



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- T1000434-v1

*LIGO*

Date 7/22/10

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## Advantages of cleaning optics with Red First Contact

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Garilynn Billingsley, Margot Phelps

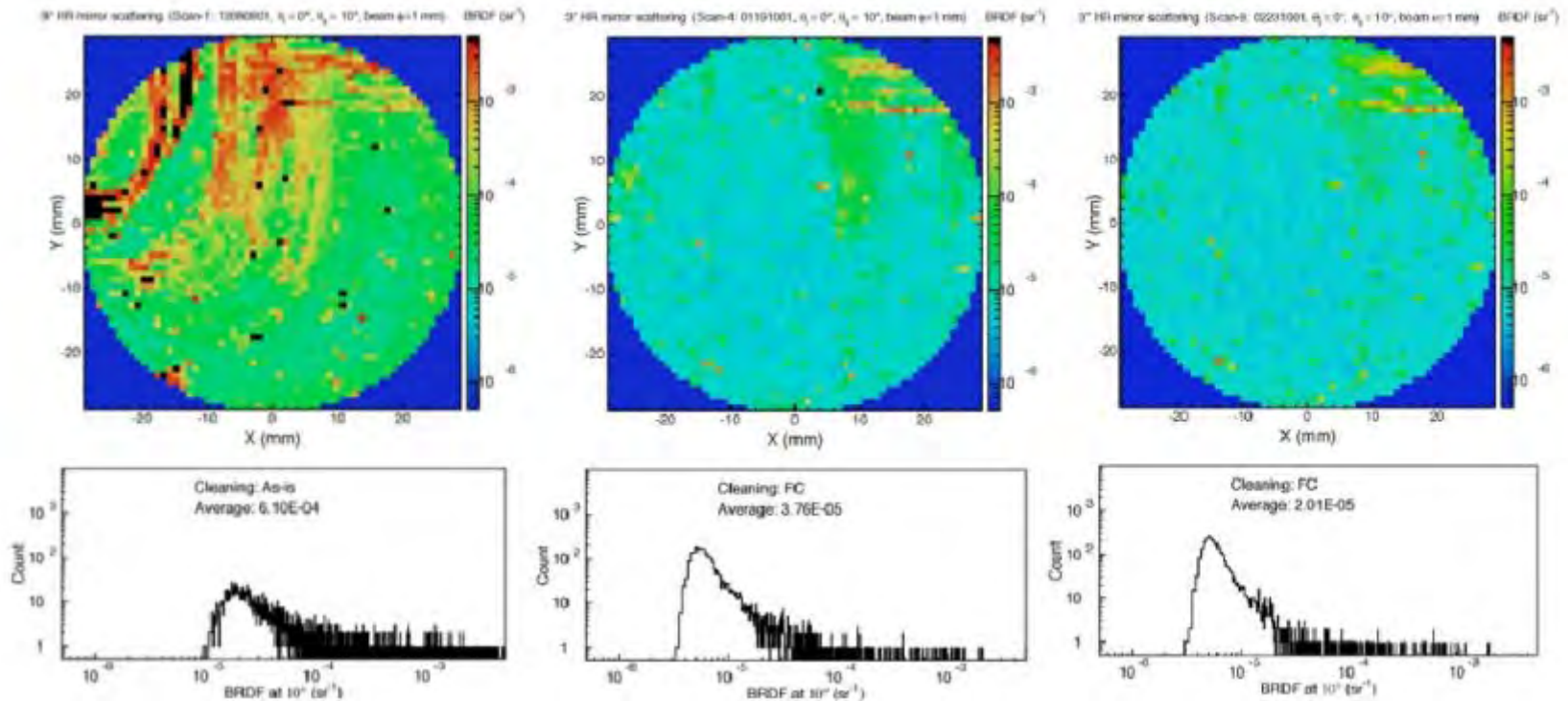
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# Sequential Progression First Contact BRDF Tests - LIGO Report



