
**Plastics — Poly(phenylene ether) (PPE)
moulding and extrusion materials —**

Part 2:

**Preparation of test specimens and
determination of properties**

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*Plastiques — Matériaux à base de poly(phénylène éther) (PPE) pour
moulage et extrusion —
Partie 2: Préparation des éprouvettes et détermination des propriétés*

ISO 15103-2:2007

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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 15103-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

This second edition cancels and replaces the first edition (ISO 15103-2:2000), which has been technically revised.

ISO 15103 consists of the following parts, under the general title *Plastics — Poly(phenylene ether) (PPE) moulding and extrusion materials*:

- *Part 1: Designation system and basis for specifications*
- *Part 2: Preparation of test specimens and determination of properties*

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Plastics — Poly(phenylene ether) (PPE) moulding and extrusion materials —

Part 2: Preparation of test specimens and determination of properties

1 Scope

This part of ISO 15103 specifies the methods of preparation of test specimens and the test methods to be used in determining the properties of poly(phenylene ether) moulding and extrusion materials. Requirements for handling test material and for conditioning both the test material before moulding and the specimens before testing are given here.

Procedures and conditions are described for the preparation of test specimens, and procedures for measuring properties of the materials from which these specimens are made are given. Properties and test methods which are suitable and necessary to characterize poly(phenylene ether) moulding and extrusion materials are listed.

The properties have been selected from the general test methods in ISO 10350-1:1998. Other test methods in wide use for, or of particular significance to, these moulding and extrusion materials are also included in this part of ISO 15103, as are the designatory properties specified in ISO 15103-1.

In order to obtain reproducible and comparable test results, it is necessary to use the methods of specimen preparation and conditioning, the specimen dimensions and the test procedures specified herein. Values determined will not necessarily be identical to those obtained using specimens of different dimensions or prepared using different procedures.

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 62, *Plastics — Determination of water absorption*

ISO 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 178, *Plastics — Determination of flexural properties*

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 180, *Plastics — Determination of Izod impact strength*

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 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

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

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

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

ISO 1183-3, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pycnometer method*

ISO 3167, *Plastics — Multipurpose test specimens*

ISO 3451-1, *Plastics — Determination of ash — Part 1: General methods*

ISO 8256 *Plastics — Determination of tensile-impact strength*

ISO 10350-1:1998, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

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

ISO 11359-2:1999, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ISO 15103-1, *Plastics — Poly(phenylene ether) (PPE) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 15512, *Plastics — Determination of water content*

IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulation materials*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60243-1, *Electrical strength of insulating materials — Test methods — Part 1: Tests at power frequencies*

IEC 60250, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths*

IEC 60296, *Fluids for electrotechnical applications — Unused mineral insulating oils for transformers and switchgear*

IEC 60695-11-10, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

3 Preparation of test specimens

3.1 General

It is essential that specimens are always prepared by the same procedure (injection moulding), using the same processing conditions.

3.2 Treatment of material before moulding

Before processing, the moisture content of the material sample shall not exceed 0,05 % by mass. If the moisture level exceeds this limit, the sample shall be dried in accordance with the manufacturer's instructions until the moisture content no longer exceeds the limit.

3.3 Injection moulding

Specimens shall be prepared in accordance with ISO 294-1, using the conditions specified in Table 1.

