
**Plastics — Polyetheretherketone
(PEEK) moulding and extrusion
materials —**

**Part 2:
Preparation of test specimens and
determination of properties**

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*Plastiques — Matériaux à base de polyétheréthercétone (PEEK) pour
moulage et extrusion —*

Partie 2: Préparation des éprouvettes et détermination des propriétés

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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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Plastics — Polyetheretherketone (PEEK) moulding and extrusion materials —

Part 2: Preparation of test specimens and determination of properties

1 Scope

This document specifies the methods of preparation of test specimens and the test methods to be used in determining the properties of polyetheretherketone (PEEK) 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.

Procedures and conditions for the preparation of test specimens and procedures for measuring properties of the materials from which these specimens are made are also given. Properties and test methods that are suitable and necessary to characterize PEEK moulding and extrusion materials are listed.

In order to obtain reproducible and comparable test results, the methods of preparation and conditioning, the specimen dimensions and the test procedures specified herein are used. 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

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

ISO 294-3, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 3: Small plates*

ISO 294-4, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 4: Determination of moulding shrinkage*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

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

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

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

ISO 3915, *Plastics — Measurement of resistivity of conductive plastics*

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

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

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

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

ISO 11443, *Plastics — Determination of the fluidity of plastics using capillary and slit-die rheometers*

ISO 15512, *Plastics — Determination of water content*

ISO 20753, *Plastics — Test specimens*

ISO 23153-1, *Plastics — Polyetheretherketone (PEEK) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

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 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*

IEC 62631-2-1, *Dielectric and resistive properties of solid insulating materials — Part 2-1: Relative permittivity and dissipation factor — Technical frequencies (0,1 Hz - 10 MHz) — AC Methods*

IEC 62631-3-1, *Dielectric and resistive properties of solid insulating materials — Part 3-1: Determination of resistive properties (DC methods) — Volume resistance and volume resistivity — General method*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Preparation of test specimens

4.1 General

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

The procedure to be used is indicated in [Table 1](#).

4.2 Treatment of material before moulding

Product shall pre-dried to moisture level of not greater than 0,05 % in accordance with ISO 15512.

4.3 Injection moulding

Injection-moulded specimens shall be prepared in accordance with ISO 294-1 or ISO 294-3, using the conditions specified in [Table 1](#).

An appropriate hold pressure, consistent with the production of blemish-free mouldings, shall be used.

Table 1 — Conditions for injection moulding of test specimens

Material	Melt temperature °C	Mould temperature °C	Average injection velocity mm/s	Cooling time s	Total cycle time s
PEEK	360 – 400 ^{a, b}	175 – 210	100 ± 20 ^c	25 ± 10 ^c	60 ± 10 ^c
^a Excessively high temperatures should be avoided for grades containing PTFE. ^b Higher temperatures (up to 420 °C) can be required for filled grades. ^c Based on specimen type A1 specified in ISO 20753.					

5 Conditioning of test specimens

Unfilled PEEK test specimens shall be conditioned for at least 16 h at 23 °C ± 2 °C, with no relative humidity requirement. Specimens containing fillers or additives that are susceptible to moisture uptake shall be conditioned for at least 16 h at 23 °C ± 2 °C and (50 ± 10) % relative humidity.

6 Determination of properties

The properties listed in [Table 2](#) have been selected from the general test methods in ISO 10350-1. Additional properties and other test methods in wide use for or of particular significance to PEEK moulding and extrusion materials are given in [Table 3](#). The designatory properties are specified in ISO 23153-1.

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

No.	Property	Symbol	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation	Test conditions and supplementary instructions
1	Rheological properties						
1.1	Melt volume-flow rate	MVR	cm ³ /10 min	ISO 1133-1	Moulding compound	—	400 °C / 2,16 kg for MVR > 2,5 cm ³ /10 min 400 °C / 10 kg for low-flow materials Refer to ISO 1133-1 for guidance
1.2	Moulding shrinkage	S_{Mp}	%	ISO 294-4	60 × 60 × 2	M	Parallel
1.3		S_{Mn}					Normal

Table 2 (continued)

