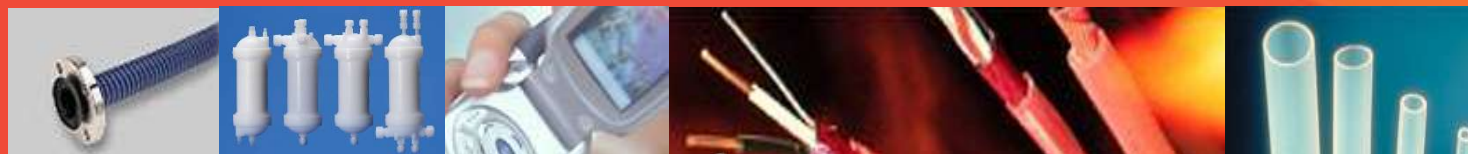


DOLDER AG

Fachseminar 26.09.2019
Böblingen, V8 Motorwelt



Erik Winkler
Jeanne Driebeek

Agenda



Who is Chemours?

Teflon™ / Tefzel™ products introduction

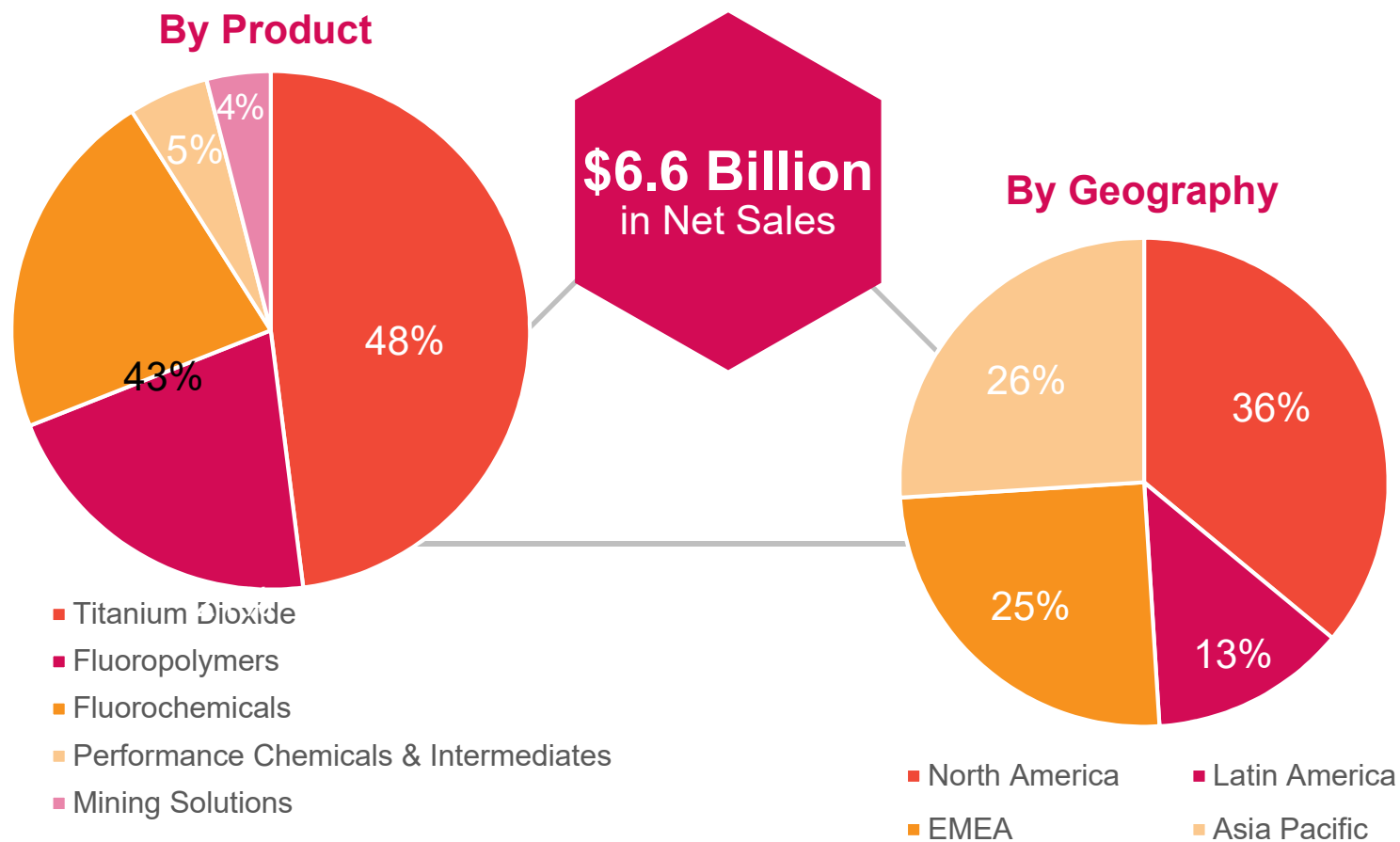
New product innovations

Who is Chemours?

2015 spin-off from DuPont de Nemours
„A start-up with > 200 years of legacy“



Our 2018 Financials



Our Businesses: Chemours Titanium Technologies (CTT)



Market Leader global manufacturer of high-quality TiO_2

80+ years of leadership in TiO_2

Segments
Coatings, plastics, laminate and paper products

Brands
Ti-Pure™

Our Businesses: Chemours Chemical Solutions (CCS)



Market Leader producer of solid sodium cyanide across the Americas

High Credibility in the safe and efficient manufacture of bulk chemicals

Segments
bulk and commodity chemicals, industrial chemicals, and mining solutions

Products
cyanide, aniline, glycolic acid

Our Businesses: Chemours Fluoroproducts (CFP)



Market Leader global manufacturer of fluoroproducts

80 years of experience

Segments

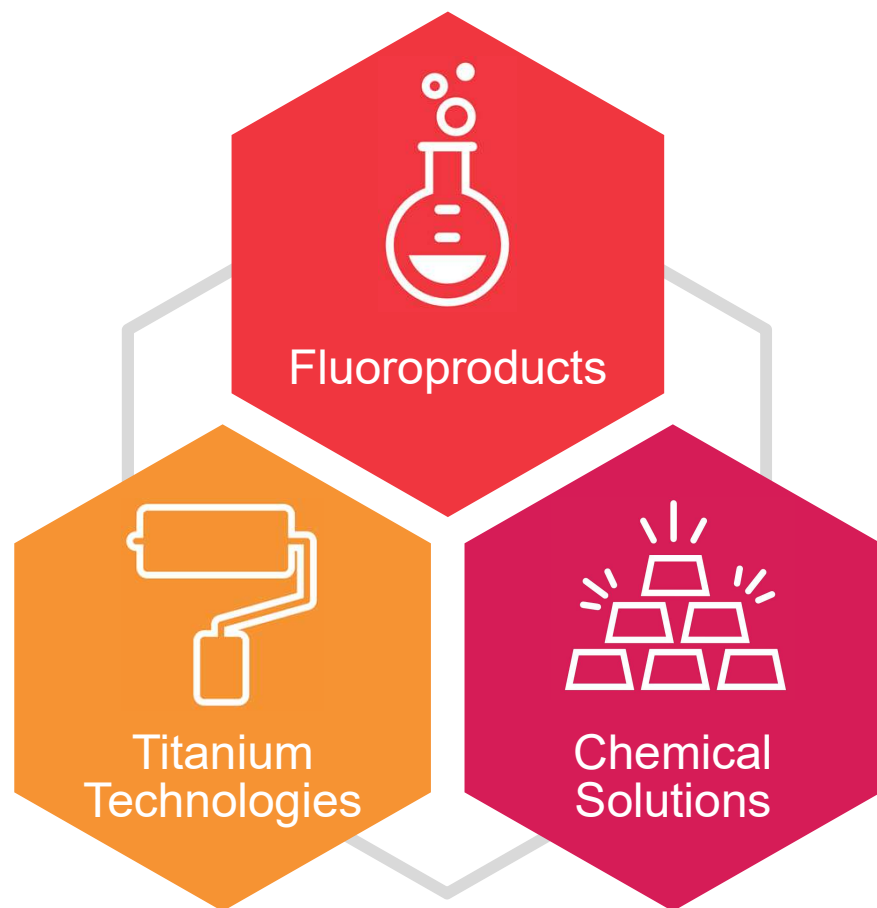
low global warming potential (GWP) refrigerants, specialties, industrial resins, monomers, melts, surface protection

