Status Report
GSFC W Tile Etching & Priming
For GLAST Trays
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GSFC Efforts

1. Examination of 100\(\mu\) W Tile
   a. Cross-Section Photomicrographs
   b. Surface Examination
   c. Metallurgical Composition
2. Check on BR127 Batch & Verification of GSFC Application Process
3. Check of BR127 Compatibility with 2216
4. Development of an Effective Acid Etch for W
5. Proof of Etch & Primer Effectiveness
6. Recommendation for Process Control Test Specimen
7. Tile Processing Status
1a. Photo Examination of 100µW

Figure 3. Cross section of tungsten foil showing “stringers” of included material. ~ 200X

Figure 5. SEM photograph of included material. EDS revealed very high carbon, low tungsten content in included material as opposed to tungsten base material

Photomicrographs Show Carbon-like Foreign Material and Layered Nature of Tile

Conclusions:

a. Etch Must Remove Surface Material Beyond Nearest “Stringer” to Surface
b. Stringer Areas May Weaken Tile
1b. Surface Examination

• GSFC Chemist’s Results:
  – Etched Surface is Clean (Minor Hydrocarbons Found)
  – Surface Remains Clean after 120C Temperature Exposure
  – Soak in Acetone does not Extract Contaminants from Tile

Conclusion: Etched Tile Should not Pose a Contamination Problem to Primer Cure
1c. Metallurgical Composition

• Check on Metallurgical Composition is in Progress
2. BR127 Batch and Process Verification

- BR127 Batch Checked Using Standard Lap Shear Specimen

<table>
<thead>
<tr>
<th>Adherent Material</th>
<th>Adhesive Material</th>
<th>Lap Shear Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.063” 6061 (Standard GSFC Etch and BR-127 Primer)</td>
<td>Loctite EA 9309.3NA</td>
<td>3971* 4200</td>
</tr>
</tbody>
</table>

*EA 9309.3 NA Failed Adhesively to Primer. Primer Remained on Adherents

Conclusions: BR127 Batch & Application Process are Proper
3. BR127 Compatibility with 2216

- W Lap-Shear Specimens Failed 2216 Cohesively w/o Primer Failure

<table>
<thead>
<tr>
<th>Adherent Material</th>
<th>Adhesive Material</th>
<th>Lap Shear Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>700-micron W</td>
<td>Scotchweld 2216</td>
<td>Test Value</td>
</tr>
<tr>
<td>(MIL-HNBK-961B Etch and BR-127 Primer)</td>
<td>Gray</td>
<td>3764*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3564*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3200</td>
</tr>
</tbody>
</table>

*2216 Cohesive Failure. BR127 Remained on W

Conclusion: BR127 is Compatible with 2216
4. Effective Etch for Tungsten

- Etches Investigated
  a. MIL-HNBK-961B: HF, Nitric, Sulfuric, H₂O
  b. HF
  c. Ammonium Biflouride

<table>
<thead>
<tr>
<th>Etch Type</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Minimal W removed; More Like Acid Cleaning than Etching</td>
</tr>
<tr>
<td>b.</td>
<td>Aggressive Etch; Roughened Etched Surface Suitable for Bonding; Material Removal is Controllable.</td>
</tr>
<tr>
<td>c.</td>
<td>Commercial Formulation; Roughened Etched Surface Suitable for Bonding; Material Removal is Controllable (5% to 10% by weight); Best potential for Production Use</td>
</tr>
</tbody>
</table>

Conclusions: Ammonium Biflouride is Most Suitable for Production and Appears to Give a Bondable Surface
5. Proof of Etch & Primer

• Original Test Specimen was T-peel Type
  – Flexing of Adherents is Inherent in Specimen
  – Flexing Loosens Primer Unrealistically Compared to Expected Tray Deformation

• Switched to Flatwise Tension Specimen (Modified ASTM C297)
  – No Flexing of Adherents
  – Standard Adhesion Test
  – Repeatable Results
5. Flatwise Tension Results

100-micron W Tiles:
Ammonium Biflouride Etch and BR-127 Primer; 5% Weight Removed by Etch
Production Size Bath

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Failure Load (lb)</th>
<th>Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Problem with Test Machine</td>
<td>W Tear over 1/8 of Specimen(^1)</td>
</tr>
<tr>
<td>2</td>
<td>2345</td>
<td>W Tear on Specimen Edge(^1)</td>
</tr>
<tr>
<td>3</td>
<td>2451</td>
<td>W Tear; 2216 Cohesive Failure to Block(^1)</td>
</tr>
<tr>
<td>Average</td>
<td>2398</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)BR-127 Remained Attached to 2216
5. Flatwise Tension Specimens: 1, 2, 3

5% Material Removed

Tungsten Tear
5. Flatwise Tension Results
Continued

100-micron w tiles:
Ammonium Biflouride Etch and BR-127 Prime; 10% Weight Removed by Etch
Production Size bath

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Failure Load (lb)</th>
<th>Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2460</td>
<td>W Tear over 50% of Specimen$^1$</td>
</tr>
<tr>
<td>5</td>
<td>2476</td>
<td>W Tear over 50% of Specimen$^1$</td>
</tr>
<tr>
<td>6</td>
<td>2456</td>
<td>30% Adhesive to Tile; 70% cohesive to Block$^{1,2}$</td>
</tr>
<tr>
<td>Average</td>
<td>2464</td>
<td></td>
</tr>
</tbody>
</table>

$^1$BR-127 Remained Attached to 2216
$^2$2216 Likely Failed to Block First and Caused 2216 to Fail to Tile
5. Flatwise Tension Specimens: 4, 5, 6

2216 Cohesive Failure

Tungsten Tear
Flatwise Tension Conclusions

Conclusions:

a. Samples with 5% & 10% Material Removed Performed Equally Well
b. Select 5% Material Removal to Minimize Science Impact
c. BR127 Adhesion to Etched W is Very Good
d. BR127 Adhesion Can Exceed W Delamination Strength
e. Ammonium Biflouride Etch and BR127 Should Work for Tile Bonding
6. Process Control Test

- Recommend Flatwise Tension Test for Process Control Test
- Tests Tile and Its Bonding Surface Directly
- Data Indicate 2000 lb as a Reasonable Pass-Fail Value
7. GSFC Tile Processing

- Ammonium Biflouride Etch Process was Scaled Up for 10-Tile Batch
  - 5% Material To Be Removed by Etch
  - Bath Will be Checked Daily to Ensure Proper Material Removal
- GSFC Can Etch & Prime Upwards of 75 Tiles per Day
- Status As of 5 October 2004:
  - 270 100\(\mu\) Tiles Have Been Etched & Primed
  - Process Control Test Results were Good
- GSFC Can Process over 300 Tiles per Week

**Conclusion:**
GSFC is Willing & Able to Process (Etch & Prime) GLAST Tiles for Tower Production