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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

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*Plastics — 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*

<https://standards.iteh.ai/catalog/standards/sist/c28111c7-d497-449b-9848-3da43c1dcad1/iso-11542-2-1998>



## 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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11542-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

ISO 11542 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*

Annexes A and B form an integral part of this part of ISO 11542.

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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

### 1 Scope

This part of ISO 11542 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 11542, as are the designatory properties specified in part 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 standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11542. 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 11542 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 62:—1), *Plastics — Determination of water absorption.*

ISO 75-1:1993, *Plastics — Determination of temperature of deflection under load — Part 1: General test method.*

ISO 75-2:1993, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite.*

ISO 178:1993, *Plastics — Determination of flexural properties.*

1) To be published. (Revision of ISO 62:1980)

- ISO 179-1:—<sup>2)</sup>, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test.*
- ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing.*
- ISO 293:1986, *Plastics — Compression moulding test specimens of thermoplastic materials.*
- ISO 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles.*
- ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics.*
- ISO 527-4:1997, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastics composites.*
- ISO 899-1:1993, *Plastics — Determination of creep behaviour — Part 1: Tensile creep.*
- ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*
- ISO 1210/IEC 60695-11-10:—<sup>3)</sup>, *Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame (50 W) ignition source.*
- ISO 1628-3:1991, *Plastics — Determination of viscosity number and limiting viscosity number — Part 3: Polyethylenes and polypropylenes.*
- ISO 2818:1994, *Plastics — Preparation of test specimens by machining.*
- ISO 3146:—<sup>4)</sup>, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods.*
- ISO 3167:1993, *Plastics — Multipurpose test specimens.*
- ISO 4589-1:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 1: Guidance.*
- ISO 4589-2:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test.*
- ISO 8256:1990, *Plastics — Determination of tensile-impact strength.*
- ISO 10350:1993, *Plastics — Acquisition and presentation of comparable single-point data.*
- ISO 11542-1:1994, *Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*
- IEC 60093:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials.*
- IEC 60112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*
- IEC 60243-1:1998, *Electrical strength of insulating materials — Test methods — Part 1: Tests at power frequencies.*
- IEC 60250:1969, *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 60296:1982, *Specification for unused mineral insulating oils for transformers and switchgear.*

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<sup>2)</sup> To be published. (Revision of ISO 179:1993)

<sup>3)</sup> To be published. (Revision of ISO 1210:1992)

<sup>4)</sup> To be published. (Revision of ISO 3146:1985)

### 3 Preparation of test specimens

It is essential that specimens are always prepared by the same procedure using the same conditions. The test specimens shall be prepared by compression moulding.

#### 3.1 Treatment of the material before moulding

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

#### 3.2 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	5	5 to 15

A type 1 (frame) mould 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 avoids sink marks.

For thicker sheet ( $\approx 4$  mm), a type 2 (positive) mould has been found to work satisfactorily. 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.

### 4 Conditioning of test specimens

Test specimens shall be conditioned in accordance with ISO 291 for at least 40 h at  $23\text{ °C} \pm 2\text{ °C}$  and  $(50 \pm 5)\%$  relative humidity.

### 5 Determination of properties

In the determination of properties and the presentation of data, the standards, supplementary instructions and notes given in ISO 10350 shall be applied. All tests shall be carried out in the standard atmosphere of  $23\text{ °C} \pm 2\text{ °C}$  and  $(50 \pm 5)\%$  relative humidity unless specifically stated otherwise in the tables which follow.

