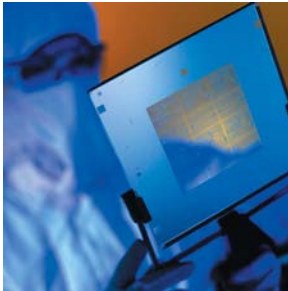




Teflon® PFA HP *Plus*

Rugged Fluoropolymer Builds More Reliability Into High-Purity Processes



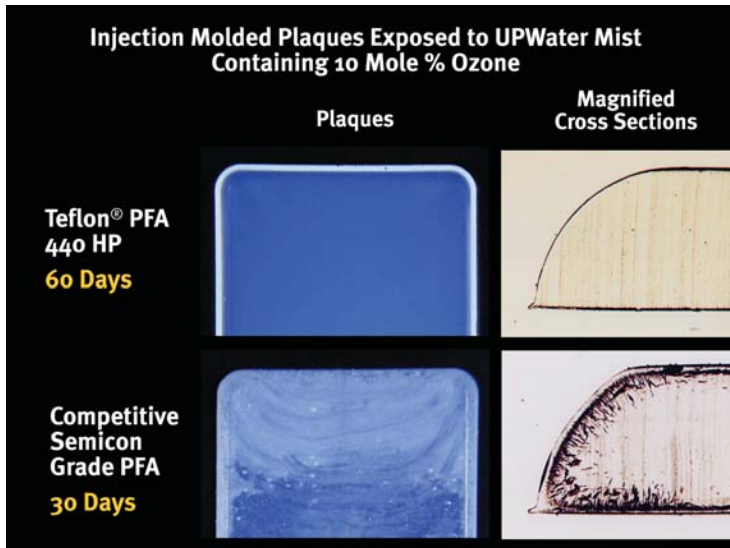
Teflon® PFA HP *Plus* withstands repeated flexing and aggressive stress-cracking agents and has the unsurpassed purity of Teflon® PFA HP

In semiconductor industry critical-purity processes, **Teflon® PFA HP *Plus*** fluoropolymer resins perform where many other materials fall short.

DuPont scientists developed the **Teflon® PFA HP *Plus*** generation to give manufacturers new opportunities to improve system reliability and reduce cost of ownership while maintaining the same high levels of purity and contamination protection as standard Teflon® PFA HP.

Components made of the new generation fluoropolymer meet those objectives by delivering:

- Longer life under dynamic loads such as repeated flexing
- More resistance to stress cracking by specialty fluorosurfactants such as aggressive developers
- Smaller equipment footprints with smaller multifunctional molded parts
- Smoother surfaces for resistance to microbial contamination
- Inert non-polar polymer chain end groups for unsurpassed protection against ionic and metallic contamination, even from ozonated fluids
- Unmatched HCl permeation resistance



These images show injected molded parts of Teflon® PFA 440 HP after 60-day exposure to ultra-pure water mist containing 10 mole % ozone. Notice that both the flat view and the magnified view show no deterioration in the Teflon® PFA 440 HP.

However, the competitive semiconductor grade material PFA shown in the bottom photos has bubbles and crazing on the flat view after only 30 days of exposure. The magnified side corner view shows stress cracking into the polymer surface.

Ozone Resistance

The increased usage of ozonated fluids to enhance the cleaning-process steps in the semiconductor industry provides another reason to use Teflon® PFA HP and **Teflon® PFA HP Plus**. That's because the DuPont products have fluorinated end groups that protect the molecular chain from ozone attack during the component's exposure to ozonated fluids.

Non- or partially fluorinated polymers have reactive end groups that can contribute to contamination in three ways:

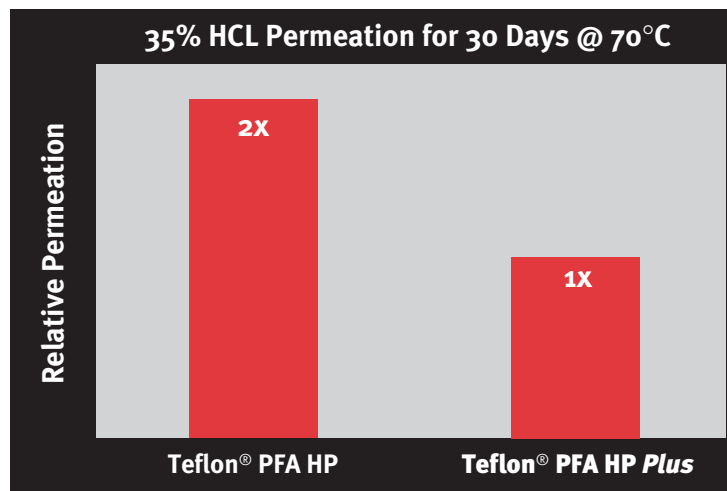
- Reactive end groups can extract metals from the processing equipment whose metal ions then contaminate finished products.
- Reactive end groups can attract and then release contaminants that can produce intermittent spikes in contaminant levels in process fluids which, in turn, may upset processes where purity is critical.
- Reactive end groups can be attacked by the very aggressive ozone molecule resulting in crazing, bubbling and stress cracking of the polymer.

But thanks to DuPont's patented, fully fluorinated process that produces non-reactive end groups, those contamination worries are eliminated.

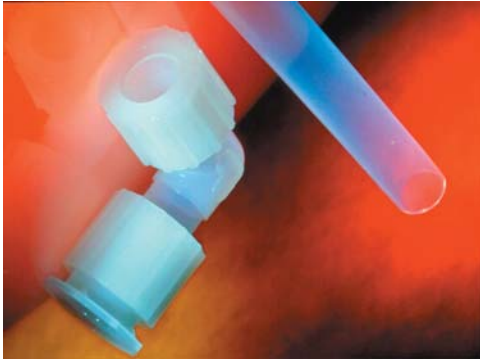
Hydrochloric Acid Permeation

As the semiconductor industry has moved from aluminum to copper conductors in chip manufacture, the industry has in turn increased its usage of hydrochloric acid (HCl). HCl is a very small molecule that permeates through PFA. That permeation cannot be completely stemmed but DuPont **Teflon® PFA HP Plus** has reduced HCl permeation by almost 50 percent.

For the highest purity as well as the best level of protection against contamination and permeation, there's no equal to Teflon® PFA HP or **Teflon® PFA HP Plus**.



The graph above illustrates 35% HCl permeation over a 30-day period. Note that Teflon® PFA HP Plus has reduced permeability almost twice as much as Teflon® PFA HP. This improved permeation resistance is due to the altered morphology of the structure which creates smaller spherulites that provide a more tortuous path for the HCl molecule.

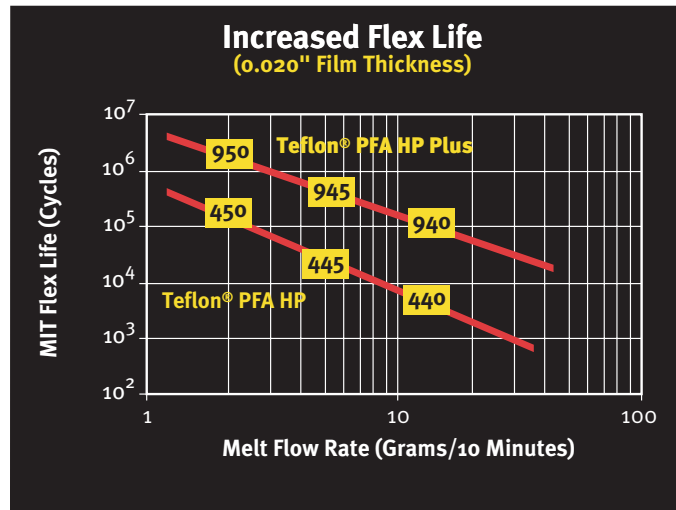


Small integrally molded features of these fluid-handling components are possible, thanks to the excellent melt flow properties of Teflon® PFA HP Plus.

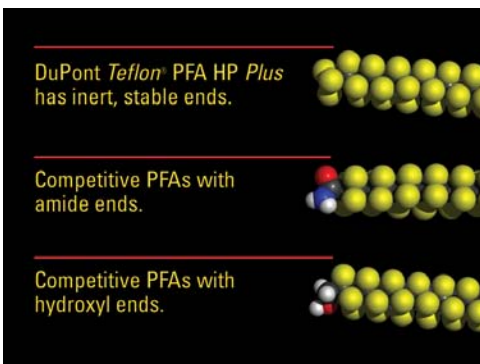
— Manufacturer: Entegris.

