16-Mar-06

LIGO-T060061-01-D Helena Armandula

SEM Analysis Report from ITM07

ITM07 was taken from the 4K Hanford interferometer in 2005 when the mirror was found to be responsible for most of the thermal lensing observed in H1.
After removal and upon immediate inspection, particles were found on the surface of the mirror in addition of a blotchy film.

The particles were analyzed by the Evans Analytical Group. Evans provided 12 mm dia.“stubs”covered with carbon tape to collect particle samples. One “stub” was pressed on the mirror’s surface twice to collect particles on the carbon tape and was returned to their laboratory for analysis.

The provided sample was anchored on the sample holder and inserted in a Hitachi S-4700A SEM (Scanning Electron Microscope). Attached to the SEM for Energy Dispersive X-ray analysis (EDX) was an Oxford system.

Following is their report:

10 Mar 2006

Helena Armandula
California Institute of Technology (Caltech)

Subject: Scanning Electron Microscopy Analysis Report
Job Number: C05K5210
Purchase Order Number: P204296

Dear Helena Armandula:

Please find enclosed the final report for the SEM analysis of your samples, as detailed in the following table.

Date received:	17 Feb 2006
Results faxed/emailed:	10 Mar 2006
Results emailed to:	ahelena@ligo.caltech.edu
Number of samples:	1
Number of hours:	2.00
Priority Surcharge	0%

Your samples will be retained for eight weeks after their receipt. After this time they will be disposed of, unless you specifically request otherwise. We will maintain copies of the report and data files for three years.

Thank you for using the analytical services of the Evans Analytical Group. We appreciate your business and welcome any suggestions you may have for improving the quality and efficiency of our service. Please do not hesitate to call us if you have any questions regarding this report.

Sincerely,

Hoainam Ho
Scientist, SEM and FIB Services
(Tel. 408-530-3680; Email: hho@eaglabs.com)
Enclosures:

SCANNING ELECTRON MICROSCOPY (SEM)
LABORATORY ANALYSIS REPORT
10 Mar 2006
JOB NUMBER C05K5210
PO NUMBER P204296

for

Helena Armandula
California Institute of Technology (Caltech)

Prepared by:

Hoainam Ho
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SEM ANALYSIS REPORT

Requester: Helena Armandula
Job Number: C05K5210
Analysis Date: 03 Mar 2006

Purpose:

The purpose of this analysis was to determine the elements present on the collected particles.

Samples:

1 stub.

Summary:

Several types of particles were observed on the stub. Please see the results and discussion section.

Experimental:

The provided sample was anchored on the sample hold and inserted in a Hitachi S-4700A SEM (Scanning Electron Microscope). Attached to the SEM for Energy Dispersive X-ray analysis (EDX) was an Oxford system. This technique can detect all elements heavier than and including boron (atomic number 5). Detection limits are on the order of 0.5 to 1% by weight if the peaks are isolated; however, in practice the minimum detection limit will typically be 1-2% by weight due to spectral overlaps, which can mask (make undetectable) some elements present in minor concentrations (e.g. sulfur and molybdenum).

Working voltage of 15KeV was used to analyze the residue. The analytical volume is estimated to be approximately 1-micron deep and 1-micron across. Any sub-micron particles will contain signals from its surrounding materials. Approximately 70% of the stub area was scanned for particles, avoiding the edges for unwanted particles due to handling. More particles were examined during scanning and only a representative set of particles were captured.

Results and Discussion:

Several types of residue observed on the stub. Particles containing high signals of oxygen (O) and silicon (Si) were probably from the mirror material, glass. Particles containing carbon (C) together with the elements (O), sodium (Na), chlorine (Cl), potassium (K), and calcium (Ca) were probably organic dust. Particles containing O, Al, Si, sulfur (S), calcium (Ca) and, for some particles, additional anions, were probably minerals (silicate, sulfate) or ceramics (alumina and silica). Carbon tape was used to collect the particles; therefore, C signal in each of the spectra was partially associated with the tape. Please see the attached images and EDS spectra.

After reviewing this report, you may assess our services using an electronic service evaluation form. This can be done by clicking on the link below, or by pasting it into your internet browser. Your comments and suggestions allow us to determine how to better serve you in the future. http://www.eaglabs.com/evaluate.htm?job=C05K5210.