

# Altaflo® 480 Ultra-High Purity PFA Tubing

## WHITE PAPER

### Overview

**Pexco** has developed a new line of ultra-high purity (UHP) PFA tubing and pipe that offers significant improvements over standard high purity materials. Made with 100% virgin-grade Daikin AP-231 SH resin, Altaflo 480 UHP PFA tubing meets or exceeds key SEMI F57 requirements, helping semifab operators reduce contamination, increase wafer yields and maximize system uptime.

### Key Properties

**CT Associates and Balazs Analytical Services** analyzed samples of **Altaflo 480 UHP PFA** according to the SEMI F57 specification, performing additional hydrochloric acid (HCl) extraction tests for trace metal contamination. Key results demonstrate that Altaflo 480 UHP PFA tubing exhibits:

- Ultra-low total organic carbon (TOC) contamination at 0.2% of the SEMI F57 limit
- Minimal ionic contamination, with nearly all ions measured below reportable limits
- Extremely low trace metal extractables, including an HCl mass extraction rate roughly 2% of a major semiconductor equipment manufacturer's specification

**Daikin's high-performance AP-231 SH resin** also provides Altaflo 480 UHP PFA tubing a high degree of chemical resistance and mechanical reliability, including:

- Upper service temperature of 500°F (260°C)
- Enhanced resistance to aggressive fluorosurfactants to minimize stress cracking
- Extended flex life comparable to that of PTFE

## Total Organic Carbon (TOC) Contamination

TOC contamination in liquid chemical distribution systems can impact many stages of semiconductor manufacturing, including oxidation, etching, cleaning, epitaxy, and thin film deposition. When present in ultrapure water systems, TOC promotes bacterial growth, a problem that can cause manufacturing delays.

Testing indicates Altaflo 480 UHP PFA tubing contains exceptionally low levels of TOC, just slightly higher than the reportable limit and far exceeding the SEMI F57 limit.

Surface extractable TOC, $\mu\text{g}/\text{m}^2$ Leached at $85 \pm 5^\circ\text{C}$ , 7 days	Reporting Limit	Altaflo 480 UHP PFA Tubing	SEMI F57 Limit
Total	40	100	$\leq 60,000$

## Ionic Contamination

Ionic contamination is problematic in fluid-handling systems because it exerts a corrosive effect on microelectronic devices. Furthermore, evaporation of contaminated solutions may result in surface residues that degrade device quality and performance.

With the exception of fluoride, leach tests performed on Altaflo 480 UHP PFA tubing indicate all measured anions test below the reporting limit. The level of fluoride extraction from the tubing is far below the SEMI F57 limit, at only 1%.

Surface extractable TOC, $\mu\text{g}/\text{m}^2$ Leached at $85 \pm 5^\circ\text{C}$ , 7 days	Reporting Limit	Altaflo 480 UHP PFA Tubing	SEMI F57 Limit
Bromide	1	*	$\leq 100$
Chloride	0.5	*	$\leq 3,000$
Fluoride	20	680	$\leq 60,000$
Nitrate	1	*	$\leq 100$
Nitrite	0.5	*	$\leq 100$
Phosphate	1	*	$\leq 300$
Sulfate	1	*	$\leq 300$

\*Analysis revealed the analyte was not found at or above the reporting limit.

## Metallic Extractables

The extraction of metallic contaminants from fluoropolymer components presents serious risks to the semiconductor manufacturing process, namely etching of critical surfaces and the alteration of electrical properties of microelectronic devices, both of which can cause device failure.

Lab analysis indicates levels of trace metal extraction below the reportable limit for most elements. Nickel was detected at the acceptable level specified in SEMI F57. All other detected elements were far below the limits specified in the standard.

Surface extractable TOC, $\mu\text{g}/\text{m}^2$ Leached at $85 \pm 5^\circ \text{C}$ , 7 days	Reporting Limit	Altaflo 480 UHP PFA Tubing	SEMI F57 Limit
Aluminum	0.02	0.1	$\leq 10$
Arsenic	0.5	*	—
Barium	0.02	*	$\leq 15$
Boron	0.2	3.1	$\leq 30$
Cadmium	0.07	*	$\leq 5$
Calcium	1	*	$\leq 20$
Chromium	0.07	*	$\leq 1$
Copper	0.1	*	$\leq 15$
Iron	0.2	*	$\leq 5$
Lead	0.1	*	$\leq 1$
Lithium	0.07	*	$\leq 2$
Magnesium	0.05	*	$\leq 5$
Manganese	0.07	*	$\leq 5$
Nickel	0.1	1.0	$\leq 1$
Potassium	0.2	*	$\leq 15$
Sodium	0.1	*	$\leq 15$
Strontium	0.02	*	$\leq 0.5$
Titanium	0.1	*	—
Tin	0.05	*	—
Vanadium	0.07	*	—
Zinc	0.1	0.6	$\leq 10$

\* = Analysis revealed the analyte was not found at or above the reporting limit.

‘—’ = Test not currently required by SEMI F57-0314, as limits of acceptance have not yet been established. SEMI F57-0314 says this value should be reported if available, but not required.

