

# Restek Corporation Performance Coatings



**RESTEK**

**HR**OMalytic **ECH**nology **PTy Ltd** **+61(0)3 9762 2034**

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

# Restek Corporation Background

Established in 1985 as gas chromatography supplies company

Currently \$25M+ annual revenue, double-digit growth 16 of 18 years

- GC columns and consumables
- Chemical standards
- LC columns and consumables
- Air analysis canisters and supplies
- Performance Coatings Division



**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECH**nology Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Performance Coatings Background

Began with tubing in 1987

Stand-alone parts in 1993

Initial goal to impart the inertness of glass on a steel surface (Silcosteel<sup>®</sup>)

New surfaces in 1997 expanded applicability and performance (Siltek<sup>™</sup>)

Patent protection

Concerted development effort launched in 2002

RESTEK

**CHROM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# What can we coat?

## Tubing:

- 0.004" to 0.5" ID
- 2000+ ft. continuous lengths

## Complex geometry parts (inside and out)

- Fittings, valves, frits, custom parts
- Largest vessel: 1' ID x 4' cylinder w/ 10" opening

## Substrates

- Stainless steels, steels, alloys, glass, ceramics

RESTEK

**HROM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# What can't we coat?

Nickel (most high-performance alloys will coat)

Aluminum\*

Copper

Brass

Gold, Silver-plated components

Magnesium

Elastomers

\*heat-dependent

RESTEK

**CHROM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Basic Manufacturing Process

Receive items

Document – digital, customer contact

Clean

- Standard: caustic ultrasonic bath, 2 systems
- Custom: solvation via other means

Process

- Vacuum
- 400°C
- Chemical vapor deposition, silicon-based

Clean

Document – digital, customer contact

Pack, ship

RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Application Areas

Analytical (passivation): Silcosteel<sup>®</sup>,  
Siltek<sup>™</sup>, Sulfinert<sup>™</sup>

- Transfer lines
- Instrumentation parts
- GC consumables

Anti-Coking: Silcosteel<sup>®</sup>-AC

Anti-Corrosion: Silcosteel<sup>®</sup>-CR

Ultra-High Vacuum: Silcosteel<sup>®</sup>-UHV

RESTEK

**HRM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)



## Coating Appearances

Silcosteel<sup>®</sup>

Sulfinert<sup>™</sup>

Siltek<sup>™</sup>

**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECH**nology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)



# Coating Appearances (cont.)



**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# New Process Oven



**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# More Parts



**RESTEK**

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Inertness

Application: Reduce activity of substrate (ie., stainless steel) to minimize adsorption of compounds

Coated system products deliver better reproducibility and accuracy by reducing hold-up of active compounds

List of some active compounds: Hydrogen Sulfide, Nitrous Oxides, Mercury, Alcohols, Aldehydes, Ketones, etc.,.

RESTEK

**HRM**alytic +61(0)3 9762 2034  
**ECH**nology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Project Objective

- To create passivation processes for stainless steel and glass surfaces which will allow the analysis of low-ppbv sulfur gases
  - Chromatographic sampling system
  - Containment vessels (high pressure vessels and air sampling canisters)

# Testing System for Sulfur Gas Storage Transfer

- Sulfinert™-deactivated sample cylinders with Sulfinert™ sample valves
- Sulfinert™-deactivated sampling system (transfer line, sampling valve, 1ml sample loop)
- 48hr (minimum) containment of dry sample
- 55ppbv reference standard
- Dimethyl sulfide internal standard

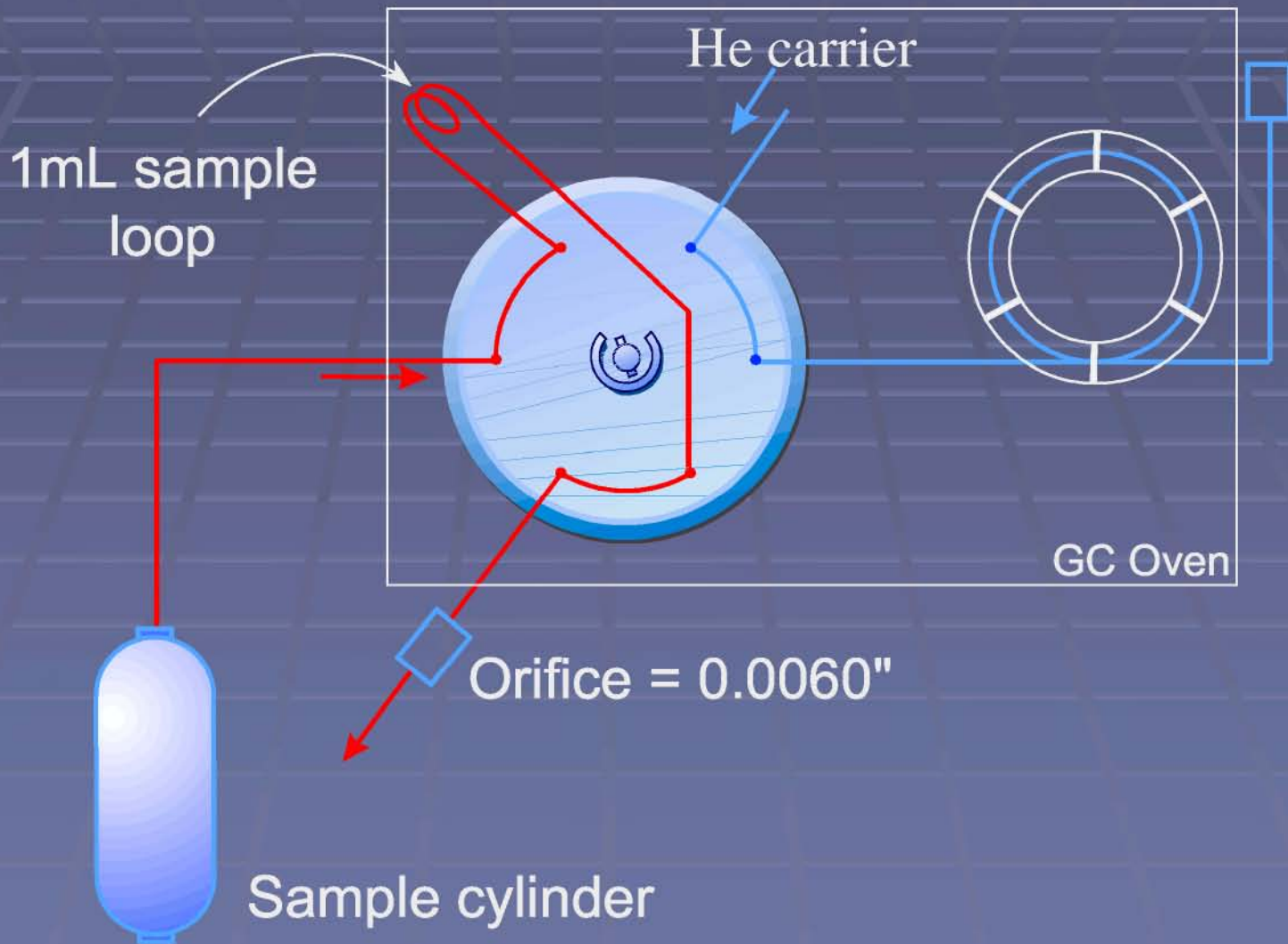
**RESTEK**

**HRMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Complete Sulfur Analysis System



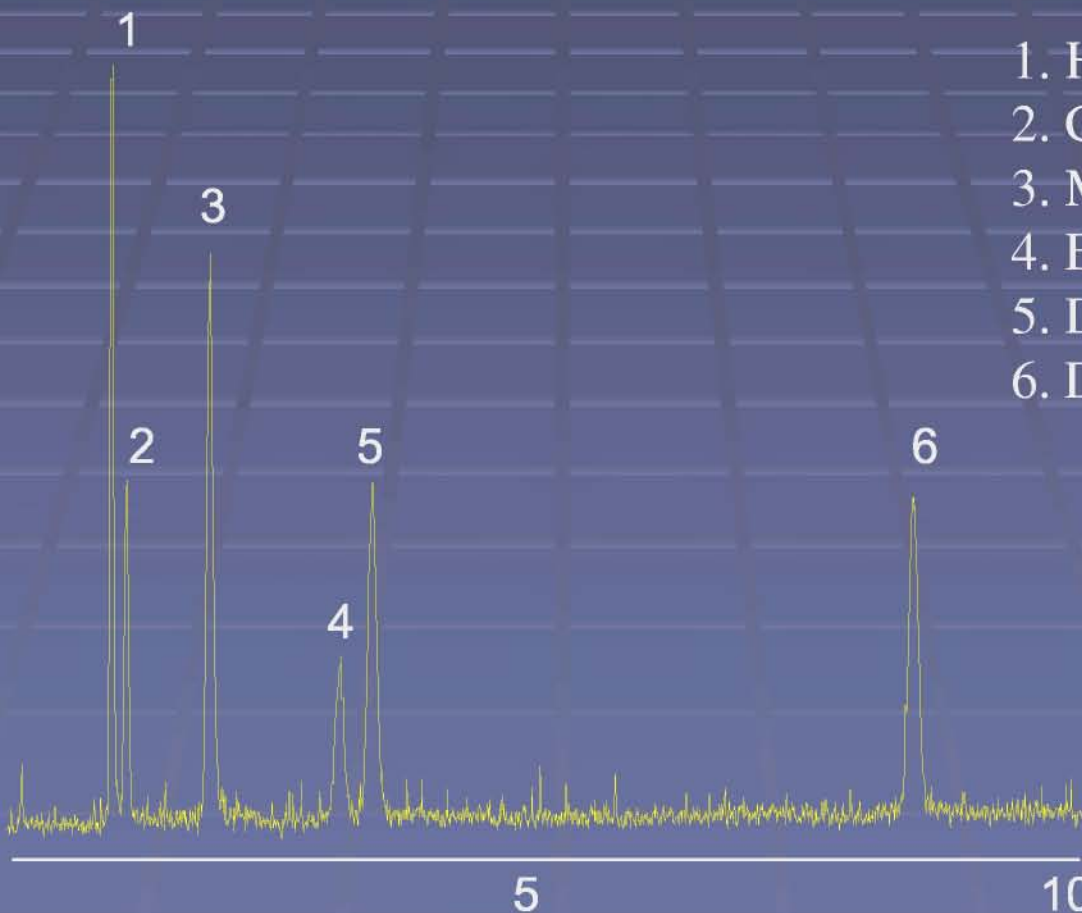
RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# 11 ppbv Sulfur Standard



