Viton® fluoroelastomer

A Product of DuPont Dow Elastomers

Selection Guide

Introduction

Viton fluoroelastomer was introduced in 1957 to meet the needs in the aerospace industry for a high-performance sealing elastomer. Since then, the use of Viton fluoroelastomer has spread quickly to many other industries, especially in the automotive, fluid power, appliance, and chemical industries. With 40 years of field-proven performance, Viton fluoroelastomer has developed a reputation for its outstanding performance in very hot and extremely corrosive environments.

Valuable Properties of Viton Fluoroelastomer

Vulcanizates based on Viton fluoroelastomers provide an exceptional balance of physical property characteristics, including the following features:

- Resistance to temperature extremes:

  Heat—Viton withstands high temperature and simultaneously retains its good mechanical properties better than most other elastomers. Oil and chemical resistance also are relatively unaffected by elevated temperatures. Compounds of Viton remain usefully elastic indefinitely when exposed to laboratory air oven aging up to 204°C (400°F) or to intermittent test exposures up to 260°C (500°F). High temperature service limits are generally considered to be:

  3,000 hr at 232°C (450°F)

  1,000 hr at 260°C (500°F)

  240 hr at 288°C (550°F)

  48 hr at 316°C (600°F)

  Cold—Viton is generally serviceable in dynamic applications down to –18 to –23°C (0 to –10°F), although special formulations permit its use in static applications down to –54°C (–65°F). Also, Viton has proven to be satisfactory for static seals used under conditions approaching absolute zero.

- Resistance to degradation by a greater variety of fluids and chemicals than any nonfluorinated elastomer, providing the best proven fluid resistance of any commercial rubber. Excellent resistance to oils, fuels, lubricants, and most mineral acids.
- Extremely low permeability to a broad range of substances, including particularly good performance in oxygenated automotive fuels.
- Resistance to aliphatic, aromatic hydrocarbons that are solvents for other rubbers.
- Exceptionally good resistance to compression set, even at high temperatures.
- Exceptionally good resistance to atmospheric oxidation, sun, and weather. Excellent resistance to fungus and mold.
- Good electrical properties in low voltage, low frequency applications.
- Low burning characteristics; inherently more resistant to burning than other, non-fluorinated hydrocarbon rubbers.

The Various Families and Types of Viton Fluoroelastomer

There are three major families of standard Viton fluoroelastomer: A, B, and F. The Viton A types are comprised of vinylidene fluoride (VF2) and hexafluoropropylene (HFP). The B and F types are made with vinylidene fluoride (VF2), hexafluoropropylene (HFP), and tetrafluoroethylene (TFE).

Viton fluoroelastomer products are designated as A, B, or F types according to their relative resistance to attack by fluids and chemicals. The differences in fluid resistance that exist among these families are the result of different levels of fluorine in the polymer, which is determined by the types and relative amounts of monomers that comprise the polymer.

In general, the standard types of Viton exhibit outstanding resistance to attack by a wide variety of fluids, including mineral acids and aliphatic and aromatic hydrocarbons. The higher the fluorine content of the polymer, the less will be the effect, as measured by volume increase, for example. The most significant differences between standard types of Viton®, in terms of resistance to volume change or retention of physical properties, are noted in low molecular weight, oxygenated solvents (such as methanol and methyl t-butyl ether).

As mentioned above, the fluid resistance of Viton polymers improves with increasing levels of fluorine. This is shown in Table 1, below (note the volume increase after aging in methanol at 23°C [73°F]). As the fluorine content increases, however, the low temperature flexibility of the polymer decreases, and a compromise must be made between the fluid resistance and low temperature flexibility of the final vulcanizate.

For those applications that require the best performance in both fluid resistance and low temperature flexibility, a number of specialty types of Viton were developed that contain a fluorinated vinyl ether monomer. Polymers that contain this monomer exhibit significantly improved low temperature flexibility, compared to standard types of fluoroelastomer.

Viton GLT, introduced in 1976, was the first commercial fluoroelastomer to use this fluorinated vinyl ether monomer. This polymer provides the same excellent resistance to heat and fluids that is typical of the A types of Viton fluoroelastomer. Viton GFLT, like Viton GLT, exhibits significantly improved low temperature flex characteristics compared to standard types of fluoroelastomer, but in addition, provides the same superior resistance to fluids that is typical of the F types of Viton fluoroelastomer as well.

Extreme Types of Viton

Fluoroelastomers that contain vinylideneflouride (VF2) are subject to attack by high pH materials, including caustics and amines. In addition, standard fluoroelastomers are not resistant to low molecular weight carbonyl compounds, such as methylethyl ketone, acetone, or methyl tertiarybutyl ether.

Viton Extreme™, ETP-500 and ETP-900, commercialized in 1998, are fluoroelastomers made with ethylene, tetrafluoroethylene (TFE), and perfluoromethylvinyl ether (PMVE). This unique combination of monomers provides outstanding resistance to fluids. The ETP types of Viton exhibit the same excellent resistance to acids and hydrocarbons typical of standard types of Viton. Unlike conventional fluoroelastomers, however, ETP types of Viton also provide excellent resistance to low molecular weight esters, ketones, and aldehydes. In addition, these unique polymers are inherently resistant to attack by base, and thus provide excellent resistance to volume swell and property loss in highly caustic solutions and amines.

Additional information regarding performance differences between the various families and types of Viton fluoroelastomer is presented in Tables 3–6 to assist in selecting the particular grade of Viton that is best suited for both a given end-use application and for a specific manufacturing process.

