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ISO 12086-1

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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

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Contents

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

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*

Annexes A and B form an integral part of this part of ISO 12086. Annexes C, D, E and F are for information only.

Plastics — Fluoropolymer dispersions and moulding and extrusion materials —

Part 1:
Designation system and basis for specifications

1 Scope

1.1 ISO 12086-1 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 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. 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 fluoromonomer(s) 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 informative 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 5.3 and those properties to be designated for each fluoropolymer are listed in 5.6 and in normative 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 shall be 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 also should be emphasized, i.e. materials with different designations may be suitable for use in the same application. ISO 12086-1 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 shall be determined in accordance with the test methods specified in ISO 12086-2, if suitable.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12086. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12086 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 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles.*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics.*

ISO 842:1984, *Raw materials for paints and varnishes — Sampling.*

ISO 1043-1:1987, *Plastics — Symbols — Part 1: Basic polymers and their special characteristics.*

ISO 1043-2:1988, *Plastics — Symbols — Part 2: Fillers and reinforcing materials.*

ISO 1133:1991, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.*

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

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

ASTM D 1430-91a, *Specification for polychlorotrifluoroethylene (PCTFE) plastics.*

ASTM D 1600-93, *Terminology for abbreviated terms relating to plastics.*

ASTM D 3222-91a, *Specification for unmodified poly(vinylidene fluoride) (PVDF) molding, extrusion, and coating materials.*

ASTM D 3418-83(1988), *Test method for transition temperatures of polymers by thermal analysis.*

ASTM D 3892-93, *Practice for packaging/packing of plastics.*

ASTM D 4591-93a, *Test method for determining temperatures and heats of transitions of fluoropolymers by differential scanning calorimetry.*

ASTM D 4895-91a, *Specification for polytetrafluoroethylene (PTFE) resins produced from dispersion.*

3 Definitions

3.1 The terminology given in ISO 472 is applicable to this part of ISO 12086, except for terms defined in 3.2. The terms listed in 3.1.1 to 3.1.3 are repeated from ISO 472 to be sure there is no misunderstanding.

3.1.1 dispersion: A heterogeneous system in which a finely divided material is distributed in another material.

3.1.2 fluoroplastic: A plastic based on polymers made with 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.

3.1.3 latex: A colloidal aqueous dispersion of a polymeric material.

3.2 For the purposes of this part of ISO 12086, the following additional definitions apply.

3.2.1 amorphous: Noncrystalline, or devoid of regular structure.

3.2.2 bulk density: The mass (in grams) per litre of material, measured under the conditions of the test.

3.2.3 copolymer: A polymer formed from two or more types of monomer.

3.2.4 emulsion polymer (as it applies to fluoropolymer materials)**:** Material isolated from its polymerization medium as a colloidal aqueous dispersion of the polymer solids.

NOTE 1 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.

3.2.5 fluorocarbon plastic: A plastic based on polymers made from perfluoromonomers only.

3.2.6 fluoroelastomer: An 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.

3.2.7 fluoropolymer: Synonymous with *fluoroplastic* (see 3.1.2).

3.2.8 melt-processible: Capable of being processed by, for example, injection moulding, screw extrusion, and other operations typically used with thermoplastics.

3.2.9 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 2 With PTFE, "moulding" and "compaction" are terms used interchangeably with "preforming".

3.2.10 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.

3.2.11 reprocessed plastic: Material from the manufacture of semifinished forms of fluoropolymers that has been converted to a form suitable for further use.

NOTES

3 This material is often referred to as byproduct from processing.

4 Related definitions are presented in ASTM D 5033-90, *Guide for the development of standards relating to the proper use of recycled plastics.*

3.2.12 sintering: A thermal treatment during which the material is melted and recrystallized by cooling, with coalescence occurring during the treatment.

3.2.13 standard specific gravity (SSG): The 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 5 The SSG of unmodified PTFE is inversely related to its molecular mass.

3.2.14 suspension polymer: A polymer isolated from its liquid polymerization medium as a solid having a particle size well above colloidal dimensions.

3.2.15 zero-strength time (ZST): A 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):

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

4.3 For the purposes of this part of ISO 12086, the following abbreviated terms apply in addition to those given in 3.2 and 4.2.

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

5 Designation system

The designation system for thermoplastics is based on the following standardized 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 coding, 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 related to composition of the polymer (see 5.1).

Data block 2: Position 1: Intended application or method of processing (see 5.2).
Positions 2 to 8: Important properties, additives, and supplementary information (see 5.2).

Data block 3: Designatory properties (see 5.3 and 5.6).

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 5.4).

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 five data blocks shall be separated from each other by commas. If a data block is not used, the comma that would be at its end shall be included, thus resulting in a doubling of the separation sign (,,).

5.1 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 letters in data block 1
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

5.2 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 supplemental information, if requested, (up to seven items) is given 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 & 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 modified
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

5.3 Data block 3

Each member of the fluoropolymer family has its own set of designatory properties selected from the properties listed below and discussed further in 5.6. 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 subclause 5.6 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 se-

quence, "..", 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 6 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.

5.3.1 Transition temperatures

5.3.1.1 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.

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