1. H<sub>2</sub>S
2. COS
3. Methyl Mercap
4. Ethyl Mercap
5. Dimethyl Sul
6. Dimethyl Dis

RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

0.53mm, 7.0µm



# List of Sulfur Compounds

Compound Name	Formula	Conc (ppmv)	Conc (ppbv)	Conc a (ppbv)
Hydrogen sulfide	H <sub>2</sub> S	105	11.51	10.83
Carbon monyl sulfide	COS	98	10.74	5.73
Methyl mercaptan	CH <sub>3</sub> SH	101	11.07	7.38
Ethyl mercaptan	CH <sub>3</sub> CH <sub>2</sub> SH	101	11.07	5.71
Dimethylsulfide	CH <sub>3</sub> SCH <sub>3</sub>	99	10.85	6.81
Dimethyl disulfide	CH <sub>3</sub> SSCH <sub>3</sub>	100	10.96	7.46

**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECH**nology Pty Ltd

**Australian Distributors**  
 Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# System Repeatability

Compound Name	%RSD
hydrogen sulfide	2.2
carbonyl sulfide	4.2
methyl mercaptan	2.0
ethyl mercaptan	8.7
dimethylsulfide	3.3
dimethyl disulfide	9.2

n=7

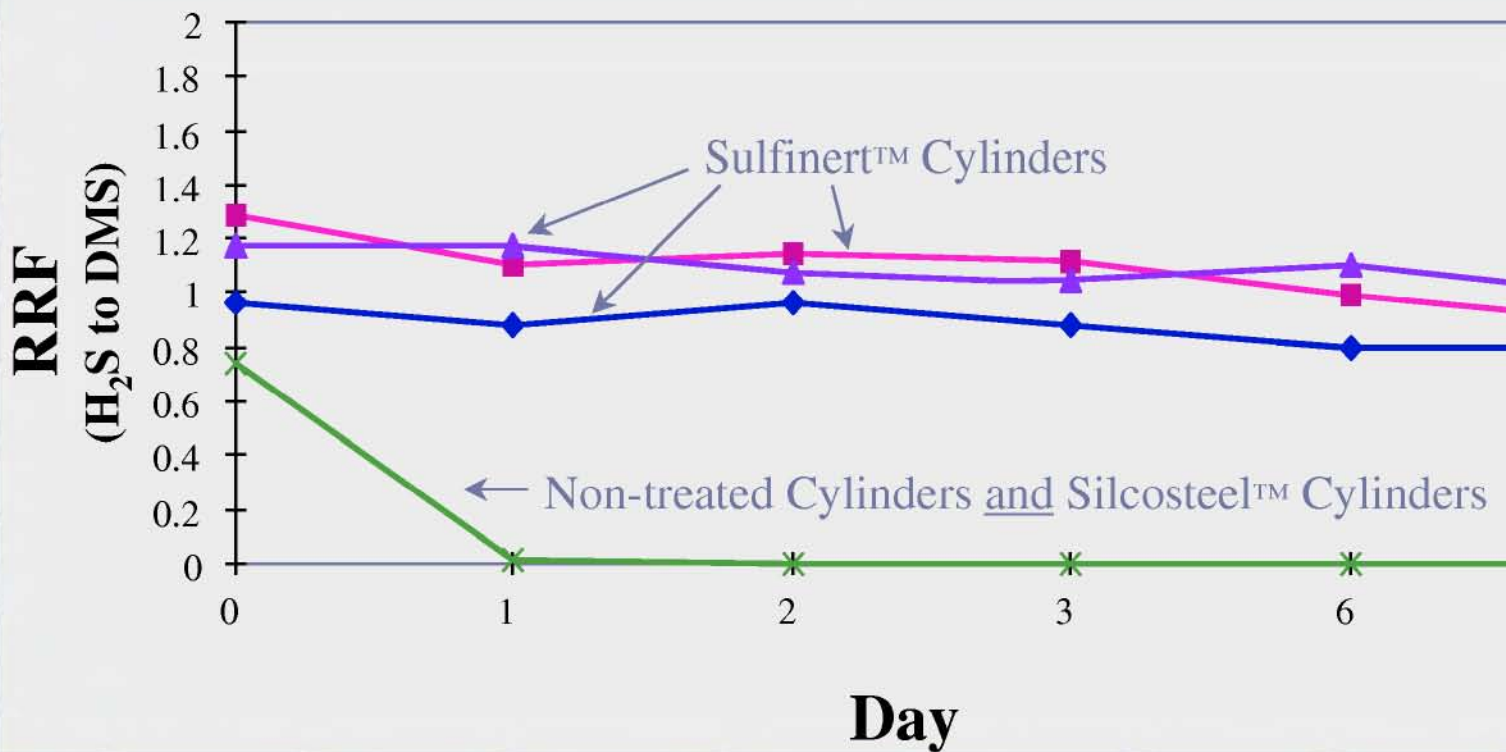
RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

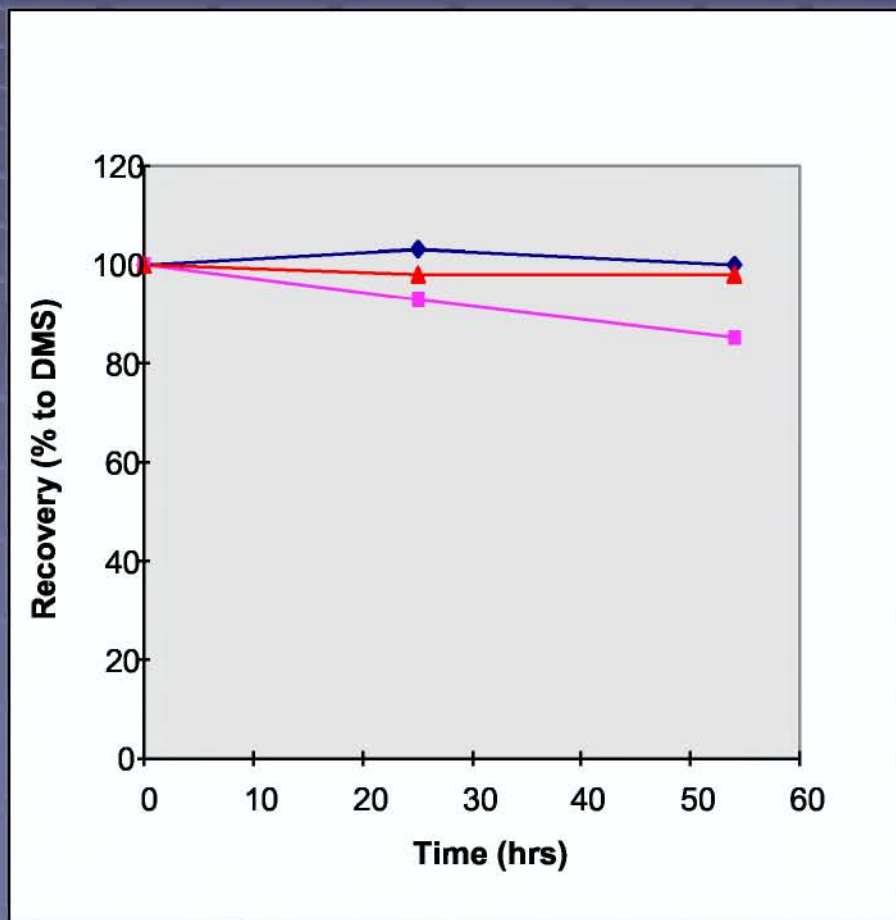
Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# 17ppbv H<sub>2</sub>S Containment in 500ml Cylinders



# H<sub>2</sub>S at 27.57ppbv in 300ml Sulfinert Cylinders



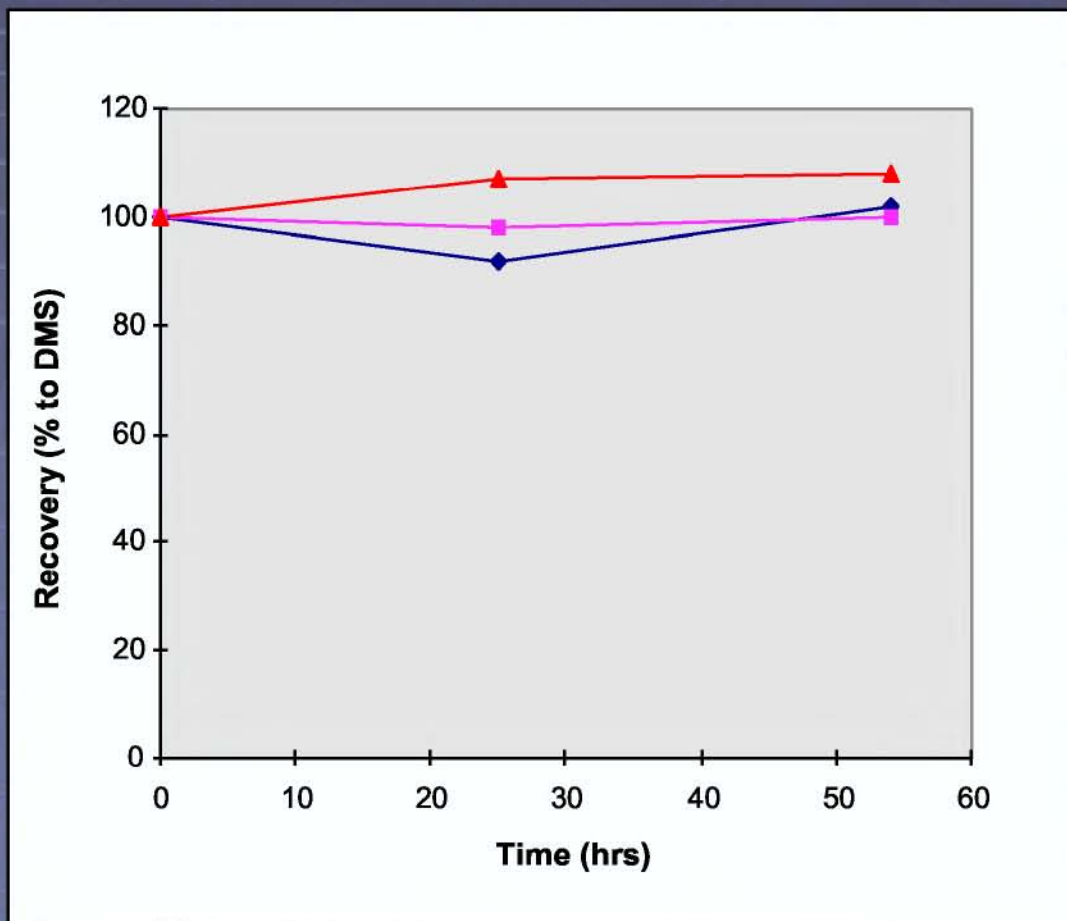
RESTEK

**HRM**alytic +61(0)3 9762 2034  
**ECH**nology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# COS at 14.59ppbv in 300ml Sulfinert Cylinders



