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Plastics — Test specimens

Plastiques — Éprouvettes

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20753 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

Introduction

Up to now, information on plastics test specimens has been specified in several different locations: in test method standards (e.g. ISO 527-2), in ISO 3167 (for multipurpose test specimens) and in ISO 294-1, ISO 294-2, ISO 294-3 and ISO 294-5 (for moulding conditions). The aim of this International Standard is to give the designations and dimensions of test specimens used for the acquisition of comparable data, and also other frequently used specimens, in one document for ease of reference. This will be followed by a revision of the ISO 294 series, which will define only the injection-moulding conditions and will refer to this International Standard for the dimensions of the specimens. Other International Standards that have hitherto used different designations for the same specimen type will also be revised to bring the designations into line with those in this International Standard.

Plastics — Test specimens

1 Scope

1.1 This International Standard specifies dimensional requirements relating to test specimens prepared from plastics materials intended for processing by moulding, as well as to test specimens prepared by machining from sheets or shaped articles. It gives, in one document, the designations and dimensions of test specimens used for the acquisition of comparable data and also other frequently used specimens.

The following types of test specimen are specified:

a) Type A1 and type A2 specimens (1 = injection moulded, 2 = machined from a sheet or shaped article)

These are tensile test specimens from which, with simple machining, specimens for a variety of other tests can be taken (see Annex A).

The type A1 specimen corresponds to the ISO 3167:2002 type A multipurpose test specimen. The principal advantage of a multipurpose test specimen is that it allows all the test methods mentioned in Annex A to be carried out by all test laboratories on the basis of comparable mouldings. Consequently, the properties measured are coherent as all are measured using similar specimens prepared in the same way. In other words, it can be expected that test results for a given set of specimens will not vary appreciably due to unintentionally different moulding conditions. On the other hand, if desired, the influence of moulding conditions and/or different states of the specimens can be assessed without difficulty for all of the properties measured.

Also described are reduced-scale test specimens designated type Axy, where x is the number indicating the method of specimen preparation (1 = injection moulded, 2 = machined from a sheet or shaped article) and y is a number indicating the scale factor (1:y). These can be used e.g. when full-sized test specimens are not convenient or when sample material exists in small quantities only.

b) Type B specimens

These are bar specimens which can be directly moulded or can be machined from the central section of type A1 specimens or from sheets or shaped articles.

c) Type C specimens

These are small tensile test specimens which can be directly moulded or machined, e.g. from plates (Type D specimens), from the central section of type A1 specimens or from sheets or shaped articles.

d) Type D1 and type D2 specimens

These are square plates of thickness 1 mm and 2 mm, respectively.

If a particular type of test specimen is not mentioned in this International Standard, this does not mean that there is any intention to exclude the use of the specimen. Additional specimen types may be added in future if they are commonly used.

2 Normative references

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

ISO 293, *Plastics — Compression moulding of test specimens of thermoplastic materials*

ISO 294-1, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

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

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

ISO 10350-1, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

ISO 10350-2, *Plastics — Acquisition and presentation of comparable single-point data — Part 2: Long-fibre-reinforced plastics*

ISO 10724-1, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

ISO 11403-1, *Plastics — Acquisition and presentation of comparable multipoint data — Part 1: Mechanical properties*

ISO 11403-2, *Plastics — Acquisition and presentation of comparable multipoint data — Part 2: Thermal and processing properties*

ISO 11403-3, *Plastics — Acquisition and presentation of comparable multipoint data — Part 3: Environmental influences on properties*

3 Terms and definitions

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

3.1
multipurpose test specimen
type A1 or type A2 tensile test specimen as shown in Figure 1 and specified in Table 1 and Table 2, respectively

NOTE 1 Although ISO 3167:2002 refers to both the type A and type B specimens, defined in that International Standard, as multipurpose test specimens, for the purposes of this International Standard it is the type A1 specimen which is the preferred specimen for the acquisition of comparable data and hence the true multipurpose test specimen.

NOTE 2 The type A1 specimen can be made suitable for a variety of tests by simple cutting, because the length l_1 of the narrow parallel-sided section is 80 mm $\pm$ 2 mm.