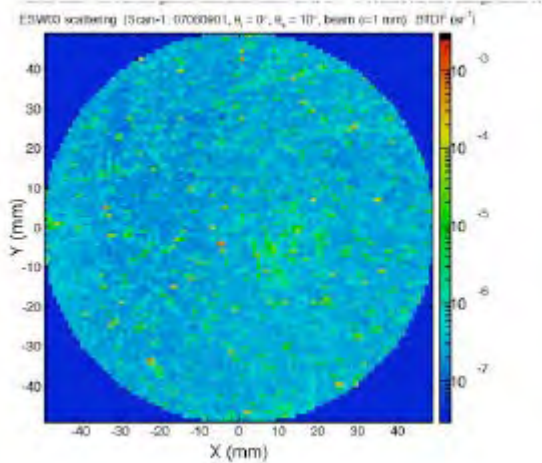
**Apply. Peel. Repeat as/if needed.**

“A highlight of the BRDF tests shows that repeated applications of FC only improves optical surfaces”

“Optical contamination control in the Advanced LIGO ultra-high vacuum system”, Margot H. Phelp, Kaitlin E. Gushwaa, and Calum I. Torriea, Proc. of SPIE Vol. 8885, 88852E · doi: 10.1117/12.2047327

-LIGO Laboratory, California Institute of Technology, 1200 E. California Blvd., Pasadena, CA

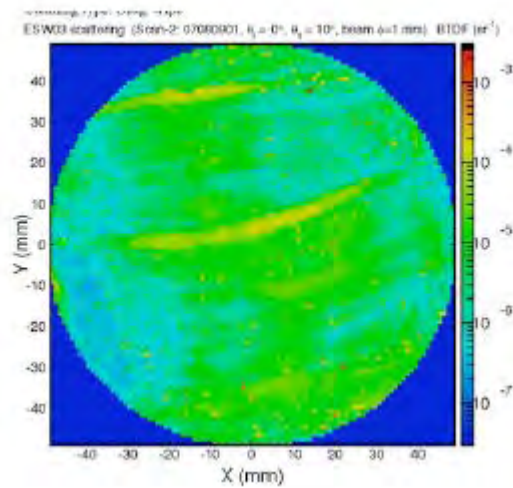
# "Bidirectional Reflectance Distribution Function." LIGO Caltech



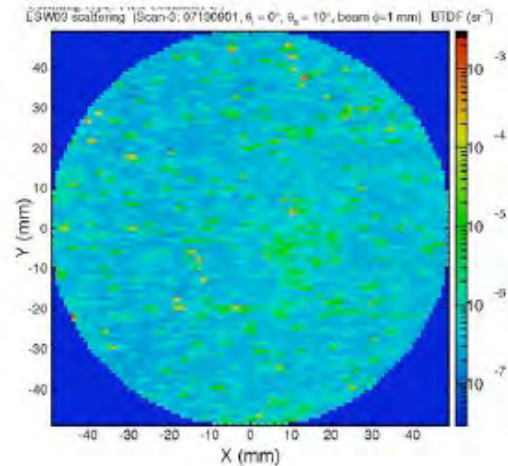
BRDF = Reflectance of a target as a function of illumination geometry and viewing geometry.

“Not only did cleaning with First Contact leave no residue, it also removed nearly all the residue left by the methanol. -LIGO Internal Report T1000137-v3

