INTERNATIONAL STANDARD

**ISO 12086-1**

Second edition
2006-02-15

# Plastics — Fluoropolymer dispersions and moulding and extrusion materials —

## Part 1: Designation system and basis for specifications

*Plastiques — Polymères fluorés: dispersions et matériaux pour moulage et extrusion —*

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

Reference number
ISO 12086-1:2006(E)

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Published in Switzerland

 

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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.

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 12086-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

This second edition cancels and replaces the first edition (ISO 12086-1:1995), which has been technically revised.

ISO 12086 consists of the following parts, under the general title *Plastics — Fluoropolymer dispersions and moulding and extrusion materials*:

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

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

# Plastics — Fluoropolymer dispersions and moulding and extrusion materials —

## Part 1: Designation system and basis for specifications

## 1 Scope

**1.1** This part of ISO 12086 establishes a system of designation for fluoropolymer materials that may be used as the basis for specifications. It covers the homopolymers and various copolymers of fluoromonomers used as dispersions and for moulding, extrusion and other specialized applications. This part of ISO 12086 describes the designation system and provides codes and tables of values for the designatory properties. The designation system is applicable both to conventional thermoplastic fluoropolymers, processed by various techniques, and those materials that are processed by the unique operations required for the non-conventional thermoplastic polytetrafluoroethylene. The materials include both the fluorocarbon polymers and the various other fluoropolymers as virgin polymers or processed for reuse or recycling. This part of ISO 12086 also includes an extension of the designation system that provides a basis for specification of the materials. This basis for specification may be used to prepare specifications related to well-defined applications. As explained in Clause 5, these specifications will use data blocks 1 to 4 and, if necessary, data block 5 as a complement, the last-mentioned data block containing the specific requirements in relation to the application. Fluoroelastomers are specifically excluded.

**1.2** Fluoropolymers are long-chain homopolymers and copolymers of fluoromonomers. Fluoropolymers can be modified with small amounts of different fluoromonomers. In general, provided the polymer is not modified with more than five percent by mass of modifying fluoromonomer(s), it can be classed as the base polymer. PVDF is classed as the base polymer when it is modified during polymerization with up to two percent by mass of additional fluoromonomers in the polymer structure. For PTFE, up to one percent by mass of a modifying comonomer is the limit for the material to be classed as polytetrafluoroethylene. A general discussion of members of the fluoropolymer family is included in Annex C. This part of ISO 12086 is particularly concerned with, but is not limited to, the materials listed in 4.2. The accepted abbreviated term for each material is included in 4.2.

**1.3** The various types of fluoropolymer are differentiated from each other by a classification system based on the fluoropolymer genus and appropriate levels of the designatory properties, along with information about basic polymer parameters, intended application or method of processing, important properties, additives, colorants, fillers and reinforcing materials. Designatory properties for each fluoropolymer are selected from the general list in 5.4, and those properties to be designated for each fluoropolymer are listed in 5.7 and in Annexes A and B.

**1.4** Provision is made for designation of materials involved in reuse and recycling of the fluoropolymers covered by this part of ISO 12086. A set of designatory properties is provided for reprocessed PTFE because of its special requirements. For non-virgin conventional thermoplastic fluoropolymers, the same designatory properties as used for virgin materials are used with inclusion of the code Z1, Z2 or Z3 in data block 1 as specified in Table 1.

**1.5** It is not intended to imply that materials having the same designation necessarily give the same performance. The converse should also be emphasized, i.e. materials with different designations may be suitable for use in the same application. This part of ISO 12086 does not provide engineering data, performance data or processing conditions which may be required to specify materials for particular end-use applications (see the discussion on use of data block 5 in Clauses 5 and 7). If such additional properties are required, they can be determined in accordance with the test methods specified in ISO 12086-2, if suitable.

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

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

ISO 1043-2, *Plastics — Symbols and abbreviated terms — Part 2: Fillers and reinforcing materials*

ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

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 12000, *Plastics/rubber — Polymer dispersions and rubber latices (natural and synthetic) — Definitions and review of test methods*

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

ASTM D 1430, *Standard Classification System for Polychlorotrifluoroethylene (PCTFE) Plastics*

ASTM D 1600, *Standard Terminology for Abbreviated Terms Relating to Plastics*

ASTM D 3222, *Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding, Extrusion and Coating Materials*

ASTM D 3418, *Standard Test Method for Transition Temperatures of Polymers by Differential Scanning Calorimetry*

ASTM D 3892, *Standard Practice for Packaging/Packing of Plastics*

ASTM D 4591, *Standard Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry*

ASTM D 4895, *Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion*

ASTM D 5033, *Standard Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following terms and definitions apply. The terms listed in 3.1 to 3.3 are repeated from ISO 472 to be sure there is no misunderstanding.

**3.1**
**dispersion**
heterogeneous system in which a finely divided material is distributed in another material

**3.2**
**fluoroplastic**
plastic based on polymers made with monomers containing one or more atoms of fluorine, or copolymers of such monomers with other monomers, the fluoromonomer being in the greatest amount by mass

**3.3**
**latex**
colloidal aqueous dispersion of a polymeric material

**3.4**
**amorphous**
noncrystalline, or devoid of regular structure

**3.5**
**bulk density**
mass (in grams) per litre of material, measured under the conditions of the test

**3.6**
**copolymer**
polymer formed from two or more types of monomer

**3.7**
**emulsion polymer**
⟨fluoropolymer materials⟩ material isolated from its polymerization medium as a colloidal aqueous dispersion of the polymer solids

NOTE This definition, used in the fluoropolymer industry, is similar to that for “latex” in ISO 472 and is quite different from the definition for “emulsion” in ISO 472.

**3.8**
**fluorocarbon plastic**
plastic based on polymers made from perfluoromonomers only

**3.9**
**fluoroelastomer**
elastomer based on polymers made from monomers containing one or more atoms of fluorine, or copolymers of such monomers with other monomers, the fluoromonomer(s) being in the greatest amount by mass

**3.10**
**fluoropolymer**
synonymous with fluoroplastic (see 3.2)

**3.11**
**melt-processible**
capable of being processed by, for example, injection moulding, screw extrusion and other operations typically used with thermoplastics

**3.12**
**preforming**
compacting powdered PTFE material under pressure in a mould to produce a solid object, called a preform, that is capable of being handled

NOTE With PTFE, “moulding” and “compaction” are terms used interchangeably with “preforming”.

**3.13**
**presintered resin**
resin that has been treated thermally at or above the melting point of the resin at atmospheric pressure without having been previously preformed

**3.14**
**reprocessed plastic**
material from the manufacture of semifinished forms of fluoropolymers that has been converted to a form suitable for further use

NOTE 1 This material is often referred to as a byproduct from processing.

NOTE 2 Related definitions are presented in ASTM D 5033.

**3.15**
**sintering**
⟨PTFE⟩ thermal treatment during which the material is melted and recrystallized by cooling, with coalescence occurring during the treatment

**3.16**
**standard specific gravity**
**SSG**
specific gravity of a specimen of PTFE material preformed, sintered and cooled through the crystallization point at a rate of 1 °C per minute in accordance with the appropriate sintering schedule as described in ISO 12086-2

NOTE The SSG of unmodified PTFE is inversely related to its molecular mass.

