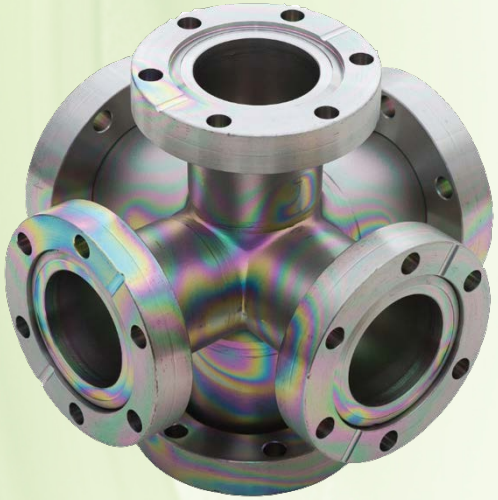
A Bulk, Low Energy Surface Treatment for 3-Dimensional Substrates via CVD Processing



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Taking Control of Surfaces

- Silicon (Si) naturally prevents unwanted chemical reactions (adsorptive or corrosive) with substrate
- Functionalization further enhances silicon's advanced properties for demanding applications
- Chemical Vapor Deposition (CVD) process provides robust and repeatable outcomes

SilcoTek® Introduction

- Born in chromatography
- SilcoTek launched in 2009
- Focused exclusively on CVD coatings

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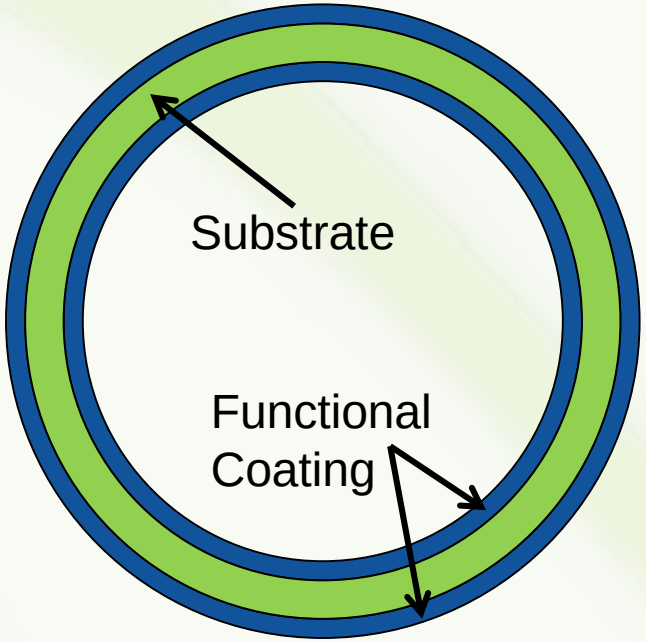
Applications

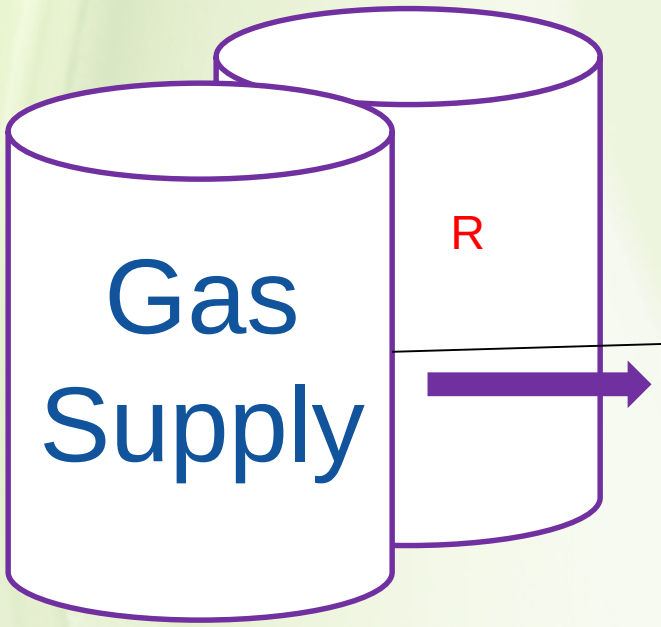
Analytical Chemistry	Oil and Gas Exploration
Refinery/Petrochemical	Semiconductor Manufacturing
Bio/Pharma	Automotive
Aerospace	Offshore
Chemical Manufacturing	Power Generation

