

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

Tecnoflon® PFR 95HT is a perfluoroelastomer (FFKM) offering a significantly wider operational range and superior compression set resistance than any other perfluoroelastomer, thanks to its unique peroxide curing system that does not need any coagent (TAIC or equivalent) for curing to be carried out.

It can offer a very broad chemical resistance in a wide variety of media including acids, caustics, ketones, aldehydes, esters, ethers, methanol, solvents, sour gases, hydrocarbons, steam, hot water and mixed process streams along with excellent thermal resistance.

Tecnoflon® PFR 95HT is suitable for most applications in temperature ranging from – 10 °C to 300 °C. Because of its specific proprietary cross-linking agent, Tecnoflon® PFR 95HT outperforms triazine cured FFKMs in high temperature water and steam, up to 300 °C.

Tecnoflon® PFR 95HT can be combined with other typical fluoroelastomer compounding ingredients; its mixing can be accomplished with two roll mills or internal mixers. Finished goods may be produced by a variety of rubber processing methods.

The primary use for Tecnoflon® PFR 95HT is the manufacturing of any kind of elastomeric sealing element such as Orings, gaskets, valve bodies, butterfly valves, pump housings and stators, metal bonded parts, diaphragms, profiles, etc. These sealing elements can be used in mechanical seals, pumps, compressors, valves, reactors, mixers, sprayers, dispensers, quick connect couplings, controls, instrumentation, etc. in chemical and petrochemical industry, hydrocarbon processing, petroleum exploration and extraction, food processing, pharmaceutical and bio analytical industry, aerospace and semiconductor manufacturing industries.

Tecnoflon® PFR 95HT is registered in the FDA Inventory of Effective Premarket Notifications for Food Contact Substances. It can be compounded so that the finished gaskets or seals can be used in food processing equipments (see “food processing compounds” section below).

Tecnoflon® PFR 95HT is marketed in the form of raw polymer (1 kg and 5 kg boxes) in order to give the transformer the freedom and the opportunity to develop and fine tune compounds and items best suited to produce high performance rubber articles such as Orings, seals, diaphragms and other parts used in process industries.

### Handling and safety

Normal care and precautions should be taken to avoid skin contact, eye contact and breathing of fumes. Smoking is prohibited in working areas. Wash hands before eating or smoking. For complete health and safety information, please refer to the material safety data sheet.

### Basic characteristics of the raw polymer are as follows

Property	Typical Value	Unit	Test Method
ML (1+10') at 121 °C	75	MU	ASTM D1646
Specific gravity	2.05	g/cm <sup>3</sup>	ASTM D792
Colour	Translucent		
Packaging/Form	1 kg and 5 kg / slabs		

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Typical black compounds

Test Compound	Unit	70 Shore A	75 Shore A	80 Shore A	Test Method
Tecnoflon® PFR 95HT	phr	100	100	100	
Luperox® 101XL-45	phr	1.5	1.5	1.5	
ZnO	phr	5	–	5	
Austin Black 325	phr	10	12	15	
N-990 MT Carbon Black	phr	10	12	15	
MADI LI01S	phr	–	–	0.3	
Armeen® 18D	phr	–	–	0.3	

Property	Unit	70 Shore A	75 Shore A	80 Shore A	Test Method
Mooney viscosity ML (1+10') at 121 °C	MU	108	115	120	ASTM D1646
Compound density	g/cm <sup>3</sup>	1.99	1.94	1.98	ASTM D792
<b>MDR 12 min at 170 °C arc 0.5°</b>					ASTM D6601
Minimum torque	lb·in	2.7	2.9	3.3	
Maximum torque	lb·in	21.1	19.7	29.7	
t <sub>s2</sub>	s	55	62	49	
t' <sub>50</sub>	s	123	138	124	
t' <sub>90</sub>	s	364	348	276	
<b>Post cure: (8+16) h at 290 °C</b>					
100% modulus	MPa	6.9	7.7	13.6	ASTM D412C
Tensile strength	MPa	18.3	17.0	16.5	
Elongation at break	%	224	202	130	
Hardness	Shore A	72	73	80	ASTM D2240
<b>Compression set</b> 25% deformation, O-ring #214					ASTM D395 method B
70 h at 200 °C	%	21	23	23	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Compression set resistance