Table 1 — Conditions for injection moulding of test specimens

Material	Temperature of deflection under load (see ISO 15103-1)	Filler content % by mass	Melt volume-flow rate		Melt temperature °C	Mould temperature °C										
			Conditions	Value cm ³ /10 min												
PPE	A210	0	—	—	340	120										
PPE+PS	A080	0	—	—	220	50										
	A090	0	250 °C, 10 kg	> 30	220	60										
				≤ 30	240											
		> 0 but ≤ 50	—	—	260											
	A100 A110	0	250 °C, 10 kg	> 20	240	70										
				≤ 20	260											
		> 0 but ≤ 50	300 °C, 5 kg	> 20	260											
	A120 A130	0	250 °C, 10 kg	> 5	280	80										
				≤ 5	290											
		> 0 but ≤ 50	300 °C, 5 kg	> 10	280											
	A140 A150	0	250 °C, 10 kg	> 3	300	100										
				≤ 3	310											
		> 0 but ≤ 50	300 °C, 5 kg	> 4	290											
	A160	≤ 50	—	—	300	120										
	A170	≤ 50	—	—	310	120										
A180 A190 A200	≤ 50	—	—	340	120											
A210	0	—	—	340	120											
PPE+PA	—	≤ 50	280 °C, 5 kg	> 30	280	100										
				≤ 30	300											
PPE+PP	—	≤ 50	250 °C, 10 kg	> 5	250	60										
				≤ 5	270											
PPE+PPS	—	≤ 70	300 °C, 10 kg	> 30	300	100										
				≤ 30	320											
PPE+other	B180	≤ 30	—	—	280	80										
		> 30 but ≤ 50			300	100										
	B190	0	—	—	290	90										
		> 0 but ≤ 50			300	100										
	B200	0	—	—	310	120										
		> 0 but ≤ 50			320	120										
B210	≤ 50	—	—	320	120											
PPE+PS+other	A200	≤ 50	—	—	320	120										
<p>Other injection-moulding conditions shall be as follows:</p> <table border="0"> <tr> <td>For PPE, PPE+PS, PPE+PS+other</td> <td>For PPE+PA, PPE+PP, PPE+PPS, PPE+other</td> </tr> <tr> <td>Average injection velocity: 200 mm/s ± 100 mm/s</td> <td>Average injection velocity: 200 mm/s ± 100 mm/s</td> </tr> <tr> <td>Hold pressure: 70 MPa ± 30 MPa</td> <td>Hold pressure: 50 MPa ± 30 MPa</td> </tr> <tr> <td>Hold-pressure time: 20 s ± 5 s</td> <td>Hold pressure time: 20 s ± 5 s</td> </tr> <tr> <td>Total cycle time: ≤ 50 s</td> <td>Total cycle time: ≤ 50 s</td> </tr> </table>							For PPE, PPE+PS, PPE+PS+other	For PPE+PA, PPE+PP, PPE+PPS, PPE+other	Average injection velocity: 200 mm/s ± 100 mm/s	Average injection velocity: 200 mm/s ± 100 mm/s	Hold pressure: 70 MPa ± 30 MPa	Hold pressure: 50 MPa ± 30 MPa	Hold-pressure time: 20 s ± 5 s	Hold pressure time: 20 s ± 5 s	Total cycle time: ≤ 50 s	Total cycle time: ≤ 50 s
For PPE, PPE+PS, PPE+PS+other	For PPE+PA, PPE+PP, PPE+PPS, PPE+other															
Average injection velocity: 200 mm/s ± 100 mm/s	Average injection velocity: 200 mm/s ± 100 mm/s															
Hold pressure: 70 MPa ± 30 MPa	Hold pressure: 50 MPa ± 30 MPa															
Hold-pressure time: 20 s ± 5 s	Hold pressure time: 20 s ± 5 s															
Total cycle time: ≤ 50 s	Total cycle time: ≤ 50 s															

4 Conditioning of test specimens

4.1 General

Test specimens of all materials which are not modified with polyamides shall be conditioned for at least 24 h at $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 10)\%$ relative humidity. Properties of polyamide-modified material shall be determined on specimens in the dry-as-moulded state or on specimens in the moist state. The state of the specimens shall be stated in the test report.

4.2 Dry-as-moulded state

Specimens shall be moulded from dry granules (see 3.2 and 3.3). Specimens are considered to be in the dry-as-moulded state when they have been placed immediately after moulding in a moisture-proof container at $23\text{ °C} \pm 2\text{ °C}$ and stored at this temperature for at least 48 h.

