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Viton® Selection Guide

This document from The Chemours Company presents various types of Viton® fluoroelastomers (FKM) and associated technical data.

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Viton™ Fluoroelastomers

Selection Guide

Technical Information

Introduction

Viton™ fluoroelastomer was introduced in 1957 to meet the needs of the aerospace industry for a high-performance seal elastomer. Since then, the use of Viton™ fluoroelastomer has expanded to many other industries, especially in the automotive, fluid power, appliance, and chemical fields. With over half a century of proven performance, Viton™ fluoroelastomer has developed a reputation for outstanding performance in high temperature and extremely corrosive environments.

Valuable Properties of Viton™ Fluoroelastomer

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

Resistance to Temperature Extremes

Heat—Compared to most other elastomers, Viton™ is better able to withstand high temperature, while simultaneously retaining its good mechanical properties. Oil and chemical resistance are also essentially unaffected by elevated temperatures. Compounds of Viton™ remain substantially elastic indefinitely when exposed to laboratory air oven aging up to 204 °C (399 °F) or to intermittent exposures up to 316 °C (601 °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 (601 °F)

Cold—Viton™ low temperature performance is dependent on type, with serviceability as low as –31 °C (–24 °F) in dynamic seals and –45 °C (–49 °F) in static seals using Viton™ GLT-S.

Viton™ is characterized by its:

- Resistance to degradation by a greater variety of fluids and chemicals than any other non-fluorinated elastomer. 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 dissolve 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.

Safety and Handling

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 minutes 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 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 Chemours technical bulletin, "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.

Chemours™

The Various Families and Types of Viton™ Fluoroelastomers

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

In general, Viton™ exhibits outstanding resistance to attack from 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 A, B, and F types of Viton™, in terms of resistance to volume change or retention of physical properties, are exhibited in low molecular weight, oxygenated solvents (such as methanol and methyl t-butyl ether).

As mentioned above, the fluid resistance of Viton™ A, B, and F types improves with increasing fluorine levels. This is shown in Table 1 (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 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 copolymerized fluorinated vinyl ether monomer. Polymers that contain this monomer exhibit significantly improved low temperature flexibility, compared to standard types of fluoroelastomer.

Viton™ GLT-S provides the same excellent resistance to heat and fluids that is typical of the A types of Viton™ fluoroelastomer. Viton™ GFLT-S, like Viton™ GLT-S, exhibits significantly improved low temperature flex characteristics compared to standard types of fluoroelastomer. In addition, Viton™ GFLT-S provides the same superior resistance to fluids that is typical of the F types of Viton™ fluoroelastomer.

Types of Viton™ Extreme™

Fluoroelastomers that contain copolymerized vinylidene fluoride (VF_2) 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 methyl ethyl ketone, acetone, or methyl tertiarybutyl ether.

Viton™ Extreme™ ETP-600S is a copolymer of ethylene, tetrafluoroethylene (TFE), and perfluoromethylvinyl ether (PMVE). This unique combination of monomers provides outstanding resistance to fluids and is an example of an ETP polymer. The ETP types of Viton™ exhibit the same excellent resistance to acids and hydrocarbons typical of A, B, and F 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 a specific manufacturing process.

Table 1. Polymer Fluorine Content Versus Fluid Resistance and Low Temperature Flexibility

	Standard Types			Specialty Types		
	A	B	F	GLT-S	GFLT-S	ETP-S
Nominal Polymer Fluorine Content, wt%	66	68	70	64	67	67
Percent Volume Change in Fuel C, 168 hr at 23 °C (73 °F)*	4	3	2	5	2	4
Percent Volume Change in Methanol, 168 hr at 23 °C (73 °F)*	90	40	5	90	5	5
Percent Volume Change in Methyl Ethyl Ketone, 168 hr at 23 °C (73 °F)*	>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	–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. These are not intended to serve as specifications.

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 cross-linking or curing system that is used to vulcanize the elastomer.