Before 2.05 ppm avg BRDF

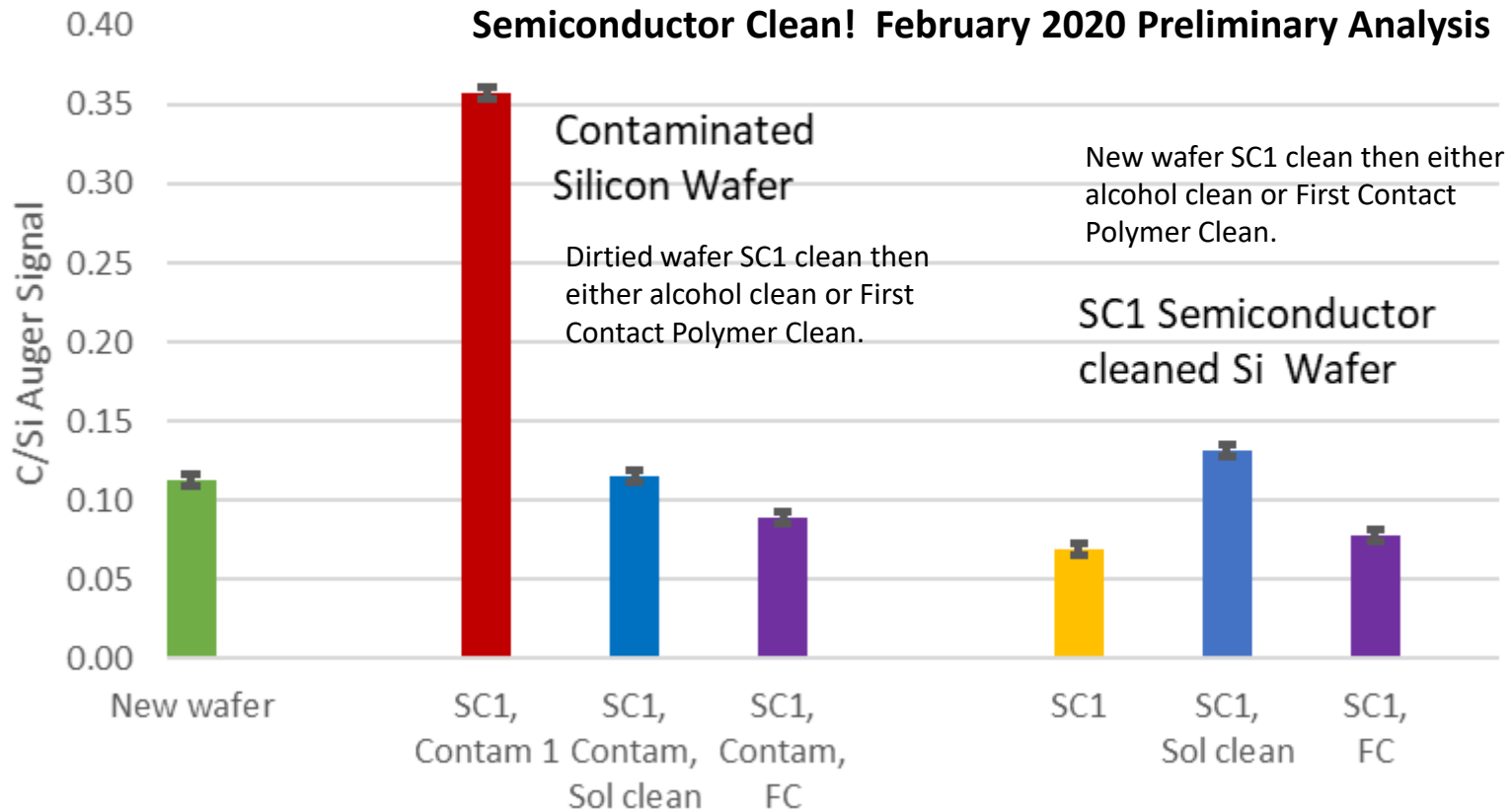


After MeOH Dragwipe  
10.7 ppm avg BRDF



After FCP 2.05 ppm avg BRDF

# Auger Residue Analysis of Solvent Cleaning and FCP Monolayer Surface Sensitive technique



## What is SC1? SC-1): organic clean + particle clean

The first step of RCA process (called SC-1, where SC stands for Standard Clean) is performed with a solution of (ratios may vary)<sup>[2]</sup> •5 parts of deionized water, 1 part of [ammonia water](#), (29% by weight of  $\text{NH}_3$ ), 1 part of aqueous  $\text{H}_2\text{O}_2$  ([hydrogen peroxide](#), 30%) at 75 or 80 °C<sup>[1]</sup> typically for 10 minutes. This base-peroxide mixture removes organic residues. Particles are also very effectively removed, even insoluble particles, since SC-1 modifies the surface and particle [zeta potentials](#) and causes them to repel.<sup>[4]</sup> This treatment results in the formation of a thin [silicon dioxide](#) layer (about 10 Angstrom) on the silicon surface, along with a certain degree of metallic contamination (notably [iron](#)) that will be removed in subsequent steps. -Wikipedia, [https://en.wikipedia.org/wiki/RCA\\_clean](https://en.wikipedia.org/wiki/RCA_clean) accessed March-06-2022.