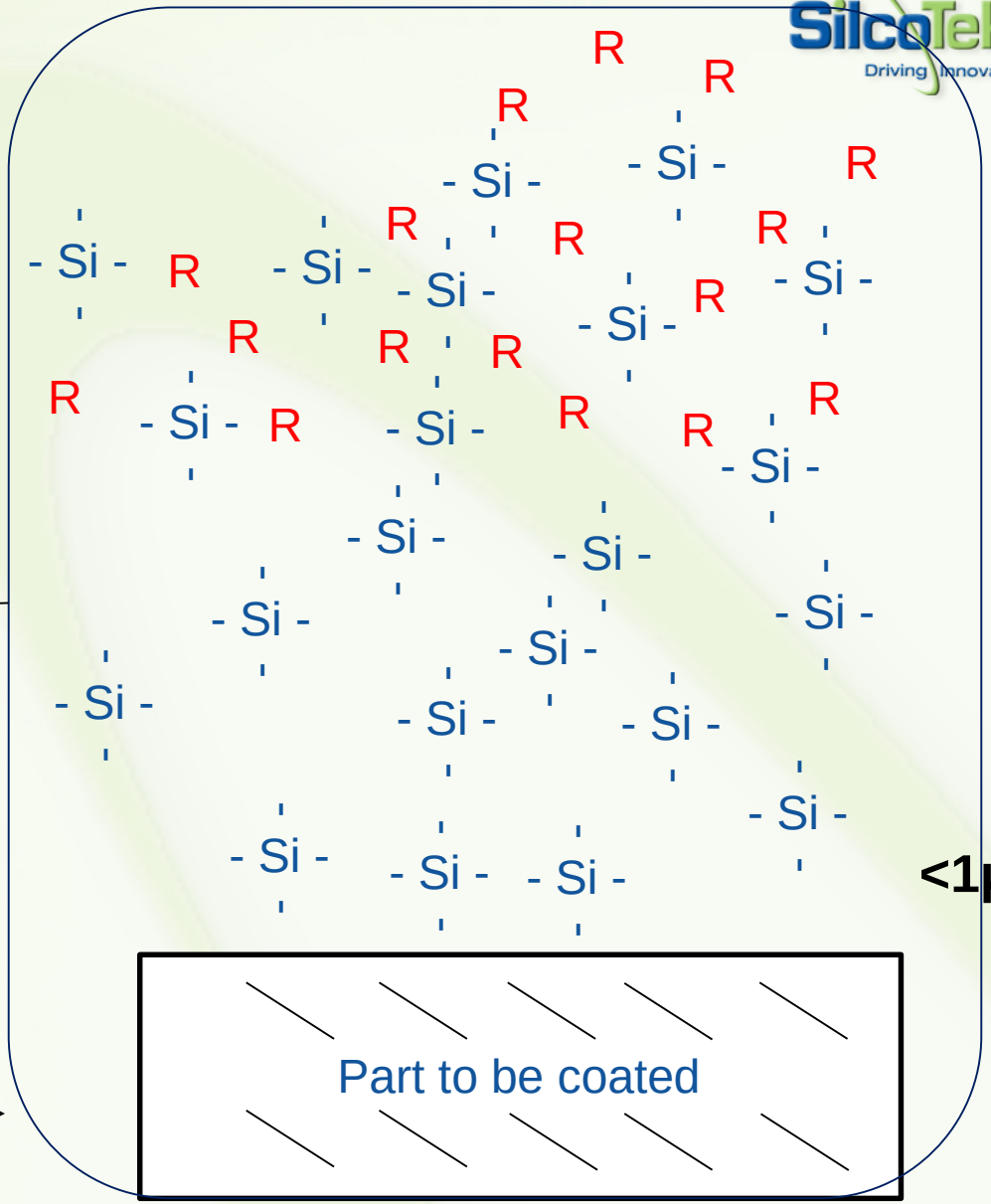
What we do

- Thermal chemical vapor deposition (CVD) “coatings”
- Amorphous silicon (a-Si)-based
- Functionalization for **advanced** properties



The CVD Process





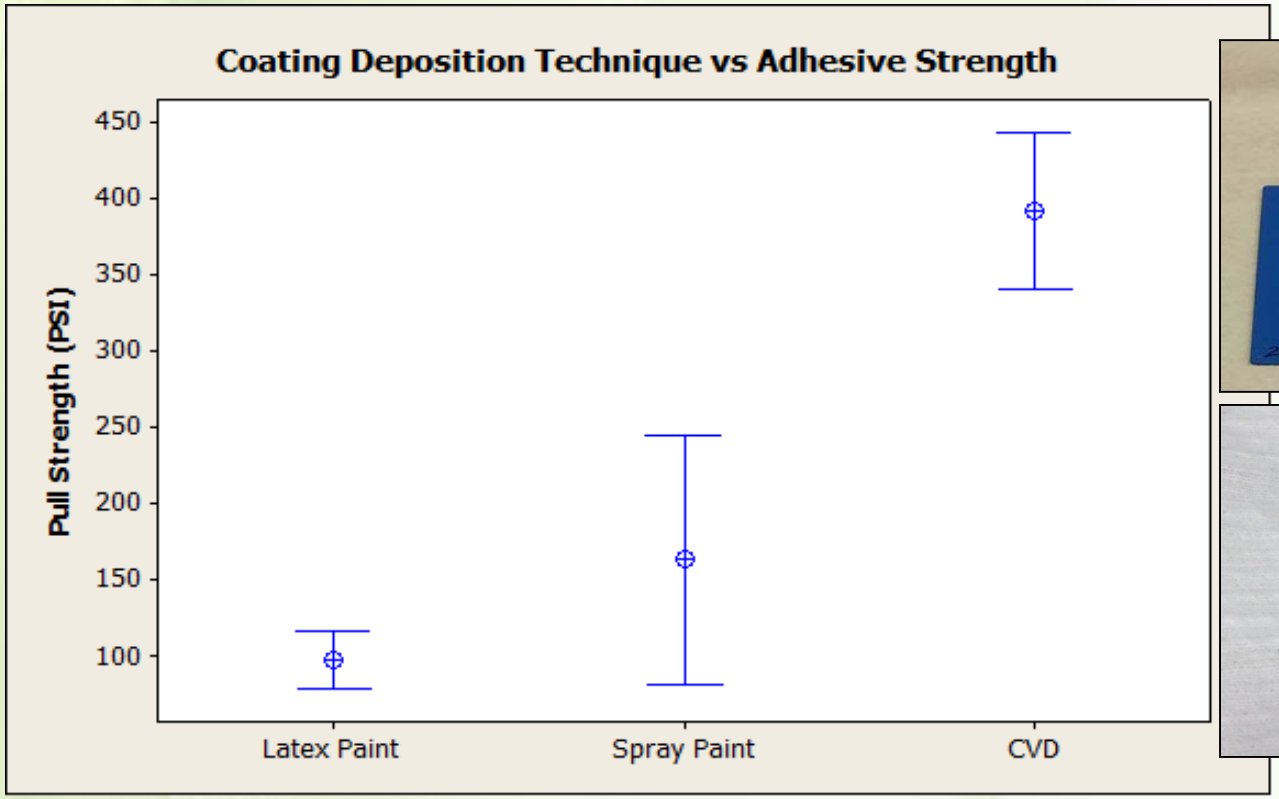
Processing Chamber (vacuum)

