Viton™ GF-600S

Fluoroelastomers

Technical Information

Introduction

Viton™ GF-600S* is a next generation, easy processing, peroxide-cured 70% fluorine fluoroelastomer based on new Advanced Polymer Architecture (APA). Viton™ GF-600S exhibits improved processability coupled with similar or improved fluids resistance in aromatic hydrocarbons, alcohols, methanol, water, steam, and acids.

Features

- Cures exceptionally fast to a high state of cure
- Exhibits improved mold flow, less shear sensitivity, and lower extruder die swell for a ~65 Mooney FKM
- Exhibits excellent physical properties with high elongation, both original and aged
- Exhibits excellent compression set resistance with short (2 hr) or no post-cure

Processing

A load factor of >70% for internal mixing of Viton™ GF-600S is recommended. The recommended process aids for Viton™ GF-600S are 1 phr of Struktol® HT 290 or combinations of 0.5 phr Armeen® 18D with carnauba wax or Struktol® WS 280. Diak™ No. 7 (TAIC) coagent is recommended for all Viton™ GF-600S compounds. Use at a 2.5 phr level or less is generally satisfactory, unless high modulus is needed. At higher levels, TAIC can bleed out and cause molding flaws.

Safety and Handling

Before handling or processing Viton™ GF-600S, be sure to read and be guided by the suggestions in the Chemours technical bulletin, "Handling Precautions for Viton™ and Related Chemicals."

Product Description

Chemical Composition	Copolymer of hexafluoropropylene, vinylidene fluoride, and tetrafluoroethylene with a cure site monomer
Physical Form	Sheet
Appearance	Off-white to tan
Odor	None
Mooney Viscosity, ML 1 + 10 at 121 °C (250 °F)	65
Specific Gravity	1.90
Storage Stability	Excellent
Fluorine, %	~70

*Viton™ GF-600S was formerly named VTR-8600.

Chemours™

Table 1. General Properties of Viton™ GF-600S

		Viton™ GF-600S
Viton™ GF-600S		100
Zinc Oxide		3
N990		30
Diak™ No. 7		3
Luperox® 101XL 45		3
Total phr		139
Mooney Scorch at 121 °C (250 °F)		
Minimum, MU		32
2 pt rise, min		19.5
5 pt rise, min		21.3
10 pt rise, min		23.1
ODR at 162 °C (324 °F), 3° Arc, 100 Range, 30 min Clock		
ML, dN.m		16
ts2, min		1.2
t'50, min		2.8
t'90, min		5.2
MH, dN.m		158
MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 12 min Clock		
ML, dN.m		1.9
ts2, min		0.4
t'50, min		0.6
t'90, min		0.9
t'95, min		1.0
MH, dN.m		30.4
Rosand Capillary Rheometer at 100 °C (212 °F), 1.5 mm Die, L/D = 0/1 and 10/1		
Piston Speed, mm/min	*Shear Rate, sec^{-1}*	*Pressure, MPa (L/D = 0/1 die)*
5	44	4.4
12.7	113	5.1
50.8	452	7.5
127	1129	9.5
250	2223	12.1
Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure		
M10, MPa		0.7
M100, MPa		4.2
Tb, MPa		13.8
Eb, %		285
Hardness, A, pts		69
Physical Properties at RT—Original, Cure 7 min at 177 °C (351 °F), Post-Cured at 232 °C (450 °F)		*2 hr*
M10, MPa		0.7
M100, MPa		5.4
Tb, MPa		20.7
Eb, %		269
Hardness, A, pts		72

Table 1. General Properties of Viton™ GF-600S (continued)

	Viton™ GF-600S
Compression Set, Method B, O-Rings, 22 hr at 200 °C (392 °F)	*2 hr*
No Post-cure	19
Post-cured at 232 °C (450 °F)	17
Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven	
M10, MPa	0.7
M100, MPa	5.0
Tb, MPa	20.5
Eb, %	297
Hardness, A, pts	72
Pt change	0
% change, M10	1
% change, M100	–8
% change, Tb	–1
% change, Eb	10
Physical Properties at RT—Heat-Aged 70 hr at 275 °C (527 °F) in Oven	
M10, MPa	0.8
M100, MPa	3.7
Tb, MPa	14.3
Eb, %	361
Hardness, A, pts	71
Pt change	–1
% change, M10	11
% change, M100	–32
% change, Tb	–31
% change, Eb	34
Physical Properties at RT—Aged 168 hr at 150 °C (302 °F) in ASTM #105 Oil, 5W/30	
M10, MPa	0.8
M100, MPa	5.8
Tb, MPa	13.7
Eb, %	176
Hardness, A, pts	73
Pt change	1
% change, M10	14
% change, M100	6
% change, Tb	–34
% change, Eb	–35
Volume Swell, %	1.1
Volume Swell After Immersion—Time and Temperature as Noted	
Fuel C, 168 hr at 23 °C (73 °F)	1.2
Methanol, 168 hr at 23 °C (73 °F)	2.4
Water, 168 hr at 100 °C (212 °F)	3.7

