INTERNATIONAL STANDARD

**ISO 20029-2**

First edition
2017-11

# Plastics — Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion —

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

*Plastiques — Élastomères thermoplastiques à base de polyester/ester et polyéther/ester pour moulage et extrusion —*

*Partie 2: Préparation des éprouvettes et détermination des propriétés*

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Reference number
ISO 20029-2:2017(E)

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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 20029-2 cancels and replaces ISO 14910-2:2013, which has been technically revised.

A list of all parts in the ISO 20029 series can be found on the ISO website.

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# Introduction

The structure of thermoplastic elastomer material standards is based on the following considerations.

For each type of thermoplastic elastomer, reference is made to the relevant material standard.

Thermoplastic-elastomer materials are classified into three classes according to the primary elastomeric property, hardness, as shown in Figure 1 below. This classification on the basis of hardness reflects the special position of thermoplastic elastomers between rubber materials on the one hand and plastics on the other.

Each class is subdivided into standard properties and special properties. The classes have many standard properties and many special properties in common. Furthermore, a standard property in one class can be a special property in another class and vice versa.

Special properties are those properties which are in wide use or of particular significance in the practical characterization of a specific material.

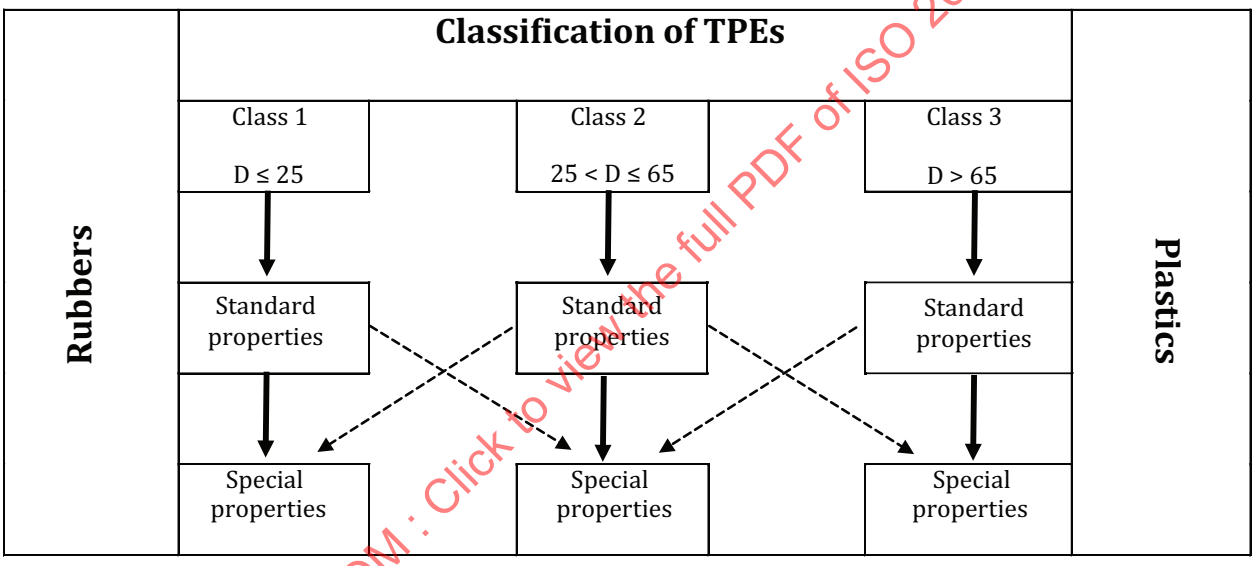


**Figure 1 — Classification of thermoplastic elastomers on the basis of their hardness**

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# Plastics — Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion —

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

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## 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 polyester/ester and polyether/ester elastomer 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.

Procedures and conditions for the preparation of test specimens in a specified state 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 thermoplastic polyester/ester and polyether/ester 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 document, as are the designatory properties specified in ISO 20029-1 (hardness, melting temperature and tensile/flexural modulus).

