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Plastics — Thermoplastic semi-finished products for machining — Requirements and test methods

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Plastiques - Produits semi-finis thermoplastiques pour usinage - Exigences et méthodes d'essai

Kunststoffe - Thermoplastische Halbzeuge für die spanende Verarbeitung - Anforderungen und Prüfmethoden

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Foreword

This document (EN 15860:2010) has been prepared by Technical Committee CEN/TC 249 “Plastics”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2010, and conflicting national standards shall be withdrawn at the latest by December 2010.

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1 Scope

This European Standard specifies the requirements and associated test methods that apply to semi-finished products such as rods, hollow bars and plates made from thermoplastic materials. These semi-finished products are used predominantly for the manufacture of finished parts by means of machining.

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.

EN ISO 291:2008, *Plastics — Standard atmospheres for conditioning and testing (ISO 291:2008)*

EN ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST) (ISO 306:2004)*

EN ISO 307, *Plastics — Polyamides — Determination of viscosity number (ISO 307:2007)*

EN ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles (ISO 527-1:1993 including Corr. 1:1994)*

EN ISO 527-2:1996, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Corr.1:1994)*

EN ISO 1043-1:2001, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics (ISO 1043-1:2001)*

EN ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133:2005)*

EN ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method (ISO 1183-1: 2004)*

EN ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method (ISO 1183-2:2004)*

EN ISO 2818, *Plastics — Preparation of test specimens by machining (ISO 2818:1994)*

EN ISO 10350-1, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials (ISO 10350-1:2007)*

EN ISO 11357-1, *Plastics — Differential scanning calorimetry (DSC) — Part 1: General principles (ISO 11357-1:2009)*

ISO 1628-5, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 5: Thermoplastic polyester (TP) homopolymers and copolymers*

ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature*

ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization*

ISO 15527:2007, *Plastics — Compression-moulded sheets of polyethylene (PE-UHMW, PE-HD) — Requirements and test methods*

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3 Terms and definitions

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

3.1
semi-finished products
rods, hollow bars and panels/plates from which finished parts are manufactured by means of machining

3.2
rods
long, straight and solid products manufactured by means of extrusion, casting or compression moulding and having a uniform circular cross-section over their entire length

3.3
hollow bars
long, straight and hollow products manufactured by means of extrusion, casting or compression moulding and having a uniform circular cross-section, with concentric inside and outside diameter, over their entire length

3.4
panels
plates
flat, rectangular, solid products manufactured by means of extrusion, extrusion, calendering, casting or compression moulding and having a thickness of at least 0,2 mm which is uniform over their full cross-section

4 Materials

The semi-finished products shall be made of thermoplastic materials (see Table 1). These materials may contain additives such as processing aids, reinforcing agents, fillers, stabilizers or colorants, in which case, they are further referred to in this standard as "modified materials".

The nature and the quantity of these additives can influence the mechanical, thermal and electrical properties of the semi-finished products. The choice and the quantities of additives used are left to the discretion of the manufacturer of the semi-finished products.

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Table 1 — List of the thermoplastic materials most commonly used for the manufacture of semi-finished products

Abbreviated terms (according to EN ISO 1043-1:2001)	Materials
ABS	Acrylonitrile-butadiene-styrene
ECTFE	Ethylene-chlorotrifluoroethylene copolymer
PA 6	Polyamide 6
PA 6 C[a]	Polyamide 6, cast
PA 66	Polyamide 66
PA 12	Polyamide 12
PA 12 C[a]	Polyamide 12, cast
PA 46	Polyamide 46
PA 6/12 C[ab]	Polyamide 6/12, cast
PBT	Polybutylene terephthalate
PC	Polycarbonate
PEEK	Polyetheretherketone
PE-HD	Polyethylene, high density (Group 2.1 or 3.1 of ISO 15527:2007)
PE-LD	Polyethylene, low density
PE-UHMW	Polyethylene, ultra high molecular weight (Group 1.1 or 1.2 of ISO 15527:2007)
PEI	Polyetherimide
PESU	Polyethersulfone
PET	Polyethylene terephthalate
POM-C	Polyoxymethylene, copolymer
POM-H	Polyoxymethylene, homopolymer
PP-B	Polypropylene, block copolymer
PP-H	Polypropylene, homopolymer
PP-R	Polypropylene, random copolymer
PPE+PS	Polystyrene modified polyphenylene ether
PPS	Polyphenylene sulfide
PPSU	Polyphenylene sulfone
PSU	Polysulfone
PVC-C	Polyvinyl chloride, chlorinated
PVC-HI	Polyvinyl chloride, high-impact modified
PVC-U	Polyvinyl chloride, unplasticized
PVDF	Polyvinylidene fluoride

