Designation: D 5575 – 99

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

This standard is issued under the fixed designation D 5575; 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 specification 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 specification 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. These polymers may 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 specification.[2] This specification 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 specification.

1.5 The minimum specification properties are established by this specification. 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 and the practices of IEEE/ASTM SI–10 incorporated herein, except where common usage or test method specify common units acceptable within IEEE/ASTM SI–10.

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

NOTE 1—Although the values listed in Table 1, Table 2, Table 3, Table 4, Table 5 are necessary to include the range of properties available in existing materials, they should not 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 can vary with the thermomechanical history of the sample. Specimens prepared by different techniques could have properties that may vary.

1.8 Test methods used in this specification may involve 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.

NOTE 3—**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 and health practices and determine the applicability of regulatory limitations prior to use.* See Note 3 and Section 10 for specific hazards statements.

NOTE 4—Most of the technical content of this specification is included as part of ISO 12086/1, 2. These standards have been approved for publication and are in the final editing process. Many designations from the ISO standards will be similar to those from this ASTM specification.

2. Referenced Documents

2.1 *ASTM Standards:*

[1] This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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This new standard is needed to cover commercial products outside the scope of Specification D 3222.

[2] Fluoropolymer property specification data from international standards can include properties intentionally excluded from this specification (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 elognation
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.

NOTE 5—For ASTM and ISO documents, the equivalent or a comparable method is listed after each citation in parentheses.

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[4] (IEC 250)

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials[4] (IEC 93)

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[5] (ISO 291)

D 638 Test Method for Tensile Properties of Plastics[5] (ISO 527/1,2,3)

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement[5] (ISO 1183)

D 883 Terminology Relating to Plastics[5] (ISO 472, ISO 1043/1, -2)

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer[5] (ISO 1133)

D 1600 Terminology for Abbreviated Terms Relating to Plastics[5]

D 1999 Guide for the Selection of Specimens and Test Parameters for International Commerce[5]

D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-like Combustion of Plastics (Oxygen Index)[6] (ISO 4583)

D 3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding, Extrusion, and Coating Materials[6]

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis[6]

D 3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer[6]

D 3892 Practice for Packaging/Packing of Plastics[6]

D 4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry[7]

D 4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets[7]

D 5740 Guide for Writing Material Standards in the D 4000 Format[7]

IEEE/ASTM S1–10 Standard for Use of the International System of Units (SI)[8]

2.2 *IEC and ISO Standards:*[9]

IEC 93 Recommended Methods of Test for Volume and Surface Resistivities of Electrical Insulating Materials

IEC 250 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 D 618)

ISO 293 Plastics—Compression Molding Test Specimens of Thermoplastic Materials (Practice 4703)

ISO 472 Plastics—Vocabulary (Terminology D 883)

ISO 527/1,2,3 Plastics—Determination of Tensile Properties (Test Method D 638)

ISO 1043/1 Plastics—Symbols—Part 1: Symbols for Basic Polymers and Their Special Characteristics (Terminology D 883)

[4] *Annual Book of ASTM Standards*, Vol 10.01.

[5] *Annual Book of ASTM Standards*, Vol 08.01.
[6] *Annual Book of ASTM Standards*, Vol 08.02.
[7] *Annual Book of ASTM Standards*, Vol 08.03.
[8] *Annual Book of ASTM Standards*, Vol 14.02.
[9] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

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	|Ls50	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	|Ls65		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	D 638 Type I
b	1.6 to <1.7	b			10E3 to 10E12	b	40 to <50	b	D 638 Type II
c	1.7 to< 1.8	c			>10E12	c	50 to <60	c	D 638 Type III
d	1.8 to <1.9	d				d	60 to< 70	d	D 638 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	D 638M Type MI
k		k	3.2 to< 3.5	<0.0020		k		k	D 638M Type MII
l		l	3.5 to <4.0	<0.0022		l		l	D 638M Type MIII
m		m	4.0 to< 4.5	<0.0024		m		m	D 1999 Type 1A
n		n	4.5 to <5.0	<0.0026		n		n	D 1999 Type 1B
o		o	5.0 to< 5.5	<0.0028		o		o	D 1999 Type II
p		p	5.5 to <6.0	<0.0030		p		p	D 1708
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	

