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# Plastics — Thermoplastic polyurethanes for moulding and extrusion —

## Part 1: Designation system and basis for specifications

*Plastiques — Polyuréthannes thermoplastiques pour moulage et extrusion —*

*Partie 1: Système de désignation et base de spécification*



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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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

ISO 16365 consists of the following parts, under the general title *Plastics — Thermoplastic polyurethanes for moulding and extrusion*:

— *Part 1: Designation system and basis for specifications*

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

— *Part 3: Distinction between ether and ester polyurethanes by determination of the ester group content*



 

# Plastics — Thermoplastic polyurethanes for moulding and extrusion —

# Part 1: Designation system and basis for specifications

## 1 Scope

This part of ISO 16365 establishes a system of designation for thermoplastic polyurethane elastomers, which is based on ISO 1043 (all parts) and ISO 11469.

The designation system may be used as the basis for specifications.

The designation system is applicable to all thermoplastic polyurethane elastomers. It applies to materials ready for normal use in the form of powder, granules or pellets, unmodified or modified by colourants, fillers or other additives, etc.

The types of thermoplastic polyurethane are differentiated from each other by a classification system based on appropriate levels of the designatory properties:

a) hardness;

b) tensile modulus of elasticity (optional);

and on information about the alternating hard and soft segments in the main chain, the intended application and/or method of processing, important properties, additives, colour, fillers, and reinforcing materials.

It is not intended to imply that materials having the same designation give necessarily the same performance. This part of ISO 16365 does not provide engineering data, performance data, or data on processing conditions which may be required to specify a material for a particular application and/or method of processing. If such additional properties are required, it is intended that they be determined in accordance with the test methods specified in ISO 16365-2, if suitable.

In order to specify a thermoplastic elastomer for a particular application or reproducible processing, additional requirements are intented to be given in data block 5 (see 3.1 and 3.6).

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 527 (all parts), *Plastics — Determination of tensile properties*

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

ISO 1043-4, *Plastics — Symbols and abbreviated terms — Part 4: Flame retardants*

ISO 11469, *Plastics — Generic identification and marking of plastics products*

ISO 18064, *Thermoplastic elastomers — Nomenclature and abbreviated terms*

ISO 16365-2, *Plastics — Thermoplastic polyurethanes for moulding and extrusion — Part 2: Preparation of test specimens and determination of properties*

# 3 Designation system

## 3.1 General

The designation system for polyurethanes is based on the following standardized pattern (Figure 1).

| Designation | | | | | | |
|---|---|---|---|---|---|---|
| | Identity Block | | | | | |
| Description block (optional) | International Standard Block | Individual Item Block | | | | |
| | | Data Block 1 | Data Block 2 | Data Block 3 | Data Block 4 | Data Block 5 |

**Figure 1 — Data block designation system**

The designation consists of an optional description block, reading "Thermoplastics", and an identity block comprising the International Standard number and an individual item block. For unambiguous designation, the individual item block is subdivided into five data blocks comprising the following information.

— Data block 1: Identification of the thermoplastic polyurethane by its abbreviated symbol (TPU), in accordance with ISO 18064, and optional information on the alternating hard and soft segments in the main chain (see 3.2).

— Data block 2: Fillers or reinforcing materials including summarized nominal content (3.3):

  — important properties, modifier, and flame retardant (3.3);

  — declaration of recyclate: R followed by a number representing the percentage by mass of recyclate (3.3).

— Data block 3: Application and processing:

  — Position 1: method of processing (3.4);

  — Positions 2 and further: additives, supplementary information and other characteristics (3.4).

— Data block 4: Designatory properties (3.5):

  — hardness;

  — modulus.

— Data block 5: For the purpose of specifications, a fifth data block containing additional information may be used (see 3.6). The kind of information and the code-letters used are not the subject of this part of ISO 16365.

The first character of the individual item block shall be a hyphen.

The five data blocks shall be separated from each other by a comma.

If a data block is not used, this shall be indicated by doubling the separation sign, i.e. by two commas (,,).

Terminal commas may be omitted.



 

For part marking the first two data blocks of the designation are used, connected with a hyphen, and placed between the punctuation marks '>' and '<', where no spaces are used between the codes.

| Designation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description block (optional) | Identity block | | | | | | | | | |
| | International Standard | Individual item block | | | | | | | | |
| | | Data block 1 | | Data block 2 | | | Data block 3 | | Data block 4 | Data block 5 |
| | | Polymer | | Performance and origin | | | Application and processing | | Properties | Additional information |
| | | Type | Segment (optional) | Filler | Flame retardant | Recyclate | Processing | Characteristics | | |
| Thermoplastics | 16365 | TPU | -ARES | (GF+MD)35 | FR(3) | R50 | M | A | 40–75 | |
| > Part marking < | | | | | | | | | | |
| No | No | Yes | | Yes | | | No | | No | No |

Designation: **ISO 16365-TPU,(GF+MD)35 FR(30) (R50),MA,40-75,,**

## 3.2 Data block 1

In this data block, after the hyphen, the thermoplastic polyurethane is identified by using the symbols and designations specified below.