Table 1
Polymer Fluorine Content versus Fluid Resistance and Low Temperature Flexibility

	Standard Types			Specialty Types			
	A	**B**	**F**	**B70**	**GLT**	**GFLT**	**ETP**
Nominal Polymer Fluorine Content, wt%	66	68	70	66	64	67	67
Percent Volume Change in Fuel C, 168 hr at 23°C (73°F)*	4	3	2	5	5	2	4
Percent Volume Change in Methanol, 168 hr at 23°C (73°F)*	90	40	5	90	90	5	5
Percent Volume Change in Methylethyl Ketone, 168 hr at 23°C (73°F)*	>200	>200	>200	>200	>200	>200	19
Percent Volume Change in 30% Potassium Hydroxide, 168 hr at 70°C (158°F)*	(Samples too swollen and degraded to test)						14
Low Temperature Flexibility, TR-10, °C*	–17	–13	–6	–19	–30	–24	–12

*Nominal values, based on results typical of those obtained from testing a standard, 30 phr MT (N990) carbon black-filled, 75 durometer vulcanizate.

Curing Systems for Viton Fluoroelastomer

In addition to inherent differences between the various types and families of Viton fluoroelastomer, a number of compounding variables have major effects on the physical property characteristics of the final vulcanizates. One very important variable is the crosslinking or curing system that is used to vulcanize the elastomer.

Diamine curatives were introduced in 1957 (DIAK-1) for crosslinking Viton A. While these diamine curatives are relatively slow curing, and do not provide the best possible resistance to compression set, they do offer unique advantages, such as excellent adhesion to metal inserts and high hot tensile strength.

Most fluoroelastomers currently are crosslinked with Bisphenol AF, a curative first introduced in 1970, in the first commercial curative-containing precompound, Viton E-60C. Compounds of Viton that use this curative exhibit fast rates of cure and excellent scorch safety and resistance to compression set.

In 1987, an improved bisphenol curative was introduced, which was made available in several different precompounds: Viton A-201C, A-202C, A-401C, and A-402C. The modified system provides faster cure rates, improved mold release, and slightly better resistance to compression set, compared to the original bisphenol cure system used in Viton E-60C and E-430. Additional precompounds of Viton, incorporating this modified curative, were introduced in 1993, including Viton A-331C, A-361C, B-201C, B-601C, and B-651C. A brief description of all these products can be found in Table 6.

In 1976, efficient peroxide curing of fluoroelastomers was made possible for the first time with the introduction of Viton GLT. The peroxide cure system provides fast cure rates and excellent physical properties in polymers such as GLT and GFLT, which cannot be readily cured with either diamine or bisphenol crosslinking systems. In the case of polymers such as Viton GF, GBL-200, and GBL-900, the peroxide cure has been shown to provide enhanced resistance to aggressive automotive lubricating oils and steam and acids. Vulcanizates of Viton polymer cured with peroxide do not generally show any significant difference in resistance to other fluids and chemicals, compared to the same polymer cured with bisphenol.

A comparison of the various processing and physical property characteristics of compounds using the different cure systems is shown in Table 2.

Table 2
A Comparison of Cure Systems Used in Crosslinking Viton

	Type of Cure System		
Property, Processing Characteristic	**Diamine**	**Bisphenol**	**Peroxide***
Processing Safety (Scorch)	P–F	E	E
Fast Cure Rate	P–F	E	E
Mold Release/Mold Fouling	P	G–E	F–G
Adhesion to Metal Inserts	E	G	G
Compression Set Resistance	P	E	G
Steam, Water, Acid Resistance	F	G	E
Flex Fatigue Resistance	G	G	G

Rating: E = Excellent G = Good F = Fair P = Poor

*Luperco 101-XL (trademark of Pennwalt Corporation) and Varox Powder (trademark of R. T. Vanderbilt Co., Inc.) are commonly used.

Selecting a Specific Type of Viton® Fluoroelastomer

Inherent Physical Property Differences Between Types/Families of Viton Products

The physical properties of vulcanizates based on Viton fluoroelastomers are determined to a large extent by the type and amount of the filler(s) and curative(s) used in the formulation, and by the temperature and duration of the curing cycle used in their manufacture.

In terms of resistance to compression set, low temperature flexibility, and resistance to certain classes of fluids, however, some inherent differences exist between the various types, or families of Viton polymers. They are the natural result of the differences in types and relative amounts of monomers that are used in the manufacture of the many various grades of Viton polymers.

The differences in physical property characteristics which exist between various types and families of Viton fluoroelastomer products are outlined in very general terms in Table 3, below.

As an example, resistance to compression set is an important property for seals in general, and, if this property was considered to be the most important feature for a particular part, then one of the A-types of Viton might be the best choice for the job. However, if resistance to the widest possible range of fluids is a more important consideration than compression set, only, then F-type Viton polymers might well be a better choice for that particular end-use application. Further, if both fluid resistance and low temperature flexibility are equally important requirements for maximizing the end-use suitability of a given part, then products in the GFLT family of Viton polymers would represent the best overall choice of products.

Table 3
Physical Property Differences Between Types/Families of Viton Products

Family or Type of Viton Fluoroelastomer	Resistance to Compression Set	General Fluids/ Chemical Resistance*	Low Temperature Flexibility**
A	1	3	2
B	2	2	2
F	2	1	3
GB, GBL	2	2	2
GF	3	1	3
GLT	2	3	1
GFLT	2	1	1
ETP	3	1	2

1 = Excellent—Best performance capability of all types
2 = Very Good
3 = Good—Sufficient for all typical fluoroelastomer applications

* See *Table 4* for a more detailed guide to choosing the best type of Viton fluoroelastomer, relative to specific classes of fluids and chemicals.

