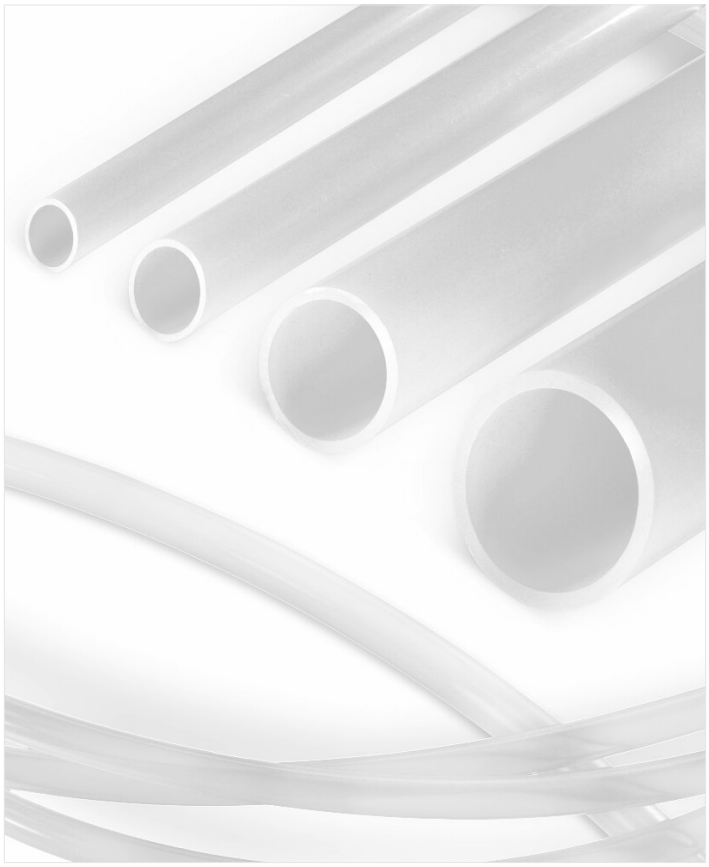
FluoroLine® PFA Tubing

Ultraclean PFA tubing for advanced semiconductor applications



Entegris offers multiple grades of ultrapure FluoroLine® PFA tubing for primary containment: high-purity HP PFA plus, high-purity high molecular weight (HMW) PFA, high-purity PFA and superclean tubing (SCT). Each is made from 100% virgin PFA material and is ideal for use in high-purity, highly corrosive applications. Entegris has spent significant time analyzing the extrusion process making targeted process modifications to develop the cleanest tubing available on the market to date. The most recent addition and highest grade of tubing available is Entegris superclean tubing. It is constructed from an advanced resin formulation that provides improved cleanliness and surface finish. Characteristics of the SCT tubing include:

- Super clean new PFA resin material
- Leverages proprietary ultraclean extrusion process
- Produces improved extractable and particle performance over standard processing of extrusion resins
- The smoothest surface finish of all PFA tube offering
- Reduced costly chemical system flush-up time and metal contamination levels

SuperClean tubing excels in faster flush times after installation and reduces on-wafer defects related to tube cleanliness, making it the stand-alone choice for low single nanometer processes that require PFA tubing. By optimizing both the PFA resin properties and the tube extrusion process, Entegris has developed a truly unique solution for high purity tubing.

SuperClean tube provides:

- The lowest total metal extractables of commercially available PFA resins.
- Approximately 35% to 77% smoother surface finish
- Reduced system flush-up times

These properties of SCT tubing provide the highest levels of chemical resistance to aggressive chemicals (acids/bases), solvents, and deionized water. The smoothness of the material prevents particle adhesion which allows for the rapid flush times needed to get new loops and tools online.

REDUCED SURFACE ROUGHNESS

Tubing surface roughness Ra (Roughness Average) measures the arithmetic mean of microscopic peaks and valleys on a tube's inner or outer wall. It is expressed in micrometers (µm) where a lower number indicates a smoother surface. The Ra is the mean of the absolute values of the profile heights measured from a mean line averaged over the profile, see equation.[1] A lower Ra value implies it is less likely for particles to stick to the surface and therefore should reduce the flush time to achieve the desired liquid particle count (LPC) value. Figure 1 presents the numerical values and a graph of the SCT tubing vs other grades.

