

GENESIS SILICON CARBIDE CONCENTRATOR TARGET 60003 PRELIMINARY ELLIPSOMETRY MAPPING RESULTS. M.J. Calaway¹, M.C. Rodriguez², and E.K. Stansbery³: (1) Jacobs (ESCG) at NASA Johnson Space Center, Houston, TX; (2) Geocontrol Systems (ESCG) at NASA Johnson Space Center, Houston, TX; (3) NASA, Johnson Space Center, Houston, TX; michael.calaway-1@nasa.gov.

Introduction: The Genesis concentrator was custom designed to focus solar wind ions primarily for terrestrial isotopic analysis of $^{17}\text{O}/^{16}\text{O}$ and $^{18}\text{O}/^{16}\text{O}$ to $\pm 1\%$, $^{15}\text{N}/^{14}\text{N}$ to $\pm 1\%$, and secondarily to conduct elemental and isotopic analysis of Li, Be, and B [1, 2]. The circular 6.2 cm diameter concentrator target holder was comprised of four quadrants of highly pure semiconductor materials that included one amorphous diamond-like carbon, one ^{13}C diamond, and two silicon carbide (SiC) [1] (see image 1). The amorphous diamond-like carbon quadrant was fractured upon impact at Utah Test and Training Range (UTTR), but the remaining three quadrants survived fully intact and all four quadrants hold an important collection of solar wind.

The quadrants were removed from the target holder at NASA Johnson Space Center Genesis Curation Laboratory in April 2005, and have been housed in stainless steel containers under continual nitrogen purge since time of disintegration. In preparation for allocation of a silicon carbide target for oxygen isotope analyses at UCLA, the two SiC targets were photographed for preliminary inspection of macro particle contamination from the hard non-nominal landing as well as characterized by spectroscopic ellipsometry to evaluate thin film contamination [3, 4]. This report is focused on Genesis SiC target sample number 60003.

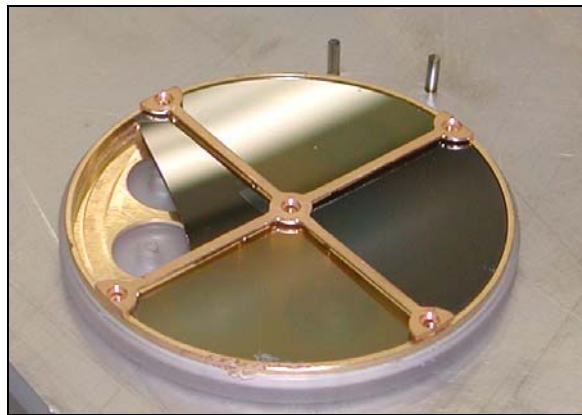


Image 1: Genesis Concentrator Target after Landing

Particle Contamination: 60003 SiC target is in very good condition compared to other Genesis array wafer materials that survived the non-nominal hard landing. The target showed visible signs of array fragment dust and possibly a small deposit of halite

and gypsum crystallization at the outside edge near ellipsometry spot 6 (see image 2), most likely from saturated carbonate mud from the landing site at UTTR. Currently methods of surface cleaning the SiC target are under evaluation by Genesis science team members.

Ellipsometry Results: Both SiC targets underwent spectroscopic ellipsometry characterization at the NASA Genesis ISO 4 (class 10) cleanroom Curation Laboratory. Ellipsometry data was collected at 18 different locations on a 0.5 cm grid interval. Image 2 shows two examples of transect lines that were completed on target 60003. The line from spot 4 to spot 6 (5 measurement spot points along transect) is from the center of the concentrator to the outer edge which corresponds to the location of the predicted solar wind concentration gradient. Spot 18 to spot 9 (7 measurement spot points along transect) is a straight transect line close to the parallel arc ion implantation gradient.

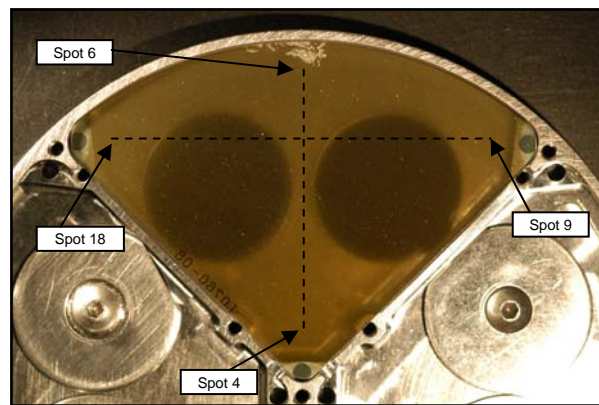
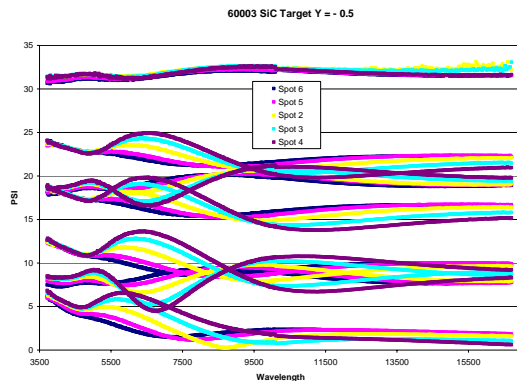