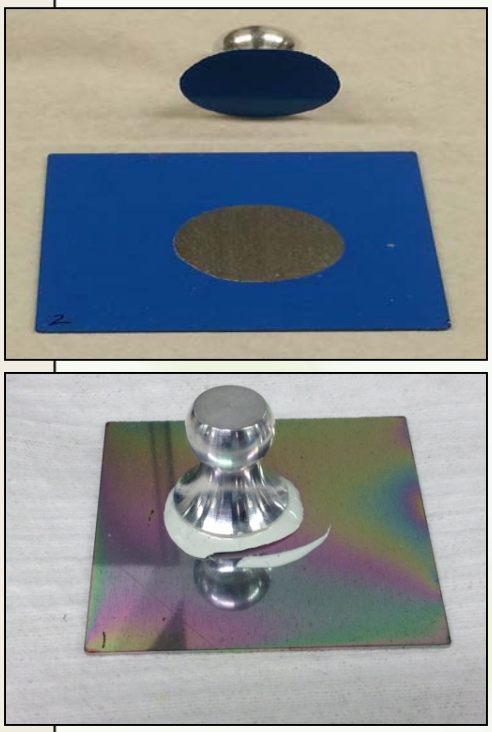
Up to 450° C

Advantages of CVD

- Non-line-of-sight; uniformly treats 3D, high aspect ratio part geometries
- Molecular adhesion to base substrate
- Scalable, versatile, and highly reproducible

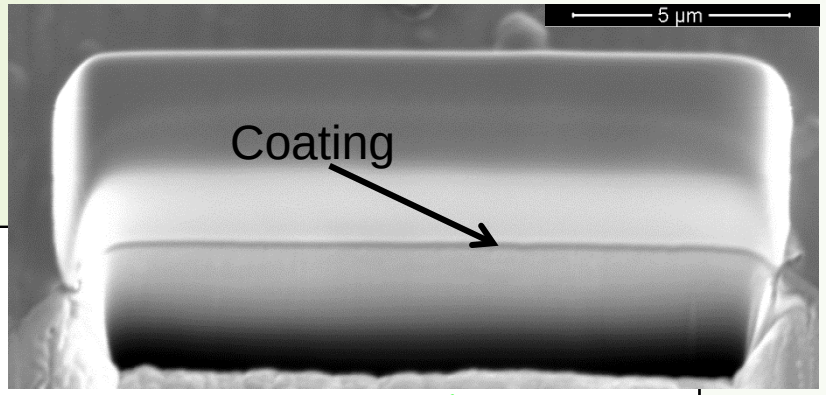
Coating Adhesion (Pull Strength)

