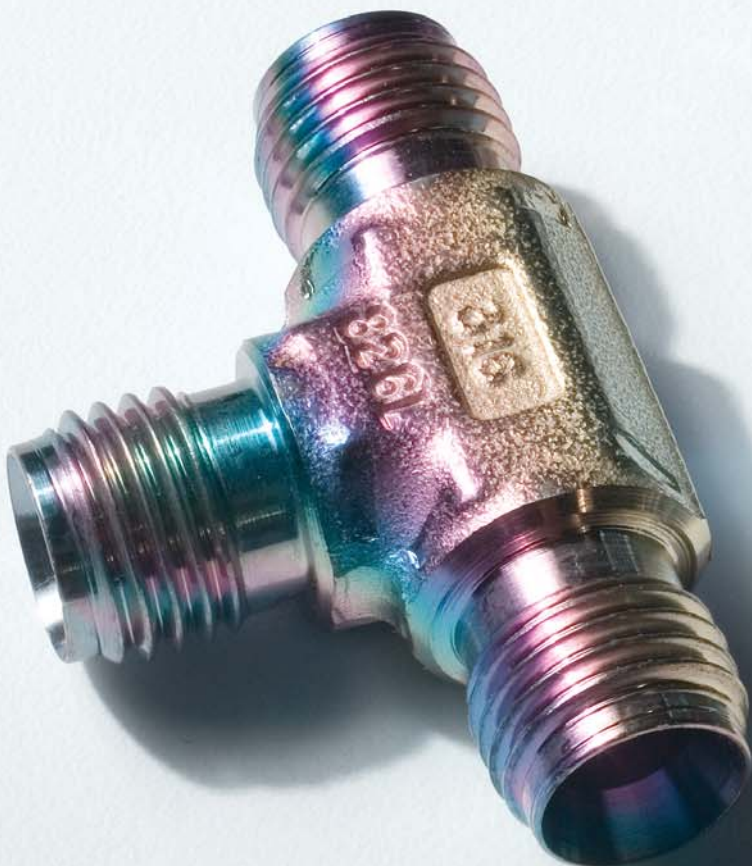


Restek Performance Coatings

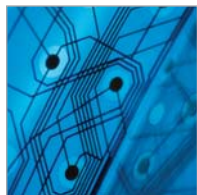




Restek Performance Coatings

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Restek Performance Coatings Overview



Treatments

Restek's Performance Coatings (RPC) Division specializes in innovative surface treatments for steel, stainless steel, alloys, glass, ceramics, and other materials. Restek surface treatments are chemically inert, ultra pure, and corrosion resistant, making them ideal for analytical uses.

The Restek Performance Coatings family of surface treatments includes:

- **Silcosteel®**—A general purpose passivation layer for steel and stainless steel. US Patent 6,511,760.
- **Siltek®**—The ultimate passivation of treated surfaces, from glass to high nickel alloys of steel. US Patent 6,444,326.
- **Silcosteel®-AC**—Dramatically reduces carbon buildup on stainless steel components. US Patent 6,444,326.
- **Silcosteel®-CR**—A corrosion resistant layer that increases the lifetime of system components in acidic environments containing hydrochloric acid, nitric acid, or seawater. US Patent 7,070,833.
- **Silcosteel®-UHV**—Greatly reduces outgassing from components of ultra-high vacuum systems. US Patent 7,070,833.
- **Sulfinert®**—A required treatment for metal components when analyzing for parts-per-billion levels of organo-sulfur compounds. US Patent 6,444,326.

Restek Performance Coatings have provided solutions to:

- **Laboratories** save thousands in needless retests caused by high surface activity through the use of Siltek® treated analytical flow paths.
- **Refiners** save millions yearly by detecting plant upsets sooner with Restek treated sampling systems.
- **Natural gas producers** are able to precisely assess feed stock quality with Sulfinert® sample cylinders.
- **Semiconductor manufacturers** eliminate yield-robbing contamination with Silcosteel®-CR treated process systems.
- **Chemical and petrochemical plants** save down time and maintenance costs by reducing corrosion in process systems treated with Silcosteel®-CR.
- **Research and semiconductor operations** improve throughput by speeding pump-down rates in vacuum processes, using Silcosteel®-UHV treatment.
- **NASA** has improved analytical instrument durability and sensitivity by treating analytical pathways with Silcosteel® coating.
- **Power plants** nationwide are able to cost effectively detect mandated mercury emissions, using Siltek® treated systems.

To learn how Restek Performance Coatings can meet your process or materials challenge, contact our technical service group at 800-356-1688, ext. 4, or contact your Restek representative.

For a free sample, visit www.restekcoatings.com/sample



1985

Paul Silvis opened Restek for business in one room of an elementary-school-turned-business incubator.



1987

Restek invents Silcosteel® coating and successfully applies it to instruments for the analytical industry.



1993

Restek develops an approach for treating both the outside and inside of mass spectrometer components.



1998

Restek is awarded the first of several patents for surface treatments.



1999

Silcosteel®-treated air monitoring system components installed in the space shuttle Discovery.

Treatment Process

Restek Performance Coatings are deposited using a patented process in which the item to be treated is heated under vacuum. When the item has been heated to the appropriate temperature, reacting silicon-like gases that form the protective surface are introduced, depositing a durable layer that grows and overlays itself multiple times. The reaction layer penetrates into the treated piece and binds solidly. It is not a line-of-sight coating; it is integrated with the substrate and is, therefore, extremely durable. Treatments apply uniformly, even at corners, holes, and machined ridges.



Gary Barone
Restek Performance
Coatings Business
Development Manager
18+ years of service!

Treated Products for Chromatography

Restek Performance Coating's surface treatments have found many applications worldwide, from analytical laboratories to refineries to semiconductor operations. Makers of scientific instruments have benefited from Restek treatments since the mid 1990s, allowing detection of compounds at the parts-per-trillion level. The chromatographer will realize these benefits when treating sample pathways, from injector to detector. Available from stock for immediate delivery, some treated chromatographic products include:

- MXT® columns (pages 100-107)
- Inlet liners (see the Instrument Supplies section, beginning on page 130)
- Inlet seals (pages 150-151)
- FID jets (see the Instrument Supplies section, beginning on page 130)
- Tubing and fittings (pages 392-396)
- SilcoCan™ air monitoring canisters (pages 402-403)
- Sample cylinders and valves (pages 385, 419)
- Sample loops (page 385)

free sample

www.restekcoatings.com/sample

RESTEK PERFORMANCE COATINGS



Restek Performance Coatings also offers treatments on a custom basis. Specialized items in your laboratory can benefit by having an inert surface. See page 398 for more information.



2002 RPC becomes a separate division of Restek, expanding into a state-of-the-art treatment facility.



2003 Silcosteel®-AC and Silcosteel®-CR developed.



2004 R&D magazine recognizes Silcosteel®-UHV as one of the 100 most technologically significant products of the year.



2004 Silcosteel®-treated components enter orbit on the Cassini-Huygens Mission to Saturn.



2006 Silcosteel® high-performance automotive coatings awarded 2 "Best New Product" awards at SEMA 2006.

Sulfinert® Treatment*

The most inert passivation surface available, Sulfinert® treatment is ideal for complying with the most stringent sulfur and mercury regulations and achieving the lowest detection limits. The Sulfinert® layer prevents compounds from contacting the reactive stainless steel surface. Sulfinert® parts can be used over a wide pH range. Combine our custom service for parts such as manifolds and valves with our stock Sulfinert® parts to ensure your entire system is inert.

Features

Inert.

Durable and flexible layer, incorporated into the surface.

Stable in acidic or weakly basic (pH 8-9) environments.

Proven thermal stability to 450°C in an inert atmosphere.

Nonpolymeric.

Treated tubing and fittings in stock for immediate delivery.

Benefits

Sample, transfer, and analyze sulfur compounds and other active compounds at parts-per-billion levels.

Items can be worked after treatment—no flaking, chipping, or cracking.

Sample sulfur compounds without compromising compound stability.

Effectively bake-out contaminants.

No memory effects, as seen with Teflon®-coated parts.

Parts are available when you need them.

industries served

Petrochemical (exploration and refining)
Chemical
Mercury monitoring

Sulfur Compound Sampling, Storage, and Transfer Considerations**More accurate results and faster cycle times, using Sulfinert® treated components**

Accurate analyses for parts-per-million to parts-per-billion levels of sulfur-containing compounds in petrochemical streams are critical to meeting new regulations for lower levels of sulfur in diesel fuel and gasoline. Many organo-sulfur compounds—hydrogen sulfide, methyl mercaptan, and ethyl mercaptan among them—react with or adsorb strongly to metal surfaces. Adsorption of sulfur compounds in sampling, storage, and/or transfer apparatus can cause prolonged analysis cycle times as well as inaccurate, falsely low values. Sulfinert® treatment adds value to your process by ensuring accurate analytical results, improved yields, and faster cycle times. Save thousands by improving the surface performance of your analytical and process systems.

