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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Plastics — Polyalkylene terephthalates —

Part 2 :

Preparation of test specimens and determination
of properties

Plastiques — Polyalkylène téréphtalates —

Partie 2: Préparation des éprouvettes et détermination des caractéristiques

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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.

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 7792-2 was prepared by Technical Committee ISO/TC 61, *Plastics*.

ISO 7792 consists of the following parts, under the general title *Plastics* — *Polyalkylene terephthalates*:

- *Part 1: Designation*
- *Part 2: Preparation of test specimens and determination of properties*

Plastics — Polyalkylene terephthalates —

Part 2 :

Preparation of test specimens and determination of properties

1 Scope

1.1 This part of ISO 7792 describes the preparation of test specimens from polyalkylene terephthalate thermoplastics, PET and PBT, and specifies the conditions of test for determining the properties of the materials.

1.2 The properties of finished products made from polyalkylene terephthalate thermoplastic materials depend on the material used, on the shape of the product, on the physical and morphological state of the material resulting from the moulding conditions, and on the test conditions. Therefore, to obtain reproducible test results, the defined methods of preparation of test specimens and defined test conditions specified in this part of ISO 7792 shall be applied.

1.3 Agreements between vendor and purchaser shall be based on one or more properties measured using the specimens and test conditions specified in this part of ISO 7792.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7792. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7792 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 75 : 1987, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 178 : 1975, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179 : 1982, *Plastics — Determination of Charpy impact strength of rigid materials.*

ISO 180 : 1982, *Plastics — Determination of Izod impact strength of rigid materials.*

ISO 291 : 1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 294 : 1975, *Plastics — Injection moulding test specimens of thermoplastic materials.*

ISO/R 527 : 1966, *Plastics — Determination of tensile properties.*

ISO 537 : 1980, *Plastics — Testing with the torsion pendulum.*

ISO 899 : 1981, *Plastics — Determination of tensile creep.*

ISO 1133 : 1981, *Plastics — Determination of the melt flow rate of thermoplastics.*

ISO 1183 : 1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

ISO 1628-5 : 1986, *Plastics — Determination of viscosity number and limiting viscosity number — Part 5: Poly(alkylene terephthalates).*

ISO 2039-1 : 1987, *Plastics — Determination of hardness — Part 1: Ball indentation method.*

ISO 2039-2 : 1987, *Plastics — Determination of hardness — Part 2: Rockwell hardness.*

ISO 3451-2 : 1984, *Plastics — Determination of ash — Part 2: Polyalkylene terephthalates.*

ISO 6188 : 1986, *Plastics — Poly(alkylene terephthalate) granules — Determination of water content.*

IEC 93 : 1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulation materials.*

IEC 112 : 1979, *Method for determining the comparative and the proof tracking indices of solid insulation materials under moist conditions.*

IEC 243 : 1967, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

IEC 250 : 1969, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulation materials at power, audio and radio frequencies including metre wavelengths.*

3 Preparation of test specimens

3.1 Water content of moulding material

The water content of the moulding material for the preparation of test specimens shall not exceed 0,02 (m/m) for both PET and PBT. In the case of filled materials, this limit refers to the total mass of thermoplastic and filler.

PET and PBT material having a water content of more than 0,02 (m/m) shall be dried according to the instructions of the manufacturer.

In order to ensure that the moisture content remains low, it is recommended that the material in the feed hopper of the injection moulding machine be blanketed with dried air or nitrogen. Better results can be obtained using a dehumidifier hopper dryer.

3.2 Injection moulding of test specimens

The requirements of ISO 294 with regard to the mould design, the injection moulding machine and the moulding operation shall be met.

3.2.1 Mould temperatures

The mould temperatures presented in table 1 are recommended. The temperature of the mould cavity surface shall be measured according to ISO 294.

3.2.2 Other processing conditions

Other recommended processing conditions are given in table 2.

NOTE — For materials with flame retardant additives, application of the lower limits of the plastic melt temperatures presented in table 2 is recommended. If specified by the manufacturer, still lower temperatures may be used.

The residence time of the molten material in the cylinder shall not exceed 10 min with PET and 15 min with PBT.

During the moulding, the decrease in viscosity number shall not exceed

- 20 % with PET
- 25 % with PET containing flame retardant additives
- 10 % with PBT.

3.2.3 Uniformity of mouldings

Mouldings shall be weighed as a check on uniformity; the masses shall not deviate by more than 0,1 % from each other. The test specimens shall have a smooth surface and be free from streaks, excessive sink marks, chatter marks and voids. Except for amorphous PET, microtome sections ($\leq 10 \mu\text{m}$ thick) of the entire central section perpendicular to the axis shall show under the polarizing microscope an almost homogeneous crystalline texture.

4 Determination of properties

Properties shall be determined in accordance with the International Standards listed in table 3. Unless otherwise stated, test specimens for the determination of mechanical properties, electrical properties and density shall be conditioned before testing for at least 16 h in the standard atmosphere of $23 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ and $50 \% \pm 5 \%$ relative humidity (see ISO 291).