Table 2. Viton™ GF-600S—Filler Study

	5-MT Black	30-MT Black	60-MT Black	40-Wollastocoat	40-$BaSO_4$
Viton™ GF-600S	100	100	100	100	100
N990 (MT Black)	5	30	60	—	—
Wollastocoat 10022	—	—	—	40	—
Blanc Fixe ($BaSO_4$)	—	—	—	—	40
Armeen® 18D	0.5	0.5	0.5	0.5	0.5
Diak™ No. 7 (TAIC)	3	3	3	3	3
Varox® DBPH-50	3	3	3	3	3
Total phr	111.5	136.5	166.5	146.5	146.5
Mooney Scorch at 121 °C (250 °F)					
Minimum, MU	18.6	24.9	7.4	31.3	22.6
2 pt rise, min	13.6	10.5	6.2	10.7	15.1
5 pt rise, min	14.4	11.7	7.6	11.3	15.8
10 pt rise, min	15.6	12.8	8.8	11.9	17.6
ODR at 162 °C (324 °F), 3° Arc, 100 Range, 30 min Clock					
ML, dN.m	13	15	17	17	17
ts2, min	0.9	0.7	0.5	0.9	1.3
t'50, min	1.7	1.4	1.2	2.3	2.7
t'90, min	4.4	3.1	2.3	11.0	8.2
MH, dN.m	108	148	191	137	132
MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock					
ML, dN.m	1.2	1.6	2.7	1.9	1.6
ts2, min	0.5	0.4	0.3	0.4	0.4
t'50, min	0.6	0.6	0.6	0.6	0.6
t'90, min	0.9	1.0	1.4	0.8	0.9
t'95, min	1.0	1.3	2.2	0.9	1.1
MH, dN.m	16.7	28.1	48.8	27.2	21.9
Physical Properties at RT—Original, Cured 5 min at 177 °C (351 °F), No Post-Cure					
M10, MPa	0.3	0.7	1.6	0.8	0.5
M100, MPa	1.3	3.4	7.3	4.3	1.7
Tb, MPa	13.3	10.7	10.6	10.8	10.7
Eb, %	386	350	236	361	381
Hardness, A, pts	54	70	84	69	61
Physical Properties at RT—Original, Cured 5 min at 177 °C (351 °F), Post-Cured 2 hr at 232 °C (450 °F)					
M10, MPa	0.4	1.0	2.4	1.0	0.6
M100, MPa	1.5	5.4	11.7	7.2	2.2
Tb, MPa	18.6	18.3	17.4	13.1	15.0
Eb, %	380	302	215	308	384
Hardness, A, pts	57	77	89	72	65

Table 2. Viton™ GF-600S—Filler Study (continued)

	5-MT Black	30-MT Black	60-MT Black	40-Wollastocoat	40-$BaSO_4$
Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven					
M10, MPa	0.3	1.3	3.1	1.1	0.6
M100, MPa	1.4	5.7	12.7	8.9	3.1
Tb, MPa	20.7	18.2	19.2	13.1	15.5
Eb, %	465	315	167	306	417
Hardness, A, pts	59	79	88	73	67
Pt change	2	2	–1	1	2
% change, M10	–3	27	29	15	4
% change, M100	–5	6	8	23	43
% change, Tb	11	–1	11	0	4
% change, Eb	23	4	–22	–1	9
Physical Properties at RT—Aged 168 hr at 150 °C (302 °F) in Oven, ASTM #105 Oil, 5W/30					
M10, MPa	0.4	1.4	3.4	1.3	0.6
M100, MPa	1.7	6.7	11.8	8.6	2.3
Tb, MPa	7.6	11.2	13.7	10.7	4.1
Eb, %	239	158	120	150	219
Hardness, A, pts	60	78	91	74	65
Pt change	3	1	2	2	0
% change, M10	23	33	43	28	0
% change, M100	13	25	1	20	6
% change, Tb	–59	–39	–21	–18	–73
% change, Eb	–37	–48	–44	–51	–43
Volume Change, %	1.3	1.2	1.4	1.3	2.6
Compression Set, Method B, O-Rings, 22 hr at 200 °C (392 °F)	*2 hr*	*2 hr*	*2 hr*	*2 hr*	*2 hr*
No Post-cure	27	37	40	28	44
Post-cured at 232 °C (450 °F)	21	29	31	25	34
Volume Swell After Immersion—Time and Temperature as Noted					
Fuel C, 168 hr at 23 °C (73 °F)	3.1	3.6	3.3	2.6	2.4
Methanol, 168 hr at 23 °C (73 °F)	2.9	2.7	2.4	2.6	2.4
Water, 168 hr at 100 °C (212 °F)	5.5	3.5	0.3	7.8	5.4
Compound Specific Gravity	1.90	1.89	1.87	2.10	2.24
Brittle Point—ASTM D746-95, Calculated Method					
No Post-cure	–56	–26	–10	–14	–54
Post-cured at 232 °C (450 °F)	–54	–42	–12	–16	–46

