Applications Note

Greatly Enhance Semiconductor Process Performance

Restek Performance Coatings

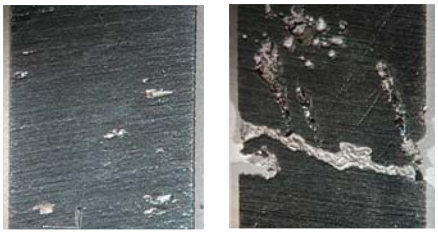
See us at **Semicon West** booth #2964

- **Save money**—reduce corrosion maintenance costs by up to 65%.
- **Improve process yields**—reduce moisture and ion contamination.
- **Save process time**—reduce vacuum pump-down times by 2.5X.
- **Simple!**—improve performance of existing components with Restek's custom coating service.

Pathways in semiconductor process systems require high corrosion resistance, low moisture content, and high purity. The current substrate of choice in semiconductor manufacturing, electropolished VIM/VAR (vacuum induction melt/vacuum arc melt) 316L stainless steel, fails to perform in many demanding process environments. The result is increased periodic maintenance, prolonged equilibration times, system contamination, and inaccurate analytical results.

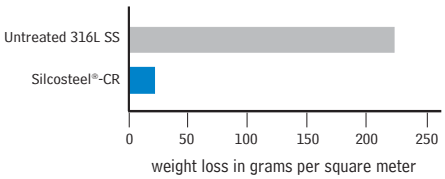
Restek's patented non-line-of-sight chemical vapor deposition (CVD) processes produce a high purity, flexible, amorphous silicon layer, diffused into the base metal lattice. The layer will conform to the most intricate surface while maintaining high dimensional tolerances; it will deform with tubing surfaces, allowing radius bends or leak-free seals.

Figure 1 316L stainless steel shows significant crevice corrosion; a Silcosteel®-CR treated coupon shows only minor pitting (ASTM G 48, Method B).



Silcosteel®-CR treated | untreated

Silcosteel®-CR treated stainless steel outperforms uncoated metal **by an order of magnitude** in chloride environments.



Silcosteel®-CR treatment improves corrosion resistance

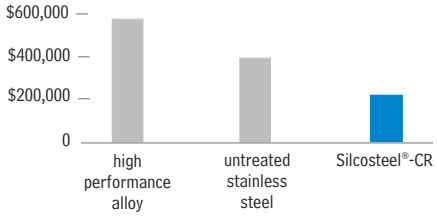
Independent laboratory testing shows Silcosteel®-CR treatment improves corrosion resistance by up to 10x over untreated 316L stainless steel.[1] Silcosteel®-CR treatment is compatible with many chemicals used in the semiconductor industry. Visit us online at **www.restekcoatings.com/semicon** for a complete list of common semiconductor chemicals and their compatibility.

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 five-fold.[2]

By improving the corrosion resistance of 316L stainless steel by up to 10x, Silcosteel®-CR treatment reduces costly maintenance and field failures due to system corrosion. Figure 2 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 significantly lowers the life cycle cost of stainless steel or alloys (US dollars).



Restek Surface Treatments

We offer surface treatments that enhance performance in many applications:

Silcosteel®-CR—A corrosion resistant layer that increases the lifetime of system components in acidic environments.
Silcosteel®-UHV—Greatly reduces outgassing from components of ultra-high vacuum systems.
Siltek®—The ultimate passivation for treated components, from glass to high nickel alloys of steel.
Sulfinert®—A required treatment for metal components when analyzing for parts-per-billion levels of organo-sulfur compounds.
Silcosteel®-AC—Dramatically reduces carbon buildup on stainless steel components.
Silcosteel®—A general-purpose passivation layer for steel and stainless steel.

