

LIGO-T060026-00-D

40 m Large Air Oven Qualification Tests

Helena Armandula, Robert Taylor

After the 40m large air bake oven was commissioned, a series of FTIR analyses were performed on several aluminum baked parts to evaluate the level of hydrocarbon residue contamination, if any.

The tests were done by Mark Anderson, from JPL, and his reports are grouped in this document.

To: Helena Armandula 10/17/2005
From: Mark S. Anderson
Subject: LIGO Aluminum Part Processed in New Oven: Molecular Contamination Analysis

Purpose

An aluminum part was sampled using solvent wipes. This was to determine the level and identity of molecular (oily) contamination on the surface after processing in a new oven.

Method

The analytical swabs consisted of extracted fiber-free lens tissue using dichloromethane solvent. The areas sampled were ~300 square centimeters. The low volatility residue was analyzed using Diffuse Reflectance/ Fourier Transform Infrared (DRIFT/FTIR) spectroscopy. FTIR provides chemical functional group information for quantitative analysis and qualitative identification of materials. The analysis followed the ACL-120 procedure that complies with Mil-STD-1246C Notice 3 and is sensitive to the most stringent level (A/100).

Results and Discussion

The hardware surface is very clean. The tap holes could be cleaned further. A common mixture of compounds was removed from the surfaces and tap holes.

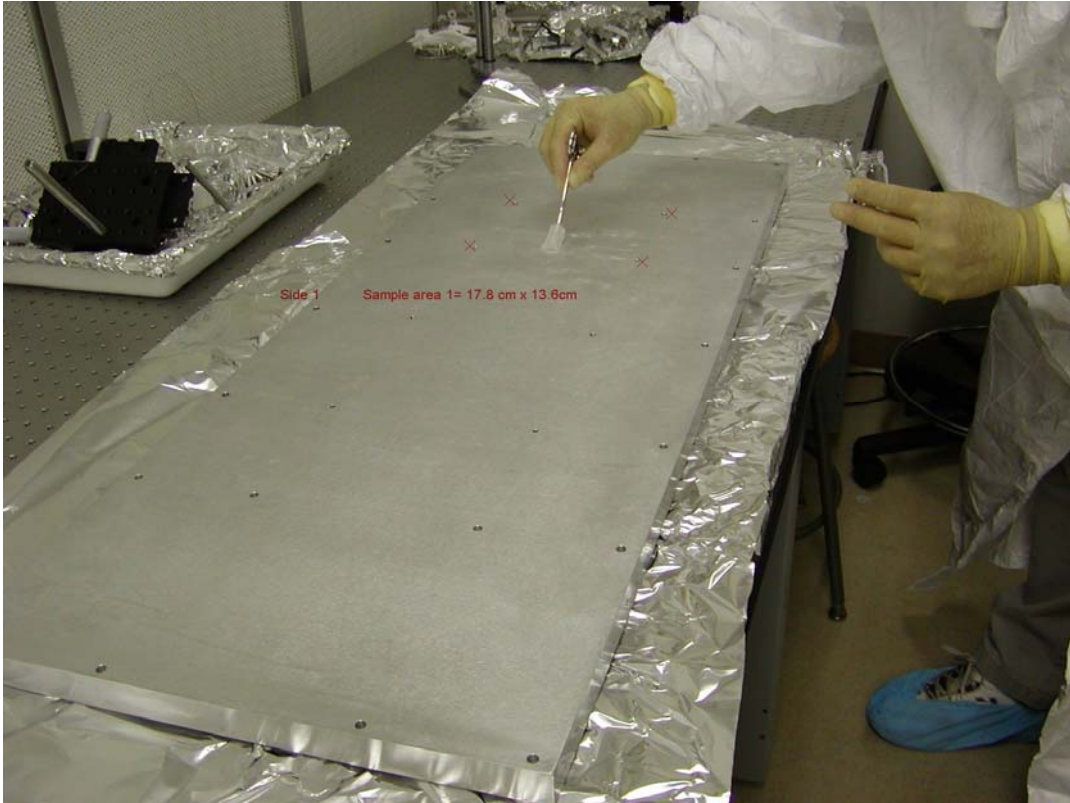
Sample Location	Chemical Functional Group	~Amount,
Side 1 Area 1	AHC, Ester, Silicone	0.04 micrograms/cm ²
Side 1 Area 2	AHC, Ester, Silicone	0.03 micrograms/cm ²
Side 2 Area 1	AHC, Ester, Silicone	0.06 micrograms/cm ²
Side 2 Area 2	AHC, Ester, Silicone	0.06 micrograms/cm ²
Side 1 Tap Hole	AHC	12 micrograms total
Side 1 hole untapped	AHC	10 micrograms total
Side 2 Tap Hole	AHC	2 micrograms total
Side 2 hole untapped	AHC	6 micrograms total
Control Swab	-	No oily residue detected <0.1 micrograms

