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Introduction: The purpose of preliminary examination of the Genesis sample collectors is to provide information on the condition and availability of collector materials to the science community as a basis for allocation requests. Similarly, the information will be used by the Genesis Sample Allocation sub-committee of CAPTEM to determine the optimum allocation scheme, and by the Genesis Curator to determine the processing sequence for allocation production. The plan includes a decision process and detailed examination and documentation protocol for whole arrays and individual collectors (wafers, concentrator targets, bulk metallic glass, gold foil, and polished aluminum). It also includes a plan for communicating the information obtained to the scientific community. The plan does not include a detailed plan for preliminary examination of the SRC lid foil collectors, the process for removal of individual collectors from their frames, or for the subsequent subdivision of collector materials for allocation.

Decision Process and Limitations on Preliminary Examination: Preliminary examination has at its foundation the premise that the scientific community requires some minimum amount of information to intelligently request appropriate samples for scientific analysis. There is a distinct line between obtaining information to aid in the scientific allocation process and performing the scientific analysis itself. These considerations must be balanced when defining the useful limits of preliminary examination. Preliminary examination of the Genesis samples is limited to the documentation of the physical condition and surface contamination of the collector materials. There is a point where the benefit of information gained by additional analyses and handling of the collectors is outweighed by the risk of compromise to the samples during that handling and analysis. Thus, careful evaluation of the benefits of additional analyses to sample allocation process must take place at each step of the preliminary examination to determine the merits of proceeding with these analyses.

In addition to providing useful information to the scientific community, preliminary examination for Genesis follows a “do no harm” policy characterized by analyses that are non-invasive and non-destructive and a “do not modify” policy characterized with no physical contact or introduction of contaminant to the collectors. All processing of the collector materials must be low energy with limited thermal agitation / diffusion of the implanted solar wind.

To be of value, preliminary examination needs to aid scientists in selecting the most suitable samples for their particular analyses. The Genesis collectors may have experienced conditions such as micrometeoroid impacts, launch and re-entry vibrations, outgassing of spacecraft components, and/or exposure to thruster exhaust and/or reentry gases, which could lead to contamination and interfere with the interpretation of analytical results. Thus, the things the science community needs to know are: (1) Is there significant contamination or damage? (2) How much is there? (3) How is it distributed? (4) Can we identify it?

Preliminary Examination:

Visual Inspection and Photodocumentation. The first step in any examination of the collectors is a visual inspection and inventory of the condition of the arrays and individual collectors. Complete arrays and mounted collectors will be surveyed by both visual and photographic techniques for comparison with preflight documentation. A visual inspection summary of arrays will be produced to provide a “quick-look” of the array condition and to give context to more detailed examinations of individual collectors. These notes will include location of any broken or missing collectors as well as impact features, surface defects, and areas of haze.

Materials will be examined and photographed in both direct and oblique light, since studies confirm that different features are detectable under different conditions. An example is shown in Figure 1 where direct illumination reveals little if any molecular contamination, but oblique illumination makes the presence of a non-uniform film more obvious. The addition of color filters enhances the effect even further. All handling including the type of tools used, duration of exposure, and processing performed will be recorded and archived in data packs.

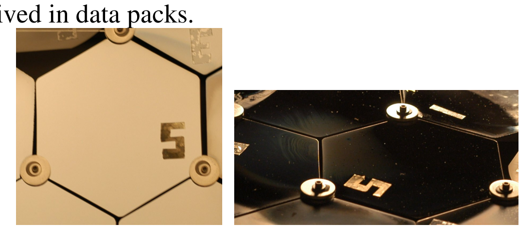

Figure 1: Different viewing conditions to detect molecular haze.

Optical Microscopy. There is potential for particulate contamination associated with micrometeoroid impacts and related spallation. Such impacts can leave residue and/or visible cracks and craters on the surface of the collectors. These defects may interfere with some analyses. In addition, it is possible for impact events to cause mixing effects that could redistribute the implanted solar wind. Thus, it is important to identify the extent of the damage zone surrounding such features in order to make useful allocations. This is best accomplished under higher than 10x magnification, in a darkfield geometry. Optical microscopy becomes a necessary part of preliminary examination to characterize impacts, particles, & surface defects but can accommodate samples of only limited size and is only applicable to collectors once they have been removed from their arrays or frames. Although this technique, particularly darkfield reflectance, is extremely useful for examining surface particulates and impact features, it is, unfortunately, of limited value in the investigation of molecular contamination, and additional techniques must be employed.

Spectroscopic Ellipsometry. For molecular contamination, the thickness of the contamination layer and its distribution across the surface of the collector are of interest. Spectroscopic ellipsometry uses the change in state of linearly polarized light upon reflection to determine film thickness, index of refraction and extinction coefficients. The collector shown in Figure 2 exhibits an asymmetric distribution of contamination varying in thickness from 40 – 150Å. While one edge of the film may not be useful for analysis, the majority of the collector would be. Spectroscopic ellipsometry is a cleanroom compatible technique used throughout the semiconductor industry in evaluating thin films. It is possible to determine limited compositional information of the mapped film from inferences on molecular content and structure from the optical coefficients. Of particular use in identifying the types of contamination layers anticipated on the Genesis collectors is the extension of the technique to near-IR wavelengths.

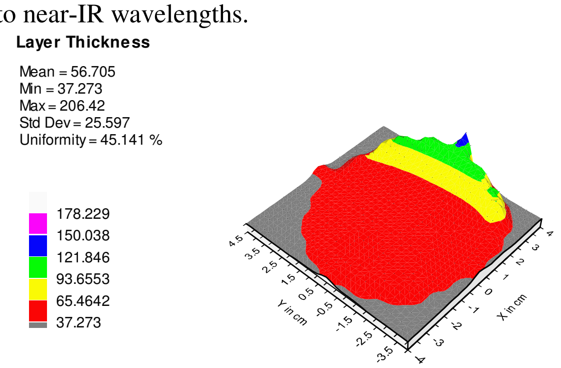

Figure 2: Ellipsometry of a contaminated collector.

The only remaining question about contamination that remains outstanding is the determination of specific chemical identity. Unfortunately, this is not an issue which is easily addressed. The majority of techniques which are capable of chemical identification are destructive, are not cleanroom compatible, and introduce unacceptable contamination to the sample. It would seem as though there is little hope of obtaining such information on contaminated Genesis collectors. However, each of the Genesis collector arrays is assembled using aluminum washer assemblies which systematically map the face of the array. These materials are not useful for solar wind analyses because of bulk impurities, however they are useful for contamination mapping using techniques such as FTIR spectroscopy or XPS. While these techniques are inappropriate for application to the collectors, they can be used to examine molecular contamination on the washers to infer some knowledge of the corresponding material on the collectors.

Documentation: All of the information produced for each array and collector will be archived for access and long-term availability to the scientific community. The visual inspections will include notes on observations of condition and absence of collectors. The photodocumentation will include a catalog of array photos (normal and oblique incidence angles). For each individual collector a datapack will be compiled that includes:

- Tracking to parent array, position, orientation
- Visual inspection at 1X and 10X
- Photographs at normal and oblique angles
- Microscopic examination notes and photos for anomalies observed in visual inspection
- Ellipsometric analysis and maps where films or hazes are observed.

The preliminary assessment described above will be performed in a Class 10 cleanroom environment at the Johnson Space Center. It is critical that all operations and storage of these materials be carried out in such an environment to preserve the level of cleanliness with which the payload was assembled, and that subsequent contamination or decay of collector condition is minimized in order to preserve a reservoir of pristine solar wind samples well into the 21st century.