***JPL* ANALYTICAL CHEMISTRY LABORATORY J012**

Flight Hardware Materials Analysis Group
Thermal and Propulsion Section 3530

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Subject: Evaluation of CO2 Ice Cleaning Process

Purpose

The use of CO2 Ice spray cleaning for sensitive optics was examined. The cleaning procedure was evaluated to determine if the CO2 ice spray deposited oily contamination. In addition, the optical surface was tested to determine if the CO2 ice spray eroded the optical surface.

Method

After CO2 spray cleaning, glass test plates were rinsed with dichloromethane and 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.

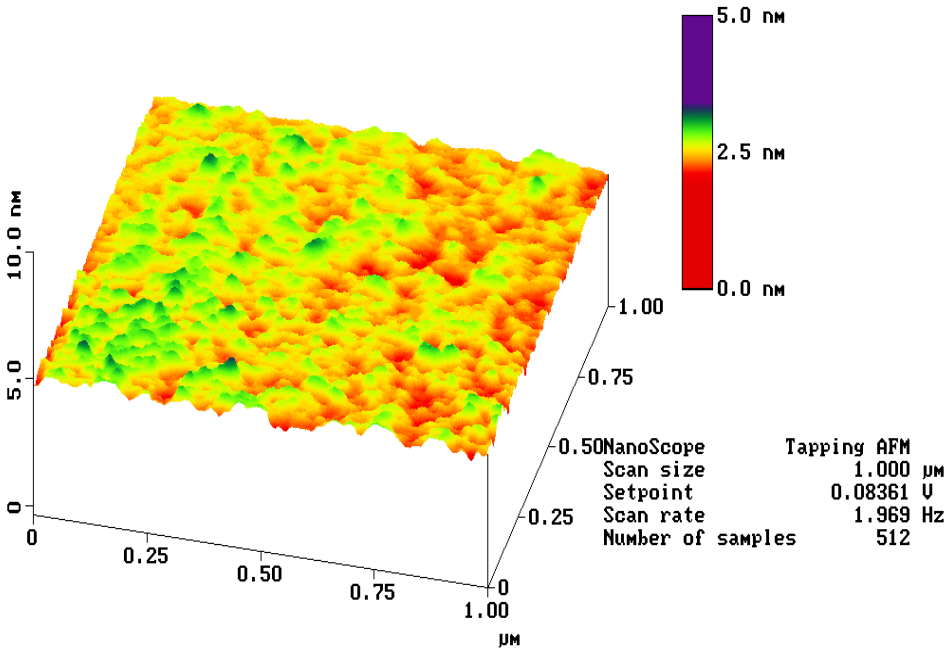
An optical flat surface was examined before and after CO2 ice spraying using Atomic Force Microscopy(AFM). AFM provides a sensitive measure of surface roughness to determine if any significant erosion has occurred.

Results

The CO2 spray cleaning did not deposit a significant amount of oily residue. Two samples were examined and both had less than 0.01 micrograms per square centimeter of organic or silicone residue. A 1.0 ug/cm^2 level corresponds to an average film thickness of 100 angstroms for a residue with a density of 1.0.

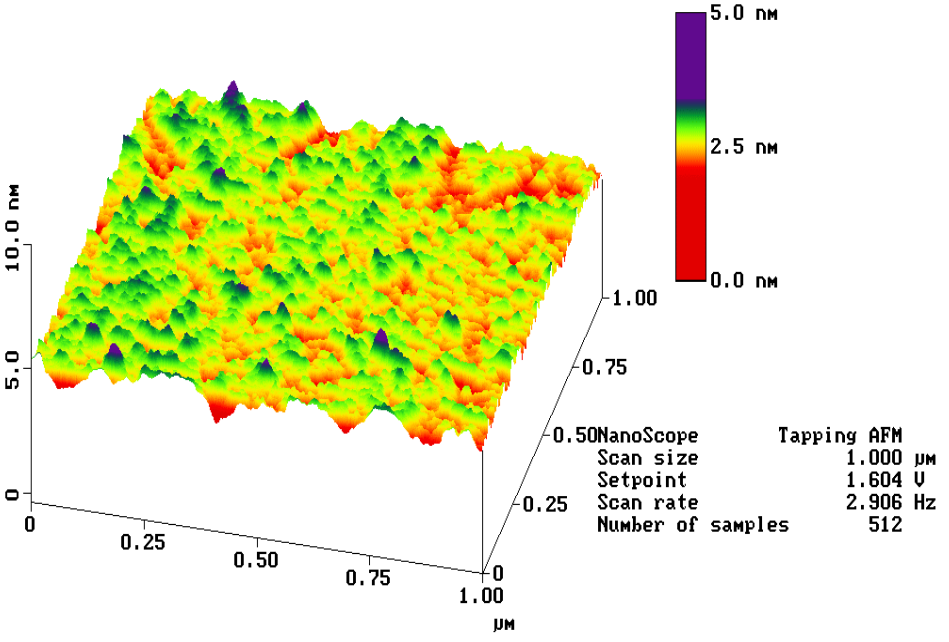
The CO2 spray cleaning did not significantly erode the optical surface. A one square micron area before cleaning had a RMS roughness of 0.18 nanometers (nm) after cleaning the RMS roughness was 0.25nm. Most optical flats cluster around 0.6 nm RMS. If the CO2 cleaning eroded the surface, the roughness change is expected to be much greater. The AFM images are given below:

Before CO2 Ice Spray Cleaning:



Ligo Optic Pre-CO2 Cleaning, RMS=0.18nm
ligo1.000

After CO2 Ice Spray Cleaning:



Ligo Optic: After CO2 Cleaning, RMS=0.25nm
ligo2.000