A 1.0 microgram per square centimeter level is a 10-nanometer average film thickness (density of 1.0).

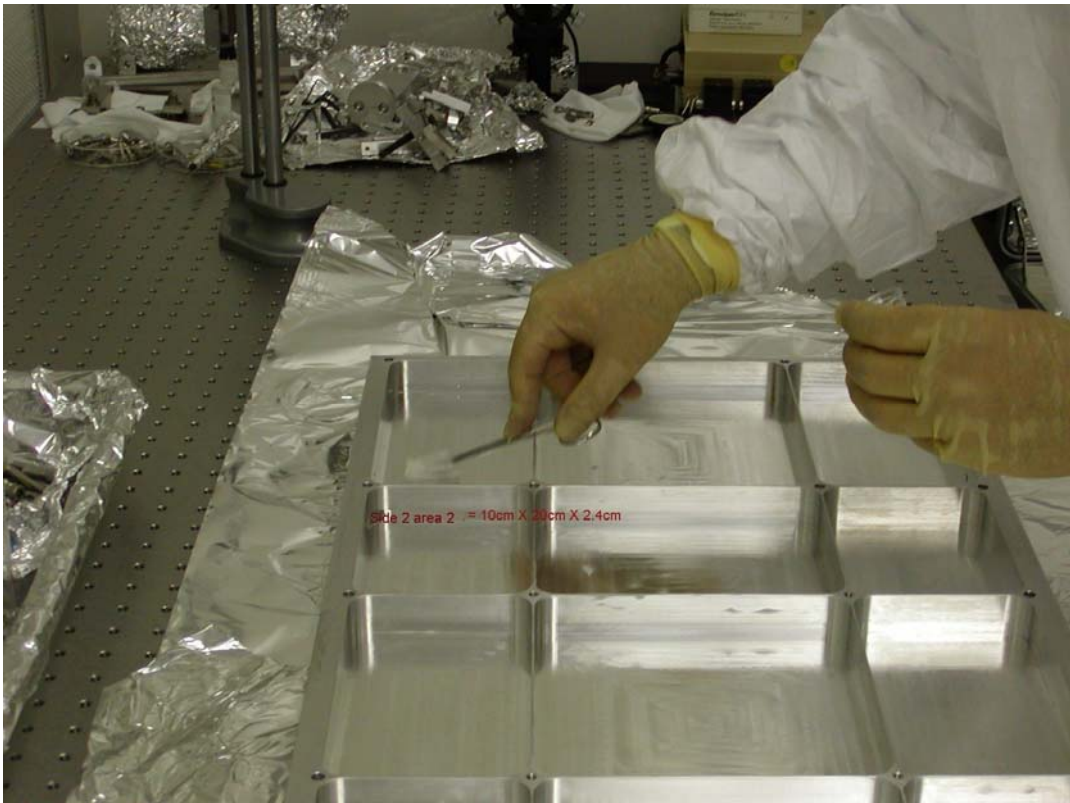
AHC = Aliphatic hydrocarbon, common lubricant

Esters are from plasticizers and are a component of fingerprints

Silicone = polydimethylsiloxane



Aluminum test piece



To: Helena Armandula 10/28/2005
From: Mark S. Anderson
Subject: LIGO Parts: Molecular Contamination Analysis

Purpose

Part surfaces were swab-sampled and submitted for chemical analysis. This was to determine the level and identity of molecular (oily) contamination on the surface. In addition, an “All Foil” UHV rated foil was similarly tested for residue.