Table 3. Comparison of Different Peroxides in Viton™ GF-600S

	A08-01	A08-02	A08-03	A08-04	A08-05	A08-06
		2 phr	3 phr	3 phr	3 phr	3 phr
Peroxide Type Used	Control	DBPH50	DBPH50-HP	130 XL	802-40KE	DCP-40KE
Viton™ GF-600S	100	100	100	100	100	100
Zinc Oxide	3	3	3	3	3	3
N990	30	30	30	30	30	30
Diak™ No. 7 (TAIC)	3	3	3	3	3	3
Varox® DBPH-50	3	2	—	—	—	—
Varox® DBPH-50-HP	—	—	3	—	—	—
Varox® 130XL	—	—	—	3	—	—
Varox® 802-40KE	—	—	—	—	3	—
Varox® DCP-40KE	—	—	—	—	—	3
Total phr	139	138	139	139	139	139
Mooney Scorch at 121 °C (250 °F)						
Minimum, MU	32	33	30	29	31	31
2 pt rise, min	18.8	24.4	>30	>30	25.4	13.2
5 pt rise, min	19.7	25.9	—	—	>30	14.2
10 pt rise, min	21.0	27.1	—	—	—	15.0
ODR at 162 °C (324 °F), 3° Arc, 100 Range, 30 min Clock						
ML, dN.m	16	16	14	14	15	17
ts2, min	1.0	1.2	1.9	1.4	1.2	1.0
t'50, min	2.0	2.4	4.9	3.1	2.9	2.1
t'90, min	3.4	3.6	6.4	4.7	4.7	3.6
MH, dN.m	161	154	135	138	157	169
MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock						
ML, dN.m	1.8	1.8	1.5	1.5	1.7	1.9
ts2, min	0.4	0.4	0.7	0.5	0.4	0.4
t'50, min	0.6	0.7	1.2	0.9	0.7	0.6
t'90, min	0.9	1.1	2.1	1.7	1.4	0.9
t'95, min	1.0	1.3	2.7	2.3	1.8	1.1
MH, dN.m	31.8	32.6	33.9	33.9	34.9	34.1
Spider Transfer Mold Flow Test—Sprue 0.031 in, ~ 0.8 mm, Cured 7 min at 177 °C (351 °F)						
Total Shot Weight, g	35.1	34.9	35.0	35.0	35.0	34.9
Weight of Spider, g	12.3	17.9	26.0	23.7	19.1	14.1
Fill Factor, %	35	51	74	68	54	40
Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure						
M10, MPa	0.7	0.7	0.7	0.8	0.8	0.8
M100, MPa	4.6	4.9	4.1	5.0	5.2	5.1
Tb, MPa	14.2	14.4	14.3	15.9	16.1	14.8
Eb, %	262	236	283	267	280	281
Hardness, A, pts	70	70	71	72	72	71
Hot Tear Strength at 150°C—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure						
Tear Die B, nicked, N/mm	10.3	10.0	10.5	11.1	10.8	11.6

Table 3. Comparison of Different Peroxides in Viton™ GF-600S (continued)