Brands

Teflon™
Opteon™
Freon™
Krytox™

First fluoropolymer
discovered in 1938

Our Businesses



Market Leader in safe production and manufacture of performance chemicals

Combining leading products, applications expertise, and market-shaping chemistry



Market Leader in manufacturing of fluoroproducts



Market Leader in titanium dioxide (TiO₂) production



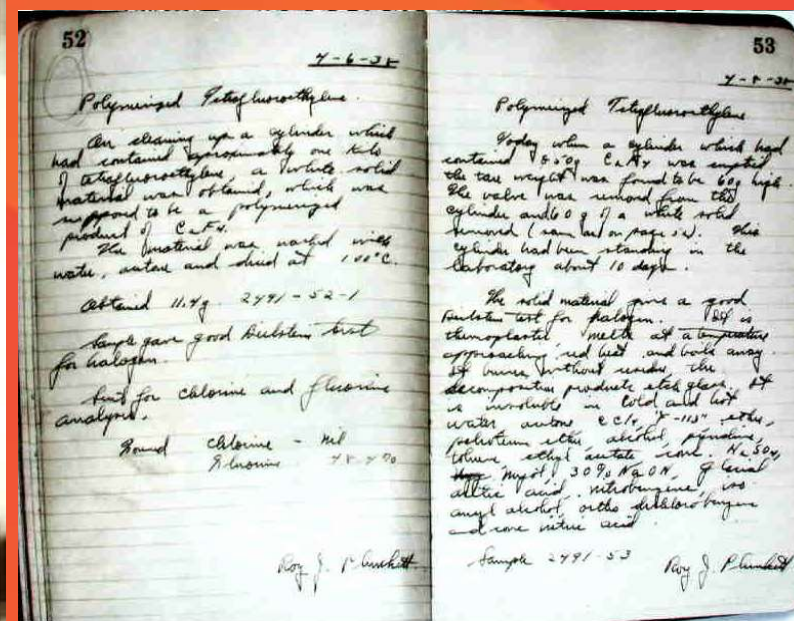
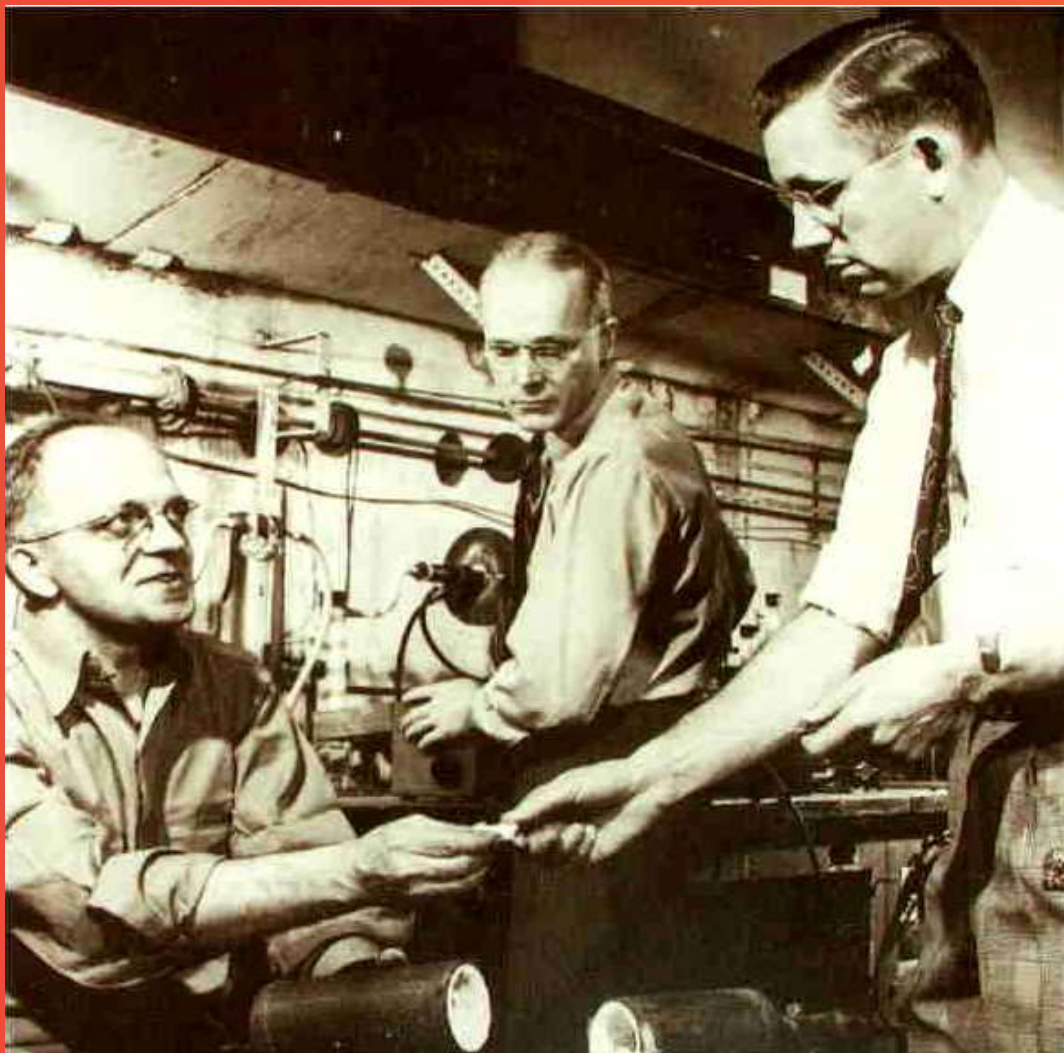
Market Leader in solid sodium cyanide production across the Americas



Teflon™ / Tefzel™ products introduction



A serendipitous discovery nearly 80 years ago....