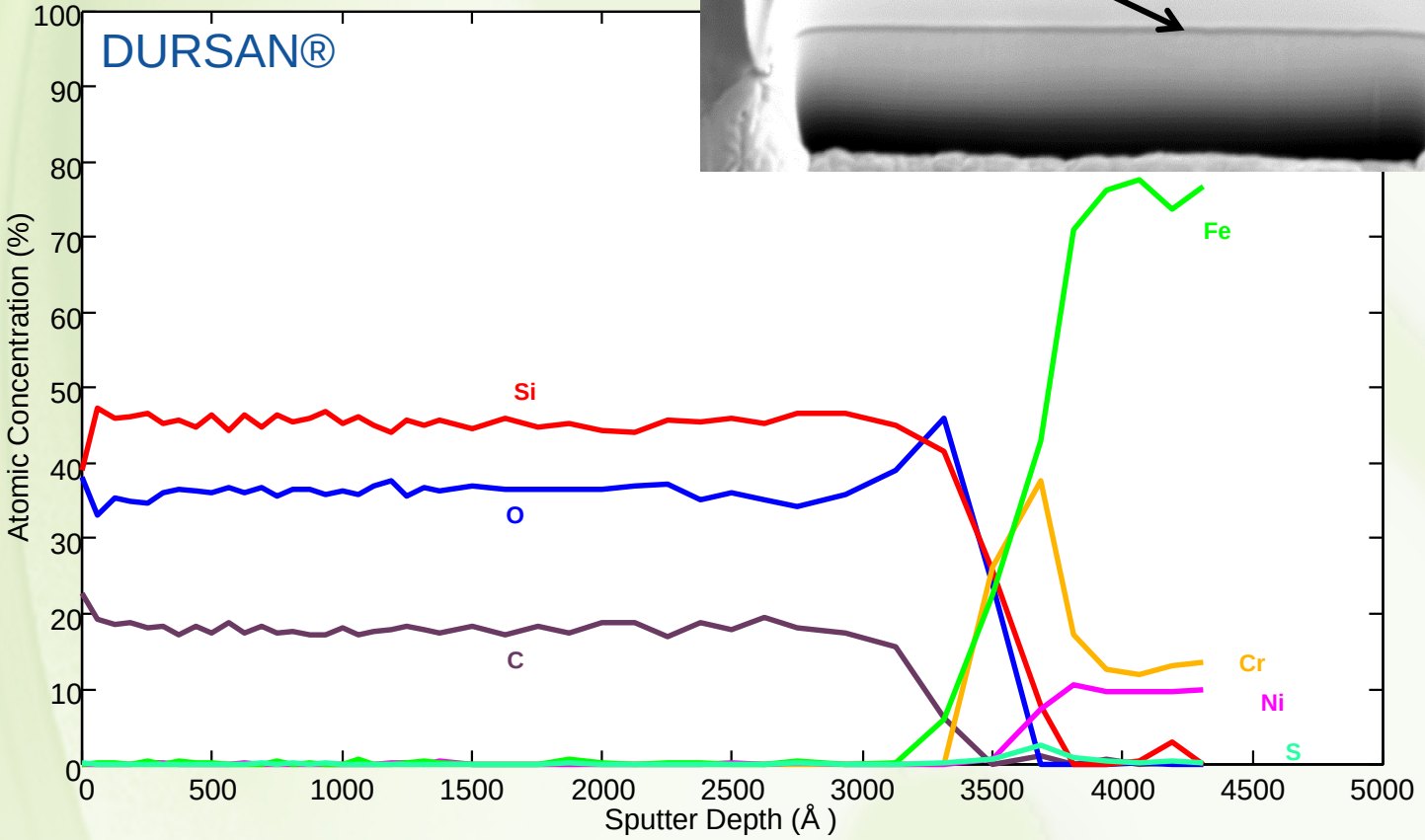




- Adhesive Strength to Dursan® Fails Before Coating Adhesion to Substrate (>200-300 PSI)

Elemental Composition





* - Auger Electron Spectroscopy depth profile of Dursan® on 304 S.S.