** Flexibility, as measured by Temperature of Retraction (TR-10), Gehman Torsional Modulus, Glass Transition (Tg), or Clash-Berg Temperature. Brittle-Point tests are a measure of impact resistance only and do not correlate at all with the low temperature sealing capability of a vulcanizate.

Differences in Fluid Resistance Between Types/Families of Viton Products

As in the case of physical properties, different polymer compositions will result in inherent differences with regard to fluid resistance.

Table 4 outlines the differences that exist between types and families of Viton products, in terms of their resistance to various classes of fluids and chemicals.

In as much as certain types or families of Viton products may exhibit performance that is superior to other types in one regard, but not quite as good in some other aspect, it is important to consider the requirements of the part to be manufactured, in terms of both its physical property requirements and its fluid or chemical resistance needs.

Using Tables 3 and 4, the compounder can select the best type or family of Viton product for a given end-use application, based on the best combination of physical property and fluid resistance characteristics.

Table 4
Differences in Fluid Resistance Between Families or Types of Viton Fluoroelastomer

	Family or Type of Viton Fluoroelastomer							
	A	B	F	GB	GF	GLT	GFLT	ETP
	Cure System							
	Bisphenol			Peroxide				
Hydrocarbon Automotive, Aviation Fuels	1	1	1	1	1	1	1	1
Oxygenated Automotive Fuels (containing MeOH, EtOH, MTBE, etc.)	NR	2	1	2	1	NR	1	1
Reciprocating Engine Lubricating Oils (SE-SF Grades)	2	1	1	1	1	1	1	1
Reciprocating Engine Lubricating Oils (SG-SH Grades)	3	2	2	1	1	1	1	1
Aliphatic Hydrocarbon Process Fluids, Chemicals	1	1	1	1	1	1	1	1
Aromatic Hydrocarbon Process Fluids, Chemicals	2	2	1	1	1	2	1	1
Aqueous Fluids: Water, Steam, Mineral Acids (H_2SO_4, HNO_3, HCl, etc.)	3	2	2	1	1	1	1	1
Amines, High pH Caustics (KOH, NaOH, etc.)	NR	NR	NR	NR	NR	NR	NR	1
Low Molecular Weight Carbonyls (MTBE, MEK, MIBK, etc.)	NR	NR	NR	NR	NR	NR	NR	1

1 = Excellent—Best choice of Viton type(s) for service in this class of fluid/chemical; minimal volume increase, change in physical properties.

2 = Very Good—Good serviceability in this class of fluid/chemical; small amounts of volume increase and/or changes in physical properties.

3 = Good—Suitable for use in this class of fluid/chemical; acceptable amounts of volume increase and/or changes in physical properties.

NR = Not Recommended—Excessive volume increase or change in physical properties.

Viton® Product Naming System

With the introduction of six new, improved processing precompounds in 1993, a new naming system was adopted for Viton fluoroelastomer products. The new system incorporates the following information in a product name:

- Nominal Mooney Viscosity
- Family type (relative fluid resistance)
- Relative state of cure (relative level of crosslinking agent present in curative-containing precompounds)
- Whether or not the product can be crosslinked using a peroxide cure system
- Whether or not the product is a gum polymer or a precompound, which contains a preset, carefully controlled amount of bisphenol crosslinking system.

Each character in the product name has a specific use, as outlined below:

Character #: 1st 3rd 5th

Viton A-401C

Character #: 2nd 4th

1st Character (Letter)

- Represents the family of Viton—A, B, or F.
- A “G” prefix, in addition to a family prefix, indicates that the polymer can be crosslinked with the peroxide cure system.
- An “L” designation indicates that the A, B, or F type polymer provides slightly improved low temperature flexibility characteristics versus other polymers within the same family. An “LT” designation indicates a more significant improvement in low temperature performance criteria.

2nd Character (Number)

Represents nominal Mooney Viscosity of the product—ML 1 + 10 at 121°C (250°F).

3rd Character (Number)

Represents the relative level of curative in a precompound on a scale of 10 ⟶ 1 (10 is represented by 0):

0 = High curative level (for optimum compression set)

9 ⟶ 2 = Intermediate, decreasing levels of curative (increased elongation at break, tear resistance)

1 = Low curative level (for optimum tear, flex resistance)

4th Character (Number)

Represents a slightly different version of a particular precompound (e.g., Viton A-402C contains a process aid, A-401C does not).

5th Character (Letter)

- No letter suffix indicates that the product is a gum polymer only and contains no curatives (may contain process aid).
- “C” indicates that the product is a precompound, containing accelerator and curative.

Choosing a Viton® Product for Use in a Particular Type of Manufacturing Process

The Viton product line includes a wide variety of different families or types of fluoroelastomer products, which exhibit some inherent differences in their end-use capabilities (see Tables 3 and 4). In addition, a broad range of viscosities is offered for most types of Viton , providing a wide degree of utility in various manufacturing processes.

Having selected a family or given class of Viton products for an end use, the compounder must then choose which particular Viton product is best suited for use in a specific manufacturing process.

The Viton Application Guide (Table 5) lists the Viton products that are recommended for particular end-use applications, according to the various processes that are most commonly used in their manufacture.

The Viton Product Listing (Table 6) provides more specific information about the various individual Viton products. Contact your DuPont Dow Elastomers sales or technical representative to obtain more detailed information or data on specific Viton products.