„The use of Teflon™ is limited
only by your imagination“

Dr. Roy Plunkett

HISTORY OF PRODUCT INTRODUCTION

TEFLON™ PTFE

1938

TEFLON™ FEP

1960

TEFZEL™ ETFE

1970

TEFLON™ PFA

1972

TEFLON™ FFR

2009

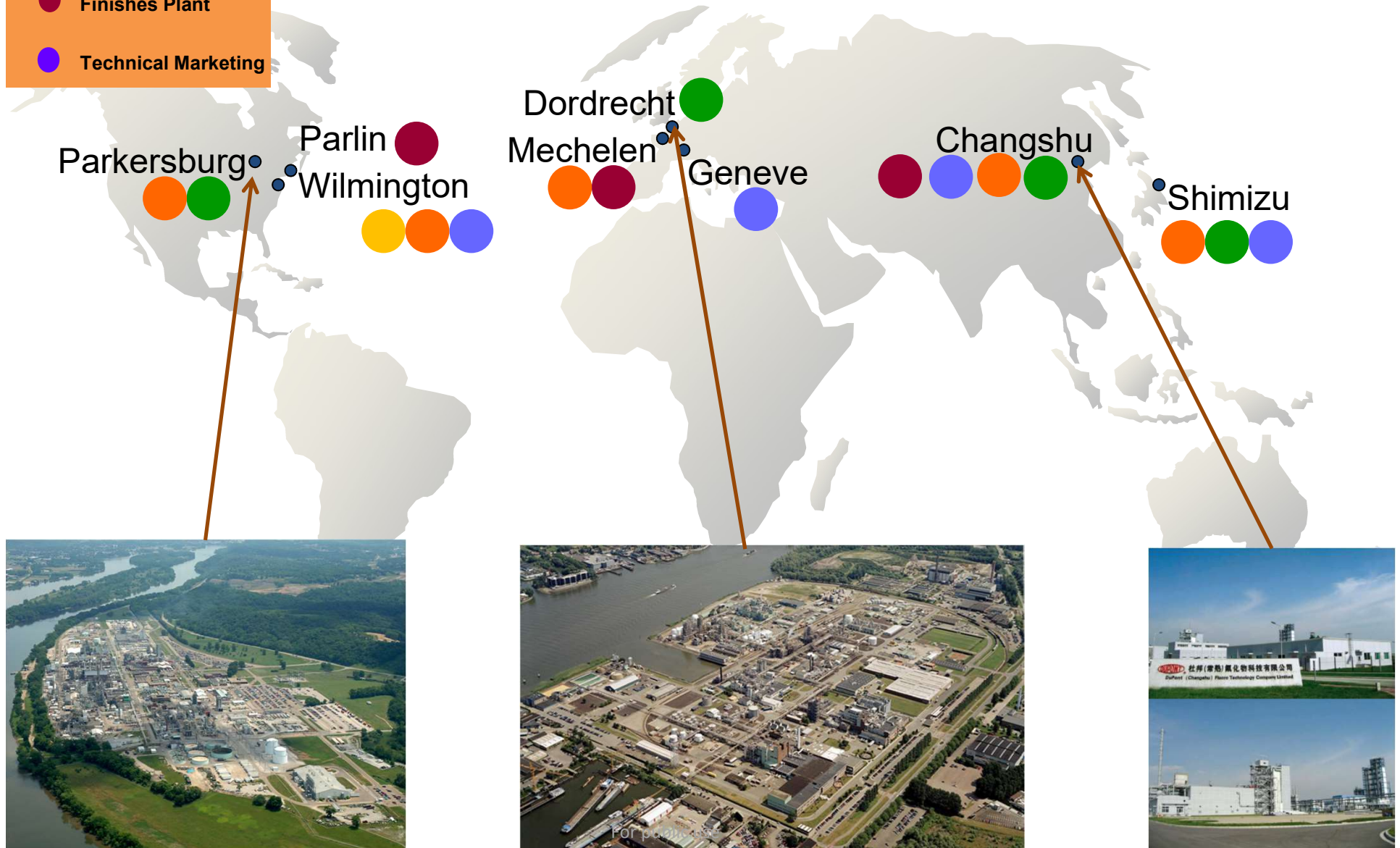
ECCTREME™ ECA

2011 (currently no availability)

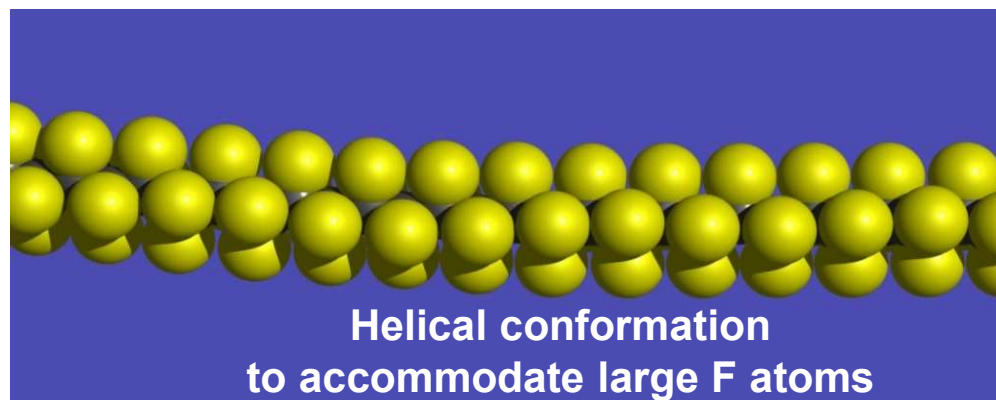
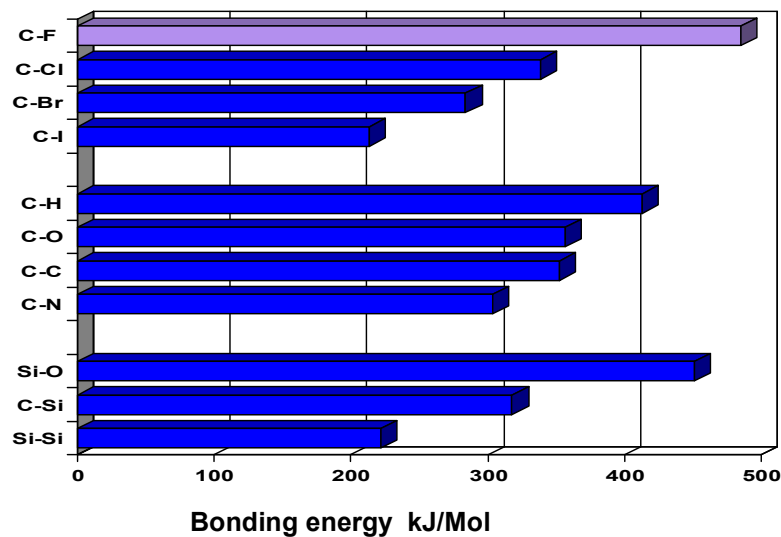
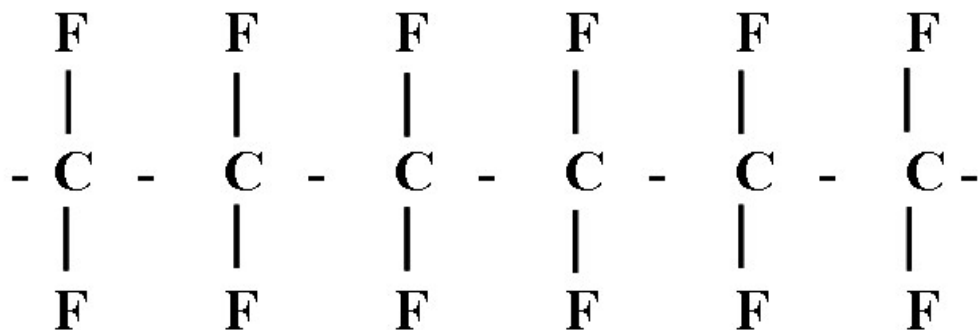


Fluoro Polymer Solutions around the World

- CR&D
- FPS Research
- Polymer Plant
- Finishes Plant
- Technical Marketing

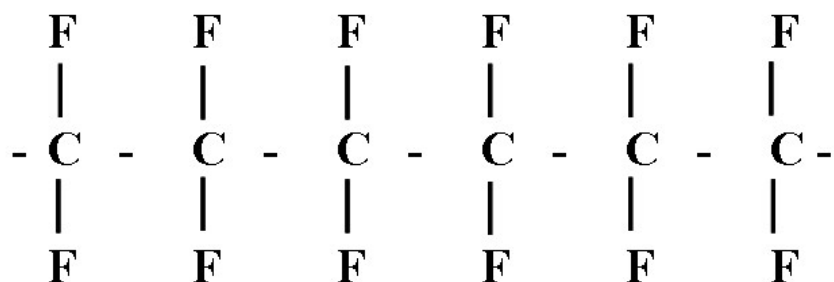


Teflon™ PTFE



VERY Long linear chain
Tight packing of F atoms
No polarity
“Introvert”