## Hydrochloric Acid (HCl) Extraction

While performance values of tubing in ultrapure water systems are important, it's equally critical to understand tubing behavior in aggressive chemicals like hydrochloric acid (HCl), commonly used in semiconductor manufacturing. CT Associates analyzed Altaflo 480 UHP PFA tubing in a 12-day extraction test, performed in 35% HCl using a dynamic extraction method. The results demonstrate the tubing is extraordinarily stable in HCl, with area-normalized surface and mass extraction rates far below a major semiconductor equipment manufacturer's specifications (0.7% and 2%, respectively).

Area-normalized extraction rate, ng/cm <sup>2</sup> /day 35% HCl, 7 days	ALTAFLO 480 UHP PFA Tubing	Major semiconductor equipment manufacturer's specification
Surface contamination	0.14	<20
Bulk contamination	0.012	<0.5

## Chemical Resistance

In addition to its high degree of purity, PFA is widely used in the semiconductor industry because of its extreme chemical resistance. Inert to nearly all industrial chemicals, UHP PFA provides added environmental stress crack resistance over standard grade PFA, even when exposed to harsh fluorosurfactants used in semifab wet chemical processes.

Tests performed according to ASTM protocols demonstrate the superior flex life and flexural strength of Altaflo 480 UHP PFA tubing, durability that helps extend system life and lower the total cost of ownership.

	ASTM Test Method	Units	Values
MIT Flex Life	D 2176	KCycles	1,750,000
Flex Modulus	D 790	PSI	90,000

## Physical Properties

**Altaflo 480 UHP PFA tubing** and pipe are produced exclusively with 100% virgin-grade Daikin AP-231 SH semiconductor-grade resin, recognized by many experts as a material of choice for fluoropolymer components in high purity applications.

**Altaflo 480 UHP PFA tubing** meets or exceeds the requirements of ASTM D 6867-03 (Standard Specification for PFA Tubing). It also resists combustion and doesn't promote flame spread, with a UL 94 V-0 rating.

Property	ASTM Test Method	Units	Values
Upper Service Temperature	—	—	500°F
Specific Gravity	D 792	—	2.15
Tensile Strength	D 1708	PSI	4500
Elongation	D 638	%	400
Hardness	D 2240	Shore D	60

\*The above information is based on tests performed at 73°F and can vary in individual applications based on parameters such as temperature, chemical concentration, pressure, etc. Please consult factory for details.

## Pexco Altaflo's Performance Focus

With even low levels of impurities impacting wafer yield and performance, purity is especially critical for tubing and pipe, which provide the greatest exposed surface area for introducing contaminants. At the same time, strength and chemical resistance are crucial for minimizing system downtime in order to maintain production levels.

Pexco manufactures tubing and pipe using high performance fluoropolymer resins that offer the best performance for end users. Daikin's AP-231 SH has the lowest melt flow rate of their entire line of PFA resins, making it suitable only for tubing and linings.

## Production

**ALTAFLO 480 UHP PFA tubing and pipe** is produced and packaged in a clean room manufacturing facility. Our proprietary production process is designed to protect products from outside contaminants, from the point where raw material is introduced to extrusion to final packaging.

Tubing is available in coiled configurations manufactured to customer specifications. Precision cutting is available for tubing under 1" using high-speed rotary cutting equipment that ensures consistently straight and smooth cutting of fluoropolymer materials. Pexco offers custom assembly services such as heat forming, flaring, slitting and sub-assembly packaging. Upon request, we can also provide private labeling services including custom labeling and boxing.

## Packaging

Altaflo tubing comes in 25 ft., 50 ft., 100 ft., 500 ft. and 1000 ft. lengths, with longer and custom lengths available. Standard packaging procedures for our UHP PFA tubing include anti-static heavy polyethylene bags that minimize particulate matter at the tubing surface upon opening. Inner polybags are heat-sealed before being placed inside a second polybag, which is also heat-sealed.

Upon request, we also offer our ALTAPAK™ packaging option, which includes surfactant cleaning, DI rinse and nitrogen purge, all performed within a class 100 clean room environment.

## Delivery

We understand the importance of maximizing system uptime, which is why we provide same-day shipping on standard orders. Because we maintain such a large in-stock inventory, we're also able to quickly shift production to custom extrusion orders for expedited delivery.

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## About the Company

**Pexco** is an innovative producer of high-performance fluoropolymer and fluoroplastic tubing and pipe. Our focus on thermoplastics and thermosets allows us to use only high-grade, high molecular weight resins, resulting in products that provide the best end-use performance in terms of purity, chemical resistance, and overall system reliability.

Our **UHP PFA tubing** is produced and packaged in a clean room facility, using a proprietary production process designed to ensure product purity and cleanliness. Standard packaging includes a double layer of heat-sealed, anti-static heavy polybags to minimize particulate matter at the tubing surface. We also provide same-day shipping on standard orders and expedited production and shipping for custom extrusions.

## Important Notice

All statements, information and data given herein are believed to be accurate and reliable, but are presented without guarantee, warranty or responsibility of any kind, expressed or implied. Due to the nature of applications involving the use of fluoropolymers, we suggest that all customers test product within the conditions specific to their application prior to use.

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