Designation: D5575 – 18 (Reapproved 2023)

Standard Classification System for Copolymers of Vinylidene Fluoride (VDF) with Other Fluorinated Monomers[1]

This standard is issued under the fixed designation D5575; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This classification system covers both developing property designations and specifications for thermoplastic compositions consisting of vinylidene fluoride (VDF) polymers modified with other fluoromonomers and property-enhancing additives. The other fluoromonomers include one or more of the following: hexafluoropropylene (HFP), tetrafluoroethylene (TFE), and chlorotrifluoroethylene (CTFE). The additives are those that improve its flame resistance, processing, or physical properties. However, these additives are not normally considered to be reinforcing. This classification system covers thermoplastic compositions supplied in pellet or powder forms.

1.2 A designation or specification applies only to the virgin polymers prepared from vinylidene fluoride (>50 weight %) with one or more of the following comonomers: hexafluoropropylene, tetrafluoroethylene, and chlorotrifluoroethylene. Some polymers contain additives to enhance certain properties.

1.3 This system constitutes a line callout as a means of designating and specifying properties of VDF-based copolymers. At least four of the designated properties are used to define a polymer's specification. Specification criteria from international documents can be used if their criteria match designation properties currently used by this classification system.[2] This classification system is not intended for the selection of materials.

1.4 The manufacturer of the virgin resin shall establish the designation of a resin based on the property value criteria in this classification system.

1.5 The minimum specification properties are established by this classification system. Additional specification properties, based on the designation properties cited, can be established by the resin supplier and customer.

1.6 The values stated in SI units are to be regarded as standard.

1.7 The property tests are intended to provide information for specifications of modified VDF-copolymer compositions. It is not the purpose of this classification system to provide engineering data for design purposes.

NOTE 1—Although the values listed in Table 1, Table 2, Table 3, Table 4, and Table 5 are necessary to include the range of properties available in existing materials, they are not to be interpreted as implying that every possible combination of the properties exists or can be obtained. It is possible for a user or designer, using Tables 1-5, to call out property relationships that are physically impossible to occur in a copolymer made using current technology.

NOTE 2—Many of these polymers exhibit polymorphism.[3] The type and extent of crystalline structure will vary with the thermomechanical history of the sample. Properties vary based on the technique used to prepare the specimens.

1.8 Test methods used in this classification system can result in the incidental production of hazardous materials. Modified VDF polymer fluoroplastics melt between 90 and 182°C (194 and 359°F) and are thermally stable up to about 350°C (662°F), or somewhat higher, depending on the composition. (**Warning—**Evolution of corrosive, colorless, and toxic hydrogen fluoride can occur under certain conditions.)

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* See Warning in 1.8 and Section 10 for specific hazards statements.

NOTE 3—Many, but not all of the codes and specifications found in this classification system are also in ISO 12086-1 and ISO 12086-2.

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

[1] This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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This standard is needed to cover commercial products outside the scope of Specification D3222.

[2] Fluoropolymer property specification data from international standards can include properties intentionally excluded from this classification system (for example, composition). The only property criteria from other documents that can be used are those having similar properties allowed under the designation system.

[3] Lovinger, A. J., "Poly(vinylidene fluoride)," *Developments in Crystalline Polymers,* Vol 1, Chapter 5, D.C. Bassett, Ed., Applied Science, London, 1982.

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Codes for the Information on Fluoropolymers Used in Data Block 1

Code	Meaning
A	modified
B	block copolymer
H	homopolymer
K	copolymer
L	graft polymer
R	random copolymer
Z	other

TABLE 2 Code-Letters Used in Data Block 2 (Intended Application or Method of Processing, Essential Properties, Additives, or Other Information