[a] "C" means "cast "

[b] PA 6/12 with max. 15 % laurinlactam

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5 Requirements

5.1 As-delivered condition

Semi-finished products shall be free of blisters, voids, cracks, foreign matter and other defects which make the product unfit for the intended use. Specific requirements in this respect shall be agreed upon between supplier and customer.

The semi-finished products shall be manufactured in such a way that their internal stress level is minimal (see 5.6.2).

Natural coloured materials: slight variations in hue originating from raw materials and/or manufacturing process are allowed.

Natural colour means that no additives (colorants) are added to the raw materials during their manufacture and processing into semi-finished products for the purpose of obtaining another colour.

Coloration: this shall be uniform and shall be agreed upon between supplier and customer. Slight variations in hue originating from raw materials and/or manufacturing process are allowed.

The testing of the as-delivered condition shall be performed according to 6.4.

NOTE Semi-finished products made from PA are dry after manufacture, but absorb moisture during storage. The moisture content in the as-delivered condition is a function of the type of moulding material, the cross-section (plate thickness, rod diameter or hollow bar wall thickness) of the semi-finished product concerned, as well as the type and period of storage.

Semi-finished products made from POM, PEEK and PP are permitted to have light patches in the centre of the cross-section.

Microporosity in the centre of the cross-section may occur in semi-finished products made from POM-H and PP. The largest diameter or the widest part of the microporosity line(s) shall, however, not exceed 4 %. The procedure for the determination and measurement of microporosity is described in Annex A.

When semi-finished products made from POM and PP are subject to specific requirements, e. g. pressure tightness and/or dielectric strength, they shall be agreed upon between supplier and customer.

5.2 Surface appearance

Semi-finished products shall essentially have smooth surfaces. Shallow marks, grooves and irregularities resulting from the manufacturing process are allowed provided that the product meets the dimensional requirements according to 5.3, 5.4 and 5.5.

Testing of the surface appearance shall be performed according to 6.5.

Specific requirements with respect to the surface appearance are to be agreed upon between supplier and customer.

5.3 Dimensions and tolerances for rods

5.3.1 Diameter

The diameters commonly available are given in the delivery programmes of the suppliers.

The tolerances on the diameters are given in Table 2 for different diameter ranges.

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Table 2 — Tolerances on diameters for rods