How to Use the Viton Application Guide

The Viton Application Guide (Table 5) has been designed to facilitate choosing the type of Viton that is best suited for meeting both the property requirements of the intended end use and the needs of the production method used to manufacture the finished product.

The guide is divided into five general categories (columns) of end-use products, differentiated primarily by physical form:

- Sheet form goods, such as gaskets, diaphragms, etc.
- Simple shapes, such as O-rings, V-rings, etc., which do not typically require high levels of demolding tear resistance, but generally require high states of cure to obtain the best compression set possible.
- Complicated molded shapes, such as shaft seals or valve stem seals, which require good hot tear upon demolding because of the undercuts in the molds used to form such parts and good adhesion to metal inserts (obtained during the vulcanization of the parts).
- Complicated molded shapes that do not involve adhesion to metal inserts during vulcanization, but require good resistance to tear during demolding. Carburetor roll-over cages, boots, and reed valves are examples of such parts.
- Extruded shapes, such as rod, tubing, or hose constructions.

Each general end-use category listed is divided into four columns, each listing Viton products within a specific family or type of Viton fluoroelastomer—A, B, F, and specialty grades.

The guide is further divided into the five major types of process (rows) by which these general end-use categories might be produced:

- Compression molding
- Transfer molding
- Injection molding
- Extrusion
- Calendering

Within the blocks formed by the “intersection” of a given end-use category (column) and the type of process by which the end products will be manufactured (row), we have listed the grades of Viton that we believe are appropriate choices for meeting the physical property requirements of the finished product and that are best suited for the chosen manufacturing process.

The Viton products we believe will provide the best combination of end-use physical properties, together with the best processing characteristics for given methods of manufacture, are listed in bold type.

Additional details of specific types of Viton can be found in the Viton Product Listing and in product-specific data sheets.

Table 5
Viton Fluoroelastomer Application Guide*

	Application	Reinforced/Unreinforced Sheet Stock (Gaskets, Diaphragms, etc.)				Molded (Non-Bonded), Simple Shapes (O-Rings, V-Rings, etc.)				Molded (Bonded), (Valve Stem,	
	Viton Family	**A**	**B**	**F**	**Specialty**	**A**	**B**	**F**	**Specialty**	**A**	**B**
Manufacturing Process	Compression Molding	**A-331C** **A-361C** **A-401C, A-402C** **A-405CT** A-601C A-500 E-430, E-60C E-45, E-60 A	**B-201C** **B-435C** **B-601C** **B-641C** **B-651C** **GBL-200** **GBL-205LF** B-600 B-401 B GBL-900	**F-605C** **GF-205NP** **GF-300** F-601C GF	**B-70** **GLT-305, -505** **GLT-506** **GBLT-301, -601** **GFLT-301, -501** **GFLT-502** **ETP-500** **ETP-900** GLT GFLT	**A-401C, A-402C** **A-405CT** **A-331C** **A-601C** A-500 E-430, E-60C E-45, E-60 A, A-HV	**B-601C** **B-641C** **B-651C** **GBL-200** **GBL-205LF** **GBL-900** B-600 B-401 B	**F-605C** **GF-205NP** **GF-300** F-601C GF	**B-70** **GLT-506** **GBLT-301** **GBLT-601** **GFLT-502** **ETP-500** **ETP-900** GLT GFLT	**A-361C** A-500 E-430 E-45, E-60 E-430 A AHV	**B-435C** **B-651C** **GBL-200** **GBL-205LF** GBL-900 B-600 B-401 B
	Transfer Molding	**A-201C, A-202C** **A-275C** **A-205CT** **A-331C** **A-361C** **A-401C, A-402C** **A-405CT** A-200 A-500 E-45	**B-201C** **B-435C** **B-641C** **GBL-200** **GBL-205LF** B-200	**F-605C** **GF-205NP** **GF-300**	**B-70** **GLT-305, -505** **GLT-506** **GBLT-301, -601** **GFLT-301** **GFLT-502** **ETP-500**	**A-275C** **A-201C, A-202C** **A-205CT** **A-331C** **A-361C** **A-401C, A-402C** A-200 A-500 E-45	**B-201C** **B-641C** **B-651C** **GBL-200** **GBL-205LF** B-200 B-600 B-401	**F-605C** **GF-205NP** **GF-300**	**B-70** **GLT-305** **GLT-506** **GBLT-301** **GFLT-301** **GFLT-502** **ETP-500**	**A-361C** E-430 E-45 A-200 A-500 E-45	**B-435C/B-135C** **B-641C** **GBL-200** **GBL-205LF** B-200 B-401
	Injection Molding	**A-275C** **A-201C, A-202C** **A-205CT** **A-401C, A-402C** A-331C A-361C A-200 A-500	**B-201C** **B-435C/B-135C** **GBL-205LF** B-651C B-200, B-600	**F-605C** **GF-205NP** **GF-300**	**GLT-305** **GLT-506** **GBLT-301** **GFLT-301** **GFLT-501** **GFLT-502**	**A-275C** **A-201C, A-202C** **A-205CT** **A-401C, A-402C** **A-331C** **A-361C** A-100 A-200, A-500	**B-201C** **B-601C** **B-651C** **GBL-200** **GBL-205LF** B-200	**F-605C** **GF-205NP** **GF-300**	**GLT-305** **GLT-506** **GBLT-301** **GFLT-301** **GFLT-502**	**A-361C** A-100 A-200 A-500	**B-435C/B-135C** **B-651C** **GBL-200** **GBL-205LF** B-200
	Extrusion	**A-201C, A-202C** **A-205CT** **A-401C, A-402C** **A-331C, A-361C** **A-405CT** A-200 A-500	**B-201C** **B-435C** **B-641C** **B-651C** **GBL-200** **GBL-205LF** B-200 B-401 B-600	**F-605C** **GF-205NP** **GF-300** F-601C	**B-70** **GLT-305, -505** **GLT-506** **GBLT-301, -601** **GFLT-301, -501** **GFLT-502** **ETP-500**						
	Calendering	**A-201C, A-202C** **A-205CT** **A-401C, A-402C** **A-405CT** **E-430, E-60C** **A-331C** **A-361C** E-45, E-60 A	**B-201C** **B-435C** **B-601C** **B-641C** **B-651C** **GBL-200** **GBL-205LF** B-200, B-600 B-401 GBL-900	**F-605C** **GF-205NP** **GF-300** F-601C	**B-70** **GLT-305, -505** **GLT-506** **GBLT-301, -601** **GFLT-301, -501** **GFLT-502** **ETP-500**						