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 95HT	100	phr	
Luperox® 101XL-45	1.5	phr	
ZnO	5	phr	
Austin Black 325	8	phr	
N-990 MT Carbon Black	7	phr	

Property	Typical Value	Unit	Test Method
<b>Post cure: (8+16) h at 290 °C</b>			
100 % modulus	6.3	MPa	ASTM D412C
Tensile strength	18.0	MPa	
Elongation at break	207	%	
Hardness	68	Shore A	ASTM D2240
<b>Compression set</b>			
25 % deformation, O-ring #214			ASTM D395 method B
70 h at 23 °C	25	%	
70 h at 100 °C	18	%	
70 h at 200 °C	18	%	
70 h at 225 °C	30	%	
70 h at 250 °C	39	%	
70 h at 275 °C	50	%	
70 h at 300 °C	58	%	
70 h at 316 °C	67	%	
336 h at 200 °C	30	%	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Heat aging

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 95HT	100	phr	
Luperox® 101XL-45	1.5	phr	
ZnO	5	phr	
Austin Black 325	8	phr	
N-990 MT Carbon Black	7	phr	

Property	Unit	70h	168h	336h	1,000h	Test Method
<b>Heat aging at 250°C</b>						ASTM D573
Δ Tensile strength	%	-1	-2	-13	-24	
Δ Elongation at break	%	7	12	19	30	
Δ Hardness	Shore A	-1	-2	-2	-2	
Δ Weight	%	-0.7	-1.3	-1.7	-2.2	
<b>Heat aging at 275°C</b>						ASTM D573
Δ Tensile strength	%	-1	-18	-30	-40	
Δ Elongation at break	%	20	35	45	65	
Δ Hardness	Shore A	-1	-2	-3	-4	
Δ Weight	%	-1.1	-2.0	-3.1	-3.6	
<b>Heat aging at 300°C</b>						ASTM D573
Δ Tensile strength	%	-20	-39	-50	-	
Δ Elongation at break	%	40	62	85	-	
Δ Hardness	Shore A	-2	-3	-4	-	
Δ Weight	%	-2.1	-3.1	-4.0	-	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### High temperature steam resistant compound

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 95HT	100	phr	
Luperox® 101 (92 %)	1	phr	
Austin Black 325	15	phr	
N-990 MT Carbon Black	15	phr	
Armeen® 18D	0.5	phr	

Property	Typical Value	Unit	Test Method
<b>MDR 12 min at 170°C arc 0.5°</b>			ASTM D6601
Minimum torque	2.8	lb·in	
Maximum torque	26.1	lb·in	
$t_{s2}$	46	s	
$t'_{50}$	94	s	
$t'_{90}$	188	s	

#### Post cure: (8+16) h at 200°C

100% modulus	11.0	MPa	ASTM D412C
Tensile strength	14.5	MPa	
Elongation at break	164	%	
Hardness	79	Shore A	ASTM D2240

#### Compression set

25% deformation, O-ring #214

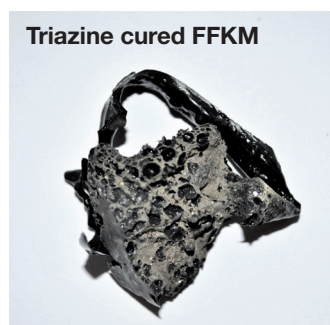
ASTM D395  
method B

70 h at 200°C	19	%	
70 h at 300°C	41	%	

#### Steam, 168 h at 300°C

ASTM D471

Δ Tensile strength	11	%	
Δ Elongation at break	-17	%	
Δ Hardness	0	Shore A	
Δ Weight	-0.8	%	



Thanks to its specific proprietary cross-linking chemistry, Tecnoflon® PFR 95HT shows negligible physical properties loss after 1 week at 300°C steam exposure, largely outperforming triazine cured FFKMs that are severely degraded in the same conditions (see the pictures on the left).

