO 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

ISO 3650, *Geometrical Product Specifications (GPS) — Length standards — Gauge blocks*

ISO 9493, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Dial test indicators (lever type) — Design and metrological characteristics*

ISO 13102, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Electronic digital-indicator gauge — Design and metrological characteristics*

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Callipers; Design and metrological characteristics*

ISO 20753, *Plastics — Test specimens*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
linear dimension
shortest distance measured with the equipment described in Clause 4, between any two points selected on the plastics specimen

3.2
thickness
shorter dimension of the (ideally) rectangular cross section perpendicular to the longitudinal direction of a bar test specimen

3.3
width
longer dimension of the (ideally) rectangular cross section perpendicular to the longitudinal direction of a bar test specimen

3.4
length
dimension measured between two parallel cross sections of the specimen perpendicular to the longitudinal direction of a bar test specimen

4 Measuring equipment

4.1 General

The choice of measuring equipment for the measurement of dimensions is influenced by the characteristics of the specimen being measured and by the requirements on the accuracy.

NOTE Each material will differ in its response to test method parameters, which include, but cannot be limited to the rate of loading, the ultimate load, the dwell time and the dimensions of the contact points between the measuring instrument and the test specimen (presser foot and anvil, or other geometries). For a specific plastics material, these responses can cause measurements made using one method to differ significantly from measurements made using another method. The compressibility of the material will have greater influence when comparing measurements taken with non-contact apparatus and spring-loaded micrometers.

Care shall be taken to ensure that the measuring equipment used does not leave on the measured surface any marks, scratches or cracks which could influence the results of the measurement.

International Standards for measuring equipment do not specify limits on errors but demand that the manufacturers data sheet supply all the necessary information. The requirements on instrument capabilities given in this International Standards enable the user to select the appropriate instrument.

4.2 Micrometers

Micrometers shall conform to the requirements of ISO 3611 where appropriate.

Micrometers that are equipped with a system which ensures that a preset load is applied during measurement shall exert a force at the measurement faces of between 5 N and 15 N.

4.3 Vernier callipers

Vernier callipers shall conform to the requirements of ISO 13385-1. Digital-reading callipers can be used provided they comply with the relevant requirements of these standards.

4.4 Dead-weight dial gauge micrometers and electronic digital indicator gauges

4.4.1 Dead-weight dial gauge micrometers shall conform to the requirements of ISO 463 or, if applicable, ISO 9493. For electronic digital indicator gauges ISO 13102 applies. Micrometers and electronic indicator gauges shall have the following features (if applicable):

a) a presser foot that moves in an axis perpendicular to the anvil face;

b) presser foot and anvil surfaces (those which contact the specimen) that are parallel to within 5 µm;

c) a vertical dial spindle;

d) a dial indicator that is essentially friction-free and capable of repeatable readings within ±10 µm at zero setting or on a steel gauge block;

e) a frame, housing the indicator, of such rigidity that a load of 15 N applied to the dial housing will produce a deflection of the frame not greater than the smallest scale division on the indicator dial.

The dial shall be graduated continuously to read directly to the nearest 2,5 µm or better. If necessary, equip the dial with a revolution counter that displays the number of complete revolutions of the large hand.

Possible types of contact face for dead-weight and electronic indicator gauge micrometers are shown in Annex A.

4.4.2 Instruments as specified in 4.4.1 exert measuring forces on the test specimen. Instruments with measuring forces between 0,15 N and 3 N are preferred.

NOTE The International Standards cited in 4.4.1 require that the measuring force range is given in the relevant technical documentation.

4.5 Non-contact devices and other alternative devices

Non-contact measuring devices (optical and laser) and other alternative devices may be used provided the device meets the error-measurement requirements of alternatively applicable mechanical devices.

NOTE Non contacting devices tend to measure the largest possible dimensions of test specimens and might differ from those measured with contacting devices due to influences caused by sink marks and draft angles that are typical for injection moulded plastics specimens.

