Silcolek.

Game-Changing Coatings™

SilcoTek Coatings 101





- <u>Year founded</u>: 2009
- Employees: 50



- Mission: To create Game-Changing Coatings™
- Purpose: To solve our customers' toughest material problems, help them beat the competition, and take their innovations and products to the next level



Company Scope

Surface enhancement / engineering via CVD technology

- Silicon- (a-Si) and silicon oxide-based coatings
- Surface functionalization and modification
- Characterization and testing
- Custom solution development
- Technical support

ISO 9001:2015 Certified





Maintain Plus 1 Service & Support

Develop the final solution

Evaluate coating options

Understand the application and problem



Our Business Model

- 1. Coating service to customer-supplied parts
 - Currently a majority of our business
 - Working directly with end-users (20%), OEMs (30%), and via resale (50%)
- 2. Licensing
 - Patents and know-how to run coating operation at customer facility
 - Major part of future vision
 - SilcoTek HQ becomes R&D and marketing house
 - Network of licensees provide the coating service
 - Major OEMs and VARs (value-added resellers) drive business



Core Values

- We firmly believe our success is based on these core values:
 - F Fast failure
 - I In the light
 - S Servant leadership
 - H Honesty
 - I Innovation
 - N Never stop learning
 - G Give it all you've got



- SilcoTek ZIP Code our daily code of conduct:
 - Zero Disappointments, Integrity in all we do, Plus 1 customer service



1987

 Restek[®] invents Silcosteel[®] to make stainless steel GC capillary column perform like glass columns.



Paul Silvis – Founder of Restek[®] and led the spin-off of SilcoTek. Current SilcoTek President, CEO, and Head Coach.



1990-2000

 A team dedicated to the Silcosteel coating technology experiments with new custom coatings for a variety of applications.





2000-2008

 Demand grew for "Restek Performance Coatings" outside of just chromatography applications (Restek's core business).







2009

 Restek Performance Coatings spins off to form SilcoTek[®], an independent coating technology and services company.





2013



 36,000 ft² state-of-theart coating facility is built, tripling previous coating capacity.







Where are we?





Process Overview Video





What SilcoTek Does and Why



What we do

- Thermal CVD of materials onto substrates like stainless steel, titanium, super alloys, glass, ceramics, etc.
- Additional steps for more advanced surface properties
- Also able to directly functionalize substrate without coating



What are SilcoTek Coatings?

- <u>Barrier coatings</u> that prevent unwanted surface interactions and/or provide new surface properties that the base material can't
- Why?
 - Chemical compatibility (often called chemical *inertness*)
 - Corrosion resistance
 - Non-stick \rightarrow anti-fouling, anti-coking, easier cleaning, etc.





Advantages of CVD Coatings

- Non-line-of-sight deposition; uniformly treats 3D, high aspect ratio part geometries
- Molecular adhesion to base substrate. Won't flake.
- Scalable, versatile, and highly reproducible



Surface Properties

- Chemically inert / non-reactive
- Non-stick, high release
 - Hydrophobic
 - Oleophobic
 - Anti-fouling
- Oxidation resistant
- Corrosion resistant
- Dielectric or semi-conductive
- Stable up to 1410° C





Composition of SilcoNert 2000 (aka Sulfinert – exactly the same)





Composition of Dursan





CVD-Coated Parts





Why?



Why?

- Increase system uptime eliminate delays and detect upsets sooner
- Increase lifetime
- Comply with regulations and standards
- Save money



Common Applications

- LNG/CNG sampling and testing
- Environmental analysis
- Heat exchangers
- Refinery, flare, and flue gas
- NOx and SOx
- Mercury and Ammonia
- Low sulfur regulation compliance
- Research (reactors, vacuum, etc.)

- Process monitoring
- Chemical manufacturing
- Automotive and Aerospace
- HCI streams
- H₂S
- Mold release
- Semiconductor manufacturing
- Medical diagnostics and devices



SilcoTek's Coating Process



1. Receipt and Inspection





2. Surface Preparation





3. Vessel Loading



Largest current size: 1.63m x .76m ID



4. Oven Loading and Coating





5. Post-Clean





6. QC





7. Packaging and Shipping





Benefits



Benefits: Inertness

- A more durable, less permeable, higher temperature alternative to Teflon®
- Get very accurate, very reliable analyzer results more quickly



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SilcoNert, 2000

SilcoNert, 2000 Benefits: Inertness

- Required for accurate analysis of sulfurs, mercury, or other highly active molecules
- Confidently assess chemical content of oil, gas, air, or process stream



Inertness

- SilcoNert[®] 2000 improves storage of H2S & Mercaptans
 - Reduces adsorption effects
 - Improves analytical reliability
 - Increased accuracy
 - 17ppbv H₂S Containment in 500ml Cylinders







Benefits: Corrosion Resistance

- Extend life of process equipment
- Drastically cut costs related to exotic materials and part replacement
- Keep the versatility and ease of using stainless steel



6M HCI at room temperature

- Solution of uncoated coupon turned green after a 24-hour immersion; solutions of coated coupons showed very slight color changes.
- Both SL1000 and Dursan provide good protection under this condition, with Dursan slightly outperforming Silcolloy.





