

Fluoropolymers

Fundament of our products

Basic Presentation



Products +
Instruments

Agenda

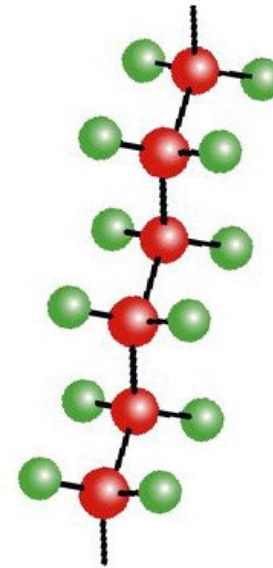
- **Material properties**
- **Resistance to chemicals**
- **Surface condition**
- **Purity (Leaching)**
- **Permeation**



Material properties

Fluoropolymers in general

- Outstanding chemical stability
- Service temperatures up to 260°C
- Extremely anti-adhesive, smooth surface
- Ultra-high purity
- Superior electrical insulator
- Hydrophobic



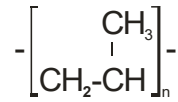
Material properties

Fluoropolymers in general

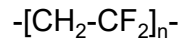
– PP

– PVDF

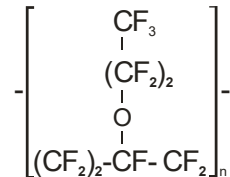
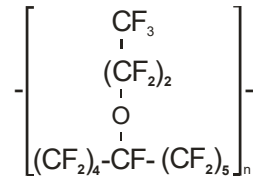
– PTFE



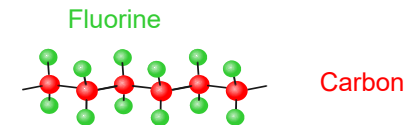
– TFM™-PTFE



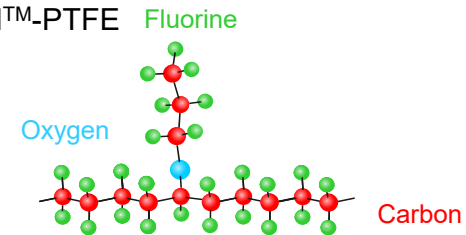
– PFA



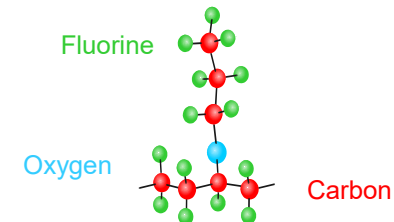
PTFE



TFM™-PTFE



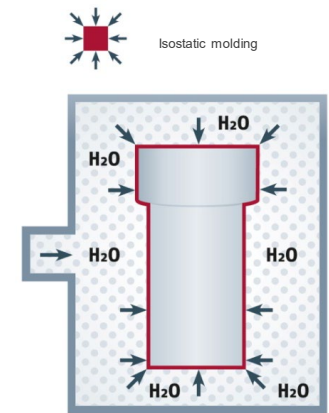
PFA



Processing Competence - Fluoropolymers

Improved Material Properties by Isostatic Molding

- Homogeneous compression by even force application from all directions via hydraulic medium
- Sintering
- Cooling
- Mechanical reworking
- Quality control

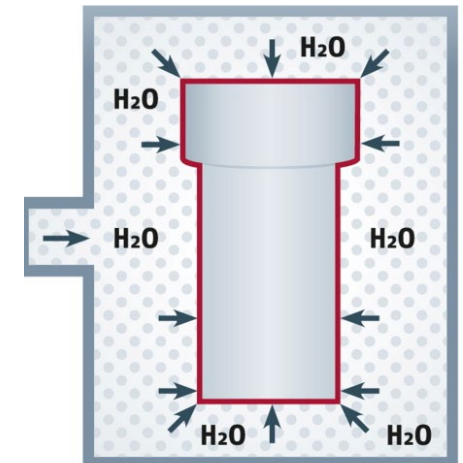
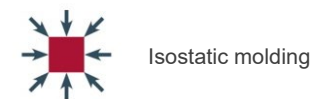


Vessel design - Processing Competence

Improved Material Properties by Isostatic Molding

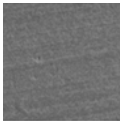
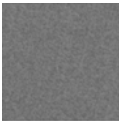
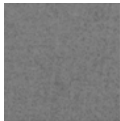
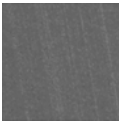
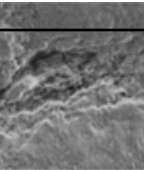
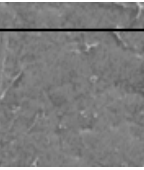
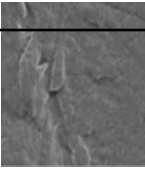
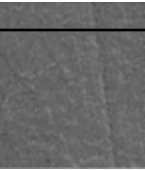
Homogeneous compression of the material from all directions

