INTERNATIONAL STANDARD

ISO 13000-1

Second edition
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Plastics — Polytetrafluoroethylene (PTFE) semi-finished products —

Part 1: Requirements and designation

Plastiques — Semi-produits en polytétrafluoroéthylène (PTFE) —

Partie 1: Spécifications et désignation

Reference number
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Contents

Page

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

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

This second edition cancels and replaces the first edition (ISO 13000-1:1997), which has been technically revised.

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*

Plastics — Polytetrafluoroethylene (PTFE) semi-finished products —

Part 1: Requirements and designation

1 Scope

This part of ISO 13000 specifies 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 ISO 12086-1, may contain up to 1 % 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 colorant is permitted. This part of ISO 13000 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 may also 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 referenced documents are indispensable for the application 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 472, *Plastics — Vocabulary*

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

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

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

3 Terminology

3.1 Terms and definitions

For the purposes of this part of ISO 13000, the terms and definitions given in ISO 472 and ISO 12086-1 and the following terms and definitions apply.

3.1.1
moulded basic shape
〈PTFE〉 semi-finished product made by preforming and sintering without additional processing

3.1.2
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

3.1.3
skived tape
film or sheet prepared by cutting, slicing or shaving

NOTE The term “veneered tape” is deprecated.

3.2 Abbreviated terms and symbols

The abbreviated terms given in ISO 1043-1 are applicable to this part of ISO 13000.

4 Requirements for PTFE semi-finished products

4.1 General

After considering the specific shape, dimensions and dimensional tolerances, 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 in accordance with 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

4.2.1 General

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

4.2.2 Skived tape, skived sheet and film

Code-letter	Thickness	Tolerance
a	< 0,1 mm	$^{+0,01}_{0}$ mm
b	⩾ 0,1 mm	$^{+10}_{0}$ %

The standard tolerance for width is $^{+3}_{0}$ %, with a maximum of 30 mm. For slit skived tape, the exact width shall be agreed upon between purchaser and supplier.

The standard tolerance for length is $^{+2}_{0}$ %.

4.2.3 Moulded sheet

Code-letter	Thickness	Tolerance
a	< 5 mm	$^{+0,75}_{0}$ mm
b	⩾ 5 mm	$^{+15}_{0}$ %

The length and width tolerance shall be $^{+3}_{0}$ %.

4.2.4 Extruded or moulded rods

As extruded or moulded:

Code-letter	Diameter	Tolerance
a	< 10 mm	$^{+0,6}_{0}$ mm
b	⩾ 10 mm	$^{+6}_{0}$ %

The standard tolerance for length is:

Code-letter	Length	Tolerance
a	⩽ 500 mm	$^{+10}_{0}$ mm
b	> 500 mm	$^{+2}_{0}$ %

Centreless ground:

Tolerance on diameter for all diameters: $^{+0,04}_{0}$ mm.

Tolerance on length:

Code-letter	Length	Tolerance
a	⩽ 500 mm	$^{+10}_{0}$ mm
b	> 500 mm	$^{+2}_{0}$ %

4.2.5 Thin-walled tube extruded from coagulated dispersion powder

The standard tolerance on inner diameter and wall thickness is:

Code-letter	Dimension	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 $^{+2}_{0}$ %.

4.2.6 Extruded and moulded tubes

Code-letter	Outer diameter	Tolerance on	
		inner diameter	outer diameter
a	< 10 mm	$^{0}_{-6}$ mm	$^{+0,6}_{0}$ mm
b	$\geqslant 10$ mm	$^{0}_{-6}$ %	$^{+6}_{0}$ %

The standard tolerance for length is:

Code-letter	Length	Tolerance
a	$\leqslant 500$ mm	$^{+10}_{0}$ mm
b	> 500 mm	$^{+2}_{0}$ %

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 g/cm^3 to 2,19 g/cm^3 except that:

a) products made from reprocessed material or blends with reprocessed material shall have a density in the range of 2,14 g/cm^3 to 2,23 g/cm^3;

b) tubing extruded from coagulated dispersion powders shall have a density in the range of 2,13 g/cm^3 to 2,23 g/cm^3.

4.6 Hardness

All products that have a shape or dimensions such that measurements can be made precisely shall have a ball indentation hardness of 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 colorant 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 colorant has been added, its presence shall be reported in all documentation related to a particular product.