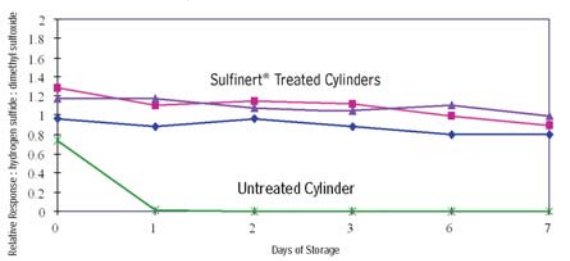
Sulfinert® offers exceptional performance in sample storage systems.

Figure 1 compares a gas containing 17ppbv of hydrogen sulfide stored for 7 days in untreated and Sulfinert® treated stainless steel sample cylinders. The data show the Sulfinert® treated system will reliably

store ppb levels of the active sulfur-containing compound during transport from the sampling site to the analytical laboratory. In contrast, hydrogen sulfide degraded rapidly in the untreated cylinder, and was lost totally within 24 hours.

Visit www.restekcoatings.com to download technical studies and learn more about how Sulfinert® can improve the performance of your analytical system.

Figure 1 Sulfur compounds are stable in Sulfinert® treated stainless steel systems (17ppbv hydrogen sulfide in 500mL cylinders).

**it's a fact**

A Sulfinert® treated system will store and transfer ppb levels of active sulfur-containing compounds without adsorption.

**product guide**

Sulfinert® treated **sample cylinders, valves, and loops** are available from stock for immediate shipment—see page 385.

A wide variety of stock Sulfinert® treated **tubing and fittings** are available—see pages 392–396.

Custom treatment is available for **your existing equipment**—see page 398.

*See Frequently Asked Questions on page 391.

Eliminate adsorptive effects in sample transfer systems with Sulfinert.

A comparison of the transport properties of Sulfinert® treated electropolished stainless steel tubing, untreated electropolished stainless steel tubing, and raw commercial grade stainless steel tubing show only Sulfinert® treated electropolished stainless steel has the inertness necessary for quantitatively transferring sulfur compounds at low ppmv to low ppbv concentrations in sample streams.

Figure 2 demonstrates how Sulfinert® treatment can eliminate costly analytical test errors caused by sulfur adsorption. Sulfinert® treated electropolished tubing did not adsorb methyl mercaptan to any measurable extent, delivering a representative sample with no delay. The untreated electropolished tubing, in contrast, totally adsorbed methyl mercaptan for more than 75 minutes, and the sulfur gas level did not stabilize until approximately 130 minutes. Conventional 316L seamless tubing totally adsorbed methyl mercaptan for more than 90 minutes, and the sulfur gas level did not stabilize until approximately 140 minutes.

Closely correlated to the adsorption of sulfur compounds by system components is the subsequent release of the adsorbed compounds. When adsorption of sulfur-containing compounds is prolonged, desorption from the surface also is slow. This “memory” of adsorbed active compounds can cause long delays in equilibrating a sample stream. Figure 3 demonstrates the memory effects of the three types of tubing. The Sulfinert® treated tubing shows less retention of sulfur compounds by several orders of magnitude, indicating very high inertness.



David Smith
Restek Performance
Coatings Senior Scientist
16+ years of service!

Figure 2 Sulfinert® treated electropolished stainless steel tubing (red) does not adsorb methyl mercaptan (500ppbv).

blue—untreated electropolished tubing,
violet—commercial grade tubing.

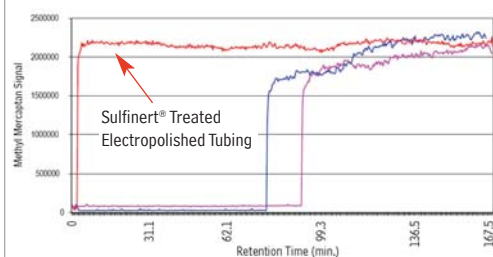
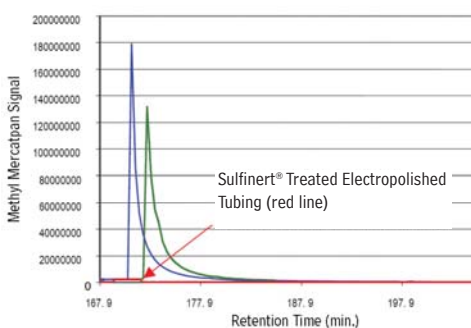


Figure 3 Sulfinert® treatment (red) prevents memory effects compared to untreated electropolished (blue) and raw (green) tubing.



free sample

www.restekcoatings.com/sample

free literature

**Sulfinert®-Treated Sample
Cylinders: Increase Storage
Time for Active Sulfur
Compounds**

Download your free copy from
www.restek.com.

Applications Note
lit. cat.# 59164B

Improve reliability while reducing costs!

Sulfinert® adds value to sampling and transfer systems by improving test accuracy and reducing cycle times. Improved accuracy and reliability of data for sulfur, achieved using Sulfinert® treated transfer and sampling equipment, mean downstream processes can be more precisely controlled, resulting in considerable cost savings. Shorter cycles translate directly into more samples collected and analyzed in a given period of time. Typical savings can be calculated by looking at the average per-hour cost of operating a process that relies on accurate quantification of sulfur compounds.¹ Example monetary values are listed in Table I.

Table I

A 1-hour delay can cost:¹

800,000 tpy ethylene plant	\$50,000
250,000 tpy LDPE unit	\$36,000
250,000 tpy EBSM styrene plant	\$33,000
200,000 tpy anti-freeze process	\$3,600

tpy = tons per year

In Summary

We obtained accurate data, with no delay between samples, by using Sulfinert® treated electropolished tubing in the sampling-storage-transport system. In contrast, we obtained significantly less accurate data, even with delays of more than two hours between samples, by using untreated tubing. Analysts charged with monitoring sulfur levels in process streams can significantly improve profitability by using Sulfinert® treated system components and Sulfinert® treated electropolished tubing transport lines.

Reference

¹Application of TrueTube™ in Analytical Measurement Cardinal UHP (St. Louis, MO) August 2004. Available at www.restekcoatings.com, by contacting us at 800-356-1688, ext. 4, or by contacting your Restek representative. Request lit. cat.# 59088.

thank you

Shell Research and
Technology Centre,
Amsterdam, for data used in
evaluating sulfur gas uptake
and memory effects of tubing
substrates.



Prevent Adsorption of Mercury, Sulfur, and Nitrogen Compounds In Stack and Monitoring Equipment

As concerns grow over mercury in the environment, new regulations have been developed to measure, and eventually reduce, mercury emissions from coal-fired electric utilities. For example, the US EPA will require all electric utilities to measure mercury emissions starting on January 1, 2009. The most popular methods of sampling will be based on continuous mercury monitoring systems (CMMS) and sorbent tube samplers. To ensure quantitative storage and transfer, and accurate analysis, of the low levels of mercury in streams sampled from flue stacks, these sampling systems must be inert.

Siltek® surface treatment has been used in a wide variety of applications in which an inert surface is of paramount importance. To measure the impact of Siltek® treatment on adsorption of mercury during storage, we compared the performances of 304 grade stainless steel gas sampling cylinders (Swagelok®, Solon OH) with and without Siltek® treatment.

We filled each cylinder with $8\mu\text{g}/\text{m}^3$ of elemental mercury (approximately 1 part per billion) (Spectra Gases, Alpha NJ) and assessed the mercury concentration in each cylinder over time to determine changes in mercury concentration. Detection was achieved by direct interface gas sampling to an atomic adsorption detector. Sample pathway regulator and tubing were Siltek® treated to ensure accurate transfer.

The data in Figure 1 demonstrate that Siltek® treatment provides a stable surface for elemental mercury, and untreated stainless steel does not. Based on these results, we conclude that Siltek® surface treatment for steel or stainless steel components and tubing in CMMS and sorbent tube mercury sampling systems will improve analytical reliability. For more information about Siltek® surface treatment, visit us at: www.restekcoatings.com

industries served

Stack gas monitoring

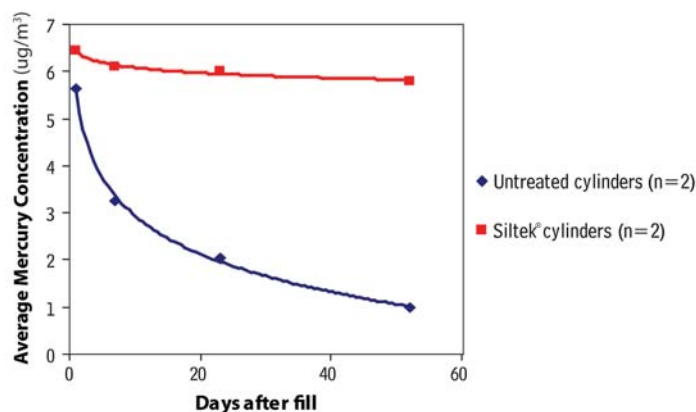
free sample

www.restekcoatings.com/sample

thank you

Ted Neeme and Steve Mandel from Spectra Gases for their contributions to this work.