ISO 1043/2 Plastics—Symbols—Part 2: Fillers and Reinforcing Materials (Terminology D 883)

ISO 1133 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics (Test Method D 1238)

ISO 1183 Plastics—Methods for Determining Density and Relative Density of Non-Cellular Plastics (Test Methods D 792)

ISO 4583 Plastics—Determination of Flammability By Oxygen Index

TABLE 5 Codes for Filler and Physical Form of Materials for Use in Data Block 4

Code	Material	Code	Form/Structure
B	boron	B	beads, spheres, balls
C	carbon	C	chips, cuttings
CG	graphite	D	powder
E	clay	F	fiber
G	glass	G	ground
K	calcium carbonate	H	whisker
M	mineral, metal	K	knitted fabric
Ma	aluminum oxide	L	layer
Mb	bronze	M	mat (thick)
MC	calcium fluoride	N	nonwoven (fabric)
Md	molybdenum disulfide	P	paper
Me	stainless steel	S	roving
P	mica	T	scale, flake
Q	silica	V	cord
R	aramid	W	veneer
S	synthetic, organic	X	not specified
T	talcum	Y	yarn
X	not specified	Z	others
Z	none		

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

3. Terminology

3.1 *Definitions:*

3.1.1 *copolymer*—a polymer derived from more than one species of monomer. **ISO 472**

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 fluoro-monomer(s) being in the greatest amount by mass. **ISO 12086**

3.1.3 *monomer*—a low-molecular-weight substance consisting of molecules capable of reacting with like or unlike molecules to form a polymer. **D 883**

3.1.4 *thermoplastic*—a plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion. **D 883**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *amorphous*—noncrystalline or devoid of regular structure.

3.2.2 *contamination*—the presence of nonpolymer particulate and debris in the polymer, excluding any property-enhancing additives.

3.2.3 *fluoropolymer*—synonymous with fluoroplastic.

3.2.4 *melt-processible*—capable of being processed by, for example, injection molding, screw extrusion, and other operations typically used with thermoplastics.

3.2.5 *polymorphism*—the ability of a material to form two or more different but stable crystalline forms.

3.2.6 *thermomechanical history*—the mechanical and thermal exposure that a material experiences before testing.

3.3 *Abbreviations:Abbreviations:*

3.3.1 *CTFE*—chlorotrifluoroethylene (1-chloro-1,2,2-trifluoroethylene). **D 1600**

3.3.2 *DMAC*—dimethylacetamide.

3.3.3 *DSC*—differential scanning calorimetry.

3.3.4 *HFP*—hexafluoropropylene (1,1,2,3,3,3-hexafluoropropylene).

3.3.5 *MFR*—melt-flow rate.

3.3.6 *MV*—melt viscosity.

3.3.7 *PVDF*—poly(vinylidene fluoride). **D 1600**

3.3.8 *TFE*—tetrafluoroethylene (1,1,2,2-tetrafluoroethylene). **D 1600**

3.3.9 *VDF*—vinylidene fluoride (1,1,-difluoroethylene).

3.3.10 *VDF/CTFE*—vinylidene fluoride/chlorotrifluoroethylene copolymer.

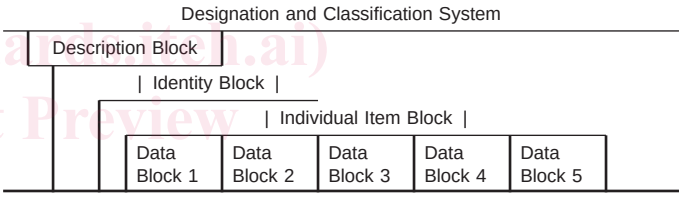
3.3.11 *VDF/HFP*—vinylidene fluoride/hexafluoropropenecopolymer.

3.3.12 *VDF/TFE*—vinylidene fluoride/tetrafluoroethylene copolymer.