**3.17**
**suspension polymer**
polymer isolated from its liquid polymerization medium as a solid having a particle size well above colloidal dimensions

**3.18**
**zero-strength time**
**ZST**
measure of the relative molecular mass of PCTFE

## 4 Abbreviated terms and symbols

**4.1** The abbreviated terms given in ISO 1043-1 and ISO 1043-2 are applicable to this part of ISO 12086.

**4.2** This part of ISO 12086 is particularly concerned with, but is not limited to, the materials listed below (there are minor differences from ISO 1043-1 and ISO 1043-2 that reflect current usage of the terms and abbreviated terms):

| | |
|---|---|
| ECTFE | ethylene-chlorotrifluoroethylene copolymer |
| EFEP | ethylene-tetrafluoroethylene-hexafluoropropene copolymer |
| ETFE | ethylene-tetrafluoroethylene copolymer |
| FEP | perfluoro(ethylene-propene) copolymer |
| PCTFE | polychlorotrifluoroethylene |
| PFA | perfluoro(alkoxy alkane) |
| PTFE | polytetrafluoroethylene |
| PVDF | poly(vinylidene fluoride) |
| PVF | poly(vinyl fluoride) |
| TFE/PDD | tetrafluoroethylene-perfluorodioxole copolymer |
| VDF/CTFE | vinylidene fluoride-chlorotrifluoroethylene copolymer |
| VDF/HFP | vinylidene fluoride-hexafluoropropene copolymer |
| VDF/TFE | vinylidene fluoride-tetrafluoroethylene copolymer |
| VDF/TFE/HFP | vinylidene fluoride-tetrafluoroethylene-hexafluoropropene copolymer |

**4.3** For the purposes of this part of ISO 12086, the following additional abbreviated terms apply.

| | |
|---|---|
| AF | amorphous fluoropolymer |
| ESG | extended specific gravity |
| MFR | melt mass-flow rate |
| MVR | melt volume-flow rate |
| SSG | standard specific gravity |
| SVI | stretching-void index |
| TII | thermal-instability index |
| ZST | zero-strength time |

# 5 Designation system

## 5.1 General

The designation system for thermoplastics is based on the following standard pattern:

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

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 plastic by its abbreviated term in accordance with ISO 1043-1 (supplemented, if necessary, by the abbreviated term for the fluoropolymer as listed in 4.2 or ASTM D 1600) and information about the composition of the polymer (see 5.2).

— Data block 2: Position 1: Intended application and/or method of processing (see 5.3).

Positions 2 to 8: Important properties, additives and supplementary information (see 5.3).

— Data block 3: Designatory properties (see 5.4 and 5.7).

— Data block 4: Fillers or reinforcing materials designated by letters as given in ISO 1043-2 (supplemented by the codes listed in Table 20), along with arabic numerals representing the nominal percentage content by mass (see 5.5).

— Data block 5: Additional details included in this data block will transform the general designation of a material into a material specification. This may be done by reference to particular requirements for properties, by reference to a suitable national standard, or both. See Clause 7 for further discussion and examples.

The first character of the individual-item block shall be a hyphen. The 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 (,,).

## 5.2 Data block 1

In this data block, fluoropolymers are identified by the abbreviated term given in ISO 1043-1, followed by a hyphen and one letter that codes additional information about the polymer as specified in Table 1. See 4.2 for a list of commonly used fluoropolymers with the abbreviated term for each.

**Table 1 — Code-letters used for additional information in data block 1**

| Code-letter | Meaning of code-letter |
|---|---|
| **A** | Modified |
| **B** | Block copolymer |
| **C** | Controlled rheology, narrow molecular-mass distribution |
| **D** | Dispersion |
| **E** | Emulsion polymer |
| **F** | Filler resin (additive resin) |
| **G** | Casting polymer |
| **H** | Homopolymer |
| **K** | Copolymer |
| **L** | Graft polymer |
| **M** | Bulk polymer |
| **R** | Random copolymer |
| **S** | Suspension polymer |
| **SS** | Presintered suspension polymer |
| **Z1** | In-house-recovered material; out of specification/waste |
| **Z2** | Reprocessed; byproduct from processing |
| **Z3** | Postconsumer material |

## 5.3 Data block 2

This block can indicate up to eight items of information coded by letters as specified in Table 2. Information about intended application or method of processing is given in position 1. Information about important properties, additives and supplementary information (up to seven items) is given, if requested, in positions 2 to 8. The code-letters are specified in Table 2.

If only one letter is given (e.g. E), its meaning must come from position 1. If information is presented in positions 2 to 8 and no specific information is given in position 1, a code-letter in position 1 is required. If no code-letter is appropriate, the letter X shall be inserted in position 1. An alphabetical order is recommended if more than one code-letter is used in any of positions 2 to 8.

Any indication of an intended application in data block 2 shall be selected carefully. Many materials are capable of more than one application or method of processing, e.g., extrusion (E) and moulding (M). Such materials are not special modifications and shall be coded “general use” (G). Coding for special methods of processing shall be reserved for materials designed for the application.

**Table 2 — Code-letters used in data block 2**

| Intended application or method of processing | | Essential properties, additives or other information | |
|---|---|---|---|
| **Code-letter** | **Position 1** | **Code-letter** | **Positions 2 to 8** |
| **A** | Adhesives | **C** | Coloured |
| **B** | Blow moulding | **D** | Powder |
| **B1** | Extrusion blow moulding | **D1** | Dry blend |
| **B2** | Injection blow moulding | **D2** | Free-flowing |
| **C** | Calendering | **D3** | Not free-flowing |
| **E** | Extrusion | **E** | Expandable |
| **F** | Filled compounds | **F** | Special burning characteristics |
| **G** | General use | **F1** | Oxygen index > 95 % |
| **H** | Coating | **F2** | Flame retarded |
| **H1** | Powder coating | **F4** | Reduced smoke emission |
| **H2** | Dip coating | **G** | Granules |
| **H3** | Wet coating | **G1** | Pellets |
| **H4** | Impregnation | **G2** | Lentils |
| **H5** | Spray coating | **G3** | Beads |
| **K** | Cable and wire coating | **H1** | Stabilized against radiation |
| **L** | Monofilament extrusion | **L** | Light and weather stabilized |
| **M** | Moulding | **M** | Nucleated |
| **M1** | Injection moulding | **M1** | Modified by comonomer |
| **M2** | Transfer moulding | **N** | Natural (no colour added) |
| **P** | Paste extrusion | **N1** | Suitable for food contact |
| **Q** | Compression moulding | **N2** | High purity |
| **Q1** | Automatic moulding | **P** | Impact modifiied |
| **Q2** | Isostatic moulding | **R** | Mould release agent |
| **R** | Rotational moulding | **S** | Lubricated |
| **S** | Sintering | **S1** | External lubrication |
| **T** | Tape manufacture | **T** | Transparent |
| **T1** | Skived tape or film | **T1** | Translucent |
| **T2** | Unsintered tape or film | **T2** | Opaque |
| **T3** | Expanded tape or film | **T3** | Improved transmission in UV |
| **V** | Thermoforming | **T4** | Reduced transmission in UV |
| **X** | No indication | **V** | Heat shrinkable |
| **Y** | Textile yarns, spinning | **W1** | Improved chemical resistance |
| | | **X** | Crosslinkable |
| | | **Y** | Increased electrical conductivity |
| | | **Z** | Antistatic |

## 5.4 Data block 3

### 5.4.1 General

Each member of the fluoropolymer family has its own set of designatory properties selected from the properties listed below and discussed further in 5.7. Annex A provides the information in tabular form. Annex B provides a summary that lists each of the fluoropolymers specifically included in this part of ISO 12086 and its designatory properties. Table number and page references are provided for each designatory property along with the subclause and page reference to the test method provided in ISO 12086-2. The designatory properties shall be determined in accordance with the test methods and conditions indicated for each item. There is one position in data block 3 for each of the designatory properties for a particular fluoropolymer. Therefore, data block 3 may have more positions for one fluoropolymer than for another. As an example, from Annex A or B one finds seven designatory properties for PTFE-S, so there will be seven positions in data block 3 for this polymer. PTFE-Z, on the other hand, has only two designatory properties, and there will therefore be only two positions in data block 3. The codes for some properties such as melt flow rate may require more than one letter or number. The results shall be classified and coded in data block 3 as indicated in the tables and presented in the order that the designatory properties are presented in 5.7 and listed in Annex A. A full stop shall be used to separate the code or codes in one position from those in the next. When codes for a property are not included, this shall be indicated by the full stop that normally would be included at the end of the codes for that position. The result is that two full stops in sequence, "..", show that codes for a property have not been included in the designation.