Dimensions in millimetres

Diameter ranges	Column 1 ECTFE PEEK PA 6 PET PA 66 POM PA 12 PPS PA 46 PVDF PBT	Column 2 PA 6 C PA 6/12 C PA 12 C	Column 3 ABS PC PEI PESU PPE+PS PPSU PSU	Column 4 PE-LD PE-HD PE-UHMW PP-B PP-H PP-R	Column 5 PVC-C PVC-HI PVC-U
up to 4	+ 0,6 + 0,1	—	+ 0,7 + 0,1	+ 0,3 + 0,1	
over 4 up to 6		—		+ 0,4 + 0,1	
over 6 up to 8	+ 0,7 + 0,1	—	+ 0,8 + 0,1	+ 0,5 + 0,1	
over 8 up to 10				+ 0,6 + 0,1	
over 10 up to 12	+ 0,8 + 0,2	—	+ 0,9 + 0,2	+ 0,7 + 0,2	
over 12 up to 16				+ 0,8 + 0,2	
over 16 up to 18				+ 0,9 + 0,2	
over 18 up to 20				+ 1,2 + 0,2	
over 20 up to 25	+ 1,0 + 0,2	—	+ 1,2 + 0,2		
over 25 up to 30					
over 30 up to 32	+ 1,2 + 0,2	+ 1,4 + 0,2	+ 1,2 + 0,2	+ 1,3 + 0,2	
over 32 up to 36			+ 1,6 + 0,2		
over 36 up to 40				+ 1,5 + 0,2	
over 40 up to 45	+ 1,3 + 0,3	+ 1,9 + 0,3	+ 2 + 0,3	+ 2 + 0,3	
over 45 up to 56					
over 56 up to 63	+ 1,6 + 0,3	+ 2,5 + 0,3	+ 2,5 + 0,3	+ 2,3 + 0,3	
over 63 up to 70				+ 2,5 + 0,3	
over 70 up to 80	+ 2,0 + 0,4	+ 2,8 + 0,4	+ 3,0 + 0,4	+ 3,0 + 0,4	
over 80 up to 90	+ 2,2 + 0,5	+ 3,2 + 0,5	+ 3,4 + 0,5	+ 3,4 + 0,5	+ 3,0 + 0,5
over 90 up to 100	+ 2,5 + 0,6	+ 3,5 + 0,6	+ 3,8 + 0,6	+ 3,8 + 0,6	+ 3,5 + 0,6
over 100 up to 110	+ 3,0 + 0,7	+ 3,9 + 0,7	+ 4,2 + 0,7	+ 4,2 + 0,7	+ 4,0 + 0,7
over 110 up to 125	+ 3,5 + 0,8	+ 4,3 + 0,8	+ 4,6 + 0,8	+ 4,6 + 0,8	+ 5,0 + 0,8
over 125 up to 140	+ 3,8 + 0,9	+ 5,0 + 0,8	+ 5,4 + 0,9	+ 5,4 + 0,9	+ 6,0 + 0,9
over 140 up to 150	+ 4,2 + 1,0	+ 5,3 + 0,8	+ 5,8 + 1,0	+ 5,8 + 1,0	+ 7,0 + 1,0
over 150 up to 160	+ 4,5 + 1,1	+ 6,0 + 0,8	+ 6,3 + 1,1	+ 6,3 + 1,1	+ 8,0 + 1,1
over 160 up to 180	+ 5,0 + 1,2	+ 6,5 + 1,0	+ 7,4 + 1,2	+ 7,4 + 1,2	+ 9,0 + 1,2

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Table 2 (*continued*)

Dimensions in millimetres

Diameter ranges	Column 1 ECTFE PEEK PA 6 PET PA 66 POM PA 12 PPS PA 46 PVDF PBT	Column 2 PA 6 C PA 6/12 C PA 12 C	Column 3 ABS PC PEI PESU PPE+PS PPSU PSU	Column 4 PE-LD PE-HD PE-UHMW PP-B PP-H PP-R	Column 5 PVC-C PVC-HI PVC-U
over 180 up to 200	+ 5,5 + 1,3	+ 7,5 + 1,0	+ 8,5 + 1,3	+ 8,5 + 1,3	+ 10,0 + 1,3
over 200 up to 220	+ 5,8 + 1,3	+ 8,5 + 1,0	+ 9,0 + 1,3	+ 9,0 + 1,3	+ 11,0 + 1,3
over 220 up to 250	+ 6,2 + 1,5	+ 9,5 + 1,0	+ 9,5 + 1,5	+ 9,5 + 1,5	+ 11,0 + 1,5
over 250 up to 280	+ 6,6 + 1,5	+ 11,0 + 1,0	—	+10,0 + 1,5	+ 12,0 + 1,5
over 280 up to 320	+ 7,5 + 1,5	+ 12,0 + 1,5		+ 10,5 + 1,5	—
over 320 up to 360	+ 8,5 + 1,5	+ 13,5 + 1,5		+ 12 + 1,5	
over 360 up to 400	+ 9,5 + 1,5	+ 15,0 + 1,5		+ 12 + 1,5	—
over 400 up to 450	+ 10,5 + 1,5	+ 16,5 + 1,5			
over 450 up to 500	+ 11,5 + 1,5	+ 18,0 + 1,5	—		
over 500 up to 600	—	+ 21 + 3		—	
over 600 up to 700	—	+ 25 + 3			