5 Procedure

5.1 General

This International Standard applies but is not limited to measurements on test specimens specified in ISO 20753.

Specimens shall be clean and free from imperfections that can adversely affect the measurements.

Unless otherwise specified, all measurements shall be made after the specimens have been conditioned at one of the standard laboratory atmospheres defined in ISO 291. The preferred climate is 23/50 class 2. Select the appropriate instrument from Table 1.

Table 1 — Guide to applicability of instruments

Specimen preparation	Instrument	Thickness	Width	Length
Injection- and compression moulded	Vernier callipers			✓
	Micrometers	✓	✓	
	Dead-weight dial gauge micrometers and electronic digital indicator gauges	✓	✓	
	Non-contact devices	(✓)	(✓)	✓
Machined	Vernier callipers	✓	✓	✓
	Micrometers	✓	✓	
	Dead-weight dial gauge micrometers and electronic digital indicator gauges	✓	✓	
	Non-contact devices	✓	✓	✓
NOTE Parentheses (...) indicate that for specimens with draft angles these methods are not ideally suited.				

5.2 Accuracy requirements

The accuracy requirements for the dimension measurements shall be as specified in Table 2, if not otherwise specified in the referring standard.

Table 2 — Accuracy requirements

Dimensions in millimetres

Range of dimensions	Required accuracy
<10	±0,02
≥10	±0,1

5.3 Number and location of measurement points

The number of measurement points depends on the size and shape of the specimen, but shall be at least three for each dimension. The measurement points shall be as widely separated as possible, in order to give a good average. The arithmetic mean of all the measured values is taken as the value of the dimension of the specimen.

For injection moulded specimens it is acceptable to measure the dimensions width and thickness of the cross section in the centre of the specimen at one point only (see Annex B).

For multipurpose and bar test specimens, the thickness shall be measured in the middle of the specimen between the two edges. The measurement points between the instrument and the test specimen shall be within the measurement region for the specific dimension (see Figure B1, 1 and 2).

5.4 Calibration of equipment

Calibrate micrometers and callipers under the appropriate standard laboratory test conditions in accordance with the test method applicable to the specific material under test.

Gauge blocks shall be traceable and conform to ISO 3650.

Use several standard gauge blocks covering the measurement range of the micrometer. The known dimensional accuracy of such blocks shall be within ±10 % of the smallest scale division on the micrometer dial or scale. Thus, if an instrument's smallest scale division is 2 µm, the standard gauge block dimension shall be known to within ±0,2 µm. Perform calibration procedures only after the instrument has been checked and found to meet the requirements of the pertinent International Standard or the manufacturer's specifications.

From the calibration measurements, construct a calibration correction curve that will provide corrections to the measured dimension of the specimens. To obtain the correction curve, plot the true dimension of the gauge block against the measured value.

Perform calibration procedures at least once every year. For heavily used equipment or for equipment subjected to a harsh environment, the recommended verification interval is once every 30 days.

5.5 Measuring with a micrometer

Select appropriate measuring tips. When measuring injection moulded specimens use cylindrical tips with diameters of 1,5 mm ≤ Ø ≤ 6,4 mm and flat contact faces. Observe the measuring range as shown in Figure B1.

Before measuring each specimen check that the instrument is clean, removing any contamination as necessary. Set and/or check the zero of the instrument, as applicable, before measuring each specimen.

Close the micrometer on an area of the specimen near a measurement point. Observe the reading, then open the micrometer approximately 100 µm beyond this reading and move the specimen so that the micrometer is over the first measurement point.

Using the ratchet, or the friction thimble, close the micrometer at such a rate that the change in the reading on the scale or digital display can be followed easily. Continue the closing motion until the ratchet clicks three times, the friction thimble slips, or the two contact surfaces can be felt to be in full contact with the specimen. Record the reading indicated. Move the specimen so that the micrometer is over another measurement position, and repeat the procedure given above. Recheck the instrument zero setting after measuring each specimen.