Teflon™ PTFE Fluoroplastic Outstanding Properties

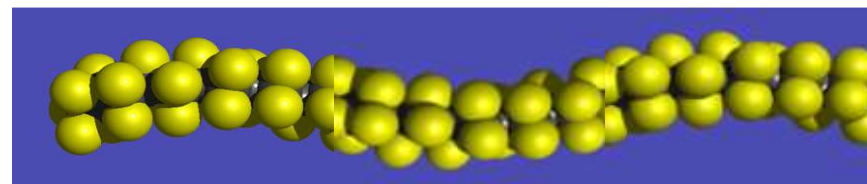


Long chain
Tight packing of F atoms
No polarity
“introvert”

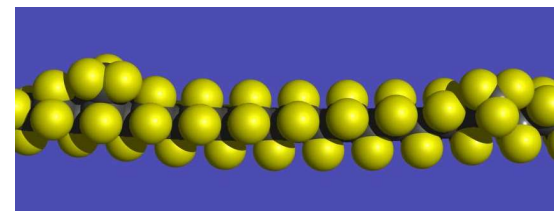
- **Chemical Inertness**
- **Low extractables ; high purity**
- **Non-Stick ; Easy Cleaning**
- **Low Friction ; Self-Lubricating**
- **Dielectrical Properties**
- **Weather Resistance & Non Ageing**
- **Insensitive to UV**
- **Non-Toxic**
- **Wide Temperature Range resistance**
(- 200 °C / + 260 °C)
- **Flexible over a wide range of temperature**
- **Non Flammable**

Chemours Fluoroplastic Portfolio

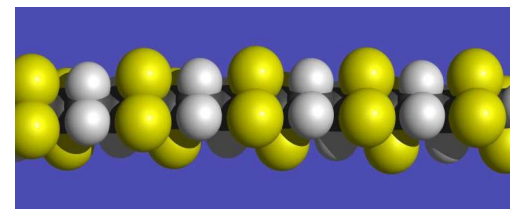
Teflon® PTFE $(-\text{CF}_2-\text{CF}_2-)_n$
(Polytetrafluorethylene)
Discovered 1938



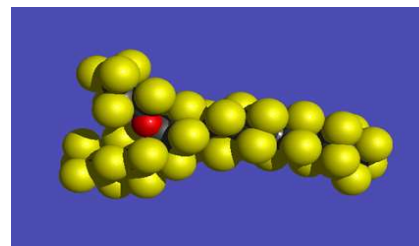
Teflon® FEP $(-(\text{CF}_2-\text{CF}_2-\text{CF}_2)_m-\text{CF}(\text{CF}_3)-\text{CF}_2-)_n$
(Fluorinated Ethylene Propylene)
Dvlp. 1960



Tefzel® ETFE $(-\text{CH}_2-\text{CH}_2-\text{CF}_2-\text{CF}_2-)_n$
(Ethylene Tetrafluorethylene)
Dvlp. 1970



Teflon® PFA $(-(\text{CF}_2-\text{CF}_2-\text{CF}_2)_m-\text{FCOC}_3\text{F}_7-\text{CF}_2-)_n$
(Perfluoroalkoxy)
Dvlp. 1972



10 00 to 10 000 times shorter chains
than PTFE

In most cases, the best properties are obtained without compounding



Chemours™

Typical Properties

Chain length
Co-monomer content



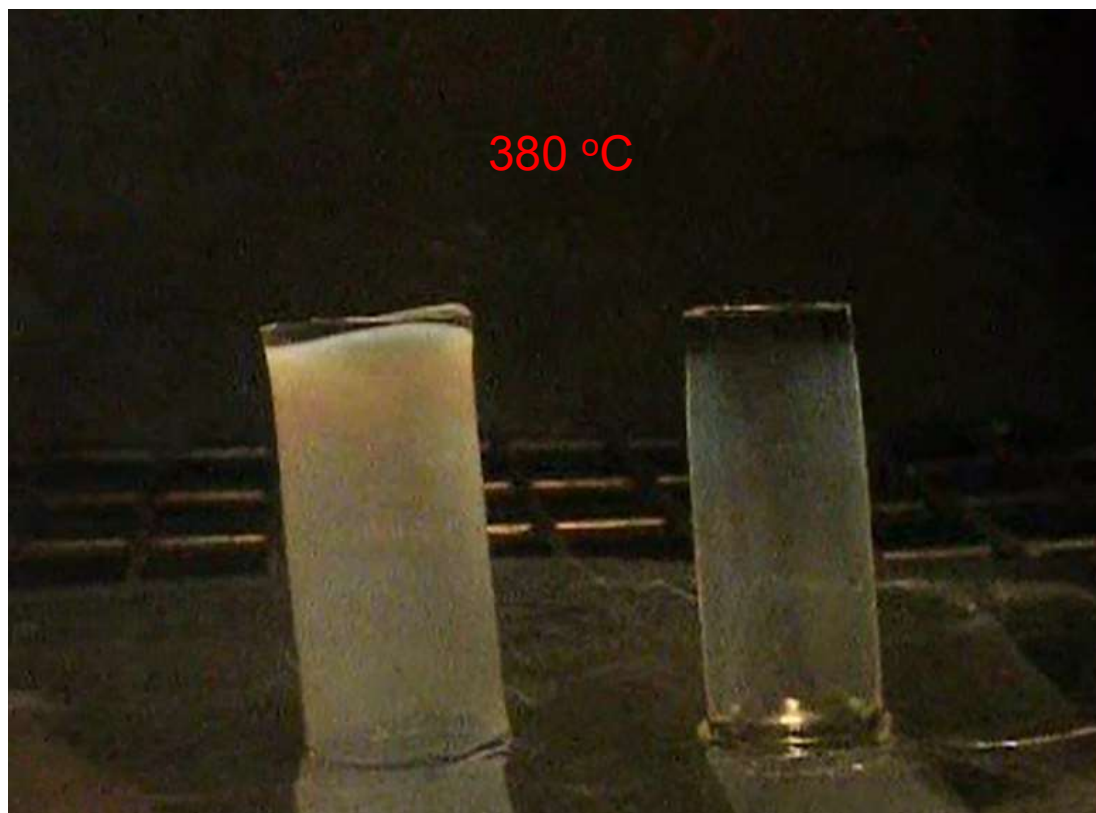
Property	Units	PTFE	FEP	PFA	ETFE
Molecular Weight		$10^6 - 10^7$	$250 - 600 \times 10^3$	$250 - 450 \times 10^3$	$250 - 400 \times 10^3$
Comonomer Content	% Weight	< 1	10 - 12	2,8 - 4,0	20
Melting Point (ASTM D 4591)	°C	327 - 342	260	305	265
Melt Viscosity	Pa.s	$10^{10} - 10^{11}$	$3 - 55 \times 10^4$	$3 - 35 \times 10^4$	$0,5 - 13 \times 10^4$
Melt Flow Rate(*) (ASTM D 1238)	g/10 min.	No Flow	1 - 30	1,5 - 40	2,5 - 64