Figure 1 Siltek® treated gas sampling cylinders show very good inertness toward mercury.



it's a fact

Improve analytical reliability and prevent corrosion, using Siltek®/Sulfinert® treated components. See Frequently Asked Questions on [page 391](#).

product guide



Sulfinert® treated **sample cylinders and valves**—see page 385.

Coiled electropolished Siltek® tubing (page 394); Coiled 316L Siltek® tubing (page 395); or 6-foot length seamless, straight 316L Siltek® tubing (page 396).

Siltek® fittings (pages 392–393.)

Custom treatment is available for **your existing equipment**—see page 398.

Sulfinert® Treated Swagelok® Sample Cylinders

- Stable storage of samples containing ppb levels of sulfur compounds.
- Manufactured by Swagelok®; D.O.T. rated to 1,800psi (12,411kPa) at room temperature.
- 304 grade stainless steel with 1/4" female NPT threads on both ends.

Description	Size	qty.	cat.#
Sulfinert® Sample Cylinder	75cc	ea.	24130
Sulfinert® Sample Cylinder	150cc	ea.	24131
Sulfinert® Sample Cylinder	300cc	ea.	24132
Sulfinert® Sample Cylinder	500cc	ea.	24133
Sulfinert® Sample Cylinder	1000cc	ea.	24134
Sulfinert® Sample Cylinder	2250cc	ea.	21394



Sulfinert® Treated Alta-Robbins Sample Cylinder Valves

- All wetted parts are Sulfinert® treated for inertness.
- Compatible with Sulfinert® treated Swagelok® sample cylinders.
- Large, durable, Kel-F® seat ensures leak-free operation; temperature range: -40°C to 120°C.

Description	qty.	cat.#
1/4" NPT Exit	ea.	21400
1/4" Compression Exit	ea.	21401
1/4" NPT with Dip Tube*	ea.	21402
1/4" NPT with 2850psi Rupture Disc	ea.	21403
1/4" NPT Male Inlet x 1/4" Female Outlet with 2850psi Rupture Disc	ea.	21404

*To order catalog #21402 (Sulfinert Alta-Robbins Sample Cylinder Valve, 1/4" NPT with Dip Tube), please call Customer Service at 800-356-1688, ext. 3, or contact your Restek representative. Specify dip tube length or % outage when ordering (maximum length = 5.25" / 13.3cm). Note: End of part will not be treated after cutting tube to length.



Sulfinert® Treated Rupture Disc Tee

2850psig (19,650kPa) rating; 1/4" NPT connections.

Description	qty.	cat.#
Sulfinert® Treated Rupture Disc Tee (1/4" NPT connections)	ea.	21396
Replacement Rupture Disc (not Sulfinert® treated)	ea.	24298



Sulfinert® Treated Gas Sampling Valves and Sample Loops

- Ideal for samples containing low concentrations of sulfur or other active compounds.
- Sample loop sizes from 5µL to 5cc.

Sulfinert® Treated Gas Sampling Valves (1/16" fittings, 0.40mm port diameter; "W Type" valve)

Description	qty.	cat.#
Sulfinert® Gas Sampling Valve; 4-Port	ea.	20584
Sulfinert® Gas Sampling Valve; 6-Port	ea.	20585
Sulfinert® Gas Sampling Valve; 10-Port	ea.	20586



Replacement Rotors (Not Coated)

Description	qty.	cat.#
Replacement Rotor for 4-Port Sulfinert® Gas Sampling Valve	ea.	20587
Replacement Rotor for 6-Port Sulfinert® Gas Sampling Valve	ea.	20588
Replacement Rotor for 10-Port Sulfinert® Gas Sampling Valve	ea.	20589

Sulfinert® Treated Gas Sample Loops (1/16" fittings, for "W Type" valves)

Description	Size	qty.	cat.#
Sulfinert® Sample Loops	5µL	ea.	22840
Sulfinert® Sample Loops	10µL	ea.	22841
Sulfinert® Sample Loops	20µL	ea.	22842
Sulfinert® Sample Loops	25µL	ea.	22843
Sulfinert® Sample Loops	50µL	ea.	22844
Sulfinert® Sample Loops	100µL	ea.	22845
Sulfinert® Sample Loops	250µL	ea.	22846
Sulfinert® Sample Loops	500µL	ea.	22847
Sulfinert® Sample Loops	1mL	ea.	22848
Sulfinert® Sample Loops	2mL	ea.	22849
Sulfinert® Sample Loops	5mL	ea.	22850





Silcosteel®-CR Treatment

Silcosteel®-CR surface treatment protects equipment exposed to hydrochloric acid, nitric acid, or marine environments, upgrading the corrosion resistance of 300-grade stainless steels by an order of magnitude. Silcosteel®-CR treatment provides a significant cost savings, relative to high performance alloys, and offers major advantages over traditional overlay coatings. Traditional coatings rely primarily on primers or surface tension to remain in contact; delamination and blistering are common problems. In contrast, the Silcosteel®-CR layer is incorporated into the stainless steel lattice. The dense, chemically inert surface is both durable and flexible—treated components can be worked into place without chipping, cracking, or otherwise damaging the coating. Silcosteel®-CR treated tubing and many fittings are available from stock on pages 392-396. Contact us for custom coating service.

Features

Improves corrosion resistance of 300 grade stainless steels by an order of magnitude.

Durable and flexible layer, incorporated into the surface.

Use to temperature of 600°C.

Benefits

Significantly decreased maintenance cycles and costs for components in corrosive environments.

Items can be worked after treatment—no flaking, chipping, or cracking.

Use under conditions in which conventional coatings fail, reducing the need for high-cost super alloys.

An effective, durable solution to corrosion—achieve specialty alloy performance using austenitic stainless steels!

In acidic environments it is critical to engineer solutions to account for the depreciation of equipment caused by corrosion. Current commercial solutions that address corrosion are specialized alloys (e.g., Inconel®, Monel®, Hastelloy®) or coatings. A Silcosteel®-CR layer upgrades the corrosion resistance of 300-grade stainless steels by greater than an order of magnitude and are more cost-effective than specialty alloys.

Like all other Restek surface treatments, a Silcosteel®-CR layer is both durable and flexible. The coating builds from many starting points on the steel surface. Repeated overlaying as the coating grows on the surface creates a dense, chemically inert layer. The layering process also creates flexibility—treated components can be worked into place without cracking, chipping, or otherwise damaging the coating.

Pitting and Crevice Corrosion Testing of Silcosteel®-CR Treated 316L Stainless Steel and Bare Steel, by ASTM G 48, Method B

Each sample was weighed to the nearest 0.0001 gram, then a rubber gasket was wrapped around the center to simulate a crevice. Each sample was immersed in 6% by weight ferric chloride solution for 72 hours, per the ASTM test method. After 72 hours, the sample was recovered and reweighed to the nearest 0.0001 gram, to determine weight loss.

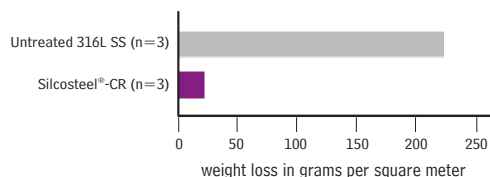
Table I shows Silcosteel®-CR treated 316L stainless steel exhibited an order of magnitude less corrosion, compared to bare stainless steel. Silcosteel®-CR treated stainless steel exhibited no crevice corrosion, while untreated stainless steel exhibited severe crevice corrosion (Figure 1).

Figure 1 Silcosteel®-CR treated 316L stainless steel shows no crevice corrosion and only slight pitting corrosion, while bare 316L stainless steel exhibits severe crevice corrosion.



Table I Silcosteel®-CR treated samples show very little weight loss after exposure to 6% w/w ferric chloride solution.

Sample	Weight Loss (g/m ²)
Silcosteel®-CR sample 1	19
Silcosteel®-CR sample 2	25
Silcosteel®-CR sample 3	25
Bare Steel sample 1	231
Bare Steel sample 2	209
Bare Steel sample 3	228



industries
served

Marine
Oil and gas exploration
Process plants

it's a fact

A Silcosteel®-CR layer upgrades the corrosion resistance of 300-grade stainless steels by greater than an order of magnitude.

Cyclic Polarization Electrochemical Corrosion Testing of Silcosteel®-CR Treated 316L Stainless Steel and Bare 316L and Bare 304 Stainless Steel, by ASTM G 61

Samples were tested in accordance with ASTM G 61 in acidic and neutral aqueous solutions, at 23°C, at three chloride ion (Cl⁻) levels. Tables II and III summarize the test results: Silcosteel®-CR treated 316L stainless steel outperformed bare 316L stainless steel by a factor of approximately 30-50 in neutral chloride solutions, and by approximately 10-15 in acidic chloride solutions. At a chloride concentration of 3000ppm, Silcosteel®-CR treated 316L stainless steel outperformed 304 stainless steel by a factor of approximately 45 in neutral solutions and by approximately 17 in acidic solutions.

Table II Corrosion rate in mpy (mil per year) determined by electrochemical testing.