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

This document has been developed on the basis of ISO 10350-1, as at the moment, no standard exists for the acquisition and presentation of comparable single-point data for thermoplastic elastomers. After publication of this document and the analogous document for polyurethanes (ISO 16365-2), it is the intention to develop ISO 10350-3 for the acquisition and presentation of comparable single-point data for thermoplastic elastomers, based on this document and ISO 16365-2, as the basis for the development of thermoplastic-elastomer material standards.

## 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 34-1:2015, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

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*

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

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

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

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

ISO 815-1, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

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

ISO 974, *Plastics — Determination of the brittleness temperature by impact*

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

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

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

ISO 11357-4, *Plastics — Differential scanning calorimetry (DSC) — Part 4: Determination of specific heat capacity*

ISO 11359-2:1999, *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 20029-1, *Plastics — Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion — Part 1: Designation system and basis for specification*

ISO 20753, *Plastics — Test specimen*

ISO 22007-2, *Plastics — Determination of thermal conductivity and thermal diffusivity — Part: Transient plane heat source (hot disc) method*

ISO 22007-3, *Plastics — Determination of thermal conductivity and thermal diffusivity — Part 3: Temperature wave analysis method*

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ISO 22007-4, *Plastics — Determination of thermal conductivity and thermal diffusivity — Part 4: Laser flash method*

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

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

IEC 60243-1, *Electric 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 60695-11-10, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

ASTM E96, *Standard Test Methods for Water Vapor Transmission of Materials*

## 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 http://www.iso.org/obp

## 4 Preparation of test specimens

### 4.1 Treatment of the material before moulding

Before processing, the material sample shall have reached room temperature and the moisture content of the material sample shall not exceed 0,05 % (by mass).

The material shall be dried as specified in Table 1, preferably using a vacuum oven with a dry $N_2$ purge and a maximum pressure of 0,01 MPa.

**Table 1 — Drying conditions**

| Dryer type | Temperature |
|---|---|
| Vacuum oven with $N_2$ purge; $p \leq 0{,}01$ MPa | 80 °C to 135 °C |
| Vacuum oven | 80 °C to 120 °C |
| Desiccant dryer, pre-dried-air dryer | 80 °C to 120 °C |
| Hot-air oven | 80 °C to 135 °C |

Drying at temperatures higher than those in Table 1 might change the molecular mass and hence, the properties of the material. The drying temperature recommended by the supplier should preferably be used.

The moisture content of filled or reinforced materials shall be expressed as a percentage of the total mass of the compound. The moisture content shall be determined in accordance with ISO 15512.

To ensure that the moisture content remains low, it is recommended that the sample material in the feed hopper of the injection-moulding machine be blanketed with a suitable gas (dried air, nitrogen or argon, for example). Better results might be obtained using a dehumidifier hopper drier.

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### 4.2 Injection moulding

Injection-moulded specimens shall be prepared in accordance with ISO 294-1, using the conditions specified in Table 2. The moulding conditions recommended by the supplier should preferably be used. The specimens shall be prepared by injection moulding from dry granules. It is essential that specimens are always prepared by the same procedure using the same processing conditions. The material shall be kept in moisture-proof containers until it is required for use.

**Table 2 — Conditions for injection moulding of test specimens**

| Mould temperature | Melt temperature | Nozzle temperature | Heating-zone temperature | | |
|---|---|---|---|---|---|
| | | | Front | Centre | Rear |
| °C | °C | °C | °C | °C | °C |
| 20 to 50 | Melting temperature + 30 °C | 230 to 250 | 200 to 240 | 200 to 240 | 200 to 240 |
| Injection pressure: 10 MPa to 100 MPa, holding pressure: 10 MPa to 100 MPa, back pressure 0,5 MPa to 2 MPa, injection velocity: 100 mm/s to 300 mm/s. | | | | | |

## 5 Conditioning of test specimens

Test specimens for the determination of mechanical properties, electrical properties and density shall be conditioned for at least 16 h at (23 ± 2) °C and (50 ± 10) % relative humidity.

## 6 Determination of properties

### 6.1 General

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 in this document. Values determined will not necessarily be identical to those obtained using specimens of different dimensions or prepared using different procedures.

For all ISO test methods applied in this document (see Tables 3 to 9), which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of the test specimen, ISO 20753 shall be used instead.

