

EXAMPLES OF OPTICAL ASSESSMENT OF SURFACE CLEANLINESS OF GENESIS SAMPLES.

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Introduction: Optical microscope assessment of Genesis solar wind collector surfaces is a coordinated part of the effort to obtain an “assessed clean” subset of flown wafer material for the scientific community. Microscopic survey is typically done at 50X magnification at selected $\sim 1\text{mm}^2$ areas on the fragment surface. This survey is performed each time a principle investigator (PI) returns a sample to JSC for documentation as part of the established cleaning plan. The cleaning plan encompasses sample handling and analysis by Genesis science team members, and optical survey is done at each step in the process. Sample surface cleaning is performed at JSC (ultrapure water [1] and UV ozone cleaning [2]) and experimentally by other science team members (acid etch [3], acetate replica peels [4], CO₂ snow [5], etc.). The documentation of each cleaning method can potentially be assessed with optical observation utilizing Image Pro Plus software [6]. Differences in particle counts can be studied and discussed within analysis groups. Approximately 25 samples have been identified as part of the cleaning matrix effort to date.

Sample 60326: Flown sample 60326 is a silicon-on sapphire (SOS) layered fragment from the bulk-array. It is 22.7 x 9.3 mm in one dimension and has a thickness of 706 μm . The sample has been UPW and exposed to UV ozone cleaning at JSC. It has also had an additional surface cleaning in an HCl bath (Caltech). This sample did not have the benefit of high magnification scanning before its allocation in 2007, but its return to JSC in 2011 provided an opportunity to document the sample surface as part of this cleaning study effort. An overview scan (Fig.1) shows that small features were subsequently added to the sample surface.



Fig. 1. Sample 60326. Features present at the time of allocation are in yellow. Features present after PI return are in red. The area bounded by the square was scanned at higher magnification (position 1).

Additional scans were taken at 50X magnification. Sample features were classified using Image Pro Plus software to differentiate between size categories. Each object (user defined colored pixels detected by the software) has length and area data recorded in Excel. The data can be displayed in various formats for analysis. The image below (Fig.2.) displays an inset of data for position 1. This inset displays 413 objects detected by the software.

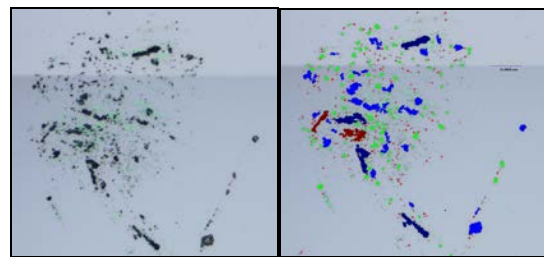


Fig.2. Selected area of interest on sample 60326. The area is 0.02mm^2 . The image at right has been classified into colored size bins.

Classification			
File View			
Class	Objects	% Objects	
1	259	63.950619	
2	111	27.407408	
3	29	7.1604939	
4	2	.49382716	
5	4	.98765433	

Fig. 3. Example of colorized size binning for sample 60326 using Image Pro Plus.

Sample 61052: Flown sample 61052 is a float – zone silicon (FZ-Si) fragment from the bulk-array. It is 7 x 6.8 mm in one dimension and has a thickness of 718 μm . The sample has been UPW and exposed to UV ozone cleaning at JSC. It has also had an additional surface cleaning by CO₂ snow exposure (Argonne National Lab). The sample was imaged before allocation (after JSC cleaning) and after its return at selected areas. 464 objects were detected after its return to JSC, compared to 321 objects observed at the time of its allocation. Figure 5 illustrates an example of the size of added particles on position 1.

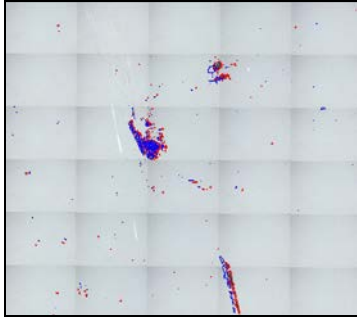


Fig. 4. Sample 61052, position 1. Features present at the time of allocation are in red. Features present after PI return are in blue. The field of view is $\sim 1\text{mm}^2$.



Fig. 5. Inset of sample 61052, position 1. The sizes (in μm) of detected features are displayed. Objects outlined in red were present before PI return (these do not have measurements displayed). The field of view is $\sim 0.1\text{mm}^2$.

References: [1] Calaway M.C. et al (2009) LPSC XL, Abstract # 1183. [2] Calaway M.C. et al (2007) LPSC XXXVIII, Abstract # 1627. [3] Burnett D.S. et al (2006) LPSC XXXVII, Abstract # 1627. [4] Kuhlman K.R. et al (2007) LPSC XXXVIII, Abstract # 1627. [6] Veryovkin I. et al (2011) LPSC XLII, Abstract # 2308. [6] Rodriguez M. et al (2012) LPSC XLIII, Abstract # 2750.