

Tecnoflon® PFR 5910M / PFR 5920M

Perfluoroelastomers

Tecnoflon® PFR 5910M and PFR 5920M are perfluoroelastomers (FFKM) designed for high performance applications where both purity and chemical resistance are required, mainly for semiconductor manufacturing applications.

Tecnoflon® PFR 5910M and PFR 5920M contain nanoparticles of PTFE which acts as organic filler: it reinforces the materials without the use of conventional contaminating fillers, such as carbon black or minerals. Mineral fillers such as BaSO₄, TiO₂, SiO₂, aluminum oxide and aluminum silicate exhibit high plasma resistance: they can therefore shield the polymer, but may contaminate the chamber by leaving discrete particles as soon as the polymer is etched by plasma. On the other hand, PTFE and FFKMs have similar etching rates, so that polymeric filled compounds can be completely etched to form volatiles, significantly reducing the potential for particle generation.

The main properties of Tecnoflon® PFR 5910M and PFR 5920M are as follows:

- High purity (low amount of extractables)
- Very good oxygen and fluorine plasma resistance
- Very low particle generation
- Low outgassing
- Low friction
- High abrasion resistance
- Low modulus
- Excellent mechanical and sealing properties

They are suitable for applications at temperatures ranging from -10 °C to 270 °C. Their extreme cleanliness along

with their good plasma and chemical resistance make Tecnoflon® PFR 5910M and PFR 5920M the suitable sealing materials for most dry (plasma etching, PECVD, LPCVD, metal CVD, PVD, ALD, plasma cleans) and wet semiconductor processes (wafer cleaning, polymer removal, wet etching, polishing).

Tecnoflon® PFR 5910M and PFR 5920M can be combined with the cure system and other typical fluoroelastomer compounding ingredients; their mixing can be accomplished with two roll mills or internal mixers. Finished goods may be produced by a variety of rubber processing methods. If only liquid peroxide is added to the polymers during the compounding stage, translucent items are produced.

The primary use for Tecnoflon® PFR 5910M and PFR 5920M is the manufacturing of any kind of elastomeric sealing element such as chamber seals, lid seals, window seals, gas inlet seals, fitting seals, slit valve gates, lip seals, wafer handling parts, etc. used in the semiconductor industry.

Tecnoflon® PFR 5910M and PFR 5920M are 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 the final application.

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	PFR 5910M	PFR 5920M	Unit	Test Method
ML (1+10') at 121 °C	93	113	MU	ASTM D1646
Specific gravity	2.06	2.08	g/cm ³	ASTM D792
Colour	Translucent	Translucent		
Packaging/Form	1 kg and 5 kg/Slabs	1 kg and 5 kg/Slabs		

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Translucent compound

Test Compound	PFR 5910M	PFR 5920M	Unit	Test Method
Tecnoflon® PFR 5910M	100	–	phr	
Tecnoflon® PFR 5920M	–	100	phr	
Luperox® 101 (92%)	1	1	phr	

Property	PFR 5910M	PFR 5920M	Unit	Test Method
Compound density	2.06	2.08	g/cm ³	ASTM D792
MDR 12 min at 160°C arc 0.5°				ASTM D6601
Minimum torque	2.0	3.5	lb·in	
Maximum torque	13.5	17.4	lb·in	
t _{s2}	61	58	s	
t' ₅₀	95	104	s	
t' ₉₀	220	245	s	
Post cure: (8 + 16) h at 230°C				
100% modulus	2.5	4.7	MPa	ASTM D412C
Tensile strength	17.8	18.7	MPa	
Elongation at break	285	260	%	
Hardness	62	73	Shore A	ASTM D2240
Compression set 25% deformation, O-ring #214				ASTM D395 method B
70 h at 200°C	20	23	%	
70 h at 300°C	53	60	%	

