
**Plastics — Polytetrafluoroethylene (PTFE)
semi-finished products —**

**Part 1:
Requirements and designation**

*Plastiques — Semi-produits en polytétrafluoroéthylène (PTFE) —
Partie 1: Spécifications et désignation*



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International Organization for Standardization
 Case postale 56 • CH-1211 Genève 20 • Switzerland
 Internet central@iso.ch
 X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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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 13000-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

ISO 13000 consists of the following parts, under the general title *Plastics — Polytetrafluoroethylene (PTFE) semi-finished products*:

- *Part 1: Requirements and designation*
- *Part 2: Preparation of test specimens and determination of properties*

Annex A of this part of ISO 13000 is for information only.

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Plastics – Polytetrafluoroethylene (PTFE) semi-finished products

Part 1:

Requirements and designation

1. Scope

This specification deals with the requirements for processed unfilled polytetrafluoroethylene (PTFE) products which may occur in several forms. The PTFE used to make the semi-finished product is described in ISO 12086-1 and, as provided in that International Standard, may contain up to one percent of a comonomer. The PTFE used to make the semi-finished product may be virgin, reprocessed, or recycled resin. The addition of up to 1,5 % by mass of pigment or colourant is permitted. The standard allows for four grades based on tensile strength and elongation at break. The semi-finished products can be as processed (type P) or dimensionally stabilized (type S) and also may have specified electrical properties or other properties when they are required for an application.

NOTE: References to other standard specifications for semi-finished products made from polytetrafluoroethylene are listed in Annex A for information.

2. Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 472:1988 *Plastics — Vocabulary.*

ISO 1043-1:1997 *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics.*

ISO 12086-1:1995 *Plastics — Fluoropolymer dispersions and moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 12086-2:1995 *Plastics — Fluoropolymer dispersions and moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties.*

ISO 13000-2:1997 *Plastics — Polytetrafluoroethylene (PTFE) semi-finished products — Part 2: Preparation of test specimens and determination of properties.*

3. Terminology

3.1 Definitions

The definitions in ISO 472 and ISO 12086-1 are applicable to this International Standard.

3.2 Definitions for this International Standard

For the purposes of this International Standard the following definitions apply.

3.2.1

moulded basic shape

(of PTFE): semi-finished product made by preforming and sintering without additional processing.

3.2.2

semi-finished product

material in the form of skived tape, sheets, rods, tubes, tubing, moulded basic shapes or special shapes that is produced for use either directly without further fabrication or in fabricating end use products, or both.

3.2.3

skived tape

film or sheet prepared by cutting, slicing, or shaving.

NOTE: The term "veneered tape" is deprecated.

3.3 Abbreviated terms and symbols

The abbreviated terms given in ISO 1043-1 are applicable to this International Standard.

4. Requirements for PTFE semi-finished products

4.1 General

After considering the specific shape, dimension, and dimensional tolerance, the primary basis for specifying a semi-finished product of PTFE is the tensile strength and percentage elongation at break of the product. Tests to determine the values for specification shall be run according to the methods in ISO 13000-2. The semi-finished product is identified as "type P" for as-processed or "type S" for stabilized and also may be designated as "type E" with specified electrical properties when required for a particular application. The exclusion of the use of reprocessed or recycled material shall be specified if needed in order to meet special customer requirements. The values required for other properties are given in their respective subclauses.

4.2 Dimensions and dimensional tolerances

Dimensional tolerances shall be measured at 23 ± 2 °C.

4.2.1 Skived tape, skived sheet, and film

Code		tolerance
a	thickness < 0,1 mm	- 0,0; + 0,01 mm
b	thickness ≥ 0,1 mm	- 0,0; + 10 %

The standard tolerance for width is - 0,0 mm; + 3 % with a maximum of 30 mm. For slit skived tape, the exact width is to be agreed upon between purchaser and supplier.

The standard tolerance for length is -0,0; + 2 %.

