SilcoTek's Corrosion Resistant CVD Coatings

SilcoTek® Corporation
225 PennTech Dr.
Bellefonte, PA 16823

+1 (814) 353-1778
www.SilcoTek.com

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- The challenge of corrosion
- Salt spray
- Corrosive immersions (HCl, H_2SO_4, bleach, etc.)
- Pitting and crevice corrosion
- Evaluation on carbon steel substrates
- Galvanic corrosion
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The Challenge of Corrosion

- Aggressive process and sample media
- Harsh external environments
- Expensive maintenance and replacement
- Little room for failure

SilcoTek's Solutions

Dursan®

Ceramic-like with full pH range resistance and mechanical durability

Silcolloy®

Excellent protection from acids, high temperatures, and oxidation

Salt Spray (ASTM G85)

- 8,064 hours of acidified salt spray per ASTM G85-A2
  - Dursan coating is unaffected and provides excellent protection on stainless steel in a salt spray environment. Silcolloy shows minor rust.

Uncoated 316L

Silcolloy-coated 316L

Dursan-coated 316L

Salt Spray (ASTM G85)

(continued from previous slide)

- Dursan-coated 316L SS is completely unaffected by 168 days of acidified salt spray
  - Even corrosion resistant duplex alloy 2205 showed moderate corrosion under these conditions

Uncoated Duplex Alloy 2205

Dursan-coated 316L

Salt Spray (ASTM G85)

- 4 weeks of pH-neutral salt spray (NaCl), then 4,032 hours of acidified salt spray per ASTM G85-A2
  - Total exposure time: 8,736 hours

Uncoated 316L

Silcolloy-coated 316L

Dursan-coated 316L

Salt Spray (ASTM G85)

(continued from previous slide)

- Dursan coating provides complete protection even after 8,736 hours of cyclic salt spray exposure
  - Silcolloy shows minimal corrosion at coupon edges