*Recommended Viton Products in **Bold** Print

Table 5
Viton Fluoroelastomer Application Guide*

	Complicated Shapes Shaft Seals, etc.)		Molded (Non-Bonded), Complicated Shapes (Boots, Valves, etc.)				Extruded Goods (Hose, Tubing, Extruded Profiles, etc.)			
	F	**Specialty**	**A**	**B**	**F**	**Specialty**	**A**	**B**	**F**	**Specialty**
	F-605C/GF **GF-205NP** **GF-300** F-601C/GF	**B-70** **GLT-305, -505** **GBLT-301, -601** **GFLT-301, -501** **ETP-500, -900** GLT GFLT	**A-331C** **A-401C/A-500** **A-402C/A-500** **A-601C/A-200** **A-361C** E-430 E-45, E-60 A AHV	**B-435C** **B-651C** **B-641C** **GBL-200** **GBL-205LF** GBL-900 B-600 B-401 B	**F-605C/GF** **GF-205NP** **GF-300** F-601C/GF	**B-70** **GLT-506** **GBLT-301, -601** **GFLT-502** **ETP-500, -900** GFLT GLT				
	F-605C/GF **GF-205NP** **GF-300**	**B-70** **GLT-305, -505** **GLT-505** **GBLT-301, -601** **GFLT-301, -501** **ETP-500**	**A-275C/A-200** **A-331C** **A-202C/A-200** **A-402C/A-200** **A-361C** A-200 A-500 E-430 E-45, E-60	**B-435C/B-135C** **B-651C** **B-641C** **GBL-200** **GBL-205LF** GBL-900 B-600 B-401	**F-605C/GF** **GF-205NP** **GF-300**	**B-70** **GLT-305** **GLT-506** **GBLT-301** **GFLT-301** **GFLT-502** **ETP-500**				
	F-605C/GF **GF-205NP** **GF-300**	**GLT-305** **GBLT-301** **GFLT-301**	**A-275C/A-200** **A-331C** **A-202C/A-200** **A-402C/A-200** **A-361C** A-200 A-500	**B-435C/B-135C** **B-651C** **GBL-200** **GBL-205LF** B-200	**F-605C/GF** **GF-205NP** **GF-300**	**GLT-305** **GBLT-301** **GFLT-301**				
							A-201C, A-202C **A-205CT** **A-401C, A-402C** **A-361C** **A-405CT** A-200, A-500 E-430, E-60C E-45, E-60 A	**B-201C** **B-435C** **B-641C** **B-651C** **B-641C** **GBL-200** **GBL-205LF** B-200, B-600 B-401	**F-605C** **GF-300** **GF-205NP** F-601C GF	**B-70** **GLT-305, -505** **GLT-506** **GBLT-301, -601** **GFLT-301, -501** **GFLT-502** **ETP-500, -900** GLT GFLT

Table 6
Viton A-, B-Type Fluoroelastomer Product Listing

Viton Product Grade	Polymer Properties: Nominal Viscosity, ML 1 + 10 at 121°C*	Polymer Properties: Specific Gravity	Polymer Properties: Polymer Fluorine Content, %	Nominal Physical Properties**: Compression Set, % 70 hr/200°C	Nominal Physical Properties**: Temperature of Retraction (TR-10) °C	Nominal Physical Properties**: Volume Increase, After 7 days/ MeOH/23°C
A-Types: Curative-Containing Precompounds						
A-201C	20	1.81	66.0	15		
A-202C	20	1.81	66.0	15		
A-205CT	20	1.81	66.0	16		
A-275C	20	1.81	66.0	17		
A-331C	30	1.81	66.0	20		
A-361C	30	1.81	66.0	20		
A-401C	40	1.81	66.0	15	–17	+75 to 105%
A-402C	40	1.81	66.0	15		
A-405CT	40	1.81	66.0	16		
A-601C	60	1.81	66.0	12		
E-430	45*	1.81	66.0	30		
E-60C	60*	1.81	66.0	25		
A-Types: Gum Polymers						
A	65*	1.82	66.0	30		
A-100	10	1.82	66.0	15		
A-200	20	1.82	66.0	15		
A-500	50	1.82	66.0	15	–17	+75 to 105%
A-HV	160	1.82	66.0	15		
E-45	50*	1.82	66.0	25		
E-60	65*	1.82	66.0	20		
B-Types: Curative-Containing Precompounds						
B-135C	10	1.85	68.5	25		
B-201C	20	1.85	68.5	25		
B-435C	40	1.85	68.5	25		
B-601C	60	1.85	68.5	20	–13	+35 to 45%
B-641C	60	1.85	68.5	30		
B-651C	60	1.85	68.5	30		
B-Types: Gum Polymers						
GBL-200	20	1.85	67.0	40	–15	+40 to 50%
GBL-205LF	20	1.86	67.0	40	–15	+40 to 50%
GBL-900	90	1.85	67.0	35	–15	+40 to 50%
B-200	20	1.86	68.5	25	–13	+35 to 45%
B-401	40	1.86	68.5	25	–13	+35 to 45%
B-600	60	1.86	68.5	20	–13	+35 to 45%
B	75	1.86	68.5	40	–13	+35 to 45%