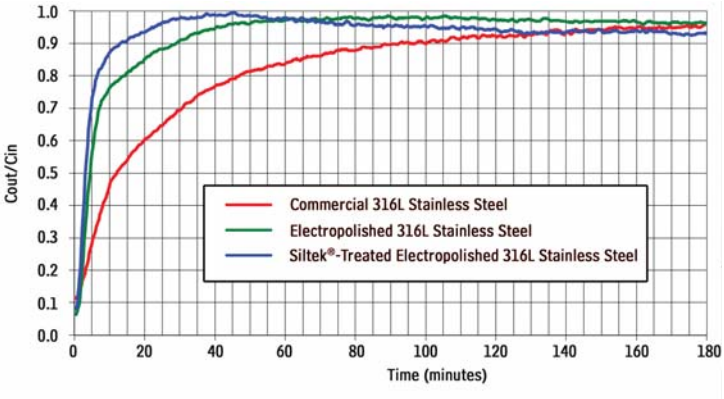
Restek *Performance* Coatings

www.restekcoatings.com/semicon

Accelerate moisture dry-down with Siltek® treatment

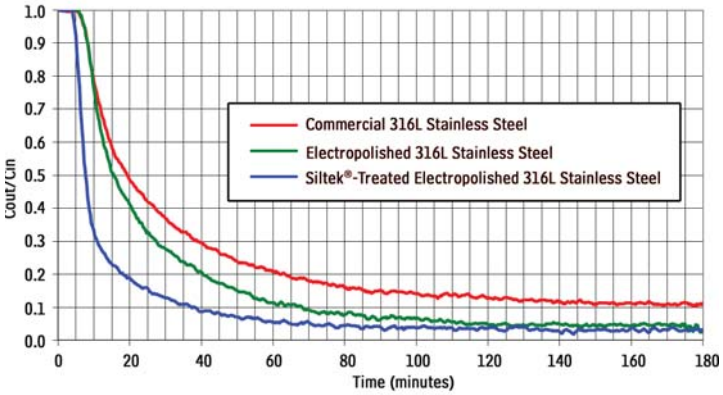
Gas transfer systems serving the semiconductor industry require low moisture content. Data for wet-up and dry-down experiments, measuring the relative response time for moisture content change in treated electropolished stainless steel tubing and standard 316L stainless steel tubing, demonstrate a great advantage in using Siltek® treated versus untreated tubing.

Figure 3 Restek treated electropolished tubing stabilizes at 1ppm moisture much faster than conventional surfaces.[3]



Wet-up curves for Siltek® treated electropolished, untreated electropolished, and standard tubing are compared in Figure 3. 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.[2] 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. Figure 4 compares the dry-down performance for tubing saturated with 10ppm of moisture.

Figure 4 Restek treated electropolished tubing dries much faster than conventional surfaces.[3]



Silcosteel®-UHV treatment cuts pump-down times

Semiconductor processes requiring frequent pump-downs can realize dramatic productivity improvements by treating vacuum chambers with Silcosteel®-UHV.

The slow outgassing of water vapor and other contaminants in process vacuum chambers can greatly hinder evacuation rates, process throughput, and ultimate base pressures. The application of Silcosteel®-UHV throughout exposed surfaces of vacuum systems can dramatically reduce outgassing rates and provide a productivity advantage to process chambers that require more rapid and efficient evacuations.

Figure 5 Silcosteel®-UHV treated ultra-high vacuum system components show greatly reduced evacuation times.

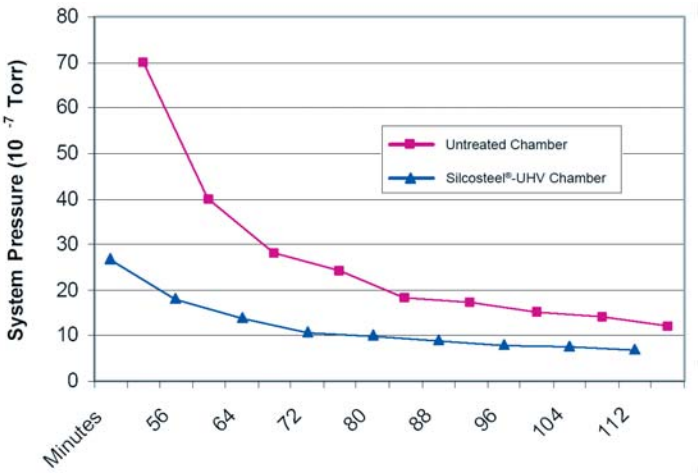


Figure 5 compares pump-down rates for a Silcosteel®-UHV treated vs. an untreated chamber. Silcosteel®-UHV will reduce pump down times by 2.5x or more, compared to untreated chambers.[4]

Conclusion

Restek Performance Coatings can help semiconductor manufacturers meet cost and productivity challenges by improving the surface performance of stainless steel:

- **Silcosteel®-CR improves corrosion resistance by 10x or more.**
- **Siltek® eliminates moisture contamination by 50% or more.**
- **Silcosteel®-UHV improves chamber productivity by 2.5x or more.**

Silcosteel®-CR, Siltek®, or Silcosteel®-UHV can be applied to existing process components. We stock Silcosteel®-CR and Siltek® treated Swagelok® and Parker fittings, as well as Siltek® and Silcosteel®-CR treated 316L electopolished and seamless tubing for immediate shipment. Custom treatment is available for process-specific components.