New Design Flexibility

Thanks to their greater toughness, the higher-melt-flow grades of **Teflon® PFA HP Plus** can be used to mold long-lasting compact parts with thinner walls and more finely detailed features. Such parts save space in crowded cabinets and clean rooms. Melt flow data are shown in the table on page 5. Three grades are available to meet specific needs.



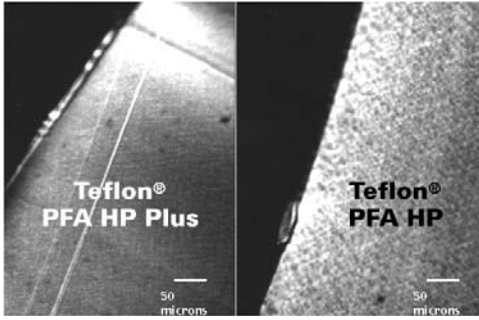
Teflon® PFA HP Plus provides more flex life and higher flow than HP grades.



Safeguarding Process Purity

You can specify **Teflon® PFA HP Plus** with the confidence that it delivers the same high level purity and inertness as standard HP, the proven standard in wetted semiconductor components since 1989. Like HP, **Teflon® PFA HP Plus** is manufactured by a patented process that replaces end groups with fluorine to reduce polarity for minimal ionic attraction and polymer reactivity.

In conventional PFAs, the end groups contain carbon, oxygen and hydrogen atoms in arrangements that interact with ions because they are strongly polar. In some PFAs, end group components are partially replaced with fluorine for reduced polarity, but the remaining components have much higher polarity.



Very small spherulites in Teflon® PFA HP Plus are part of a toughened mechanical structure.

Increased Mechanical Reliability

Teflon® PFA HP Plus provides increased flex life and improved chemical resistance that can extend component life for reduced downtime and lower cost of ownership. In tests, parts molded from PFA HP Plus provide up to 10 times the flex life of standard HP parts. The very small spherulites shown at left contribute to the toughened structure of Teflon® PFA HP Plus. The physical properties of the commercial grades of Teflon® PFA HP Plus are shown in the table on the next page.

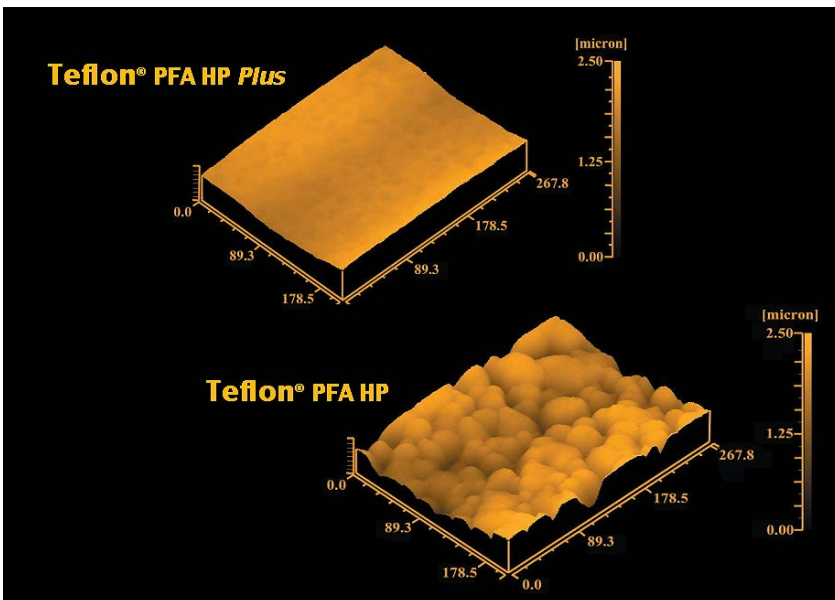
Resistance to Specialty Fluorosurfactant Shibley 701 at 100x Use Concentration in Tubing at R.T.