Method

The analytical swabs consisted of extracted fiber-free lens tissue using dichloromethane solvent. The low volatility residue was analyzed using Diffuse Reflectance/ Fourier Transform Infrared (DRIFT/FTIR) spectroscopy. FTIR provides chemical functional group information for quantitative analysis and qualitative identification of materials. The analysis followed the ACL-120 procedure that complies with Mil-STD-1246C Notice 3 and is sensitive to the most stringent level (A/100).

Results and Discussion

The parts were very clean in terms of oily residue. However, the swabs removed some dark insoluble material that gave it a contaminated appearance. The dark material was fine particles (likely metallic) and this common on machined parts.

The “All foil” UHV foil was very clean and is a remarkable product.

Sample	Chemical Functional Group	~Amount,
Part1, 1A PN 50156	Mainly AHC	0.04 micrograms/cm ²
Part 1, 1B Tapped Hole PN 50156	AHC	~1.0 microgram total
Part 2, 1A, PN 50156	AHC	~0.04 micrograms/cm ²
Part 2, 1B Tapped Hole PN 50156	AHC	2.7 micrograms total
Part 3, 1A, PN 50156	AHC	0.03 micrograms/cm ²
Part 3, 1B Tapped Hole PN 50156	AHC	1.6 micrograms total
Part 4, 1A, PN 50156	AHC	~0.02 micrograms/cm ²
Part 4, 1B Tapped Hole PN 50156	AHC	1.5 micrograms total
UHV Foil	Trace AHC, very clean	~0.005 micrograms/cm ²

A 1.0 microgram per square centimeter level is a 10-nanometer average film thickness (density of 1.0).

AHC = Aliphatic hydrocarbon, common lubricant

To: Helena Armandula 11/3/2005
From: Mark S. Anderson
Subject: LIGO Parts: Molecular Contamination Analysis

Purpose

Part surfaces were swab-sampled and submitted for chemical analysis. This was to determine the level and identity of molecular (oily) contamination on the surface.

Method

The analytical swabs consisted of extracted fiber-free lens tissue using dichloromethane solvent. The low volatility residue was analyzed using Diffuse Reflectance/ Fourier Transform Infrared (DRIFT/FTIR) spectroscopy. FTIR provides chemical functional group information for quantitative analysis and qualitative identification of materials. The analysis followed the ACL-120 procedure that complies with Mil-STD-1246C Notice 3 and is sensitive to the most stringent level (A/100).

Results and Discussion

The parts were generally clean in terms of oily residue. The parts with the higher levels are shaded in the table below. These are not necessarily unacceptable but may warrant additional cleaning.

Sample / Part Number	Chemical Functional Group	~Amount,
#1 D50165 2x6"	Mainly AHC	0.05 micrograms/cm ²
#2 D50165 4 holes	AHC, Ester	~1.5 micrograms/4 holes
#3 1 D50165 2x6"	AHC	~0.01 micrograms/cm ²
#4 D50165 4 holes	AHC	~1.4 micrograms/4 holes
#5 D50165 2x6"	AHC	0.1 micrograms/cm ²
#6 D50165 4 holes	AHC	17 micrograms/4 holes
#7 D050162 5x5"	AHC + Silicone (30%)	0.05 micrograms/cm ²
#8 D050162 Weld 1/2X24"	AHC, Ester, Silicone	0.3 micrograms/cm ²
#9 D050162 5x5" + weld 1/2x12"	AHC + Silicone (10%)	0.05 micrograms/cm ²
#10 D050162 5x5"+ weld 1/2x12"	AHC, Ester, Silicone	0.2 micrograms/cm ²
#11 D050158 6x6"	AHC, Organic Acid/Salt	0.03 micrograms/cm ²
#12 D050164 7x7"	AHC, 5% Silicone	0.3 micrograms/cm ²

A 1.0 microgram per square centimeter level is a 10-nanometer average film thickness (density of 1.0).