(*) Measured at 372 °C for FEP and PFA and 297 °C for ETFE

For public use

PTFE versus „Melts“

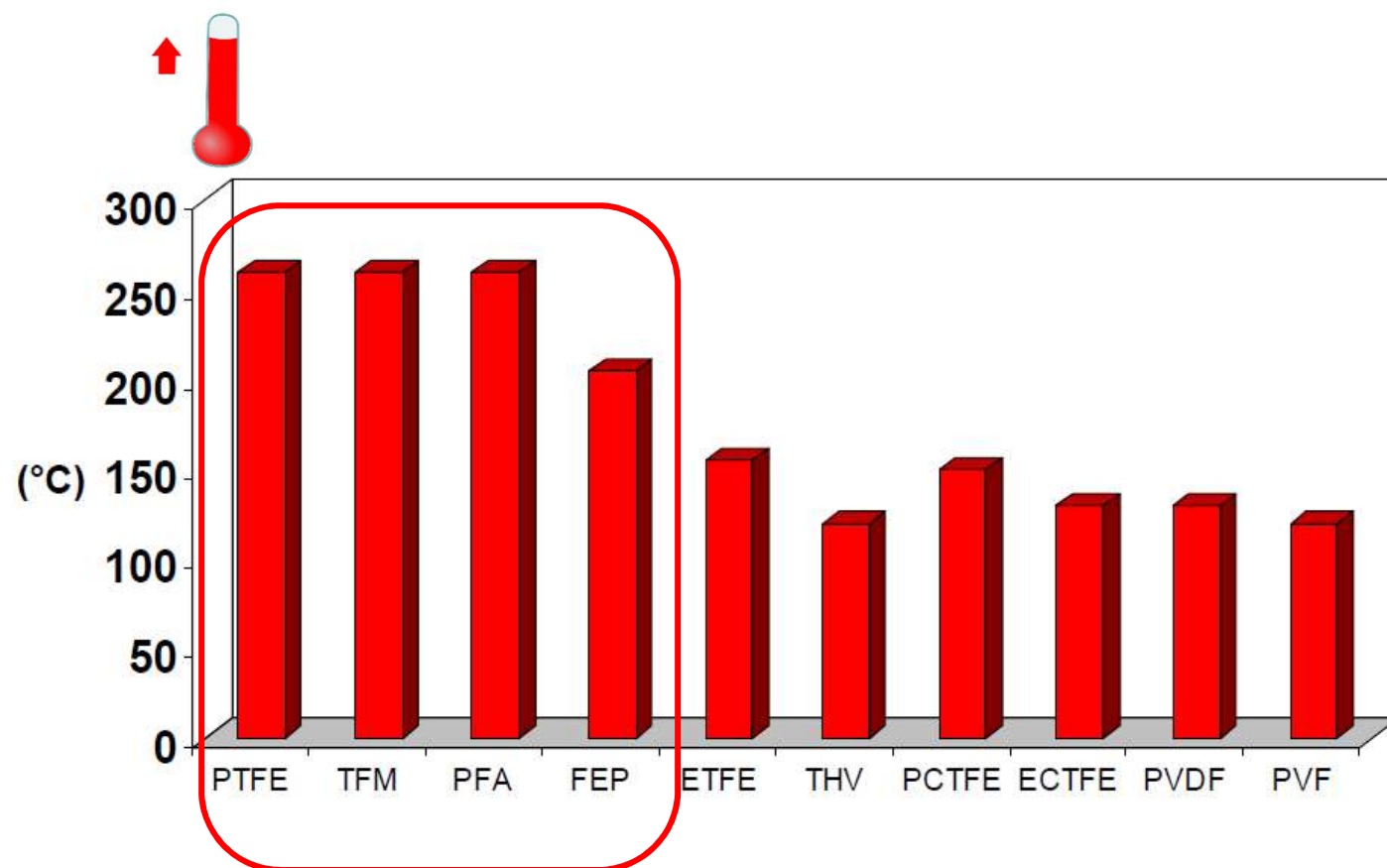


What is the difference between PTFE and PFA in melting stage.wmv

Thermal Properties

Property	Units	PTFE	FEP	PFA	ETFE
PEAK MELTING TEMP. (ASTM D 4591)	°C	327	260	305	265
SERVICE TEMP. (ISO 2578, 20.000 h)	°C	260	205	260	155
FLAME CLASS (UL94)		94V-0	94V-0	94V-0	94V-0
LIMITING OXYGEN INDEX (ISO 4589)	%	>95	>95	>95	30 - 32
HEAT OF COMBUSTION (ISO 1716)	MJ/kg	4,9 - 5,0	4,8 - 5,1	4,7 - 4,9	12,4 - 12,6

Continuous Service Temperatures of fully and partially fluorinated resins



ECA UL classification up to 300°C

Electrical Properties

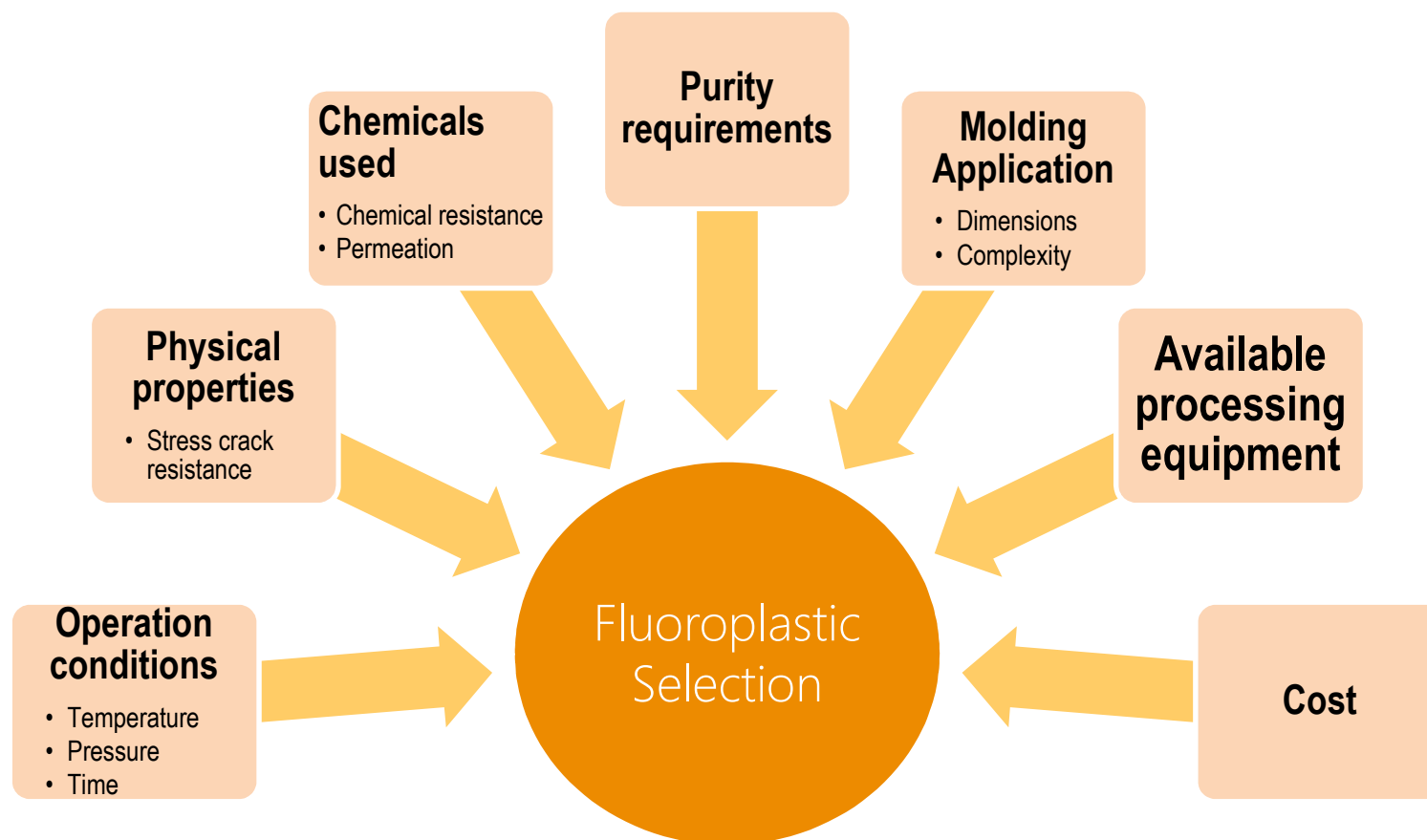
Property	Units	PTFE	FEP	PFA	ETFE
RELATIVE PERMITTIVITY (ASTM D 150)	1 kHz-1 MHz	2,040	2,060	2,050	2,60
DISSIPATION FACTOR (ASTM D 150)	@ 1 MHz	0,00010	0,00058	0,00010	0,005
ARC RESISTANCE (ASTM D 495)	s	240 - 300	240 - 300	240 - 300	60 - 120
VOLUME RESISTIVITY (ASTM D 257)	W.m	$> 10^{16}$	$> 10^{16}$	$> 10^{16}$	$> 10^{14}$
SURFACE RESISTIVITY (ASTM D 257)	W	$> 10^{16}$	$> 10^{17}$	$> 10^{16}$	$> 10^{14}$