A full stop is not used at the end of the last position in the data block unless the last position is vacant.

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 range limit because of manufacturing tolerances, the designation is not affected. The resin manufacturer shall set the codes in data block 3.

NOTE Not all the combinations of the values of the designatory properties have to be provided for currently available polymers. Not all combinations of designatory properties are possible for a polymer.

### 5.4.2 Transition temperatures

#### 5.4.2.1 Melting-peak temperature

The melting-peak temperature shall be determined in accordance with the principles of ASTM D 3418 and ASTM D 4591, modified by details given in ISO 12086-2. Melting-peak temperature shall be used as a designatory property for crystalline and semicrystalline polymers. Codes and ranges are given in Table 3.

#### 5.4.2.2 Glass-transition temperature

The glass-transition temperature shall be determined in accordance with the principles of ASTM D 3418, modified by details given in ISO 12086-2. The glass-transition temperature shall be used as a designatory property for amorphous fluoropolymers. Codes and ranges are listed in Table 3.

**Table 3 — Codes and ranges for thermal transition temperatures in data block 3**

| Code | Range of temperature (°C) |
|---|---|
| **A** | < 20 |
| **B** | 20 to < 30 |
| **C** | 30 to < 40 |
| **D** | 40 to < 50 |
| **E** | 50 to < 60 |
| **F** | 60 to < 70 |
| **G** | 70 to < 80 |
| **H** | 80 to < 90 |
| **I** | 90 to < 100 |
| **J** | 100 to < 110 |
| **K** | 110 to < 120 |
| **L** | 120 to < 130 |
| **M** | 130 to < 140 |
| **N** | 140 to < 150 |
| **O** | 150 to < 160 |
| **P** | 160 to < 170 |
| **Q** | 170 to < 180 |
| **R** | 180 to < 190 |
| **S** | 190 to < 200 |
| **T** | 200 to < 210 |
| **U** | 210 to < 220 |
| **V** | 220 to < 230 |
| **W** | 230 to < 240 |
| **X** | 240 to < 250 |
| **Y** | 250 to < 260 |
| **Z** | 260 to < 270 |
| **1** | 270 to < 280 |
| **2** | 280 to < 290 |
| **3** | 290 to < 300 |
| **4** | 300 to < 310 |
| **5** | 310 to < 320 |
| **6** | 320 to < 330 |
| **7** | 330 to < 340 |
| **8** | 340 to < 350 |
| **9** | 350 to < 360 |
| **0** | ⩾ 360 |

### 5.4.3 Relative molecular mass

#### 5.4.3.1 General

Standard specific gravity (SSG) is the property usually used to measure the relative molecular mass of the polymers used in the PTFE industry. The melt mass-flow rate (MFR) is usually used for conventional thermoplastic fluoropolymers. For PCTFE, the zero-strength time (ZST) is used. With MFR, the codes have three digits: a number to indicate the value of the flow rate and two letters to indicate the test load and test temperature, respectively.

#### 5.4.3.2 Standard specific gravity (SSG)

SSG shall be determined in accordance with the procedure described in ISO 12086-2. Codes and ranges are listed in Table 4.

**Table 4 — Codes for standard specific gravity (SSG) in data block 3**

| Code | SSG |
|---|---|
| **0** | < 2,140 |
| **1** | 2,140 to < 2,160 |
| **2** | 2,160 to < 2,180 |
| **3** | 2,180 to < 2,200 |
| **4** | 2,200 to < 2,220 |
| **5** | 2,220 to < 2,240 |
| **6** | ⩾ 2,240 |

#### 5.4.3.3 Melt mass-flow rate and melt volume-flow rate

Melt mass-flow rate or melt volume-flow rate shall be determined in accordance with ISO 1133, modified by details provided in ISO 12086-2 and using test conditions selected from Tables 6 and 7 of this part of ISO 12086. The melt mass-flow rate is indicated in data block 3 by the codes and ranges given in Table 5 followed by the codes for temperature and load given in Tables 6 and 7. If melt volume-flow rate is determined, the melt mass-flow rate may be calculated from the volume-flow rate and the melt density of the polymer.

**Table 5 — Codes for melt mass-flow rate (MFR) in data block 3**

| Code | **MFR** (g/10 min) |
|---|---|
| **0** | < 0,1 |
| **1** | 0,1 to < 0,2 |
| **2** | 0,2 to < 0,5 |
| **3** | 0,5 to < 1,0 |
| **4** | 1,0 to < 2,1 |
| **5** | 2,0 to < 5,0 |
| **6** | 5,0 to < 10,0 |
| **7** | 10,0 to < 20,0 |
| **8** | 20,0 to < 50,0 |
| **9** | ⩾ 50,0 |

**Table 6 — Codes for MFR test temperature in data block 3**

| Code | **Test temperature** (°C) |
|---|---|
| **A** | 372 ± 1 |
| **B** | 297 ± 1 |
| **C** | 271,5 ± 1 |
| **D** | 265 ± 1 |
| **E** | 230 ± 1 |

**Table 7 — Codes for MFR test load in data block 3**

| Code | **Test load** (kg) |
|---|---|
| **1** | 0,325 |
| **2** | 1,20 |
| **3** | 2,16 |
| **4** | 3,8 |
| **5** | 5,0 |
| **6** | 10,0 |
| **7** | 12,5 |
| **8** | 21,6 |
| **9** | 31,6 |

#### 5.4.3.4 Zero-strength time (ZST)

Zero-strength time shall be determined as described in ASTM D 1430 and the results coded as indicated in Table 8.

**Table 8 — Codes for zero-strength time (ZST) in data block 3**

| Code | **ZST** (s) |
|---|---|
| **0** | < 115 |
| **1** | 115 to < 175 |
| **2** | 175 to < 300 |
| **3** | 300 to < 750 |
| **4** | 750 to < 2 500 |
| **5** | ⩾ 2 500 |

### 5.4.4 Mechanical properties

Tensile strength, tensile yield stress, percentage elongation at break and modulus properties shall be determined in accordance with the principles of ISO 527-2, modified by details given in ISO 12086-2. Tables 9 to 12 provide the codes to use for each range of tensile strength (including specimen thickness for PTFE-S), tensile yield stress, percentage elongation at break and tensile modulus.