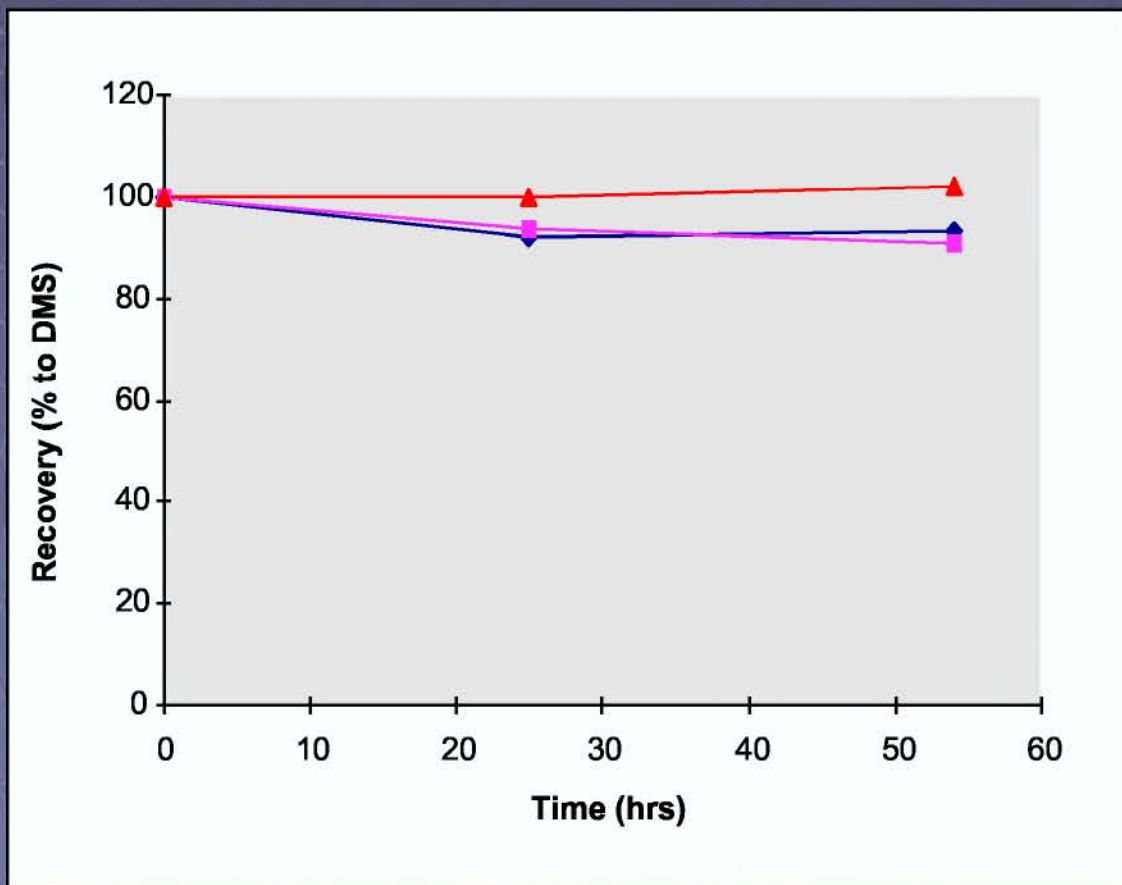
RESTEK

**CHROMALYTIC** +61(0)3 9762 2034  
**ECHNOLOGY** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Ethyl Mercaptan at 14.53ppbv in 300m Sulfinert™ Cylinders



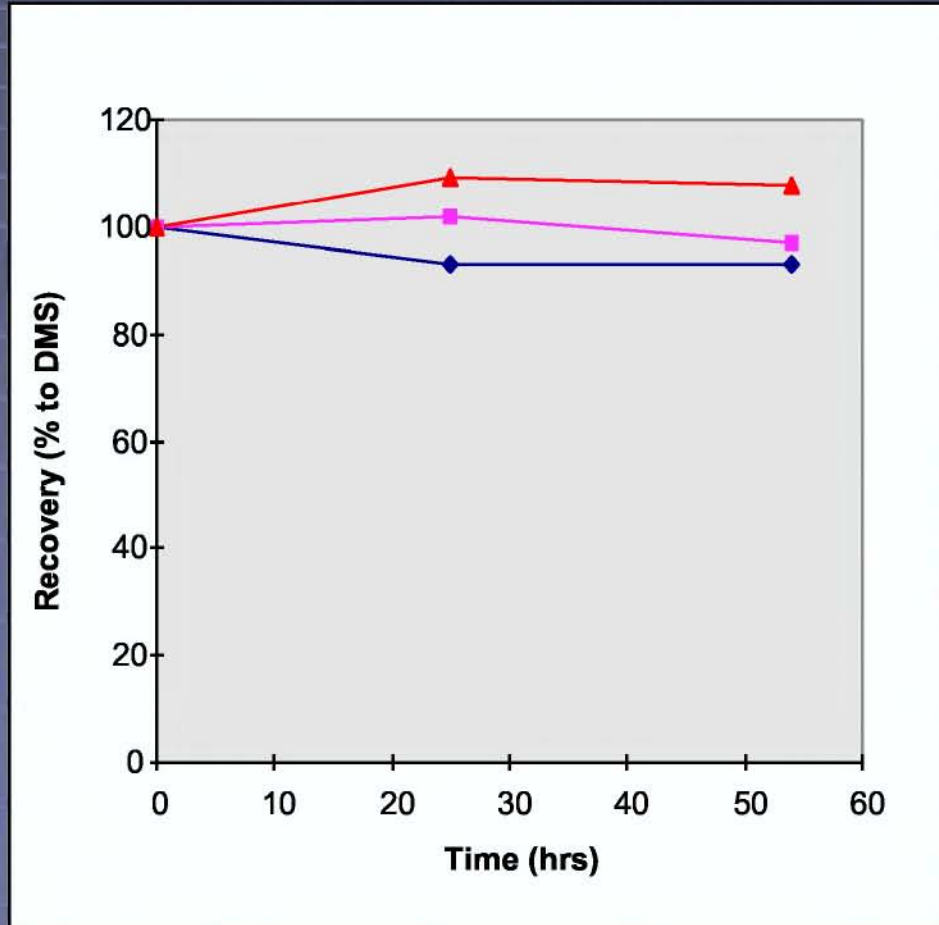
RESTEK

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Methyl Mercaptan at 18.8ppbv in 300m Sulfinert™ Cylinders



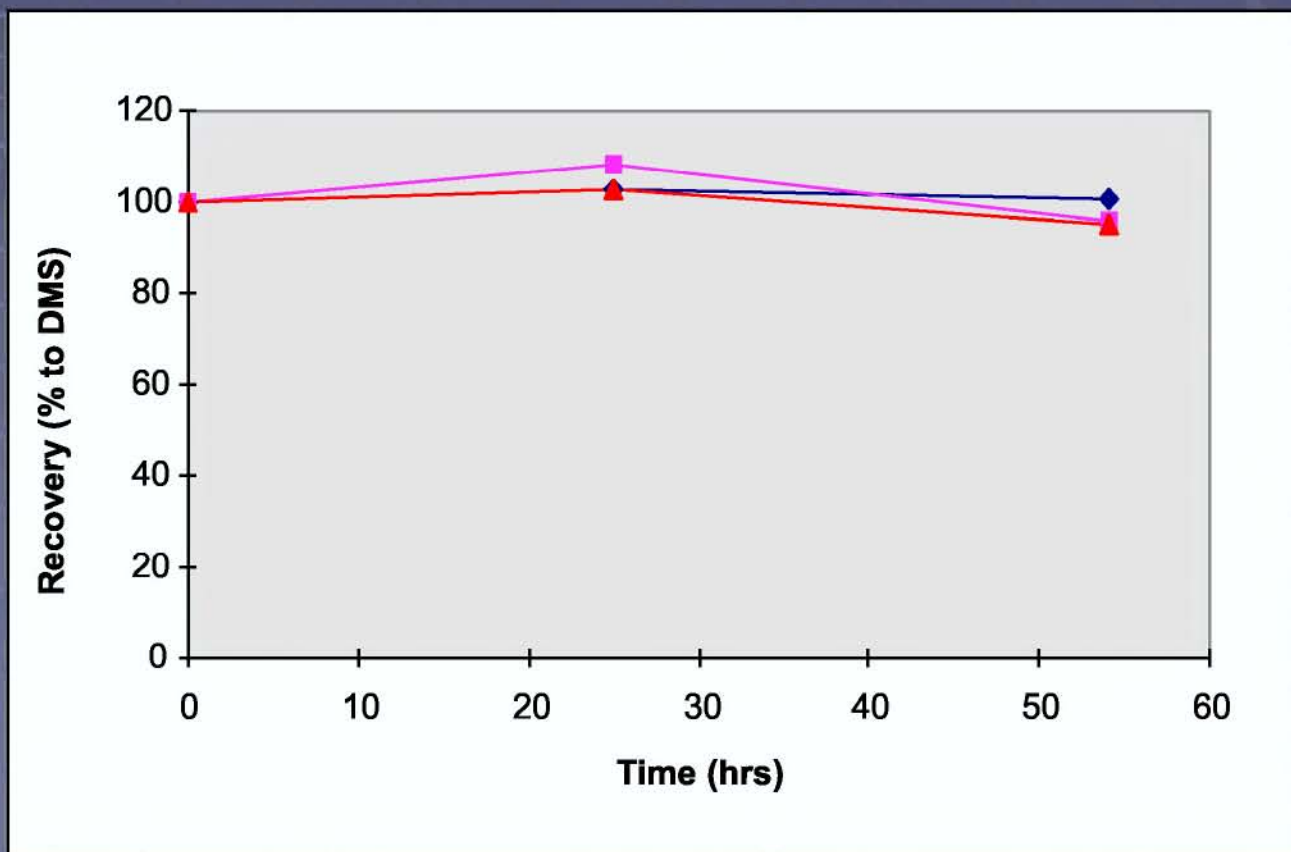
RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Dimethyl Disulfide at 18.99ppbv in 300ml Sulfinert™ Cylinders



RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)



# Ambient Air Sampling Canisters Objective

- Demonstrate suitability for storage of low level (1-20ppbv) sulfurs in SilcoCan™ canisters.