3.3.13 *VDF/TFE/HFP*—vinylidene fluoride/tetrafluoroethylene/hexafluoropropene copolymer.

4. Classification and Designation

4.1 The classification and designation system of the polymers is based on the following standardized pattern taken from ISO 12086/1:



4.1.1 The designation system consists of the following:

4.1.1.1 An optional description block, reading "Thermoplastics,"

4.1.1.2 An identity block comprising the ASTM standard number, and

4.1.1.3 An individual item block.

(1) The individual item block is subdivided into five data blocks that include the information in 4.2-4.6. Data Block 5 is used when a designation is converted to a specification. See Section 7 for more details.

(2) The blocks shall be separated from each other by commas. If a data block is not used, this shall be indicated by doubling the separation sign, that is, by two commas (,,).

4.2 *Data Block 1*—This data block identifies the fluoropolymer by its abbreviation from the list in 3.3 (additional terms are listed in ISO 12086/1, 2, or Terminology D 1600). The abbreviation is followed by a hyphen and a one-letter code giving more information about the polymer, using the codes from Table 1.

4.3 *Data Block 2*:

4.3.1 This block can indicate up to eight items of information coded by letters as specified in Table 2. Position 1 gives information about intended application or method of processing. Positions 2 through 8 provide up to seven items that can use codes from Table 2 to indicate the polymer's form as well as specific special characteristics.

4.3.2 If only one letter is given (for example, E), it must apply to Position 1. Whenever there is an indication of properties, etc., in Positions 2 to 8, a code in Position 1 is required. The code "X" indicates that no other letter code is appropriate. An alphabetical order is recommended if more than one code letter is used in Positions 2 to 8.

NOTE 6—Selecting the application or processing method for Position 1 of Data Block 2 should be done carefully. Many polymers are capable of more than one application or method of processing (for example, extrusion (E) and molding (M) resins should be coded "general use" (G)). Coding for special methods of processing should be reserved for polymers only designed for the application.

4.4 *Data Block 3*:

4.4.1 Data Block 3 is used as the designation or general description of the fluoropolymer's properties. The property values are presented by code letters in seven of eight positions within Data Block 3. Each position represents a specific property listed in Table 3. Table 4 lists the code letters corresponding to the various property values. The values are determined by the methods cited in Section 8. At least four of the seven properties are specification properties. Position 8 cites specimen preparation methods when the designation is converted to a specification.

4.4.1.1 Each position may contain one or more code letters, depending on the property cited. The positions are separated by a hyphen (-). Use of an asterisk (*) or question mark (?) before the code letters denotes that property as a specification property.

4.4.1.2 The resin manufacturer shall assign the codes in Data Block 3, based on test results from Table 4. If test values lie on, or on either side of, a cell limit because of manufacturing tolerances, the resin manufacturer shall state which cell will designate.

NOTE 7—Other properties could be used as designation and specification properties for these polymers. Most are similar to the ones used and would only duplicate measuring the same property. Other properties either do not have standard test methods or are outside of the property focus of the document scope (for example, comonomer ratios).

4.4.2 *Melting Endotherm Peak Temperature (Position 1)*—Melting endotherm peak temperature shall be determined in accordance with the principles of Test Methods D 3418 and D 4591. Semicrystalline polymers shall use melting endotherm peak temperature as a designatory property. Cell codes and ranges are given in Table 4.

4.4.3 *Melt-Flow Rate or Melt Viscosity (Position 2)*—Melt viscosity (MV) shall be determined using Test Method D 3835. Melt-flow rate (MFR) shall be determined in accordance with Test Method D 1238 or ISO 1133, using test conditions selected from Table 4. The melt viscosity or the melt-flow rate is indicated in Data Block 3 by the cell code and ranges in accordance with Table 4, followed by the codes for temperature and load for MFR and shear rate for MV also included in Table 4. Order for Position 2 is as follows:

Position 2 Order

1st = MFR
2nd = MFR load
3rd = MV
4th = Temperature

4.4.4 *Tensile Strength Properties (Positions 3 and 4)*—Tensile-strength properties shall be determined in accordance with the principles of Test Method D 638 or ISO 527 modified by details given in 8.9 or ISO 12086/2. Table 4 provides the codes to use for each range of tensile strength and modulus, and percentage elongation at yield and break. Order for Positions 3 and 4 are as follows:

Position 3 Order	Position 4 Order
1st = tensile yield	1st = tensile-yield elongation
2nd = tensile break	2nd = tensile-break elongation
3rd = tensile modulus	

4.4.5 *Density (Relative Density, Specific Gravity) (Position 5)*—Density shall be determined in accordance with the principles of Test Methods D 150 or ISO 12086/2. The cell codes are listed in Table 4.