**Table 9 — Codes for tensile strength and tensile yield stress in data block 3**

| Code | **Tensile strength and tensile yield stress** (MPa) |
|---|---|
| **A** | < 15 |
| **B** | 15 to < 20 |
| **C** | 20 to < 25 |
| **D** | 25 to < 30 |
| **E** | 30 to < 35 |
| **F** | 35 to < 40 |
| **G** | 40 to < 45 |
| **H** | 45 to < 50 |
| **I** | 50 to < 55 |
| **J** | ⩾ 55 |

**Table 10 — Codes for percentage elongation at break in data block 3**

| Code | **Percentage elongation at break** |
|---|---|
| **A** | < 50 |
| **B** | 50 to < 100 |
| **C** | 100 to < 150 |
| **D** | 150 to < 200 |
| **E** | 200 to < 250 |
| **F** | 250 to < 300 |
| **G** | 300 to < 350 |
| **H** | 350 to < 400 |
| **I** | 400 to < 500 |
| **J** | 500 to < 600 |
| **K** | 600 to < 800 |
| **L** | ⩾ 800 |

**Table 11 — Codes for tensile modulus in data block 3**

| Code | **Tensile modulus** (MPa) |
|---|---|
| **A** | < 500 |
| **B** | 500 to < 800 |
| **C** | 800 to < 1 200 |
| **D** | 1 200 to < 1 600 |
| **E** | 1 600 to < 2 000 |
| **F** | 2 000 to < 3 000 |
| **G** | 3 000 to < 4 000 |
| **H** | 4 000 to < 6 000 |
| **I** | ⩾ 6 000 |

**Table 12 — Codes for specimen thickness for PTFE-S in data block 3**

| Code | **Specimen thickness** (mm) |
|---|---|
| **1** | < 0,125 |
| **2** | 0,125 to < 0,500 |
| **3** | 0,500 to < 1,00 |
| **4** | ⩾ 1,00 |

### 5.4.5 Density

Density shall be determined in accordance with the principles of ISO 1183-1 and ISO 1183-2 as specified in ISO 12086-2. The codes are listed in Table 13.

**Table 13 — Codes for density in data block 3**

| Code | **Density** ($g/cm^3$ at 23 °C) |
|---|---|
| **A** | < 1,6 |
| **B** | 1,6 to < 1,7 |
| **C** | 1,7 to < 1,8 |
| **D** | 1,8 to < 1,9 |
| **E** | 1,9 to < 2,0 |
| **F** | 2,0 to < 2,1 |
| **G** | 2,1 to < 2,2 |
| **H** | 2,2 to < 2,3 |
| **I** | 2,3 to < 2,4 |
| **J** | 2,4 to < 2,5 |
| **K** | 2,5 to < 3,0 |
| **L** | 3,0 to < 3,5 |
| **M** | 3,5 to < 4,0 |
| **N** | 4,0 to < 4,5 |
| **O** | 4,5 to < 5,0 |
| **P** | 5,0 to < 5,5 |
| **Q** | 5,5 to < 6,0 |
| **R** | 6,0 to < 6,5 |
| **S** | 6,5 to < 7,0 |
| **T** | ⩾ 7,0 |

### 5.4.6 Percentage fluoropolymer and surfactant

Percentage fluoropolymer and surfactant shall be determined in accordance with the procedures provided in ISO 12086-2. The surfactant content shall be reported as the percentage by mass based on the content of dry fluoropolymer. The percentage shall be coded in position 6 of data block 3 by combining the code-number for the percentage fluoropolymer from Table 14 with the code-letter for percentage of added surfactant from Table 15.

**Table 14 — Codes and ranges for percentage fluoropolymer in dispersions in data block 3**

| Code | Percentage fluoropolymer |
|---|---|
| **2** | ⩽ 40 |
| **4** | > 40 |

**Table 15 — Codes and ranges for added-surfactant content in data block 3 (calculated as a percentage of the mass of the polymer)**

| Code | Percentage surfactant, minimum |
|---|---|
| **A** | < 0,5 |
| **B** | 0,5 to < 2,5 |
| **C** | 2,5 to < 3,5 |
| **D** | ⩾ 3,5 |

### 5.4.7 Particle size

Particle size shall be determined by the method described in ISO 12086-2. An appropriate method for particle size depends upon the particular fluoropolymer. The methods include wet- or dry-sieve analysis, electric sensing-zone testing and light scattering. Automated or other instruments that have been shown to provide equivalent results shall be acceptable alternatives to the detailed procedures given in ISO 12086-2. Codes and ranges are given in Table 16.

**Table 16 — Codes and ranges for particle size (50 % retention) in data block 3**

| Code | **Particle size** (µm) |
|---|---|
| **0** | < 10 |
| **1** | 10 to < 125 |
| **2** | 125 to < 250 |
| **3** | 250 to < 355 |
| **4** | 355 to < 500 |
| **5** | 500 to < 710 |
| **6** | 710 to < 1 000 |
| **7** | ⩾ 1 000 |

### 5.4.8 Bulk density

Bulk density shall be determined as described in ISO 12086-2. Codes and ranges are listed in Table 17.

**Table 17 — Codes and ranges for bulk density in data block 3**

| Code | **Bulk density** (g/l) |
|---|---|
| **1** | < 500 |
| **2** | 500 to 800 |
| **3** | > 800 |

### 5.4.9 Powder-flow time

Powder-flow time shall be determined as described in ISO 12086-2. Codes and ranges are listed in Table 18.

**Table 18 — Codes and ranges for powder-flow time in data block 3**

| Code | **Powder-flow time** (s) |
|---|---|
| **0** | Test inappropriate |
| **1** | < 10 |
| **2** | 10 to 20 |
| **3** | > 20 |

### 5.4.10 Extrusion pressure

Extrusion pressure shall be determined by the procedure described in ISO 12086-2. Codes and ranges are listed in Table 19.

**Table 19 — Codes and ranges for extrusion pressure in data block 3 (determined using a reduction ratio of 400:1)**

| Code | **Extrusion pressure** (MPa) |
|---|---|
| **1** | < 15 |
| **2** | 15 to 35 |
| **3** | > 35 |

### 5.4.11 Contamination

Specification for freedom from contamination may be established by agreement between the seller and the purchaser.

## 5.5 Data block 4

Data block 4 is used to indicate:

— the type of filler or reinforcing material used as an additive;

— the physical form of the additive.

These items can be coded as specified in ISO 1043-2. Table 20 lists codes for types and forms of typical additive material. The additive content may be coded by figures representative of the nominal percentage mass content of the material, separated from the code for the material itself by a hyphen "-" if required for clarity. Mixtures of materials, forms of materials (powder, fibre, etc.), or both, are designated by combining the codes using a "+" sign.

**Table 20 — Codes for fillers and reinforcing materials in data block 4**

| Code | Material | Code | Form/structure |
|---|---|---|---|
| **B** | Boron | **B** | Bead, spheres, balls |
| **C** | Carbon | **C** | Chips, cuttings |
| **C1** | Coke | **D** | Powder |
| **C2** | Partially graphitized carbon | **F** | Fibre |
| **C-G** | Graphite | **G** | Ground |
| **E** | Clay | **H** | Whiskers |
| **G** | Glass | **K** | Knitted fabric |
| **K** | Calcium carbonate | **L** | Layer |
| **M** | Mineral, metal | **M** | Mat (thick) |
| **M1** | Aluminium oxide | **N** | Non-woven and thin |
| **M2** | Bronze | **P** | Paper |
| **M3** | Calcium fluoride | **S** | Rovings |
| **M4** | Molybdenum disulfide | **T** | Scales, flakes |
| **M5** | Stainless steel | **V** | Cord |
| **P** | Mica | **W** | Veneer |
| **Q** | Silica | **X** | Not specified |
| **R** | Aramid | **Y** | Yarn |
| **S** | Synthetic, organic | **Z** | Others |
| **S-X** | X is the abbreviated term for a polymer used as the filler | | |
| **T** | Talcum | | |
| **X** | Not specified | | |
| **Z1** | In-house-recovered material | | |
| **Z2** | Reprocessed material | | |
| **X3** | Postconsumer material | | |

## 5.6 Data block 5

Use of this data block provides for specification of fluoropolymer materials in addition to designation. As mentioned earlier in the general discussion of the data block system, this may be done by explicit reference to specific properties, to a suitable national standard, or to a combination of the two. Test methods provided in ISO 12086-2 shall be used to determine the properties specified. The properties that may be specified are not limited to the designatory properties. Codes and ranges are included in ISO 12086-2 for some properties that are often required for specifications but that are not used for designation and, therefore, are not included in this part of ISO 12086. Additional discussion and examples for guidance on the use of data block 5 are provided in Clause 7.