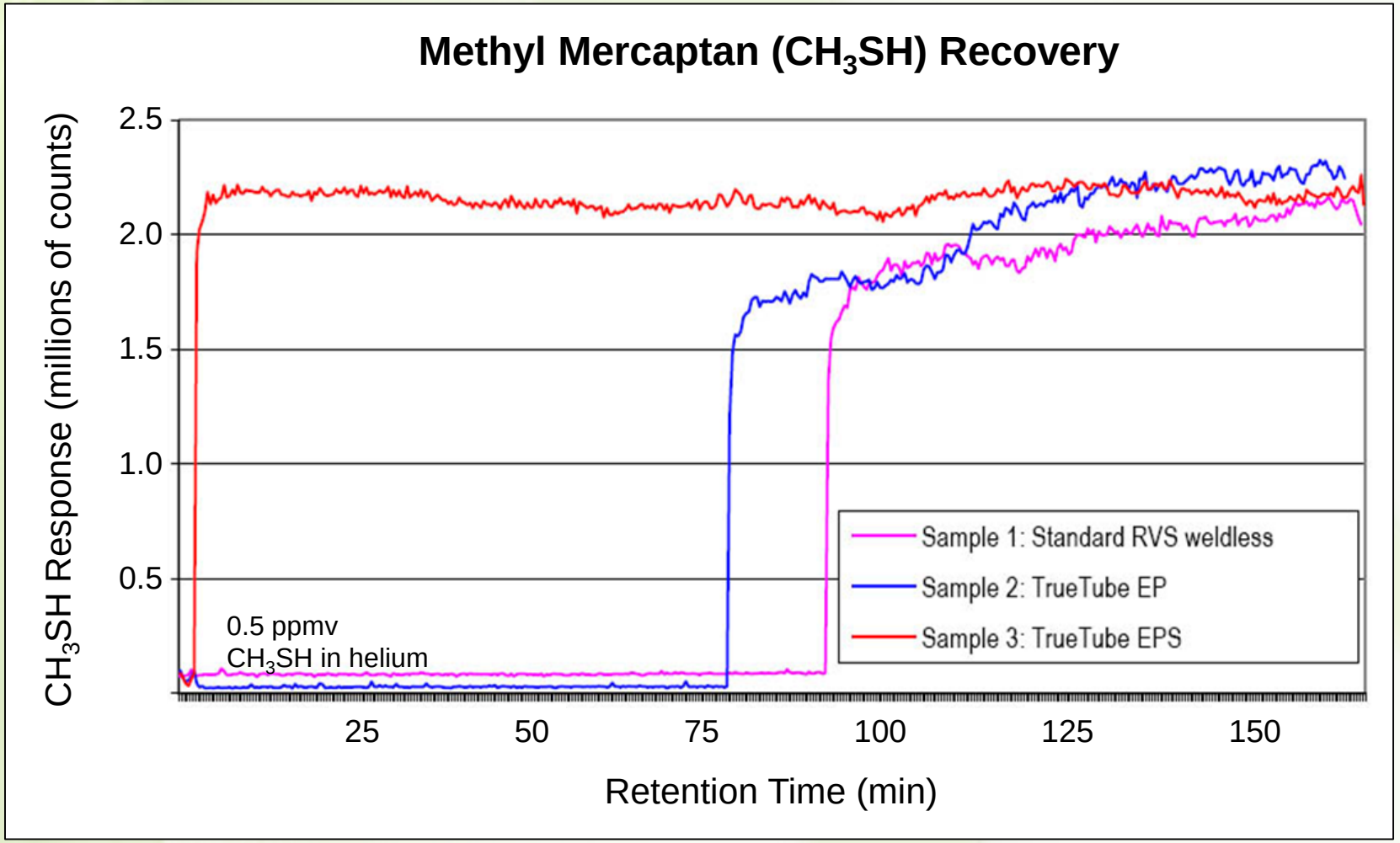
Coating Properties

1. Chemical inertness
   - Accurately analyze trace (as low as parts-per-trillion) H2S, mercury, ammonia, etc.
2. Corrosion resistance
   - Longer life, less maintenance, lower costs
3. Low energy
   - Hydrophobicity, anti-stiction, anti-coking, etc.

Chemical Inertness

Preventing adsorption to allow chemical detection at trace (<ppm) levels

Inert Barrier Stops Reactivity



*Data courtesy of Shell Research Technology Centre, Amsterdam and O'Brien Corp.

Corrosion Resistance

Increasing usable lifetime of ideal materials of construction

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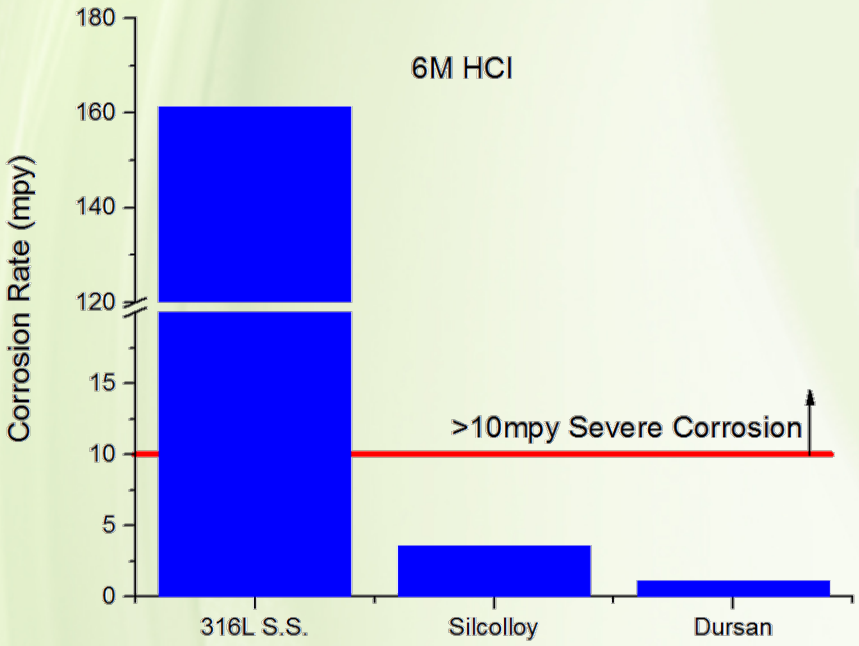
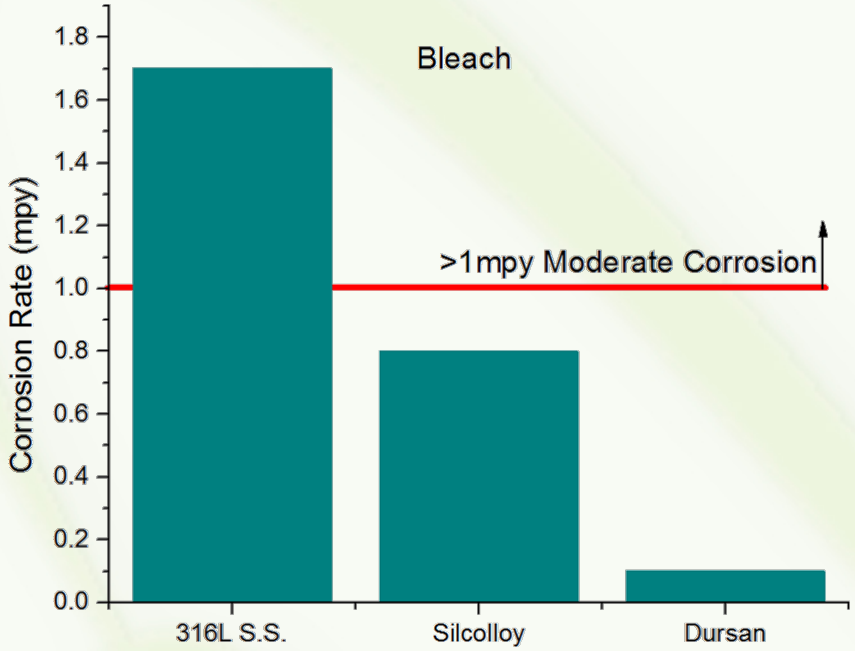
Corrosion Resistance



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

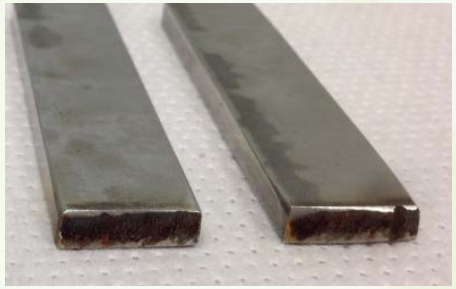
- ASTM G31 Guidelines
- 15% NaClO Exposure
- 72 hrs at Room Temperature