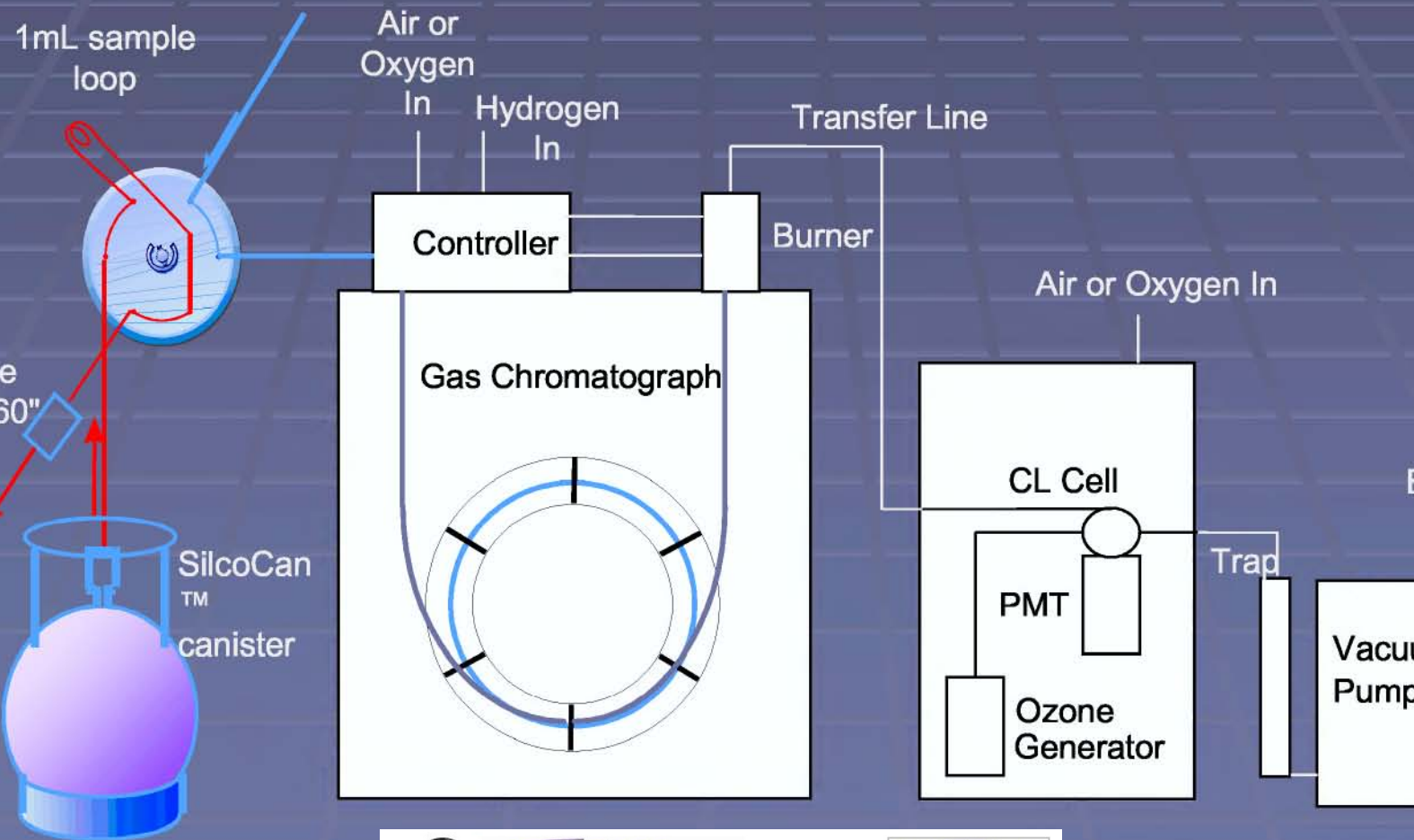
**RESTEK**

**HRMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Block diagram of Analytical System



RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

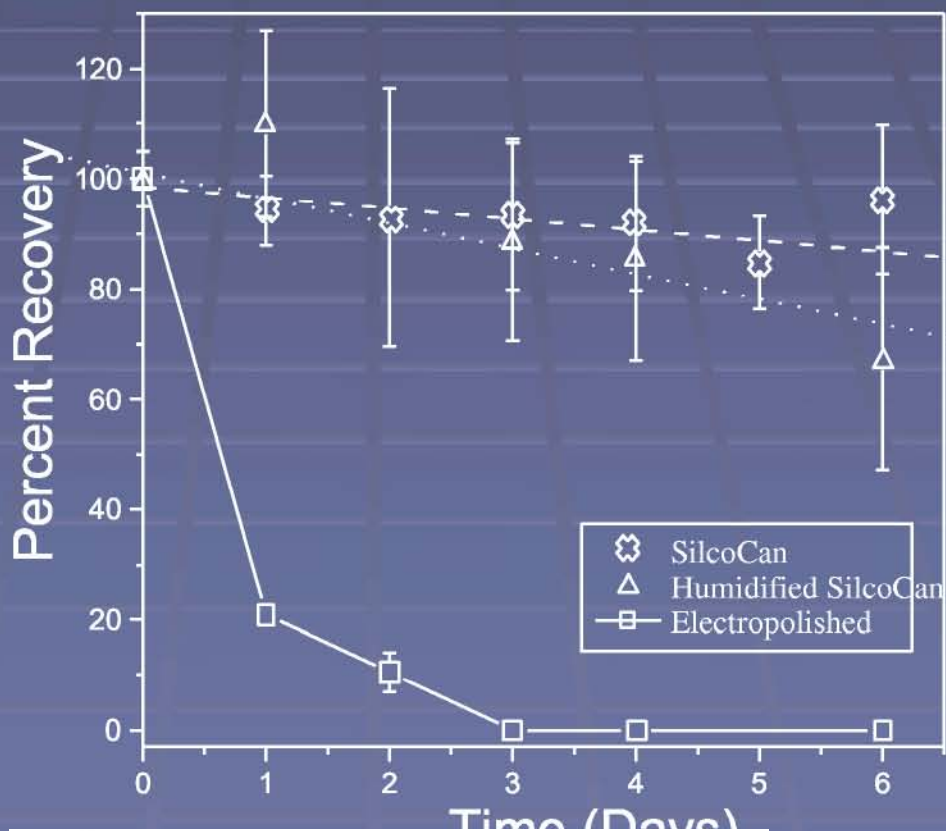
Australian Distributors  
Importers & Manufacturers  
www.chromtech.net.au

NEW! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Stability Study Test

- 11ppbv
- 6 days stability study
- Reference std is at 55ppbv
- Dimethyl sulfide as internal standard
- SilcoCans (n=18)
- Humidified (rh=50%) SilcoCans (n=5)
- Electropolished Cans (n=2)