3.2
l_1
length of the narrow parallel-sided section (central section) of the type A and type CP tensile test specimens, the length of the type B bar specimen and the length of the side of the type D plate specimen

3.3
l_2
distance between the broad parallel-sided sections (tabs) of the type A and type CP tensile test specimens

3.4
l_3
overall length of the type A and type C tensile test specimens

3.5
b_1
width of the narrow parallel-sided section (central section) of the type A tensile test specimen, the minimum width of the type C test specimen and the length of the side of the type D plate specimen

3.6
b_2
width of the broad parallel-sided sections (tabs) of the type A and type C tensile test specimens

3.7
r
radius of the shoulder region of the type A and type C tensile test specimens

3.8
h
thickness of the test specimen

4 Preparation of test specimens

4.1 General

Test specimens shall be prepared in accordance with the relevant material specification. When none exists, specimens shall be either directly compression or injection moulded from the material in accordance with ISO 293, ISO 294-1, ISO 295 or ISO 10724-1, as appropriate, or machined in accordance with ISO 2818 from sheets that have been compression or injection moulded from the compound, extruded from the compound or polymerized and cast.

Strict control of all the specimen preparation conditions is essential to ensure that all test specimens in a set are in the same state.

All surfaces of the test specimens shall be free from visible flaws, scratches or other imperfections. With moulded specimens, any flash present shall be completely removed, taking care not to damage the moulded surface.

The broad sides of multipurpose test specimens shall be suitably marked (see Note), for injection-moulded specimens to distinguish between the sides formed by the cavity plate and the fixed plate of the mould (see ISO 294-1 or ISO 10724-1), for compression-moulded and machined specimens to identify any asymmetry resulting from the underlying moulding process.

For injection-moulded specimens, the sides can be identified by the impressions of the ejection pins and by the draft angle. Compression-moulded and machined specimens shall be marked at their shoulders. ISO bars taken from the central section of multipurpose test specimens shall be marked outside their central 64 mm section, which is loaded during flexural testing.

NOTE Asymmetry with respect to thickness may influence the flexural properties, including the temperature of deflection under load (see Annex A).

4.2 Injection moulding of test specimens

Test specimens shall be injection moulded as specified in ISO 294-1 or ISO 10724-1, as appropriate, and under the conditions defined in the relevant International Standard for the material under examination or, if no such standard exists, as recommended by the manufacturer of the material or as agreed upon between the interested parties.

4.3 Compression moulding of test specimens

Test specimens shall be compression moulded as specified in ISO 293 or ISO 295, as appropriate, and under the conditions defined in the relevant International Standard for the material under examination or, if no such standard exists, as recommended by the manufacturer of the material or as agreed upon between the interested parties.

4.4 Preparation of test specimens by machining

4.4.1 Preparation of test specimens by machining shall be performed either as specified in ISO 2818 or as agreed upon by the interested parties, using suitably processed injection- or compression-moulded sheets or shaped articles.

4.4.2 Bar test specimens having a width of 10 mm shall be cut symmetrically from the central parallel-sided section of a type A1 or type A2 test specimen.

The surface of the central parallel-sided section of the test specimens shall remain as moulded:

— The width of the machined sections of the specimen shall be not less than that of the central parallel-sided section, but may exceed the width of the latter by not more than 0,2 mm.

— During the machining operation, care shall be taken to avoid any damage to the moulded surfaces of the central parallel-sided section.

For the preparation, from type A1 or type A2 test specimens, of parallel-sided test specimens longer than 80 mm in the case of type A1 test specimens or longer than 60 mm in the case of type A2 test specimens, the broad ends of the specimen shall be machined to the width of the central parallel-sided section.

When machining test specimens from sheets or plates of which the history is not known, machine the specimens from locations that appear appropriate or as agreed between the interested parties. Record this information in the test specimen preparation report.

5 Types of test specimen and their dimensions

5.1 Types of test specimen

Table 1 gives an overview of the types of test specimen that shall be used for the acquisition of comparable data in accordance with ISO 10350-1 or ISO 10350-2 or in accordance with ISO 11403-1, ISO 11403-2 or ISO 11403-3. Where applicable, type A1 specimens and specimens machined from the central section of the type A1 specimen shall always be used.