No.	Property	Symbol	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation	Test conditions and supplementary instructions	
2 Mechanical properties								
2.1	Tensile modulus	E_t	GPa	ISO 527-1 ISO 527-2	ISO 20753 Type A1 or A2	M	Test speed 1 mm/min	
2.2	Yield stress	σ_y	MPa				Failure with yielding:	
2.3	Yield strain	ϵ_y	%				Test speed 50 mm/min	
2.4	Nominal strain at break	ϵ_{tB}	%				Failure without yielding:	
2.5	Stress at break	σ_B	MPa				$\epsilon_B \leq 10\%$: Test speed 5 mm/min	
2.6	Strain at break	ϵ_B	%				$\epsilon_B > 10\%$: Test speed 50 mm/min	
2.7	Flexural modulus	E_f	GPa	ISO 178	80 × 10 × 4	M	Failure without yielding: Use method A: 2 mm/min for materials that break without yield;	
2.8	Flexural strength at break/maximum flexural strength	σ_{fM}	MPa				Yields without break: Use method B: Measure modulus at 2 mm/min then increase test speed to 100 mm/min	
2.9	Charpy impact strength	a_{cU}	kJ/m ²				ISO 179-1	80 × 10 × 4 V-notch, $r = 0,25$
2.10	Charpy notched impact strength	a_{cN}		Method 1eA (edgewise impact)				
3 Thermal properties								
3.1	Melting temperature	T_m	°C	ISO 11357-3	Moulding compound	M	Record peak temperature	
3.2	Glass transition temperature	T_g		ISO 11357-2			Use 10 K/min	
3.3	Temperature of deflection under load	$T_f 1,8$		ISO 75-1 and ISO 75-2			80 × 10 × 4	Record half-step-height temperature
3.4		$T_f 8,0$		Prepared from ISO 20753			Flatwise loading	
3.5	Coefficient of linear thermal expansion	α_p	ppm/K	ISO 11359-2	M	Parallel	Record secant value over temperature range 23 °C to 55 °C	
3.6		α_n				Transverse		
3.7	Burning behaviour	B50/3		IEC 60695-11-10	125 × 13 × 3		Record classification V-0, V-1, V-2, HB40 or HB75	
4 Electrical properties								
4.1	Relative permittivity	$\epsilon_r 1k$		IEC 62631-2-1	$\geq 60 \times \geq 60 \times 2$ or type A1 (only ISO 3915)	M	1 kHz	Compensate for electrode edge effects
4.2		$\epsilon_r 1M$					1 MHz	
4.3	Dissipation factor	$\tan\delta 1k$					1 kHz	
4.4		$\tan\delta 1M$					1 MHz	
4.5	Volume resistivity	ρ_e	$\Omega \cdot m$	IEC 62631-3-1 or ISO 3915	$\geq 10 \times 75$ to 150×2 (only ISO 3915)	M	Voltage 500 V for IEC 62631-3-1; ≤ 10 V for ISO 3915. Value at 1 min	
4.6	Electrical strength	$E_B 1$	kV/mm	IEC 60243-1	$\geq 60 \times \geq 60 \times 2$		Use 20 mm diameter spherical electrodes, Immerse in transformer oil in accordance with IEC 60296 Use a voltage rate of 2 kV/s	
4.7	Comparative tracking index		CTI	IEC 60112	$\geq 20 \times \geq 20 \times 4$		Use solution A	
5 Other properties								
5.1	Water absorption	w_w	%	ISO 62	Thickness ≥ 1 mm	M	Saturation value in water at 23 °C	
5.2		w_w					Saturation value in water at 100 °C	
5.3		w_H					Equilibrium value at 23 °C, 50 % RH	
5.4	Density	ρ	kg/m ³	ISO 1183-1 ISO 1183-3	Prepared from centre of multipurpose test specimen	M		

Table 3 — Additional properties and test conditions of particular utility to PEEK materials

No.	Property	Symbol	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation	Test conditions and supplementary instructions
1	Other properties						
1.1	Water content	w	%	ISO 15512	Moulding compound	—	
1.2	Melt viscosity	MV	Pa·s	ISO 11443	Moulding compound	—	Method A2 Test temperature 400 °C Shear rate 1 000 s ⁻¹ Capillary die L/D 16:1

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