Code	Position 1	Code	Positions 2 to 8
A	adhesives	C	colored
B	blow molding	D	powder
B1	extrusion blow molding	D2	free-flowing
B2	injection blow molding	D3	not free-flowing
C	calendaring	E	expandable
E	extrusion	F	special burning characteristics
G	general use	F1	nonflammable
H	coating	F2	flame retarded
H1	powder coating	F4	reduced smoke emission
H2	dip coating	G	granules
K	cable and wire coating	G1	pellets
L	monofilament extrusion	L	light and weather stabilized
M	molding (injection/transfer)	M	nucleated
Q	compression molding	N	natural (no color added)
R	rotational molding	N1	suitable for food contact
V	thermoforming	N2	high purity
X	no indication	P	impact modified
Y	textile yarns, spinning	R	mold release agent
Z	other	S	lubricated
		T	transparent
		T1	translucent
		T2	opaque
		W1	improved chemical resistance
		Y	increased electrical conductivity
		Z	antistatic

TABLE 3 Designatory and Specification Properties for Data Block 3

Position Number[A]	Property
1	[B] melt temperature
2	[B] melt flow rate/melt viscosity
3	[B] tensile strength and modulus
4	tensile elongation
5	[B] density
6	electrical
7	flammability by oxygen index (OI)
8	specimen preparation method and type

[A] Property test information for Positions 1 to 7 are given in Section 8.
[B] Positions 1, 2, 3, and 5 are mandated as the minimum specification properties.

Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*[4]

NOTE 4—For ASTM and ISO documents, the equivalent or a comparable method is listed after each citation in parentheses.

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
D257 Test Methods for DC Resistance or Conductance of Insulating Materials
D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1600 Terminology for Abbreviated Terms Relating to Plastics
D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
D3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
D3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer
D3892 Practice for Packaging/Packing of Plastics
D4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry
D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D5740 Guide for Writing Material Standards in the Classification Format
IEEE/ASTM S1–10 Standard for Use of the International System of Units (SI)

2.2 *IEC and ISO Standards:*[5]

IEC 60093 Recommended Methods of Test for Volume and Surface Resistivities of Electrical Insulating Materials
IEC 60250 Recommended Methods for the Determination of the Permittivity and Dielectric Dissipation Factor of Electrical Insulating Materials at Power, Audio and Radio Frequencies Including Metre Wavelengths
ISO 291 Plastics—Standard Atmospheres for Conditioning and Testing (Practice D618)
ISO 293 Plastics—Compression Molding Test Specimens of Thermoplastic Materials (Practice 4703)
ISO 472 Plastics—Vocabulary (Terminology D883)
ISO 527/1,2,3 Plastics—Determination of Tensile Properties (Test Method D638)
ISO 1043/1 Plastics—Symbols—Part 1: Symbols for Basic Polymers and Their Special Characteristics (Terminology D883)
ISO 1043/2 Plastics—Symbols—Part 2: Fillers and Reinforcing Materials (Terminology D883)
ISO 1133 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