The prefix TP is followed by a letter representing the category of the thermoplastic elastomer as detailed in ISO 18064. For urethane thermoplastic elastomers the prefix TP is followed by the letter U.

Thermoplastic polyurethanes consist of a block copolymer of alternating hard and soft segments with urethane chemical linkages in the hard blocks and ether, ester, or carbonate linkages or mixtures of them in the soft blocks. The "TPU" group is sub-categorized into groups according to the linkages in the soft blocks. The following symbols shall be used:

— TPU-ARES: Aromatic isocyanate, polyester polyol;

— TPU-ARET: Aromatic isocyanate, polyether polyol;

— TPU-AREE: Aromatic isocyanate, polyol with ester and ether linkages;

— TPU-ARCE: Aromatic isocyanate, polycarbonate polyol;

— TPU-ARCL: Aromatic isocyanate, polycaprolactone polyol;

— TPU-ALES: Aliphatic isocyanate, polyester polyol;

— TPU-ALET: Aliphatic isocyanate, polyether polyol.

The identification of the subcategories by the above-mentioned symbols is optional.

## 3.3 Data block 2

In this data block, the type of filler or reinforcing material is represented by a single code-letter and its physical form by a second code-letter, the code-letters as specified in Table 1. Subsequently (without a space), the mass content may be given by a two-figure code-number.

Mixtures of filler materials or forms may be indicated by combining the relevant codes using the sign "+" within parentheses followed by the total filler content outside the parenthesis. For example, a mixture of 25 % by mass glass fibre (GF) and 10 % by mass mineral powder (MD) shall be indicated by (GF+MD)35.

Separated from the reinforcement code by a space, the addition of a flame retardant or flame retardant behaviour is represented by the code FR, where the type of flame retardant in accordance with ISO 1043-4 is given by a two letter-code between parentheses.

Separated by a space from the flame retardant or the reinforcement code if no flame retardant code is used, the declaration of recyclate is represented by the code, R, between parentheses, (R). Following the code, R, the mass content may be given between the parenthesis without a space. For example, a TPU material containing 20 % glass fibres resulting from an overall minimum 70 % of mass recyclate and 30 % of virgin material would be indicated TPU-GF20 (R70).

**Table 1 — Coding system for fillers and reinforcing materials in data block 2**

| Code-letter | Material (Position 1) | Form (Position 2) |
|---|---|---|
| B | Boron | Balls, beads, spheres |
| C | Carbon[a] | |
| D | | Powder, dry blend |
| F | | Fiber |
| G | Glass | Granules, ground |
| H | | Whiskers |
| K | Calcium carbonate ($CaCO_3$) | |
| M | Mineral[a] | |
| ME | Metal[b] | |
| S | Organic, synthetic | |
| T | Talc | |
| X | Not specified | Not specified |
| Z | Others[a] | Others |

[a] These materials may be identified after the code-letter, e.g. by chemical symbol or additional codes to be agreed upon.

[b] Metal filler shall be identified by the chemical symbol (in capital letters) after the mass content. For example, steel whiskers may be designated "MEH05FE".

## 3.4 Data block 3

In this data block, information about intended applications or method of processing is represented by a code-letter, followed by code-letters describing additives, supplementary information, and other characteristics. The code-letters are specified in Table 2.

If no specific information is given on the method of processing the letter X shall be used as the first code-letter.

**Table 2 — Codes used in data block 3**

| Code-letter | First letter | Letters 2 to 8 |
|---|---|---|
| A | Adhesive | Processing stabilized |
| B | Blow moulding | Antiblocking |
| C | Calendering | Coloured |
| D | Disc manufacture | Powder |
| E | Extrusion | Expandable |
| F | Extrusion of films | Special burning characteristics |
| G | General use | Granules |
| H | Coating | Heat stabilized |
| K | Cable and wire coating | |
| L | Monofilament extrusion | Light and/or weather stabilized |
| M | Moulding | Nucleated |
| N | Multiple processing modes | Natural (no colour added) |
| O | | Stabilized against oxidation |
| R | Rotational moulding | Mould release agent |
| S | | Lubricated |
| T | | Transparent |
| W | | Stabilized against hydrolysis |
| X | No indication | |
| Z | | Antistatic |

## 3.5 Data Block 4

### 3.5.1 General

In this data block, the hardness is represented by a 2-figure code-number (see 3.5.2) and the tensile modulus of elasticity by a 3-figure code-number (see 3.5.3). The code-numbers are separated from each other by hyphens.