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

- Full line of treated 1/16", 1/8", 1/4", and 3/8" fittings.
- Silcosteel®-CR treatment enhances corrosion resistance by 10X, or more.
- Custom treatment available for any Swagelok® fitting, or other system parts.
- Siltek® treatment eliminates moisture contamination by 50% or more.

		Siltek®/Sulfinert® Treated		Silcosteel®-CR Treated	
Fitting Type	Size	cat.#	price	cat.#	price
Union	1/16"	22540	$73.50	22575	$73.50
	1/8"	22541	$65.20	22576	$65.20
	1/4"	22542	$65.20	22577	$65.20
	3/8"	22909	$65.20	22904	$65.20
Tee	1/16"	22543	$126.30	22578	$126.30
	1/8"	22544	$94.20	22579	$94.20
	1/4"	22545	$85.90	22580	$85.90
	3/8"	22910	$113.90	22905	$113.90
Reducing Union	1/8" to 1/16"	22546	$73.50	22581	$73.50
	1/4" to 1/16"	22547	$69.30	22582	$69.30
	1/4" to 1/8"	22548	$69.30	22583	$69.30
	3/8" to 1/4"	22911	$65.20	22906	$65.20
Elbow	1/8"	22549	$73.50	22584	$73.50
	1/4"	22550	$73.50	22585	$73.50
Plug	1/16"	22572	$52.80	22619	$52.80
	1/8"	22573	$42.40	22620	$42.40
	1/4"	22574	$39.30	22597	$39.30
Cross	1/8"	22551	$136.60	22586	$136.60
	1/4"	22552	$126.30	22587	$126.30
Tube End Reducer	1/8" tube to 1/16"	22553	$58	22588	$60
	1/4" tube to 1/16"	22554	$64.20	22589	$65.20
	1/8" tube to 1/4"	22555	$58	22590	$58
	1/4" tube to 1/8"	22556	$58	22591	$58
Port Connector	1/8"	22557	$58	22592	$58
	1/4"	22558	$58	22593	$58
	1/8" tube to 1/4"	22559	$58	22594	$58
Male Connector	1/8" to 1/8" NPT	22561	$63.10	22595	$63.10
	1/4" to 1/4" NPT	22562	$63.10	22596	$63.10
	1/16" to 1/8" NPT	22563	$63.10	22610	$63.10
	1/8" to 1/4" NPT	22564	$63.10	22611	$63.10
	1/4" to 1/8" NPT	22565	$63.10	22612	$63.10
	3/8" to 3/8" NPT	22912	$59	22907	$59
	3/8" to 1/4" NPT	22913	$53.80	22908	$53.80
Female Connector	1/8" to 1/8" NPT	22566	$63.10	22613	$63.10
	1/4" to 1/4" NPT	22567	$63.10	22614	$63.10
	1/4" to 1/8" NPT	22568	$63.10	22615	$63.10
	1/8" to 1/4" NPT	22569	$63.10	22616	$63.10
Bulkhead Union	1/8"	22570	$94.20	22617	$94.20
	1/4"	22571	$83.80	22618	$83.80

Decades of Innovation

Restek's experience with surface coatings began in 1987. At a client's request, we developed technology to coat intricate metal parts in explosives detectors. Driven by this success, we applied our technology to gas chromatography products and analysis equipment. Since our initial project, Restek's coating experts have developed a family of surface treatments to address specific needs and enhance the performance of system components used by industry, scientists, and enthusiasts worldwide. Now, our experts have developed treatments that provide a durable, unique finish to automotive and motorcycle parts. Restek surface treatments are **Driving Innovation.™**

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
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
3. *Relative Response Time of True Tube™ when Measuring Moisture Content in a Sample Stream* Test Report, Haritec Scientific & Engineering Support, Calgary, Alberta, Canada, May 2004. Courtesy of O'Brien Corporation, available on request from Restek.
4. D. Smith; M. Higgins; B. Kendall; *Low Outgassing of Silicon-Based Coatings on Stainless Steel Surfaces for Vacuum Applications*; Presented at annual SVC meeting, Restek Corporation/Elvac Laboratories (2005).