Salt Spray

- 24 weeks of acidified salt spray per ASTM G85-A2. Total exposure time: 4032 hours.
- Uncoated coupons: moderate rust on all faces
- Duplex alloy 2205 showed rust on edges
- Dursan-coated coupons: no visual rust or weight loss

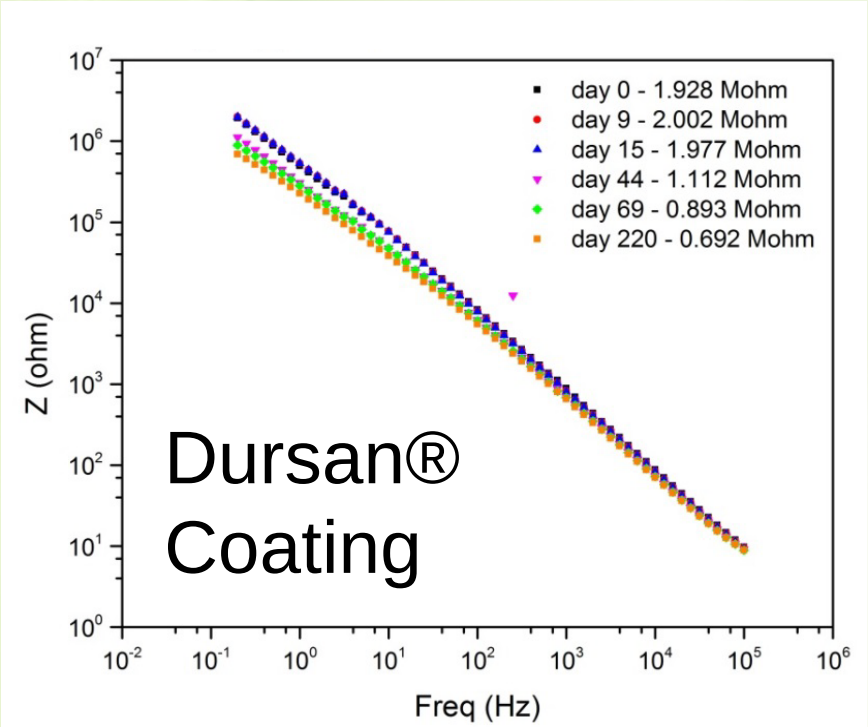
Bare 316L

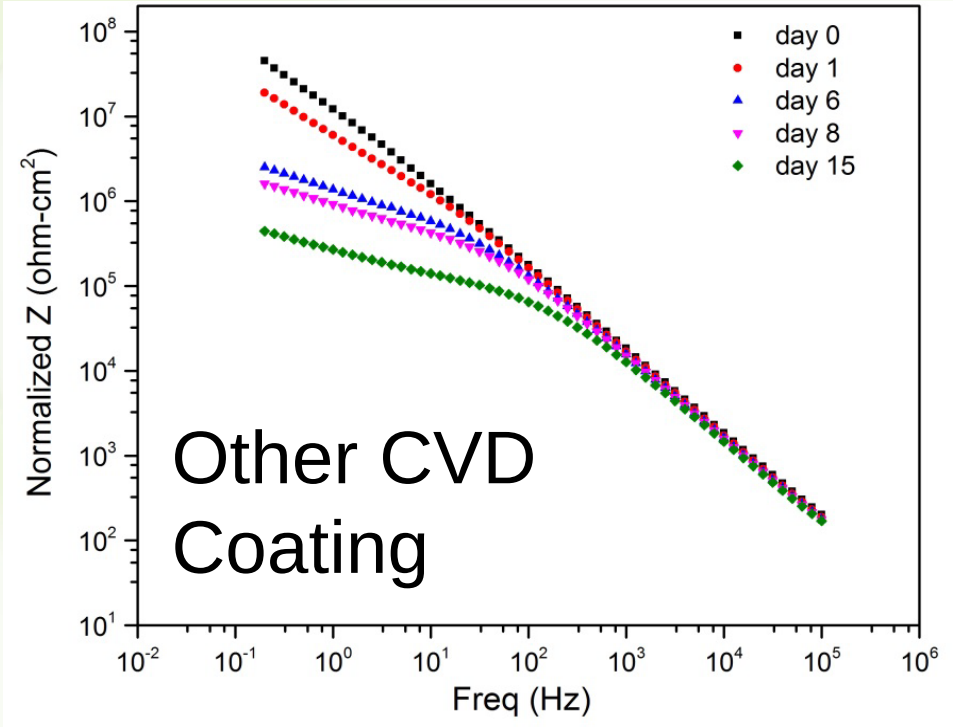


Duplex 2205

Dursan-coated

EIS – Salt Water (5% NaCl)





Dursan® shows dielectric stability over 220+ days in salt water, demonstrating sustained corrosion resistance