Benefits: Low Surface Energy

- Reduce negative effects from moisture
- Make surfaces easier to clean and less likely to retain particulate
- Improve efficiency (think of motor oil ads)



Hydrophobicity Studies





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Rough: 120 grit; 58 rms (μin.) Smooth: mirror-like #8; 10 rms (μin.)

Oleophobicity studies on Fluoro-Functionalized (Notak[™]) 316 SS





How to Recommend Coatings



Statements that indicate a SilcoTek coating may be a solution...

- "I'm analyzing _____ at low levels..."
- "Need an inert surface for ppm/ppb-levels..."
- "Corrosion on stainless steel..."
- "Need a more hydrophobic surface..."
- "Getting unwanted build-up, 'sludge'..."
- "Losing our signals from our analyzer..."

- "Fouling problems"
- "Don't want metal interfering with my sample"
- "High purity coating"
- "Need to eliminate catalysis/adsorption"
- "Sulfinert" (old name for SilcoNert 2000)
- "Silcosteel" (old name for SilcoNert 1000)



Choosing a Coating

- Ask customer these 5 questions, then see chart on next slide:
- 1. What surface properties are required?
- 2. Which of these properties is most important?
- 3. What is the temperature of this application?
- 4. What is the pH of your sample/process stream?
- 5. What material(s) need to be coated?



SilcoTek® Coatings Comparison Guide

This chart scores SilcoTek coatings' properties in relation to each other, not alternative materials. To aid in choosing the best coating for your application, select the required properties from the left column and sum their scores for each coating you're considering. Generally, the coating with the highest total score should be an appropriate choice, but contact us at SilcoD@SilcoTek.com or 814-353-1778 if you are unsure.

1-Poor 2 - Fair	3 - Good	4 - Excellent	be an appropriate choice, but contact us at SitcoD@SitcoTex.com of 614-335-1776 if you are unsure					
SilcoTek Coating	SilcoNert® 1000	SilcoNert [®] 2000	SilcoGuard®	SilcoKlean®	Silcolloy®	Dursan®	Dursox®	Notak™
Acid Corrosion Resistance	2	2	3	2	4	4	4	TBD
Base Corrosion Resistance	1	1	1	1	1	4	4	TBD
Hydrophobicity	2	3	2	3	2	3	1	4
Hydrophilicity	1	1	1	1	1	1	4	1
Oleophobicity	1	1	1	1	1	1	1	3
Non-stick/ Release	2	2	2	2	2	3	3	4
Chemical Inertness	2	4	2	2	2	3	2	TBD
Maximum Application Temp.	1410° C	400° C	1410° C	450° C	1410° C	450° C	1250° C	350° C
Allowable pH Range	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 14	0 - 14	TBD
Material Composition	Amorphous silicon	Amorphous silicon + hydrocarbons	Multi-layered amorphous silicon	Amorphous silicon + hydrocarbons	Multi-layered amorphous silicon	Amorphous silicon oxide + hydrocarbons	Amorphous silicon oxide	Non-polymeric fluoro-organic
Common Applications	Analytical, Chemical Processing, Stack & Flare, Oil & Gas	Analytical, Chemical Processing, Stack & Flare, Oil & Gas	Semiconductor, Research & Analytical, Vacuum Processing	Automotive, Aerospace, Stack & Flare, Refining	Semiconductor, Stack & Flare, Chemical Processing, Oil & Gas	Corrosion, Pharmaceutical, Analytical, Chemical Processing, Oil & Gas	Corrosion, Research, Semiconductor	Mold Release, Heat Exchanges, Life Sciences



Resources

In addition to the handouts you've received today...

- Overview Brochure FAQs
- <u>Material Compatibility Guide</u>
- <u>Coating Care Guide</u>
- Process Overview
- <u>Whitepapers</u>
- <u>Application notes</u>
- Blog, whitepapers, application notes, and a lot more: <u>www.SilcoTek.com</u>



Collaboration

- Consider SilcoTek your "coating consultants"
- Very flexible with visits and creating custom sales/marketing materials
- Approved Partner Program
 - Contact Luke Patterson
 (luke.patterson@silcotek.com)







Thank you!

For quotes or tech. service: SilcoD@SilcoTek.com or (814) 353-1778