Annex B gives an overview of the designation system used for ISO test specimens.

NOTE It has been shown that, for some materials, the results of tests using directly moulded 80 mm × 10 mm × 4 mm bars differ from those obtained using 80 mm × 10 mm × 4 mm bars machined from the central section of the multipurpose test specimen. For this reason, ISO 10350-1 recommends that the central section of the multipurpose test specimen be used. For licensees of the CAMPUS® database, this is mandatory.

Table 1 — Types of test specimen to be used for acquisition of comparable data

Shape	Other details	Designation	Comments
Tensile specimen (with narrow parallel-sided section and tabs)	Multipurpose (see 5.2.1)	Type A1	Identical with type A of ISO 3167:2002 and with type 1A of ISO 527-2:1993, injection moulded
Bar	See 5.3	Type B2	Rectangular bar, machined from central section of type A1
Small tensile specimen	See 5.4	Type CW13	Identical with type 4 of ISO 8256:2004, injection moulded
Plate	See 5.5	Type D12	Thickness 2 mm, injection moulded

Table 2 gives an overview of additional types of test specimen.

Table 2 — Additional types of test specimen

Shape	Other details	Designation	Comments
Tensile specimen (with narrow parallel-sided section and tabs)	Multipurpose (see 5.2.1 and 3.1, Note 1)	Type A2	Identical with type B of ISO 3167:2002 and with type 1B of ISO 527-2:1993, machined from sheets prepared by any method
	Reduced-scale (see 5.2.2)	Type A12, A22	Identical with type 1BA of ISO 527-2:1993, scale factor 1:2, injection moulded or machined
		Type A13, A23	Injection moulded or machined from type D1 or D2 plate specimens, scale factor 1:3
		Type A14, A24	Like type A1, scale factor 1:4, longer ends, injection moulded or machined
		Type A15, A25	Identical with type 1BB of ISO 527-2:1993, scale factor 1:5, injection moulded or machined
		Type A18, A28	Like type A1, scale factor 1:8, longer ends, injection moulded or machined
Bar	See 5.3	Type B1	Rectangular bar, injection moulded
		Type B3	Rectangular bar, machined from sheets (prepared by any method) or compression moulded
Small tensile specimen	See 5.4	Type CW21, Type CW22	Identical with type 4 of ISO 8256:2004 and type S of ASTM D 1822-06, machined from type D1 or D2 plate specimens
		Type CP1z, Type CP2z	Identical with type 2 of ISO 8256:2004, injection moulded or machined, thickness z mm
Plate		Type D1x, D2x	Injection moulded or machined, thickness x mm

5.2 Tensile test specimens with parallel-sided central section

5.2.1 Multipurpose test specimens (type A1 and type A2)

The general design of tensile test specimens is shown in Figure 1. Table 3 gives details of the dimensions of and acceptable tolerances for type A1 and type A2 specimens.