Siltek®/Sulfinert® Treated & Silcosteel® Treated Parker Plug & Ball Valves

		Siltek®/Sulfinert® Treated			Silcosteel® Treated		
Fitting Type	Size	qty.	cat.#	price	qty.	cat.#	price
Plug Valve	1/8"	ea.	21586	$230.80	ea.	21576	$193.50
	1/4"	ea.	21587	$230.80	ea.	21577	$193.50
Ball Valve	1/8"	ea.	21588	$313.60	ea.	21578	$261.90
	1/4"	ea.	21589	$313.60	ea.	21579	$261.90

Restek *Performance* Coatings

800-356-1688 • 814-353-1300 • fax: 814-353-1309

www.restekcoatings.com/semicon

Tubing

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

simply **the best**

Siltek®/Sulfinert®- and Silcosteel®-treated electropolished tubing is the best tubing choice when purity, inertness, and reproducibility are concerns.

Top: electropolished finish, surface roughness average number: 5-10. Bottom: conventional finish, surface roughness average number: 23-27.

Questions?

Our coatings experts are here to help.
For a free technical consultation, call:
Marty Higgins at 800-356-1688, ext 2307
Gary Barone at 800-356-1688, ext 2135
David Smith at 800-356-1688, ext 2154

free literature

Learn more about our precisely applied, highly durable surface treatments: request our brochure lit. cat.# 59493.

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Lit. Cat.# 580102A

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

ID	OD	cat.#	Price-per-foot 5-24 ft.	25-99 ft.	100-299 ft.	>300 ft.
0.085" (2.16mm)	1/8" (3.18mm)*	22536	$25.90/ft.	$20.70/ft.	$17.40/ft.	$14.50/ft.
0.180" (4.57mm)	1/4" (6.35mm)*	22537	$25.90/ft.	$20.70/ft.	$17.40/ft.	$14.50/ft.

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

ID	OD	cat.#	Price-per-foot 5-24 ft.	25-99 ft.	100-299 ft.	>300 ft.
0.085" (2.16mm)	1/8" (3.18mm)*	22538	$25.90/ft.	$20.70/ft.	$17.40/ft.	$14.50/ft.
0.180" (4.57mm)	1/4" (6.35mm)*	22539	$25.90/ft.	$20.70/ft.	$17.40/ft.	$14.50/ft.

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

ID	OD	cat.#	Price-per-foot 5-24 ft.	25-199 ft.	200-399 ft.	>400 ft.
0.055" (1.40mm)	1/8" (3.18mm)*	22896	$19.40/ft.	$15.50/ft.	$12.90/ft.	$10.40/ft.
0.180" (4.57mm)	1/4" (6.35mm)*	22897	$19.40/ft.	$15.50/ft.	$12.90/ft.	$10.40/ft.
0.277" (7.04mm)	3/8" (9.52mm)**	22915	$18.75/ft.	$15/ft.	$12.50/ft.	$10/ft.

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

ID	OD	cat.#	Price-per-foot 5-24 ft.	25-199 ft.	200-399 ft.	>400 ft.
0.055" (1.40mm)	1/8" (3.18mm)*	22508	$19.40/ft.	$15.50/ft.	$12.90/ft.	$10.40/ft.
0.180" (4.57mm)	1/4" (6.35mm)*	22509	$19.40/ft.	$15.50/ft.	$12.90/ft.	$10.40/ft.
0.277" (7.04mm)	3/8" (9.52mm)**	22914	$18.75/ft.	$15/ft.	$12.50/ft.	$10/ft.

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

6 foot Length

ID	OD	qty.	cat.#	price
0.055" (1.40mm)	1/8" (3.18mm)*	ea.	22898	$233.40
0.180" (4.57mm)	1/4" (6.35mm)*	ea.	22899	$167.30
0.277" (7.04mm)	3/8" (9.52mm)**	ea.	22900	$192

*0.035" wall thickness **0.049" wall thickness

Contact us!
Restek will treat your **existing tubing, fittings, & custom process components.**

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Silcosteel®-CR	A corrosion resistant layer that increases the lifetime of system components in acidic environments.
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