- No preferred directions, strainless and distortion-free
- Increased, homogeneous density
- Reduced microporosity and adsorption effects
- Improved surface structure
- Increased tensile strength in all directions



Processing Competence - Fluoropolymers

Improved Material Properties by Isostatic Molding

Comparison of PTFE vs TFM™-PTFE				
Material	PTFE		TFM™-PTFE	
Compression-molding technique	Single axis 	Isostatic 	Single axis 	Isostatic 
Density (g/cm³)		2.15	2.16	2.16
Tensile strength (N/mm²)	38.9	41.3	44.0	45.1
Elongation at rupture	289	333	484	489
REM image 100-fold magnification				
REM image 2500-fold magnification				

Material properties

Composition and properties of PTFE

- Perfluorinated plastic with melting point of 327 °C, molecular weight approx. 108 g/mol
- Complete protection of C-C-bonds by F-atoms
- Processable by molding, sintering and chip removing techniques
- Nearly universal resistance to chemicals
- Service temperature: - 250 °C to + 250 °C
- High purity, excellent dielectric properties
- No embrittlement, no aging



Material properties

Composition and properties of modified PTFE: TFM™-PTFE

- Molecular weight is about 1/5 of the molecular weight of PTFE, with melting point of 327 °C.
- Contains the same perfluorinated modifier as PFA, but less than 1 %
- Therefore TFM™-PTFE closes the gap between classical PTFE and PFA
- Weldable by special techniques, thanks to the „shift versus thermoplastic properties“
- Cold-flow, pore content and stretch-void-index are improved
- Nearly universal resistance to chemicals
- Service temperature: - 250 °C to + 250 °C
- High purity, excellent dielectrical properties
- No embrittlement, no aging



Material properties

Composition and properties of PFA

- Thermoplastic processable perfluorinated polymere
- Molecular weight approx. 1 % of PTFE, therefore processable by fusion
- 4 to 10 % modifier
- melting point: 305 to 290°C
- Highly modified → highly amorph: high transparency, improved alternate bending and good chemical resistance to stress crack
- Chemical stability and service temperature comparable with PTFE
- Processing methods: injection molding, extrusion, transfer molding
- Thermoplastic processing technics open up new applications for this „material with PTFE-properties“



Material properties

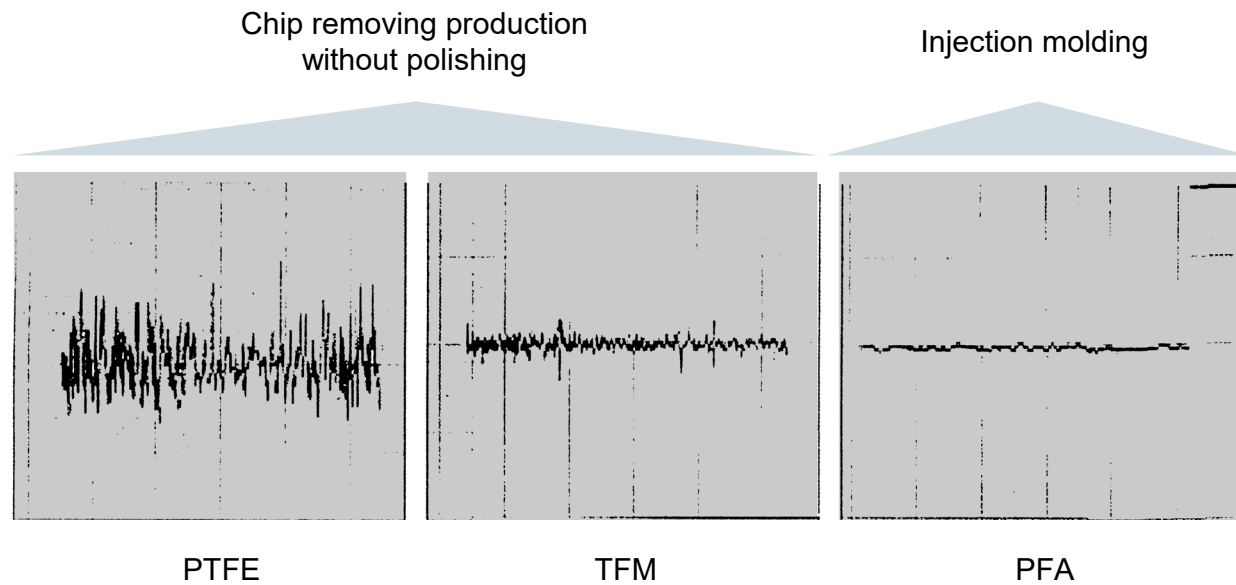
Composition and properties of Fluoropolymers