5.6 Measuring with vernier callipers

Before measuring each specimen check that the instrument is clean, removing any contamination as necessary. Set and/or check the zero of the instrument, as applicable, before measuring each specimen.

Progressively close the sliding jaw of the callipers onto the specimen until the contact faces of the callipers just touch the surfaces of the specimen without compressing or damaging it. Move the specimen slightly back and forth, simultaneously continuing to bring the contact surfaces of the calliper together slowly until resistance to the back-and-forth movement is felt. Record the reading indicated.

Move the callipers to another measurement point, and repeat the procedure given above.

Recheck the instrument zero setting after measuring each specimen.

5.7 Measuring with a dead-weight dial gauge micrometer or electronic indicator

Select appropriate measuring tips. When measuring injection moulded specimens, cylindrical and rectangular tips having flat contact faces and sharp tips (knife edges) are acceptable. The diameter of cylindrical tips or the width of rectangular and sharp tips shall be between 1,5 mm ≤ Ø ≤ 6,4 mm. Observe the measuring range as shown in Figure B1.

Place the dial gauge micrometer on a solid, level, clean table or bench that will not vibrate excessively during the measurements. Confirm that the anvil and presser foot surfaces are clean. Zero the instrument.

Raise the presser foot slightly. Move the specimen so that the micrometer is at the first measurement point, and lower the presser foot to a dial reading approximately 0,5 mm higher than the expected reading.

Drop the foot onto the specimen. This procedure minimizes small errors caused by lowering the pressure foot slowly onto the specimen. Record the dial reading. Move the specimen to another measurement position and repeat the procedure given above.

Recheck the instrument zero setting after measuring each specimen. Any change in the setting is usually the result of contaminating particles being transferred from the specimen to the contact surfaces of the presser foot and anvil. This condition necessitates the cleaning of these surfaces.

5.8 Measuring with non-contact devices

Calibrate the equipment following the manufacturer's instructions. Measure the specimen dimensions at the locations specified in 5.3.

6 Test report

If not specified otherwise in the referring standard, the test report shall contain the following information:

a) a reference to this International Standard;

b) the type and designation of the plastics material;

c) the type of test specimen;

d) the conditioning used;

e) the measuring equipment used;

f) for each specimen:

— the number of measurements made for each dimension,

— the arithmetic mean of the measurements made for each dimension;

g) any deviations from the specified procedure;

h) the date of measurement.

Annex A
(informative)