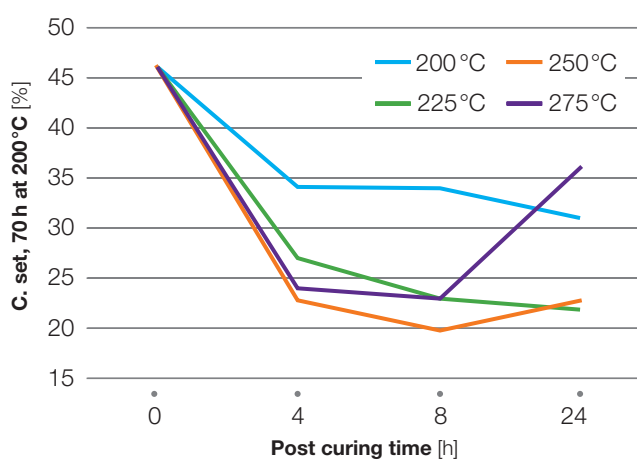
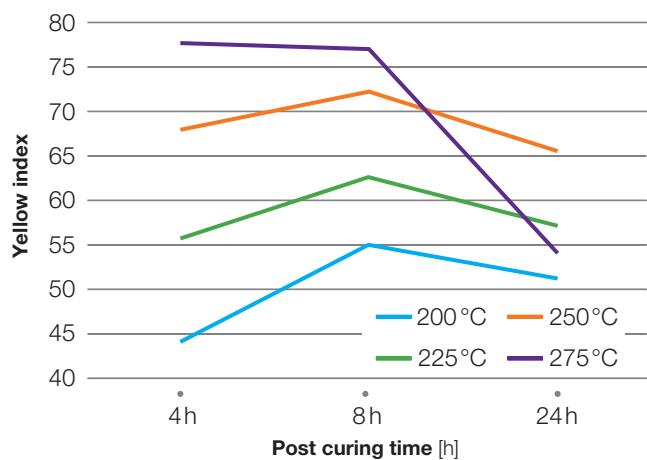
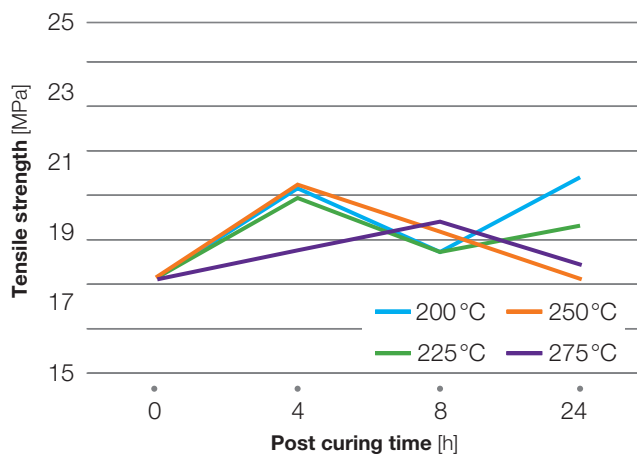
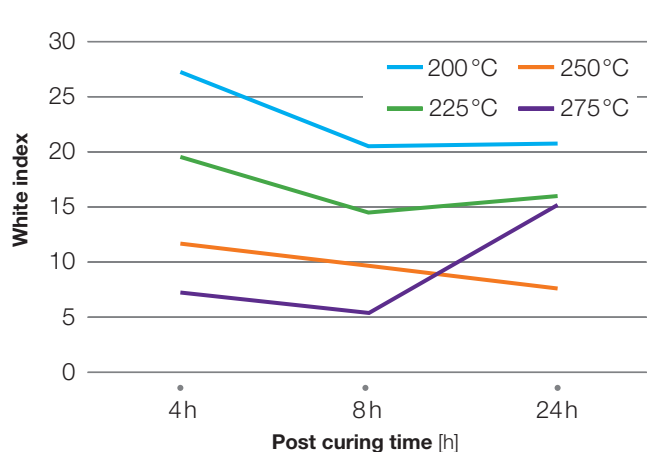
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Post curing

The properties (colour and physical properties) of a translucent Tecnoflon® PFR 5920M compound were studied as a function of the postcuring cycle, performed in an air circulating oven with a reduced number of air changes (7 to 14 complete air changes per hour).

The colour is measured as white and yellow index following the ASTM E313 norm. A brownish colour is usually developed at higher temperatures, because of the decomposition products of 2,5-bis-(t-butyl-peroxy)-2,5-dimethylhexane initiator.



A lower postcuring temperature (i.e. 200°C) leads to a lighter colour.

An intermediate postcuring temperature (such as 225°C) is needed to develop the best balance of physical properties.