4.4.6 *Electrical Properties (Position 6)*— Electrical properties for d-c and a-c currents shall be determined by Test Methods D 150, D 257, or their ISO equivalents. The cell codes are listed in Table 4. Order for Position 6 is as follows:

Position 6 Order

Position 1 = resistivity
Position 2 = frequency (listed as the exponent of the power of ten)
Position 3 = dielectric constant
Position 4 = dissipation factor
Positions 5 to 7, 8 to 10, 11 to 13, ... (repeat of 2 to 4 for each frequency cited)

4.4.7 *Flammability Properties (Position 7)*—Flammability properties shall be determined by oxygen index (OI) values using Test Method D 2863 or ISO 4583. The cell codes are listed in Table 4.

4.4.8 *Specimen Preparation and Type (Position 8)*—This position is used only when a designation is converted to a specification to describe the molded specimen type and its preparation. Section 9 provides information on preparing compression-molded specimens. Cell codes are listed in Table 2 and Table 4. Order for Position 8 is as follows:

Position 8 Order

1st = molding method (from Table 2, Position 1)
2nd = tensile bar type and method (Table 4)

NOTE 8—Using specimen preparation method and type cited in Position 8 should allow the supplier and customer to monitor polymer properties while minimizing the effects of specimen preparation.

4.5 *Data Block 4*—Data Block 4 is used to site the type (Position 1) and form (Position 2) of fillers or other materials added to the fluoropolymer. Letter codes listed in Table 5 are used to indicate the type and form used (supplemental codes can be found in ISO 1043/2). The nominal content, by weight percent, is noted by arabic numerals after Position 2 to the nearest 1 %. Additive contents below 2 % need not be specified. For designation clarity, a hyphen (-) may be used to separate material type codes. When a material is present in more than one form, a plus sign (+) may be used to separate the form codes.

4.6 *Data Block 5*:

4.6.1 Data Block 5 is used to denote changes in the values of a property when the designation is converted to specification. The type of changes would be the following:

4.6.1.1 To cite the alternate property value range when a (?) is used in Data Block 3. Where more than one (?) is cited, the value ranges shall be listed in order of their occurrence.

NOTE 9—It is recommended that any ranges smaller than designated by Table 4 codes be greater than the precision and bias for the test method that measures the property.

4.6.1.2 To cite a current ASTM or other standard specification for the polymer (see 4.7 for restrictions).

4.6.1.3 A combination of 4.6.1.1 and 4.6.1.2.

4.7 *Designation and Specification Restrictions*:

4.7.1 Data Block 5 of the specification call-out cannot cite properties beyond the scope of this specification. In other words, specification criteria or properties from other specifications that conflict with this specification's scope are not allowed.

NOTE 10—Some specifications cite properties that are either not detectable or use test methods not available to most customers. Therefore, specification property values or results shall be able to be determined by a user without *a priori* knowledge of the polymer's manufacturer, polymerization process, or any other unique finishing process.

4.7.2 A commercial grade of polymer should not have multiple designations for Data Block 2. The application choice should be broad enough for a variety of the applications to which it can be applied.

4.7.3 An alternate specification property range in Data Block 5 shall not be greater than the original designation-code range from Table 4 and either the preceding or following code. In other words, if a property code is normally "D," the new range could encompass values or ranges from Code "C and D" or "D and E." The new values cannot encompass a range cited by Codes "C to E" or greater.

4.7.4 At no time shall a designation for a commercial grade have more than one designation for Data Blocks 1, 2, 3, and 4. If the code values need to be modified from those cited in Table 4, the changes shall be done by use of a (?) and listed in Data Block 5.

