**Genesis Discovery Mission: Science Canister Processing at JSC.** E. K. Stansbery[1], K. E. Cyr[1], J. H. Allton[2], C. M. Schwarz[2], J. L. Warren[2], C. S. Schwandt, and J. D. Hittle[3], [1]NASA Johnson Space Center, Mail Code SN2, Houston, TX 77058, [2]Lockheed Martin, Houston, TX 77058, [3]Certified Associates, Houston, TX 77058.

**Introduction:** Genesis addresses questions about materials and processes involved in the origins of the solar system by providing precise knowledge of solar isotopic and elemental compositions. Solar wind ions are collected and returned to Earth for analyses. The spacecraft has two primary instruments to collect solar wind: a set of "collector arrays" each of which can deploy to sample different solar wind regimes, and a "concentrator" that is an electrostatic mirror to concentrate and focus low mass ions onto a 6 cm target.[1]

One of the key challenges to obtaining a good sample of solar wind, uncontaminated by terrestrial atoms, is to have clean collection surfaces in a clean sample canister and clean facilities to handle the samples for allocation and future reference. The Johnson Space Center (JSC) is responsible for contamination control for the mission, for ensuring the cleanliness of collection surfaces, and for providing a clean environment for handling of the samples. The level of cleanliness required is high; at the time of analysis (after sample return), the surface contamination by C, N, O must each be $<10^{15}$ atoms/cm$^2$ and for other elements the number of atoms/cm$^2$ of each surface contaminant shall not exceed the estimated solar wind fluence of the species (varies by element between U at $\sim10^4$ atoms/cm$^2$ to Fe, Si, Mg, and Ne at $\sim10^{12}$ atoms/cm$^2$ ). [2]

**Collector Material Installation:** The heart of the Genesis payload consists of a stack of five arrays, each containing 54-55 full hexagonal wafers and 6 half-hexagonal wafers. Once the Genesis spacecraft is in orbit around the Earth-Sun L1 libration point, the canister will open, exposing the arrays and allowing the solar wind ions and atoms to embed into the collector wafers. Because the expected fluence of solar wind collected during the mission is relatively small, the collector wafers were required to be of ultra-pure materials and stored and handled under extremely clean conditions. The ultra-pure wafer materials include silicon, germanium, diamond-coated silicon, vitreloy and aluminum-coated, gold-coated and bare sapphire. [3]

We stored and handled the collector wafers in a Class 10 cleanroom. Over 1,000 wafers were inventoried, documented, inspected and tracked as they were either installed into the cleaned payload arrays or left in cleanroom storage. Several wafers of varying types were analyzed by JSC, the California Institute of Technology and others for cleanliness and/or material purity.

During installation, personnel in the Class 10 cleanroom were fully suited in cleanroom coveralls, boots, gloves and helmets that contained full face masks and HEPA-filtration units which filtered exhaled breath before releasing it into the room. Particle levels in the cleanroom were continuously monitored during installation using a particle counter, and molecular contaminants were measured using wafer witness plates and the trace organic carbon levels absorbed in water during installation. Wafers were handled with special wafer tweezers or, in the case of wafers coated with a thin, fragile layer of gold or aluminum, by a combination of vacuum wand and stainless steel spatula.

**Figure 1:** A half-hexagon is installed into an array, completing the first row of installed wafers.

**Science Canister Cleaning:** Genesis canister components were cleaned and assembled within Class 10 cleanroom environments in contrast to typical spacecraft assembly in large Class 100,000 cleanrooms. Based on our experience in processing the engineering model (EM), a cleaning plan was developed for each hardware component. Examples of general approaches to final cleaning for various materials are shown in table 1. A detailed data package was developed for every component incorporating the actual cleaning process used for that item, original packaging information if appropriate, detailed cleanliness verification data, and a cleaning verification summary.

All items underwent some level of inspection and cleaning preparation prior to entering the laboratory. Wetable components were precleaned using reagent grade isopropanol followed by ultrasound in weak detergent solution and thorough rinsing. Liberal use was made of a 100X binocular microscope to assure precleaning effectiveness. The final cleaning fluid was ultrapure water (UPW) characterized by resistivity >18 MÙ and total organic carbon (TOC) <5 ppb. Components were cleaned in an ultrasonic cascade bath for 30 minutes and dried in a HEPA filtered cleanroom oven under nitrogen purge. Blind holes and cavities were dried with a heated nitrogen probe and monitored for dryness using a Vaisala moisture probe. All laboratory nitrogen included a point-of-use purifier.