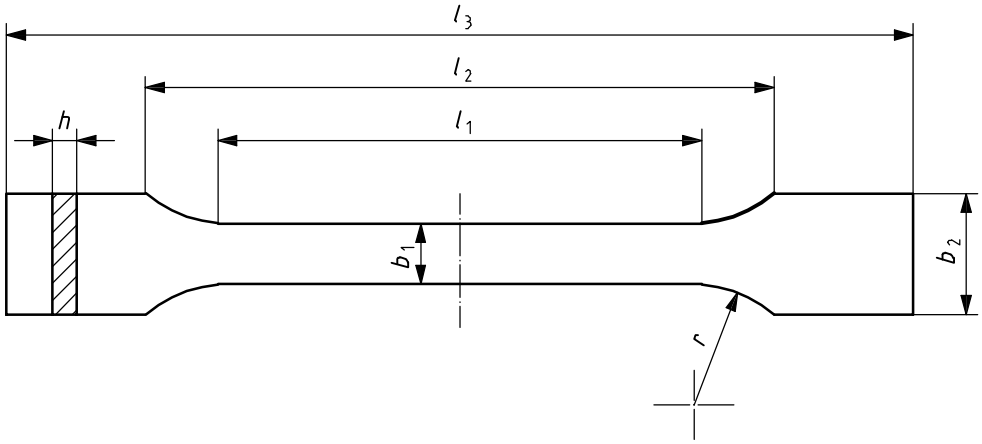


Figure 1 — General design of tensile test specimens

Table 3 — Dimensions of type A1 and type A2 test specimens

Dimensions in millimetres

Dimension		Type A1 (injection moulded)	Type A2 (machined)
l_3	Overall length [a]	$\geqslant$ 170	$\geqslant$ 150
l_2	Distance between broad parallel-sided sections [b]	109,3 $\pm$ 3,2	108 $\pm$ 1,6
l_1	Length of narrow parallel-sided section	80 $\pm$ 2	60,0 $\pm$ 0,5
r	Radius of shoulder [c]	24 $\pm$ 1	60,0 $\pm$ 0,5
b_2	Width at ends	20,0 $\pm$ 0,2	
b_1	Width of narrow parallel-sided section	10 $\pm$ 0,2	
h	Thickness (preferred)	4,0 $\pm$ 0,2	
	Distance between clamps	115 $\pm$ 1	

[a] The recommended overall length of 170 mm of the type A1 test specimen is consistent with ISO 294-1 and ISO 10724-1. For some materials, the length of the tabs may need to be extended (e.g. l_3 = 200 mm) to prevent breakage or slippage in the jaws of the test machine.

[b] Resulting from l_1, r, b_1 and b_2, but within the indicated tolerance limits.

[c] The value given for the radius of the type A1 specimen corresponds to the recommendation made in ISO 3167:2002. ISO 3167:2002 still allows the former radius tolerance limits of 20 mm to 25 mm, but recommends that a radius of (24 $\pm$ 1) mm be used, which may become mandatory in the next revision of ISO 3167.

5.2.2 Reduced-scale test specimens

The general design of tensile test specimens is shown in Figure 1. The designation of reduced-scale tensile test specimens is type Axy, where

A is the specimen type;

x indicates the method of preparation;

y is the scale factor.

Table 4 gives details of the dimensions of, and acceptable tolerances for, specimen types Ax4, Ax8, Ax2, Ax3 and Ax5, x being either 1 for injection moulding or 2 for machining.

Table 4 — Dimensions of reduced-scale test specimens

Dimensions in millimetres

Specimen designation	**A12** **A22**	**A13** **A23**	**A15** **A25**	**A14** **A24**	**A18** **A28**
Scale factor (see comments in last row)	1:2	≈ 1:3 except for thickness and l_1	1:5 except for thickness	1:4 except for l_3	1:8 except for l_3
l_3	⩾ 75	⩾ 60	⩾ 30	⩾ 45	⩾ 23,8
l_2	58 ± 2	35 ± 1	23 ± 2	27,5 ± 1	13,8 ± 0,5
l_1	30 ± 0,5	24 ± 0,5	12 ± 0,5	20 ± 0,5	10 ± 0,5
b_1	5 ± 0,5	3,5 ± 0,2	2 ± 0,2	2,5 ± 0,1	1,25 ± 0,05
b_2	10 ± 0,5	7,2 ± 0,2	4 ± 0,2	5,0 ± 0,2	2,5 ± 0,1
r	⩾ 30	⩾ 8,8	⩾ 12	6,3 ± 0,2	3,2 ± 0,2
h	⩾ 2 ± 0,1	1 or 2 ± 0,05	⩾ 2 ± 0,1	1,0 ± 0,1	0,5 ± 0,1
Preparation	Machining (or injection moulding)	Machining from plates (type D1 or D2) (or injection moulding)	Machining (or injection moulding)	Injection moulding (or machining)	Injection moulding (or machining)
Comments	—	The disproportionately small value of l_1 allows longer ends that make gripping easier	—	The disproportionately large value of l_3 allows longer ends that make gripping easier	The disproportionately large value of l_3 allows longer ends that make gripping easier

5.3 Bar test specimens (type B)

Bar test specimens shall have the following dimensions:

length l_1: (80 ± 2) mm;

width b_1: (10,0 ± 0,2) mm;

thickness h: (4,0 ± 0,2) mm.

The designation of bar test specimens is type Bx, where

B is the specimen type;

x indicates the method of preparation.