*ML 1 + 10 measured at 100°C
**Nominal physical properties typical of those that can be expected of vulcanizates based on the specific type of Viton noted, in a 70A hardness, MT carbon black-filled formulation.

Table 6
Viton A-, B-Type Fluoroelastomer Product Listing

Viton Fluoroelastomer Product Description	Viton Fluoroelastomer Product Suggested Uses/Applications
Fast cure rate, excellent injection molding rheology, mold release	FDA-compliant***: injection-molding O-rings, gaskets; extruded shapes
A-201C plus process aid; faster cure rate, slightly higher mold shrinkage	Injection-molding O-rings, extruded shapes
Improved rheology/processing version of A-201C, containing Viton “tracer”	Injection→transfer molding O-rings, gaskets; extruded shapes
Optimized for injection molding/flash strength/mold release	Injection →transfer molding O-rings, gaskets
Excellent mold flow, high elongation/tear resistance	Compression →injection molding of complex shapes, requiring maximum hot tear
Excellent mold flow, tear resistance, bonding to metal inserts	Compression →injection molding of complex shapes, bonded metal inserts
Excellent rheology at high shear rates, excellent resistance to compression set	FDA-compliant***: compression, transfer, or injection molding of O-rings
Viton A-401C plus process aid; faster cure rate, slightly higher mold shrinkage	Compression, transfer, or injection molding of O-rings, gaskets
Improved rheology/processing version of A-401C, containing Viton “tracer”	Compression, transfer, or injection molding of O-rings, gaskets
High viscosity, high state of cure; optimum resistance to compression set	FDA-compliant***: compression molding of O-rings, simple shapes
Intermediate state of cure, very good milling characteristics	Compression molding of general molded goods
High state of cure, very good milling characteristics	Compression molding of O-rings, calendered sheet
Intermediate viscosity: good general-purpose dipolymer	Coatings, calendered sheet products, general molded goods
Ultra-low viscosity: excellent polymer rheology	Coatings, viscosity modifier for higher viscosity types
Low viscosity: excellent polymer rheology	FDA-compliant***, cured w. VC-50: injection molding applications
Intermediate viscosity: excellent polymer rheology	FDA-compliant***, cured w. VC-50: compression, transfer, injection molding
Ultra-high viscosity: excellent physical properties	FDA-compliant***, cured w. VC-50: compression molding, high strength vulcanizates
Very good milling, calendering characteristics	Calendered sheet, general-purpose compression molding
Very good milling, calendering characteristics	Calendered sheet, general-purpose compression molding
Very low viscosity incorporated cure B-type, like B-435C	Injection-molding, viscosity modifier for other B-types
Excellent extrudability: low die swell, fast rates, smooth surface	Injection-molding O-rings, extruded fuel hose veneer
Improved processing/mold release/bonding versus B-641C, B-651C	Injection→compression molding of metal-bonded parts
Excellent balance of resistance to compression set/fluids	FDA-compliant***: compression→ injection molding of O-rings, simple shapes
Excellent balance of calenderability, physical properties, resistance to acid	Calendered sheet, flue duct expansion joints
Excellent mold flow, very good tear resistance, bonding to metal inserts	Compression→injection molding of complex shapes, bonded metal inserts
Excellent resistance to automotive lubricating oils, aqueous fluids	Transfer → compression molding auto lubricating oil, coolant system seals
Excellent resistance to aqueous media/acids	Transfer →compression molding chemical process industry seals, gaskets
Excellent resistance to automotive lubricating oils, aqueous fluids	Compression molding automotive lubricating oil, coolant system seals
Excellent extrudability; lower MeOH permeability than A-types	FDA-compliant***: high shear extrusion applications—fuel hose veneer, coatings
Intermediate viscosity, very good extrudability, superior fluids resistance	Extruded hose, tubing; calendered sheet
Intermediate viscosity, excellent polymer rheology, superior fluids resistance	FDA-compliant***: compression, transfer, and injection molding
High viscosity, superior fluids resistance, high green strength	Cured with VC-20/VC-30, compression molded oil seals, general molded goods

***Cure-containing precompounds, and polymers + VC-50 (at levels less than or equal to 2.50 phr rubber) have been determined to be in compliance with FDA 21 CFR-177.2600—Rubber Articles for Repeated Food Contact. See Viton Technical Bulletin VT.150.2 (R3) for additional details.