## 5.7 Designatory properties for fluoropolymers

### 5.7.1 Designatory properties applicable to all fluoropolymers

#### 5.7.1.1 General

For each polymer, usually only one of the properties listed in 5.7.1.2 to 5.7.1.5 will be selected as the designatory property. An exception involves mechanical properties, for which one or more properties may be selected in accordance with Annex A or B.

#### 5.7.1.2 Thermal-transition temperatures, °C

Melting-peak temperature, $T_m$ (for crystalline polymers).

Glass-transition temperature, $T_g$ (for amorphous polymers).

#### 5.7.1.3 Relative molecular mass

Melt mass-flow rate (MFR), g/10 min (dg/min) (for conventional thermoplastic materials and PTFE-F).

Standard specific gravity (SSG) (for PTFE-type materials except PTFE-F).

Zero-strength time (ZST), s (for PCTFE only).

#### 5.7.1.4 Mechanical properties

Tensile stress at yield (yield stress), MPa (for PVDF and its copolymers).

Tensile stress at break (tensile strength), MPa (for other fluoropolymers).

Percentage elongation at break.

Tensile modulus, MPa (for PVDF and its copolymers).

#### 5.7.1.5 Density, g/cm$^3$

### 5.7.2 Designatory properties specific to particular classes of fluoropolymer

#### 5.7.2.1 Dispersions

**5.7.2.1.1** Polymer in the dispersion expressed as a percentage of the mass of the dispersion.

**5.7.2.1.2** Surfactant in the dispersion expressed as a percentage of the mass of the polymer.

#### 5.7.2.2 PTFE and related polymers that usually are not processed by typical extrusion, injection moulding, etc.

(include the requirements of 5.7.2.2.1 for the polymer isolated from PTFE dispersions)

**5.7.2.2.1** All properties from 5.7.1 (in 5.7.1.3, use SSG).

**5.7.2.2.2** Particle or agglomerate size for PTFE powders.

**5.7.2.2.3** Bulk density for PTFE powders.

**5.7.2.2.4** Powder-flow time for PTFE powders.

**5.7.2.2.5** Extrusion pressure for emulsion-polymer PTFE.

#### 5.7.2.3 Conventional thermoplastic fluoropolymers

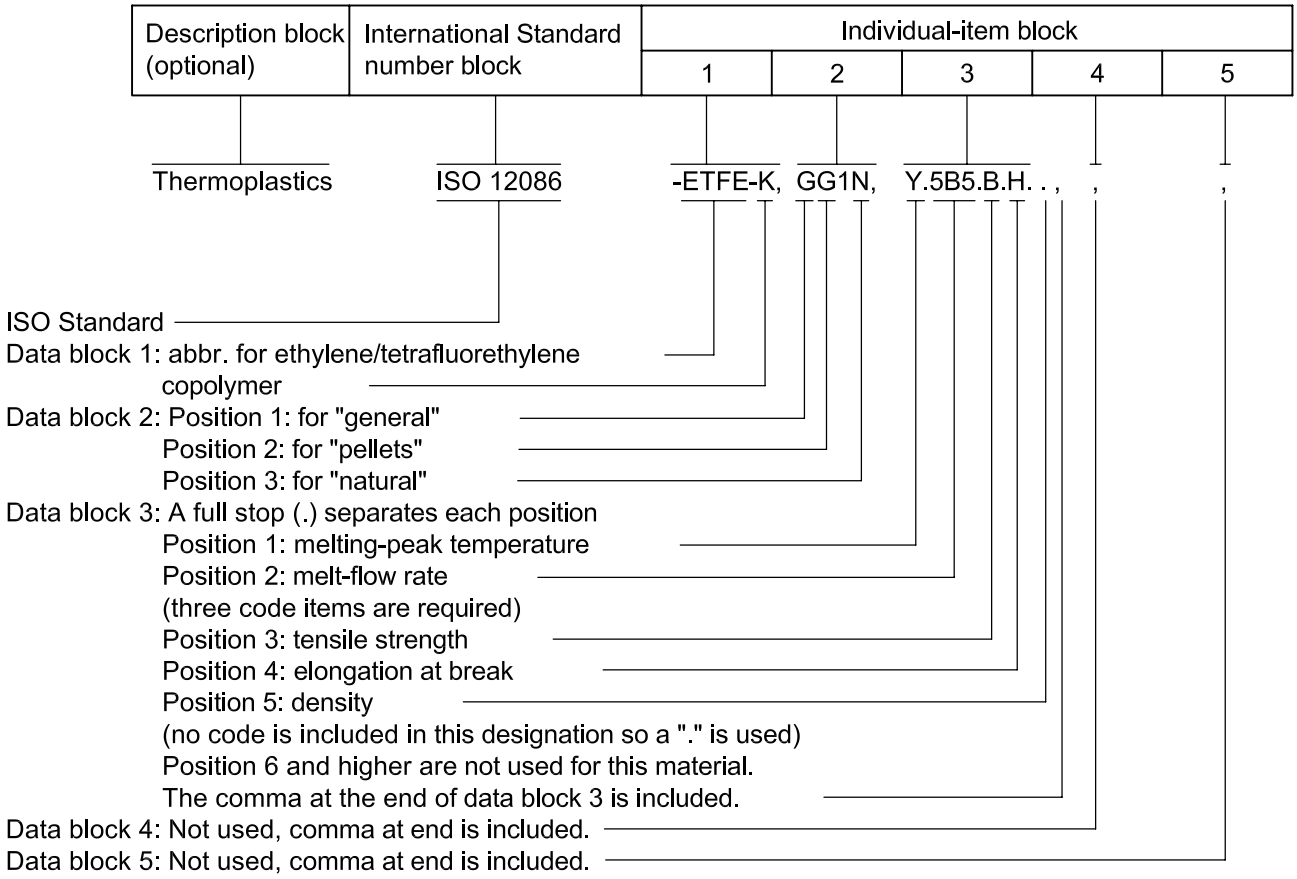
Conventional thermoplastic fluoropolymers require use of all the properties listed in 5.7.1. In 5.7.1.3 use melt-flow rate (except for PCTFE where ZST shall be used).

## 6 Example of a designation

ETFE fluoropolymer material for general-purpose moulding and extrusion.

**Designation:** Thermoplastics ISO 12086-ETFE-K,GGIN,Y.5B5.B.H..,,,

Detailed explanation of the designation:




## 7 Specifications for fluoropolymers

**7.1** Data block 5 provides for converting a designation into a specification. Four preferred ways to use data block 5 are outlined below with examples of each procedure. Other systems that will provide the information needed for a specification may be used.