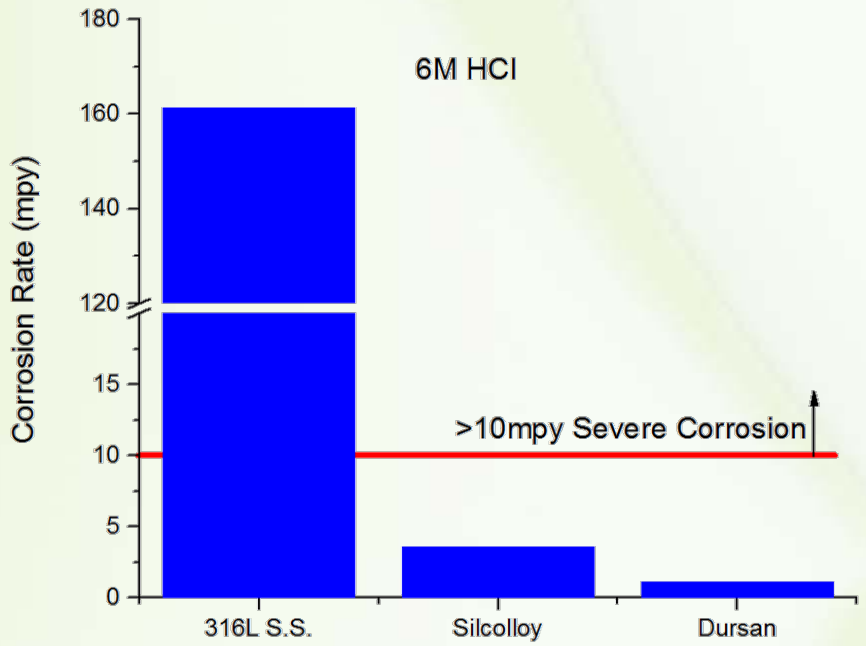
Uncoated 316L

Silcolloy-coated 316L

Dursan-coated 316L

HCl

- ASTM G31 Guidelines
- 6M HCl Acid Exposure
- 24 hrs at Room Temperature

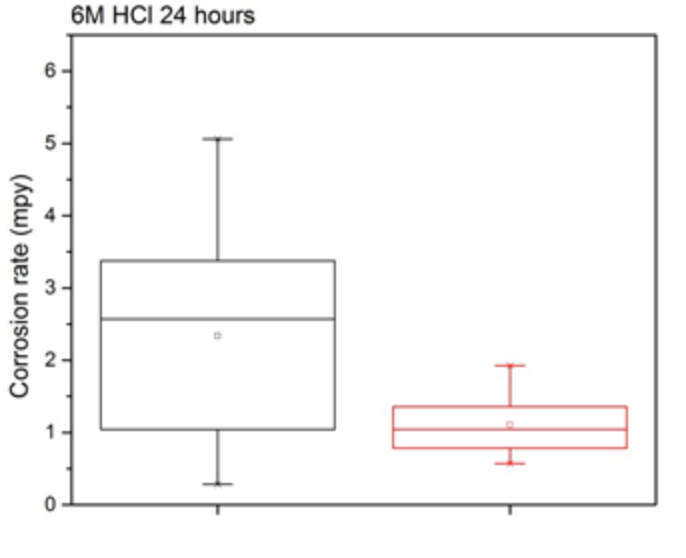


Both Dursan and Silcolloy coatings provide an excellent barrier to corrosion from HCl.

The coatings add considerable lifetime to parts in refinery and chemical manufacturing service, amongst others.

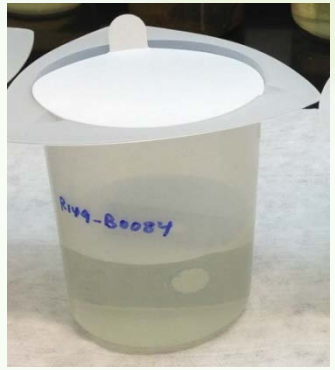
HCl

HCl Corrosion



Other coating | Dursan®

Other Coating

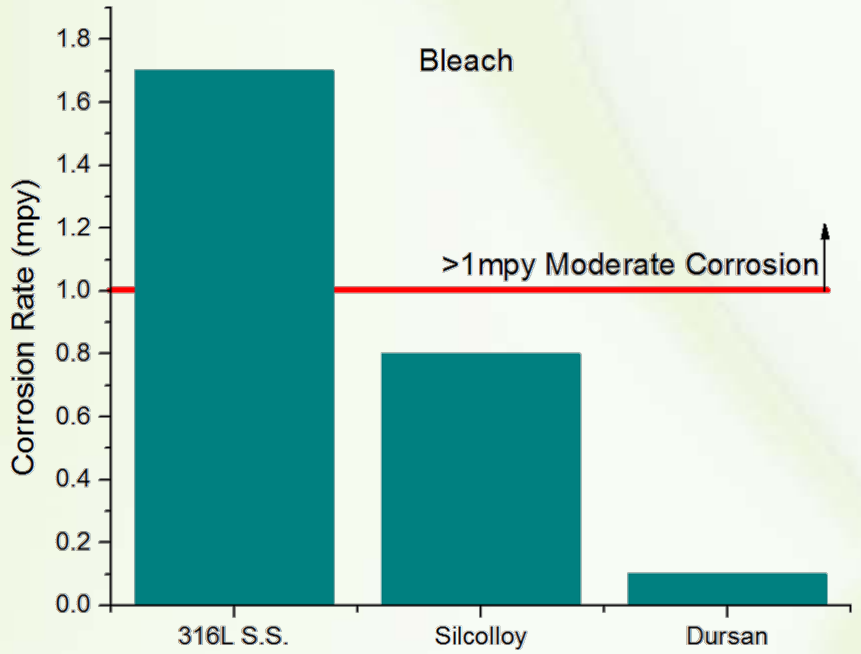


Dursan®

The solution containing Dursan-coated 316L SS shows no discoloration (corrosion) after the 24hr immersion test.