They can be prepared as follows:

type B1: by injection moulding;

type B2: by machining from the central section of the type A1 test specimen (see also Figure 1);

type B3: by machining from sheets or shaped articles, or by compression moulding to the required dimensions.

5.4 Small tensile specimens (type C)

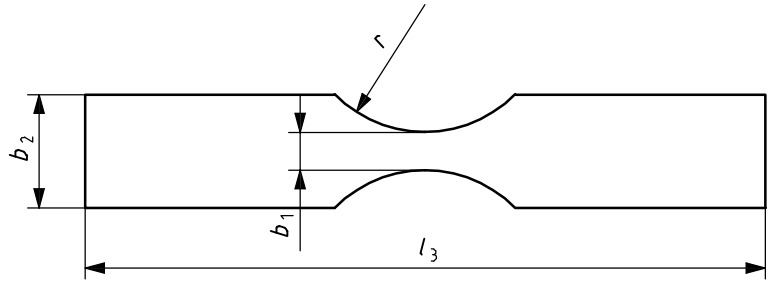
Small tensile specimens shall have the dimensions given in Table 5 (see also Figure 2).

Table 5 — Dimensions of type C test specimens

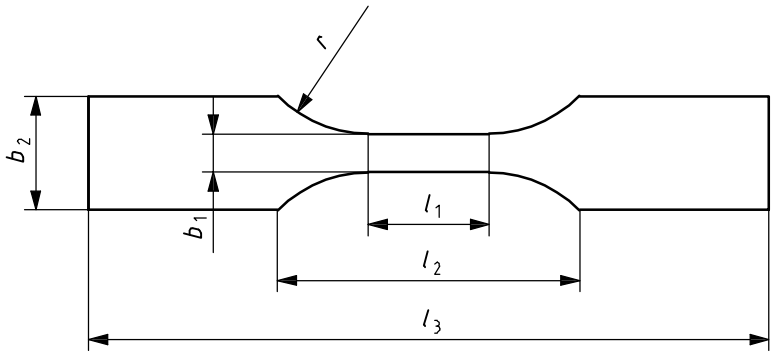
Dimensions in millimetres

Dimension	Type CW	Type CP
l_3	60 ± 1	60 ± 1
b_2	10,0 ± 0,2	10,0 ± 0,2
b_1	3,0 ± 0,1	3,0 ± 0,1
h [a]	3,0 ± 0,1	3,0 ± 0,1
r	15 ± 1	10 ± 1
l_1	—	10,0 ± 0,2
l_2	—	30,0 ± 0,5

[a] Other thicknesses: 1 mm, 2 mm.



a) Type CW



b) Type CP

Figure 2 — General design of type CW and type CP test specimens

The designation of small tensile specimens is type C*xyz*, where

C (position 1) = specimen type;

x (position 1a) = W (specimen with waist) or P (specimen with parallel-sided central section);

y (position 2) indicates method of preparation (1 = injection moulding; 2 = machining);

z (position 3) = 1, 2 or 3, indicating the thickness of the specimen, in millimetres.

Machining of specimens can be done from sheets or from type D plate specimens (see 5.5).

Possible designations are:

CW11	CW21	CP11	CP21
CW12	CW22	CP12	CP22
CW13	CW23	CP13	CP23

This designation system is especially designed to describe commonly used thicknesses of injection-moulded specimens (small tensile specimens and plate specimens). Specimens machined from shaped articles or other finished parts may have different thicknesses. In that case, the essential information is the specimen shape (CW2 or CP2). The actual thickness will be given in the test report.

5.5 Plate specimens (type D)

Plate specimens shall have the following dimensions:

l_1: (60 ± 2) mm;

b_1: (60 ± 2) mm;

h: (1,0 ± 0,1) mm for type D1 or (2,0 ± 0,1) mm for type D2.

They can be prepared by injection moulding, by compression moulding or by machining from flat sheets of suitable thickness. The designation is type D*xy*, where

D is the specimen type;

x indicates the method of preparation;

y is the thickness, in millimetres.

6 Report on preparation of test specimens

The report shall contain the following information:

a) a reference to this International Standard;

b) the specimen type;

c) the type of material used and the source, manufacturer's code, grade and form, including history, etc., if known;

d) the method of moulding and the conditions used;

e) the method of machining and the conditions used;

f) the specimen thickness, if modified from the standard thickness;

g) the number of test specimens prepared;

h) the date of preparation.

