INVESTIGATION OF BACKSIDE TEXTURES FOR GENESIS SOLAR COLLECTORS

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Background

• The single crystal, pure silicon (Si) collectors were fabricated by two methods:
  1) Float zone (FZ)
  2) Czochralski (CZ) [1].

• The Czochralski method results in a bulk composition with slightly higher oxygen.

• The Genesis flown CZ silicon array wafers were purchased from MEMC Electronics.

• Most of the Genesis flown FZ silicon was purchased from Unisil and cleaned by MEMC.

• A few FZ wafers were acquired from International Wafer Service (IWS).

Problem?

Because of slight differences in bulk purity and surface cleanliness among the fabrication processes and the specific vendor, it is desirable to know which variety of silicon and identity of vendor, so that appropriate reference materials can be used.

Distinguishing Between FZ and CZ

• Pre-flight: CZ vs FZ was verified by using a gloss meter on the backside of each wafer flown. CZ wafers ranged 29-41 gloss units, Unisil FZ 50-90 and IWS FZ 90-115. These units are a measure of specular reflectance.

• Post-landing: Silicon recovered collector fragments are speciated as to CZ or FZ by using FT-IR to measure a C-0 peak present in CZ.

During subdivision of a special silicon collector (the concentrator target), the backside texture was observed to be different from typical CZ. This investigation was started to see if backside textures were useful identifiers of silicon type or manufacturer. At first it was believed that the FZ had a square texture in the backside while CZ had a more wrinkled texture. Backside images of nonflight CZ and FZ (Figs 2 – 4) of known manufactures were imaged. These images were used to compare the flown samples of FZ and CZ (Figs 5 – 7). A total of 7 nonflight samples and 15 flight samples were imaged (Table 1).

Optical Images of Backside: CZ vs. Unisil FZ vs. IWS FZ

Non-flight Genesis Samples

Fig. 2: Sample 3CZ00527.

Genesis Flight Samples

Fig. 5: (left) Sample 61287, (right) sample 61335. Both samples are Si-CZ from the bulk solar wind arrays.

Non-flight FZ (Unisil)

Fig. 3: Sample 3FZ01918 (left) and 3FZ01969 (right).

Non-flight FZ (IWS)

Fig. 4: Sample 3FZ01938 (left) and 3FZ01914 (right).

Table 1: Total number of samples that were imaged from the back.

<table>
<thead>
<tr>
<th></th>
<th>CZ</th>
<th>FZ wrinkled</th>
<th>FZ rectangular</th>
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<tbody>
<tr>
<td>Non-flight</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Flown</td>
<td>8</td>
<td>6</td>
<td>1</td>
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Conclusion: The preliminary images suggest that CZ and Unisil FZ are similar, but perhaps subtle difference can be discerned with more work. However, this limited sampling suggests that IWS FZ samples can be easily distinguished from Unisil FZ by backside textures.

A New Cleaning Issue: Residue – from Post-it?

While imaging the backside of Si flown samples (Table 1), an unknown residue exhibiting the rainbow colors of thin film interference (Fig. 8) was noted. It is speculated that the residue is from the adhesive of post-it notes on which these samples were mounted at the recovery site in Utah.

During the Genesis sample recovery in Utah, the fragments were placed in different types of containers (vials, jars, etc.). To prevent the samples from scratching any further, some of them were placed solar wind up on the adhesive side of post-its. Many samples were left in that position for years. All the flight samples that were imaged from the back (Table 1) were once kept in post-it notes and all of them have the residue on the backside.

This residue was also seen on the backside of DOS (Fig. 9). From 9 DOS samples that were imaged, 4 came from post-it notes and all 4 had the residue on the back. The remaining residue-free fragments were not from post-its.

Persistent Residue

Sample 61332 was handheld and washed from the back with UPW since it contained residue on the back (Fig. 8). The sample was then cleaned in the wafer spinner. Images taken afterwards show residue on the front side of sample. Before UPW cleaning the sample had no residue on the front side. A second UPW cleaning did not remove the residue on the frontside (Fig. 10).

Investigation Plan

• Examine post-it residue on non-flight silicon, compare optically
• Experiment with removal using organic solvents
• Develop backside cleaning technique

Fig. 10: Sample 61332 after 2nd UPW cleaning.

Fig. 8: Residue on backside of flown Si samples 61267 and 61332.

Fig. 9: Residue on backside of flown DOS sample 61329. (left) A 20X image, (right) a 50X image.