

SLOVENSKI STANDARD
oSIST prEN ISO 21304-2:2019
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Polimerni materiali - Materiali na osnovi polietilena z ultra visoko molsko maso (PE-UHMW) za oblikovanje in ekstrudiranje - 2. del: Priprava preskušancev in ugotavljanje lastnosti (ISO/DIS 21304-2:2019)

Plastics - Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties (ISO/DIS 21304-2:2019)

Plastiques - Matériaux à base de polyéthylène à très haute masse moléculaire (PE-UHMW) pour moulage et extrusion - Partie 2: Préparation des éprouvettes et détermination des propriétés (ISO/DIS 21304-2:2019)

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Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials —

Part 2: Preparation of test specimens and determination of properties

Plastiques — Matériaux à base de polyéthylène à très haute masse moléculaire (PE-UHMW) pour moulage et extrusion —

Partie 2: Préparation des éprouvettes et détermination des propriétés

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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 shall 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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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

This first edition of ISO 21304-2 cancels and replaces ISO 11542-2:1998, which has been technically revised.

ISO 21304 consists of the following parts, under the general title *Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials*:

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

A list of all parts in the ISO 21304- series can be found on the ISO website.

Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials —

Part 2: Preparation of test specimens and determination of properties

1 Scope

This part of ISO 21304 specifies the methods of preparation of test specimens and the test methods to be used in determining the properties of PE-UHMW 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 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 PE-UHMW moulding and extrusion materials are listed.

The properties have been selected from the general test methods in ISO 10350-1. 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 21304, as are the designatory properties specified in ISO 21304-1.

In order to obtain reproducible and comparable test results, it is necessary to use the methods of 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 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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 293:2004, *Plastics — Compression moulding of test specimens of thermoplastic materials*

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*

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ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

ISO 899-1, *Plastics — Determination of creep behaviour — Part 1: Tensile creep*

ISO 1133-2, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 2: Method for materials sensitive to time-temperature history and/or moisture*

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 1628-3, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 3: Polyethylenes and polypropylenes*

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

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

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

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 15527:2010, *Plastics — Compression-moulded sheets of polyethylene (PE-UHMW, PE-HD) — Requirements and test methods*

ISO 20753, *Plastics — Test specimens*

ISO 21304-1, *Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

IEC 60112, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

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, *Specification for unused mineral insulating oils for transformers and switchgear*

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

IEC 62631-3-2, *Dielectric and resistive properties of solid insulating materials — Part 3-2: Determination of resistive properties (DC methods) — Surface resistance and surface resistivity*

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:

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

4 Preparation of test specimens

4.1 Treatment of the material before moulding

Before processing, no pretreatment of the material sample is normally necessary.

4.2 Compression moulding

Compression-moulded sheets shall be prepared in accordance with ISO 293 using the conditions specified in Table 1. The test specimens for the determination of the properties shall be machined from the compression-moulded sheets in accordance with ISO 2818 or stamped.

Table 1 — Compression-moulding conditions

Material	Moulding temperature °C	Average cooling rate °C/min	Demoulding temperature °C	Full pressure MPa	Full-pressure time min	Preheating pressure MPa	Preheating time min
All grades	210	15	≤40	10	30±1	5	5 to 15

A flash mould (see ISO 293:2004, Figure 1) may be used, but it is necessary to start cooling whilst simultaneously applying the full pressure. This avoids the melt being pressed out of the frame and also avoids sink marks.

For thicker sheet (≥ 4 mm), a positive mould (see ISO 293:2004, Figure 2) shall be used. The preheating time depends on the type of mould and the type of energy input (steam, electricity). For frame moulds, 5 min is usually sufficient but for positive moulds, due to the bigger mass, a preheating time of 5 min to 15 min can be necessary, especially if electric heating is used.

5 Conditioning of test specimens

Unfilled PE-UHMW test specimens shall be conditioned in accordance with ISO 291 for at least 40 h at $23\text{ °C} \pm 2\text{ °C}$, with no relative humidity requirement. Test specimens containing fillers and / or additives that are susceptible to moisture uptake shall be conditioned for at least 40 h at $23\text{ °C} \pm 2\text{ °C}$ and $50\% \pm 10\%$ relative humidity.

6 Determination of properties

In the determination of properties and the presentation of data, the standards, supplementary instructions and notes given in ISO 10350-1 shall be applied. Unless specifically stated in Table 2 and Table 3, testing of unfilled PE-UHMW test specimens shall be carried out at a standard temperature of $23\text{ °C} \pm 2\text{ °C}$ with no relative humidity requirement. Specimens made from materials containing fillers and / or additives that are susceptible to moisture uptake shall be tested in a standard atmosphere of $23\text{ °C} \pm 2\text{ °C}$ and $50\% \pm 10\%$ relative humidity.