Low Energy

Increasing efficiency by preventing adhesion of unwanted media

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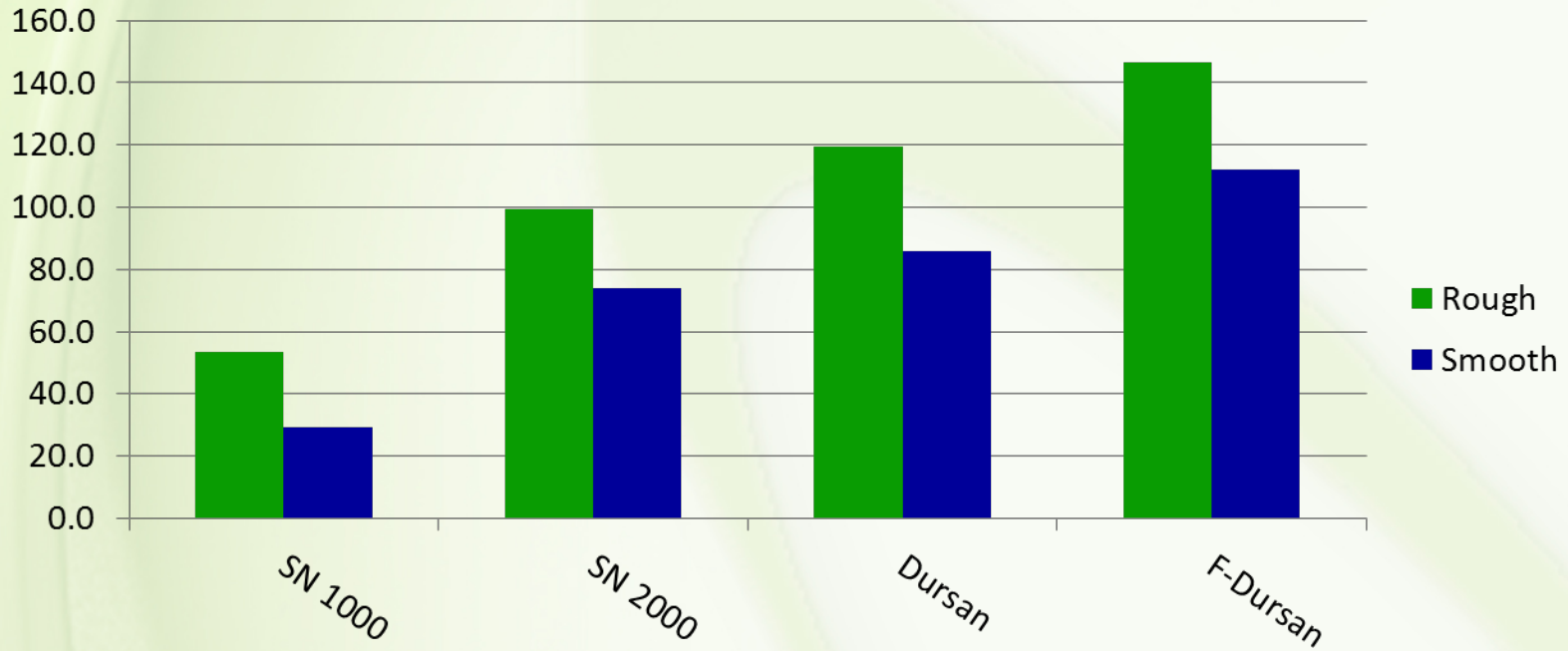
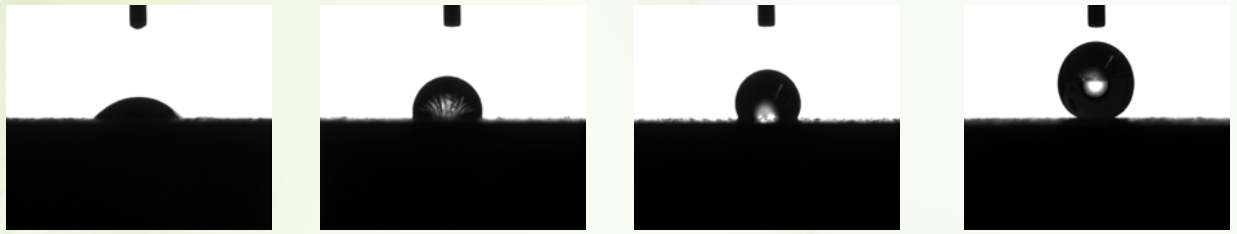
Low Energy, High Potential

- Substantially reduce coking/fouling
  - Improve fuel efficiency in auto applications
- Prevent sticking
  - Biomaterials, chemicals, etc.

- Improve hydrophobicity
  - Needed in process monitoring, sampling, and other analytical applications

Hydrophobicity





SN 1000
49°

SN 2000
101°

Dursan
121°

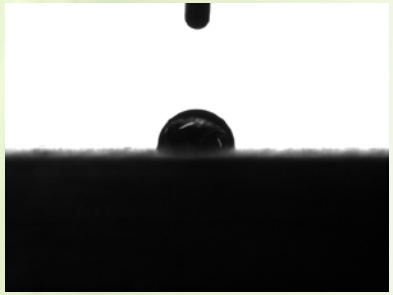
FluoroDursan
163°

← Rough Coupons

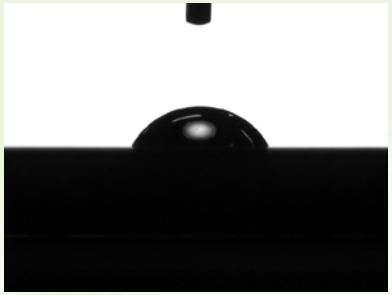
Rough: 120 grit; 58 rms (µin.)
Smooth: mirror-like #8; 10 rms (µin.)