All tests shall be carried out in the standard atmosphere of (23 ± 2) °C and (50 ± 10) % relative humidity unless specifically stated otherwise in Tables 4 to 9.

Table 3 is compiled from ISO 10350-1 (see Clause 1) and gives an overview of the standard properties and special properties which are appropriate to thermoplastic polyester/ester and polyether/ester moulding and extrusion materials. These properties are those considered useful for comparisons of data generated for different thermoplastic elastomers.

Tables 4, 6 and 8 contain those properties that are considered to be standard properties for the relevant hardness class. Tables 5, 7 and 9 contain those properties that are considered to be special properties for the relevant hardness class, i.e. in wide use and/or of particular significance in the practical characterization of thermoplastic polyester/ester and polyether/ester moulding and extrusion materials.

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**Table 3 — Overview of standard properties and special properties for the characterization of thermoplastic polyester/ester and polyether/ester materials**

| Properties | Test method | Shore D ≤ 25 | | 25 < Shore D ≤ 65 | | Shore D > 65 | |
|---|---|---|---|---|---|---|---|
| Rheological properties | | Standard | Special | Standard | Special | Standard | Special |
| Melt mass-flow rate/melt volume-flow rate | ISO 1133-2 | X | | X | | X | |
| Mechanical properties | | Standard | Special | Standard | Special | Standard | Special |
| Hardness, Shore D | ISO 868 | X | | X | | X | |
| Tensile modulus | ISO 527-2 | X | | X | | X | |
| Tensile stress[a] | | | | | | | |
| at 5 % and 10 % strain | | | | | X | X | X |
| at > 50 % strain | | | X | | X | | X |
| Stress at break[a] | | X | X | X | X | X | X |
| Yield stress[a] | | | X | | X | X | X |
| Strain at break[a] | | | X | X | X | X | X |
| Nominal strain at break | | X | X | | X | | X |
| Strain at yield[a] | | | X | | X | | X |
| Tensile creep modulus | ISO 899-1 | | X | | X | | X |
| Flexural modulus | ISO 178 | | X | | X | X | |
| Tensile impact strength[a] | ISO 8256 | X | X | | X | | |
| Charpy unnotched impact strength | ISO 179-1 or ISO 179-2 | | X | | X | X | |
| Charpy notched impact strength[a] | | | X | X | X | X | |
| Brittleness temperature | ISO 974 | X | | | X | | X |
| Tear strength | ISO 34-1:2015, method B, procedure (a) | X | | X | | | X |
| Compression set | ISO 815-1 | X | | | X | | X |
| Thermal properties | | Standard | Special | Standard | Special | Standard | Special |
| Specific heat capacity | ISO 11357-4 | | X | | X | | X |
| Thermal conductivity | ISO 22007-2, ISO 22007-3 or ISO 22007-4 | | X | | X | | X |
| Melting temperature | ISO 11357-3 | X | | X | | X | |
| Deflection of temperature under load | ISO 75-2 | | | | X | X | |
| Coefficient of linear thermal expansion[a] | ISO 11359-2:1999, method A | X | X | X | X | X | X |
| Vicat softening temperature | ISO 306 | | | | X | X | |
| Oxygen index | ISO 4589-2 | | X | | X | | X |
| Burning behaviour | IEC 60695-11-10 | | X | | X | | X |
| Electrical properties | | Standard | Special | Standard | Special | Standard | Special |
| Relative permittivity | IEC 60250 | | X | | X | | X |
| Dissipation factor tan $\delta$ | IEC 60250 | | X | | X | | X |
| Volume resistivity | IEC 60093 | | X | | X | | X |
| Surface resistivity $\sigma_e$ | IEC 60093 | | X | | X | | X |
| Dielectrical strength | IEC 60243-1 | | X | | X | | X |
| Comparative tracking index (CTI) | IEC 60112 | | X | | X | | X |

[a] Both 'Standard' and 'Special' property as a result of different test conditions.