**7.2** Convert a designation into a specification by placing an asterisk "*" before the code for a property in data block 3 and then including an asterisk at a corresponding place in data block 5 to indicate that the data block limits shown in the designation are specification limits and that the provisions in Subclause 5.3 are not in effect. One or more properties may be chosen in defining a specification.

EXAMPLE Provide a designation and specification, where each designatory property is desired as part of the specification with the specification limits equal to the range limits, for a PVDF homopolymer, suspension-polymerized, standard grade for extrusion, sold as natural-coloured granules and having:

— a melting point between 170 °C and 180 °C;

— an MFR between 5 and 10 when tested at 230 °C and 5 kg load;

— a tensile yield stress between 50 MPa and 55 MPa;

— an elongation at break between 50 % and 100 %;

— a tensile modulus between 2 000 MPa and 3 000 MPa; and

— a density between 1,7 g/cm$^3$ and 1,8 g/cm$^3$.

(These properties describe a Type II PVDF as defined in ASTM D 3222.)

The designation and specification is:

ISO 12086-PVDF-S,EGN,*Q.*6E5.*I.*B.*F.*C,,*.*.*.*.*.*

**7.3** Convert a designation into a specification by including in data block 5 a property selected from the list in this part of ISO 12086 or from ISO 12086-2 and providing the required values directly or by use of range tables. There are instances where the values given in the range tables are not satisfactory for specification purposes. To indicate this situation, a question mark "?" may be used in data block 3 in place of the code for the values, and the range of values for the specification is included in parentheses (curved brackets) at the corresponding position in data block 5.

EXAMPLE A VDF/HFP random copolymer, standard grade for extrusion, sold as natural-coloured granules and having:

— a melting point between 130 °C and 140 °C;

— an MFR between 4 and 8 when tested at 230 °C and 5 kg load;

— a tensile yield stress between 15 MPa and 20 MPa;

— an elongation at break between 600 % and 800 %;

— a tensile modulus less than 500 MPa; and

— a density between 1,7 g/cm$^3$ and 1,8 g/cm$^3$.

Two of these properties are specifically required, namely high flexibility, shown by the tensile modulus below 500 MPa, and an MFR value between 4 and 8. At this time, there is no generally accepted standard that includes a material meeting these requirements. Consequently, the specification cannot be made by reference to an existing standard.

The designation and specification is:

ISO 12086-VDF/HFP-R,EGN,M.?E5.B.K.*A.C,,?(4-8).*

**7.4** Convert a designation into a specification by using data block 5 with reference to an ASTM standard. This use of data block 5 is based on the general format shown in Table 21. Annex D includes a list of widely used ASTM standard specifications for fluoropolymers that are available for reference when the system described in Examples 1 and 2 is selected for specification purposes.

EXAMPLE 1 Specification of a PTFE resin using an ASTM standard specification:

**Table 21 — Specification using data block 5**

| Standard number block | Type | Grade | Class | Special notes |
|---|---|---|---|---|
| EXAMPLE ASTM D 4895 | I | 2 | C | |

The entry ",ASTM D 4895.I2C" in data block 5 would specify an emulsion-polymer form of polytetrafluoroethylene that had all of the properties listed for that type, grade and class in the appropriate specified properties, tables, or both, in the specification identified. A full stop "." is used as the separator between the standard number and the type. Separators are not needed between the type, grade and class. A zero "0" shall be included between the codes for type and class if no grade is included in the specification. Provision for special notes is included so that other information can be furnished when required. When special notes are used, they shall be preceded by a full stop.

EXAMPLE 2 Specification of a PVDF material using an ASTM standard specification:

A specification for the PVDF material described in 7.2 would be:

ISO 12086-PVDF-S,EGN,Q.6E5.I.B.F.C,,ASTM D 3222.II

**7.5** Convert a designation into a specification by using data block 5 in which the procedures described in 7.2 and 7.3 are combined with reference to national standard specifications as described in 7.4.

EXAMPLE Material similar to that described in the example given in 7.2 is to be specified, with the added requirement that the MFR under the conditions of the test shall be 4 g/10 min to 6 g/10 min.

The designation and specification is:

ISO 12086-PVDF-S,EGN,Q.?CE.I.B.F.C,,ASTM D 3222.II.?(4-6)

# 8 Packaging and marking

## 8.1 Packaging

The material shall be packaged in standard commercial containers so constructed as to ensure acceptance by common or other carriers for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

## 8.2 Marking

Shipping containers shall be marked with the name of the material, the type of material and the quantity contained therein. All packing, packaging and marking provisions of ASTM D 3892 shall apply to this part of ISO 12086.

# 9 Sampling

Sampling shall be statistically adequate to satisfy the requirements of this part of ISO 12086.

# Annex A
(normative)

# Designatory properties for common fluoropolymer types

ISO 12086 is particularly concerned with, but is not limited to, the materials included in this annex. In Tables A.1 and A.2, X indicates that the property concerned is used as a designatory property.

**Table A.1 — Polytetrafluoroethylene (PTFE)** [a]

| | S | E | SS | Z | F | D |
|---|---|---|---|---|---|---|
| **Thermal properties** | | | | | | |
| Melting-peak temperatures | X | X | X | X | X | X |
| Glass-transition temperature | | | | | | |
| **Relative molecular mass** | | | | | | |
| SSG | X | X | | | | X |
| MFR (use three codes — value, temperature, load) | | | | | X | |
| ZST | | | | | | |
| **Mechanical properties** | | | | | | |
| Tensile strength | X | X | | | | |
| Thickness of specimen | X | | | | | |
| Percentage elongation at break | X | X | | | | |
| **Dispersions** | | | | | | |
| Percentage polymer | | | | | | X |
| Percentage surfactant | | | | | | X |
| **Particle size** | X | X | X | X | X | |
| **Bulk density** | X | X | X | | X | |
| **Powder-flow time** | X | | X | | | |
| **Extrusion pressure** | | X | | | | |

[a] In some countries:

S (suspension material) is known as granular PTFE;

E (emulsion polymer) is known as CD (coagulated dispersion) or FP (fine powder);

SS (suspension sintered) is known as presintered granular;

D (dispersion) is known as emulsion;

F (filler resin) includes the materials often referred to as micropowders or L (lubricating) powders.

See Table 1 for further description of the code-letters.

**Table A.2 — Conventional thermoplastic fluoropolymers**

| | AF | Group I | | Group II | PCTFE | PVF |
|---|---|---|---|---|---|---|
| | | PFA<br>FEP<br>EFEP<br>ETFE | ECTFE<br>VDF/TFE/HFP<br>VDF/TFE | PVDF<br>VDF/HFP<br>VDF/CTFE | | |
| **Thermal properties** | | | | | | |
| Melting-peak temperature | | | X | X | X | X |
| Glass-transition temperature | X | | | | | |
| **Relative molecular mass** | | | | | | |
| SSG | | | | | | |
| MFR (use three codes — value, temperature, load) | X | | X | X | | X |
| ZST | | | | | X | |
| **Mechanical properties** [a] | | | | | | |
| Tensile yield stress | | | | X | | |
| Tensile strength | X | | X | X | | X |
| Percentage elongation at break | X | | X | X | X | X |
| Tensile modulus | | | | X | | |
| **Density** [a] | X | | X | X | X | X |
| **Dispersions** [b] | | | | | | |
| Percentage polymer | X | | X | X | | |
| Percentage surfactant | X | | X | X | | |
| **Particle size** [c] | X | | X | X | X | |

[a] Only for pellets of conventional thermoplastic fluoropolymers.