Image 2: SiC Target 60003 with Ellipsometry Transects

Graph 1 and 2 below show highlighted ellipsometry data from SiC sample 60003. Graph 1 illustrates the transect line between spot 4 to 6 and graph 2 illustrates the transect line from spot 18 to 9. Both graphs show collected data at 55°, 60°, 65°, 70°, 75°, 80°, and 85° ellipsometry angles and the data is plotted with respects to PSI and wavelength measured in Angstroms [4].

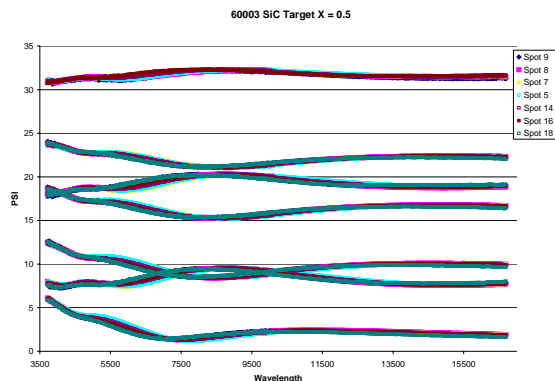
Unmodeled ellipsometry data shows that the SiC material substrate has been altered when compared to non-flight reference materials. At 5000 Å in wavelength on graph 1, the material substrate has

been altered at each spot location. This is seen in the changing difference in PSI at each spot location.



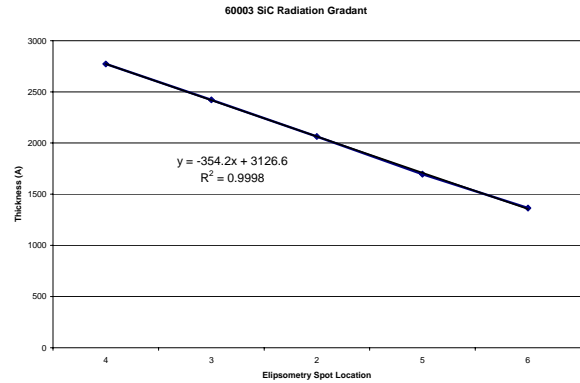
Graph 1: Ellipsometry Raw Data from Spot 4 to 6.

However, graph 2 below shows a homogeneous material substrate alteration and PSI does not change along the spot location transect.



Graph 2: Ellipsometry Raw Data from Spot 9 to 18.

After ellipsometry data was collected, an ellipsometry model for flown SiC material was derived to account for the found material alteration. The current model consisted of a base substrate layer of bulk SiC, a generalized oscillation model based on SiC coupled with a graded layer (typical for deep ion implantation models), and a surface thin-film layer that would contain any contamination as well as the SiO₂ oxide thin film. Graph 3 shows a material alteration zone depth (measured in Angstroms) in the substrate below the surface of the thin-film at each ellipsometry spot location between spot 4 to 6. The graph also illustrates a proposed model of the gradient of solar wind radiation damage by material alteration with an equation of the line at $y = -354.2x + 3126.6$. However, this radiation gradient is yet to be verified by other experimentation.



Graph 3: Ellipsometry Modeled Radiation Depth Gradient. Increasing Distance from Concentrator Focal Point from Left to Right (Spot 4 to 6).

Visual inspection and macro images also possibly show a slight change in the color gradient between the outer edges to the center of the concentrator target. If this is correct, the darker colors near the center of the target would relate to the increased amount of ion implantation into the SiC material. Ellipsometry models also show that a slight increase in the surface thin-film range between 38 to 90 Å. However, it is currently unclear if the concentrator targets are contaminated by an organic contaminate or this is an increase of the SiO₂ layer.

Summary: Image results show that macro particle contamination is very low and should not hinder the ability to analyze solar wind elemental abundances [5]. A preliminary ellipsometry model shows a slight increase of the surface layer towards the center focal point of the targets. The ellipsometry data also shows substrate alteration increasing towards the center of the targets. This material alteration is currently interpreted as a radiation damage zone layer induced by solar wind ion implantation.

References: [1] Burnett, D.S. et al. (2003) Space Science Reviews 102 (1-2), 1-28; [2] Wiens, R.C et al. (2003) Space Science Reviews 102(1-2), 93-118; [3] Burnett, D.B. et al. (2005) LPSC XXXVI, Abstract # 2405; [4] Calaway, M.J. et al. (2006) LPSC XXXVII, Abstract # 1420; [5] Heber, V.S. et al. (2006) LPSC XXXVII, Abstract # 5314.