5. General Requirements

5.1 The material should be ordered by the manufacturer's trade name and corresponding copolymer line callout and the necessary suffix properties to define the material.

5.2 The material shall be of uniform composition and free of foreign matter to a contamination level agreed upon between the purchaser and the seller.

5.3 Adequate statistical sampling shall be considered an acceptable alternative.

6. Example of a Designation

6.1 The following example is for VDF/HFP fluoropolymer material for general-purpose molding with a designation of:

7. Specifications for Fluoropolymers

7.1 *Designation Conversion to Specification*:

7.1.1 A designation is converted into a specification by preceding 4 or more property codes in Data Block 3 with an asterisk and adding the specimen preparation codes in Data Block 3, Position 8, from Table 2 and Table 4.

7.1.1.1 Four property codes, cited by Data Block 3 positions, that must be included in a specification are as follows:

Data Block 3 Position	Property
1	melt temperature
2	melt-flow rate or melt viscosity, or both
3	tensile strength and modulus
5	density

7.1.2 *Specification Using Designation Ranges*:

7.1.2.1 *Example (see* Appendix X2*)*:

A VDF/CTFE copolymer, a general-use grade, sold as granules, and having the following (specification properties are in boldface type):

(*1*) **A melting point of 165°C,**
(*2*) **An MV of 1500 Pa/s when tested at 230°C at 100 s^{-1},**
(*3*) **A tensile strength yield of 28 MPa; break strength not cited; modulus of 800 MPa,**
(*4*) Elongation yield of 9 %; break of 450 %,
(*5*) **Density between 1.78,**
(*6*) Electricals of:
Volume resistivity greater than 2.3 $E^{14}\Omega$,
Dielectric constant at 1 kHz at 10.1; at 10 kHz at 9.3; 1 MHz at 7.3,
Dissipation factor at 1 kHz at 0.021; at 10 kHz at 0.031; at 1 MHz at 0.15,
(*7*) OI at 53, and
(*8*) Tested using compression-molded specimens using ISO 527 Type-6A tensile bars.

Designation and specification where each designatory property is desired as part of the specification with the specification limits equal to the cell limits is as follows:

ASTM D5XXX, VDF/CTFE-K,
GG,*P-*ZZE-*DZC-BI-*C-C3VU4UVSXY-C-*QG, Z,,

7.1.3 *Specification Using Alternate Property Ranges*:

7.1.3.1 When the values given in the cell tables are not satisfactory for specification purposes, indicate this situation by inserting a question mark in Data Block 3 at the beginning of the destination cell code and the specification range given in Data Block 5.

7.1.3.2 *Example (see* Appendix X3*)*:

A modified VDF/HFP copolymer that is processed by extrusion, with reduced-burning characteristics and smoke emissions. The resin is marketed as pellets, contains a lubricant, and is opaque. The additive level is less than 2 %. Its properties are as follows (specification properties are in boldface type):

(*1*) **A melting point of 143°C,**
(*2*) **An MV between 1300 and 1700 Pa/s when tested at 230°C at 100 s^{-1},**
(*3*) **A tensile strength yield of 24 MPa; break not cited; modulus of 1000 MPa,**
(*4*) Elongation yield of 12 %; break of 350 %,
(*5*) **Density of 1.79,**
(*6*) Electricals not cited.
(*7*) OI greater than 80,
(*8*) **Tensile specimens are compression-molded and Test Method D 638, Type I,** and
(*9*) The melt-viscosity range encompasses two ranges.

Designation and specification is as follows:

ASTM D5XXX, VDF/HFP-A, EFF4G1ST2, *N-*ZZ?E-*CZC-CH-*C-ZZ-*C-QA, Z, ?1300–1700,

8. Property Determination Methods

8.1 The following subsections of Section 8 cite test methods used to determine polymer-property values of code levels from Table 4 for Data Block 3 of a designation or specification line call-out. When a test value normally varies between two code levels, the manufacturer shall designate the code levels. Several properties are tested using molded specimens. Section 9