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**Table 3** *(continued)*

| Properties | Test method | Shore D ≤ 25 | | 25 < Shore D ≤ 65 | | Shore D > 65 | |
|---|---|---|---|---|---|---|---|
| Other | | Standard | Special | Standard | Special | Standard | Special |
| Density | ISO 1183-1, ISO 1183-2 or ISO 1183-3 | X | | X | | X | |
| Water absorption | ISO 62 | X | | X | | X | |
| Mould shrinkage | ISO 294-4, ISO 20753 | X | | X | | X | |
| Water vapour transmission | ASTM E96 | | X | | X | | X |
| Moisture content | ISO 15512 | | X | | X | | X |

[a] Both 'Standard' and 'Special' property as a result of different test conditions.

## 6.2 Shore D hardness ≤ 25

### 6.2.1 Standard properties and test conditions

**Table 4 — Standard properties and test conditions — Shore D hardness ≤ 25**

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions | |
|---|---|---|---|---|---|---|
| **Rheological properties** | | | | | | |
| MVR or MFR | $cm^3$/10 min or g/10 min | ISO 1133-2 | Moulding compound | Dried | Load 2,16 kg, 5 kg or 10 kg | |
| | | | | | Melting temperature | Test temperature |
| | | | | | ≤ 175 °C | 190 °C |
| | | | | | > 175 °C but ≤ 210 °C | 230 °C |
| | | | | | > 210 °C, Blow moulding materials | 250 °C |
| **Mechanical properties** | | | | | | |
| Hardness | Shore D units | ISO 868 | ≥ 80 × ≥ 10 × ≥ 12 | M | Shore D - 15 s<br>Five measurements ≥ 9 mm from any edge, ≥ 6 mm apart. Specimens may be stacked to obtain minimum thickness of 12 mm | |
| Tensile modulus | MPa | ISO 527-2 | ISO 20753 type A12 | M | 1 mm/min | |
| Stress at break[c] | MPa | | ISO 20753 type A12 or ISO 37 type 2 | | 500 mm/min | |
| Nominal strain at break[c] | % | | | | 500 mm/min | |
| Tensile impact strength | $kJ/m^2$ | ISO 8256 | 80 × 10 × 4 Machined double V-notch $r$ = 1 | M | Only to be quoted if fracture cannot be obtained with notched Charpy test | |
| Brittleness temperature | °C | ISO 974 | 20 × 0,25, 2,5 × 0,05, or 2,0 × 0,1 | M | | |
| Tear strength | kN/m | ISO 34-1:2015, method B, procedure (a) | Angle test piece, 2 mm thick | M | Test speed 500 mm/min | |
| Compression set | % | ISO 815-1 | Ø 13 × 6 | M | 23 °C for 72 h and 70 °C for 24 h | |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 4** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| **Thermal properties** | | | | | |
| Melting temperature | °C | ISO 11357-3 | Moulding compound | M | Record peak melting temperature<br>Use 10 °C/min |
| Coefficient of linear thermal expansion | $°C^{-1}$ | ISO 11359-2:1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal<br>Determine the secant value over the temperature range 23 °C to 55 °C |
| **Other properties** | | | | | |
| Density | $kg/m^3$ | ISO 1183-1, ISO 1183-2 or ISO 1183-3 | ISO 20753, prepared from the centre part type A12 | M | |
| Water absorption | % | ISO 62 | 60 × 60 × 1 | M | Saturation value in water at 23 °C |
| Mould shrinkage | % | ISO 294-4, ISO 20753 | 60 × 60 × 2 | M | |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