# H<sub>2</sub>S at 11ppbv in 6l Air Sampling Cans



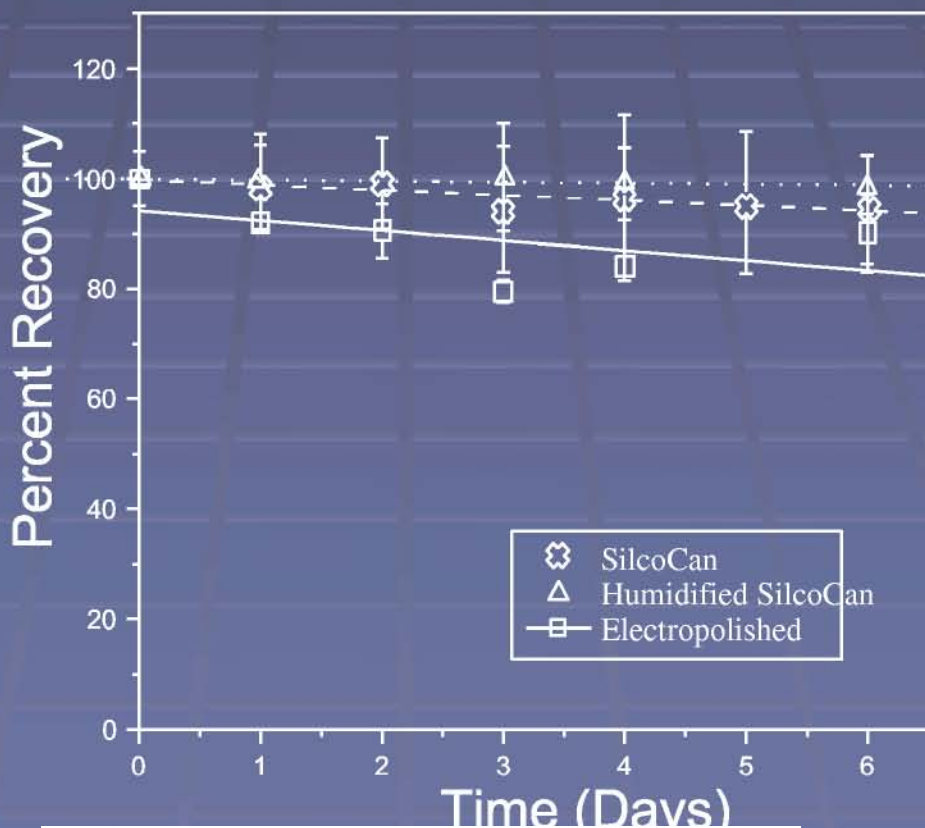
RESTEK

**HRMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# CO<sub>2</sub> at 10ppbv in 6l Air Sampling Can



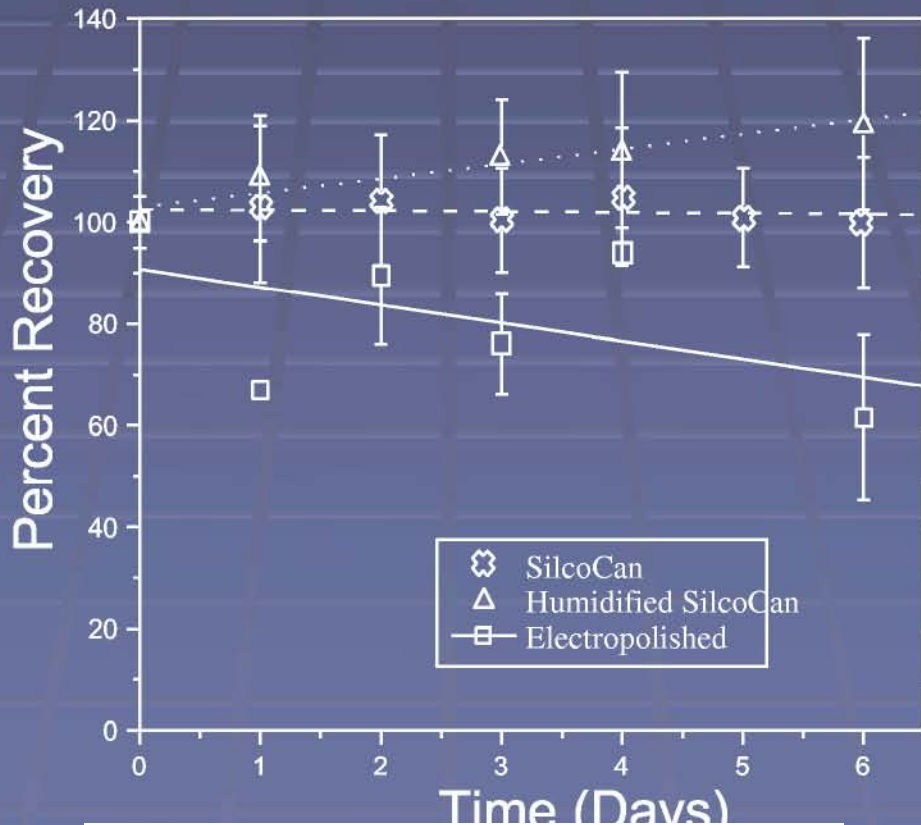
RESTEK

**CHROMALYTIC** +61(0)3 9762 2034  
**ECHNOLOGY** Pty Ltd

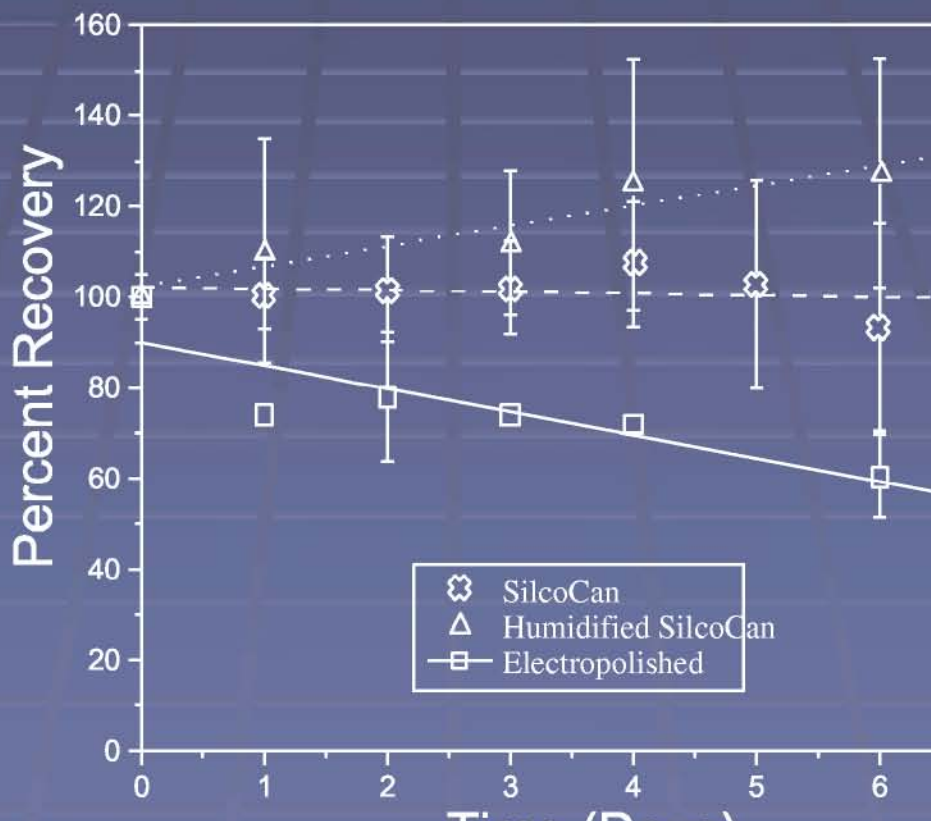
Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

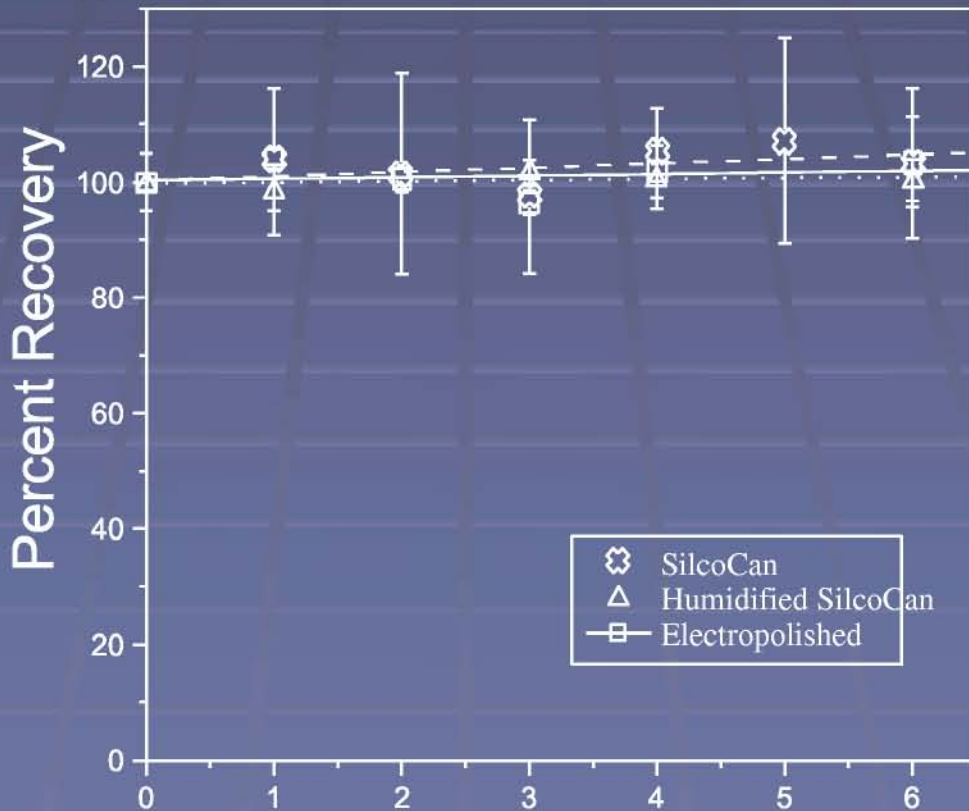
# Methyl Mercaptan at 11ppbv in 6l Air Sampling Cans



# Ethyl Mercaptan at 11 ppbv in 6l Air Sampling Cans



# Dimethyl Disulfide at 11ppbv in 6l Air Sampling Cans

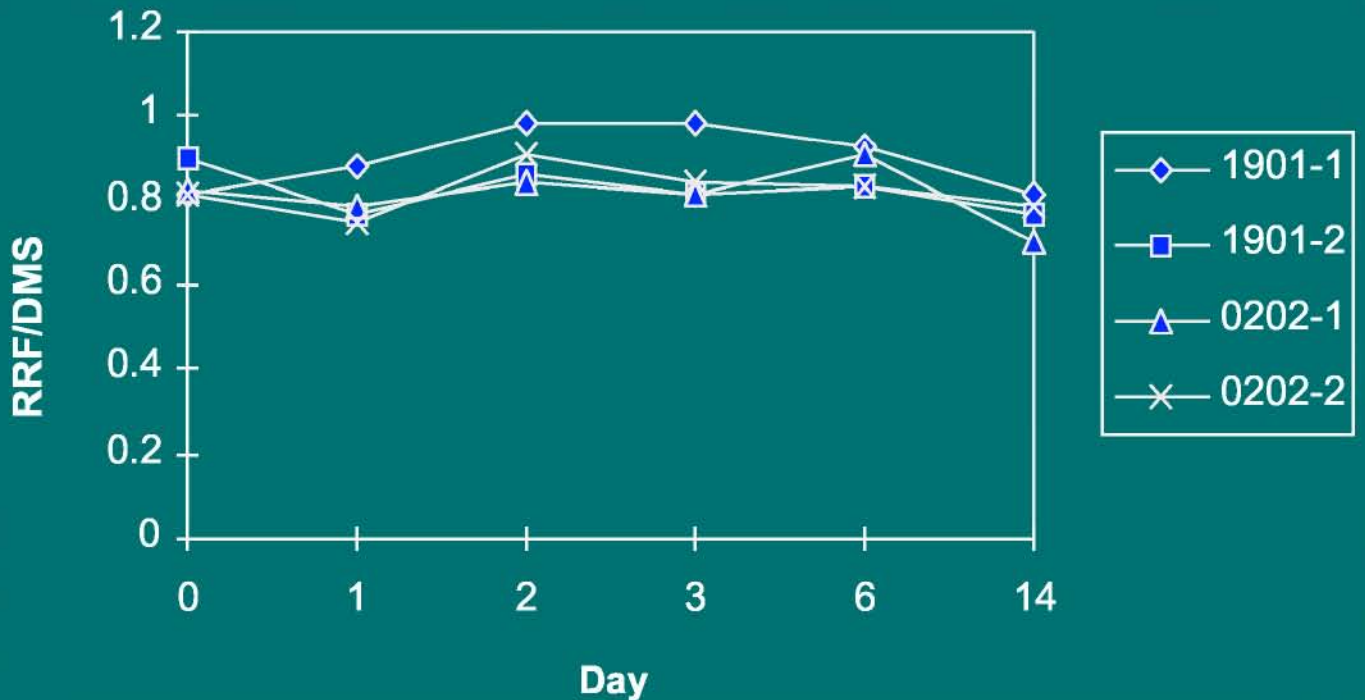




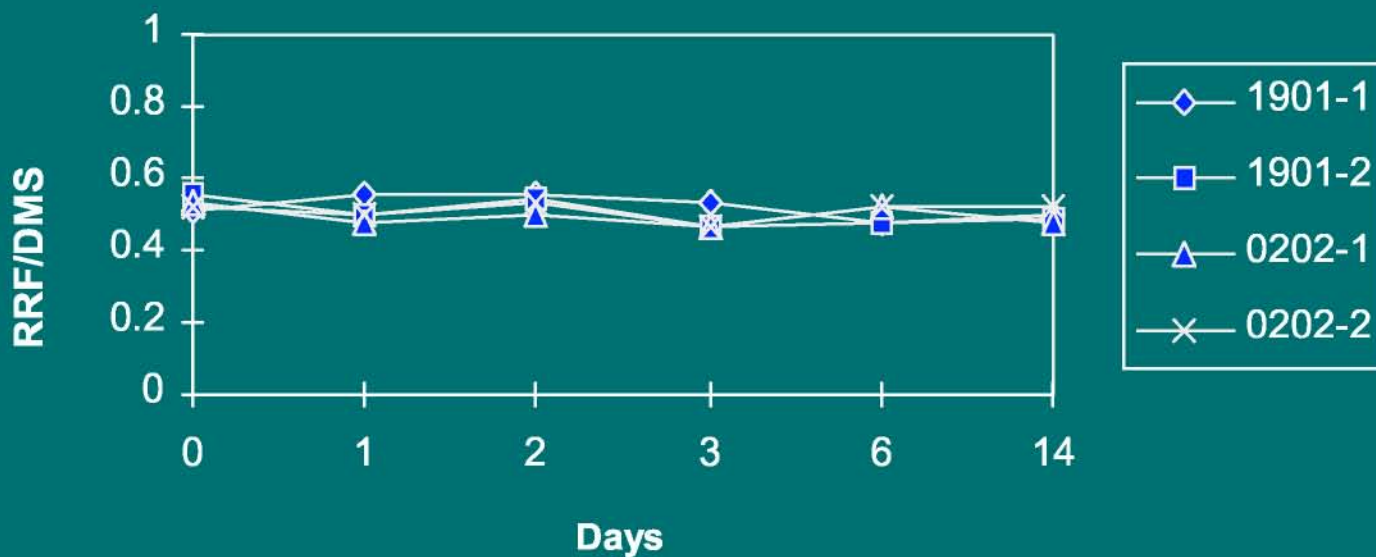
# Extended Stability Study

- Is the SilcoCan capable of storing 11ppbv sulfurs longer than 6 days?
- Tested 4 SilcoCans on Day 14