15% Bleach

- ASTM G31 Guidelines
- 15% NaClO Exposure
- 72 hrs at Room Temperature

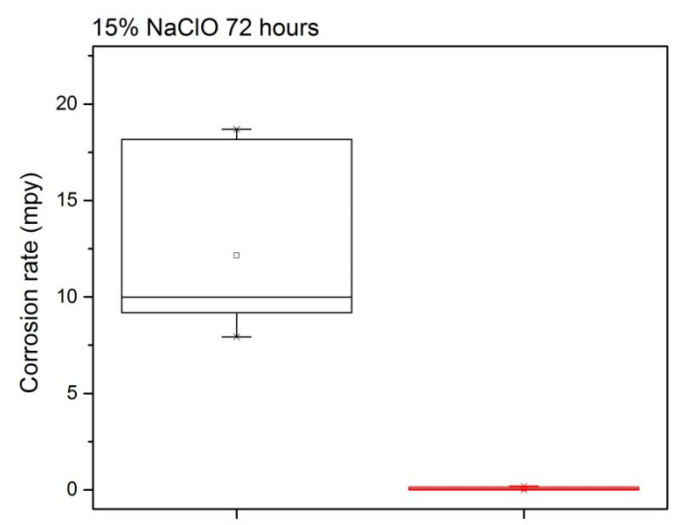


Bleach is very aggressive to stainless steel and other surface treatment, but Dursan provides stable protection.

This is especially useful in biomedical and pharma applications where bleach is commonly used.