If no specific information is given in one of the two positions, the letter X shall be used.

If a property value falls on or near a range limit, the manufacturer shall state which range will designate the material. If subsequent individual test values lie on, or on either side of, the limit because of manufacturing tolerances, the designation is not affected.

NOTE Not all combinations of the values of the designatory properties are provided by currently available polymers.

### 3.5.2 Hardness

The Shore hardness shall be determined in accordance with ISO 868.

The possible values of the hardness are divided into 16 ranges, each represented by a 2-figure code-number as specified in Table 3.

**Table 3 — Code-numbers used for hardness in data block 4**

| Code-number | Range of hardness Shore D | Range of hardness Shore A (indication) |
|---|---|---|
| 05 | ≤7 | ≤35A |
| 10 | >7 but ≤12 | ±45A |
| 15 | >12 but ≤17 | ±56A |
| 20 | >17 but ≤22 | ±67A |
| 25 | >22 but ≤27 | ±75A |
| 30 | >27 but ≤32 | ±81A |
| 35 | >32 but ≤37 | ±86A |
| 40 | >37 but ≤42 | ±90A |
| 45 | >42 but ≤47 | ±95A |
| 50 | >47 but ≤52 | >95A |
| 55 | >52 but ≤57 | |
| 60 | >57 but ≤62 | |
| 65 | >62 but ≤67 | |
| 70 | >67 but ≤72 | |
| 75 | >72 but ≤77 | |
| 80 | >77 | |

NOTE The hardness of thermoplastic elastomers is measured in Shore A and Shore D according to ISO 868. Shore hardness is a measure of the resistance of a material to the penetration of a needle under a defined spring force. It is determined as a number from 0 to 100 on the scales A or D. The higher the number, the higher the hardness of the material. The Shore A is used for (very) flexible types and the Shore D for flexible and more rigid types. The Shore A and D ranges do overlap. Therefore, for designation purposes a parameter combining the hardness ranges of the Shore A and D is used as this scale which covers the whole range and is able to discriminate between rather flexible, medium and rigid materials. For values around and above 50 this parameter is identical to the Shore D hardness.

### 3.5.3 Tensile modulus of elasticity

The tensile modulus of elasticity shall be determined in accordance with ISO 527 (all parts).

The possible values of the tensile modulus of elasticity are divided into 10 ranges, each represented by a 3-figure code-number as specified in Table 4.

**Table 4 — Code-numbers used for tensile modulus of elasticity in data block 4**

| Code-number | Range of modulus<br>MPa |
|---|---|
| 002 | ≤30 |
| 004 | >30 but ≤50 |
| 006 | >50 but ≤70 |
| 008 | >70 but ≤90 |
| 010 | >90 but ≤110 |
| 015 | >110 but ≤200 |
| 025 | >200 but ≤300 |
| 040 | >300 but ≤500 |
| 075 | >500 but ≤1000 |
| 200 | >1 000 but ≤3 000 |
| 400 | >3 000 but ≤6 000 |
| 800 | >6 000 but ≤10 000 |
| 999 | >10 000 |

### 3.6 Data block 5

Indication of additional requirements in optional data block 5 is a way of transforming the designation of a material into a specification for a particular application. This may be done for example by reference to a suitable national standard or to a standard-like, generally established specification (see Clause 4).

## 4 Examples of designations

EXAMPLE 1 A unstabilized polyurethane thermoplastic elastomer (TPU) based on aromatic isocyanate (AR) and polyetherol (ET), natural (not coloured) (N) intended for general (G) and having a Shore A hardness of 85 corresponding to a Shore D hardness of 35 (35) and unknown tensile modulus of elasticity would be designated:

| **Designation** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description block (optional) | **Identity block** | | | | | | | | | |
| | International Standard | **Individual item block** | | | | | | | | |
| | | **Data block 1** | | **Data block 2** | | | **Data block 3** | | **Data block 4** | **Data block 5** |
| | | Polymer | | Performance and origin | | | Application and processing | | Properties | Additional information |
| | | Type | segment (optional) | Filler | Flame retardant | Recyclate | Processing | Characteristics | | |
| Thermoplastics | 16365 | TPU | -ARET | | | | G | N | 35-X | |
| > Part marking < | | | | | | | | | | |
| No | No | Yes | | Yes | | | No | | No | No |

Designation: **Thermoplastics ISO 16365-1 TPU-ARET,, GN, 35-X,,**