Equation

$$R_a = \frac{1}{n}\sum_{i=1}^{n}\left|y_i\right| \quad (1)$$

Surface roughness calculations @ 100× magnification

	Ra (100×)
SCT	0.032 µm
450	0.053 µm
451	0.049 µm
950	0.142 µm

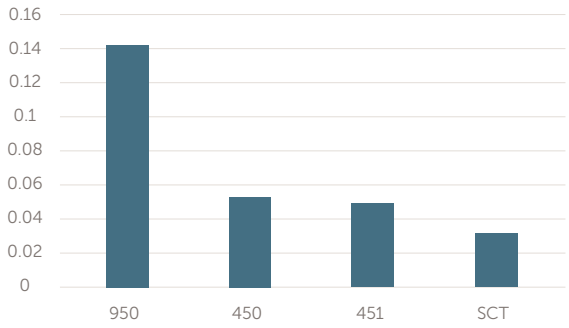


Figure 1. Surface roughness.

REDUCED FLUSH TIME

The ability to quickly qualify a line and turn the tool over to production is critical to getting a fab up and running. With the highest surface area of any component, tubing plays a key role in increasing or decreasing flush-up performance. Contamination levels and flush times were evaluated both internally and contracted through a second party test lab.[2] SEMI F104 establishes a test method for allowable particles contributed by components used in conveying ultra-pure liquids used in the semiconductor process. A summary of a few test results are presented in Figure 2 below proving the SCT is significantly cleaner than other grades.

Particulate Contamination

- Test method: SEMI F104[1]
- Completed by 2nd party lab[2]
- Geometric mean of 2 samples
- ½" tubing

Liquid Particle Count (F104 Test Method) – ½" Tubing

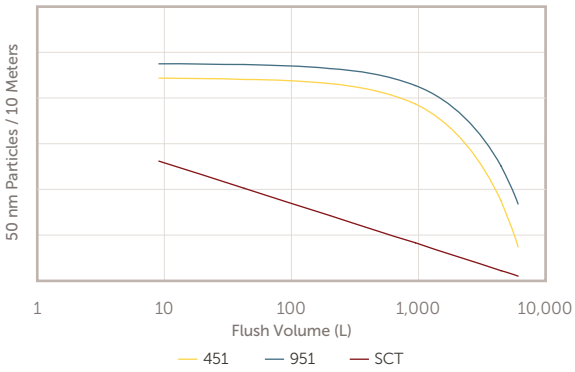


Figure 2. Particulate contamination vs. flush volume.

Total Metals Contamination

SEMI F57 sets strict limits on trace metallic contributions from ultra-high-purity polymer components used in semiconductor liquid chemical and ultrapure water (UPW) systems to ensure they do not leach metallic ions or impurities that ruin wafer yields. Example results for metals and total organic carbon (TOC) are shown in Figures 3 and 4.

- Test method: SEMI F57[3] Metals
- Soak in UPW for 1 week at 85°C
- ½" tubing

F57 Total Metals – ½" Tubing

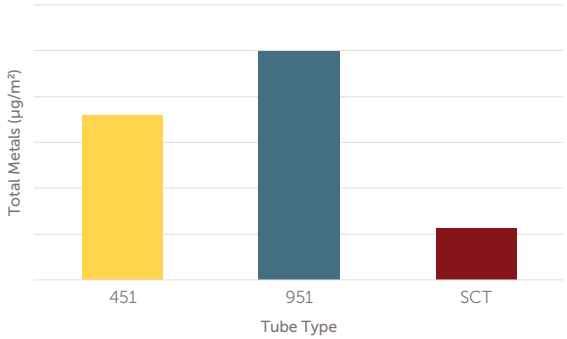


Figure 3. Metals contamination in tubing grades.

Fluorides Contamination

- Test method: SEMI F57[3] Metals
- Soak in UPW for 1 week at 85°C
- Equipment: Sievers 900 Laboratory TOC Analyzer

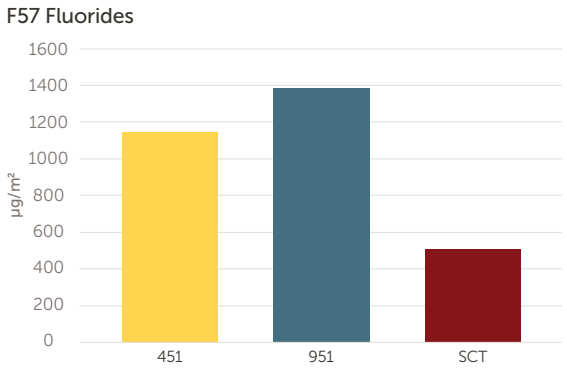


Figure 4. TOC contamination in tubing grades.

