STATUS OF RECONSTRUCTION OF FRAGMENTED DIAMOND-ON-SILICON COLLECTOR FROM GENESIS SPACECRAFT SOLAR WIND CONCENTRATOR.

M. C. Rodriguez[1] , M. C. Calaway[2], J. H. Allton[3], K. M. McNamara[3] and J. D. Hittle[2]. [1]GeoControl Systems (ESCG) at NASA Johnson Space Center, Houston, TX, 77058, Melissa.Rodriguez-1@nasa.gov; .[2]Jacobs (ESCG) at NASA Johnson Space Center, Houston, TX; [3] NASA, Johnson Space Center, Houston, TX.

Introduction: In addition to passive solar wind collector surfaces, the Genesis Discovery Mission science canister had on board an electrostatic concave mirror for concentrating the solar wind ions, known as the "concentrator". The 30-mm-radius collector focal point (the target) was comprised of 4 quadrants: two of single crystal SiC, one of polycrystalline 13C diamond and one of diamond-like-carbon (DLC) on a silicon substrate. [DLC-on-silicon is also sometimes referenced as Diamond-on-silicon, DOS.] Three of target quadrants survived the hard landing intact, but the DLC-on-silicon quadrant fractured into numerous pieces (Fig. 1). This abstract reports the status of identifying the DLC target fragments and reconstructing their original orientation.

Fig. 1. Configuration of quadrants as removed from the concentrator in Utah. Additional fragments of the broken quadrant were recovered from the concentrator interior.

Pre-flight Preparation of the Diamond-like Carbon on Silicon: The diamond-like-carbon thick film (1.5 to 3.0 µm) was applied to the 550-µm-thick silicon substrate at Sandia National Laboratories under vacuum by sputtering multiple thin layers . An annealing step was performed after each thin layer deposition to reduce internal stresses in the bulk material. Since the annealing process introduced additional contamination, the second to last annealing step was omitted to preserve a relatively clean upper 2000-3000 Å layer for solar wind capture [1]. Clip marks from the sputtering process are visible in the recovered target (Fig.2).

Condition of the Concentrator Targets as Recovered in Utah: The target quadrants, in a steel holder, were relatively protected inside of the concentrator, suspended on steel ribs and cushioned by steel mesh. After the concentrator was removed from the canister, the target holder with 3 intact targets and one broken target was extracted and stabilized for transport to Johnson Space Center in Houston. All loose pieces of collector fragments were carefully picked out of the concentrator, imaged and packaged separately.

Confirmation of loose fragments as target material. All of the fragments retrieved from the concentrator were examined optically to confirm material was DLC-on-silicon and that the thickness matched that of the target. Table 1 shows the wafer thickness averages and range for all DLC-on-silicon fragments measured as of September 2008. While wafer thickness of target and L array are not distinguishable, the DLC-on-silicon concentrator target should not be confused with other solar wind regimes. All candidate pieces were individually imaged with Leica MZ9 and DM6000M microscopes. A 5X mosaic was recorded.

TABLE 1.

Regime	Average Thickness, µm	Minimum Value, µm	Maximum Value, µm
Concen-trator	564 ±4	557	573
L array	558 ±4	547	572
H array	603 ±5	592	621
E array	649 ±6	632	665
B/C array	702 ±4	689	718

Fitting together DLC-on-silicon target pieces. The candidate target pieces were fitted together to a) confirm a fragment was indeed a target specimen, and b) to establish orientation. Orientation with respect to the concentrator focal point is critical, since solar wind fluence and isotopic fractionation differ with distance from focal point. Pieces confirmed by fitting together are shown in Figs. 2-4. Also shown are additional pieces recovered from the concentrator which are "very likely" to be target fragments, but their orientation cannot be established at this time. Table 2 compiles the sample numbers for "confirmed" and for "very likely" DLC-on-silicon target specimens.

Features seen on DLC target images. Crash-related particulate debris is similar to that found on the other concentrator quadrants and includes spacecraft and Utah sediments [2]. Particulate debris has not yet been quanitifed. Unique to the DLC-on-silicon quadrant are sinuous areas where the DLC layer was separated from the silicon during quadrant breakup (example indicated by arrow in Fig. 4).

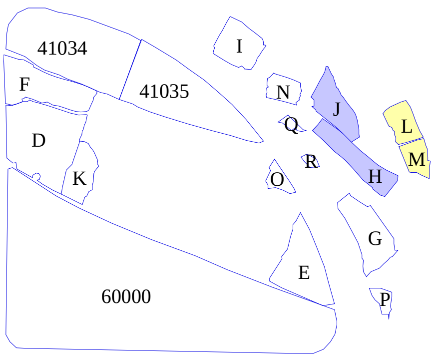

Fig. 2. Key to identification of samples in Figs. 3 & 4. Fragments H & J fit together. Fragments L & M fit together.

TABLE 2.

Key for Figs. 2-4. Samples are sorted by area. Eight confirmed and oriented samples are shown with an asterisk*.

Key	Sample	Area, mm^2
*A	60000	241
*B	41034	53
*C	41035	45
*D	41251	37
*E	41299	22
*F	60741	21
G	60740	18
H	60738	14
I	60736	12
J	60742	12
*K	60743	10
L	60735	7
M	60746	6
N	60747	6
*O	60737	4
P	60744	3
Q	60750	1
R	60751	1
	Total area =	514

Fig. 3. DLC-on-silicon quadrant fragments fitted together, ambient illumination, Leica MZ9 microscope.

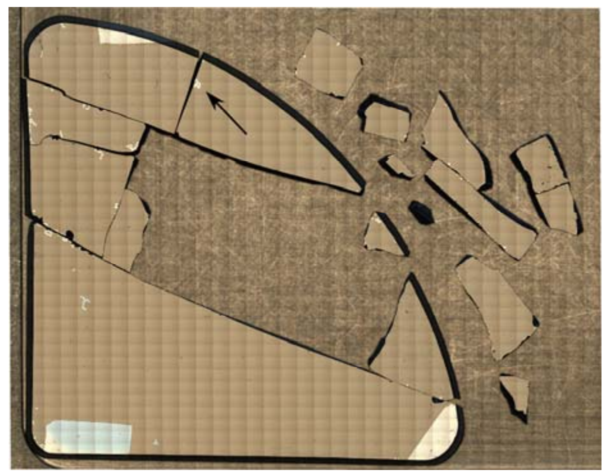

Fig. 4. Mosaic of DLC-on-silicon quadrant fragments fitted together, bright field illumination, Leica DM6000 M microscope. Clip marks from carbon coating process are visible as bright areas on perimeter. Closer inspection reveals shadow from target holder in lower left clip mark. Arrow indicates example of "sinuous" area.

Summary. Thus far 440 mm^2, or 67%, of the area of the DLC-on-silicon concentrator collector is confirmed and oriented. Further, an additional 11%, comprising 73 mm^2, is identified as "very likely" based on recovery from the concentrator interior and on material composition and thickness. The orientation of these "very likely" fragments is not yet determined and work continues. Loss of fine material during fracture makes fitting difficult; thus, other methods need to be applied.

Reference: [1] Jurewicz A. J. G. *et al.* (2003) *Space Sci. Rev., 105,* 535-560. [2] Calaway *et. al.* (2008) LPS XXXIX Abstract #1423.