4.2.2 Moulded sheet

Code		tolerance
a	thickness < 5 mm	- 0,0; + 0,75 mm
b	thickness ≥ 5 mm	- 0,0; + 15 %

Length and width tolerance shall be - 0,0 mm; + 3 %

4.2.3 Extruded or moulded rods

As extruded or moulded

Code	diameter	tolerance
a	< 10 mm	- 0,0 mm; + 0,6 mm
b	≥ 10 mm	- 0,0 mm; + 6 %

The standard tolerance for length is:

Code	length	tolerance
a	≤ 500 mm	-0,0; + 10 mm
b	> 500 mm	-0,0; + 2 %

Centerless ground

Tolerance on diameter for all diameters: -0,0; + 0,04 mm

Tolerance on length:

Code	length	tolerance
a	≤ 500 mm	-0,0; + 10 mm
b	> 500 mm	-0,0; + 2 %

4.2.4 Thin-walled tube extruded from coagulated dispersion powder

Code		tolerance
a	inner diameter < 5 mm	± 0,25 mm
b	inner diameter ≥ 5 mm	± 5 %
c	wall thickness < 1,0 mm	± 0,1 mm
d	wall thickness ≥ 1,0 mm	± 10 %

The standard tolerance for length is -0,0; + 2 %.

4.2.5 Extruded and moulded tubes

Code	tolerance		
	outer diameter	inner diameter	outer diameter
a	< 10 mm	- 0,6 mm; + 0	- 0,0; + 0,6 mm
b	≥ 10 mm	- 6 %; + 0	- 0,0; + 6 %

The standard tolerance for length is:

Code	length	tolerance
a	≤ 500 mm	-0,0; + 10 mm
b	> 500 mm	-0,0; + 2 %

The tube shall be capable of being machined concentrically to the required nominal dimensions and the eccentricity of the bore shall not exceed 4,0 % of the nominal inside diameter.

NOTE: The machining of the tube to the nominal dimensions with the inner and outer surfaces concentric is feasible if the maximum inner diameter, calculated by difference between the outer diameter and two times the minimum wall thickness, is within the specified tolerance.

For a moulded tube, the tolerance on the outer diameter shall be a minimum value. A larger diameter than is provided for by the plus tolerance is acceptable for moulded tube, either type P or S that is to be machined to the final dimension.

4.3 Tensile strength and percentage elongation at break

The grade for semi-finished products is determined by the minimum values of tensile strength and percentage elongation at break shown in Table 1, determined as specified in ISO 13000-2.

NOTE: There are some configurations of PTFE that might not be able to be produced with a high grade classification.

Table 1

Grade	1	2	3	4
Tensile strength MPa	25	20	15	10
Elongation at break %	280	200	150	75

4.4 Dimensional stability

This requirement applies only to type S (stabilized) material.

The maximum change in any dimension shall not exceed 0,5 %, determined as specified in ISO 13000-2.

4.5 Density

All semi-finished products shall have a density in the range of 2,13 to 2,19 g/cm³ except that:

- a. products made from reprocessed material or blends with reprocessed material shall have a density in the range of 2,14 to 2,23 g/cm³ and
- b. tubing extruded from coagulated dispersion powders shall have a density in the range of 2,13 to 2,23 g/cm³.

4.6 Hardness

All products that have a shape or dimensions such that measurements can be made precisely shall have a ball indentation hardness more than 23 MPa or the hardness determined using the Shore D test shall have a value greater than 54. Both of the hardness tests are described in ISO 13000-2.

4.7 Colour

PTFE that does not contain a colourant shall be white to transparent after sintering. Visual perception of whiteness is usually adequate to appraise this characteristic of semi-finished products. If a quantitative value is required for whiteness, the test procedure in ISO 13000-2 shall be used. The value required shall be as agreed upon between producer and purchaser. If pigment or colourant has been added, its presence shall be reported in all documentation related to a particular product.

NOTE: The presence of pigments or colourants may affect some properties of the material, e. g. chemical resistance and electrical properties, and it is advisable for the purchaser and supplier to agree upon the type and grade of pigment to be used.

4.8 Dielectric strength (DS), breakdown voltage, and electrical flaws

This requirement applies only to materials coded E with specified electrical properties required for an application. The required values for the various shapes reflect the same dielectric strength when corrected for thickness by the standard relationship.

NOTE: The IEC has responsibility for standards related to electrical properties. Since there are, however, no IEC standards that are pertinent to the scope and needs of this International Standard, provision for electrical properties are included in this International Standard. Some references to general IEC standards and specific references to IEC standards for heat shrinkable tubing of PTFE are included in informative annex A.

4.8.1 Skived tape, skived sheet, and film

4.8.1.1 The minimum values required for dielectric strength, S (expressed as kV/mm), shall be computed for applicable thicknesses of materials in accordance with the following formulas, where t is the thickness of the tape in millimeters.