	Silcosteel®-CR	Bare Steel	Improvement
Neutral Solution			
100ppm chloride	0.0006	0.03	49x
3000ppm chloride	0.0009	0.03	32x
5000ppm chloride	0.001	0.03	29x
Acidic Solution (1N H₂SO₄)			
100ppm chloride	0.05	0.45	8x
3000ppm chloride	0.05	0.83	17x
5000ppm chloride	0.07	0.84	11x

Table III Comparison of Silcosteel®-CR treated 316L stainless steel versus bare 304 stainless steel at 3000ppm chloride.

	Silcosteel®-CR	Bare Steel	Improvement
Neutral Solution			
Corrosion Rate, mpy	0.0009	0.04	45x
Breakdown Potential, E _b	1460	370	
Acidic Solution (1N H₂SO₄)			
Corrosion Rate, mpy	0.05	0.83	17x
Breakdown Potential, E _b	927	370	



Marty Higgins
Restek Performance
Coatings Engineer
10+ years of service!

4000 Hour Salt Spray Testing (ASTM B 117) of Silcosteel®-CR Treated 316L Stainless Steel and Bare Steel

4000-hour salt spray testing shows Silcosteel®-CR treated stainless steel coupons exhibit no surface corrosion, while untreated coupons show surface corrosion and accelerated corrosion at the hole in the coupon (Figure 2). Neither coupon developed pitting over the test period.¹

Improve reliability while reducing costs by up to 65%!

316L gas delivery systems exposed to corrosive environments typically are replaced within 5 years of installation. Substituting a high performance alloy for 316L stainless steel can increase the cost of the system by as much as 5-fold.²

By improving the corrosion resistance of 316L stainless steel by up to 10-fold, Silcosteel®-CR treatment reduces costly maintenance and field failures due to system corrosion. Figure 3 compares the cost of Silcosteel®-CR treatment versus Hastelloy® C22™ construction in a typical gas delivery system. Silcosteel®-CR treatment demonstrates significant life-cycle cost savings, compared to unprotected stainless steel or stainless steel alloys.

Figure 2 Silcosteel®-CR treated 316L stainless steel shows no sign of attack after 4000-hour salt spray exposure, per ASTM B117.

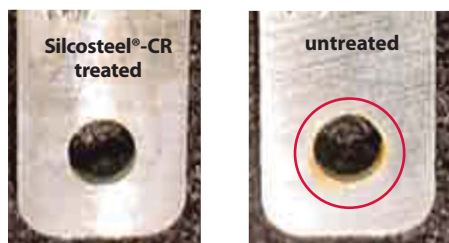
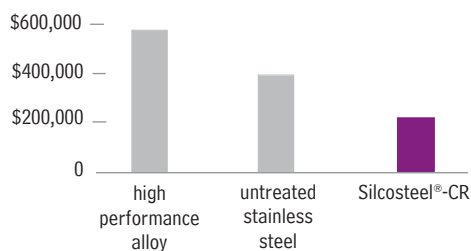


Figure 3 Silcosteel®-CR significantly lowers the life cycle cost of stainless steel or alloys (US dollars).



References

- ¹ M. Zamanzadeh; G. Bayer; G. Rhodes; D. Smith; M. Higgins; *Laboratory Corrosion Testing of a Chemical Vapor Deposited Amorphous Silicon Coating*; Matco Associates, Inc. Pittsburgh, PA; Restek Corporation, Bellefonte, PA. 2005 Reference available on request.
- ² Vininski, Joseph; Lawrence, David; Torres, Robert; Diede, Ehrich; Daniels, Mia; "Corrosion Resistance of Cost Effective Alternative Materials for Semiconductor Gas Distribution Systems"; Matheson Tri-Gas, Longmont, CO; Diede Precision Welding, Longmont, CO; Sherwood, Harsco Corporation, Washington, PA. 2002

product guide



Silcosteel®-CR tubing (pages 394–396).

Silcosteel®-CR fittings (pages 392–393.)

Custom treatment is available for **your existing equipment**—see page 398.

industries served

Aerospace
Automotive
Aviation
Chemical process
Oil and gas refining
Oil exploration
Petrochemical

did you know?

Among our surface treatments, Silcosteel®-AC treated stainless steel components exhibit the greatest reduction in coking (JP-5 fuel).

Surface Treatment	Carbon Buildup ($\mu\text{g}/\text{cm}^2$)
Silcosteel®	15.4
Sulfinert®	11.9
Silcosteel®-AC	7.4

Silcosteel®-AC

Reduce coking up to 8-fold

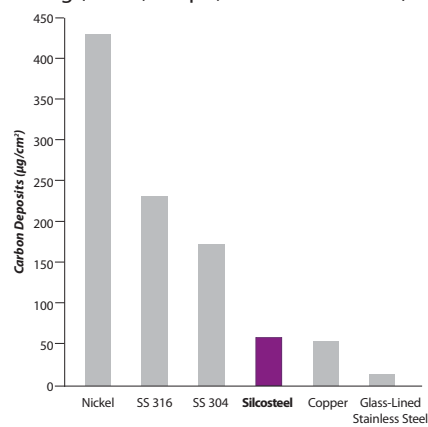
A major problem in hydrocarbon processing systems is coking—the buildup of carbon on the surface of steel or stainless steel components. Coking often is initiated by catalytic action of nickel or carbon impurities or additives in the steel used to construct the processing system components.

A Silcosteel® treated system exhibits a 3- to 5-fold reduction in coke formation, compared to untreated stainless steel (Figure 1), but a modified Silcosteel® treatment, Silcosteel®-AC, can provide an 8-fold reduction. The Silcosteel®-AC or Silcosteel® layer forms a barrier between the hot hydrocarbon stream and the coking-susceptible steel substrate, and eliminates catalytic breakdown in the hydrocarbon stream. With the elimination of surface catalytic activity, carbon will not chemically adhere to the surface. Current work indicates that the only mechanism of carbon formation in a Restek-treated system is the result of coking within the fluid phase. This material settles on the surface without adhering, and is easily removed by agitating the surface. Now, instead of “burning” out coke with oxygen at high temperatures, deposited carbon can simply be rinsed away.

Applications for Silcosteel®-AC coking control treatment include fuel injection nozzles, jet engine nozzles, engine valves, and engine cylinders.

We continue to investigate other coatings specifically designed to reduce coking. For more information, contact the Restek coatings experts.

Figure 1 Silcosteel® treated tubing exhibits a reduction in carbon deposits in tests using JP-8 fuel on various types of tubing (500°C, 500psi, 1cc/min. flow rate).



free sample

www.restekcoatings.com/sample



Silcosteel®

Driving Innovation

Automotive enthusiasts choose Silcosteel® as a unique, durable alternative to chrome plating, anodizing, and powder coating. It's rugged—stable to 1800°F—and, because each piece is treated individually, truly one-of-a-kind! For more information, visit www.restekcoatings.com/moto



Winner of 2
Best New Product
awards at SEMA 2006

product guide



Silcosteel®-AC is offered on a custom basis, applied to your existing equipment—see page 398.

- Manifolds
- Pistons
- Valves
- Injectors
- Reactors
- Process equipment

Silcosteel®-UHV

Achieve faster pump-down times by greatly reducing outgassing

Ultra-high vacuum (UHV) environments are characterized as requiring a vacuum of 10^{-9} torr or lower. At 10^{-5} torr or lower, steel components outgas large quantities of moisture. Massive pumping systems are needed to remove molecules as they are released.

We developed Silcosteel®-UHV treatment to significantly reduce outgassing by steel components in UHV systems. A Silcosteel®-UHV layer over the steel surface keeps moisture isolated from the UHV environment, and does not liberate any atmosphere of its own. The data in Figure 1 demonstrate the superior evacuation profile sustained by using Silcosteel®-UHV treated components vs. non treated components in a UHV assembly. Clearly, Silcosteel®-UHV treatment makes it possible to maintain a UHV environment with much less pumping capacity. Further, when not under vacuum, the Silcosteel®-UHV surface is far less likely to accrue a coating of water and other airborne molecules than a nontreated surface. This greatly reduces the time required to re-attain a UHV environment. The durable Silcosteel®-UHV layer will withstand the sealing requirements of UHV, maintaining knife edge integrity.

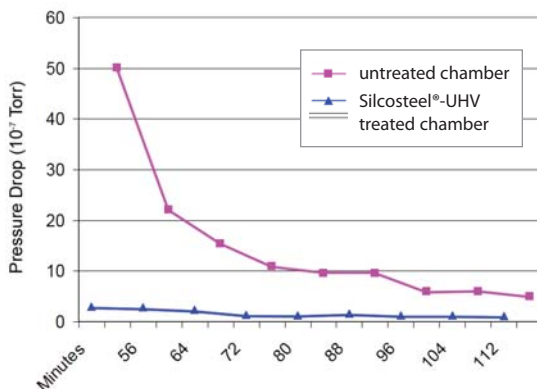
Silcosteel®-UHV treatment is available as a custom service—contact the Restek coatings experts.

industries served

Analytical instrumentation
Research
Semiconductor
Vacuum coating

Figure 1 Silcosteel®-UHV treated ultra-high vacuum system components show significantly reduced evacuation times—within 80-84 minutes of initial evacuation, the coated chamber exhibits a 9.1-fold improvement in chamber base pressure.