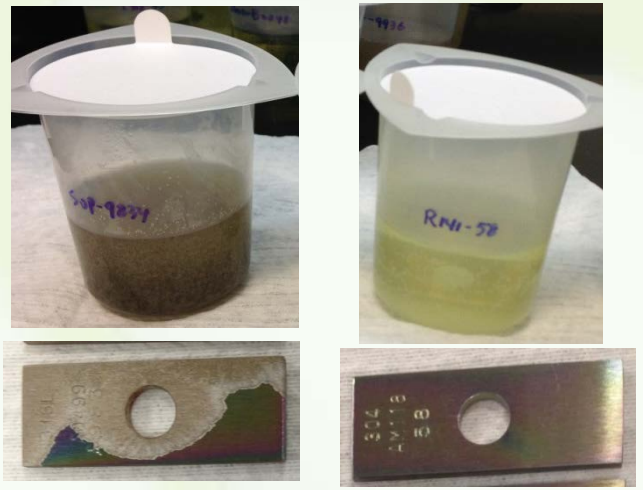
15% Bleach

Bleach Corrosion



Other Coating

Dursan®

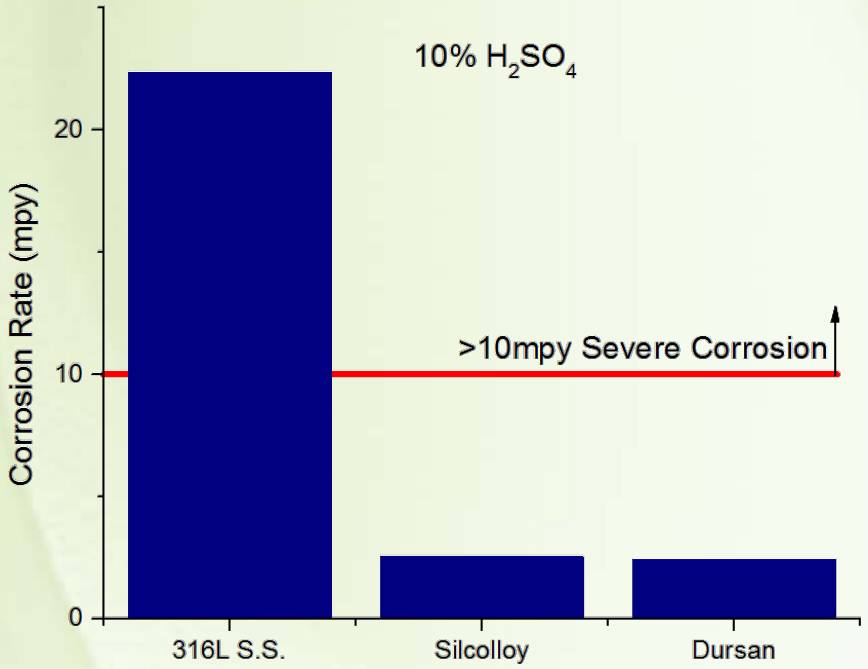


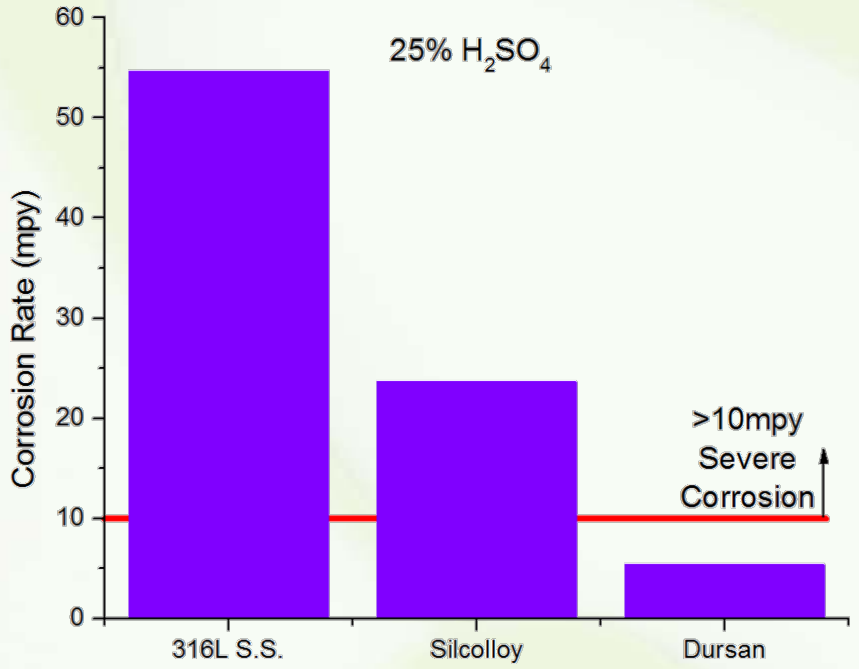
Other Coating

Dursan®

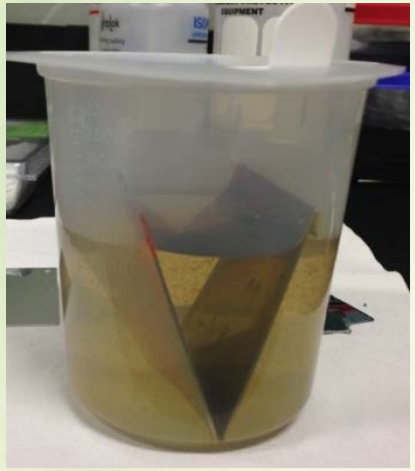
Sulfuric Acid

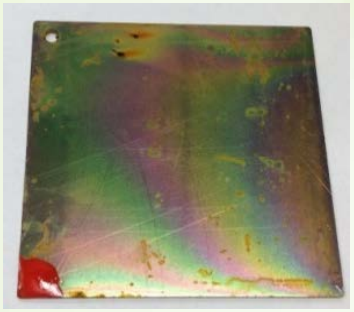
- ASTM G31 Guidelines
- Sufuric Acid Exposure
- 24 hrs at Room Temperature