*Effect of steam: 1 week at 300°C*

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Oil & gas compound

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 95HT	100	phr	
Luperox® 101XL-45	1.5	phr	
N-990 MT Carbon Black	60	phr	
PAT 777	1	phr	
Struktol® WS 280	0.5	phr	

Property	Typical Value	Unit	Test Method
<b>MDR 12 min at 170°C arc 0.5°</b>			ASTM D6601
Minimum torque	4.2	lb·in	
Maximum torque	31.2	lb·in	
$t_{s2}$	45	s	
$t'_{50}$	125	s	
$t'_{90}$	290	s	
<b>Post cure: (8+16) h at 250°C</b>			
50% modulus	9.8	MPa	ASTM D412C
100% modulus	16.7	MPa	
Tensile strength	18.4	MPa	
Elongation at break	125	%	
Hardness	93	Shore A	ASTM D2240
<b>Compression set</b>			ASTM D395 method B
25% deformation, O-ring #214			
70 h at 200°C	27	%	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Rapid gas decompression tests

The typical oil & gas Tecnoflon® PFR 95HT compound on page 6 was successfully tested in the following conditions referring to EN ISO 23936-2 standard 'Petroleum, petrochemical and natural gas industries – Non-metallic materials in contact with media related to oil and gas production Part 2: Elastomers' and successfully passed the Rapid Decompression Test.

Property	Typical Value	Unit	Test Method
Gas	90/10 CH <sub>4</sub> /CO <sub>2</sub>	mol %	
O-ring replication	4		
Groove fill	65	%	
Temperature	100	°C	
Pressure	150	bar	
Number of cycles	8		
First cycle duration	min. 68	h	
Soak time	min. 6	h	
Hold period between cycles	1	h	
De-pressurization rate	20	bar/minute	

O-rings #312 (13.64 mm internal diameter – 5.33 mm cross-section) were submitted to testing.

All O-rings met the ISO 23936-2 acceptance criterion after the 8 cycle RGD test, since the ratings were as below:

#### **ISO 23936 rating: 1000, 0000, 1100, 0000**

whereby the ISO 23936 rating numbers are as follows:

0: no cracks, holes or blisters; the exposed surface is intact.

1: any number of cracks, each < 25% CSD; total crack length shall not exceed CSD. External cracks shall be < 10% CSD; no splits permitted.

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Aerospace compound

Test Compound	Actual Value	AMS 7257C Specification	Unit	Test Method
Tecnoflon® PFR 95HT	100		phr	
Luperox® 101 (92 %)	1		phr	
N-990 MT Carbon Black	30		phr	

Property	Actual Value	AMS 7257C Specification	Unit	Test Method
<b>MDR 12 min at 170 °C arc 0.5°</b>				ASTM D6601
Minimum torque	2.3		lb · in	
Maximum torque	24.2		lb · in	
t <sub>s2</sub>	45		s	
t' <sub>50</sub>	100		s	
t' <sub>90</sub>	245		s	
<b>Post cure: (8+16) h at 290 °C</b>				
100% modulus, O-ring #214	9.4		MPa	ASTM D1414
Tensile strength, O-ring #214	18.6	> 10.3	MPa	
Elongation at break, O-ring #214	155	> 120	%	
Hardness, slabs	75	70 to 80	Shore A	ASTM D2240
<b>Compression set</b> O-ring #214				ASTM D395 method B
70 h at 200 °C	18		%	
70 h at 230 °C	20	< 40	%	
336 h at 230 °C	28		%	
70 h at 300 °C	42		%	
TR <sub>10</sub>	-1	< 5	°C	ASTM D1329

### Dry heat resistance

Property	Actual Value	AMS 7257C Specification	Unit	Test Method
<b>Heat aging, 70 h at 290 °C</b>				ASTM D573
Δ Tensile Strength	-17	> -20	%	
Δ Elongation at break	-3	> -15	%	
Δ Hardness	-1	-5 to 5	Shore A	
Weight loss	0.3	0 to 5	%	



# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Aromatic fuel resistance

Property	Actual Value	AMS 7257C Specification	Unit	Test Method
<b>Fuel B, 70 h at 23 °C</b>				ASTM D471
Δ Tensile strength	4	> -20	%	
Δ Elongation at break	-2	> -15	%	
Δ Hardness	1	-5 to 5	Shore A	
Δ Volume	0.2	0 to 5	%	

### Hydraulic fluid resistance

Property	Actual Value	AMS 7257C Specification	Unit	Test Method
<b>Skydrol® LD4, 70 h at 125 °C</b>				ASTM D471
Δ Tensile strength	-19	> -40	%	
Δ Elongation at break	14	> -15	%	
Δ Hardness	-4	-15 to 0	Shore A	
Δ Volume	4.6	0 to 15	%	

### Synthetic lubricant resistance

Property	Actual Value	AMS 7257C Specification	Unit	Test Method
<b>Reference oil 300, 70 h at 175 °C</b>				ASTM D471
Δ Tensile strength	-9	> -10	%	
Δ Elongation at break	6	> -15	%	
Δ Hardness	-2	-5 to 5	Shore A	
Δ Volume	0.6	0 to 5	%	

Tecnoflon® PFR 95HT, when properly formulated, meets the requirements of Aerospace Material Specification AMS 7257C. It offers outstanding thermal stability, excellent compression set resistance as well as excellent resistance to aromatic fuels, hydraulic fluids and gas turbine engine lubricating oils.

### Food processing compounds

Tecnoflon® PFR 95HT is registered in the FDA Inventory of Effective Food Contact Substances (FCS) Notifications, being the subject of Food Contact Notification (FCN #126), with an effective date July 21, 2001. See the list of effective notifications for FCN available on the Agency's web site at:

<http://www.accessdata.fda.gov/scripts/fdcc/?set=FCN>

The finished compounds are intended for repeated use as components of gaskets or seals used in food processing equipment intended to contact food Types I through VII as described in Table 1 of 21 CFR 176.170(c) as follows:

**Table 1:** Types of Raw and Processed Foods

- I. Nonacid, aqueous products; may contain salt or sugar or both (pH above 5.0)
- II. Acid, aqueous products; may contain salt or sugar or both, and including oil-in-water emulsions of low- or high-fat content
- III. Aqueous, acid or nonacid products containing free oil or fat; may contain salt, and including water-in-oil emulsions of low- or high-fat content
- IV. Dairy products and modifications:
  - A Water-in-oil emulsions, high- or low-fat
  - B Oil-in-water emulsions, high- or low-fat
- V. Low-moisture fats and oil
- VI. Beverages:
  - A Containing up to 8 percent of alcohol
  - B Non-alcoholic
  - C Containing more than 8 percent alcohol
- VII. Bakery products other than those included under Types VIII or IX of this table:
  - A Moist bakery products with surface containing free fat or oil
  - B Moist bakery products with surface containing no free fat or oil
- VIII. Dry solids with the surface containing no free fat or oil (no end test required)
- IX. Dry solids with the surface containing free fat or oil

Data for establishing compliance with the FDA standards for Tecnoflon® PFR 95HT based compounds were obtained from cured items having the formulation shown below:

<b>Tecnoflon® PFR 95HT</b>	<b>100</b>	phr
Luperox® 101XL-45	1.5	phr

Extraction tests were performed on slabs that were press-cured for 10 min at 170 °C, followed by an oven post-cure of 24 h at 200 °C.

### Compounding guidelines for food processing

To design FDA compliant compounds, some restrictions have to be taken into account as far as the curatives, the fillers and the process aids are concerned.