NOTE The presence of pigments or colorants 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

4.8.1 General

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 part of ISO 13000, provisions for electrical properties are included in this part of ISO 13000. Some references to general IEC standards and specific references to IEC standards for heat-shrinkable tubing of PTFE are included in Annex A.

4.8.2 Skived tape, skived sheet and film

4.8.2.1 The minimum values required for dielectric strength DS (expressed in kV/mm) shall be computed for applicable thicknesses of materials in accordance with the following formulae, where t is the thickness of the tape in millimetres:

Type	**Minimum DS** (kV/mm)
E1	$37\sqrt{0,5/t}$
E2	$30\sqrt{0,5/t}$
E3	$20\sqrt{0,5/t}$

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

4.8.3 Moulded sheet

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

Grade	**Minimum DS** (kV/mm)
E1	20,0
E2	15,0
E3	10,0

4.8.4 Moulded basic shape

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

Grade	**Minimum DS** (kV/mm)
E1	35,0
E2	25,0
E3	15,0

4.8.5 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 formulae below, where d is the diameter of the rod in millimetres:

Grade	**Minimum DS** (kV/mm)
E1	$26{,}5 + 0{,}17\,d$
E2	$23{,}0 + 0{,}11\,d$
E3	10,0

4.8.6 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 millimetres:

Breakdown voltage in kV $= 19{,}8 - 1{,}78/t$

Dielectric strength in kV/mm $= 23{,}5 - 5{,}6/t$

4.8.7 Heavy-walled tube

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

Grade	**Minimum DS** (kV/mm)
E1	29,5
E2	27,5
E3	25,6
E4	23,6
E5	12,0
E6	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 in 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, general ISO 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

5.1 General

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.

5.2 Order of presenting codes

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

Table 2 — Code-letters 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

5.2.2 A code-letter for the type: P for “as-processed” and S for “as stabilized”.

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

5.2.4 Codes for special requirements:

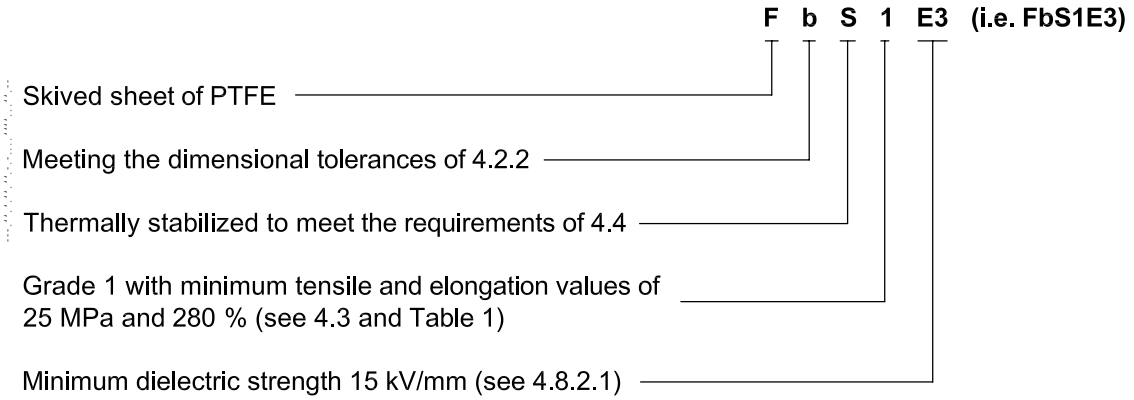
5.2.4.1 Dielectric strength: The code-letter E, with a number in accordance with Subclause 4.8, shows compliance with the requirements for dielectric strength of the particular semi-finished product. This requirement shall be used only when electrical properties are required for the application.

5.2.4.2 Other requirements: A code system for requirements listed in Subclause 4.9 may be agreed upon between purchaser and supplier.