Oleophobicity

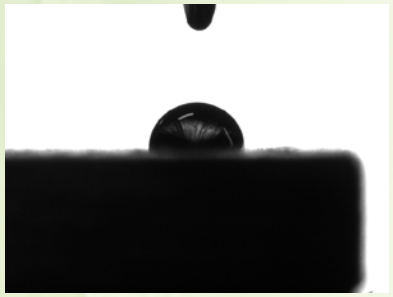
SilcoTek-Coated



Hexadecane on rough
92.6˚



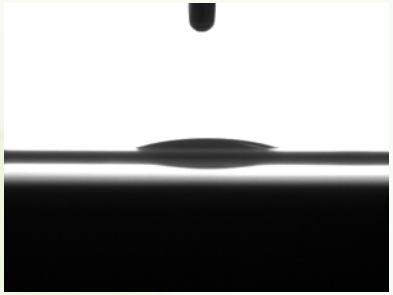
Hexadecane on smooth
66.0˚



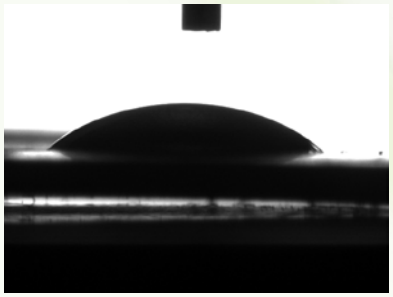
10W40 oil on rough
95.5˚

10W40 oil on smooth
70.2˚

PTFE

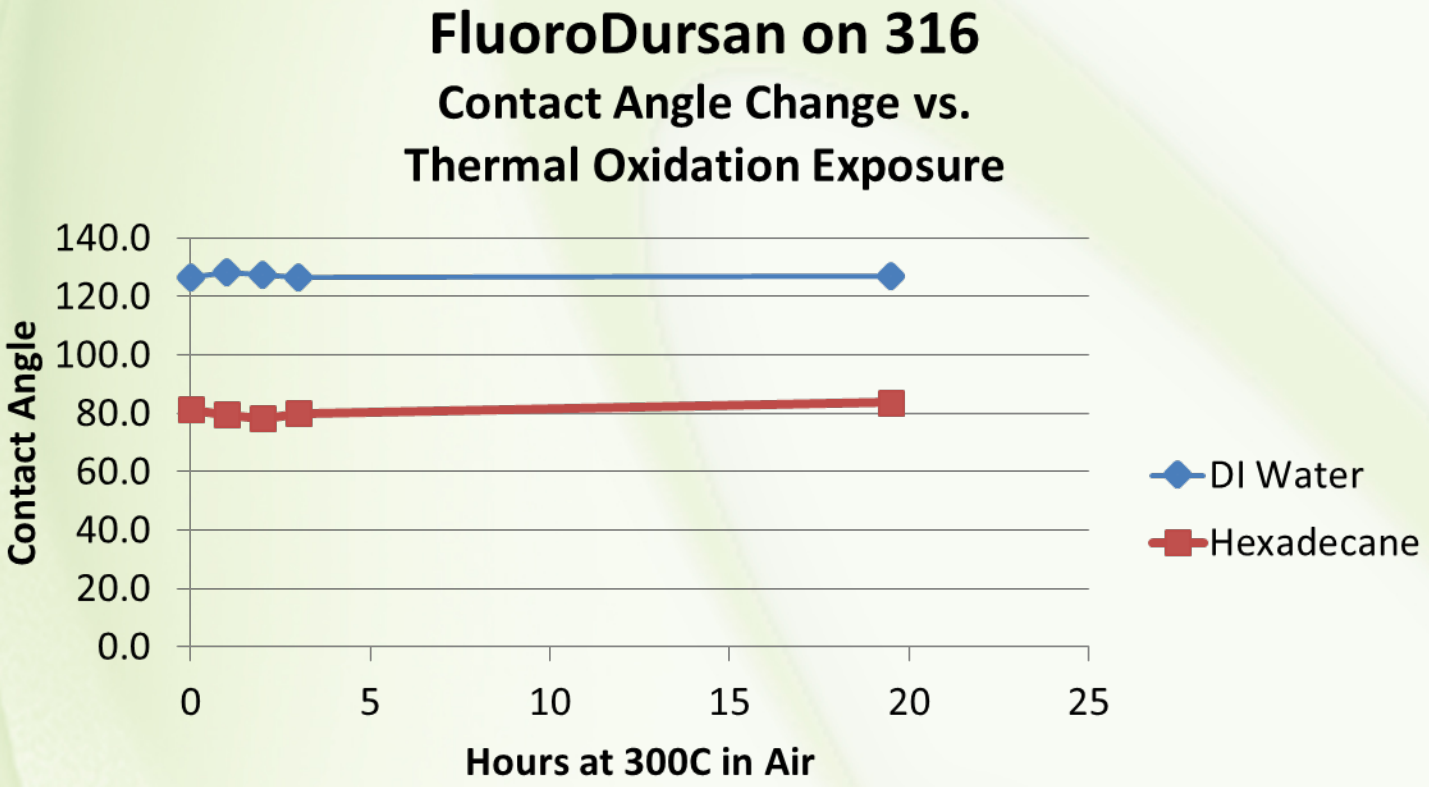


Hexadecane on PTFE
29.7˚



10W40 oil on PTFE
48.5˚

Stability of Low Energy Surface



Summary

- Functionalized silicon coatings provide ideal properties not attainable with base metals
- 3D CVD coating process is robust regardless of part complexity or tolerances
- Whether in the field or lab, SilcoTek coatings offer advanced surface performance

Questions?

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