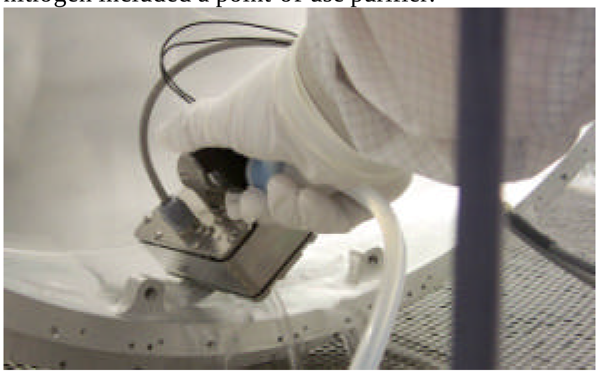

**Figure 2:** UPW cleaning of the canister base with a Megasonic pulsejet wand.

**Table 1:** General Approaches for Final Cleaning

| Material/Configuration | Cleaning Approach |
|---|---|
| Aluminum, structural: 6061, 7075 | Cold UPW (30C) ultrasonic or megasonic cascade |
| Stainless steels, Fasteners, some with dry lubricant | Hot UPW (65-75C) ultrasonic cascade |
| Polished collectors aluminum, gold, vitriloy | UPW rinse or cascade at various temperatures |
| Elastomers (o-rings) | Cold UPW (15-20C) rinse with agitation |
| Electronic boxes, enclosed mechanisms, filter housing, exterior cabling | Reagent grade Isopropanol wipe |
| Exterior painted surfaces | Vacuum brush under UV |

Cleaning processes were verified directly by SEM examination of coupons and indirectly by one or more of the following methods; (1) rinse water particle counts >1ì m, (2) rinse water ppb TOC, (3) filter particle capture, (4) microscopic inspection, (5) wipe analysis, and (6) high-intensity or black light inspection. Individual data tapes from particle counts and TOC measurements are preserved in the individual component data packs along with baseline measurements so that the results can be adequately assessed.

Aluminum is difficult to clean with water due to the formation of hydroxides and oxides on the surface that increase sorptive surface area and form crystals, which can flake off. The use of cold water and careful drying verification minimized this problem.

Representative data for rinse water particle counts and TOC are shown in figure 3 and table 2.

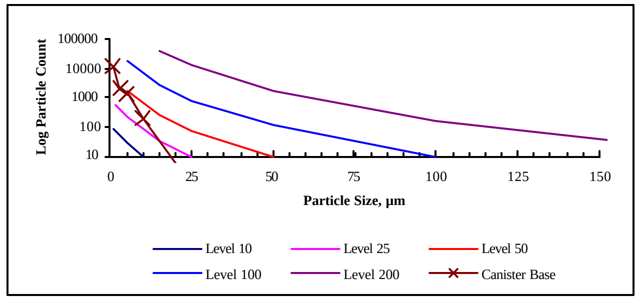


**Figure 3**: Rinse water particle analysis for the canister base relative to Mil-Std-1246C cleanliness levels.

**Table 2:** Representative Rinse Water Analyses

| Material Type | TOC, ppb |
|---|---|
| Small Al parts: batches of 50 | 21 |
| Small SS parts: batches of 100 | 33 |

**Conclusions:** It is possible to clean complex flight hardware to unprecedented levels even though each component is unique with no standard size, shape, material, or precleaning history. The cooperation and camaraderie between JPL and JSC personnel, despite differing cultures was extremely good. The professionalism and cross training (cleanroom and electrostatic discharge protocols) instilled very good work habits. The preliminary cleaning plan developed from the EM processing detailed the treatment for each component. However, additional testing of representative material coupons and a metallurgist working with the cleaning team may have uncovered some unexpected material interactions with the details of the cleaning process. Some unique tools and techniques were developed for this mission that are applicable for other flight instruments and/or missions.

**Figure 4:** R. Paynter/JPL checks the precision-cleaned and fully reassembled Genesis science canister.

**References:** [1] Burnett D.S. et al. (1997) Genesis Feasibility Study. [2] Stansbery E. K. (1998) Genesis Contamination Control Plan JSC-28272. [3] Jurewicz A. J. G. et al. (2000) LPSC XXXI, Abstract #1783.