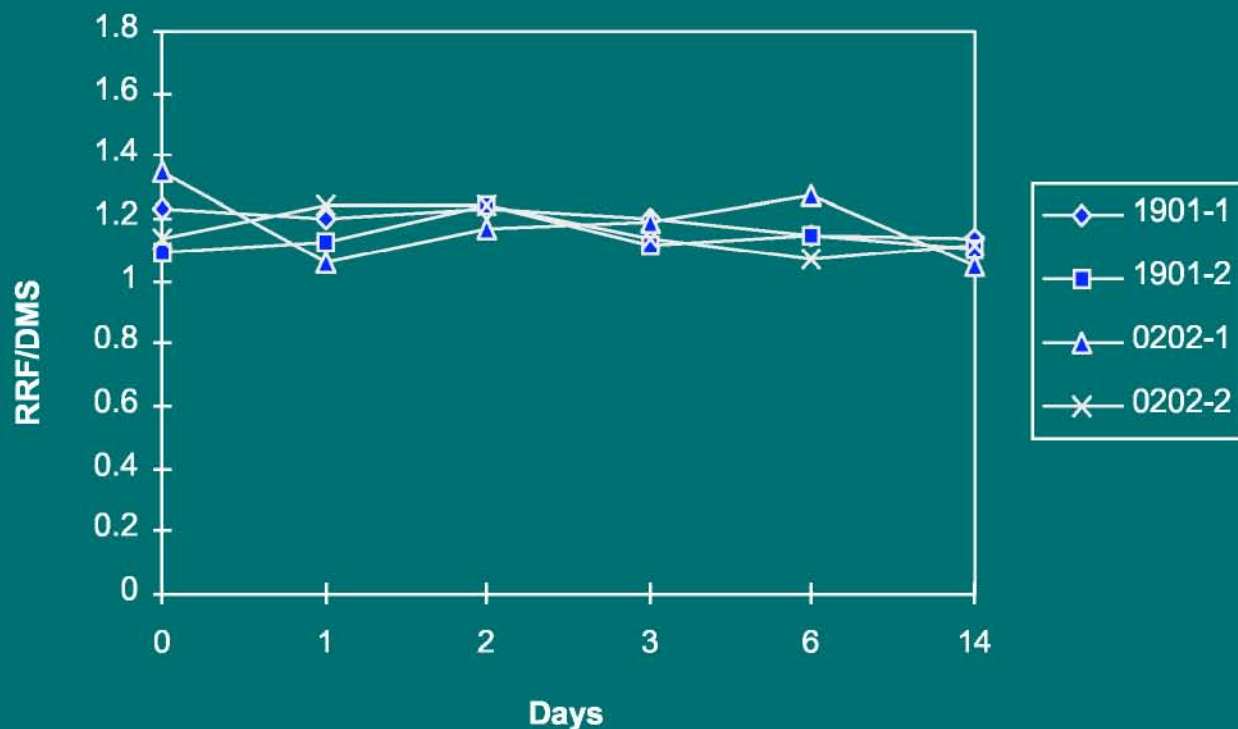
# H<sub>2</sub>S at 11ppbv for 14 days



# COS at 10ppbv for 14 Days



# Methyl Mercaptan 11ppbvfor 14 Days



# Performance of Silcosteel® Coating for transfer of NO<sub>x</sub> & Ammonia containing streams

- Study conducted by University of California Center for Environmental Research and Technology (October 2001)
- Study focused on quantifying uncertainties in continuous emission monitoring systems
- Study tried to simulate exhaust gas
- Total NO<sub>x</sub> levels in study were 0.4ppm, 2ppm and 9.5ppm total
- Dry, wet, and with ammonia

RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# NO<sub>x</sub> Study Conditions

- 100' section of 1/4" Silcosteel<sup>®</sup> coated tubing used to transfer Simulated Exhaust Streams
- Looking at recovery of components through the transfer system and relative standard deviation

# NO<sub>x</sub> Containing Sample Streams Studied

Variety of components and concentrations studied:

Each Condition tested with 3 NO<sub>x</sub> concentrations 0.4ppm, 2ppm and 9.5ppm total NO<sub>x</sub>

- Dry Simulated Exhaust
- Wet (13% H<sub>2</sub>O) Simulated Exhaust
- Wet (13% H<sub>2</sub>O) Simulated Exhaust + 6ppm Ammonia
- Wet (13% H<sub>2</sub>O) Simulated Exhaust + 10ppm Ammonia
- Wet (6% H<sub>2</sub>O) Simulated Exhaust
- Wet (6% H<sub>2</sub>O) Simulated Exhaust + 10ppm Ammonia

RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Results from Study

- Silcosteel<sup>®</sup> coated tubing showed good transfer properties for entire experimental matrix
- Performed at the same level as Teflon lined tubing.
- Both performed better than a standard stainless steel transfer line
- Study noted that results warranted further study

RESTEK

**HRM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)



# Examples of applications

Purge and Trap systems manufactured to test water quality use Restek treated tubing to insure transfer

Varian Ion trap mass spectrometer elements are coated to eliminate adsorption of ions

Sulfur sampling and transfer equipment is coated to eliminate loss of active compounds

- Testing of Ethylene and Propylene
- Testing of Beverage grade CO<sub>2</sub> for sulfur
- Testing of Sulfur compounds in beer
- Natural Gas; LPG; Gasoline; Diesel

# Anti-Coking

In applications of heated hydrocarbon transfer, carbon deposits can form

Carbon deposits are catalyzed by nickel, sulfur and carbon in steel lattice

The Silcosteel-AC coating produces a barrier that eliminates catalytic carbon buildup

**RESTEK**

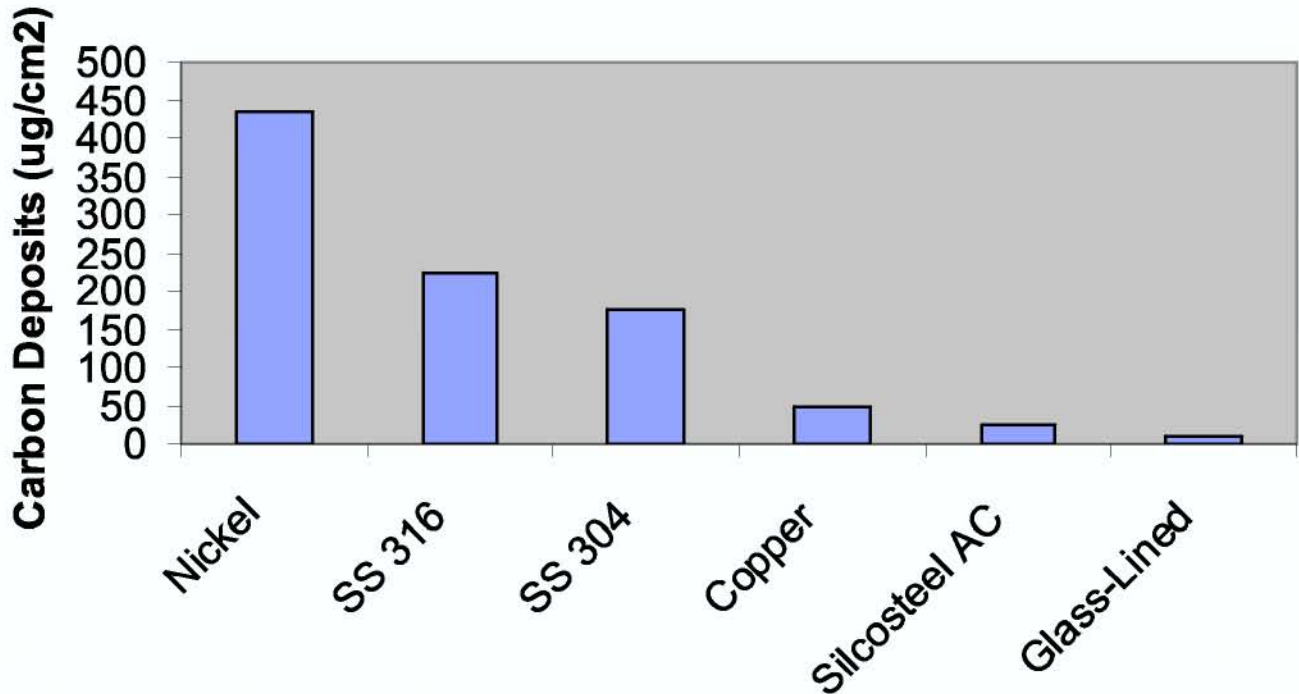
**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Anti-Coking Data