Diamine curatives were introduced in 1957 for cross-linking 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. For example, compounds cured with diamines exhibit excellent adhesion to metal inserts and high hot tensile strength.

Most fluoroelastomers are cross-linked with Bisphenol AF, a curative 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. 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-601C, and B-651C. A brief description of all these products can be found in Table 6.

Peroxide cross-linking provides fast cure rates and excellent physical properties and allows cross-linking of polymers, such as GLT-S and GFLT-S, which cannot be readily cured with either diamine or bisphenol cross-linking systems. When properly formulated, peroxide cross-linking provides enhanced resistance to aggressive automotive lubricating oils, steam, mineral and organic acids, and aggressive biodiesel. Generally, vulcanizates of Viton™ fluoroelastomers cured with peroxide do not show any significant difference in resistance to hydrocarbon fluids compared to a polymer of similar fluorine content cured with bisphenol.

In 2003, a series of peroxide-cure types of Viton™ made with Advanced Polymer Architecture (APA) was introduced. These polymers, designated as APA polymers by having an "S" suffix on the product name, incorporate a significantly improved cure site. As a result, they provide substantially better processing and physical properties, compared to the original, non-APA peroxide-cure types of Viton™. A comparison of the various processing and physical property characteristics of compounds using the various cure systems is shown in Table 2.

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 among the various families of Viton™ fluoroelastomers. These are the result of differences in the relative amount and type of monomers used in the manufacture of the various types of Viton™ fluoroelastomers.

Table 2. A Comparison of Cure Systems Used in Cross-Linking 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	G-E
Adhesion to Metal Inserts	E	G	G
Compression Set Resistance	P	E	E
Steam, Water, Acid Resistance	F	G	E
Flex Fatigue Resistance	G	G	G

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

The differences in physical property characteristics that exist between various types and families of Viton™ fluoroelastomer products are outlined in general terms in Table 3.

As an example, resistance to compression set is an important property for seals, and if this property were 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 application. However, if resistance to the widest possible range of fluids is a more important consideration, then an F-type Viton™ fluoroelastomer might 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, GFLT types of Viton™ would represent the best overall choice.

Selecting a Specific Type of Viton™ Fluoroelastomer

Differences in Fluid Resistance Among Types 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 among types of Viton™ products, in terms of their resistance to various classes of fluids and chemicals.

Because as certain types 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 physical property requirements and fluid or chemical resistance needs.

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

Table 3. Physical Property Differences Among Types/Families of Viton™ Products

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

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

*See Table 4 for a 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.

Table 4. Differences in Fluid Resistance Among Types of Viton™ Fluoroelastomer

Type of Viton™ Fluoroelastomer	A	B	F	GAL-S	GBL-S	GF-S	GLT-S	GFLT-S	ETP-S
Cure System		Bisphenol				Peroxide			
Hydrocarbon Automotive, Aviation Fuels	1	1	1	1	1	1	1	1	1
Oxygenated Automotive Fuels (containing MeOH, EtOH, MTBE, etc.)	NR	2	1	NR	2	1	NR	1	1
Reciprocating Engine Lubricating Oils (SE-SF Grades)	2	1	1	1	1	1	1	1	1
Reciprocating Engine Lubricating Oils (SG-SH Grades)	3	2	2	1	1	1	1	1	1
Aliphatic Hydrocarbon Process Fluids, Chemicals	1	1	1	1	1	1	2	1	1
Aromatic Hydrocarbon Process Fluids, Chemicals	2	2	1	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	1
Amines, High pH Caustics (KOH, NaOH, etc.)	NR	NR	NR	3	3	3	3	3	1
Low Molecular Weight Carbonyls (MTBE, MEK, MIBK, etc.)	NR	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 improved processing precompounds in 1993, a new nomenclature 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 cross-linking agent present in curative-containing precompounds)
- An indication of whether the product can be cross-linked using a peroxide cure system
- An indication of whether the product is a gum polymer or a precompound, which contains a preset, carefully controlled amount of bisphenol cross-linking system.