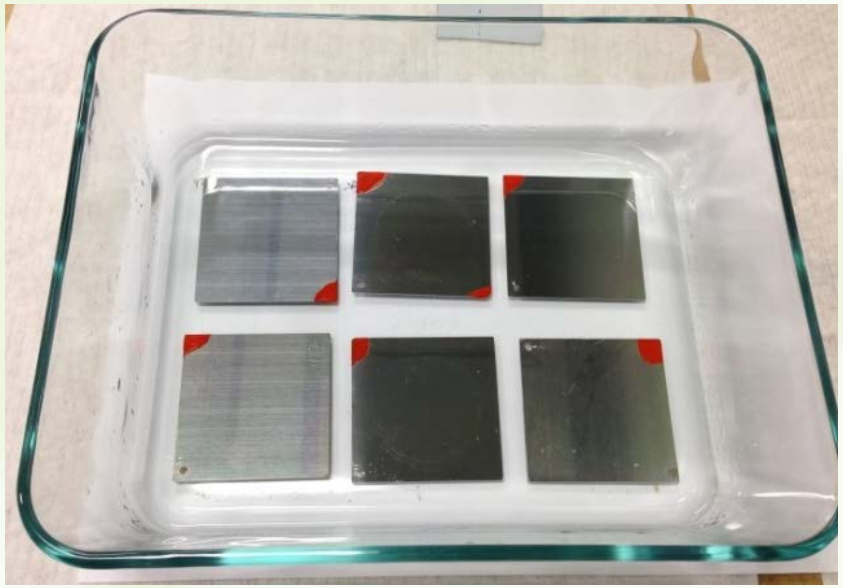




Salt Water Immersion



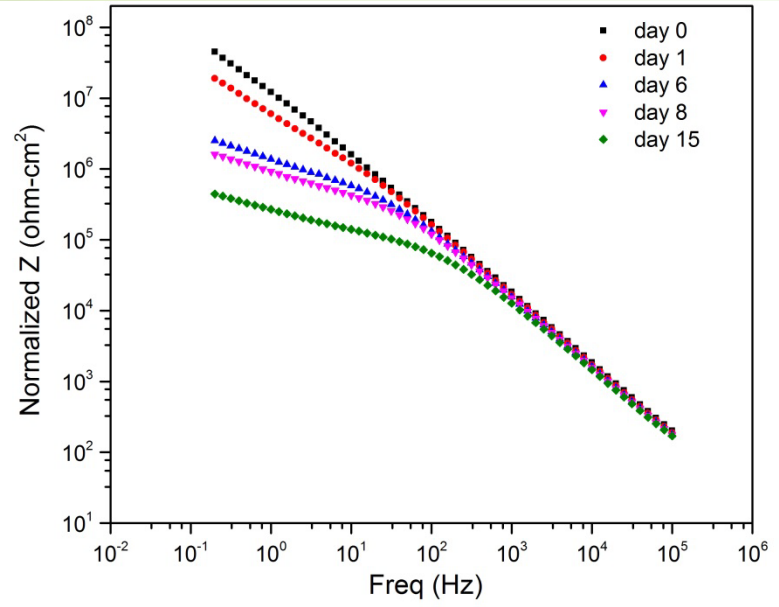


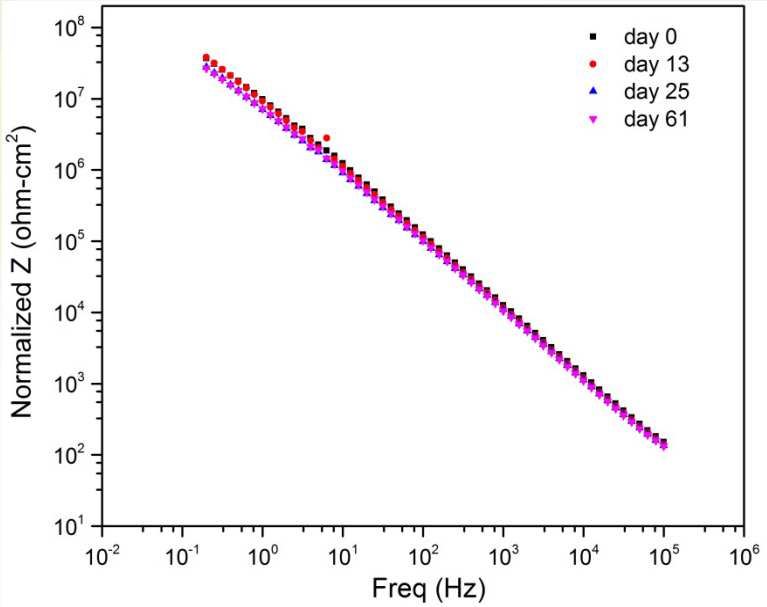


Dursan® Coating (right) shows no degradation in salt water after 60 days of exposure