#### 1. Curatives

the following restrictions apply in terms of curatives amount:

<b>Tecnoflon® PFR 95HT</b>	<b>100</b>	phr
Luperox® 101XL-45	≤ 1.5	phr

#### 2. Fillers

The following fillers are approved for use in items intended for repeated food contact use, under 21 CFR 177.2600, section v., and provide at the same time excellent processing behaviour and physical properties:

- Barium sulfate
- Silica
- Titanium dioxide
- Carbon black  
(channel process or furnace combustion process; total carbon black not to exceed 50 % by weight of rubber product; furnace combustion black content not to exceed 10 % by weight of rubber products intended for use in contact with milk or edible oils)

#### 3. Process aids

- Carnauba wax
- Struktol® HT 290  
(concentration must not exceed 5 % by weight of the rubber compound)

# Tecnoflon® PFR 95HT

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### White food processing compounds

Test Compound	Unit	70 Shore A	70 Shore A	Test Method
Tecnoflon® PFR 95HT	phr	100	100	
Luperox® 101XL-45	phr	1.5	1.5	
BaSO <sub>4</sub> (Blanc Fixe HD 80)	phr	40	–	
SiO <sub>2</sub> (Ultrasil® 360)	phr	–	10	
TiO <sub>2</sub> (Ti-Pure® R-960)	phr	5	5	

Property	Unit	70 Shore A	70 Shore A	Test method
Mooney viscosity ML (1+10') at 121 °C	MU	93	96	ASTM D1646
Compound density	g/cm <sup>3</sup>	2.44	2.08	
<b>MDR 12 min at 170 °C arc 0.5°</b>				ASTM D6601
Minimum torque	lb·in	2.7	2.8	
Maximum torque	lb·in	18.2	17.3	
t <sub>s2</sub>	s	42	45	
t' <sub>50</sub>	s	83	82	
t' <sub>90</sub>	s	214	197	
<b>Post cure: (8+16) h at 250 °C</b>				
100% modulus	MPa	5.6	5.3	ASTM D412C
Tensile strength	MPa	15.6	19.9	
Elongation at break	%	280	218	
Hardness	Shore A	70	69	ASTM D2240
<b>Compression set</b> 25% deformation, O-ring #214				ASTM D395 method B
70 h at 200 °C	%	20	25	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Low hardness – translucent compound

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 95HT	100	phr	
Luperox® 101 (92 %)	1	phr	

Property	Typical Value	Unit	Test Method
Compound density	2.05	g/cm <sup>3</sup>	
<b>MDR 12 min at 170 °C arc 0.5°</b>			ASTM D6601
Minimum torque	1.2	lb·in	
Maximum torque	11.5	lb·in	
t <sub>92</sub>	70	s	
t' <sub>50</sub>	101	s	
t' <sub>90</sub>	192	s	
<b>Post cure: (8+16) h at 250 °C</b>			
100% modulus	1.5	MPa	ASTM D412C
Tensile strength	11.4	MPa	
Elongation at break	283	%	
Hardness	56	Shore A	ASTM D2240
<b>Compression set</b> 25% deformation, O-ring #214			ASTM D395 method B
70 h at 200 °C	35	%	

# Tecnoflon® PFR 95HT

Perfluoroelastomers

## Cold flexibility

Property	Typical Value	Unit	Test Method
<b>DSC</b>			
T <sub>g</sub> onset	-7	°C	
T <sub>g</sub> midpoint	-1	°C	
<b>Retraction curve</b>			ASTM D1329
TR <sub>10</sub>	-1	°C	
TR <sub>30</sub>	3	°C	
TR <sub>50</sub>	6	°C	
TR <sub>70</sub>	9	°C	

Test Compound	Typical Value	Unit	Test Method
<b>Tecnoflon® PFR 95HT</b>	100	phr	
Luperox® 101XL-45	1.5	phr	
ZnO	5	phr	
Austin Black 325	8	phr	
N-990 MT Carbon Black	7	phr	

Property	Typical Value	Unit	Test Method
<b>Brittleness temperature</b>			ASTM D2137
100 % pass	-11	°C	
50 % pass	-17	°C	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

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### Fluid resistance overview

Fluid	Volume Swelling
Inorganic acids	< 10%
Organic acids	< 10%
Alkalis	< 10%
Amines (RT)	< 10%
Hot amines (> 70 °C)	30 – 50%
Water / Steam	< 10%
Ketones	< 10%
Esters	< 10%
Ethers	< 10%
Aldehydes	< 10%
Alcohols	< 10%
Hydrocarbons	< 10%
Sour gas	< 10%
Lubricants	< 10%
Fluorinated fluids	30 – 50%

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Fluid resistance

#### Acid fluids

For optimal acid resistance, zinc oxide and Wollastonite fillers are not recommended; white inert mineral fillers and carbon blacks should be selected in acidic and basic environments.