Each character in the product name indicates a specific characteristic as outlined below:

Character No.: 1st 3rd 5th

Viton™ A-401C

2nd 4th

1st Character (Letter)

- Represents the Viton™ fluoroelastomer family—A, B, F, or ETP
- A "G" prefix, in addition to a family prefix, indicates that the polymer can be cross-linked 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 to 1 (10 is represented by 0);

0 = High curative level (for optimum compression set)

9 to 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

5th Character (Letter)

- Absence of a 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
- "S" indicates that the product incorporates Viton™ made with APA technology

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

The Viton™ product line includes a wide variety of different 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 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 Chemours' 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 choice of 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 de-molding tear resistance, but that 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 de-molding due to 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 which require good resistance to tear during de-molding. 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 types.

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 process type by which the end products will be manufactured (row), we have listed the types of Viton™ that we believe are appropriate choices for meeting the physical property requirements of the finished product and 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 for specific types of Viton™ can be found in the Viton™ Product Listing and in product-specific data sheets.

Table 5. Viton™ Fluoroelastomer Application Guide

Manufacturing Process	Reinforced/Unreinforced Sheet Stock (Gaskets, Diaphragms, etc.)				Molded (Non-Bonded), Simple Shapes (O-Rings, V-Rings, etc.)			
	Viton™ Types							
	A	B	F	Specialty	A	B	F	Specialty
Compression Molding	A-331C A-361C A-401C A-601C A-500 A-700 AL-600	B-435C B-601C B-651C GBL-600S B-600	F-605C GF-600S	GLT-600S GFLT-600S ETP-600S	A-401C A-331C A-601C A-500 A-HV A-700 AL-600	B-601C B-651C GBL-600S B-600	F-605C GF-600S	GLT-600S GFLT-600S ETP-600S
Transfer Molding	A-201C A-331C A-361C A-401C A-200 AL-300	B-435C GBL-200S B-202	F-605C GF-200S	GLT-200S GFLT-200S ETP-600S	A-201C A-331C A-361C A-200 AL-300	B-651C GBL-200S B-202	F-605C GF-200S	GLT-200S GFLT-200S ETP-600S
Injection Molding	A-201C A-331C A-361C A-200 AL-300	B-435C GBL-200S B-202	GF-200S	GLT-200S GBLT-200S GFLT-200S	A-201C A-331C A-361C A-100 A-200 A-500 AL-300	B-601C B-651C GBL-200S B-202	F-605C GF-200S	GLT-200S GFLT-200S ETP-600S
Calendering	A-201C A-401C A-331C A-361C AL-300	B-435C B-601C B-651C GBL-200S GBL-600S B-202 B-600	F-605C GF-200S GF-600S	GLT-200S GLT-600S GFLT-200S GFLT-600S ETP-600S	—	—	—	—
	Molded (Bonded), Complicated Shapes (Valve Stem, Shaft Seals, etc.)				Molded (Non-Bonded), Complicated Shapes (Boots, Valves, etc.)			
Compression Molding	A-361C A-500 A-700 AHV AL-600	B-435C B-651C GBL-600S B-600	F-605C/GF-200S GF-200S GF-600S	GLT-200S GLT-600S GFLT-200S GFLT-600S ETP-600S	A-331C A-401C/A-500 A-601C/A-200 A-361C A-700 AHV AL-600	B-435C B-651C GBL-600S B-600	F-605C/GF-600S GF-600S	GLT-600S GFLT-600S ETP-600S
Transfer Molding	A-361C A-200 A-500 AL-300	B-435C GBL-200S B-202	GF-200S	GLT-200S GFLT-200S ETP-600S	A-200 A-331C A-361C A-200 A-500 AL-300	B-435C B-651C GBL-200S B-600	F-605C/GF-200S GF-300	GLT-200S GFLT-200S ETP-600S
Injection Molding	A-361C A-100 A-200 A-500 AL-300	B-435C B-651C GBL-200S B-202	F-605C/GF-200S GF-200S	GLT-200S GFLT-200S	A-200 A-331C A-361C A-200 A-500 AL-300	B-435C B-651C GBL-200S B-202	F-605C/GF-200S GF-200S	GLT-200S GFLT-200S