Type	Minimum DS (kV/mm)
E 1	$S = 37 \sqrt{0,5/t}$
E 2	$S = 30 \sqrt{0,5/t}$
E 3	$S = 20 \sqrt{0,5/t}$

4.8.1.2 The number of electrical flaws shall be as agreed between the purchaser and the seller.

4.8.2 Moulded sheet

The minimum values required for dielectric strength for each grade of moulded sheet are shown in the table. The requirements are based on a test specimen $1,5 \pm 0,25$ mm in thickness prepared from the moulded sheet.

Grade	Minimum DS (kV/mm)
E 1	20,0
E 2	15,0
E 3	10,0

4.8.3 Moulded basic shape

The minimum values required for dielectric strength (DS) for each grade of a moulded basic shape are shown in the table. The requirements are based on a test specimen $0,5 \pm 0,05$ mm in thickness prepared from the moulded basic shape.

Grade	Minimum DS (kV/mm)
E 1	35,0
E 2	25,0
E 3	15,0

4.8.4 Rod

The minimum values required for dielectric strength of rod are shown in the table below. The requirements are based on a test specimen 1,0 mm in thickness prepared from the rod. The minimum dielectric strength is calculated from one of the equations below where d is the diameter of the rod in mm.

Grade	Minimum DS (kV/mm)
E 1	$26,5 + 0,17 d$
E 2	$23,0 + 0,11 d$
E 3	10,0

4.8.5 Thin-walled tube

The minimum values required for breakdown voltage or dielectric strength of thin-walled tube shall be determined in accordance with ISO 13000-2 and shall be calculated from one of the equations below where t is the wall thickness in mm.

$$\begin{aligned}kV &= 19,8 - 1,78/t \\kV/mm &= 23,5 - 5,6/t\end{aligned}$$

4.8.6 Heavy-walled tube

The minimum values required for breakdown voltage or dielectric strength are shown in the table. The requirements are based on a test specimen 1,0 mm in thickness prepared from the heavy-walled tube.

Grade	Minimum DS (kV/mm)
E 1	29,5
E 2	27,5
E 3	25,6
E 4	23,6
E 5	12,0
E 6	10,0

4.9 Requirements that may be specified depending on the specific application

4.9.1 **Tolerance on the surface finish and other requirements for the nature of the surface.**

4.9.2 **Tolerance on the straightness of rod or tube.**

4.9.3 **Tolerance on the parallelism or flatness or both of sheet.**

4.9.4 **Limits to the size and frequency of internal defects, voids, or inclusions.**

4.9.5 **Colour of the product**, determined by the procedure in ISO 13000-2.

4.9.6 **Number of electrical flaws**, determined as described in ISO 13000-2.

4.9.7 **Loss of mass at 300 °C**, which shall be less than 0,5 %, determined by the procedure in ISO 13000-2.

4.9.8 **Radiographic inspection**, carried out using the procedure in ISO 13000-2.

4.9.9 **Resistance to environmental stress cracking (ESC).** For the rare occasions when testing for ESC is desired, ISO general tests for ESC of plastics are referenced in ISO 13000-2.

4.9.10 **Deformation under load,** determined as described in ISO 13000-2. When this property is specified, it shall have a maximum value of 25 %.

4.9.11 **Use of reprocessed or recycled material** may be restricted if necessary for a particular application.

5. Format for presenting a specification

A specification may be written in a one line system as outlined below. The alphanumeric codes used are included in the order shown without use of separators except that a space may be used between the individual items of a specification.

5.1 Order of presenting codes

5.1.1 A letter code for the semi-finished product selected from the list in Table 2, with the letter code for the dimension and dimensional tolerance from the appropriate part of subclause 4.2.

Table 2
Codes for the shape of the semi-finished product

F	skived tape, skived sheet, or any film
O	other shapes
R	extruded or moulded rod
S	moulded sheet
T	extruded or moulded tube
W	thin-walled tube

5.1.2 A letter code for the type: P for "as processed" and S for "as stabilized".

5.1.3 The code for the grade based on the minimum values of tensile strength and percentage elongation at break from Table 1.

5.1.4 Codes for special requirements.

5.1.4.1 Dielectric strength — The letter code E numbered according to subclause 4.8 shows compliance with the requirements for dielectric strength of the particular semi-finished product. This requirement shall be used only when electrical properties are required for the application.

5.1.4.2 Other requirements — A code system for requirements listed in subclause 4.9 may be agreed upon between purchaser and supplier.