Property	Typical Value	Unit	Test Method
<b>HCl, 37 %, 72 h at 80 °C</b>			
Δ Tensile strength	-4	%	
Δ Elongation at break	-15	%	
Δ Hardness	-1	Shore A	
Δ Volume	1.6	%	
<b>HF, 49 %, 720 h at 23 °C</b>			
Δ Tensile strength	5	%	
Δ Elongation at break	-23	%	
Δ Hardness	0	Shore A	
Δ Volume	0.3	%	
<b>Nitric acid, 65 %, 168 h at 80 °C</b>			
Δ Tensile strength	-30	%	
Δ Elongation at break	5	%	
Δ Hardness	-10	Shore A	
Δ Volume	10	%	
<b>Glacial acetic acid, 336 h at 100 °C</b>			
Δ Tensile strength	-35	%	
Δ Elongation at break	-3	%	
Δ Hardness	-10	Shore A	
Δ Volume	7	%	

# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Alkaline fluids and amines

Property	Typical Value	Unit	Test Method
<b>KOH, 50 %, 168 h at 125°C</b>			
Δ Tensile strength	-10	%	
Δ Elongation at break	-15	%	
Δ Hardness	-2	Shore A	
Δ Volume	0.4	%	
<b>Ethylene diamine, 504 h at 23°C</b>			
Δ Volume	1.8	%	
<b>Ethylene diamine, 336 h at 60°C</b>			
Δ Tensile strength	-10	%	
Δ Elongation at break	-13	%	
Δ Hardness	-8	Shore A	
Δ Volume	20	%	
<b>NH<sub>3</sub>, 28 %, 168 h at 100°C</b>			
Δ Tensile strength	-15	%	
Δ Elongation at break	-18	%	
Δ Hardness	-7	Shore A	
Δ Volume	15	%	
<b>2-(2-aminoethoxy) ethanol (diglycolamine), 168 h at 100°C</b>			
Δ Tensile strength	1	%	
Δ Elongation at break	-4	%	
Δ Hardness	-1	Shore A	
Δ Volume	7	%	
<b>N-Methyldiethanolamine (MDEA), 168 h at 100°C</b>			
Δ Tensile strength	2	%	
Δ Elongation at break	0	%	
Δ Hardness	-2	Shore A	
Δ Volume	4.6	%	



# Tecnoflon® PFR 95HT

## Perfluoroelastomers

### Miscellaneous PFR properties

In general, the following properties can be considered as typical or average values for perfluoroelastomers.

### Thermal expansion

Following the definition of linear coefficient of thermal expansion:  $L = L_0 \cdot (1 + \alpha \cdot \Delta T)$ , the average value between 80 and 250°C is as follows:

$$\alpha = 3.5 \cdot 10^{-4} \text{ 1/K}$$

### Specific heat

Temperature	Unit	Black Compound	White Compound	Test Method
50°C	J/g	0.98	0.83	
100°C	J/g	1.05	0.86	
150°C	J/g	1.12	0.91	

### Gas permeation rate

Property	Permeability (T=30°C)	Unit	Test Method
Nitrogen	250	(cm <sup>3</sup> (STP)·mm/m <sup>2</sup> ·atm·d)	
Oxygen	450	(cm <sup>3</sup> (STP)·mm/m <sup>2</sup> ·atm·d)	
Helium	5,400	(cm <sup>3</sup> (STP)·mm/m <sup>2</sup> ·atm·d)	

### Electrical properties

Dielectric constant and loss factor at 50Hz frequency. Volume and surface resistivity were measured applying 100V direct tension.

Property	Typical Value	Unit	Test Method
Dielectric constant $\epsilon'$	3.50		
Loss factor $\tan(\delta)$	0.030		
Surface resistivity $R_s$	$5.0 \cdot 10^{16}$	$\Omega$	
Volume resistivity $R_v$	$6.1 \cdot 10^{16}$	$\Omega \cdot \text{cm}$	

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