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Cold flexibility

Property	PFR 5910M	PFR 5920M	Unit	Test Method
DSC				
T _g onset	-6	-6	°C	
T _g midpoint	-4	-5	°C	
Retraction curve				ASTM D1329
TR ₁₀	1	1	°C	
TR ₃₀	5	6	°C	
TR ₅₀	8	8	°C	
TR ₇₀	11	11	°C	
Brittleness temperature				ASTM D2137
100% pass	-21	-19	°C	
50% pass	-24	-24	°C	

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High purity

Total metal content

The raw gum and 3 translucent #214 O-rings (moulded, post-cured, finished and washed in ISO 7 clean room) were submitted to the digestion by dry ashing test with the following results, expressed as actual metal content:

Property	Raw Gum	Finished O-Rings	Unit	Test Method
Al	0.070	0.400	ppm*	
Ba	0.005	0.008	ppm	
Ca	1.7	3.7	ppm	
Cd	0.001	0.0014	ppm	
Co	<0.002	0.0094	ppm	
Cr	0.02	0.23	ppm	
Cu	<0.02	0.022	ppm	
Fe	1.0	0.8	ppm	
K	0.09	0.23	ppm	
Li	<0.001	<0.001	ppm	
Mg	0.05	0.30	ppm	
Mn	0.014	0.015	ppm	
Mo	<0.0001	<0.001	ppm	
Na	0.25	0.27	ppm	
Ni	0.04	0.06	ppm	
Pb	0.007	0.008	ppm	
Ti	0.002	0.01	ppm	
Zn	0.29	1.3	ppm	
Total	3.6	7.3	ppm	

* ppm stands for mg of metal content per kg of polymer

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Extractables

Extraction of translucent #214 O-rings, produced in ISO 7 clean room as described above, was performed in some selected semicon fluids. The surface extractable cations were measured by high resolution ICP MS; all the tests were conducted twice and the results reported below derive from the average of these tests.

Sample: Tecnoflon® PFR 5910M O-rings

Cations	Unit	Ultrapure Water	Piranha Fluid	HF 49%
		1 Month at 80 °C	(H ₂ SO ₄ 96 % / H ₂ O ₂ 30 % 5:1), 1 Month at 80 °C	1 Week at 23 °C
Al	ppb*	35	135	165
B	ppb	1.4	<10	<2
Ba	ppb	0.8	<2	<2
Ca	ppb	95	80	70
Cr	ppb	0.2	13.5	<30
Cu	ppb	0.8	1.4	<10
Fe	ppb	16	150	150
K	ppb	16	28	50
Li	ppb	0.09	0.09	0.15
Mg	ppb	17	55	50
Mn	ppb	0.6	1.9	<2
Na	ppb	16	17	<20
Ni	ppb	2.3	6	<15
Pb	ppb	0.2	<2	<1
Sr	ppb	0.19	<5	<1
Zn	ppb	16	<50	<25
Total	ppb	216	488	485

* ppb stands for µg of extractable per kg of polymer

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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%

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Fluid resistance*

Wet semiconductors

Property	Typical Value	Unit	Test Method
KOH, 50 %, 168 h at 125 °C			
Δ Tensile strength	-7	%	
Δ Elongation at break	-21	%	
Δ Hardness	-2	Shore A	
Δ Volume	0.3	%	
HNO₃, 65 %/HF 49%/water 41/13/46, 720 h at 50 °C			
Δ Tensile strength	0	%	
Δ Elongation at break	-31	%	
Δ Hardness	1	Shore A	
Δ Volume	-0.6	%	
HF, 49 %, 720 h at 23 °C			
Δ Tensile strength	5	%	
Δ Elongation at break	-26	%	
Δ Hardness	0	Shore A	
Δ Volume	-0.5	%	
APM – SC1 (NH₄OH 29 %/H₂O₂ 30 %/water 1:1:5), 720 h at 23 °C			
Δ Tensile strength	22	%	
Δ Elongation at break	-22	%	
Δ Hardness	2	Shore A	
Δ Volume	0	%	
HPM – SC2 (HCl 37 %/H₂O₂ 30 %/water 1:1:6), 720 h at 23 °C			
Δ Tensile strength	8	%	
Δ Elongation at break	-18	%	
Δ Hardness	2	Shore A	
Δ Volume	-0.3	%	
SPM – Piranha fluid (H₂SO₄ 96 %/H₂O₂ 30 % 5:1), 720 h at 23 °C			
Δ Tensile strength	-5	%	
Δ Elongation at break	-26	%	
Δ Hardness	1	Shore A	
Δ Volume	0	%	

* All the fluid resistance data listed above refer to PFR 5910M; PFR 5920M shows similar behaviour.

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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:

Grade	Typical Value	Unit	Test Method
Tecnoflon® PFR 5910M	4.2	10 ⁻⁴ 1/K	
Tecnoflon® PFR 5920M	4.0	10 ⁻⁴ 1/K	

Specific heat

Temperature	Typical Value	Unit	Test Method
50	1.00	J/g	
100	1.05	J/g	
150	1.11	J/g	

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