Table 1 — Recommended mould temperatures

Raw material	Grade	Mould temp. °C
PET, unfilled	Grades intended for the fabrication of objects with an amorphous or predominantly amorphous structure	20 ± 5
PET, unfilled	Grades intended for the fabrication of objects with a semi-crystalline structure	135 ± 5
PET, filled	All grades ¹⁾	135 ± 5
PBT, filled and unfilled	All grades ¹⁾	85 ± 5

1) These materials are normally used for the fabrication of semi-crystalline objects only.

Table 2 — Processing conditions

Raw Material	State of test specimen	Plastic melt temp. °C	Cycle time s	Average injection velocity mm/s	Hold pressure		Cooling time s	Back pressure MPa*)
					Time s	Pressure MPa*)		
PET, unfilled	amorphous	285 ± 5	28 to 40	600 ± 300	12 to 17	60	15 to 20	0,2 to 0,5
PET, unfilled	semi-cryst.	275 ± 5						
PET, filled	semi-cryst.	285 ± 5						
PBT, filled	semi-cryst.	260 ± 5	34 to 45	600 ± 300	15 to 20	50	15 to 20	0,5 to 1,0
PBT, unfilled	semi-cryst.	240 ± 5						

*) 1 MPa = 1 MN/m² = 10 bar

Table 3 — Test methods and conditions

Property	Unit	Test method	Dimensions of test specimen mm	Test conditions
Mechanical				
Tensile stress at yield	MPa	ISO/R 527	150 × 10 × 4 (type 2)	Speed B (5 mm/min ± 20 %)
Tensile elongation at yield	%	ISO/R 527	150 × 10 × 4 (type 2)	Speed B (5 mm/min ± 20 %)
Tensile stress at break	MPa	ISO/R 527	150 × 10 × 4 (type 2)	Filled materials: Speed B Unfilled materials: Speed E (50 mm/min ± 10 %)
Tensile elongation at break	%	ISO/R 527	150 × 10 × 4 (type 2)	
Elastic modulus in tension	MPa	ISO/R 527	150 × 10 × 4 (type 2)	Speed A (1 mm/min)
Flexural modulus	MPa	ISO 178	80 × 10 × 4	Speed: 2 mm/min ± 20 %
Shear modulus and mechanical loss factor	MPa	ISO 537	60 × 10 × 1	−70 °C to melting point
Tensile creep modulus	MPa	ISO 899	150 × 10 × 4 (type 2)	at 1 000 h and 0,5 % elongation
Impact resistance				
— Izod	kJ·m ^{−2}	ISO 180	80 × 10 × 4 (type 1)	Notch type A (method ISO 180/1A)
— Charpy (notched)	kJ·m ^{−2}	ISO 179	80 × 10 × 4 (type 1)	Notch type A (method ISO 179/1A)
— Charpy (unnotched)	kJ·m ^{−2}	ISO 179	80 × 10 × 4 (type 1)	Method ISO 179/1D (40 mm between supports)
Ball indentation hardness		ISO 2039-1	≥ 4 mm thickness	
Rockwell hardness		ISO 2039-2	≥ 4 mm thickness	R scale
Thermal				
Deflection temperature under load	°C	ISO 75	110 × 10 × 4	Method A (1,80 MPa) Method B (0,45 MPa)
Electrical				
Surface resistance	Ω	IEC 93	100 × 100 × 1,5 (min.) ¹⁾	Test voltage: 1 000 V P25/P75 mm electrodes; insulating liquid 50 Hz and 1 MHz 50 Hz and 1 MHz 50 Hz to 60 Hz; solution A
Volume resistivity	Ω·cm	IEC 93	100 × 100 × 1,5 ¹⁾	
Dielectric strength	kV/mm	IEC 243	100 × 100 × 1,0	
Relative permittivity		IEC 250	100 × 100 × 1,5 (min.) ¹⁾	
Dissipation factor, tan δ		IEC 250	100 × 100 × 1,5 (min.) ¹⁾	
Comparative tracking index		IEC 112	50 × 50 × 3 (min.) ²⁾	
Miscellaneous				
Melt flow rate (MFR)	g/10 min	ISO 1133		PET 280 °C/2,16 kg ³⁾ PBT 250 °C/2,16 kg ³⁾
Density	g/cm ³	ISO 1183		
Water content	% (m/m)	ISO 6188		
Viscosity number (VN)	ml/g	ISO 1628-5		
Ash	% (m/m)	ISO 3451-2		

1) Preferred specimen size; 100 mm discs are acceptable alternatives.

2) Preferred specimen size; 50 mm discs are acceptable alternatives.

3) Before the determination, test specimens shall be dried in the following way:

PET: 5 h at 140 °C under vacuum at a pressure below 100 Pa;

PBT: 4 h at 120 °C under vacuum at a pressure below 100 Pa.

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