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# Plastics — Polyketone (PK) moulding and extrusion materials —

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

*Plastiques — Polycétone (PK) 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 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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This document was prepared by Technical committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.



A list of all parts in the ISO 21970 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Plastics — Polyketone (PK) 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 standard test methods to be used in determining the properties of thermoplastic polyketone moulding and extrusion materials. Requirements for handling test material and/or conditioning both the test material before moulding and the specimens before testing are given.

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 document, as are the designatory properties specified in ISO 21970-1.

It is intended that the methods of preparation and conditioning, the specimen dimensions and the test procedures specified in this document be used in order to obtain reproducible and comparable test results. 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 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

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

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 527-1, *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*

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

ISO 3451-4, *Plastics — Determination of ash — Part 4: Polyamides*

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

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 4892-3, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

ISO 4892-4, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

ISO 6603-2, *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 2: Instrumented impact testing*

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 15512, *Plastics — Determination of water content*

ISO 20753, *Plastics — Test specimens*

ISO 21970-1:2018, *Plastics — Polyketone (PK) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

IEC 60112, *Methods 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: Test at power frequencies*

IEC 60296, *Specification for 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 to 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*

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 General

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

### 4.2 Treatment of the material before moulding

Before processing, the moisture content of the material sample shall not exceed 0,2 % 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 is below the limit.

### 4.3 Injection moulding



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

**Table 1 — Injection-moulding conditions**



| Material | | Moulding conditions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Designation code for composition[a] | Designation code for melting temperature | Filler content | Melt temperature | Mould temperature | Average injection velocity | Hold pressure | Hold pressure time | Total cycle time |
| | | % | °C | °C | mm/s | MPa | s | s |
| PK-EP | 210 | 0 to 50 | 235 | 80 | 100 ± 50 | 70 ± 10 | 15 ± 5 | ≤35 |
| | 220 | | 245 | | | | | |
| | 230 | | 255 | | | | | |
| | 240 | | 265 | | | | | |
| | 250 | | 275 | | | | | |

## 5 Conditioning of test specimens

After moulding, test specimens shall be conditioned in accordance with ISO 291 for 48 h at (23 ± 2) °C and (50 ± 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. All tests shall be carried out in the standard atmosphere of (23 ± 2) °C and (50 ± 10) % relative humidity unless specifically stated otherwise in Table 2 and Table 3.

Table 2 is compiled from ISO 10350-1, and the properties listed are those which are appropriate to polyketone 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 polyketone moulding and extrusion materials.

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

| Property | Unit | Standard | Specimen type (dimensions in mm) | Test conditions and supplementary instructions |
|---|---|---|---|---|
| **Rheological Properties** | | | | |
| Melt mass-flow rate | g/10 min | ISO 1133–1 | Moulding compound | Use one of the test temperatures and loads given in ISO 21970–1:2018, Table 4 |
| Melt volume-flow rate | $cm^3$/10 min | | | |
| **Mechanical properties** | | | | |
| Tensile modulus | MPa | ISO 527–1<br>ISO 527–2 | See ISO 20753 | Test speed 1 mm/min |
| Yield strength | MPa | | | Test speed 5 mm/min<br>Failure without yielding<br>If strain at break ≤ 10 % test speed 5 mm/min<br>If strain at break > 10 % test speed 50 mm/min |
| Yield strain | % | | | |
| Nominal strain at break | % | | | |
| Stress at 50 % strain | MPa | | | |
| Stress at break | MPa | | | |
| Strain at break | % | | | |
| Flexural modulus | MPa | ISO 178 | 80 × 10 × 4 | Test speed 2 mm/min |
| Flexural strength | MPa | | | |
| Charpy unnotched impact strength | $kJ/m^2$ | ISO 179–1 | 80 × 10 × 4 | Method 1eU (edgewise impact) |
| Charpy notched impact strength | $kJ/m^2$ | ISO 179–2 | 80 × 10 × 4<br>V-notch, $r$ = 0,25 | Method 1eA (edgewise impact) |
| **Thermal properties** | | | | |
| Glass transition temperature | °C | ISO 11357–2 | Moulding compound | Method A (DSC or DTA).<br>Last column: Use 10 K/min |
| Melting temperature | °C | ISO 11357–3 | Moulding compound | Use 10 K/min |
| Heat deflection temperature | °C | ISO 75–1<br>ISO 75–2 | 80 × 10 × 4 | 0,45 MPa and 1,8 MPa |
| Flammability | mm/min | IEC 60695–11–10 | 125 × 13 × 1,6 or other thickness | Method A – linear burning rate of horizontal specimens |
| | s | | | Method B (vertical)<br>a) afterflame time<br>b) afterglow time |
| **Electrical properties** | | | | |
| Relative permittivity | — | IEC 62631-2-1 | ≥ 80 × ≥ 80 × 1 | Frequency 100 Hz and 1 MHz (compensate for electrode edge effect) |
| Dissipation factor | — | | | |
| Volume resistivity | Ω·m | IEC 62631-3-1 | | Voltage 100 V |
| Surface resistivity | Ω | IEC 62631-3-2 | | |

**Table 2** *(continued)*

| Property | Unit | Standard | Specimen type (dimensions in mm) | Test conditions and supplementary instructions |
|---|---|---|---|---|
| Electric strength | kV/mm | IEC 60243–1 | ≥ 80 × ≥ 80 × 4 | Use 25 mm/75 mm coaxial-cylinder electrode configuration. Immerse in IEC 60296 transformer oil. Use short time (rapid rise) test. |
| Comparative tracking index | — | IEC 60112 | ≥ 15 × ≥ 15 × 4 | Use solution A |
| **Other properties** | | | | |
| Water absorption | % | ISO 62 | Thickness ≥ 1 mm | Saturation value in water at 23 °C |
| | | | | Saturation value at 23 °C and 50 % relative humidity |
| Density | kg/m$^3$ | ISO 1183–1<br>ISO 1183–2<br>ISO 1183–3 | Prepared from centre of ISO 20753 type A1 | Use part of centre of multipurpose specimen |

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



| Property | Unit | Standard | Specimen type (dimensions in mm) | Test conditions and supplementary instructions | |
|---|---|---|---|---|---|
| Water content | % | ISO 15512 | Moulding compound | | |
| Ash | % | ISO 3451–4 | Moulding compound | | |
| Puncture impact behaviour | N | ISO 6603–2 | 60 × 60 × 2 | Maximum force $F_M$ | Striker diameter 20 mm. Lubricate the striker. Clamp the specimen tightly enough to prevent any out-of-plane movement of its extremities. |
| | J | | | Puncture energy $W_P$ at 50 % decrease in force after the maximum | |
| Coefficient of linear thermal expansion | °C$^{-1}$ | ISO 11359–2 | 10 × 10 × 4 | Longitudinal and transverse. Record the secant value over the temperature range 23 °C to 55 °C | |
| Oxygen index at ambient temperature | | ISO 4589–2 | 80 × 10 × 4 | Procedure A – top surface ignition | |
| UV exposure test | — | ISO 4892–1 | 150 × 50 × 4 or a type/dimension agreed between the parties concerned | — | |
| | | ISO 4892–2 | | Method B<br>Cycle 1, 2, 3 or 4 | |
| | | ISO 4892–3 | | Method C | |
| | | ISO 4892–4 | | Spray cycle 1 or 2 | |