Rods made from reinforced materials do not, however, have to meet the tolerances given in their respective column but those in Column 3.

Tolerances on other diameters or deviating tolerances shall be agreed upon between supplier and customer.

NOTE The tolerances in Table 2 apply to rods made from modified and non-modified materials.

5.3.2 Length

The tolerance on length is 0/+ 3 %.

The rods shall have neatly trimmed end faces – perpendicular to their longitudinal axis – so that the nominal length can always be obtained.

Deviating tolerances on the length shall be agreed upon between supplier and customer.

5.3.3 Roundness

The roundness deviation – the difference between the largest and the smallest diameter measured within the same cross-section – shall not be larger than half the tolerance width given in Table 2 for the respective diameter.

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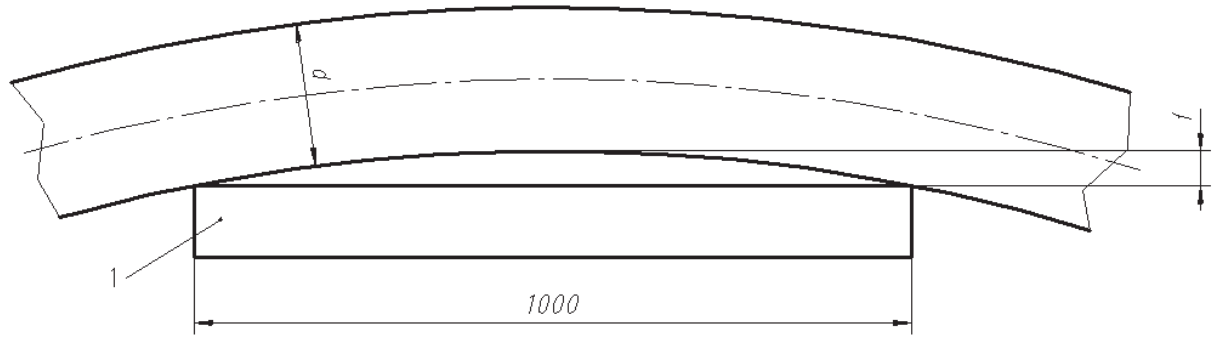
5.3.4 Straightness

The deviations of the rods from the straight line extended from edge to edge over the measuring length shall not exceed the values given in Table 3 for different diameter ranges. These limit values refer to a reference length of 1 000 mm (see Figure 1). To allow proper measuring, the rod is laid unconstrained on its side on a flat surface so that the weight of the product does not influence the results. The measured value f is the greatest distance between the straight 1 000 mm measuring ruler and the maximum concave point on the rod.

See Annex B for the conversion of the deflection as a function of the length.

NOTE An example is given in Annex B

Dimensions in millimetres



Key
1 measuring ruler
d diameter
f deviation from straight line

Figure 1 — Principle of the straightness measurement for rods

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Table 3 — Straightness requirements for rods