### 6.2.2 Special properties and test conditions

**Table 5 — Special properties and test conditions — Shore D hardness ≤ 25**

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| **Mechanical properties** | | | | | |
| Stress at break[c] | MPa | ISO 527-2 | ISO 37 type 1 or type 1A | M | 500 mm/min |
| Nominal strain at break[c] | % | | | | 500 mm/min |
| Tensile stress at > 50 % elongation[c] | MPa | ISO 527-2 | ISO 20753 type A12, ISO 37 type 1, 1A or 2 | M | 300 % elongation at 500 mm/min |
| Yield stress[c] | MPa | | | | 500 mm/min |
| Strain at break[c] | % | | | | 500 mm/min |
| Strain at yield[c] | % | | | | 500 mm/min |
| Tensile creep modulus | % | ISO 899-1 | ISO 20753 type A12 | M | 1 h, 1 000 h |
| Flexural modulus | MPa | ISO 178 | 80 × 10 × 4 | M | 23 °C and −40 °C or 23 °C and 100 °C at 2 mm/min |
| Charpy unnotched impact strength | $kJ/m^2$ | ISO 179-1 or ISO 179–2 | 80 × 10 × 4 | M | Method 1eU, edgewise impact −30 °C or −40 °C<br>Also record type failure |
| Charpy notched impact strength | $kJ/m^2$ | | 80 × 10 × 4 machined V-notch $r$ = 1 | M | Method 1eA, edgewise impact −30 °C, −40 °C<br>Also record type failure |
| **Thermal properties** | | | | | |
| Specific heat capacity | $J\ K^{-1}$ | ISO 11357-4 | Moulding compound | | |
| Thermal conductivity | W/m.K | ISO 22007-2, ISO 22007-3 or ISO 22007-4 | As per relevant part of ISO 22007 | M | |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 5** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| Coefficient of linear thermal expansion −40 °C to 23 °C | °C$^{-1}$ | ISO 11359-2:1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal |
| Coefficient of linear thermal expansion 55 °C to *T* °C | °C$^{-1}$ | ISO 11359-2:1999, method A | ISO 20753, prepared from type A1 | M | Transverse, and longitudinal end temperature *T* in accordance with manufacturer's instructions |
| Oxygen index | % | ISO 4589-2 | 80 × 10 × 4 | M | Use procedure A (top surface ignition) |
| Burning behaviour | | IEC 60695-11-10 | 125 × 13 × *d* | M | *d* = 1,5 mm or 3 mm |
| **Electrical properties** | | | | | |
| Relative permittivity | | IEC 60250 | ≥ 60 × ≥ 60 × 2 | M | Frequency 100 Hz and 1 MHz (compensate for electrode edge effects) |
| Dissipation factor | | | | | |
| Volume resistivity | Ω m | IEC 60093 | | M | |
| Surface resistivity | Ω | | | | |
| Dielectrical strength | kV/mm | IEC 60243-1 | ≥ 60 × ≥ 60 × 1 | M | |
| Comparative tracking index (CTI) | V | IEC 60112 | ≥ 20 × ≥ 20 × 4 | M | |
| **Other properties** | | | | | |
| Water vapour transmission | g/m$^2$ h | ASTM E96 | As specified in ASTM E96 | | |
| Moisture content | % | ISO 15512 | Moulding compound | | Coulometric method |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

## 6.3 25 < Shore D hardness ≤ 65

### 6.3.1 Standard properties and test conditions

**Table 6 — Standard properties and test conditions — 25 < Shore D hardness ≤ 65**

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary conditions | |
|---|---|---|---|---|---|---|
| **Rheological properties** | | | | | | |
| MVR or MFR | cm$^3$/10 min or g/10 min | ISO 1133-2 | Moulding compound | Dried | Load 2,16 kg, 5 kg or 10 kg | |
| | | | | | Melting temperature | Test temperature |
| | | | | | ≤ 175 °C | 190 °C |
| | | | | | > 175 °C but ≤ 210 °C | 230 °C |
| | | | | | > 210 °C, blow moulding materials | 250 °C |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 6** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary conditions |
|---|---|---|---|---|---|
| **Mechanical properties** | | | | | |
| Hardness | Shore D units | ISO 868 | ≥ 80 × ≥ 10 × ≥ 6 | M | Shore D - 15s<br>Five measurements ≥ 9 mm from any edge, ≥ 6mm apart. Specimens may be stacked to obtain minimum thickness |
| Tensile modulus | MPa | ISO 527-2 | ISO 20753 type A12 | M | 1 mm/min |
| Stress at break[c] | MPa | | ISO 20753 type A12 or ISO 37 type 2 | | 500 mm/min |
| Strain at break[c] | % | | | | 500 mm/min |
| Charpy notched impact strength | kJ/m$^2$ | ISO 179-1 or ISO 179-2 | 80 × 10 × 4 machined V-notch $r$ = 1 | M | Method 1eA, edgewise impact −40 °C. Also record type failure<br>If fracture cannot be obtained, use ISO 8256 tensile impact |
| Tear strength | kN/m | ISO 34-1:2015, method B, procedure (a) | Angle test piece, 2 mm thick | M | Test speed 500 mm/min |
| **Thermal properties** | | | | | |
| Melting temperature | °C | ISO 11357-3 | Moulding compound | | Record peak melting temperature<br>Use 10 °C/min |
| Coefficient of linear thermal expansion | °C$^{-1}$ | ISO 11359-2: 1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal<br>Determine the secant value over the temperature range 23 °C to 55 °C |
| **Other properties** | | | | | |
| Density | g/cm$^3$ | ISO 1183-1, ISO 1183-2 or ISO 1183-3 | ISO 20753, prepared from type A12 | M | |
| Water absorption | % | ISO 62 | 60 × 60 × 1 | M | Saturation value in water at 23 °C |
| Mould shrinkage | % | ISO 294-4, ISO 20753 | 60 × 60 × 2 | M | |