5.3 Examples of coding a specification

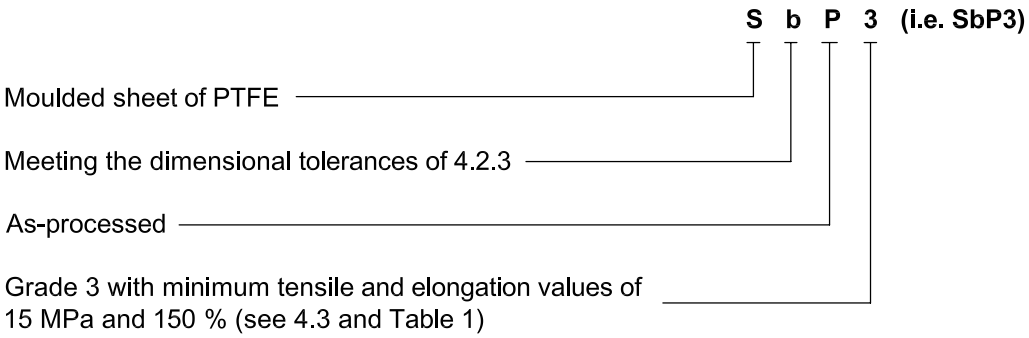
EXAMPLE 1

Codes for a skived sheet of grade 1 that is 1 mm thick, thermally stabilized and to be used for an electrical application that requires a minimum dielectric strength of 15 kV/mm:



EXAMPLE 2

Codes for a sheet 5 mm thick moulded from a blend of virgin and reprocessed PTFE powders and with a tensile strength of at least 16 MPa and a percentage elongation at break of at least 150 % and that meets the minimum requirements for density and hardness:



Annex A
(informative)

Standard specifications for semi-finished products of polytetrafluoroethylene

[1] ASTM D 1710, *Standard Specification for Extruded and Compression Molded Polytetrafluoroethylene (PTFE) Basic Shapes, Rod, and Heavy-Walled Tubing*

[2] ASTM D 2686, *Standard Specification for Polytetrafluoroethylene-Backed Pressure-Sensitive Electrical Insulating Tape*

[3] ASTM D 2902, *Standard Specification for Fluoropolymer Resin Heat-Shrinkable Tubing for Electrical Insulation*

[4] ASTM D 3294, *Standard Specification for PTFE Resin Molded Sheet and Molded Basic Shapes*

[5] ASTM D 3295, *Standard Specification for PTFE Tubing, Miniature Beading and Spiral Cut Tubing*

[6] ASTM D 3308, *Standard Specification for PTFE Resin Skived Tape*

[7] ASTM D 3369, *Standard Specification for Polytetrafluoroethylene (PTFE) Resin Cast Film*

[8] ASTM F 754, *Standard Specification for Implantable Polytetrafluoroethylene (PTFE) Polymer Fabricated in Sheet, Tube, and Rod Shapes*

[9] IEC 60674-1, *Specification for plastic films for electrical purposes — Part 1: Definitions and general requirements*

[10] IEC 60674-2, *Specification for plastic films for electrical purposes — Part 2: Methods of test*

[11] IEC 60684-1, *Flexible insulating sleeving — Part 1: Definitions and general requirements*

[12] IEC 60684-2, *Flexible insulating sleeving — Part 2: Methods of test*

[13] IEC 60684-3-240, *Flexible insulating sleeving — Part 3: Specifications for individual types of sleeving — Sheets 240 to 243: Heat-shrinkable PTFE sleeving*

Sheet 240: Heat-shrinkable PTFE sleeving, low shrink ratio, thick wall

Sheet 241: Heat-shrinkable PTFE sleeving, low shrink ratio, intermediate wall

Sheet 242: Heat-shrinkable PTFE sleeving, low shrink ratio, thin wall

Sheet 243: Heat-shrinkable PTFE sleeving, high shrink ratio

[14] DIN 65374, *Luft- und Raumfahrt; Halbzeug und Formteile aus Polytetrafluorethylen (PTFE); Technische Lieferbedingungen; Aerospace: polytetrafluoroethylene (PTFE) semi-finished products and moulded parts; technical specification* (Text in German and English)

[15] GKV, *Quality requirements, test specifications and tolerances for PTFE products*

The JIS standards listed below are the Japanese issue:

[16] JIS K 6884, *General tolerance for polytetrafluoroethylene (Machine cut)*

[17] JIS K 6885, *Unsintered polytetrafluoroethylene tapes for thread sealing*

[18] JIS K 6894, *Fluoroplastic coating film on metal substrate*

[19] JIS K 6895, *Method for determination of dimension of polytetrafluoroethylene parts*

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