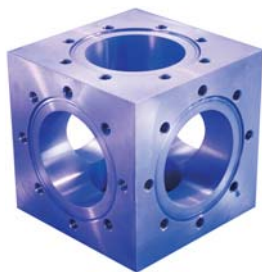
Experimental setup: A common turbomolecular pump attached to two dimensionally identical chambers isolated by all-metal valves. One chamber is Silcosteel®-UHV treated (blue), the other is untreated (violet). Using valve switching, chamber vacuums are alternately measured during evacuation. The outgassing contribution of untreated valves and components are measured and mathematically subtracted to obtain corrected base pressures for each chamber.



R&D 100 Award

Silcosteel®-UHV was recognized by a panel of independent judges and editors of *R&D Magazine* as one of the 100 most technologically significant products introduced in 2003.

product guide



Silcosteel®-UHV is offered on a custom basis and is applied to your existing equipment—see page 398.

- UHV chambers
- Tubing and piping
- Conflat flanges
- Fittings
- Valves
- Pumps

Siltek®—Moisture Uptake (Wet-Up) and Release (Dry-Down)

Improve Moisture Wet-Up and Dry-Down Rates

Efficient low level moisture detection, even through long sample paths, is now possible using Siltek® treatment. In analytical, oil refining, and semiconductor manufacturing, even ppm levels of moisture can damage instruments, yield inaccurate analytical results, damage catalysts, increase periodic maintenance or reduce process yields. Detecting and managing low-level moisture has become a vital element in cost effective processes. Data for wet-up and dry-down experiments, measuring the relative response time for moisture content change in Siltek® treated electropolished stainless steel tubing, untreated electropolished stainless steel tubing, and standard 316L stainless steel tubing, demonstrate a significant advantage to Siltek® treated versus untreated substrates.¹

In wet-up testing, Siltek® treated electropolished tubing reached the 98% saturation limit in 30 minutes, compared to 60 minutes for electropolished tubing. Standard tubing could only achieve a 96% uptake, after 180 minutes (Figure 1). This demonstrates the exceptional hydrophobicity of the Siltek® treatment.

After the tubing was stabilized with 1ppm of moisture, moisture dry-down curves show Siltek® treated electropolished tubing achieved dry-down in 35 minutes, electropolished tubing required 65 minutes, and standard tubing required 175 minutes. This demonstrates Siltek® treatment's ability to reduce instrument equilibrium time, thus improving process feedback accuracy and process yields.

In the transfer of ultra-high purity gas streams, Restek treated tubing and system components dramatically improve dry-down. Further, they reduce contamination from moisture carryover, and extend periodic maintenance cycles.

industries served

Analytical instrumentation
Oil refining
Research
Semiconductor

thank you

Tubing used in the wet-up/dry-down experiments was supplied by Cardinal UHP (St. Louis, MO).

Reference

¹ Harris, P. *Relative Response Time of TrueTube™ When Measuring Moisture Content in a Sample Stream* test report, O'Brien Corp. (St. Louis, MO) 2004
Reference available on request.

Figure 1 Restek treated electropolished tubing (blue line) stabilizes at 1ppm moisture much faster than conventional surfaces.¹

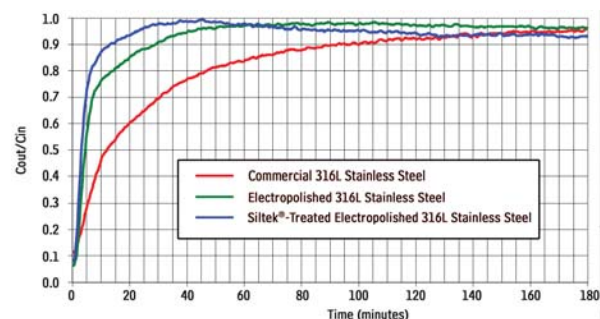
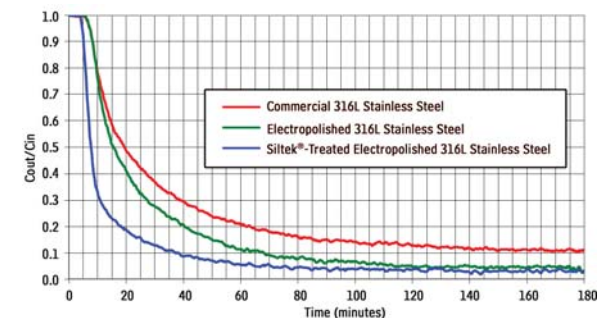


Figure 2 Restek treated electropolished tubing (blue line) dries much faster than conventional surfaces.¹



To learn more about how Siltek® improves moisture performance and to download the entire moisture study, go to our website, www.restekcoatings.com.

product guide



Siltek®/Sulfinert® tubing (pages 394–396) and **Siltek®/Sulfinert® fittings** (pages 392–393) are in stock and available for immediate shipment.

Custom treatment is available for **your existing equipment**—see page 398.

- Reactors
- UHV chambers
- Pumps
- Gas manifolds

1. Can treated tubing be bent?

Treated tubing can be bent into curves with a bend radius greater than 1 inch for 1/16-inch OD tubing, 2 inches for 1/8-inch OD tubing, or 4 inches for 1/4-inch OD tubing. The treatment layer will remain intact as long as the tubing isn't stretched dramatically. If tight bends are necessary, use a treated elbow union or bend untreated tubing and send it to Restek for custom treatment.

2. Can compression fittings be used without crushing the treatment layer?

Yes. The layer is thin and permeates the surface. It compresses with minimal damage.

3. Why are the Restek treatments varied colors?

The colors are caused by light passing through the thin layer. As the film thickness changes, so does the color. Coating depths and colors are: blue: 300-450 angstroms (Silcosteel®); rainbow: 1200 angstroms (Silcosteel®, Siltek®, Sulfinert®); silver/gray: up to 20µm (Silcosteel®-AC, Silcosteel®-CR, Silcosteel®-UHV).

4. Is welding possible after Restek treatment?

Yes. The coating does not interfere with the welding of two coated components. The coating is lost at the weld and in the heat affected zones approximately 2 to 5mm on either side of the weld.

5. Is any additional chemical deactivation necessary?

A Sulfinert® or Silcosteel® layer leaves few exposed active sites, so there usually is no need for additional treatment. Chemical deactivation is useful in chromatographic applications in which water will be vaporized on the Silcosteel® treated surface, but is not necessary for Sulfinert® treated surfaces. Parts used in high-temperature applications (>400°C) cannot be chemically deactivated.

6. What are the temperature constraints of Restek surface treatments?

On stainless steel, a Silcosteel® layer is stable to 600°C. Parts treated with a secondary polymeric layer are limited to temperatures of 400°C in inert atmospheres and 250°C when oxygen is present, the temperature maximums for the polymer. Temperatures above 600°C can be used under certain conditions—please contact us for information.

7. How is treated tubing cut?

Cut treated tubing with a conventional tubing cutter or with Restek's cutting pliers (cat. #20193). The thin layer cleaves, leaving a clean break.

8. What dimensions of treated tubing are available?

Treated tubing is available in a wide range of ID and OD dimensions. For stock treated tubing, see pages 394-396 of this catalog.

9. Why use Sulfinert® or Silcosteel® treatment instead of Teflon® coating?

Three reasons: 1) Sulfinert® and Silcosteel® layers are nonpolymeric, so they do not exhibit the problems associated with gas permeability. 2) Teflon® coating often flakes off the surface, while the Sulfinert® or Silcosteel® layer is tightly integrated into the substrate lattice. 3) Teflon® coating is limited to 280°C, while Silcosteel® treated stainless steel tubing and fittings can be used to 600°C.

10. Why use Siltek®/Sulfinert® treated tubing for transfer lines?

Siltek®/Sulfinert® treated stainless steel tubing offers all of the advantages of glass or fused silica tubing for the transfer of active compounds (e.g., sulfurs), but is far more durable and flexible.

11. Is treated tubing similar to glass-lined tubing (GLT™)?

No. Sulfinert® or Silcosteel® treated tubing is flexible and can be bent without heating. Also, the Sulfinert® or Silcosteel® layer is highly inert, unlike impure glass.

12. How can I clean the surface of a treated part after use?

Most often, a mild organic solvent (methylene chloride, methanol, hexane) or water is sufficient. Mild sonication may assist and accelerate the process. Do not use caustic, abrasive, or high pH (pH>8) cleaners, as they will damage or dissolve the layer. Steam cleaning in the presence of oxygen or air could create surface activity, and also should be avoided.

13. What materials should I avoid using with Silcosteel® treated parts?

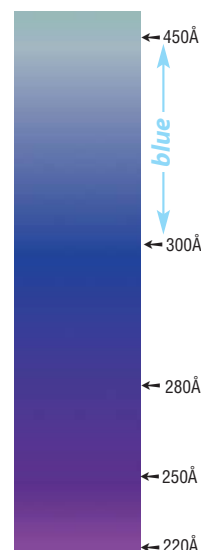
The Silcosteel® coating is silicon-based and is prone to attack by hydrofluoric acid or by basic compounds. The surface should not be exposed to media with pH>8.