a For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

b M = injection moulding.

c From 60 % strain onwards, switch to nominal strain, see Annex A.

### 6.3.2 Special properties and test conditions

**Table 7 — Special properties and test conditions — 25 < Shore D hardness ≤ 65**

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| **Mechanical properties** | | | | | |
| Stress at break[c] | MPa | ISO 527-2 | ISO 37 type 1 or 1A | M | 500 mm/min |
| Strain at break[c] | % | | | | 500 mm/min |
| Tensile stress at 5 % and 10 % elongation[c] | MPa | ISO 527-2 | ISO 20753 type A12, ISO 37 type 1, 1A or 2 | M | 500 mm/min |

a For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

b M = injection moulding.

c From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 7** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| Tensile stress at > 50 % elongation[c] | MPa | | | | 200 % or 300 % elongation at 500 mm/min |
| Nominal strain at break | % | | | | 500 mm/min |
| Yield stress[c] | MPa | | | | 500 mm/min |
| Strain at yield[c] | % | | | | 500 mm/min |
| Tensile creep modulus | MPa | ISO 899-1 | ISO 20753 type A12 | M | 1 h, 1 000 h |
| Flexural modulus | MPa | ISO 178 | 80 × 10 × 4 | M | 23 °C and −40 °C or 23 °C and 100 °C |
| Tensile-impact strength | kJ/m² | ISO 8256 | 80 × 10 × 4 Machined double V-notch r = 1 | M | Only to be quoted if fracture cannot be obtained with notched Charpy test |
| Charpy unnotched impact strength | kJ/m² | ISO 179-1 or ISO 179-2 | 80 × 10 × 4 | M | Method 1eU edgewise impact, −30 °C Also record type failure |
| Charpy notched impact strength | kJ/m² | | 80 × 10 × 4 machined V-notch r = 1 | M | Method 1eA edgewise impact, −30 °C Also record type failure |
| Brittleness temperature | °C | ISO 974 | 20 × 0,25, 2,50 × 0,05, 2,0 × 0,1 | M | |
| Compression set | % | ISO 815-1 | Ø 13 × 6 | M | 23 °C for 72 h, 70 °C for 24 h |
| **Thermal properties** | | | | | |
| Specific heat capacity | J K$^{-1}$ | ISO 11357-4 | Moulding compound | | |
| Thermal conductivity | W/m.K | ISO 22007-2, ISO 22007-3 or ISO 22007-4 | As per relevant part of ISO 22007 | M | |
| Temperature of heat deflection under load | °C | ISO 75-2 | 80 × 10 × 4 | M | 0,45 MPa |
| Coefficient of linear thermal expansion from −40 °C to 23 °C | °C$^{-1}$ | ISO 11359-2:1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal |
| Coefficient of linear thermal expansion from 55 °C to $T$ °C | °C$^{-1}$ | ISO 11359-2:1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal end temperature $T$ in accordance with manufacturer's instructions |
| Vicat softening temperature | °C | ISO 306 | 10 × 10 × > 3 | M | |
| Oxygen index | % | ISO 4589-2 | 80 × 10 × 4 | M | Use procedure A (top surface iginition) |
| Burning behaviour | | IEC 60695-11-10 | 125 × 13 × $d$ | M | $d$ = 1,5 mm or 3,0 mm |
| **Electrical properties** | | | | | |
| Relative permittivity | | IEC 60250 | ≥ 60 × ≥ 60 × 2 | M | Frequency 100 Hz and 1 MHz (compensate for electrode edge effects) |
| Dissipation factor | | | | | |
| Volume resistivity | Ω m | IEC 60093 | | M | |
| Surface resistivity | Ω | | | | |
| Dielectrical strength | kV/mm | IEC 60243-1 | ≥ 60 × ≥ 60 × 1 | M | |
| Comparative tracking index (CTI) | V | IEC 60112 | ≥ 20 × ≥ 20 × 4 | M | |