Table 2 is compiled from ISO 10350, 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)

Property	Unit	Standard	Specimen type (dimensions in mm)	Test conditions and supplementary instructions
<b>Mechanical properties</b>				
Tensile modulus	MPa	ISO 527-1, ISO 527-2 ISO 527-4	See ISO 3167	Test speed 1 mm/min
Yield strain	%			Test speed 50 mm/min
Nominal strain at break	%			Test speed 50 mm/min
Stress at 50 % strain	MPa			Test speed 50 mm/min
Stress at break	MPa			Test speed 5 mm/min. Only to be quoted if strain at break is < 10 %
Strain at break	%			
Tensile creep modulus	MPa	ISO 899-1	See ISO 3167	At 1 h } Strain ≤ 0,5 % At 1 000 h }
Flexural modulus	MPa	ISO 178	80 × 10 × 4	Test speed 2 mm/min
Tensile notched impact strength	kJ/m <sup>2</sup>	ISO 8256	80 × 10 × 4 double V-notch, r = 1	
<b>Thermal properties</b>				
Melting temperature	°C	ISO 3146	Powder	Method C (DSC or DTA). Use 10 °C/min.
Temperature of deflection under load	°C	ISO 75-1, ISO 75-2	110 × 10 × 4 edgewise or 80 × 10 × 4 flatwise	0,45 MPa and 1,8 MPa
Coefficient of linear thermal expansion	°C <sup>-1</sup>	TMA (see ISO 10350)	Prepared from ISO 3167	Parallel } Quote the secant value over the Normal } temperature range 23 °C to 55 °C
Flammability	mm/min	ISO 1210	125 × 13 × 3	Method A — linear burning rate of horizontal specimens
Ignitability	%	ISO 4589-1, ISO 4589-2	80 × 10 × 4	Procedure A — top surface ignition
<b>Electrical properties</b>				
Relative permittivity	—	IEC 250	≥ 80 × ≥ 80 × 1	Frequency 100 Hz and 1 MHz (compensate for electrode edge effect)
Dissipation factor	—			
Volume resistivity	Ω·m	IEC 93	≥ 80 × ≥ 80 × 1	Voltage 100 V
Surface resistivity	Ω			
Electric strength	kV/mm	IEC 243-1	{ ≥ 80 × ≥ 80 × 1 ≥ 80 × ≥ 80 × 3	Use 25 mm/75 mm coaxial-cylinder electrode configuration. Immerse in IEC 296 transformer oil. Use short time (rapid rise) test
Comparative tracking index	—	IEC 112	≥ 15 × ≥ 15 × 4	Use solution A
<b>Other properties</b>				
Water absorption	%	ISO 62	50 × 50 × 3 or ∅ 50 × 3 disc	24 h immersion in water at 23 °C
Density	kg/m	ISO 1183	10 × 10 × 4	Test specimen to be taken from moulded specimen

Yield stress

MPa

Test speed 50 mm/min

**Table 3 — Additional properties and test conditions of particular utility to PE-UHMW moulding and extrusion materials**

Property	Unit	Standard	Specimen type (dimensions in mm)	Test conditions and supplementary instructions
<b>Mechanical properties</b>				
Elongation stress	MPa	ISO 179-1	120 × 15 × 10 double V-notch 14° ± 2°	See annex A
Charpy notched impact strength	kJ/m <sup>2</sup>			See annex B
<b>Other properties</b>				
Viscosity number	ml/g	ISO 1628-3	Powder	

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[ISO 11542-2:1998](https://standards.iteh.ai/catalog/standards/sist/e2811fc7-d497-449b-9848-3da43c1dcad1/iso-11542-2-1998)

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## Annex A (normative)

### 5) Method for determining the elongational stress of PE-UHMW moulding material

#### A.1 Scope

This annex specifies a method for the determination of the elongational stress as a characterization of the melt viscosity of PE-UHMW moulding powder.

NOTE The melt flow rate of this material cannot be determined by the method specified in ISO 1133 because of its extremely high molecular weight.

#### A.2 Definition

**A.2.1 elongational stress,  $F(150/10)$ :** The tensile stress (force divided by initial cross-sectional area) required to increase the measured length of a test specimen by 600 % at 150 °C over a 10 min period.