	A08-01	A08-02	A08-03	A08-04	A08-05	A08-06
		2 phr	3 phr	3 phr	3 phr	3 phr
Peroxide Type Used	Control	DBPH50	DBPH50-HP	130 XL	802-40KE	DCP-40KE
Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), Post-Cured at 232 °C (450 °F) as Noted						
	2 hr	*2 hr*	*2 hr*	*2 hr*	*2 hr*	*2 hr*
M10, MPa	0.9	1.0	1.0	1.0	1.0	1.1
M100, MPa	6.7	6.7	6.0	6.7	7.0	6.7
Tb, MPa	20.0	20.7	19.3	18.3	21.5	18.5
Eb, %	233	256	252	219	266	256
Hardness, A, pts	74	74	76	76	75	75
Compression Set, Method B, O-Rings						
22 hr at 200 °C (392 °F)						
– No Post-cure	20	9	14	16	14	14
– Post-cured at 232 °C (450 °F)	16	13	14	17	14	10
70 hr at 200 °C (392 °F)						
– No Post-cure	31	24	29	30	23	21
– Post-cured at 232 °C (450 °F)	23	20	23	29	21	20
Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven						
M10, MPa	0.9	1.0	1.0	1.1	1.0	1.1
M100, MPa	5.7	5.8	5.5	5.7	5.9	6.0
Tb, MPa	20.5	20.4	20.5	19.5	20.2	18.4
Eb, %	280	281	285	281	292	286
Hardness, A, pts	75	74	76	75	75	76
Pt change	1	0	0	–1	0	1
% change, M10	1	0	–2	2	1	5
% change, M100	–15	–13	–9	–15	–15	–11
% change, Tb	3	–1	6	7	–6	0
% change, Eb	20	10	13	29	10	12
Physical Properties at RT—Heat-Aged 70 hr at 275 °C (527 °F) in Oven						
M10, MPa	0.9	1.0	1.0	1.1	1.0	1.1
M100, MPa	4.1	4.1	3.9	3.8	3.9	4.4
TB, MPa	13	13.8	13.4	11.6	12.9	13.2
Eb, %	337	350	362	346	356	351
Hardness, A, pts	74	74	75	75	75	76
Pt change	0	0	–1	–1	0	1
% change, M10	1	0	–1	1	0	7
% change, M100	–40	–39	–35	–43	–44	–35
% change, Tb	–35	–33	–31	–37	–40	–29
% change, Eb	45	37	43	58	34	37
Fluid Immersions, Volume Swell						
M15 Fuel , 168 hr at 23 °C (73 °F)	8.5	8.1	8.0	7.0	6.9	7.1
Distilled Water, 168 hr at 100 °C (212 °F)	3.7	3.3	3.5	3.0	1.7	1.9
Specific Gravity	1.906	1.905	1.903	1.903	1.908	1.907
Low Temperature Testing						
Tg by DSC, Modulated, °C	–5.9	–6.4	–5.5	–6.1	–5.5	–5.6

Varox® DBPH50 is a 45% active dispersion of 2,5-dimethyl-2-5-Di-(t-butyl-peroxy)hexane
DBPH50-HP is a 45% active dispersion of 2,5-dimethyl-2-5-Di-(t-butyl-peroxy)hexane
130XL is a 45% active dispersion of 2,5-dimethyl-2-5-Di-(t-butyl-peroxy)hexane-3
802-40KE is a 40% active dispersion of alpha-alpha'-Di(t-butyl-peroxy)diisopropylbenzene
DCP-40KE is a 40% active dispersion of Dicumyl peroxide

Table 4. Fuel/Fluids Resistance of Viton™ GF-600S

	Viton™ GF-600S	Typical ASTM D2000 SAE J200 Spec Values
	A36-06	
Viton™ GF-600S	100	
Zinc Oxide	3	
N990	30	
Armeen® 18D	0.5	
Diak™ No. 7	3	
Varox® DBPH-50	2	
Total phr	138.5	
Mooney Scorch at 121 °C (250 °F)		
Minimum, MU	29	
2 pt rise, min	9.2	
5 pt rise, min	10.9	
10 pt rise, min	12.8	
MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock		
ML, dN.m	1.4	
ts2, min	0.4	
t'50, min	0.7	
t'90, min	1.2	
t'95, min	1.5	
MH, dN.m	27.6	
Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure		
M10, MPa	0.8	
M25, MPa	1.3	
M100, MPa	3.3	
Tb, MPa	11.1	
Eb, %	362	
Hardness, A, pts	69	
Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), Post-Cured at 232°C (450 °F)		
	8 hr	
M10, MPa	1.0	
M25, MPa	1.7	
M100, MPa	6.0	
Tb, MPa	21.1	
Eb, %	294	
Hardness, A, pts	75	
Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven		A1-10
M10, MPa	1.1	
M25, MPa	1.8	
M100, MPa	5.6	
Tb, MPa	19.3	
Eb, %	292	
Hardness, A, pts	76	
Pt change	1	+10 max.
% change, M10	4	
% change, M25	1	
% change, M100	−6	
% change, Tb	−9	−25 max.
% change, Eb	−1	−25 max.