Material properties				
	PTFE	TFM	PFA	PVDF
Temperature range [°C]	-250 to +250	-250 to +250	-250 to +250	-60 to +150
Persistence to chemicals	Very high	Very high	Very high	High, reacts with strong bases (NH ₃)
Molecular weight	~ 10 ⁸ g/mol	2*10 ⁷ g/mol	10 ⁶ g/mol	
Tensile strength (ISO 12086)	20-40 N/mm ²	41 N/mm ²	15-30 N/mm ²	40-60 N/mm ²

Chemical resistance

Resistance to chemicals	
Chemical	Effect
Fluorinated hydrocarbons	swelling, reversible at short-term exposition
Alkali metals (dissolved or molten)	elimination of fluorine and polymere decomposition
Halogenes, elemental fluorine, chlorotrifluoride	chem. reaction possible at elevated temperatures, material decomposition, possibly violent reaction
Nitrating acids ($\text{H}_2\text{SO}_4/\text{HNO}_3$)	above 100°C slow material decomposition, carbonization
Monomeres, styrene, butadiene, acrylnitrile,...	could penetrate into the material; at spontaneous polymerization: swelling or polymer decomposition. popcorn-effect
High-energy radiation	γ -radiation: dose of 10kGy could reduce the mechanical properties by more than 50%

Surface properties



Purity

Leaching of Fluoropolymers

Leaching of Fluoropolymers			
Element	PTFE	TFM	PFA-HP
Mg	2.58	1.4	1.18
Al	3.73	2.2	5
Li	<0.0002	<0.0002	<0.002
B	0.085	0.091	<0.01
F	1173	1320	3522
Na	18.10	10.0	5.38
P	<4	<4	<5
S	598	500	1164
Cl	21	21	27
K	18.40	10	5.32
Ca	21.90	11	14
Cr	0.085	0.1	0.19

Leaching of Fluoropolymers			
Element	PTFE	TFM	PFA-HP
Mn	0.098	<0.002	<0.002
Fe	5.04	3.1	2.97
Ni	0.63	0.38	<0.003
Cu	21.4	24.3	0.049
Zn	6.43	4	1.23
Br	4	4	5
Mo	0.31	0.061	<0.001
Pb	2.52	1.8	0.33

Extraction time: 2 days
 Medium: 2% HNO₃
 Temperatur: 20 °C
 Result: ng/cm²

Purity

Leaching of TFM™-PTE

Conditions:

2 mm plate material

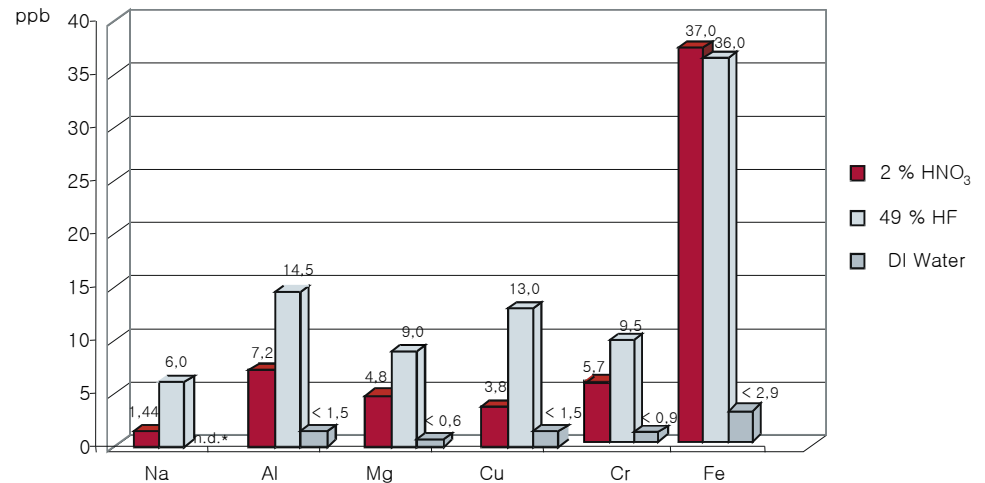
2% HNO₃, 49% HF : 20 °C, 7 days

DI water: 80°C, 7 days

Conclusion:

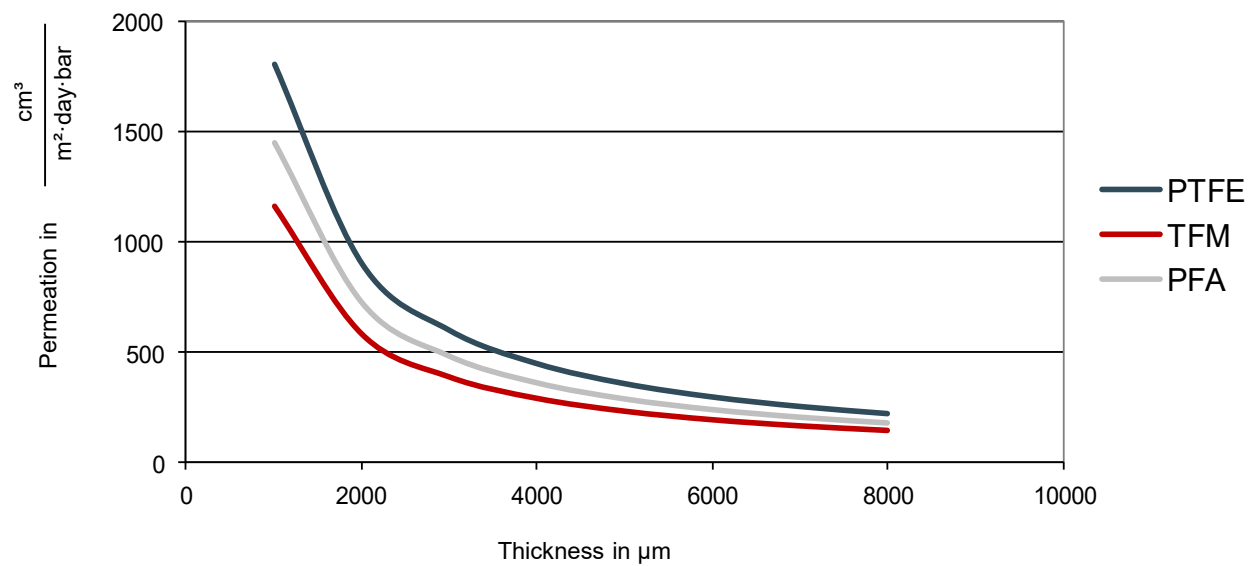
→ Purity in accordance with specification for PFA-HP

→ lower concentrations of Cr, Ni, Mo than in PFA-HP



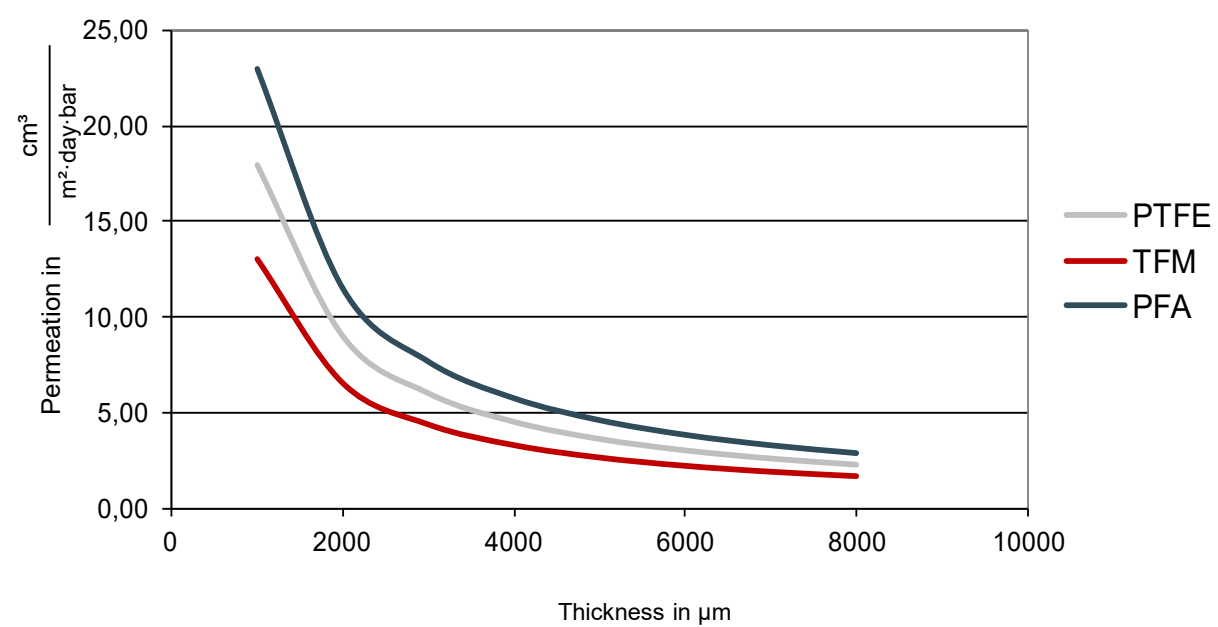
Fluoropolymers

Permeation of HCl gas at 100°C



Fluoropolymers

Permeation of water vapour at 100°C



Your Benefits

- High competence through in house production
- Customized solutions possible
- PTFE and TFMTM-PTFE comparable with PFA
- Solid, longevity TFMTM-PTFE products (inserts, pressure vessels etc.)

Thank you for your attention!



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**Products +
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