Manufacturing Process	Extruded Goods (Hose, Tubing, Extruded Profiles, etc.)			
	Viton™ Types			
	A	B	F	Specialty
Extrusion	A-201C A-401C A-361C A-200 A-500 AL-300	B-435C B-651C GBL-200S B-202 B-600	F-605C GF-200S	GLT-200S GFLT-200S ETP-600S

Table 6. Viton™ Fluoroelastomer Product Listing

Viton™ Product Type	Polymer Properties: Nominal Viscosity, ML1 + 10 at 121 °C (250 °F)	Polymer Properties: Specific Gravity	Polymer Properties: Polymer Fluorine Content, %	Nominal Physical Properties*: Compression Set, % 70 hr/200 °C (392 °F)	Nominal Physical Properties*: Temperature of Retraction (TR-10), °C	Nominal Physical Properties*: Volume Increase, After 7 days/ MeOH/23 °C (73 °F)	Viton™ Fluoroelastomer Product Description	Viton™ Fluoroelastomer Product Suggested Uses/Applications
A-Types: Curative-Containing Precompounds								
A-201C	20	1.81	66.0	15	−17	+75 to 105%	Fast cure rate, excellent injection molding rheology, mold release	Injection molding, O-rings, gaskets, extruded shapes
A-331C	30	1.81	66.0	20	−17	+75 to 105%	Excellent mold flow, high elongation/tear resistance	Compression—injection molding of complex shapes, requiring maximum hot tear
A-361C	30	1.81	66.0	20	−17	+75 to 105%	Excellent mold flow, tear resistance, bonding to metal inserts	Compression—injection molding of complex shapes, bonded metal inserts
A-401C	40	1.81	66.0	15	−17	+75 to 105%	Excellent rheology at high shear rates, excellent resistance to compression set	Compression, transfer, or injection molding of O-rings
A-601C	60	1.81	66.0	12	−17	+75 to 105%	High viscosity, high state of cure; optimum resistance to compression set	Compression molding of O-rings, simple shapes
A-Types: Gum Polymers								
A-100	10	1.82	66.0	15	−17	+75 to 105%	Ultra-low viscosity: excellent polymer rheology	Coatings, viscosity modifier for higher viscosity types
A-200	20	1.82	66.0	15	−17	+75 to 105%	Low viscosity: excellent polymer rheology	Cured with VC-50: injection molding applications
A-500	50	1.82	66.0	15	−17	+75 to 105%	Intermediate viscosity: excellent polymer rheology	Cured with VC-50: compression, transfer, injection molding
A-700	70	1.82	66.0	15	−17	+75 to 105%	High viscosity: excellent physical properties	Cured with VC-50: compression, transfer, injection molding
A-HV	160	1.82	66.0	15	−17	+75 to 105%	Ultra-high viscosity: excellent physical properties	Cured with VC-50: compression molding, high strength vulcanizates
AL-300	30	1.77	66.0	25	−19	+75 to 105%	Slightly improved low temperature flexibility. Low viscosity	Transfer, or injection molded goods, where A-types are marginal in low-temperature flexibility
AL-600	60	1.77	66.0	20	−19	+75 to 105%	Slightly improved low temperature flexibility. Medium viscosity	General molded goods, where A-types are marginal in low-temperature flexibility
GAL-200S	25	1.79	66.0	30	−19	+75 to 105%	Excellent resistance to automotive lubricating oils, aqueous fluids	FDA-compliant**: injection, transfer, or compression molded goods

continued

Table 6. Viton™ Fluoroelastomer Product Listing (continued)