a For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

b M = injection moulding.

c From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 7** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| **Other properties** | | | | | |
| Moisture content | % | ISO 15512 | Moulding compound | M | Coulometric method |
| Water vapour transmission | g/m² h | ASTM E96 | As specified in ASTM E96 | | |

a For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

b M = injection moulding.

c From 60 % strain onwards, switch to nominal strain, see Annex A.

## 6.4 Shore D hardness > 65

### 6.4.1 Standard properties and test conditions

**Table 8 — Standard properties and test conditions — Shore D hardness > 65**

| Property | Unit | Standard[a] | Specimen type[a] | Specimen preparation[b] | Test conditions and supplementary conditions | |
|---|---|---|---|---|---|---|
| **Rheological properties** | | | | | | |
| MVR or MFR | cm³/10 min or g/10 min | ISO 1133-2 | Moulding compound | Dried | Load 2,16 kg, 5 kg or 10 kg | |
| | | | | | Melting temperature | Test temperature |
| | | | | | ≤ 175 °C | 190 °C |
| | | | | | > 175 °C but ≤ 210 °C | 230 °C |
| | | | | | > 210 °C, blow moulding materials | 250 °C |
| **Mechanical properties** | | | | | | |
| Hardness | Shore D | ISO 868 | ≥ 80 × ≥ 10 × ≥ 6 | M | Shore D - 15s<br>Five measurements ≥ 9 mm from any edge, ≥ 6mm apart. Specimens may be stacked to obtain minimum thickness. | |
| Tensile modulus | MPa | ISO 527-2 | ISO 20753 type A12 | M | 1 mm/min | |
| Tensile stress at 5 % and 10 % elongation[c] | MPa | | ISO 20753 type A12 or ISO 37 type 2 | | 500 mm/min | |
| Stress at break[c] | MPa | | | | 500 mm/min | |
| Yield stress[c] | MPa | | | | 500 mm/min | |
| Strain at break[c] | % | | | | 500 mm/min | |
| Flexural modulus | MPa | ISO 178 | 80 × 10 × 4 | M | 23 °C and −40 °C or 23 °C and 100 °C at 2 mm/min | |
| Charpy unnotched impact strength | kJ/m² | ISO 179-1 or ISO 179-2 | 80 × 10 × 4 | M | Method 1eU, edgewise impact −40 °C. Also record type failure. | |
| Charpy notched impact strength | kJ/m² | | 80 × 10 × 4 machined V-notch $r$ = 1 | M | Method 1eA, edgewise impact −40 °C. Also record type failure.<br>If fracture cannot be obtained use ISO 8256 tensile impact | |

a For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

b M = injection moulding.

c From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 8** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] | Specimen preparation[b] | Test conditions and supplementary conditions |
|---|---|---|---|---|---|
| **Thermal properties** | | | | | |
| Melting temperature | °C | ISO 11357-3 | Moulding compound | M | Record peak melting temperature<br>Use 10 °C/min |
| Temperature of deflection under load | °C | ISO 75-2 | 80 × 10 × 4 | M | 0,45 MPa |
| Coefficient of linear thermal expansion | $°C^{-1}$ | ISO 11359-2:1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal<br>Determine the secant value over the temperature range 23 °C to 55 °C |
| Vicat softening temperature | °C | ISO 306 | 10 × 10 × > 3 | M | |
| **Other properties** | | | | | |
| Density | $g/cm^3$ | ISO 1183-1, ISO 1183-2 or ISO 1183-3 | ISO 20753, prepared from type A12 | M | |
| Water absorption | % | ISO 62 | 60 × 60 × 1 | M | Saturation value in water at 23 °C |
| Mould shrinkage | % | ISO 294-4, ISO 20753 | 60 × 60 × 2 | M | |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