Dual Containment Tubing

Many advanced fabs use a dual containment tubing (DCT) configuration to assure safe transport of UPW and hazardous chemicals to reduce risk of leaks or environmental contamination. While some DCT tubing configurations rely on PFA tubing installed within PVC pipe, this approach is expensive to install and carries a risk of leakage if the PVC pipe sections are not fitted correctly. Entegris offers ultraclean FluoroLine® Plus dual containment tubing for use in high-purity sub-fab applications. This innovative product allows long, continuous double-contained tubing lengths without the introduction of contaminants common when pulling tubing through traditional PVC secondary containment. The SCT can be provided as the inner tubing to deliver the cleanest option with an extra layer of containment.

SPECIFICATIONS

SIZE	TUBE SIZE OD	WALL THICKNESS	TUBE SIZE ID	MINIMUM BEND RADIUS	MAXIMUM ROLL LENGTH	MAXIMUM REEL LENGTH
1/4"	0.250 (6.35 mm) ±.004" (±.10 mm)	0.047" (1.19 mm) ±.004" (±.10 mm)	0.156 (3.96 mm)	1.5 (38 mm)	500 ft	5000 ft
3/8"	0.375 (9.52 mm) ±.004" (±.10 mm)	0.062" (1.57 mm) ±.005" (±.13 mm)	0.251 (6.38 mm)	2.0 (51 mm)	500 ft	5000 ft
1/2"	0.500 (12.70 mm) ±.005" (±.13 mm)	0.062" (1.57 mm) ±.005" (±.13 mm)	0.376 (9.55 mm)	2.3 (58 mm)	500 ft	4000 ft
3/4"	0.750 (19.05 mm) ±.005" (±.13 mm)	0.062" (1.57 mm) ±.005" (±.13 mm)	0.626 (15.90 mm)	9.0 (229 mm)	250 ft	1500 ft
1"	1.000 (25.40 mm) ±.005" (±.13 mm)	0.062" (1.57 mm) ±.005" (±.13 mm)	0.876 (22.25 mm)	11.0 (279 mm)	250 ft	750 ft
1¼"	1.250 (31.75 mm) ±.007" (±.18 mm)	0.075" (1.90 mm) ±.007" (±.18 mm)	1.100 (27.94 mm)	12.5 (318 mm)	NA*	500 ft
1½"	1.500 (38.10 mm) ±.007" (±.18 mm)	0.086" (2.18 mm) ±.007" (±.18 mm)	1.328 (33.73 mm) ±.007" (0.18 mm)	22.5" (572 mm)	NA*	500 ft
40 mm	40 mm ±.007" (±.18 mm)	0.086" (2.18 mm) ±.007" (±.18 mm)	1.398 (35.51 mm)	22.5 (572 mm)	NA*	500 ft

**Only sold in full reels*

ORDERING INFORMATION

FluoroLine Ultrapure PFA Tubing: part number

SCT _____ - ____ _____

Outside tube diameter

250 = ¼"	1000 = 1"
375 = ⅜"	1250 = 1¼"
500 = ½"	1500 = 1½"
750 = ¾"	1570 = 40 mm

Wall thickness

047 = 1.19 mm (0.047")
062 = 1.57 mm (0.062")
075 = 1.90 mm (0.075")
086 = 2.18 mm (0.086")

Package

X = 10' straight
(blank) = Roll/Reel
025F = 25ft Coil
100F = 100ft Coil
250F = 250ft Coil
500F = 500ft Coil*

**Only available in sizes <1"*

CONCLUSIONS

Entegris SCT tubing is the cleanest, easiest to flush tubing available. This is the preferred choice for high-end fabs where flush time and purity are critical. It is available stand alone or as the inner material for our dual containment solutions. According to one major chip manufacturer customer:

"Tool quals can take multiple weeks to over a month to reach particle spec. The SCT tube allows flush-up and qual time in a day or two. It's significant and clearly better."

Entegris is uniquely positioned as the only supplier offering a DCT assembly with a PFA outer tube and PFA SCT inner tube. This integrated design improves safety, reduces installation complexity, and minimizes potential leak paths, resulting in a more robust and cost-effective solution for customers.

References

[1] SEMI F104 Test Method for Evaluation of Particle Contribution of Components Used in Ultrapure Water and Liquid Chemical Distribution Systems

[2] CT Associates, Inc. Eden Prairie MN

[3] SEMI F57 Specification for High Purity Polymer Materials and Components Used in Ultrapure Water and Liquid Chemical Distribution Systems

FOR MORE INFORMATION

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