Mechanical Properties

Property	Units	PTFE	FEP	PFA	ETFE
SPECIFIC GRAVITY (ISO 1183)		2,16	2,15	2,15	1,71
TENSILE STRENGTH (ISO 12086)	MPa	26 - 36	20 - 34	25 - 35	45 - 51
ULTIMATE ELONGATION (ISO 12086)	%	325	325	350	200 - 375
(ISO 178)	MPa	490	550 - 655	520 - 690	1000 - 1380
FLEX LIFE (ASTM D 2176) (M.I.T. 0.2 mm, 270° flex)	Cycles to failure	885.000 >90 x 10 ⁶	5.000 80.000	10.000 2.000.000	5.000 35.000
IMPACT RESISTANCE 23 °C (ASTM D 256) - 54 °C	J/m	185 107	No break 158	No break 155	No break > 1.100
HARDNESS (ISO 868)	Shore D	D-55	D-55	D-56	D-67
COEFFICIENT OF FRICTION (dynamic, ASTM D 1894)		0,1	0,3	0,2	0,4

Selecting a Fluoroplastic

There are several variables to consider when selecting a fluoroplastic



Chemical Resistance

Teflon FEP fluoropolymer resins are essentially chemically inert. Up to the highest use temperature of 200°C (392°F), very few chemicals are known to react chemically with these resins. Those that do include molten alkali metals, fluorine, and a few fluorochemicals such as chlorine trifluoride, ClF_3 , or oxygen difluoride, OF_2 , which readily liberate free fluorine at elevated temperatures.

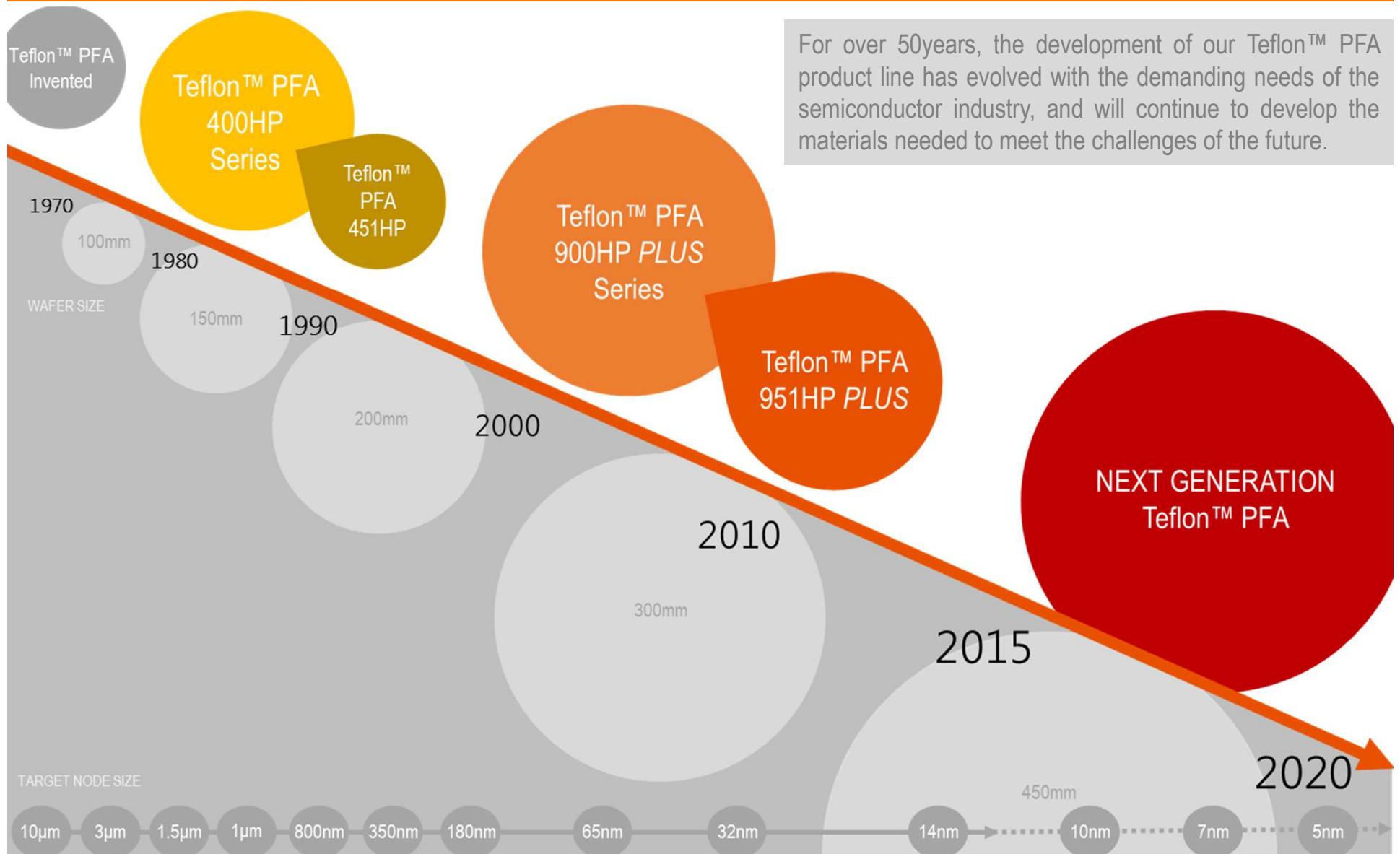
Similar statements for PTFE & PFA up to 260 °C and ETFE up to 150 °C

NOTE : chemical resistance does not relate to permeation resistance !