### 6.4.2 Special properties and test conditions

**Table 9 — Special properties and test conditions conditions — Shore D hardness > 65**

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| **Mechanical properties** | | | | | |
| Tensile stress at 5 % and 10 % elongation[c] | MPa | ISO 527-2 | ISO 37 type 1 or 1A | M | 500 mm/min |
| Stress at break[c] | MPa | | | | 500 mm/min |
| Yield stress[c] | MPa | | | | 500 mm/min |
| Strain at break[c] | % | | | | 500 mm/min |
| Tensile stress at 200 % elongation | MPa | ISO 527-2 | ISO 20753 type A12 or ISO 37 type 1, 1A or 2 | M | 500 mm/min |
| Nominal strain at break[c] | % | | | | 500 mm/min |
| Strain at yield[c] | % | | | | 500 mm/min |
| Tensile creep modulus | MPa | ISO 899-1 | ISO 20753 type A12 or ISO 37 type 1, 1A or 2 | M | 1 h, 1 000 h |
| Brittleness temperature | °C | ISO 974 | 20 × 0,25, 2,50 × 0,05, 2,0 × 0,1 | M | |
| Tear strength | kN/m | ISO 34-1:2015, method B, procedure (a) | Angle test piece, 2 mm thick | M | Test speed 500 mm/min |
| Compression set | % | ISO 815-1 | Ø 13 × 6 | M | 23 °C for 72 h, 70 °C for 24 h |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

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**Table 9** *(continued)*

| Property | Unit | Standard[a] | Specimen type[a] (dimensions in mm) | Specimen preparation[b] | Test conditions and supplementary instructions |
|---|---|---|---|---|---|
| **Thermal properties** | | | | | |
| Specific heat capacity | J $K^{-1}$ | ISO 11357-4 | Moulding compound | M | |
| Thermal conductivity | W/m.K | ISO 22007-2, ISO 22007-3 or ISO 22007-4 | As per relevant part of ISO 22007 | M | |
| Coefficient of linear thermal expansion from −40 °C to 23 °C | $°C^{-1}$ | ISO 11359-2: 1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal |
| Coefficient of linear thermal expansion from 55 °C to *T* °C | $°C^{-1}$ | ISO 11359-2: 1999, method A | ISO 20753, prepared from type A1 | M | Transverse and longitudinal end temperature *T* in accordance with manufacturer's instructions |
| Oxygen index | % | ISO 4589-2 | 80 × 10 × 4 | M | Use procedure A (top surface iginition) |
| Burning behaviour | | IEC 60695-11-10 | 125 × 13 × *d* | M | *d* = 1,5 mm or 3,0 mm |
| **Electrical properties** | | | | | |
| Relative permittivity | | IEC 60250 | ≥ 60 × ≥ 60 × 2 | M | Frequency 100 Hz and 1 MHz (compensate for electrode effects) |
| Dissipation factor | | | | | |
| Volume resistivity | Ω cm | IEC 60093 | | M | |
| Surface resistivity | Ω | | | | |
| Dielectrical strength | kV/mm | IEC 60243-1 | ≥ 60 × ≥ 60 × 1 | M | |
| Comparative tracking index (CTI) | V | IEC 60112 | ≥ 20 × ≥ 20 × 4 | M | |
| **Other properties** | | | | | |
| Water vapour transmission | g/$m^2$ h | ASTM E96 | As specified in ASTM E96 | | |
| Moisture content | % | ISO 15512 | Moulding compound | | Coulometric method |

[a] For all test methods which refer to the ISO 294 series and/or ISO 3167 for the designation and dimensions of test specimen, ISO 20753 shall be used.

[b] M = injection moulding.

[c] From 60 % strain onwards, switch to nominal strain, see Annex A.

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