To keep moisture absorption at a low level, dry-as-moulded specimens shall be tested in as short a time as possible (maximum 15 min) after removal from the moisture-proof container.

Annealing specimens prior to testing is not allowed.

5 Determination of properties

In the determination of properties and the presentation of data, the standards, supplementary instructions and notes given in ISO 10350-1:1998 shall be applied. All tests shall be carried out in the standard atmosphere of $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 10)\%$ relative humidity unless specifically stated otherwise in Tables 2 and 3.

Table 2 is compiled from ISO 10350-1:1998, and the properties listed are those which are appropriate to PPE moulding materials. These properties are those considered useful for comparisons of data generated for different thermoplastics.

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Table 3 contains those properties, not found specifically in Table 2, which are in wide use or of particular significance in the practical characterization of PPE moulding materials.

Table 2 — General properties and test conditions (selected from ISO 10350-1:1998)

Property	Unit	Standard	Specimen type (dimensions in mm)	Test conditions and supplementary instructions	
Rheological properties					
Melt mass-flow rate	g/10 min	ISO 1133	Moulding compound	250 °C/10 kg for PPE+PS (unfilled) and PPE+PP	
Melt volume-flow rate	cm ³ /10 min			300 °C/5 kg for PPE+PS (filled) 280 °C/5 kg for PPE+PA 300 °C/10 kg for PPE+PPS	
Mechanical properties					
Tensile modulus	MPa	ISO 527-2	See ISO 3167	Test speed 1 mm/min	
Yield stress	MPa			Test speed 50 mm/min	
Yield strain	%				
Nominal strain at break	%				
Stress at 50 % strain	MPa				
Stress at break	MPa				Test speed 5 mm/min. Only to be quoted if the strain at break, when tested at 50 mm/min, is < 10 %.
Strain at break	%				
Flexural modulus	MPa	ISO 178	80 × 10 × 4	Test speed 2 mm/min	
Flexural strength	MPa				
Charpy impact strength	kJ/m ²	ISO 179-1	80 × 10 × 4	Method 1eU (edgewise impact)	
Charpy notched impact strength	kJ/m ²		80 × 10 × 4 V-notch r = 0,25	Method 1eA (edgewise impact)	
Thermal properties					
Melting temperature, T_{pm}	°C	ISO 11357-3	Moulding compound	Record peak melting temperature. Use 10 °C/min rise and fall.	
Temperature of deflection under load	°C	ISO 75-2	80 × 10 × 4	1,8 MPa and 0,45 MPa	
Coefficient of linear thermal expansion	°C ⁻¹	ISO 11359-2	Prepared from ISO 3167	Record the secant value over the temperature range 23 °C to 55 °C.	
Flammability	mm/min	IEC 60695-11-10	125 × 13 × 1,5 or 3	Method A — linear burning rate of horizontal specimens	
	s			Method B (vertical) a) afterflame time, b) afterglow time	
Electrical properties					
Relative permittivity	—	IEC 60250	≥ 80 × ≥ 80 × 1	Frequency 100 Hz and 1 MHz (compensate for electrode edge effect)	
Dissipation factor	—			IEC 60093	Voltage 500 V
Volume resistivity	Ω·m	IEC 60243-1	≥ 80 × ≥ 80 × 1 ≥ 80 × ≥ 80 × 3		
Surface resistivity	Ω			IEC 60112	≥ 15 × ≥ 15 × 4
Electrical strength	kV/mm	IEC 60112	≥ 15 × ≥ 15 × 4		
Comparative tracking index	—			IEC 60112	≥ 15 × ≥ 15 × 4
Other properties					
Water absorption	%	ISO 62	50 × 50 × 3 or Ø 50 × 3 disc	24 h immersion in water at 23 °C	
Density		Any part of ISO 1183	Use part of centre of multipurpose test specimen		