SCS SiC FIBERS

Process, Properties, and Production
OUTLINE OF PRESENTATION

• History of SCS Silicon Carbide Fibers
• Manufacturing Process
• Physical and Mechanical Properties
• Current Production and Sales Price
• Future Plans
HISTORY OF SPECIALTY MATERIALS’ SCS FIBER

• Boron was ineffective in metal matrices
• The Air Force wanted a fiber for titanium
• AFML funded work in the early 70’s
  – Initially, SiC on W substrate
  – Developed SiC on C substrate
  – Improved high temperature strength retention
  – Optimized surface for handling and bonding
Specialty Materials’ Family of SCS Fibers

• SCS-6
  – Developed for titanium and ceramic matrices
  – 5.6 mil diameter

• SCS-9A
  – Developed for thin-gauge face sheets for NASP
  – 3.1 mil diameter

• SCS-ULTRA
  – Developed to achieve highest strength
  – 5.6 mil diameter
MANUFACTURING PROCESS
SCS FIBER MANUFACTURING PROCESS

Carbon Monofilament Substrate

Gas

Reactor

Gas to Recycle Plant

Continuous β Silicon Carbide

.0056 In. (.142 μm²)
CONSTRUCTION OF FIBER FOR STRENGTH AND MATRIX COMPATIBILITY

- **Zone I** - Surface Bondable & Wettable By Matrix
- **Zone II** - Broad Forgivability Zone
- **Zone III** - Inner Gradient - Necessary for Maintaining Filament Strength
PHYSICAL AND MECHANICAL PROPERTIES
Schematic of SCS CVD SiC Monofilament

CVD Silicon Carbide
Filament Properties (SCS-6)

- Diameter: 5.6 mils, 140 μm
- Tensile Strength: 500 + ksi, 3450 MPa
- Modulus: 56 msi, 400 GPa
- Density: 0.11 lb/in³, 3.0 gm/cc
COMPARISON OF SCS SILICON CARBIDE FIBERS

Fiber Strength

Occurrence (%)

Strength (KSI)

- SCS-9A
- SCS-6
- SCS Ultra
COMPARISON OF SCS SILICON CARBIDE FIBERS

Fiber Modulus

<table>
<thead>
<tr>
<th>Fiber Modulus</th>
<th>SCS-9A</th>
<th>SCS-6</th>
<th>SCS Ultra</th>
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<tbody>
<tr>
<td>Modulus (MSI)</td>
<td>40</td>
<td>45</td>
<td>50</td>
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<tr>
<td>Occurrence (%)</td>
<td>45</td>
<td>40</td>
<td>35</td>
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SCS-6 STRENGTH VS. TEMPERATURE

Approximate soak time at temperature - 3 minutes
BEND STRESS RELAXATION CREEP OF SCS-6 AND ULTRA SCS

Temperature ºC

M Value from BSR Test

Temperature ºC
COMPARISON OF TENSILE STRENGTH VS. TEMPERATURE

Approx. soak time at temperature - 3 minutes
CURRENT PLANT AND FUTURE PLANS

• Currently producing 6,000 pounds per year
• Gas recovery system can handle 10,000 pound per year
• Scale-up forecasts through 2010 have been well established
• Capacity will be added as fiber demand continues to increase