#### A.3 Apparatus (see figures A.1 and A.2)

Constant-temperature heating bath containing [ISO 11542-2:1998](https://standards.iteh.ai/catalog/standards/sist/e2811fc7-d497-449b-9848-3da43c1dcad1/iso-11542-2-1998)

- a mixer with motor (1)
- a heating coil (2)
- perforated plates (3), one fitted near the bottom of the bath, the other separating the mixer and the heating coil from the specimen
- a contact thermometer (4)
- a mercury-in-glass or equivalent thermometer (5), graduated in intervals of 0,5 °C, suitable for measuring temperatures within the range 150 °C ± 2 °C
- a stand (6) and clamps for supporting the specimen in its holder
- a specimen holder (7), in accordance with figure A.2, with arresting device (10)
- the test specimen (8)
- a set of weights (9), with hooks for suspension from the specimen holder such that the height of the weight, including its hook, is 41,5 mm in each case (for the masses of the weights, see table A.1)
- a heating-bath liquid (11)
- a stopwatch, accurate to 0,1 s
- measuring instruments, accurate to 0,02 mm, for measuring the width and thickness of the narrow parallel-sided section of the test specimen

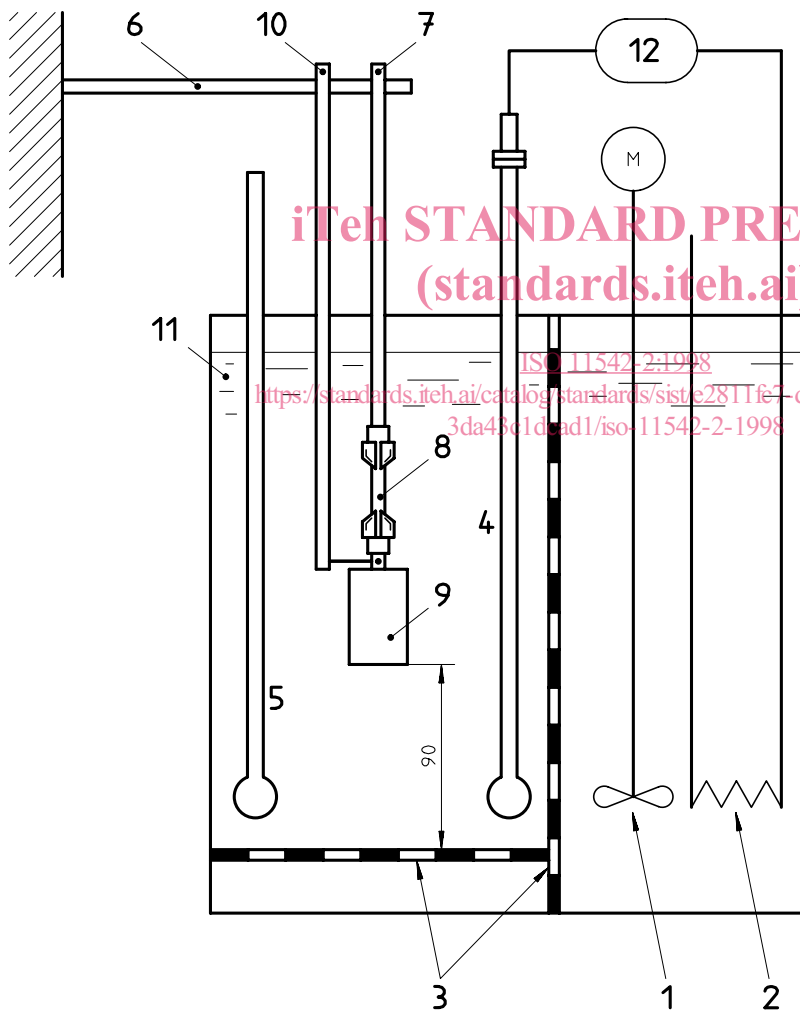
5) This property has been termed “flow value” in the past.



Table A.1 — Masses, in grams, of weights used to load specimen

100	120	150	180	200	250	300	350	400	500	600	700	800
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Dimensions in millimetres



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- Key**
- 1 Mixer with motor (M)
  - 2 Heating coil
  - 3 Perforated plates
  - 4 Contact thermometer
  - 5 Mercury-in-glass thermometer or equivalent
  - 6 Stand
  - 7 Specimen holder
  - 8 Test specimen
  - 9 Weight
  - 10 Arresting device
  - 11 Heating-bath liquid
  - 12 Temperature-control unit