14. Siltek® and Sulfinert®: What's the Difference?

Siltek® is the name for our patented deposition process. When we developed the Siltek® process, the application that showed the greatest benefit, among many we investigated, was the storage and transfer of low ppb level active sulfur compounds, such as hydrogen sulfide and mercaptans. Because there was (and continues to be) demand for a reliable surface treatment for this application, we use the name Sulfinert® to describe Siltek® treated products created specifically for this purpose.

What are the colors associated with the treatments?

Colors are created by the treatment's light refraction properties. The visible color depends on the treatment layer's thickness. Layer thickness ranges from 0.03µm to 30µm, controlled by variables in the process to our specifications. There is a degree of variability to the process, and each piece is treated individually. Therefore, every piece is unique!



Rainbow
minimum 1200Å
(0.12µm)



Gray
minimum 5µm

Treated Swagelok® and Valco® Fittings

Siltek®/Sulfinert® Treated and Silcosteel®-CR Treated Swagelok® Fittings

- Broad line of treated 1/16", 1/8", 1/4", and 3/8" fittings.
- Siltek®/Sulfinert® treatment ensures ultimate inertness; Silcosteel®-CR treatment enhances corrosion resistance by 10x, or more.
- Custom treatment available for any Swagelok® fitting, or other system part.

Fitting Type	Size	Swagelok® #	Siltek®/Sulfinert® Treated*		Silcosteel®-CR Treated	
			qty.	cat.#	qty.	cat.#
Union 	1/16"	SS-100-6	ea.	22540	ea.	22575
	1/8"	SS-200-6	ea.	22541	ea.	22576
	1/4"	SS-400-6	ea.	22542	ea.	22577
	3/8"	SS-600-6	ea.	22909	ea.	22904
Tee 	1/16"	SS-100-3	ea.	22543	ea.	22578
	1/8"	SS-200-3	ea.	22544	ea.	22579
	1/4"	SS-400-3	ea.	22545	ea.	22580
	3/8"	SS-600-3	ea.	22910	ea.	22905
Reducing Union 	1/8" to 1/16"	SS-200-6-1	ea.	22546	ea.	22581
	1/4" to 1/16"	SS-400-6-1	ea.	22547	ea.	22582
	1/4" to 1/8"	SS-400-6-2	ea.	22548	ea.	22583
	3/8" to 1/4"	SS-600-6-4	ea.	22911	ea.	22906
Elbow 	1/8"	SS-200-9	ea.	22549	ea.	22584
	1/4"	SS-400-9	ea.	22550	ea.	22585
Plug 	1/16"	SS-100-P	ea.	22572	ea.	22619
	1/8"	SS-200-P	ea.	22573	ea.	22620
	1/4"	SS-400-P	ea.	22574	ea.	22597
Cross 	1/8"	SS-200-4	ea.	22551	ea.	22586
	1/4"	SS-400-4	ea.	22552	ea.	22587
Tube End Reducer 	1/8" tube to 1/16"	SS-100-R-2	ea.	22553	ea.	22588
	1/4" tube to 1/16"	SS-100-R-4	ea.	22554	ea.	22589
	1/8" tube to 1/4"	SS-400-R-2	ea.	22555	ea.	22590
	1/4" tube to 1/8"	SS-200-R-4	ea.	22556	ea.	22591
Port Connector 	1/8"	SS-201-PC	ea.	22557	ea.	22592
	1/4"	SS-401-PC	ea.	22558	ea.	22593
	1/8" tube to 1/4"	SS-401-PC-2	ea.	22559	ea.	22594
Male Connector 	1/8" to 1/8" NPT	SS-200-1-2	ea.	22561	ea.	22595
	1/4" to 1/4" NPT	SS-400-1-4	ea.	22562	ea.	22596
	1/16" to 1/8" NPT	SS-100-1-2	ea.	22563	ea.	22610
	1/8" to 1/4" NPT	SS-200-1-4	ea.	22564	ea.	22611
	1/4" to 1/8" NPT	SS-400-1-2	ea.	22565	ea.	22612
	3/8" to 3/8" NPT	SS-600-1-6	ea.	22912	ea.	22907
	3/8" to 1/4" NPT	SS-600-1-4	ea.	22913	ea.	22908
Female Connector 	1/8" to 1/8" NPT	SS-200-7-2	ea.	22566	ea.	22613
	1/4" to 1/4" NPT	SS-400-7-4	ea.	22567	ea.	22614
	1/4" to 1/8" NPT	SS-400-7-2	ea.	22568	ea.	22615
	1/8" to 1/4" NPT	SS-200-7-4	ea.	22569	ea.	22616
Bulkhead Union 	1/8"	SS-200-61	ea.	22570	ea.	22617
	1/4"	SS-400-61	ea.	22571	ea.	22618

Siltek®/Sulfinert® Treated Valco® Fittings

Fitting Type	Size	Siltek®/Sulfinert® Treated*	
		qty.	cat.#
Valco® Zero Dead Volume Tee 	1/16"	ea.	22534
	1/8"	ea.	22535
Valco® Zero Dead Volume Union 	1/16"	ea.	22532
	1/8"	ea.	22533

*See Frequently Asked Questions on page 391.

Siltek®/Sulfinert® Treated and Silcosteel®-CR Treated Parker Fittings

A broad line of 1/16", 1/8" and 1/4" fittings is available with Siltek®/Sulfinert® or Silcosteel®-CR treatment. Because of expanding applications for these coatings, we have received many requests for a broader product offering. If you do not see everything you need, contact us for information on custom coating services.

Fitting Type	Size	Parker #	Siltek®/Sulfinert® Treated*		Silcosteel®-CR Treated	
			qty.	cat.#	qty.	cat.#
 Union	1/16"	1 SC 1	ea.	22520	ea.	22863
	1/8"	2 SC 2	ea.	22521	ea.	22864
	1/4"	4 SC 4	ea.	22522	ea.	22865
 Tee	1/16"	1 ET 1	ea.	22526	ea.	22866
	1/8"	2 ET 2	ea.	22527	ea.	22867
	1/4"	4 ET 4	ea.	22528	ea.	22868
 Reducing Union	1/8" to 1/16"	2 RU 1	ea.	22523	ea.	22869
	1/4" to 1/16"	4 RU 1	ea.	22524	ea.	22870
	1/4" to 1/8"	4 RU 2	ea.	22525	ea.	22871
 Elbow	1/16"	1 EE 1	—	—	ea.	22874
	1/8"	1 EE 2	ea.	22530	ea.	22875
	1/4"	1 EE 4	ea.	22531	ea.	22876
 Plug	1/16"	1 BLP 1	ea.	21539	ea.	22877
	1/8"	2 BLP 2	ea.	21540	ea.	22878
	1/4"	4 BLP 4	ea.	21541	ea.	22879
 Cross	1/8"	2 ECR 2	ea.	21542	ea.	22872
	1/4"	4 ECR 4	ea.	21543	ea.	22873
 Tube End Reducer	1/8" tube to 1/16"	2 TUR 1	ea.	21544	ea.	22880
	1/4" tube to 1/16"	4 TUR 1	ea.	21545	ea.	22881
	1/8" tube to 1/4"	2 TUR 4	ea.	21546	ea.	22882
	1/4" tube to 1/8"	4 TUR 2	ea.	21547	ea.	22883
 Port Connector	1/8"	2 PC 2	ea.	21548	ea.	22884
	1/4"	4 PC 4	ea.	21549	ea.	22885
	1/8" tube to 1/4"	2 PC 4	ea.	21550	ea.	22886
 Male Connector	1/8" to 1/8" NPT	2 MSC 2N	ea.	21551	ea.	22887
	1/4" to 1/4" NPT	4 MSC 4N	ea.	21552	ea.	22888
	1/16" to 1/8" NPT	1 MSC 2N	ea.	21553	ea.	22889
	1/8" to 1/4" NPT	2 MSC 4N	ea.	21554	ea.	22890
	1/4" to 1/8" NPT	4 MSC 2N	ea.	21555	ea.	22891
 Female Connector	1/8" to 1/8" NPT	2 FSC 2N	ea.	21556	ea.	22892
	1/4" to 1/4" NPT	4 FSC 4N	ea.	21557	ea.	22893
	1/4" to 1/8" NPT	4 FSC 2N	ea.	21558	ea.	22894
	1/8" to 1/4" NPT	2 FSC 4N	ea.	21559	ea.	22895
 Plug Valve, 2-Way	1/8"	2A PR4 VT SS	ea.	21586	—	—
	1/4"	4A PR4 VT SS	ea.	21587	—	—
 Ball Valve, 2-Way	1/8"	2A B2LJ2 SSP	ea.	21588	—	—
	1/4"	4A B2LJ2 SSP	ea.	21589	—	—

also available

For nontreated brass and stainless steel fittings, see pages 252-253.

RESTEK PERFORMANCE COATINGS

new!

For the newest developments, visit our Performance Coatings Division website: www.restekcoatings.com

*See Frequently Asked Questions on page 391.

Please note: Nuts and ferrules are not treated unless requested (custom parts). Nuts and ferrules normally are not in contact with samples, and thus do not require coating.



did you know?