Table 7
Viton F-, Specialty Type Fluoroelastomer Product Listing

Viton Product Grade	Polymer Properties: Nominal Viscosity, ML 1 + 10 at 121°C*	Polymer Properties: Specific Gravity	Polymer Properties: Polymer Fluorine Content, %	Nominal Physical Properties**: Compression Set, % 70 hr/200°C	Nominal Physical Properties**: Temperature of Retraction (TR-10) °C	Nominal Physical Properties**: Volume Increase, After 7 days/ MeOH/23°C
F-Types: Curative-Containing Precompounds						
F-601C	60	1.90	69.5	45	–7	+5 to 10%
F-605C	60	1.90	69.5	30	–8	+5 to 10%
F-Types: Gum Polymers						
GF	60	1.91	69.5	45	–6	+5 to 10%
GF-205NP	20	1.89	69.0	30	–10	+10 to 20%
GF-300	30	1.90	69.5	40	–6	+5 to 10%
Low-Temperature Grades of Viton Polymer						
B-70 Types						
B-70	70*	1.77	66.0	30	–19	+75 to 105%
GLT Types						
GLT-305	20	1.78	64.0	30	–30	+75 to 105%
GLT-505	50	1.78	64.0	30	–30	+75 to 105%
GLT-506	50	1.78	64.0	35	–30	+75 to 105%
GLT	90	1.78	64.0	30	–30	+75 to 105%
GBLT Types						
GBLT-301	30	1.80	65.0	40	–26	+65 to 90%
GBLT-601	60	1.80	65.0	35	–26	+65 to 90%
GFLT Types						
GFLT-301	30	1.86	66.5	40	–24	+5 to 10%
GFLT-501	50	1.86	66.5	40	–24	+5 to 10%
GFLT-502	50	1.86	66.5	45	–24	+5 to 10%
GFLT	75	1.89	66.5	35	–24	+5 to 10%
Extreme Grades of Viton						
ETP-500	50	1.82	67.0	50	–11	+10 to 15%
ETP-900	90	1.82	67.0	45	–11	+10 to 15%

*ML 1 + 10 at 100°C
**Nominal physical properties typical of those that can be expected of vulcanizates based on the specific type of Viton noted, in a 70A hardness, MT carbon black-filled formulation.

Table 7
Viton F-, Specialty Type Fluoroelastomer Product Listing

Viton Fluoroelastomer Product Description	Viton Fluoroelastomer Product Suggested Uses/Applications
Highest fluids resistance, excellent mold release characteristics	Compression molded goods requiring the best resistance to hydrocarbon fluids
Improved polymer base versus F-601C—improved rheology, compression set	FDA-compliant***: compression molded goods requiring best fluids resistance
Superior resistance to broad range of fluids and chemicals, including MeOH	Compression molded goods requiring best fluids resistance
Good physical properties without oven postcure	Transfer, compression molded goods requiring excellent fluid resistance
Excellent mold release, lower viscosity version of GF	Injection, transfer, or compression molded goods requiring best fluids resistance
Slightly improved low-temperature flexibility versus A-types of Viton	General molded goods, where A-types are marginal in low-temperature flexibility
30 Mooney GLT: best FKM low-temperature flexibility, improved mold release	Injection → transfer molded automotive fuel, chemical, petroleum industry seals
50 Mooney GLT: best FKM low-temperature flexibility, improved mold release	Bonded transfer → compression molded automotive fuel, chemical, petroleum industry seals
Best mold release of GLT types; A-type fluids resistance	Transfer → compression molded automotive fuel, chemical, petroleum industry seals
Excellent low-temperature flexibility; fluids resistance similar to A-types	Compression molded auto fuel injectors; chemical, petroleum industry valves, gaskets
Low-temperature flexibility/fluid resistance intermediate between GLT/GFLT types	Fuel systems parts: resistance to low oxygenates, low-temperature flexibility
Low-temperature flexibility/fluid resistance intermediate between GLT/GFLT types	Fuel systems parts: resistance to low oxygenates, low-temperature flexibility
30 ML GFLT: best combination of low-temperature flexibility/fluids resistance	Bonded fuel systems parts: resistance to oxygenates, low-temperature flexibility
50 ML GFLT: best combination of low-temperature flexibility/fluids resistance	Bonded fuel systems parts: resistance to oxygenates, low-temperature flexibility
Excellent processibility: best mold release of GFLT types	Non-bonded fuel systems parts: resistance to oxygenates, low-temperature flexibility
Excellent low-temperature flexibility; resistance to fluids similar to F-types	Bonded fuel systems parts: resistance to oxygenates, low-temperature flexibility
	Transfer → compression molded seals, gaskets
	Compression molded seals, gaskets

***Cure-containing precompounds, and polymers + VC-50 (at levels less than or equal to 2.50 phr rubber) have been determined to be in compliance with FDA 21 CFR-177.2600—Rubber Articles for Repeated Food Contact. See Viton Technical Bulletin VT.150.2 (R3) for additional details.

Applications

Automotive

Today, parts of Viton® fluoroelastomer are widely used in the automotive industry because of their outstanding heat and fluid resistance. They are used in the following areas:

Powertrain Systems

- Crankshaft seals
- Valve stem seals
- Transmission seals

Fuel Systems

- Veneered fuel hose
- In-tank fuel hose and tubing
- Pump seals
- Diaphragms
- Injector O-rings
- Accelerator pump cups
- Filter caps and filter seals
- Carburetor needle tips

Appliances

The heat and fluid resistance of Viton fluoroelastomer, coupled with its good mechanical strength, have made it a natural choice for many appliance parts. Seals and gaskets of Viton have literally made current appliance designs possible. Here are some typical success stories:

- In one commercial automatic drycleaning machine, no less than 107 components are made of Viton: door seals, sleeve-type duct couplings, shaft seals, O-rings, and various static gaskets. They perform in an atmosphere of perchloroethylene fumes at temperatures up to 88°C (190°F), conditions that would quickly ruin other elastomers.
- A fluid-activated diaphragm-type thermostat for gas or electric ranges owes its success to the designer's choice of Viton for the actuator element. Viton got the job because it adheres well to brass, is virtually impermeable to and is not swelled or deteriorated by the fluids used, can withstand operating temperatures of 149 to 204°C (300 to 400°F), and has the mechanical strength to resist repeated flexing.

