GENESIS SOLAR WIND COLLECTOR CLEANING ASSESSMENT: UPDATE ON 60336 SAMPLE CASE STUDY. Y.S. Goreva, K. K. Allums, C.P. Gonzalez, A.J. Jurewicz, D.S. Burnett, J.H. Allton, K.R. Kuhlman, D. Woolum. 1Smithsonian Institution, Washington, DC, gorevay@si.edu, 2Jacobs-JETS at NASA/J, Houston, TX, 3Arizona State University, Tempe, AZ, 4California Institute of Technology, Pasadena, CA, 5NASA/JSC, Houston, TX, 6Planetary Science Institute, Tucson, AZ, 7California State University, Fullerton, CA.

Introduction: To maximize the scientific return of Genesis Solar Wind return mission it is necessary to characterize and remove a crash-derived particle and thin film surface contamination. A small subset of Genesis mission collector fragments are being subjected to extensive study via various techniques [1-6]. Here we present an update on the sample 60336, a Czochralski silicon (Si-CZ) based wafer from the bulk array (B/C).

History of sample 60336: This sample has undergone multiple cleaning steps (see the table below): UPW spin wash, aggressive chemical cleanings (including aqua regia, hot xylene and RCA1), as well as optical and chemical (EDS, ToF-SIMS) imaging.

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/26/2007</td>
<td>UPW cleaned 5min @40C at JSC</td>
</tr>
<tr>
<td>5/14/2013</td>
<td>Imaged using DM6000M at JSC</td>
</tr>
<tr>
<td>7/31/2013</td>
<td>SEM analysis at PSI</td>
</tr>
<tr>
<td>8/1/2013</td>
<td>Imaged using DM6000M at JSC</td>
</tr>
<tr>
<td>8/6/2013</td>
<td>UPW cleaned and imaged at JSC</td>
</tr>
<tr>
<td>8/13/2013</td>
<td>Aqua regia and hot xylene at Caltech</td>
</tr>
<tr>
<td>9/12/2013</td>
<td>Imaged using DM6000M at JSC</td>
</tr>
<tr>
<td>9/16/2013</td>
<td>UPW cleaned and imaged at JSC</td>
</tr>
<tr>
<td>10/14/2013</td>
<td>ToF SIMS analysis at Smithsonian</td>
</tr>
<tr>
<td>10/21/2013</td>
<td>Optical imaging at Smithsonian</td>
</tr>
<tr>
<td>11/12/2013</td>
<td>Low-vacuum nanoSEM at Smithsonian</td>
</tr>
<tr>
<td>11/12/2014</td>
<td>Imaged using DM6000M at JSC</td>
</tr>
<tr>
<td>11/24/2014</td>
<td>10 min RCA1 cleaning at Dartmouth</td>
</tr>
<tr>
<td>12/2/2014</td>
<td>25 min RCA1 cleaning at Dartmouth</td>
</tr>
<tr>
<td>12/4/2014</td>
<td>Imaged using DM6000M at JSC</td>
</tr>
<tr>
<td>12/4/2014</td>
<td>UPW clean 5min, 40C at JSC</td>
</tr>
<tr>
<td>12/4/2014</td>
<td>Imaged using DM6000M at JSC</td>
</tr>
<tr>
<td>12/18/2014</td>
<td>ToF SIMS analysis at Smithsonian</td>
</tr>
</tbody>
</table>

Results: Contamination appeared on the surface of 60336 after the initial 2007 UPW cleaning. Aqua regia and hot xylene treatment (8/13/2013) did little to remove contaminants [7]. The sample was UPW cleaned for the third time and imaged (9/16/13). The UPW removed the dark stains that were visible on the sample. However, some features, like “the Flounder” (a large, 100 micron feature in Fig 1b) appeared largely intact, resisting all previous cleaning efforts. These features were likely from mobilized adhesive, derived from the Post-It notes used to stabilize samples for transport from Utah after the hard landing. To remove this contamination, an RCA step 1 organic cleaning (RCA1) was employed.

The RCA is a standard semi-conductor procedure for removing contaminants from silicon wafers. Step 1 removes organic residue and films, using H_2O_2, NH_4OH-H_2O. NH_4OH removes organics; H_2O_2 keeps the silicon from dissolving in the NH_4OH.

An initial 10 min treatment did not remove the flounder, but, possibly, made it thinner. A further 25 min treatment visibly removed the Flounder (except for imbedded grains/crevices), as well as a number of previously described contaminants ([7], Figs 1, 2, 5): CMgBr grain in position 2 is gone, some (if not all) AlOx and many Si particles are gone.

Results: Contamination appeared on the surface of 60336 after the initial 2007 UPW cleaning. Aqua regia and hot xylene treatment (8/13/2013) did little to remove contaminants [7]. The sample was UPW cleaned for the third time and imaged (9/16/13). The UPW removed the dark stains that were visible on the sample. However, some features, like “the Flounder” (a large, 100 micron feature in Fig 1b) appeared largely intact, resisting all previous cleaning efforts. These features were likely from mobilized adhesive, derived from the Post-It notes used to stabilize samples for transport from Utah after the hard landing. To remove this contamination, an RCA step 1 organic cleaning (RCA1) was employed.

The RCA is a standard semi-conductor procedure for removing contaminants from silicon wafers. Step 1 removes organic residue and films, using H_2O_2, NH_4OH-H_2O. NH_4OH removes organics; H_2O_2 keeps the silicon from dissolving in the NH_4OH.

An initial 10 min treatment did not remove the flounder, but, possibly, made it thinner. A further 25 min treatment visibly removed the Flounder (except for imbedded grains/crevices), as well as a number of previously described contaminants ([7], Figs 1, 2, 5): CMgBr grain in position 2 is gone, some (if not all) AlOx and many Si particles are gone.

Figures 3 and 4 are positive ion images of Position One area before and after RCA1 treatment (note different magnification in Fig 3 and 4). The prominent square around the Flounder in Fig 3 is an outline of the area scanned with high-vacuum SEM. From ToF-SIMS analysis it is clear that the SEM deposited various hydrocarbons in the scanned area. There is also apparent enrichment in F and Cl in the feature, as well as enrichment in Ca around it. RCA1 treatment removed the Flounder, most of Ca-rich halo around it, AlOx (2 particles in Fig3), and a K-Na particle. Remaining particles within the Flounder are likely embedded Si (Fig8a,b). Figures 6 and 7 are ion images of Position Two (Fig 5). Here we can see the removal of smaller AlOx and Na-K particulates as well, however, two big-
ger features remain (although did become smaller). These features are not pits as evidenced by SEM SE imaging (Fig 8 c, d) but, surprisingly still carry a “brown stain” chemical signature (SiC₃H₉⁺).

**Conclusions:** Although we are still uncertain on the nature of the Flounder and why it is resistant to UPW and aqua regia/hot xylene treatment, we have found RCA1 to be suitable for its removal. It is likely that the glue from sticky pads used during collector recovery may have been a source for resistant organic contamination [9]; however [8] shows that UPW reaction with crash-derived organic contamination does not make particle removal more difficult.

**References:**