## First Contact™ Polymer Solution

**NASA Goddard's SFC Materials Engineering Group** completed an ESCA/XPS analysis of two specially prepared and identical mirror surfaces, typical of those used on the *Hubble Space Telescope* optics and many other instruments designed to operate at UV wavelengths.

- *with* and *without* an application of **First Contact™** cleaning solution.

- Evaporated Al film (~100nm) overcoated with SiO<sub>x</sub> (~200nm).
- Mirrors were prepared 18 months prior to test and stored in an ordinary plastic box with no other protection.
- They had acquired surface contaminant films of the usual kind from this uncontrolled storage.
- **First Contact™** was applied to one mirror and peeled after 30 minutes.
- Both mirrors were then examined with ESCA/XPS.

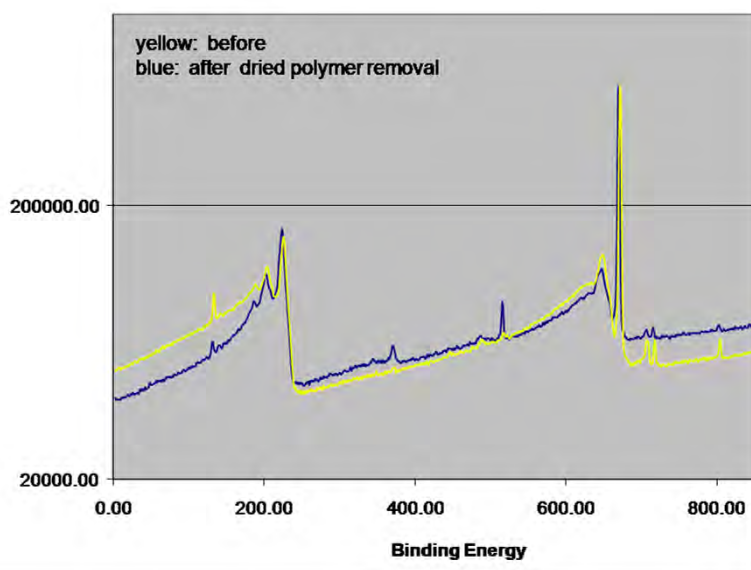
**RESULTS:** The ESCA data showed a measurable removal of incidental contaminant by the **First Contact™** application, when compared with the other mirror, and no detectable residue left by the **First Contact™**.

**NASA's CONCLUSION:** **First Contact™** performed as claimed. "ESCA tests confirmed the results reported in Photonic Cleaning Technologies' literature".





# Atomically Clean afterward: Before and after XPS Spectra on Glass



XPS	C 1s %	O 1s %	Si 2p %
After	17.8	57.4	20.6
Before	48.1	33.3	16.0

Only First Contact™ didn't leave residue...