## Carbon Deposits from JP-8 Fuel on Various Types of Tubing



- Semih Eser; PSU Prof. Fuel Sciences
- 8x improvement over raw 316L

RESTEK

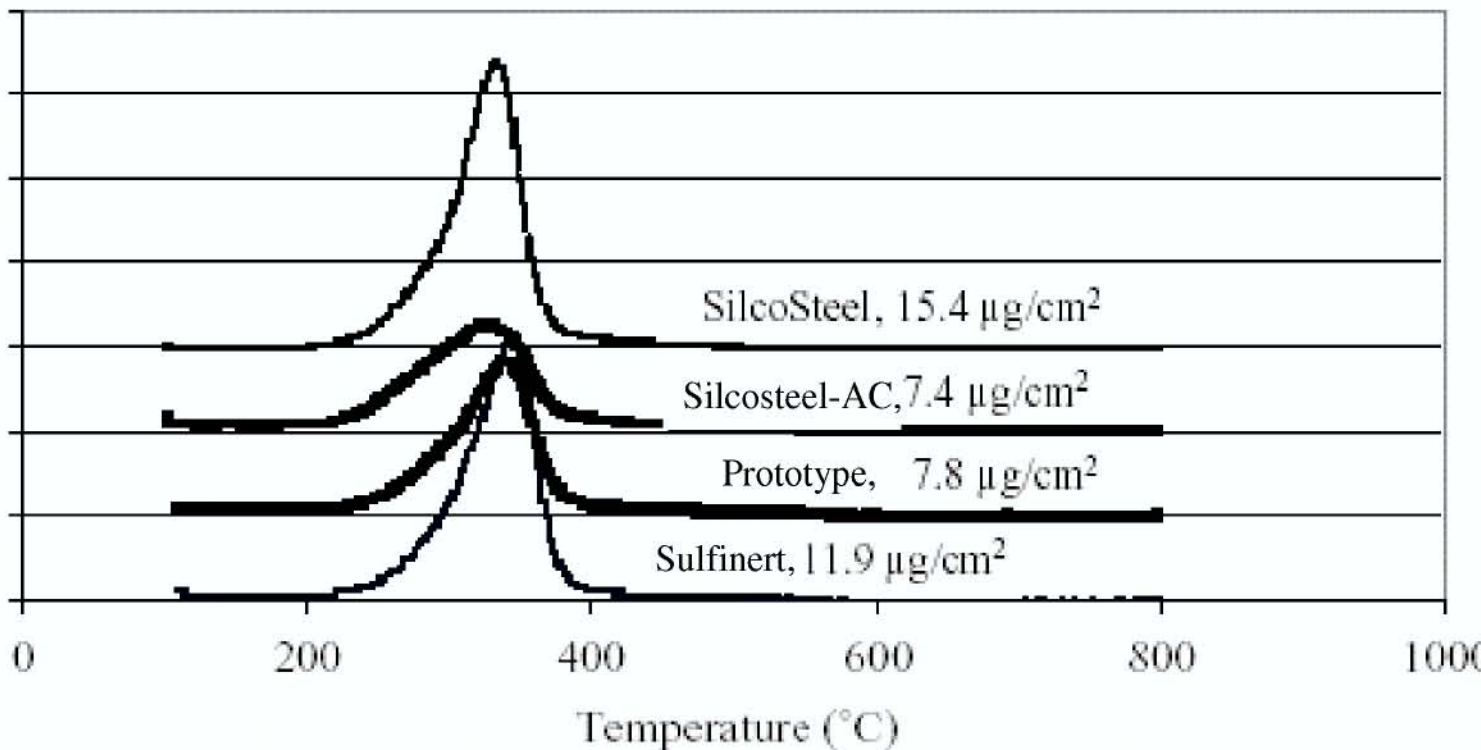
**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Anti-Coking Data (cont.)

Different coatings, SEGMENT-2, JP5,  
350°C, 4 mL/min. 24h



# Example Applications

Coating fuel injector nozzles to decrease buildup

Increasing lifetimes of Ethylene and Propylene Plug Flow reactors

Increasing reliability of valves used in internal combustion engines

Reduces fouling in heat exchangers

**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Corrosion Resistance

Stainless steel surfaces susceptible to attack from hydrochloric acid, sulfuric acid and nitric acid

Silcosteel-CR treatment produces a layer of amorphous silicon

Amorphous silicon is insoluble in hydrochloric acid, sulfuric acid and nitric acid

**RESTEK**

**HRMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

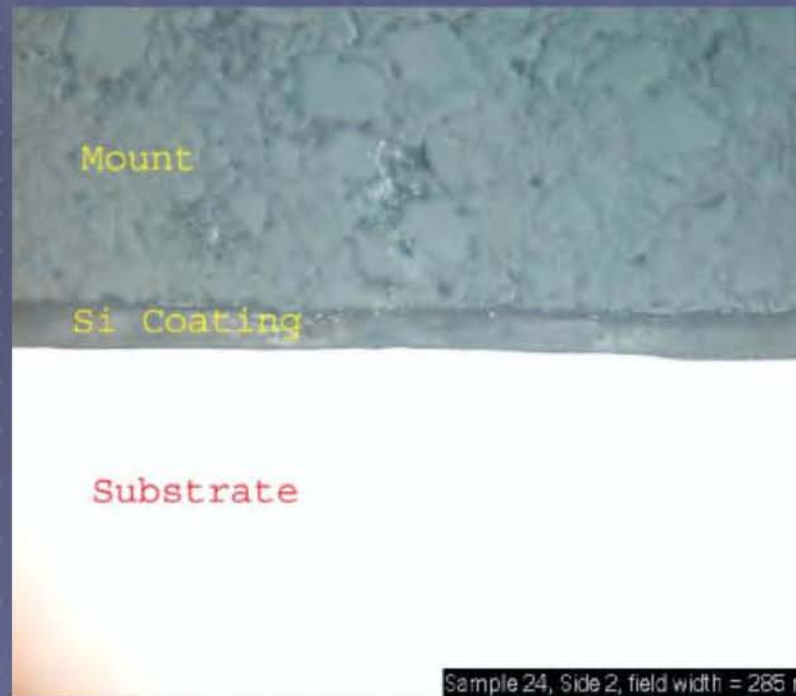
**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Corrosion Data (cont.)

## Evaluation

- Certified corrosion engineers
- Spectroscopic analysis
- Mechanical testing
- Electrochemical



Cyclic Polarization in neutral, acidic, alkaline

- Atmospheric corrosion
  - ASTM moisture condensation
  - Salt spray ASTM B117

- Stress corrosion cracking (MgCl<sub>2</sub>; ASTM G36)

RESTEK

**HROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
www.chromtech.net.au

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM G45 B Data

## ASTM G45 method B; Pitting and Crevice Corrosion

- 6% Ferric Chloride solution
- 72hrs, 20°C
- Gasket wrap

Sample	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (g/m <sup>2</sup> )
lco-CR Sample 17	10.4105	10.3710	0.0395	19
lco-CR Sample 28	10.1256	10.0743	0.0513	25
lco-CR Sample 47	10.1263	10.0742	0.0521	25
Bare Sample 27	10.0444	9.5655	0.4789	231
Bare Sample 34	10.1265	9.6923	0.4342	209
Bare Sample 37	10.1007	9.6276	0.4731	228

**RESTEK**

**HRMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd  
 www.chromtech.net.au

**Australian Distributors**  
 Importers & Manufacturers  
 www.chromtech.net.au

NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)



# ASTM G45 B (cont.)

Silcosteel<sup>®</sup>-CR treated sample showing no crevice corrosion only slight pitting corrosion



RESTEK

**CHROM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM G45 B (cont.)

Bare 316L Stainless Steel coupon showing severe crevice corrosion



RESTEK

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM G-61 Data

## ASTM G-61; Cyclic Polarization Electrochemical Corrosion Testing

- Acid, neutral, basic aqueous solutions with varying Cl<sup>-</sup> ion concentrations (100, 3000, 5000ppm)
- EG&G VersaStat System, 23°C
- 316L vs. Silcosteel<sup>®</sup>-CR on 316L, 304L

Neutral solution;  
500ppm Cl<sup>-</sup>

-CR vs 316L Raw: **50x** improvement

Sample	Ec, mV	Ic, uA/cm <sup>2</sup>	Eb, mV	CR, mpy
316L	-418	0.096	370	0.04
Silcosteel-CR 316 L	-533	0.002	1460	0.0009
304L	-435	0.145	361	0.06

Ec = corrosion potential  
Ic = current density at Ec  
Eb = pitting potential  
CR = corrosion rate

# ASTM-G61 (cont.)

Acidic Solution; 1N H<sub>2</sub>SO<sub>4</sub>;  
1000ppm Cl<sup>-</sup>

-CR vs 316L Raw: **10x** improvement

Sample	E <sub>c</sub> , mV	I <sub>c</sub> , uA/cm <sup>2</sup>	E <sub>b</sub> , mV	CR, mpy
316 L	-662	1.920	370	0.83
304 stainless steel-CR 316 L	-843	0.123	927	0.05
304 L	-639	2.650	587	1.14

Basic Solution; 1N NaOH;  
1000ppm Cl<sup>-</sup>

-CR vs 316L Raw: **4x** improvement

Sample	E <sub>c</sub> , mV	I <sub>c</sub> , uA/cm <sup>2</sup>	E <sub>b</sub> , mV	CR, mpy
316 L	-419	0.193	265	0.08
304 stainless steel-CR 316 L	-816	0.036	618	0.02
304 L	-388	1.120	668	0.48

**RESTEK**

**CHROMALYTIC** +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
www.chromtech.net.au

NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM B117 Data

ASTM B 117 – “Practice for Operating Salt Spray (Fog) Apparatus.”

- 1000 hour exposure
- 100 degree Fahrenheit
- 3.5% by weight sodium chloride

Reproduces exposure to marine environments.

**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM B117 Data (cont.)

Silcosteel<sup>®</sup>-CR treated samples showed no signs of bleeding, rusting, or pitting corrosion



RESTEK

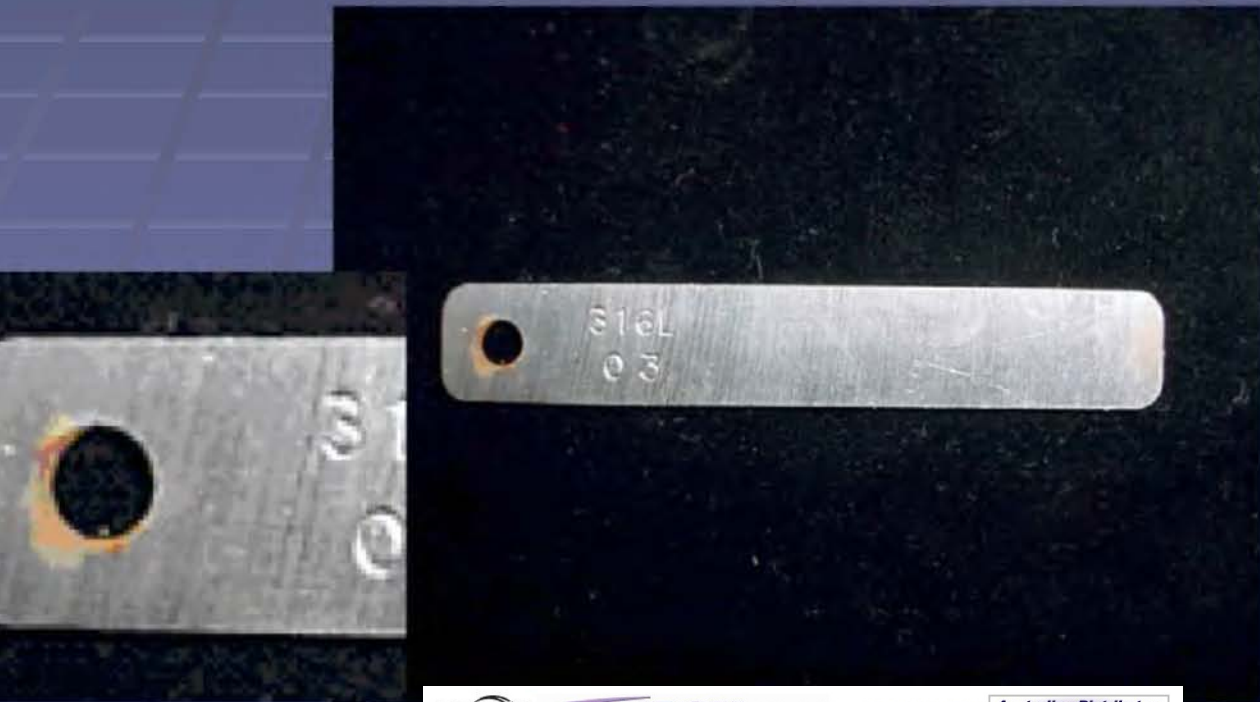
**CHROM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM B117 Data (cont.)