A smoother internal surface is less adsorptive.



Top: electropolished finish, surface roughness average number: 10-15.

Bottom: conventional finish, surface roughness average number: approx. 23-27.

ordering note

An extra charge is applied for cutting Siltek®/Sulfinert® or Silcosteel®-CR tubing. The charge is calculated from the total number of pieces produced for each line item.

for more info

Which treated tubing should I use?

See chart on page 396.

Tubing

Restek sets the standard in tubing for analytical and process applications. Complete your system with treated fittings and valves for an inert, corrosion-resistant pathway.

The extremely inert Siltek®/Sulfinert® surface is ideal in applications such as sulfurs or automotive exhaust testing, stack gas sampling, process monitoring, or in any other application in which a representative sample must be transferred without loss.

In systems used to transfer hydrochloric acid, nitric acid, or seawater, Silcosteel®-CR treated electropolished stainless steel tubing will last longer and require less maintenance. In tests, Silcosteel®-CR treatment substantially protected stainless steel from pitting and crevice corrosion. For details, visit www.restek.com and download lit. cat.# 59956.

Treated Seamless Electropolished 316L Grade Stainless Steel Tubing

Our highest performing tubing.

Recommended for:

- demanding/corrosive environments.
- high temperatures.
- ultimate inertness.

Siltek®/Sulfinert® Treated Coiled Electropolished 316L Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-99 ft.	100-299 ft.	>300 ft.
3/8" (3.18mm)*	0.085" (2.16mm)	22538				
1/4" (6.35mm)**	0.180" (4.57mm)	22539				

Silcosteel®-CR Treated Coiled Electropolished 316L Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-99 ft.	100-299 ft.	>300 ft.
3/8" (3.18mm)*	0.085" (2.16mm)	22536				
1/4" (6.35mm)**	0.180" (4.57mm)	22537				

3/8" OD: 5 ft. to 100 ft. in one continuous coil; 1/4" OD: 5 ft. to 300 ft. in one continuous coil. Longer lengths will be more than one coil.
Note: required length in meters x 3.2808 = length in feet.

Treated Welded/Drawn 304 Grade Stainless Steel Tubing

Our most popular grade of tubing.

Recommended for:

- chromatography applications.
- gas delivery systems.
- lower pressures.
- inert applications.

Siltek®/Sulfinert® Treated Coiled 304 Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-199 ft.	200-399 ft.	>400 ft.
0.022" (0.56mm)	0.011" (0.28mm)	22500				
0.029" (0.74mm)	0.021" (0.53mm)	22501				
1/16" (1.59mm)	0.010" (0.25mm)	22502				
1/16" (1.59mm)	0.020" (0.51mm)	22503				
1/16" (1.59mm)	0.030" (0.76mm)	22504				
1/16" (1.59mm)	0.040" (1.02mm)	22505				
3/8" (3.18mm)*	0.085" (2.16mm)	22506				
1/4" (6.35mm)*	0.210" (5.33mm)	22507				

*0.020" wall thickness

**0.035" wall thickness

Treated Seamless 316L Grade Stainless Steel Tubing*High durability tubing.*

- Recommended for:
- inert applications.
 - high temperatures.
 - high pressures.
 - corrosive environments.

Siltek®/Sulfinert® Treated Coiled 316L Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-199 ft.	200-399 ft.	> 400 ft.
1/8" (3.18mm)**	0.055" (1.40mm)	22508				
1/4" (6.35mm)**	0.180" (4.57mm)	22509				
3/8" (9.52mm)***	0.277" (7.04mm)	22914				

Silcosteel®-CR Treated Coiled 316L Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-199 ft.	200-399 ft.	> 400 ft.
1/8" (3.18mm)**	0.055" (1.40mm)	22896				
1/4" (6.35mm)**	0.180" (4.57mm)	22897				
3/8" (9.52mm)***	0.277" (7.04mm)	22915				

Treated Hydroguard™ Deactivated Stainless Steel Tubing

Hydroguard™ deactivation creates a high-density surface that is not readily attacked by aggressive hydrolysis.

- Recommended for:
- plumbing purge and trap systems.
 - headspace systems.

ideal for **purge & trap**

**did you know?**

Other lengths and diameters of treated tubing are available on a custom basis.

Call for availability of lengths greater than 1000ft.

ordering note

Required length in meters
x 3.2808 = length in feet.

Minimum Bend Radius for Coated Tubing

OD	Min. Bend Radius
≤ 1/16"	1" (2.5cm)
1/8"	2" (5.1cm)
1/4"	4" (10.2cm)
3/8"	6" (15.2cm)

Silcosteel® Treated Hydroguard™ Deactivated 304 Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-199 ft.	200-399 ft.	> 400 ft.
1/16" (1.59mm)	0.010" (0.25mm)	22497				
1/16" (1.59mm)	0.020" (0.51mm)	22496				
1/16" (1.59mm)	0.030" (0.76mm)	22495				
1/16" (1.59mm)	0.040" (1.02mm)	22494				
1/8" (3.18mm)*	0.085" (2.16mm)	22493				
1/4" (6.35mm)*	0.210" (5.33mm)	22492				

Silcosteel® Treated Hydroguard™ Deactivated Seamless 316L Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-199 ft.	200-399 ft.	> 400 ft.
1/8" (3.18mm)**	0.055" (1.40mm)	22491				
1/4" (6.35mm)**	0.180" (4.57mm)	22490				

Silcosteel® Treated Hydroguard™ Deactivated Electropolished 316L Grade Stainless Steel Tubing

OD	ID	cat.#	5-24 ft.	25-99 ft.	100-299 ft.	> 300 ft.
1/8" (3.18mm)*	0.085" (2.16mm)	22489				
1/4" (6.35mm)**	0.180" (4.57mm)	22488				

*0.020" wall thickness

**0.035" wall thickness

***0.049" wall thickness

new!

For the newest developments, visit our Performance Coatings Division website: www.restekcoatings.com

Treated Straight, 6-Foot Length Tubing

Silcosteel®-CR Treated Straight Seamless 316L Grade Stainless Steel Tubing

- Individual 6-foot pieces.

In response to customer requests, we offer 6-foot straight lengths of 1/8-, 1/4-, and 3/8-inch Silcosteel®-CR treated tubing. This tubing can be cut to your exact requirements using a standard tubing cutter.

6-foot Length ($\pm 1/2"$)

OD	ID	qty.	cat.#
1/8" (3.18mm)**	0.055" (1.40mm)	ea.	22898
1/4" (6.35mm)**	0.180" (4.57mm)	ea.	22899
3/8" (9.52mm)**	0.277" (7.04mm)	ea.	22900

ordering note

Required length in meters
x 3.2808 = length in feet.

Siltek®/Sulfinert® Treated Straight Seamless 316L Grade Stainless Steel Tubing

- Individual 6-foot pieces.

In response to customer requests, we offer 6-foot straight lengths of 1/8-, 1/4-, and 3/8-inch Siltek®/Sulfinert® treated tubing. This tubing can be cut to your exact requirements using a standard tubing cutter.

6-foot Length ($\pm 1/2"$)

OD	ID	qty.	cat.#
1/8" (3.18mm)**	0.055" (1.40mm)	ea.	22901
1/4" (6.35mm)**	0.180" (4.57mm)	ea.	22902
3/8" (9.52mm)**	0.277" (7.04mm)	ea.	22903

**0.035" wall thickness

***0.049" wall thickness

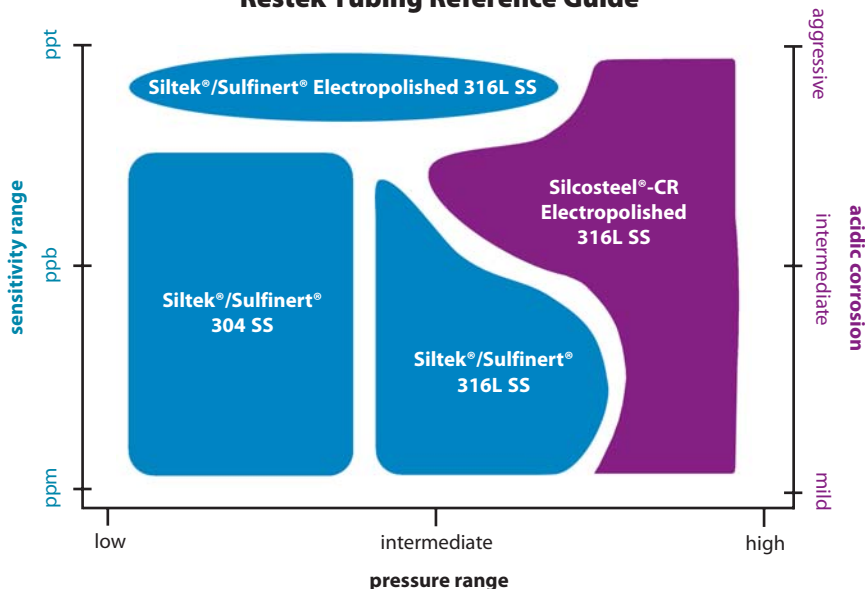


frequently asked question

Which treated tubing should I use?