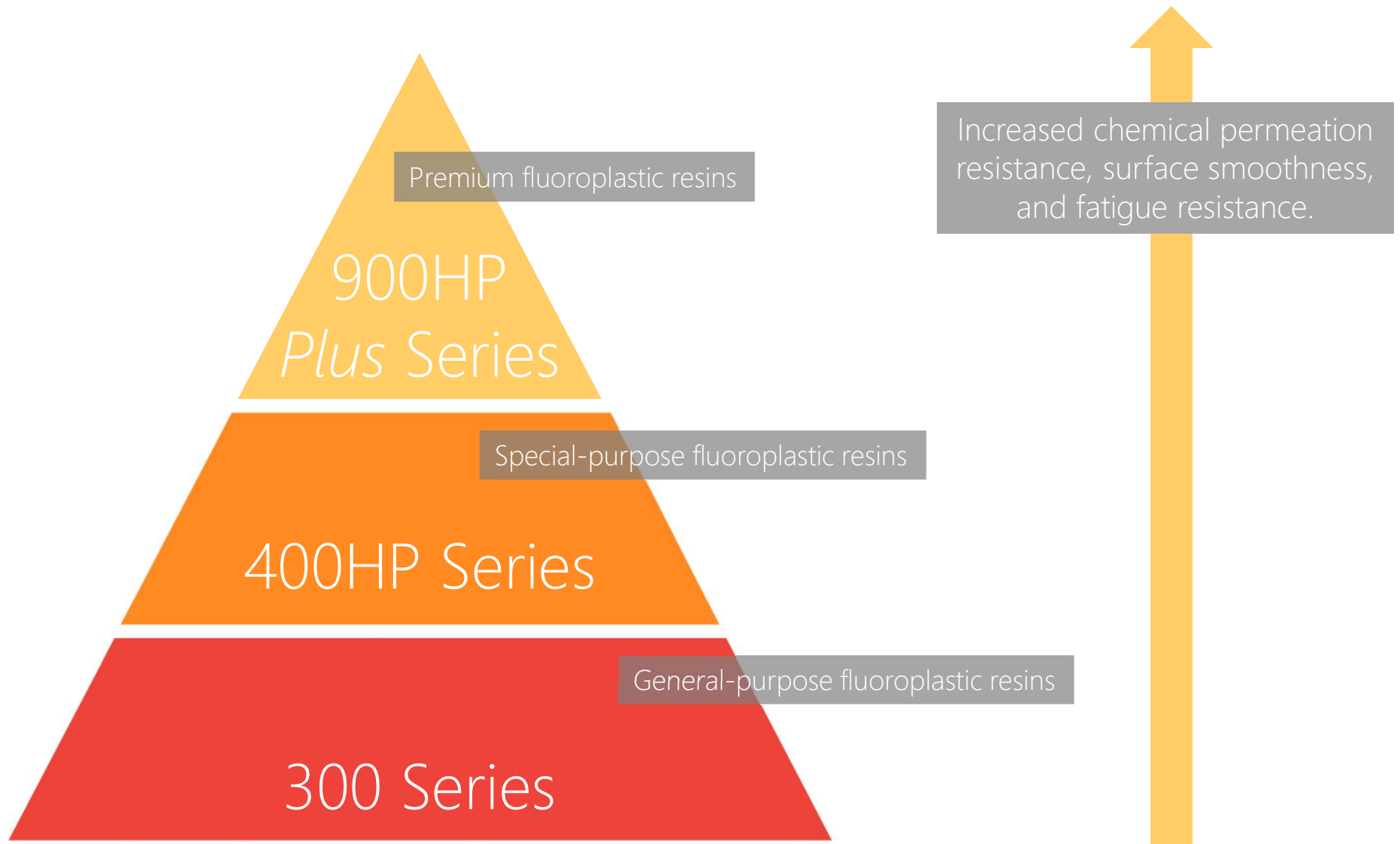


Teflon™ PFA Fluoroplastic Resins

Enabling the advancement of Moore's Law since 1973



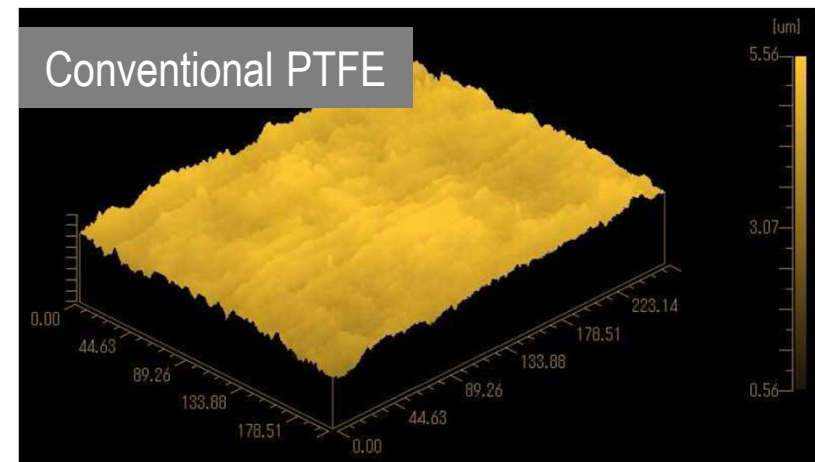
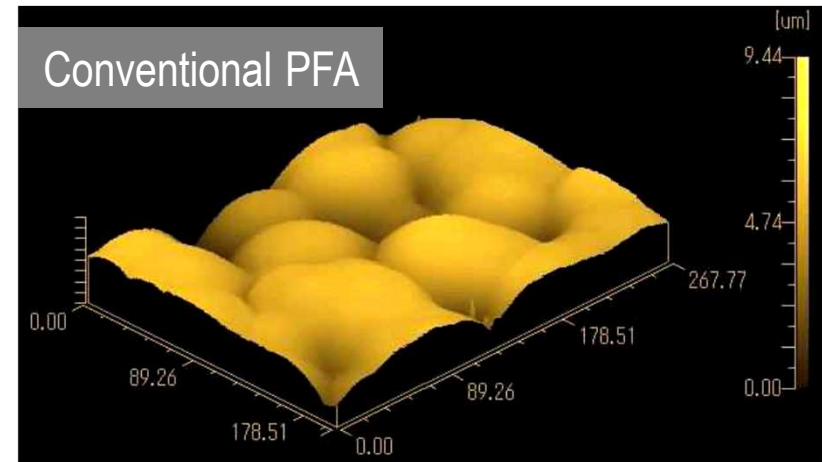
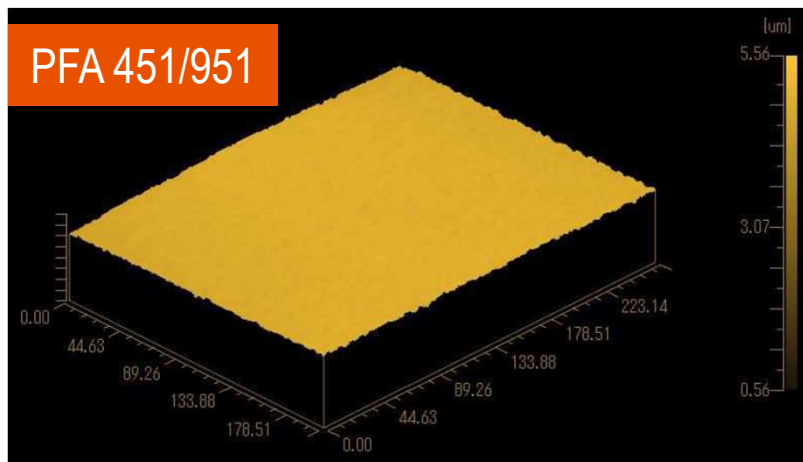
Teflon™ PFA Product Line



