Assessment of the structural integrity of 3-D woven carbon cloths that have undergone heating similar to Venus atmospheric entry conditions.

**Objective**

Based Woven Thermal Protection Materials

**Background**

Investigate the causes of embrittlement and reduction in load bearing capacity due to aerothermal heating

**Observations**

- Additional fabric testing to statistically verify mechanical property reductions
- Brittle failures in post-exposure fabrics
- Reduction in mechanical properties correlated with exposure duration
- Post-exposure strength exceeds flight requirement

**Mechanical Testing**

- Instron 5569, \( \varepsilon = 1\) mm/min
- Fabric and yarns, pre and post aerothermal exposure

**Mechanical Tests**

- BLAM Testing
- Pretest
- Pretest, sizing removed

**Results**

<table>
<thead>
<tr>
<th>Test</th>
<th>Warp (N/cm)</th>
<th>Weft (N/cm)</th>
<th>Exposure Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>136</td>
<td>1310</td>
<td>35</td>
</tr>
<tr>
<td>B2</td>
<td>97</td>
<td>660</td>
<td>135</td>
</tr>
<tr>
<td>B3</td>
<td>97</td>
<td>1310</td>
<td>139</td>
</tr>
</tbody>
</table>

**Forward Work**

- Evaluation of the structural integrity of 3-D woven carbon cloths that have undergone heating similar to Venus atmospheric entry conditions

**Conclusion**

- Reduction in mechanical properties, embrittlement
- Additional fabric testing to statistically verify mechanical property reductions
- Brittle failures in post-exposure fabrics
- Reduction in mechanical properties correlated with exposure duration
- Post-exposure strength exceeds flight requirement

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**Objective**

△ Implement game changing technology of adaptable, deployable entry placement technologies (ADEPT)

△ Low ballistic coefficient

△ More benign entry conditions

**BLAM Testing**

- Novel 3-D woven, flexible carbon cloths
- Tailorable weave patterns and properties
- Interwoven weave architectures provide structural load and heat shield TPS
- One such architecture imaged on right
- Structural and thermal layers below

△ Bi-axial load aerosol mechanical (BLAM) testing

△ Evaluate woven TPS under entry conditions

**Thermal Protection System**

△ Planetary Science Decadal Survey expresses interest in Venus

△ NASA proposes Venus Intrepid Tessera Lander (VITAL) mission

△ Implement game changing technology of adaptable, deployable entry placement technologies (ADEPT)

△ Requires novel thermal protection system (TPS)