Dimensions in millimetres

Diameter ranges	Max. allowable deviations from straight line ($f_{max.\ all.}$)					
	Column 1		Column 2	Column 3	Column 4	Column 5
	ABS, PA 12, PA 12 C, PA 46, PA 6, PA 6 C, PA 6/12 C, PA 66, PBT, PC, PEEK, PEI, PESU, PET, POM, PPE+PS, PPS, PPSU, PSU		ECTFE, PE-LD, PE-HD, PVDF	PE-UHMW	PP-H, PP-B, PP-R	PVC-C, PVC-HI, PVC-U
	non-fibre-reinforced[a]	fibre-reinforced				
up to 20	8,0	10,0	15,0	20,0	10,0	10,0
over 20 up to 32	5,0	6,5	12,0	17,5	8,0	8,0
over 32 up to 50	4,0	5,0	10,0	17,5	8,0	8,0
over 50 up to 100	4,0	5,0	8,0	15,0	6,5	6,5
over 100 up to 150	3,5	4,0	6,0	10,0	5,0	5,0
over 150	3,5	4,0	6,0	10,0	5,0	5,0
Special straightness requirements shall be agreed upon between supplier and customer.						
NOTE The limit values given in Columns 2 to 5 apply to rods made from modified and non-modified materials.						
[a] Additives other than fibres can be included in the materials.						

5.4 Dimensions and tolerances for hollow bars

5.4.1 Diameters

The diameters commonly available are given in the delivery programmes of the suppliers.

The tolerances on the outside and inside diameters are given in Table 4 for different diameter ranges.

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Table 4 — Tolerances on diameters for hollow bars

Dimensions in millimetres

Outside diameter ranges	**Tolerances on outside diameter**	**Tolerances on outside diameter**	**Tolerances on inside diameter**	**Tolerances on inside diameter**
	ABS, ECTFE, PA 6, PA 66, PA 12, PA 46, PBT, PC, PEEK, PET, PEI, PESU, POM, PPE+PS, PPS, PPSU, PSU, PVDF	PA6 C, PA12 C, PA 6/12 C	ABS, ECTFE, PA 6, PA 66, PA 12, PA 46, PBT, PC, PEEK, PET, PEI, PESU, POM, PPE+PS, PPS, PPSU, PSU, PVDF	PA6 C, PA12 C, PA 6/12 C
from 20 up to 30	+ 1,1 + 0,4	+ 3,0 + 0,8	- 0,4 - 1,1	- 0,8 - 4,0
over 30 up to 50	+ 2,0 + 0,6		- 0,6 - 2,0	
over 50 up to 60	+ 2,5 + 0,8		- 0,8 - 2,5	
over 60 up to 80	+ 3,0 + 0,8	+ 4,0 + 0,8	- 0,8 - 3,0	- 0,8 - 4,0
over 80 up to 110	+ 3,6 + 1,2	+ 5,0 + 1,0	- 1,6 - 5,0	- 1,0 - 6,0
over 110 up to 150	+ 4,5 + 1,5	+ 7,5 + 1,5	- 2,0 - 6,5	- 1,5 - 7,5
over 150 up to 180	+ 5,4 + 1,8	+ 9,0 + 1,8	- 2,2 - 7,5	- 1,8 - 9,0
over 180 up to 220	+ 6,0 + 2,0	+ 11,0 + 2,0	- 2,5 - 8,5	- 2,0 - 11,0
over 220 up to 250	+ 9,0 + 3,0	+ 12,5 + 2,5	- 3,0 - 12,0	- 2,5 - 12,5
over 250 up to 300	+ 10,0 + 3,0	+ 15,0 + 3,0	- 3,5 - 13,0	- 3,0 - 15,0
over 300 up to 400	+ 11,0 + 3,0	+ 17,5 + 3,0	- 3,5 - 14,0	- 3,0 - 17,5
over 400 up to 500	+ 13,0 + 3,0	+ 20,0 + 3,0	- 3,5 - 16,0	- 3,0 - 20,0
over 500 up to 600	+ 15,0 + 3,0	+ 25,0 + 3,0	- 3,5 - 18,0	- 3,0 - 25,0

Tolerances for other diameters or deviating tolerances shall be agreed upon between supplier and customer.

NOTE 1 The tolerances in Table 4 apply to hollow bars made from modified and non-modified materials.

NOTE 2 The tolerances in Table 4 can also be used for hollow bars made from PE and PP provided that there are no other specific standards for these materials.

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