Viton™ Product Type	Polymer Properties		Nominal Physical Properties*					
	Nominal Viscosity, ML1 + 10 at 121 °C (250 °F)	Specific Gravity	Polymer Fluorine Content, %	Compression Set, % 70 hr/200 °C (392 °F)	Temperature of Retraction (TR-10), °C	Volume Increase, After 7 days/ MeOH/23 °C (73 °F)	Viton™ Fluoroelastomer Product Description	Viton™ Fluoroelastomer Product Suggested Uses/Applications
B-Types: Curative-Containing Precompounds								
B-435C	40	1.85	68.5	25	−14	+35 to 45%	Improved processing/ mold release/bonding vs. B-641C, B-651C	Injection—compression molding of metal-bonded parts
B-601C	60	1.85	68.5	20	−14	+35 to 45%	Excellent balance of resistance to compression set/fluids	Compression—injection molding of O-rings, simple shapes
B-651C	60	1.85	68.5	30	−14	+35 to 45%	Excellent mold flow, very good tear resistance, bonding to metal inserts	Compression—injection molding of complex shapes, bonded metal inserts
B-Types: Gum Polymers								
GBL-200S	20-30	1.85	67.0	30	−16	+40 to 50%	Excellent resistance to automotive lubricating oils, aqueous fluids	FDA-compliant**: transfer—compression molding auto lubricating oil, coolant system seals
GBL-600S	65	1.85	67.0	30	−16	+40 to 50%	Excellent resistance to automotive lubricating oils, aqueous fluids	FDA-compliant**: compression molding automotive lubricating oil, coolant system seals
B-202	20	1.86	68.5	25	−14	+35 to 45%	Excellent extrudability; lower MeOH permeability than A-types	High shear extrusion applications—fuel hose veneer, coatings
B-600	60	1.86	68.5	20	−14	+35 to 45%	Intermediate viscosity, excellent polymer rheology, superior fluids resistance	Compression, transfer, and injection molding
F-Types: Curative-Containing Precompounds								
F-605C	60	1.90	69.5	30	−8	+5 to 10%	Improved polymer base vs. F-601C—improved rheology, compression set	Compression molded goods requiring best fluids resistance
F-Types: Gum Polymers								
GF-200S	25–30	1.91	70.0	35	−6	+3 to 5%	Low viscosity version of GF-600S	FDA-compliant**: injection transfer, or compression molded goods requiring best fluids resistance
GF-600S	65	1.91	70.0	35	−6	+3 to 5%	Superior resistance to broad range of fluids and chemicals, including MeOH	FDA-compliant**: compression molded goods requiring best fluids resistance

continued

Table 6. Viton™ Fluoroelastomer Product Listing (continued)

	Polymer Properties			Nominal Physical Properties*				
Viton™ Product Type	Nominal Viscosity, ML1 + 10 at 121 °C (250 °F)	Specific Gravity	Polymer Fluorine Content, %	Compression Set, % 70 hr/200 °C (392 °F)	Temperature of Retraction (TR-10), °C	Volume Increase, After 7 days/ MeOH/23 °C (73 °F)	Viton™ Fluoroelastomer Product Description	Viton™ Fluoroelastomer Product Suggested Uses/Applications
Low-Temperature Types of Viton™ Polymer								
GLT Types								
GLT-200S	25–30	1.78	64.0	30	−30	+75 to 105%	20–30 Mooney GLT: best FKM low-temperature flexibility	Injection—transfer molded automotive fuel, chemical, petroleum industry seals
GLT-600S	65	1.78	64.0	35	−30	+75 to 105%	Medium viscosity version of GLT	Transfer—compression molded automotive fuel, chemical, petroleum industry seals
GFLT Types								
GFLT-200S	25–30	1.86	66.5	35	−24	+5 to 10%	30 ML GFLT: best combination of low-temperature flexibility/ fluids resistance	FDA-compliant**: bonded fuel systems parts: resistance to oxygenates, low-temperature flexibility
GFLT-600S	65	1.86	66.5	40	−24	+5 to 10%	65 ML GFLT: best combination of low-temperature flexibility/ fluids resistance	FDA-compliant**: bonded fuel systems parts: resistance to oxygenates, low-temperature flexibility
Viton™ Extreme™ Types								
ETP-600S	60	1.82	67.0	40	−12	+10 to 15%	Outstanding resistance to fluids/chemicals, including low molecular weight acids, aldehydes, ketones	FDA-compliant**: transfer—compression molded seals, gaskets