Annex A
(informative)

Recommended applications for multipurpose test specimens or parts thereof

Method	Reference [a]	Type of specimen and/or dimensions mm
Tensile test	ISO 527-2	A
Tensile creep test	ISO 899-1	A
Flexural test	ISO 178	B
Flexural creep test	ISO 899-2	B
Compressive test	ISO 604	(10 or 50) × 10 × 4
Impact strength, Charpy	ISO 179-1, ISO 179-2	B
Impact strength, Izod	ISO 180	B
Impact strength, tensile	ISO 8256	B
Temperature of deflection under load	ISO 75-2	B
Vicat softening temperature	ISO 306	(⩾ 10) × 10 × 4
Hardness, ball indentation	ISO 2039-1	(⩾ 20) × 20 × 4
Hardness, Rockwell	ISO 2039-2	(⩾ 20) × 20 × 4
Hardness, Shore	ISO 868	(⩾ 20) × 20 × 4
Environmental stress cracking	ISO 22088-1, ISO 22088-2, ISO 22088-3, ISO 22088-4, ISO 22088-5, ISO 22088-6	A or B
Density	ISO 1183-1, ISO 1183-2, ISO 1183-3	B (⩾ 10) × 10 × 4
Oxygen index	ISO 4589-2, ISO 4589-3	B
Comparative tracking index (CTI)	IEC 60112	20 × 20 × 4
Electrolytic corrosion	IEC 60426	30 × 10 × 4
Linear expansion	ISO 11359-2	(⩾ 10) × 10 × 4

[a] See Clause 2 or Bibliography.

Annex B
(normative)

Designation system for test specimens

Table B.1 — Designation system

Position 1	Specimen type
A	Tensile specimen, multipurpose or reduced-scale
B	Bar specimen
C	Small tensile specimen
D	Plate specimen

Position 1a (for type C only)	Specimen shape
W	With waist
P	With parallel-sided central section

Position 2	Method of preparation
1	Injection moulding
2	Machining
3[a]	Machining or compression moulding

[a] This is a special case for the type B specimen, as the type B2 specimen is always machined from the central section of the injection-moulded type A1 specimen (see Table 1 and Clause B.2).

Position 3 (for reduced-scale type A)	Scale factor
1	Original size
2	1/2 size
3	1/3 size
4	1/4 size
5	1/5 size
8	1/8 size

Position 3 (for types C and D)	Thickness
1	1 mm
2	2 mm
3	3 mm

Table B.2 — Possible combinations

	Type A specimens	
	Preparation	
Scale factor	Inj. moulding (= 1)	Machining (= 2)
1	A11	A21
2	A12	A22
3	A13	A23
4	A14	A24
5	A15	A25
8	A18	A28

Type B specimens		
Preparation		
Inj. moulding (= 1)	Machined from type A1	Machined or compression moulded
B1	B2	B3

	Type C specimens			
	With waist: W		With parallel-sided central section: P	
	Preparation		Preparation	
Thickness	Inj. moulding (= 1)	Machining (= 2)	Inj. moulding (= 1)	Machining (= 2)
1 mm	CW11	CW21	CP11	CP21
2 mm	CW12	CW22	CP12	CP22
3 mm	CW13	CW23	CP13	CP23

	Type D specimens	
	Preparation	
Thickness	Inj. moulding (= 1)	Machining (= 2)
1 mm	D11	D21
2 mm	D12	D22
3 mm	D13	D23

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[18] ISO 2039-1, *Plastics — Determination of hardness — Part 1: Ball indentation method*

[19] ISO 2039-2, *Plastics — Determination of hardness — Part 2: Rockwell hardness*

[20] ISO 3167:2002, *Plastics — Multipurpose test specimens*

[21] ISO 4589-2, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test*

[22] ISO 4589-3, *Plastics — Determination of burning behaviour by oxygen index — Part 3: Elevated-temperature test*

[23] ISO 8256:2004, *Plastics — Determination of tensile-impact strength*

[24] ISO 11359-2, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

[25] ISO 22088-1, *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 1: General guidance*

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