Salt Water

Dursan® Coating (right) shows excellent dielectric stability in salt water after 60 days, providing an effective corrosion barrier on the substrate.





ASTM G48 B: Pitting and Crevice Corrosion

Corrosion Resistance on Carbon Steel

Carbon Steel

- SilcoTek's coating processes are optimized for stainless steel, titanium, and other performance alloys
- Carbon steel can still be coated successfully
- Coatings perform well on carbon steel for barrier/general chemical resistance applications. They do not provide corrosion resistance comparable to SilcoTek coatings on stainless steel substrates

Material

- Three types of carbon steel corrosion coupons were tested, with increasing amount of carbon content
  - C1018 is the most commonly available of the cold-rolled steels
  - A36 is the most commonly available of the hot-rolled steels
  - C1045 is generally supplied in the hot-rolled condition

Type of steel	C1018	A36	C1045
Carbon content	0.18%	0.26%	0.45%

uncoated

SL1000-coated

Dursan-coated

Carbon Steel –Salt Spray

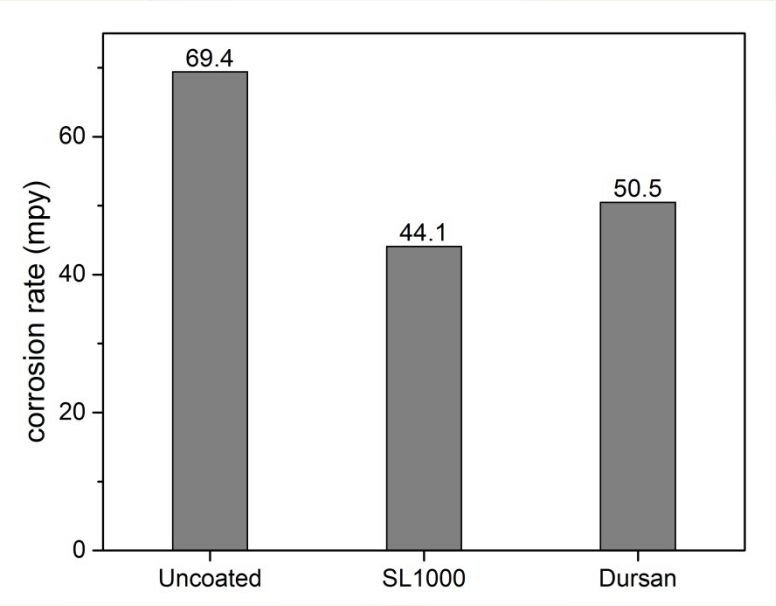
Salt spray: ASTM G85-A2

- Carbon steel type: C1018

uncoated

SL1000-coated

Dursan-coated



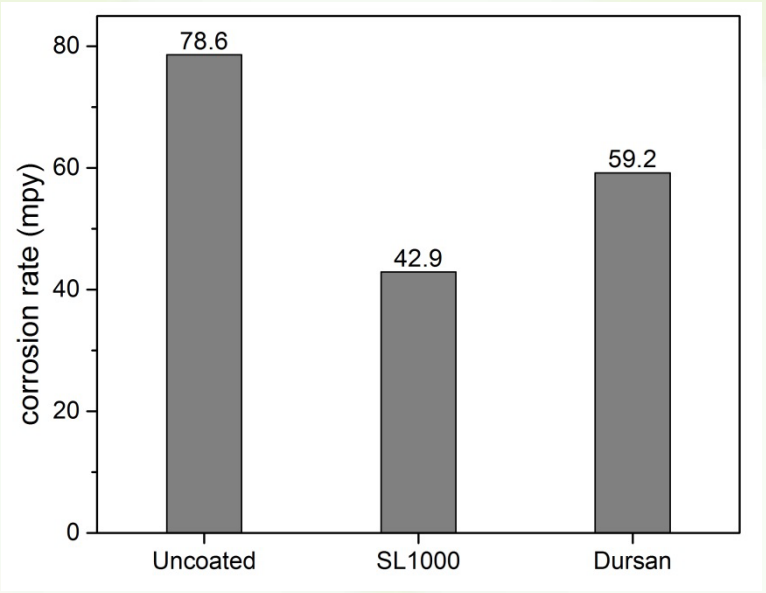
Salt spray: ASTM G85-A2

- Carbon steel type: A36

uncoated

SL1000-coated

Dursan-coated



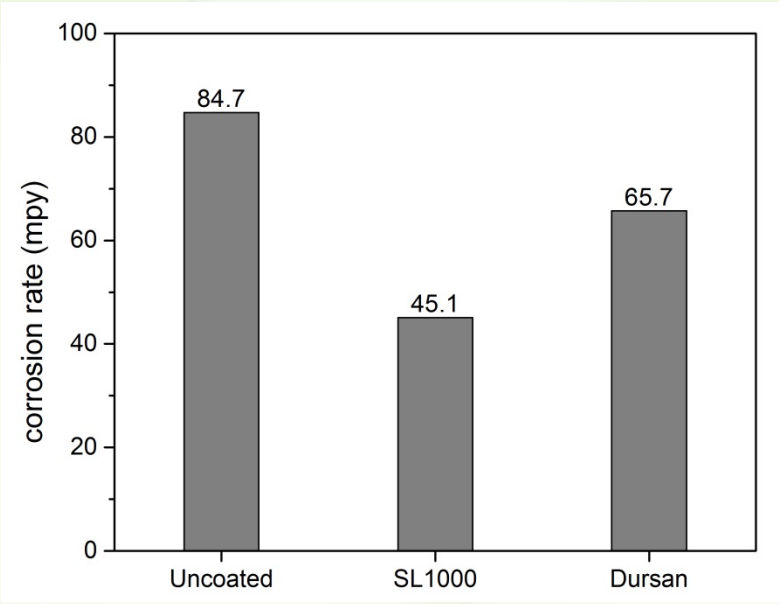
Salt spray: ASTM G85-A2

- Carbon steel type: C1045

uncoated

SL1000-coated

Dursan-coated



Carbon Steel – Salt Spray Testing

- Both coated and uncoated carbon steel coupons were severely rusted after 264 hours of exposure
- Still, SilcoTek coatings helped to reduce the corrosion rate
- Consult SilcoTek tech. service to select both the best coating and substrate for your application