The non-treated samples showed some light surface rusting, but no signs of pitting corrosion.



RESTEK

**HRM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
www.chromtech.net.au

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM D4585 Data

ASTM D 4585, “Practice for Testing the Water Resistance of Coatings Using Controlled Condensation.”

- 1000 hour study
- 100 degrees Fahrenheit
- Distilled water

Reproduces exposure to atmospheric conditions

**RESTEK**

**HRMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)



# ASTM D4585 (cont.)

Silcosteel<sup>®</sup>-CR treated samples showed no signs of bleeding, rusting, or pitting corrosion



RESTEK

**CHROM**alytic +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# ASTM D4585 (cont.)

Only a very light surface oxide film was seen on the bare samples.



**RESTEK**

**CHROMalytic** +61(0)3 9762 2034  
**ECH**nology Pty Ltd

**Australian Distributors**  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Examples Applications

Using Silcosteel-CR treated 316L stainless steel instead of items made from Hastello or Inconel in corrosive environments

Protecting the value and extending the life of expensive existing equipment in corrosive environments by use of protective coating

Increase cycle lifetime of equipment

RESTEK

**CHROMalytic** +61(0)3 9762 2034  
**ECHnology** Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# High-Vacuum (

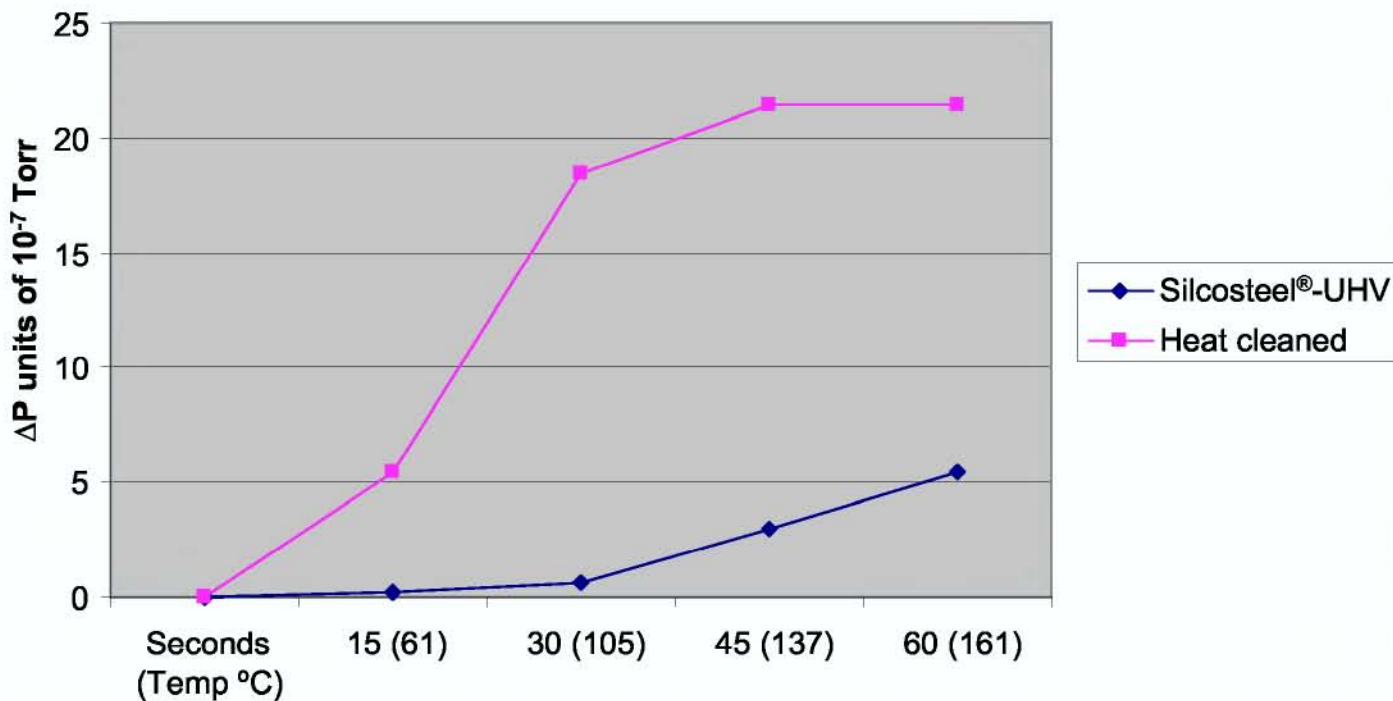
periments are characterized  
if  $1 \times 10^{-7}$  Torr or better

ditions, materials trapped  
inside the steel outg  
ronment  
ng of material increase  
ent

os and long “pump down  
achieve UHV environme  
UHV treatment produces  
aterials from outgassing in  
ironment.

# Ultra-High Vacuum Data

Pressure increase with heat



- Bruce Kendall: Elvac Labs, PSU Physics prof. (ret.)
- Turbopump,  $4.6 \times 10^{-7}$  Torr base pressure
- 1hr under vacuum ( $\Delta P1$ )
- 27x impr

RESTEK

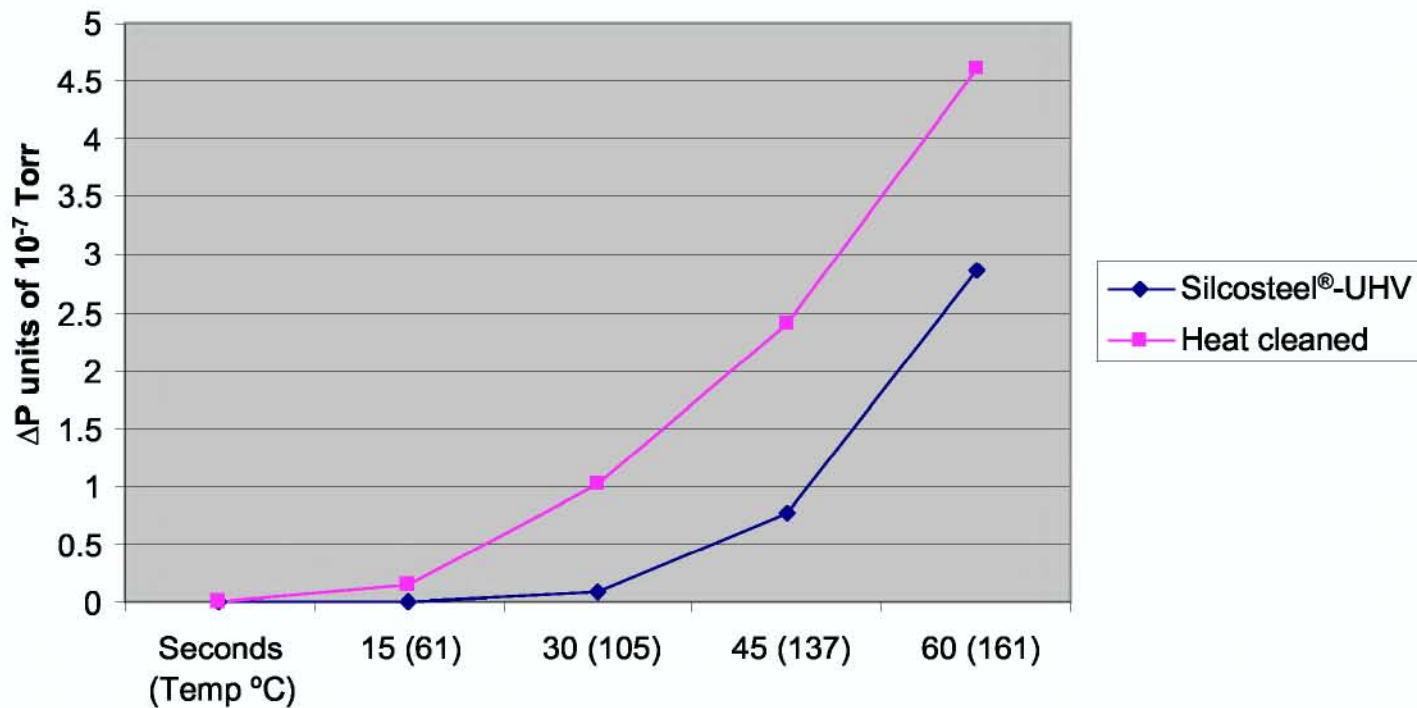
**HRMalytic** +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
www.chromtech.net.au

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Ultra-High Vacuum Data (cont.)

Pressure increase with heat



- Turbopump,  $7.5 \times 10^{-8}$  Torr base pressure
- 10hr under vacuum ( $\Delta P2$ )
- 14x im

RESTEK

**CHROMALYTIC** +61(0)3 9762 2034  
ECHnology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
www.chromtech.net.au

NEW! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Example Applications

Coating of accelerator chambers to create higher vacuum environment

Use in coating of semi-conductor manufacturing equipment to decrease defect rate

Reducing time needed to achieve high vacuum environments in analytical equipment (SEM, XPS, etc.,.)

RESTEK

**CHROMalytic** +61(0)3 9762 2034  
**ECH**nology Pty Ltd

Australian Distributors  
Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)

NEW ! : Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)

# Future

Currently renovating for expansion

New process oven (31" ID x 24" deep)

Continual process improvement and new product development

- Hardness
- Improved corrosion resistance
- Customized surfaces

 **HROMalytic** E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)  
**ECHnology** Website: [www.chromtech.net.au](http://www.chromtech.net.au)  
Australian Distributors  
PO Box 435, 232 Forest Rd, Boronia, Victoria 3155, A  
Tel: +61 3 9762 2034 Fax: +61 3 9761 1169 email: sales@c

  +61(0)3 9762 2034 Australian Distributors  
**ECHnology** Pty Ltd Importers & Manufacturers  
[www.chromtech.net.au](http://www.chromtech.net.au)  
NEW ! Website: [www.chromalytic.com.au](http://www.chromalytic.com.au), Tel: +61(0)3 9762 2034, Fax: 03 9761 1169, E-mail: [info@chromtech.net.au](mailto:info@chromtech.net.au)