Chemical Industry

Viton fluoroelastomer is very close to being a universal seal for chemical process equipment. It also serves the chemical industry in many other ways, as shown by the following summary:

- In a pumping station that handles more than 80 different solvents, oils, and chemicals, seals of Viton are used in the piping's swivel and telescoping joints. When these joints were inspected after two years' service, they were found to be as good as new.
- Valves lined with Viton eliminate heat and corrosion worries in many plants.
- Proportioning pumps that handle highly reactive chemicals are equipped with diaphragms of Viton.
- Hose made of Viton is in daily use transferring solvents and reactive petrochemicals to and from processing and distribution facilities. There are installations on ocean tankers as well as on highway trailers.
- Processing rolls for hot or corrosive service are covered with Viton.
- Flange gaskets for glass-bodied valves in a paper bleaching plant are of Viton.
- Cellular Viton replaced caulking on a process equipment enclosure, previously plagued with hot solvent leaks, and saved $4,000 per year in maintenance costs.
- Aerosol-propelled solvent solutions of Viton are sprayed on chemical process equipment as multipurpose maintenance coatings.

Industrial Use

Cutting across all industry lines are a range of applications where the good mechanical properties of Viton fluoroelastomer have permitted it to replace conventional elastomers. To cite a few:

- Stable-dimensioned O-rings in the meters of automatic gasoline blending pumps
- High vacuum seals for the world's most powerful proton accelerator
- Heat- and corrosion-resistant expansion joints for a utility company's stack gas exhaust ducts

- Tubing and seals for a variety of top-quality industrial instruments
- Compression pads for heavy-duty vibration mounts used for portable missile ground control apparatus
- Conveyor rolls for a solvent cleaning machine
- Packing rings for hydraulic activators on steel mill ladles
- Clamp cushions for parts dipped in 285°C (545°F) solder
- Jacketing for steel mill signal cable
- Deflector rolls on high-speed tinplating lines
- Precision-molded balls for check valves in oil or chemical service
- O-ring seals for test equipment in an automotive manufacturer's experimental lab

Others

- Extruded sponge over fluid transfer lines
- Brake damper coatings
- Coupling seals
- O-rings
- Diaphragms
- Gaskets

Aerospace

Reliability of materials under extreme exposure conditions is a prime requisite in this field. Aircraft designers report that O-rings of Viton® fluoroelastomer have a usable thermal range of –54 to 316°C (–65 to 600°F). Viton exhibits "long and consistent life," even at the upper end of this range. Higher temperatures can be tolerated for short periods. Viton also resists the effects of thermal cycling, encountered in rapid ascent to and descent from the stratosphere. Other desirable characteristics of Viton that are pertinent to aerospace applications are its excellent abrasion resistance and its ability to seal against "hard" vacuum, as low as 10–9 mmHg (133 nPa), absolute.

The high-performance properties of Viton have been well demonstrated in these typical aircraft and missile components:

- O-rings
- Manifold gaskets
- Coated fabric covers for jet engine exhausts between flights
- Firewall seals
- Abrasion-resistant solution coating over braid-sheathed ignition cable
- Clips for jet engine wiring harnesses
- Tire valve stem seals
- Syphon hose for hot engine lubricants

Fluid Power

Designers and engineers are discovering that seals of Viton fluoroelastomer work better and last longer in more fluid power applications than any other rubber. Viton seals effectively up to 204°C (400°F) and is unaffected by most hydraulic fluids, including the fire-resistant types. Seals of Viton can also cut maintenance costs under more moderate service conditions (below 121°C [250°F]) by providing longer, uninterrupted seal reliability.

Following are some of the applications in which seals of Viton can reduce fluid loss and minimize downtime:

- Actuators are the hydraulic components most likely to develop small, steady leaks when rubber seals wear and lose resilience, which can be extremely expensive. In a working year, day-to-day leakage from the average hydraulic system wastes enough fluid to completely fill the system more than four times. Viton prevents or reduces leakage by maintaining its toughness and resilience longer than other normal rubber seal materials under normal fluid power conditions.
- In pumps, poor sealing performance increases operating costs by wasting power. When internal seals lose resilience and allow more slippage than the pump is designed for, power is wasted. When seals swell and drag, power is wasted. Seals of Viton keep their resilience and don't swell, thus preventing power waste and helping hold down operating costs.

Safety and Handling

When the recommended handling precautions are followed, Viton® fluoroelastomers present no known health hazards. As with many polymers, minute quantities of potentially irritating or harmful gases may diffuse from uncured Viton even at room temperature. Therefore, all containers should be opened and used only in well-ventilated areas. In case of eye contact, immediately flush the eyes for at least 15 min with water. Always wash contacted skin with soap and water after handling Viton.

Potential hazards, including the evolution of toxic vapors, may arise during compounding, processing, and curing of the raw polymers into finished products or under high-temperature service conditions. Therefore, before handling or processing Viton, make sure that you read and follow the recommendations in the DuPont Dow Elastomers bulletin VT-100.1, "Handling Precautions for Viton® and Related Chemicals."

Compounding ingredients and solvents that are used with Viton to prepare finished products may present hazards in handling and use. Before proceeding with any compounding or processing work, consult and follow label directions and handling precautions from suppliers of all ingredients.

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