Teflon® 440HP	Failed in 43 days
Teflon® 450 HP	Failed in 9 months
Teflon® PFA HP Plus	No change in 17 Months

Teflon® PFA HP Plus delivers outstanding resistance to fluorosurfactants.

More Stress Crack Resistance

Parts made of Teflon® PFA HP Plus show a significant improvement in resistance to stress cracking by aggressive specialty fluorosurfactants increasingly used in semiconductor processes. The improved chemical resistance of Teflon® PFA HP Plus can have an impact on future costs by allowing current fluid handling systems to handle new process chemistries and reduce development time.



Vertical axis magnified 25X

Smoother Surfaces

Teflon® PFA HP Plus yields parts with very smooth as-molded surfaces. Smooth surfaces resist buildup of microbial contamination in water handling systems, are easy to clean and offer better aesthetics.



Watch Your Process Work

Teflon® PFA HP *Plus* has outstanding optical clarity. This is a key advantage for visual inspection of process fluids in tubing.

Teflon® PFA HP *Plus* has higher clarity than PFA HP.

Typical Property Data for Teflon® PFA HP *Plus* Fluoropolymer Resin Grades 940, 945, 950

Property	ASTM Test Method	Unit	PFA 940HP <i>Plus</i>	PFA 945HP <i>Plus</i>	PFA 950HP <i>Plus</i>
Thermal					
Nominal Melting Point	D3418	°C	285-300	285-300	285-300
Upper Service Temperature	—	°C	250	250	250
Flow Rate	D3307	g/10 min	10-30	3-10	1-3
Mechanical					
Tensile Strength, 23°C	D3307	MPa (psi)	28 (4,100)	28 (4,100)	28 (4,100)
		MPa (psi)	11 (1,600)	13 (1,900)	15 (2,200)
Tensile Yield Strength, 23°C	D3307	MPa (psi)	14 (2,000)	14 (2,000)	14 (2,000)
Ultimate Elongation, 23°C	D3307	%	310	290	260
		%	450	450	450
Flexural Modulus, 23°C	D790	MPa (psi)	650 (94,000)	600 (87,000)	600 (87,000)
		MPa (psi)	60 (8,700)	55 (8,000)	50 (7,300)
Specific Gravity	D792	—	2.12-2.17	2.12-2.17	2.12-2.17
General					
Water Absorption, 24 hr	D570	%	0.05	0.05	0.05
Limiting Oxygen Index	D2863	%	> 95	> 95	> 95
Meets FM4910, Clean Room Materials Flammability Test Protocol	—	—	Yes	Yes	Yes

Put Teflon® PFA HP *Plus* to Work for You

Learn more about what new Teflon® PFA HP *Plus* can do to make your fluid handling systems perform better. For more information about Teflon® PFA HP *Plus*, please call DuPont at (302) 479-7731, contact the nearest DuPont location listed on the back or visit www.teflon.com/semiconductor on the World Wide Web.



For more information on Fluoroproducts: (302) 479-7731

www.teflon.com/semiconductor

DuPont Fluoroproducts
P.O. Box 80713
Wilmington, DE 19880-0713

Europe

DuPont de Nemours Int'l SA
DuPont Fluoroproducts
2, chemin du Pavillon
P.O. Box 50
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
(022) 7175111

Japan

DuPont Mitsui
Fluorochemicals Co., Ltd.
Chiyoda Honsha Building
5-18, Sarugaku-cho 1-chome
Chiyoda-ku, Tokyo 101 Japan
81-3-5281-5872

Asia Pacific

DuPont China, Limited
9 Canton Road,
Tsimshatsui
Kowloon, Hong Kong
(852) 27341948
Tim-S.T.
Leung@hkg.dupont.com

Canada

DuPont Canada, Inc.
DuPont Fluoroproducts
P.O. Box 2200, Streetsville
7070 Mississauga Road
Mississauga, Ontario,
Canada L5M 2H3
(905) 821-5194

South America

DuPont do Brasil S/A
Fluoropolymers
Alameda Itapecuru, 506
06454-080 - Alphaville
P.O. Box 263
Barueri, Sao Paulo, Brazil 0645-080
0800-17-17-15
Productos.Brazil@bra.dupont.com

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