[b] Only for dispersions of conventional thermoplastic fluoropolymers.

[c] Only for powders of conventional thermoplastic fluoropolymers.

# Annex B
(normative)

# Designatory properties for common fluoropolymer types with cross-reference listing to the tables for codes in ISO 12086-1 and the test methods in ISO 12086-2

ISO 12086 is particularly concerned with, but is not limited to, the materials listed in this annex.

| | From ISO 12086-1 Table No. for codes | From ISO 12086-2 Test method subclause |
|---|---|---|
| **PTFE-S Polytetrafluoroethylene suspension powder** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Standard specific gravity (SSG) | 4 | 10.6 |
| Tensile strength | 9 | 8.2.2 |
| Thickness of test specimen | 12 | |
| Percentage elongation at break | 10 | 8.2.2 |
| Particle size | | |
| by wet-sieve analysis | 16 | 8.6 |
| by dry-sieve analysis | 16 | 8.6 |
| Bulk density | 17 | 10.3 |
| Powder-flow time | 18 | 10.5 |
| **PTFE-E Polytetrafluoroethylene emulsion powder** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Standard specific gravity (SSG) | 4 | 10.6 |
| Tensile strength | 9 | 8.2.2 |
| Percentage elongation at break | 10 | 8.2.2 |
| Particle size by dry-sieve analysis | 16 | 8.6 |
| Bulk density | 17 | 10.3 |
| Extrusion pressure | 19 | 10.4 |
| **PTFE-SS Polytetrafluoroethylene presintered material** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Particle size by dry-sieve analysis | 16 | 8.6 |
| Powder-flow time | 18 | 10.5 |
| Bulk density | 17 | 10.3 |
| **PTFE-Z Reprocessed polytetrafluoroethylene powder** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Particle size by dry-sieve analysis | 16 | 8.6 |
| **PTFE-F Polytetrafluoroethylene filler resin** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Melt mass-flow rate | 5 | 11.2 |
| Particle size by resistance-variation analysis | 16 | 8.6.4 |
| **PTFE-D Polytetrafluoroethylene dispersion** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Standard specific gravity (SSG) | 4 | 10.6 |
| Percent polymer in dispersion | 14, 15 | 9.5 |
| Percent surfactant in dispersion | 14, 15 | 9.5 |

| | | |
|---|---|---|
| **TFE/PDD-AF Tetrafluoroethylene-perfluorodioxole copolymer (amorphous fluoropolymer)** | | |
| Glass-transition temperature | 3 | 8.3.3 |
| Tensile properties [a] | 9 to 12 | 8.2.2 |
| Density | 13 | 8.4 |
| Percent polymer in dispersions [b] | 14, 15 | 9.5 |
| Percent surfactant in dispersions [b] | 14, 15 | 9.5 |
| Particle size [c] | 16 | 8.6 |
| **CONVENTIONAL THERMOPLASTICS — GROUP I** | | |
| **PFA Perfluoro(alkoxy alkane)** | | |
| **FEP Perfluoro(ethylene-propene) copolymer** | | |
| **ETFE Ethylene-tetrafluoroethylene copolymer** | | |
| **E/TFE/HFP (EFEP) Ethylene-tetrafluoroethylene-hexafluoropropene copolymer** | | |
| **VDF/TFE Vinylidene fluoride-tetrafluoroethylene copolymer** | | |
| **VDF/TFE/HFP Vinylidene fluoride-tretrafluoroethylene-hexafluoropropene copolymer** | | |
| **ECTFE Ethylene-chlorotrifluoroethylene copolymer** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Melt mass-flow rate (three codes — value, temperature and load) | 5 | 11.2 |
| Tensile strength [a] | 9 | 8.2.2 |
| Percentage elongation at break | 10 | 8.2.2 |
| Density [a] | 13 | 10.6 |
| Percent polymer in dispersions [b] | 14, 15 | 9.5 |
| Percent surfactant in dispersions [b] | 14, 15 | 9.5 |
| Particle size [c] | 16 | 8.6 |
| **CONVENTIONAL THERMOPLASTICS — GROUP II** | | |
| **PVDF Poly(vinylidene fluoride)** | | |
| **VDF/HFP Vinylidene fluoride-hexafluoropropene copolymer** | | |
| **VDF/CTFE Vinylidene fluoride-cholorotrifluoroethylene copolymer** | | |
| Melt mass-flow rate (three codes — value, temperature and load) | 3 | 8.3.3 |
| Tensile modulus | 5 | 11.2 |
| Tensile yield stress [a] | 9 | 8.2.2 |
| Percentage elongation at break [a] | 10 | 8.2.2 |
| Melting-peak temperature | 11 | 8.2.2 |
| Density [a] | 13 | 10.6 |
| Percent polymer in dispersion [b] | 14, 15 | 9.5 |
| Percent surfactant in dispersion [b] | 14, 15 | 9.5 |
| Particle size [c] | 16 | 8.6.4 |
| **PVF Poly(vinyl fluoride)** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Melt mass-flow rate (three codes — value, temperature and load) | 5 | 11.2 |
| Tensile strength | 9 | 8.2.2 |
| Percentage elongation at break | 10 | 8.2.2 |
| Density [a] | 13 | 8.4 |
| **PCTFE Polychlorotrifluoroethylene** | | |
| Melting-peak temperature | 3 | 8.3.3 |
| Zero-strength time | 8 | 12.3 |
| Tensile strength | 9 | 8.2.2 |
| Percentage elongation at break | 10 | 8.2.2 |
| Density [a] | 13 | 8.4 |
| Particle size [c] | 16 | 8.6 |

[a] Only for pellets of conventional thermoplastic fluoropolymers.
[b] Only for dispersions of conventional thermoplastic fluoropolymers.
[c] Only for powders of conventional thermoplastic fluoropolymers.

# Annex C
(informative)

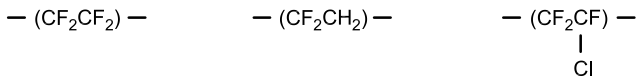
# The fluoropolymer family

The fluoropolymer family includes the fluorocarbon resins (those made from perfluoromonomers) and other fluoropolymers that contain H, Cl or other non-fluorine atoms bonded to some of the carbon atoms. The major fluoromonomers used to make fluoropolymers include, but are not limited to, tetrafluoroethylene (TFE), vinylidene fluoride (VDF) and chlorotrifluoroethylene (CTFE). The comonomers often used include perfluorocomonomers such as perfluoro(alkyl vinyl ether)s (PAVEs) and hexafluoropropene (HFP) as well as combinations of the major monomer components. Ethylene also is an important comonomer.

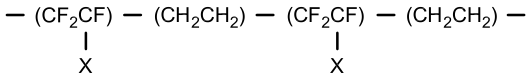
Fluoropolymers can be modified with small amounts of various fluoromonomers. The acceptable limits for the amount of modifier are presented in 1.2.

The dominant repeating unit in the molecular chain for materials based on TFE, VDF and CTFE is, respectively:

**PTFE** **PVDF** **PCTFE**



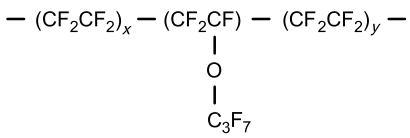
with units from the one or more comonomers that are used in some products randomly distributed along the chain. Exceptions are the materials made using TFE or CTFE and ethylene that usually are alternating copolymers as shown below, where the halogen atom, indicated by X, is F or Cl, depending on which fluoromonomer is used:



Commercial ETFE polymers often contain small amounts of additional comonomers within the five percent limit specified in 1.2.