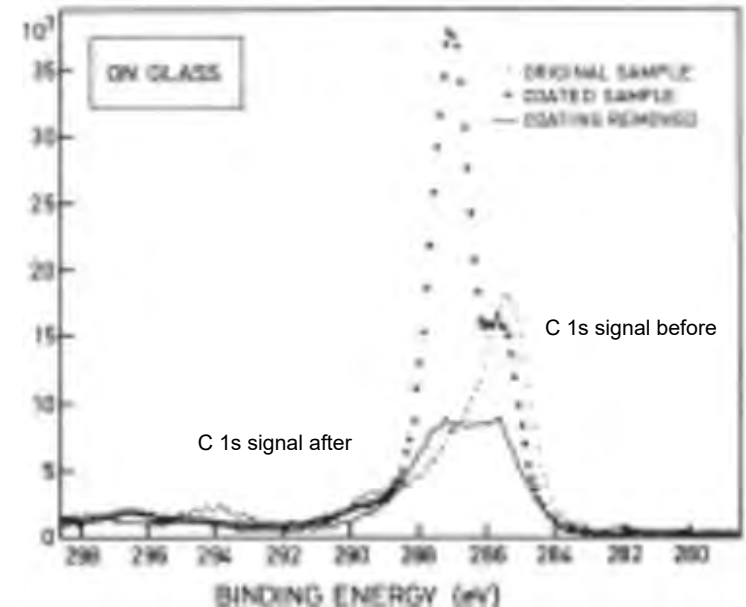


**No Residue.**

In fact, First Contact™ polymers actually removed previously existing carbon contamination present on the Si & glass surfaces.

Integrated peak area: 4 monolayers removed.

Prep for vacuum. Remove water, organics.



J. Bennett Applied Optics

**Property of Photonic Cleaning Technologies**  
**CONFIDENTIAL**

Nov. 1, 2006

Jim:

Goddard's Materials Engineering Group completed an ESCA analysis of two mirror surfaces, with and without an application of your 'First Contact' cleaning solution.

The two mirrors were sister samples, one inch squares, consisting of a ~1/16 in thick glass that was coated with an evaporated Al film (~100nm thick) that was then overcoated with SiOx (~200nm thick). This is a typical front surface mirror formulation.

Both mirrors had been prepared about 18 months ago for another purpose and were stored in my office in an ordinary plastic box with no other protection. They were in good shape, but had acquired surface contaminant films of the usual kind from this uncontrolled storage. "First Contact" was applied to one mirror and allowed to harden for 30 min. and then peeled off using the supplied paper tab. Both mirrors were then examined with ESCA.

**RESULTS:** The ESCA data showed a measurable removal of incidental contaminant by the "First Contact" application, when compared with the other mirror, and no detectable residue left by the "First Contact".

**CONCLUSION:** The "First Contact" performed as claimed. Our ESCA test confirmed the results contained within the literature that you left with us.

JBH  
Swales Aerospace  
5050 Powder Mill Road  
Beltsville, MD 20705

**CONFIDENTIAL**

# Materials Engineering Branch

## Chemical Analysis Report

**To:** NASA GSFC 546/Contamination Engineering/ Jim Heaney(Swales)

**From:** 541/Materials Engineering Branch/ John S. Canham, Ph.D.,  
SWALES Aerospace, Inc.

**Subject:** Residue from First Contact strippable cleaner

**Date:** October 24, 2006

**Analysis Number:** MATG 3179

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**Project:** HST

### Sample(s):

Un strip cleaned mirror  
Strip cleaned mirror

### Analyses:

- High temperature solid probe mass spectrometry (MS)
- Gas Chromatography/Mass Spectrometry (GC/MS)
- Thermal Desorption GC/MS
- Direct Thermal Extraction GC/MS
- Residual Gas Analysis (RGA)
- X-ray Photoelectron Spectroscopy (XPS or ESCA)
- Other

### Results:

The First Contact Polymer strippable coating was determined to not have left a residue in this case. The strip cleaned surface actually had lower surface molecular contamination as evidenced by a lower percentage of carbon on the surface of the mirror.