Possible types of contact face for dead-weight gauge micrometers

Dimensions in millimetres

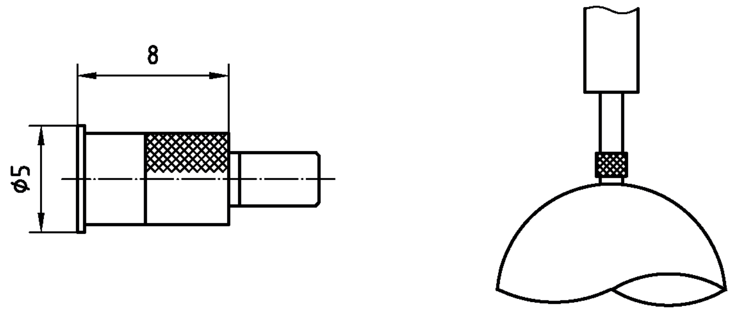


Figure A.1 — Flat

Dimensions in millimetres

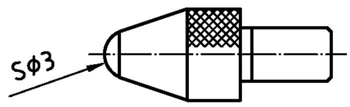


Figure A.2 — Spherical

Dimensions in millimetres

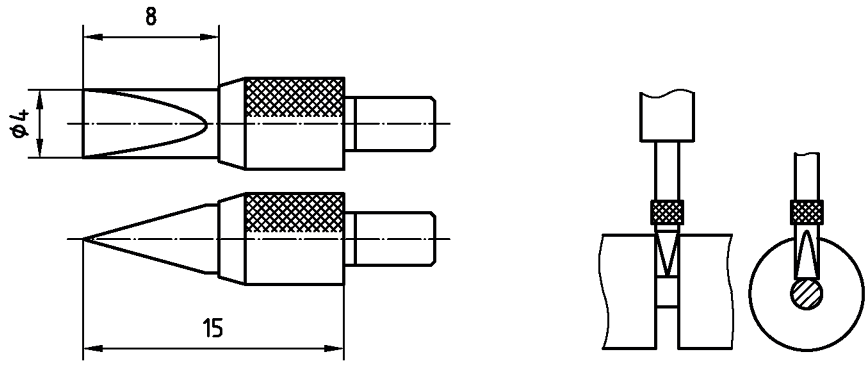


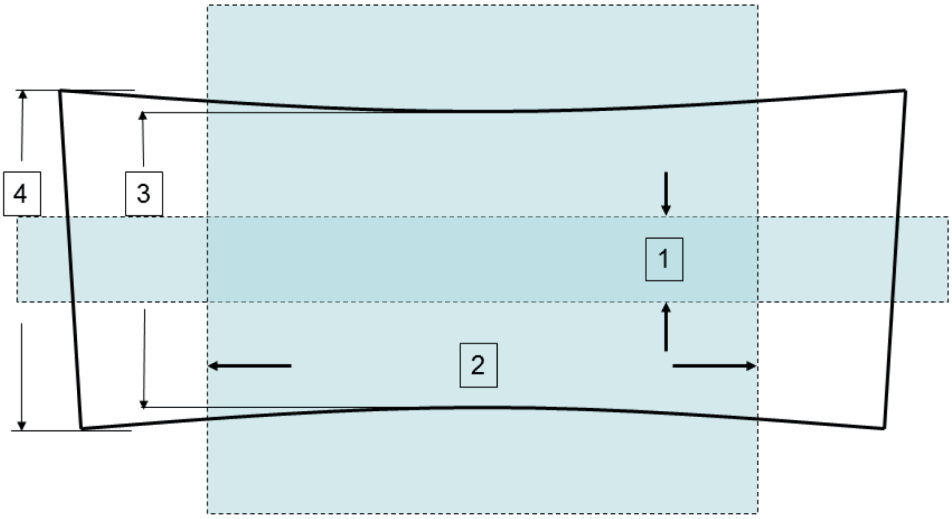
Figure A.3 — Knife-edge (carbide)

Annex B
(informative)

Measurement of injection moulded specimens

Injection moulded specimens are never perfectly rectangular and especially if made of semi-crystalline materials, may also exhibit sink marks.

Measuring tips with rounded (spherical) ends tend to determine the minimum thickness (3), while non contacting devices and contacting devices with contact surfaces larger than the specimen measure the largest possible dimensions (4).



Key

1 the measuring range for the width is ±0,5 mm from half height

2 the measuring range for the thickness is ±3,25 mm from the specimen centre

3 minimum thickness h_{min}

4 maximum thickness h_{max}

Figure B.1 — Cross section of a rectangular specimen with sink marks and draft angle (exaggerated) and indication of recommended measuring ranges (1, 2)

Recommendations for measuring width and thickness of injection moulded specimens:

Avoid measuring the thickness at the edge of the specimen and directly in the centre (see NOTE). Use contacting faces of such shape and size as to enable measuring within the measuring ranges shown in Figure B1.

NOTE This excludes the maximum and minimum thickness which for injection moulded test specimens usually are found at the edge and in the centre, respectively. Injection moulded test specimens prepared according to ISO 294-1:1996/Amd.2:2005 will generally have thickness differences due to sink marks of $\Delta h = h_{max} - h_{min} \leq 0,1$ mm (see Figure B1).

When measuring width and thickness of multipurpose test specimens (nominally 10 mm and 4 mm, respectively), it is common practice to use the same instrument for both dimensions. Thus, despite the accuracy requirements of 0,1 mm given in Table 2 for dimensions ≥10 mm, the higher accuracy of 0,02 mm is usually applied.

Bibliography

[1] ISO 23529:2010, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

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