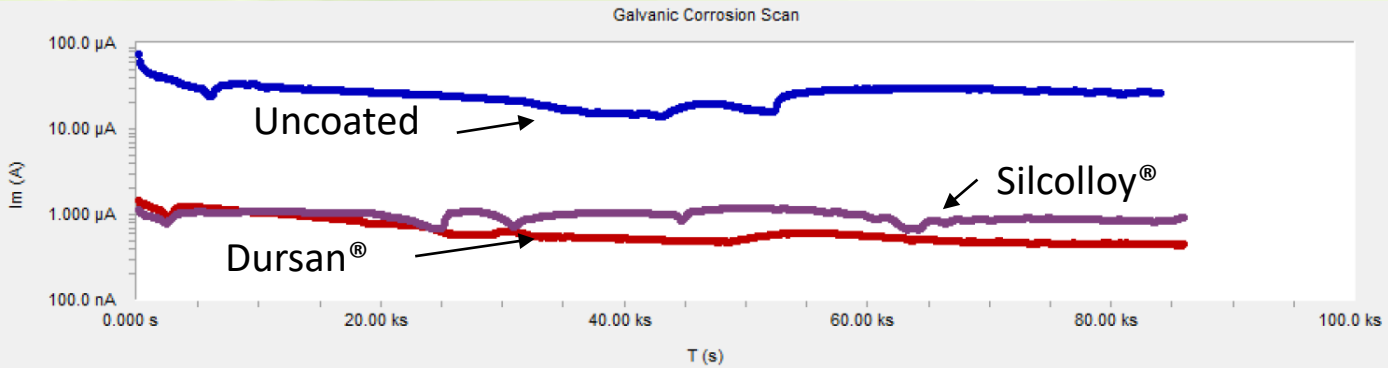
Carbon Steel - Hydrochloric Acid

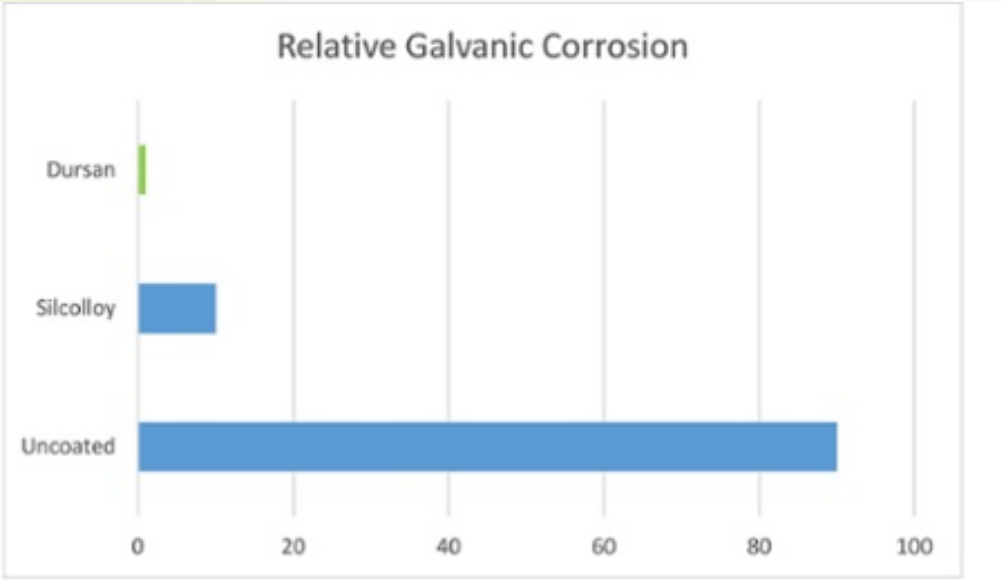
Carbon Steel – HCl Corrosion Resistance

- SilcoTek coatings on stainless steel provide excellent protection to HCl exposure (see previous slides)
- However, the coating did not provide much benefit on carbon steel in the same tests
- **Optimizing coating and substrate selection to deliver best performance for the right cost is key**

Galvanic Corrosion
304 SS coupled to 6061 Al

Galvanic Corrosion





- Both Dursan and Silcolloy noticeably minimize the effect of galvanic corrosion when coated 304SS is coupled to 6061 aluminum.
- Dursan offers drastically improved protection from galvanic corrosion over uncoated 304 SS (up to 2 orders of magnitude).

SilcoTek Coatings as a Solution

- Cost-effective alternative to exotic metals
- Upgrade current components or easily install new, coated parts
- Advantages of CVD process: easily coats complex geometries; doesn’t affect tolerances; environmentally benign

Case Study: Turner Designs Hydrocarbon Instruments

See how Turner Designs Hydrocarbon Instruments cut costs and increased performance of their oil in water monitors by using stainless steel coated by SilcoTek's corrosion resistant surface technology instead of exotic metals.

Download the case study →

Download Now

Contact SilcoTek

- For technical service and sales:
  - SilcoD@SilcoTek.com

- In the USA, call: 814-353-1778
- In the EU, call: +49 6172 279718

- www.SilcoTek.com