Table 4. Fuel/Fluids Resistance of Viton™ GF-600S (continued)

	Viton™ GF-600S A36-06	Typical ASTM D2000 SAE J200 Spec Values
Physical Properties at RT—Heat-Aged 168 hr at 60 °C (140 °F) in Diesel Fuel		
M10, MPa	1.2	
M25, MPa	1.7	
M100, MPa	5.5	
Tb, MPa	18.0	
Eb, %	304	
Hardness, A, pts	75	
Pt change	0	
% change, M10	14	
% change, M25	–5	
% change, M100	–7	
% change, Tb	–15	
% change, Eb	3	
Volume Swell, %	1.5	
Physical Properties at RT—Aged 70 hr at 23 °C (73 °F) in Fuel C		EF31
M10, MPa	1.1	
M25, MPa	1.7	
M100, MPa	5.4	
Tb, MPa	17.5	
Eb, %	262	
Hardness, A, pts	75	
Pt change	0	±5
% change, M10	10	
% change, M25	–2	
% change, M100	–9	
% change, Tb	–17	–25 max.
% change, Eb	–11	–20 max.
Volume Swell, %	1.6	0 to +10
Physical Properties at RT—Aged 168 hr at 23 °C (73 °F) in E10, 90% Fuel C/10% Ethanol		
M10, MPa	0.8	
M25, MPa	1.3	
M100, MPa	4.3	
Tb, MPa	13.8	
Eb, %	238	
Hardness, A, pts	73	
Pt change	–2	
% change, M10	–26	
% change, M25	–25	
% change, M100	–27	
% change, Tb	–35	
% change, Eb	–19	
ne Swell, %	5.4	

Table 4. Fuel/Fluids Resistance of Viton™ GF-600S (continued)

	Viton™ GF-600S A36-06	Typical ASTM D2000 SAE J200 Spec Values
Physical Properties at RT—Aged 168 hr at 23 °C (73 °F) in M15, 85% Fuel C/15% Methanol		
M10, MPa	0.8	
M25, MPa	1.1	
M100, MPa	3.5	
Tb, MPa	13.8	
Eb, %	279	
Hardness, A, pts	70	
Pt change	–5	
% change, M10	–27	
% change, M25	–35	
% change, M100	–41	
% change, Tb	–35	
% change, Eb	–5	
Volume Swell, %	8.8	
Physical Properties at RT—Aged 70 hr at 200 °C (392 °F) in Service Fluid 101		E078
M10, MPa	0.8	
M25, MPa	1.4	
M100, MPa	5.2	
Tb, MPa	18.0	
Eb, %	288	
Hardness, A, pts	74	
Pt change	–1	–15 to +5
% change, M10	–21	
% change, M25	–20	
% change, M100	–13	
% change, Tb	–15	–40 max.
% change, Eb	–2	–20 max.
Volume Swell, %	8.1	0 to +15
Physical Properties at RT—Aged 336 hr at 60 °C (140 °F) in 180PN Sour Fuel, Ford Method*		
M10, MPa	0.5	
M100, MPa	2.9	
Tb, MPa	12.7	
Eb, %	326	
Hardness, A, pts	64	
Pt change	–11	
% change, M10	–50	
% change, M100	–52	
% change, Tb	–40	
% change, Eb	11	
Volume Swell, %	18.1	

*Ford "Sour Fuel" is an 80% Fuel C/15% Methanol/5% T-Butyl Alcohol blend with copper ion and t-butyl-hydroperoxide added to bring up the peroxide number to 180.

Table 4. Fuel/Fluids Resistance of Viton™ GF-600S (continued)

	Viton™ GF-600S A36-06	Typical ASTM D2000 SAE J200 Spec Values
Physical Properties at RT—Aged 70 hr at 200 °C (392 °F) in 7700 Fluid/SAE Fluid #2		E088
M10, MPa	0.7	
M25, MPa	1.2	
M100, MPa	4.5	
Tb, MPa	17.0	
Eb, %	279	
Hardness, A, pts	71	
Pt change	–4	–15 to +5
% change, M10	–32	
% change, M25	–32	
% change, M100	–25	
% change, Tb	–19	–40 max.
% change, Eb	–5	–20 max.
Volume Swell, %	6.9	+25 max.
Compression Set, Method B, O-Rings, Post-Cured at 232 °C (450 °F)	*8 hr*	
70 hr at 200 °C (392 °F)	26	
Low Temperature Testing		
Tg by DSC, modulated, °C	–5.9	
TR-10, °C	–4.9	

Test Procedures

Property Measured	Test Procedure
Compression Set	ASTM D395, 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 (T-B) Elongation (E-B)	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

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