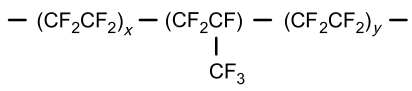
All of the fluoropolymers included in ISO 12086 are formally classed as thermoplastic polymers. The very high melt viscosity of most of the materials that are essentially PTFE, however, generally does not permit use of the procedures common with conventional thermoplastics, and requires special processing techniques. Most of the other fluoropolymers and copolymers are, like other conventional thermoplastics, usually processed in the melt by normal procedures. Conventional thermoplastic fluoropolymer materials are available as pellets, as powder and often as dispersions. The lists of designatory and specification properties indicate those properties to be selected for each type of material.

PFA fluorocarbon materials are long-chain copolymers of tetrafluoroethylene (TFE) with perfluoro(propyl vinyl ether), as shown below, or another PAVE. The repeating unit in the molecular chain is:

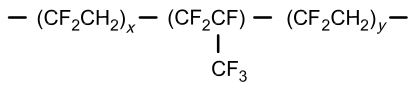


FEP fluorocarbon materials are long-chain copolymers of tetrafluoroethylene (TFE) with hexafluoropropene (HFP).

The repeating unit in the molecular chain is:



An example of a fluoropolymer made from a non-fluorocarbon monomer is poly(vinylidene fluoride-co-hexafluoropropene)



Fluoropolymer dispersions are colloidal-sized particles of long-chain synthetic fluoropolymers in a liquid. ISO 12000 provides definitions and reviews general test methods for this type of material. With some fluoropolymers, such as defined for PTFE, the homopolymer may be modified during polymerization with not more than one percent of one or more different fluoroolefins. The dispersion may be stabilized by one or more added surfactants. In addition to the base polymer and surfactant, other non-fluoropolymer materials may be present for special purposes — but, in total, not more than ten percent by mass of the fluoropolymer in the dispersion.

NOTE With TFE, the polymerization mechanism does not meet the formal requirements for it to be considered an emulsion polymerization, although the dispersion is often called an emulsion or latex. The term originally used for this class of materials was “suspensoid”.

Fluoropolymers can be manufactured in essentially completely crystalline, semicrystalline or amorphous states. It may not be possible to make any given fluoropolymer in more than one of the states. A consequence is that the types of major thermal transition can be different for different fluoropolymers. The crystalline and semicrystalline polymers will have a melting endotherm with a reportable peak temperature. The semi-crystalline polymers do have one or more glass transitions and potential for other crystal forms that have different melting-peak temperatures. The intensity of the glass transition(s) is usually much smaller than that of the melting-peak. For this reason, the preferred designatory property for semicrystalline materials is the melting-peak temperature.

# Annex D
(informative)

# Standard specifications for fluoropolymers

ASTM D 1430, *Standard Classification System for Polychlorotrifluoroethylene (PCTFE) Plastics*

ASTM D 2116, *Standard Specification for FEP-Fluorocarbon Molding and Extrusion Materials*

ASTM D 3159, *Standard Specification for Modified ETFE-Fluoropolymer Molding and Extrusion Materials*

ASTM D 3222, *Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding, Extrusion and Coating Materials*

ASTM D 3275, *Standard Classification System for E-CTFE-Fluoroplastic Molding, Extrusion, and Coating Materials*

ASTM D 3307, *Standard Specification for Perfluoroalkoxy (PFA)-Fluorocarbon Molding and Extrusion Materials*

ASTM D 4441, *Standard Specification for Aqueous Dispersions of Polytetrafluoroethylene*

ASTM D 4894, *Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials*

ASTM D 4895, *Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion*

ASTM D 5675, *Standard Specification for Fluoropolymer Micropowders*

JIS K 6896, *Polytetrafluoroethylene Powder for Molding and Extrusion Materials*

# Annex E
(informative)

# Listing of test methods included in ISO 12086-2 (in alphabetical order)

# Annex F
(informative)

# Brief instructions for use of this part of ISO 12086

## F.1 General

This part of ISO 12086 uses the conventional ISO system of five data blocks for the designation and specification of fluoropolymers. A detailed description of the system is given in the main text. This annex is included, however, to help the user read quickly the designation or specification for a fluoropolymer. The information for a particular fluoropolymer is included in the five data blocks using a system of code-letters and numbers. This system is outlined below.

Data block 1 gives the abbreviation of the name of the fluoropolymer from the list in Clause 4. Also included in data block 1 is one piece of information about the fluoropolymer using the codes from Table 1.

Data block 2 uses the codes in Table 2 to provide information in position 1 about the methods of processing recommended for the fluoropolymer or the intended application. Positions 2 to 8 use the codes from Table 2 to indicate the form of the fluoropolymer as well as specific special characteristics.

Data block 3 is used for the designation proper. This designation is a general description of the fluoropolymer in terms of key properties. For each polymer type, several properties have been selected as designatory properties and these properties may be different for different fluoropolymers. The properties are to be determined in accordance with the methods in part 2 of this International Standard. A list of the designatory properties for each fluoropolymer type is given in Annexes A and B. For a given polymer, refer first to Annex A or B to see the list of designatory properties and the number of code positions that are required for it. The codes from Tables 3 to 19 are included in data block 3 in the same order as they are presented in Annex A or B. A full stop or period (.) is used to separate the code or codes in a position. If a property scheduled to be included is not used, this is shown by including the full stop that otherwise would have been at the end of the codes. The additional signs * and ? have special uses in transforming a designation into a specification. These features are outlined below in the discussion of data block 5.

Data block 4 is used for filled or reinforced grades of fluoropolymer. Codes from Table 20 are used to designate the type and amount of additive.

Data block 5 is used to convert the designation into a specification. This conversion is described in detail in Clause 7. There are four ways provided for accomplishing the conversion. Examples of each method are presented in Clause 7 and outlined below.

a) When the limits of a range corresponding to a code are identical to the limits of the specification range, include an asterisk (*) before the code item in data block 3 and repeat the asterisk in data block 5.

b) When the limits of ranges in data block 3 are not appropriate for specification purposes, the code for the property in data block 3 is replaced by a question mark (?) and the question mark is repeated in data block 5, followed by the values required for specification of the property. One or several properties can be used for specification by combining use of * and ?.

c) For a polymer that is specified in a current ASTM standard, direct reference can be made to that standard in data block 5.

d) The features of a), b) and c) can also be combined.

## F.2 Decoding a given designation or specification

NOTE Data blocks are separated by commas. Omission of a data block is shown by including the comma for the end of the block, thus doubling the separator sign.

a) Determine which fluoropolymer is being designated from the abbreviation in data block 1 and the list in Clause 4.

b) Using data block 2 and the codes listed in Table 2, check the intended method of processing, intended application or special characteristics.

c) Using data block 3:

   1) determine which are the designatory properties for the particular fluoropolymer from the lists in Annex A or B;

   2) determine the values of the designatory properties from the codes and their explanations in Tables 3 to 19.

d) If data block 4 is included, use the codes from Table 20 to identify any additive and its concentration.

e) The presence of data block 5 shows that the designation has been converted into a specification by using one of the four approaches outlined above in this annex and discussed in detail with examples in Clause 7.

**ICS 83.080.20**

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