TABLE 4 Date Block 3

Position 1		Position 2					Position 3			Position 4		
		Melt Viscosity/Melt-Flow Rate					Tensile Strength			Tensile Elongation		
Code	Tm,° C	Code	Melt-Flow Rate, g/10 min	Load, kg	Melt Viscosity, Pa/s[A]	Temperature, °C	Code	Yield Strength, MPa	Modulus, MPa	Code	Yield, %	Break, %
a	<20	a	<0.1		<250		a	<15	<500	a	<5	<50
b	20 to <30	b	0.1 to< 0.2	0.325	>250		b	15 to <20	500 to< 800	b	5 to <10	50 to <100
c	30 to <40	c	0.2 to <0.5	1.20	>500		c	20 to <25	800 to< 1200	c	10 to <15	100 to <150
d	40 to< 50	d	0.5 to <1.0	2.16	>100		d	25 to< 30	1200 to <1600	d	15 to <20	150 to <200
e	50 to <60	e	1.0 to <2.0	3.80	>1500		e	30 to< 35	1600 to <2000	e	20 to <25	200 to <250
f	60 to <70	f	2.0 to <5.0	5.00	>2000	230	f	35 to< 40	2000 to< 3000	f	25 to <30	250 to <300
g	70 to <80	g	5.0 to <10	10.00	>2500	125	g	40 to< 45	3000 to< 4000	g	>30	300 to <350
h	80 to< 90	h	10 to < 20	12.50	>3000		h	45 to< 50	4000 to <6000	h		350 to <400
i	90 to < 100	i	20 to <50	21.60	>3500		i	50 to< 55	>6000	i		400 to <500
j	100 to< 110	j	≥50	31.60			j	55 to< 60		j		500 to <600
k	110 to< 120	k					k	60 to <65		k		600 to< 800
l	120 to< 130	l					l	≥65		l		>800
m	130 to <140	m					m			m		
n	140 to <150	n					n			n		
o	150 to <160	o					o			o		
p	160 to <170	p					p			p		
q	170 to <180	q					q			q		
r	180 to <190	r					r			r		
s	190 to <200	s					s			s		
t	200 to <210	t					t			t		
u		u					u			u		
v		v					v			v		
w		w					w			w		
x		x					x			x		
y		y					y			y		
z	not specified	z	not specified				z	not specified		z	not specified	

[A] 1 Pa/s = 10 P.

Position 5		Position 6			Position 7			Position 8	
Code	Specific Gravity, g/cm^3	Code	Electrical a-c Dielectric Constant	Loss	d-c Electric Volume	Code	Limiting Oxygen Index	Code	Specimen Type
a	<1.6	a			>10E3	a	<40	a	D638 Type I
b	1.6 to <1.7	b			10E3 to 10E12	b	40 to <50	b	D638 Type II
c	1.7 to< 1.8	c			>10E12	c	50 to <60	c	D638 Type III
d	1.8 to <1.9	d				d	60 to< 70	d	D638 Type IV
e	1.9 to< 2.0	e				e	70 to <80	e	ISO 527 Type 1A
f	2.0 to <2.1	f				f	80 to <90	f	ISO 527 Type 1B
g	2.1 to< 2.2	g		<0.0012		g	>90	g	ISO 527 Type 6A
h	2.2 to< 2.3	h	<3.0	<0.0014		h		h	ISO 527 Type 7A
i	2.3 to <2.4	i	3.0 to< 3.1	<0.0016		i		i	ISO 12086/1 Fig. 1
j	2.4 to <2.5	j	3.1 to <3.2	<0.0018		j		j	D638 Type MI
k		k	3.2 to< 3.5	<0.0020		k		k	D638 Type MII
l		l	3.5 to <4.0	<0.0022		l		l	D638 Type MIII
m		m	4.0 to< 4.5	<0.0024		m		m	
n		n	4.5 to <5.0	<0.0026		n		n	
o		o	5.0 to< 5.5	<0.0028		o		o	
p		p	5.5 to <6.0	<0.0030		p		p	D1708
q		q	6.0 to <6.5	<0.0035		q		q	
r		r	6.5 to <7.0	<0.0040		r		r	
s		s	7.0 to <8.0	<0.0060		s		s	
t		t	8.0 to <9.0	<0.0080		t		t	
u		u	9.0 to <10	<0.0100		u		u	
v		v	10 to <11	<0.0300		v		v	
w		w	11 to <12	<0.1000		w		w	
x		x	12 to <14	>0.1000		x		x	
y		y	>14			y		y	
z	not specified	z	not specified		not specified	z	not specified	z	

Thermoplastics (Test Method D1238)

ISO 1183 Plastics—Methods for Determining Density and Relative Density of Non-Cellular Plastics (Test Methods D792)

ISO 4589 Plastics—Determination of Flammability By Oxygen Index

ISO 12086-1 Fluoropolymer Dispersion and Molding and Extrusion Materials—Part 1: Designation and Specification

ISO 12086-2 Fluoropolymer Dispersion and Molding and Extrusion Materials—Part 2: Preparation of Test Specimens and Determination of Properties