Benefits of spherulite size control

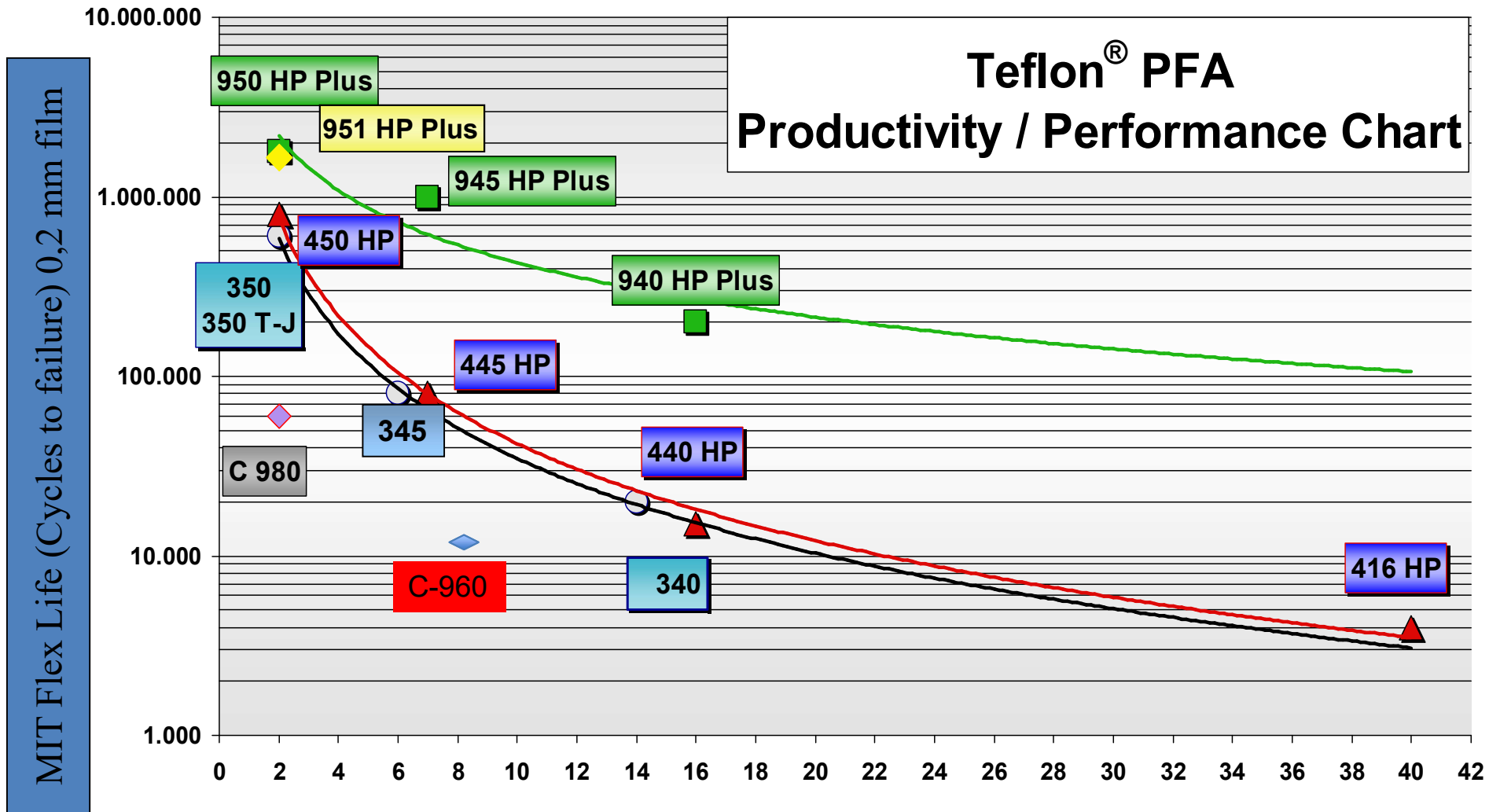
Teflon™ PFA 451HP and 951HP Plus offer superior surface smoothness over traditional PFA materials. Spherulite size control technology, allows for smoother surfaces that lead to:

- Increased crystallinity
- High chemical permeation resistance
- Excellent cleanability
- Lowest levels of extractables and particles



Teflon[®] PFA

Productivity / Performance Chart



All grades may be followed by «x»



Key PTFE 62XT X features

PTFE 62XT X:

- Allowing longer length extrusion runs.
- More flexibility of extrudate dimensions due to large reduction ratio range
- Similar properties in application as PTFE 62N X
- TUEV approval for pressure applications



Chemie Service

Key PTFE 641XT X features

PTFE 641XT X:

- Allowing longer length extrusion runs.
- More flexibility of extrudate dimensions due to large reduction ratio range
- Similar properties in application as PTFE 640XT X
- More fore giving during processing as PTFE 641XT X
- Wire insulation thickness reduction
- Reduced lubrication level as PTFE 640XT X



Introducing Teflon™ PFA C-960, a semi-conductive PFA for W&C

		PFA C-980	PFA C-960
Property	UoM	Historical Average	Typical results
MFR	g/10 min	2.8	8.3
MP (1 st)	°C	284	287
Vol. Res.	Ohm.cm	11.3	10.8
Tens. St. @ break	MPa	35.0	29.3
Elong. @ break	%	302	519
MIT Flex	MCycles	84.7	13.9
Bulk Dens.	g/l	1196	1183

- Mid range MFR
- Resistivity target < 14 Ω .cm
- Tensile strength in the range of normal PFA's
- Sufficient stress crack resistance ; MIT flex results are comparable with an FEP 100
- NOTE : This new compound is not targeted for food contact applications ;
No food approval statements

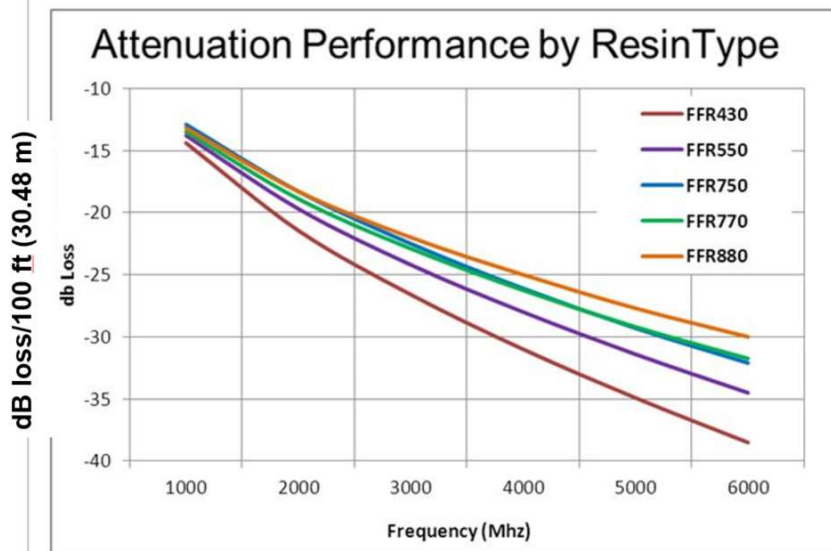


Chemours™

PFA C-960 Extrusion Experience

- Compound needs drying before processing
- Tested DDR ~50 and 100 without issues on wireline
Critical shear rate was estimated to be around 30 s^{-1} ,
We were able to run up to a shear rate of 49 s^{-1} before visually seeing the onset of melt fracture.
- 4x increase in processing speed with PFA C-960 versus PFA C-980 for the same wire construction and DDR
- Stress crack test on wire (wrap test) visually passed
- Over extrusion with another fluoropolymer without issues
These wires electrically passed LV-112 the wire wrap test
- Tube extrusion: 25x25.4 at 2.5 m/min. Very smooth inner surface
MIT Flex of tube, in extrusion direction ~30 000 cycles.

Value Proposition Fluoroplastic Foam Resins



Physical foamed wire insulation

- Smaller size with same electrical performance
- Superior electrical performance for similar size
- Higher transmission speed
- Simplified processing as self skinning is possible depending on the nature of the construction
- Weight reduction
- High dimensional stability



Thank You

Thank you for your attention

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