***JPL* ANALYTICAL CHEMISTRY LABORATORY**
Analytical Chemistry and Materials Development Group 3531
Propulsion and Materials Section 3530

To: **Betsy Bland** **04-07-10**

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Subject: **QUAD Upper and Lower Structures, (1) Upper Structure D060492, (2) Lower Structures D060462, (2) Lower Structures D060434**

Purpose

The purpose is to determine the level and identity of molecular (oily) contamination.

Method

LVR Analysis
The low volatility residue (LVR) was analyzed using Diffuse Reflectance Infrared Fourier Transform (DRIFT) spectroscopy (*1*). Blank samples were run along with the samples (*2*). FTIR provides chemical functional group information for quantitative analysis and qualitative identification of materials. The analysis followed the JPL ACL-120 procedure that complies with IEST-STD-CC1246D (*3*) and is sensitive to stringent levels (*4*).

Results and Discussion

Sample numbers **3, 4,** and **7** were compromised upon arrival and therefore could not be analyzed. The caps of the vials were loose and no Feon remained.

Sample	Chemical Functional Group	Amount (µg/cm^2)
1_D060492, 005, upper structure – pre air bake, surface	AHC	≤ 0.02
2_D060492, 005, upper structure – pre air bake, 5 holes	AHC	0.4*
3_D060492, 005, upper structure – post air bake, surface		
4_D060492, 005, upper structure – post air bake, 5 holes		
5_D060434, 010, lower structure – pre air bake, surface	AHC, Ester	≤ 0.02
6_D060492, 017, lower structure – pre air bake, 12 holes	AHC	12.1*
7_D060434, 022, lower structure – pre air bake, surface		
8_D060462, 018, upper structure – pre air bake, 12 holes	AHC	13.5*

* Total Amount for number of holes

Terminology:
AHC: Aliphatic hydrocarbon, base oil of common lubricants
Esters: common sources are from plasticizers and fingerprints
µg/cm^2: micrograms per square centimeter

References and Notes

1. M. S. Anderson et al "Analysis of Semi-Volatile Residues Using Diffuse Reflectance Infrared Fourier Transform Spectroscopy" in Optical System Contamination: Effects, Measurements, and Control VII; July 2002, edited by Phillip T. C. Chen and O. Manuel Lee; Proceedings of the SPIE, Vol. 4774, pp. 251-261, (2002).

2. The wipe blanks are less than 10% the amount in the sample and this is subtracted from the reported sample amount. High blanks (greater than 10% of the sample) are noted in the report. A typical solvent wipe has a detection limit of ~0.005 µg/cm^2 of removed residue from a 100cm^2 sample. Note this limit is well below the adventitious carbon level (ref. 4). Lower limits are possible using modified methods.

3. The analysis conforms to the Institute of Environmental Science and Technology (IEST), Contamination Control Division Document IEST 1246D “Product Cleanliness Levels and Contamination Control Program”. The contamination limits are generally set by Contamination Control Engineering. At typical limit is “Level A” (IEST-STD-CC1246D) and this is 1 microgram per square centimeter (µg/cm^2) and this corresponds to an average film thickness of 100 angstroms (assuming a density of 1.0). In many cases more stringent limits apply (4).

4. Very clean surfaces, ≤0.02 µg/cm^2, with mono-molecular layers or less are more complex to describe when cleaning or analyzing. Carbon/hydrocarbon based substances are known to rapidly (within ~1 hour) accumulate on most, if not all, freshly exposed surfaces. This “adventitious” carbon is well documented in clean rooms and vacuum systems and compositionally varies by environment. Adventitious carbon is a discontinuous layer of approximately ~0.2 nanometers thick or **~0.02** µg/cm^2 up to 0.1 µg/cm^2 (for $\rho = 1$). The last mono-layer fractions may in some cases be strongly adsorbed to the surface as a “corrosion” layer. Therefore solvent based sampling methods may not remove these fractions, particularly if the surface is porous. When specifying cleanliness level to less than A/10 IEST-STD-CC1246D (0.1 µg/cm^2) these monolayer effects become more significant. See also: H. Piao and N. S. McIntyre, “Adventitious carbon growth on aluminum and gold–aluminum alloy surfaces”, *Surface and Interface Analysis*, 2002; 33: 591–594.