*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. These are not intended to serve as specifications.

**Various types of Viton™ curative-containing precompounds have been determined to be in compliance with FDA 21 CFR-177.2600—Rubber Articles for Repeated Food Contact.

Applications

Automotive

Parts produced from 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
- Air intake manifold gaskets

Fuel Systems

- Veneered fuel hose
- In-tank fuel hose and tubing
- Pump seals, diaphragms and injector O-rings
- Accelerator pump cups
- Filter caps and filter seals
- Fuel sender seals, carburetor needle tips

Appliances

The heat and fluid resistance of Viton™ fluoroelastomer, coupled with its good mechanical strength, makes it a natural choice for many appliance parts. The use of seals and gaskets of Viton™ has resulted in design of appliances in challenging environments. Here are some typical success stories:

- In one commercial automatic dry cleaning 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 degrade 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. Because Viton™ adheres well to brass, it is virtually impermeable to and is not swelled or deteriorated by the fluids used, can withstand operating temperatures of 149–204 °C (300–399 °F), and has the mechanical strength to resist repeated flexing.

Chemical Industry

Viton™ fluoroelastomer is essentially a universal seal for chemical process equipment. Its application in the chemical industry is illustrated by the following examples:

- 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™ reduce heat and corrosion worries in many plants.
- Hose made of Viton™ transfers 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™.
- 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 multi-purpose maintenance coatings.

Industrial Use

The good mechanical properties of Viton™ fluoroelastomer allows replacement of conventional elastomers in a range of applications that cut across industry lines. 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

Aerospace

Reliability of materials under extreme exposure conditions is a prime requisite in this field. Aircraft designers report that O-rings of Viton™ fluoroelastomer provide outstanding performance over a broad thermal range, from low to extremely high temperatures, and that 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} mm Hg (133 nPa), absolute.

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

- O-rings and 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
- Siphon hose for hot engine lubricants

Fluid Power

Designers and engineers are discovering that seals of Viton™ fluoroelastomer work better and last longer than any other rubber in most fluid power applications. Viton™ seals effectively up to 204 °C (399 °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.

Some applications in which seals of Viton™ can reduce fluid loss and minimize downtime include the following:

- 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 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 design permits, 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.

Test Procedures

Property Measured	Test Procedure
Compression Set	ASTM D3955, Method B (25% deflection)
Compression Set—Low Temperature	ASTM D1299, Method B (25% deflection)
Compression Set, O-Rings	ASTM D1414
Hardness	ASTM D2240, durometer A
Mooney Scorch	ASTM D1646, using the small rotor. Minimum viscosity and time to a 1-, 5-, or 10-unit rise are reported.
Mooney Viscosity	ASTM D1646, ten pass 100 °C (212 °F) and 121 °C (250 °F)
ODR (vulcanization characteristics measured with an oscillating disk cure meter)	ASTM D2084
Property Change After Oven Heat-Aging	ASTM D573
Stress/Strain Properties 100% Modulus Tensile Strength Elongation at Break	ASTM D412, pulled at 8.5 mm/sec (20 in/min)
Stiffness, Torsional, Clash-Berg	ASTM D1043
Temperature Retraction	ASTM D1329
Volume Change in Fluids	ASTM D471

Note: Test temperature is 24 °C (75 °F), except where specified otherwise.

For more information, visit Viton.com

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