Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00167

High-Performance Fiber Coatings

Technology

GRC researchers have developed simple, cost-effective, fiber coating approaches that improve the toughness and environmental durability for state-of-the-art SiC/SiC (silicon carbide) composites with boron nitride (BN)-based fiber coatings.

Benefits

This technology leads to high-temperature composites with

- Reduced modulus and reduced thermal stress
- Improved damage tolerance and failure strain
- Improved oxidation resistance and longer structural life across a wide range of application temperatures

Commercial Applications

This technology can be used to produce high-temperature structural components used in aerospace, industrial, and military applications such as

- Engine hot-section components
- Heat exchangers
- Furnace components

Technology Description

For SiC/BN/SiC ceramic composites reinforced by high-performance SiC fibers, researchers at the NASA Glenn Research Center have developed approaches that create weak interfaces between the oxidatively durable BN-based fiber coatings and the SiC matrix material. These approaches yield materials that during service-induced matrix cracking, preferentially favor fracture and sliding to occur between the BN coating and the SiC matrix (outside debonding) rather than the conventional fracture and sliding mode between the BN coating and the SiC fiber (inside debonding) (see fig. 1). This provides the SiC/BN/SiC composite with enhanced damage tolerance and ultimate fracture strain, and also retains the BN coatings on the fiber surfaces to provide enhanced oxidative protection for the SiC fibers at temperatures where protective silica layers are slow to form [refs.1 and 2]. The outside debonding approaches also reduce the elastic modulus for the composite material, thereby reducing thermal stresses within composites subjected to thermal gradients.

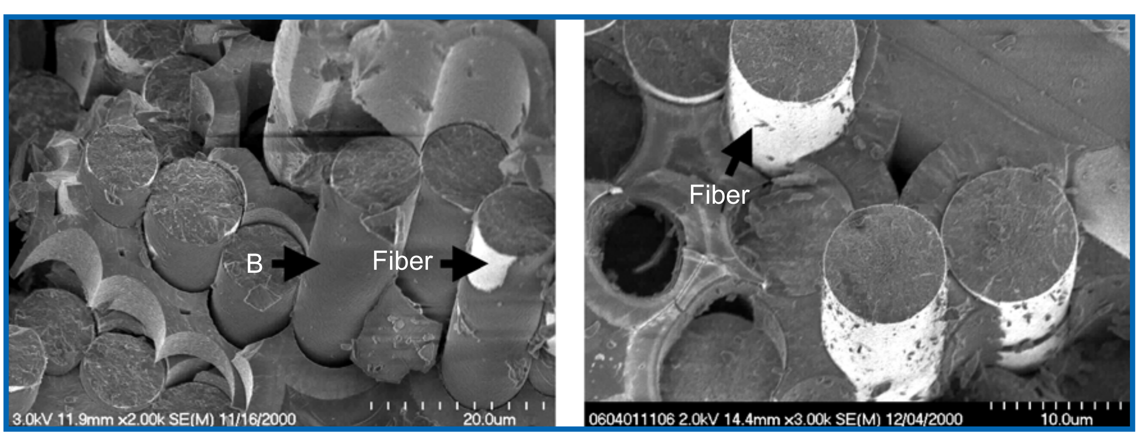

Figure 1.—Scanning electron micrograph of (a) outside debonding composite and (b) inside debonding composite. Note that the BN adheres to the outside debonding composite.

Table 1 indicates typical property improvements that have been observed when NASA's outside debonding approaches were applied to SiC/BN/SiC composite panels. These panels consisted of 0/90 fabric plies of Sylramic*-iBN SiC fibers (volume fraction ~40 percent) that were produced at GRC [ref. 3], and SiC matrices that were produced by conventional chemical vapor infiltration (CVI) at GE Power Systems Composites (GEPSC). Residual porosity in the CVI SiC matrices was filled at GEPSC by SiC slurry and silicon melt infiltration (MI). In addition to the results documented in table 1, GRC researchers have examined other SiC/BN/SiC materials that used different types of BN coatings, SiC fibers, and SiC matrix materials to show the general efficacy of the present technology.

Options for Commercialization

There is a patent application in process for this technology. NASA is seeking companies interested in applying this technology to commercial applications.

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Key Words

Fiber coatings
Silicon carbide composites
Damage tolerance
Oxidative durability

	Conventional SiC/BN/SiC (inside debonding)	Improved SiC/BN/SiC (outside debonding process A)
Average as-fabricated properties		
Tensile elastic modulus	250 +/– 30 GPa	210 +/– 30 GPa
Tensile cracking strength	200 MPa	200 MPa
Ultimate tensile strain	0.4 %	0.5 %
Ultimate tensile strength	450 MPa	450 MPa
Interfacial shear strength	~70 MPa	~7 MPa
Average rupture strength at 800 °C in air		
10 hours	280 MPa	> 350 MPa
100 hours	220 MPa	280 MPa
Average rupture life at 800 °C in air at 220 MPa	100 hours	> 1000 hours

Table 1.—Typical properties for SiC/BNSiC composite panels fabricated with ~40 percent Sylramic-iBN SiC fibers, BN fiber coatings with inside and outside debonding, and CVI plus slurry-cast MI SiC matrices.

*Sylramic SiC fiber is currently being produced by ATK COI-Ceramics, Inc.

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