### Discussion:

Figures one and two show the ESCA spectra of the un-strip cleaned surface and the strip cleaned surface. The mirrors had been cleaned using the same process prior to the application of the strip coating. The strip cleaned surface and the un-strip cleaned surface show a very thin layer of molecular contamination. The contaminant level is less than 10 nanometers on both mirrors, as evidenced by the detectability of the silica surface coating. The quantity of molecular contamination present on the surface of the strip cleaned mirror is less than that on the non-strip cleaned surface. This shows that the strip cleaner did not leave a residue, and in fact appears to

[https://d.docs.live.net/f10fa703c3745096/Documents/PCT\\_New/Advertising^J Marketing ^0 Sales/ESCA Report NASA GSFC Canham 2006.doc](https://d.docs.live.net/f10fa703c3745096/Documents/PCT_New/Advertising^J Marketing ^0 Sales/ESCA Report NASA GSFC Canham 2006.doc)

**This Report was Generated By Dr. John S. Canham, Swales Aerospace, Inc.**



have removed some of the surface molecular contamination in addition to the surface particulate contamination.

Element \ Sample	Un-stripped mirror	Stripped Mirror
Silicon atomic%	26.2	29.6
Oxygen atomic%	49.1	51.6
Carbon atomic%	26.2	18.6
Nitrogen atomic%	0.87	0.25
Sodium atomic%	0.43	----