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

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 PE-UHMW moulding and extrusion materials.

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

Property		Symbol	Standard	Specimen type (dimensions in mm)	Specimen Preparation ^a	Unit	Test conditions and supplementary in- structions		
1 Mechanical properties									
1.1	Tensile modulus	E_t	ISO 527-1 ISO 527-2 ISO 527-4	ISO 20753 Type A2	Q	MPa	Test speed 1 mm/min		
1.2	Yield stress	σ_y					Failure with yielding		
1.3	Yield strain	ε_y				%	Test speed 50 mm/min		
1.4	Nominal strain at break	ε_{tb}							
1.5	Stress at 50 % strain	σ_{50}				MPa	Failure without yielding		
1.6	Stress at break	σ_b					$\varepsilon_b \leq 10$ %: test speed 5 mm/min		
1.7	Strain at break	ε_b				%	$\varepsilon_b > 10$ %: test speed 50 mm/min		
1.8	Tensile creep modulus	E_{tc1}	ISO 899-1			MPa	At 1 h	Strain $\leq 0,5$ %	
1.9		E_{tc10^3}					At 1 000 h		
1.10	Flexural modulus	E_f	ISO 178	80 × 10 × 4		MPa	Test speed 2 mm/min		
1.11	Tensile-impact strength	α_{tl}	ISO 8256	80 × 10 × 4 Machined dou- ble V-notch, r = 1		kJ/m ²			
2 Thermal properties									
2.1	Melting temper- ature	T_m	ISO 11357-3	Powder	-	°C	Record peak melting temperature. Use 10 K/min heating/ cooling rate.		
2.2	Glass transition temperature	T_g	ISO 11357-2				Record midpoint tem- perature. Use 10 K/min heating/ cooling rate.		
2.3	Temperature of deflection under load	$T_f 1,8$	ISO 75-1	80 × 10 × 4	Q	°C	1,8 MPa	Use flatwise loading	
2.4		$T_f 0,45$	ISO 75-2				0,45 MPa		
2.5	Coefficient of linear thermal expansion	α_p	ISO 11359-2	Prepared from ISO 20753 type A2		°C ⁻¹	Paral- lel	Record the secant value over the tem- perature range	
2.6		α_n					Trans- verse		
^a Q = Compression moulding.									
^b Electrical properties are generally affected by the relative humidity. Therefore they shall be measured in a standard atmosphere of 23 °C± 2 °C and 50 % ± 10 % relative humidity.									

Table 2 (continued)

Property		Symbol	Standard	Specimen type (dimensions in mm)	Specimen Preparation ^a	Unit	Test conditions and supplementary instructions	
2.7	Flammability-Burning behaviour	B50/3	IEC 60695-11-10	125 × 13 × 3			Record one of the classifications V-0, V-1, V-2, HB, HB40 or HB75.	
2.8		B50/h		Additional thickness h				
2.9	Ignitability-Oxygen index	OI	ISO 4589-2	80 × 10 × 4		%	Use procedure A (top surface ignition).	
3 Electrical properties ^b								
3.1	Relative permittivity	ε _r 100	IEC 60250	≥ 60 × ≥ 60 × 2	Q	-	100 Hz	Compensate for electrode edge effects.
3.2		ε _r 1M					1 MHz	
3.3	Dissipation factor	tan δ 100				-	100 Hz	
3.4		tan δ 1M					1 MHz	
3.5	Volume resistivity	ρ _e	IEC 62631-3-2			Ω•m	Voltage 500 V	Measure value at 1 minute.
3.6	Surface resistivity	σ _e	IEC 62631-3-1			Ω		Use contacting line electrodes 1 mm to 2 mm wide, 50 mm long and 5 mm apart.
3.7	Electric strength	E _B 1	IEC 60243-1	≥ 60 × ≥ 60 × 1		kV/mm	Use 20 mm diameter spherical electrodes.	
3.8		E _B 2		≥ 60 × ≥ 60 × 2				
3.9	Comparative tracking index	CTI	IEC 60112	≥ 20 × ≥ 20 × 4		-	Use solution A.	
4 Other properties								
4.1	Water absorption	W _w	ISO 62	60 × 60 × 1	Q	%	Saturation value in water at 23 °C.	
4.2		W _H					Equilibrium value at 23 °C, 50 % RH.	
4.3	Density	ρ	ISO 1183-1 ISO 1183-2	10 × 10 × 4	Q	kg/m ³	Test specimen to be taken from moulded specimen.	
^a Q = Compression moulding.								
^b Electrical properties are generally affected by the relative humidity. Therefore they shall be measured in a standard atmosphere of 23 °C± 2 °C and 50 % ± 10 % relative humidity.								