AHC = Aliphatic hydrocarbon, common lubricant

To: Helena Armandula, Robert Taylor 11/14/2005
From: Mark S. Anderson
Subject: LIGO Parts: Molecular Contamination Analysis

Purpose

Part surfaces were swab-sampled and submitted 11/10/05 for chemical analysis. This was to determine the level and identity of molecular (oily) contamination on the surface.

Method

The analytical swabs consisted of extracted fiber-free lens tissue using dichloromethane solvent. The low volatility residue was analyzed using Diffuse Reflectance/ Fourier Transform Infrared (DRIFT/FTIR) spectroscopy. FTIR provides chemical functional group information for quantitative analysis and qualitative identification of materials. The analysis followed the ACL-120 procedure that complies with Mil-STD-1246C Notice 3 and is sensitive to the most stringent level (A/100).

Results and Discussion

The parts are generally clean in terms of oily residue. Sample #5 (D050162) has a higher level and, while not necessarily unacceptable, may warrant additional cleaning.

Sample / Part Number	Chemical Functional Group	Amount
#1 D050165 2x6" flat	AHC, ester, silicone	0.05 micrograms/cm ²
#2 D050165 4 holes	AHC, ester	1.7 micrograms/4 holes
#3 D050162 1/2x24" weld	AHC, ester	0.04 micrograms/cm ²
#4 D050165 2x6" flat	AHC, ester, silicone	0.05 micrograms/4 holes
#5 D050162 5x5" flat	AHC	0.3 micrograms/cm ²
#6 D050159 6x6" flat	AHC, ester, silicone	0.02 micrograms/cm ²
#7 D050162 4 holes	AHC, ester, Silicone	4.8 micrograms/4 holes
#8 D050165 2x6" flat	AHC, ester, Silicone	0.02 micrograms/cm ²
#9 D050162 1/2x24" weld	ester	0.01 micrograms/cm ²
#10 D050162 6x6" flat	AHC, ester, Silicone	0.04 micrograms/cm ²
#11 D050158 6x6" flat	AHC, ester, Silicone	0.02 micrograms/cm ²
#12 D050164 7x7" flat	AHC, ester	0.01 micrograms/cm ²

A 1.0 microgram per square centimeter level is a 10-nanometer average film thickness (density of 1.0).

AHC = Aliphatic hydrocarbon, common lubricant

To: Helena Armandula, Robert Taylor 11/29/2005
From: Mark S. Anderson
Subject: LIGO Parts: Molecular Contamination Analysis

Purpose

Part surfaces were swab-sampled and submitted 11/18/05 for chemical analysis. This was to determine the level and identity of molecular (oily) contamination on the surface.

Method

The analytical swabs consisted of extracted fiber-free lens tissue using dichloromethane solvent. The low volatility residue was analyzed using Diffuse Reflectance/ Fourier Transform Infrared (DRIFT/FTIR) spectroscopy. FTIR provides chemical functional group information for quantitative analysis and qualitative identification of materials. The analysis followed the ACL-120 procedure that complies with Mil-STD-1246C Notice 3 and is sensitive to the most stringent level (A/100).

Results and Discussion

The parts are very clean in terms of oily residue.

Sample / Part Number	Chemical Functional Group	Amount
D050070 #1	AHC, ester, silicone	0.03 micrograms/cm ²
D050070 #2	AHC, ester	~0.01 micrograms/cm ²
D050035 #1	AHC, ester, silicone	~0.01 micrograms/cm ²
D050035 #2	AHC, ester, silicone	0.03 micrograms/cm ²
Large Welded Structure	AHC	0.03 micrograms/cm ²
LWS Inside	AHC	~0.01 micrograms/cm ²
LWS Hole	AHC	~0.1 micrograms/4 holes

A 1.0 microgram per square centimeter level is a 10-nanometer average film thickness (density of 1.0).

AHC = Aliphatic hydrocarbon, common lubricant