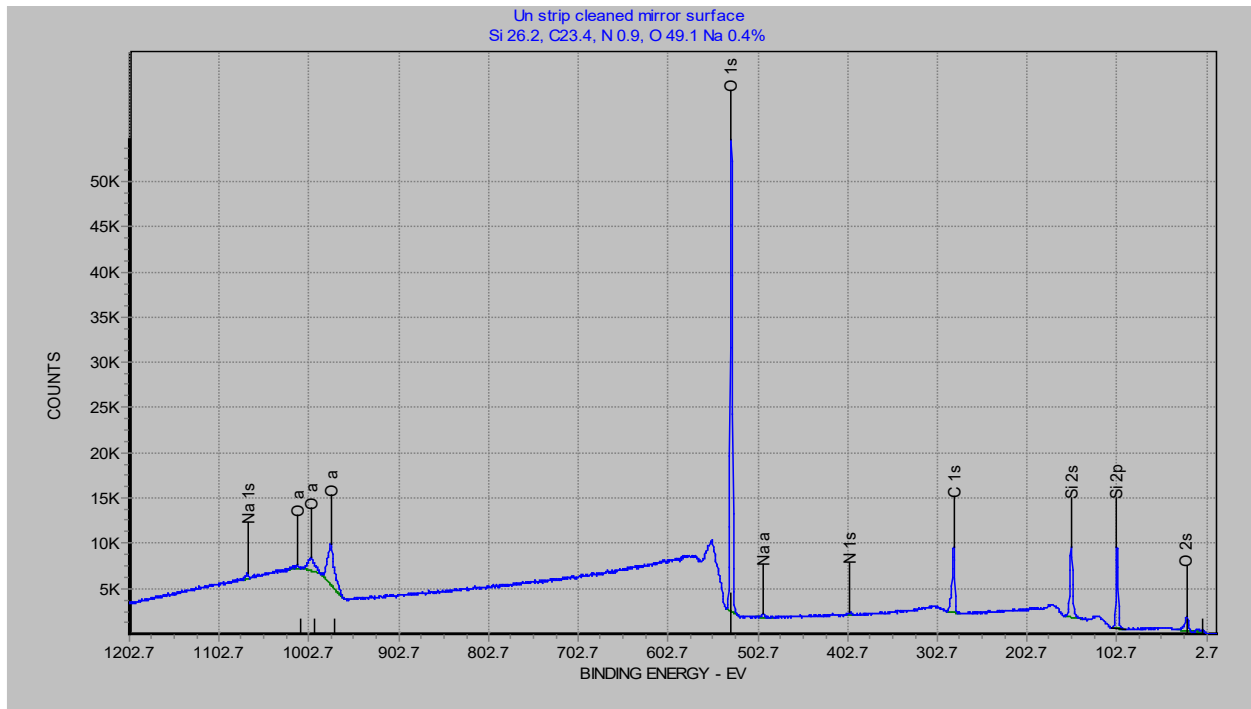


Figure 1 Unstripped mirror surface

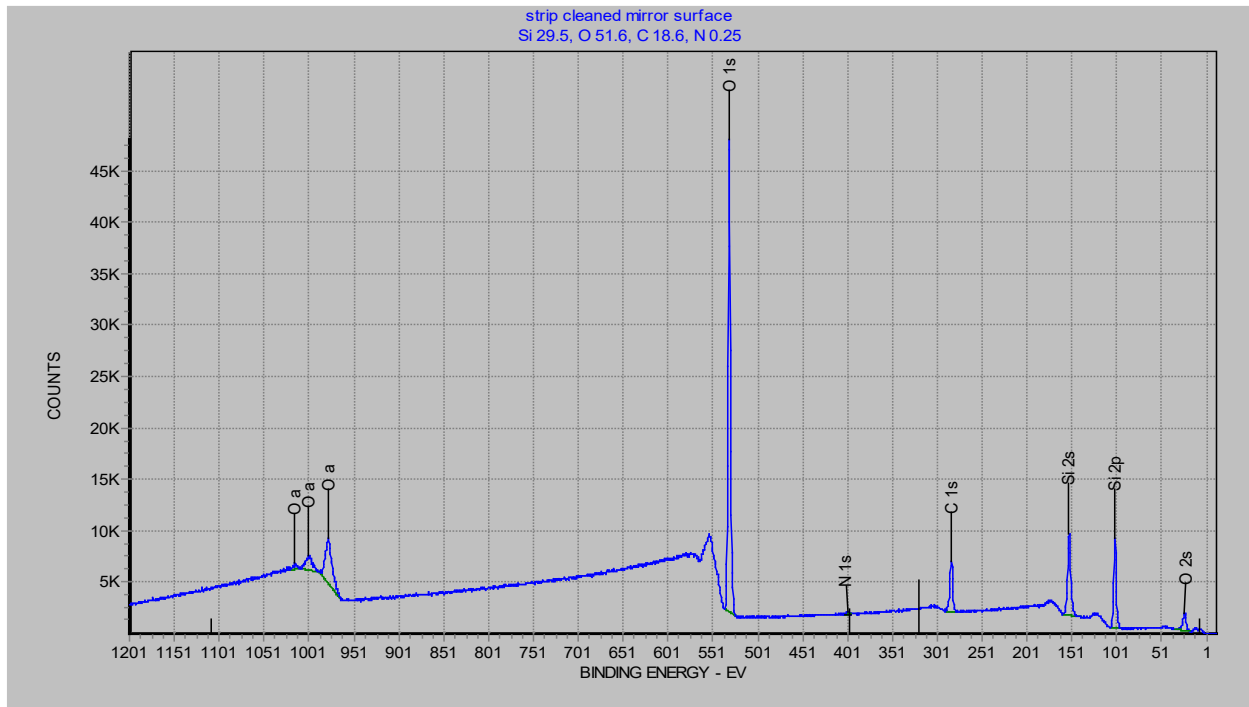


Figure 2 Strip cleaned mirror surface

Respectfully Submitted,

John S. Canham, Ph.D.  
Swales Aerospace, Inc.

cc:  
546/R. Hedgeland  
541/staff

[https://d.docs.live.net/f10fa703c3745096/Documents/PCT\\_New/Advertising^J Marketing ^0 Sales/ESCA Report NASA GSFC Canham 2006.doc](https://d.docs.live.net/f10fa703c3745096/Documents/PCT_New/Advertising^J Marketing ^0 Sales/ESCA Report NASA GSFC Canham 2006.doc)

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