Restek Performance Coatings offers several grades of tubing with varied treatments. This chart will help you determine the tubing best suited to your application with respect to pressure, sensitivity of your analysis, and acidic environment exposure. For more frequently asked questions on treated tubing, see [page 391](#) or contact the Restek Coatings experts.

Restek Tubing Reference Guide



ResTape Teflon® Tape

- For threaded connections in a wide range of plumbing materials.
- Each roll is 1/2" x 260".
- Maximum temperature: 260°C.

Description	Uses	qty.	cat.#
ResTape Green PTFE	oxygen service*	ea.	22485
ResTape Yellow PTFE	general gas service**	ea.	22486
ResTape Grey PTFE	stainless steel fittings***	ea.	22487



Ridgid® Heavy-Duty Tubing Cutter

- Specifically designed to cut 3/16"-1 1/8" stainless steel tubing.
- Large knob and 6 individual bearings for more control with less turning.
- Convenient fold-away reamer.

Description	qty.	cat.#
Ridgid® Heavy-Duty Tubing Cutter	ea.	22621



Strap Wrench

- Securely grip large, hard to turn items.
- Safely grip sample cylinders without damage when installing valves.
- Large capacity: 8" diameter cylinder.

Description	qty.	cat.#
Strap Wrench	ea.	22625



Heavy-Duty Tube Bender

- Allows precise bending of 1/4" tubing.
- Patented swivel handle can be repositioned easily, allowing easy fabrication of bends up to 180°.
- Does not score or flatten tubing.
- Calibrated to show angle of bend.

Description	qty.	cat.#
Heavy-Duty Tube Bender	ea.	22626



Flexible Inspection Light

- Inspect inside surfaces of sample cylinders or other chambers.
- 14" reach.
- 100,000-hour LED life.

Description	qty.	cat.#
Flexible Inspection Light	ea.	22627



Swaging Tool

- Preswage compression fittings for easy installation.
- Ideal for installations in tight areas.
- For Swagelok® fittings only.

Description	qty.	cat.#
Swaging Tool	ea.	22622



Tee Wrench

- Hold 1/4" or 6mm tee or cross fittings secure in multiple orientations during installation.
- Fits easily in tool box, pouch, or belt.
- Cushioned vinyl grip with generous gripping area.
- For Swagelok® fittings only.

Description	qty.	cat.#
Tee Wrench	ea.	22623



Gap Inspection Gauge

- Confirm that fittings are sufficiently tightened.
- For use with 1/4", 3/8", 1/2" Swagelok® fittings.
- For Swagelok® fittings in new installations only.

Description	qty.	cat.#
Gap Inspection Gauge	ea.	22624



*Compatible with gaseous or liquid oxygen, and with many other gases and liquids.

**Compatible with a broad range of gases and liquids.

***Anti-galling. Also compatible with many other metals and polymers.

Quoting and Custom Treatment Service

We will work with you to meet your surface treatment needs. Please contact us to discuss unique requirements. See below for obtaining a quote for custom treatment.

What can be treated?

Parts that can tolerate a sustained temperature of 400°C, with pressurization/evacuation. For more information, request *Substrate Preferences* (lit. cat.# 59929) or visit us online.

Substrates:	300- and 400-grade stainless steel, high carbon steel, titanium, ceramics, borosilicate glass, Inconel®, Hastelloy®
Parts:	fittings, valves, frits, custom parts with complex topography (inside and/or out)
Sizes of Reaction Chambers:	Largest: 10" diameter cylinder w/ 48" height or 3" diameter cylinder w/ 72" height Large processing oven: 24" diameter x 31" deep Walk-in oven: 4 feet x 4 feet x 4 feet
Tubing:	0.004" to 0.5" ID (0.10–12.7mm); continuous lengths to 2000+ ft. / 600+ meters <i>Please allow 6 inches of extra tubing on each end if the final tubing length is critical.</i>

What can't be treated?

Nickel/nickel plate, aluminum (heat-dependent), Monel®, copper, brass, gold or silver-plated components, magnesium, elastomers, and painted items cannot be treated. All paints and finishes must be removed prior to sending items to Restek for treatment. Soldered joints will not survive the coating process. Silver soldered and brazed components will not coat properly. Restek recommends the use of TIG, MIG, or nickel vacuum brazed joints for use on items to be treated.

How to Send Parts for Custom Treatment

step 1—**PRICE** the order. Contact Restek using one of the quoting methods listed below.

step 2—**OBTAIN** a Return Authorization (RA) number. Restek customer service will provide you with an RA# and mailing instructions that include a service label.

step 3—**PRINT** your service label and attach it to your shipment.

step 4—**SHIP** parts to Restek.

See "Instructions for Sending Parts to Restek Performance Coatings" (Form #18-19-10) for details. Your order will be processed and completed within 10 days of receipt of shipment unless otherwise noted.

How to Obtain a Quote on the Web

1. Visit the home page of our website: www.restekcoatings.com
 - Navigate to **Custom Coating Services** in the **Info & Support** menu.
 - From the bottom of the screen, choose the worksheet for the treatment you need and print it.
2. Check the box next to the description matching that of the items to be treated. Indicate quantity to be sent for treatment. If the item cannot be matched with any of the listed options, check "other" and list the dimensions.
3. Initial the disclaimer on the request form. This initialed disclaimer is required before we can begin to process your items.
4. Submit the form.

Quotations will be prepared and returned within 24 hours after we receive your form.

If you accept our quote, contact Restek Corporation for an authorization number. This number is required for any package shipped to Restek. Any package received without an authorization number will be returned to the sender.

How to Obtain a Quote via Email

1. Email rpcquotes@restek.com or fax 814-353-1309 indicating:
 - Coating type
 - Dimensions and quantity for each part to be coated
 - Technical drawing or photo
 - Contact and company information

Quotations will be prepared and returned within 24 hours after we receive your form.

If you accept our quote, contact Restek Corporation for an authorization number. This number is required for any package shipped to Restek. Any package received without an authorization number will be returned to the sender.

ordering note

Price and delivery time for custom treatments:

Please be sure to obtain an authorization number before you send any items to Restek. Quotes will be made within 24 hours of receipt of the sketch or part. Product delivery time is typically 10 working days or less after we receive the material.

Handling Tips

Cleaning

When cleaning a treated part, rinse with a solvent that will dissolve probable surface contaminants (i.e., use a nonpolar solvent to remove hydrocarbon contaminants, or a more polar solvent to remove more active contaminants). Avoid using cleaners containing abrasives as they can scratch the layer. Mild sonication may assist in contaminant removal, but do not oversonicate—this could damage the layer. **Do not use basic solutions with pH>8.** Do not steam clean any Restek treated system components or lines, as this could damage the layer.

Galling

As with any threaded fitting, galling may occur when assembling two treated parts. To prevent thread damage, use a thread lubricant or Teflon® tape (e.g. ResTape Stainless Steel Thread Sealing Tape, cat.# 22487). Galling potentially can be reduced when assembling a treated part and an untreated part.

Treatment Layer Troubleshooting

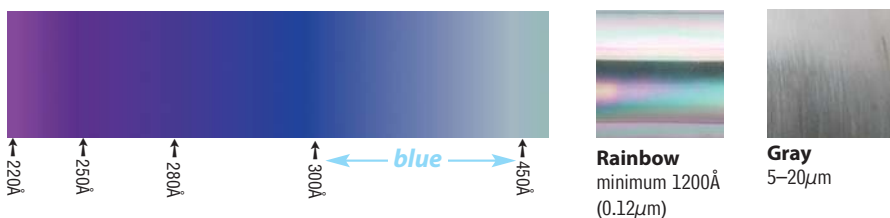
Under normal use, your treated items should deliver outstanding performance for years to come. However, effective lifetime is dependent on the severity of the environment. Factors that can impede performance are:

Contamination	Failure to properly clean the surface can allow increased surface activity. If performance changes, thoroughly clean the surface and inspect the layer for damage.
Erosion	Contact with abrasives can accelerate surface wear.
Bases	Contact with a base (pH 8 or higher) can accelerate deterioration of the layer.

Surface finish and color should stay consistent throughout the life of the product. Changes in the finish or color may indicate a partial loss of the layer. To prevent further loss, ensure no exposure to bases or abrasives.

Treatment Layer Color

Colors are created by the treatment's light refraction properties. The visible color depends on the treatment layer's thickness. Layer thickness ranges from 0.03µm to 30µm, controlled by variables in the process to our specifications. There is a degree of variability to the process, and each piece is treated individually. Therefore, every piece is unique!



Mark Eckley
Restek Performance
Coatings Manufacturing
Manager
9+ years of service!

RESTEK PERFORMANCE COATINGS



Custom Coating Service in 10 days or less! From your Restek Performance Coatings Team.

Stephanie Sunner, Shane Lucas, Randy Sampsell, Marty Higgins, Joe Miller, Mark Eckley, Randy Emel, Kathy Emel, Jeff Corman, Gary Barone, David Smith, David Facey, Carrie Sprout, Barry Spicer, Bob King, and Jim Mattzela