National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Materials and Coatings

Silicon Carbide Fiber Tows

Rapid processing method produces stronger materials, even "heals " lower-quality fibers

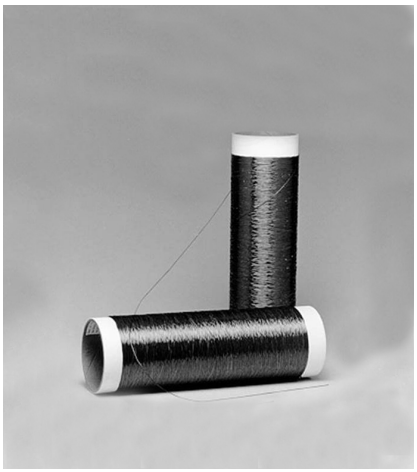
Innovators at NASA's Glenn Research Center have developed a rapid processing method that produces stronger, tailored silicon carbide (SiC) tows and even "heals" damaged or otherwise low-quality fibers. Never before could poor-quality SiC fibers be "healed" and improved by this magnitude. This simple microwave process enables SiC tows and parts made from SiC fibers to be integrated in previously impossible applications while significantly saving costs. Glenn's novel technique uses a microwave sintering furnace to reduce power requirements, processing temperatures (by as much as 1000°C), processing times, and costs. Thus, it is easier to produce quality, high-strength SiC tows, as well as to increase the effective yield of usable SiC material. This breakthrough process stands ready to significantly increase the implementation of lightweight, high-performance SiC/SiC ceramic matrix composite (CMC) materials and SiC fibers in aeronautics, automotive, power generation, and countless other industries that operate in extreme environments.

BENEFITS

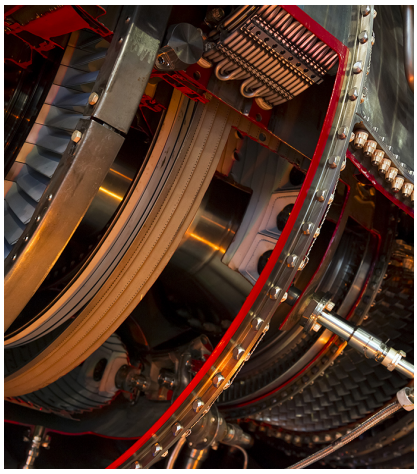
- Cost-saving: Produces quality fibers consistently and "heals" low-quality fibers, thereby reducing costs
- Low-power: Decreases extended power usage from 700 watts to 70 watts or less
- Fast: Reduces processing time from more than 24 hours to 15 minutes
- Reduced temperature: Decreases processing temperature by as much as 60%
- Increased flexibility: Simplifies processing of hybrid tows and 2D and 3D architectures

THE TECHNOLOGY

SiC fiber tows and preform materials are commonly used as reinforcements in CMCs, to make parts for use in harsh, high-temperature environments such as aircraft engines. These materials are desirable for numerous high-temperature applications because of their very low weight and outstanding thermo-chemical inertness. However, the multiple-step process using electric furnaces to produce these materials have numerous drawbacks: they are very expensive ($10,000 to $25,000 per spool); they involve high temperatures (greater than 2000°C); they require high power (more than 700 watts); and they produce much wasted material. Glenn innovators have discovered an efficient way to improve the quality and strength of SiC fiber tows using a unique microwave-furnace design that induces molecular heating. Glenn's innovation relies on microwave sintering to convert a polymer to ceramic fibers/tows/yarns, or to manipulate commercially available SiC fibers to increase strength and improve other qualities. Not only can higher quality tows be produced, but also - for the first time - old, damaged, or otherwise unusable fibers can be improved and "recycled," thereby saving significant costs by increasing yield. Even entire engine components can be placed in the furnace and restored. The desired results can be achieved in minutes rather than the usual hours or even days. Glenn's low-temperature microwave process provides greater control with less power, while also eliminating plasma generation and minimizing arcing events. Because this method also facilitates the shaping of the SiC fiber after initial processing, fabricating preforms with 2D or 3D architectures becomes simpler. Glenn's creative processing method makes producing SiC tows and preforms much less expensive, opening them up for increased use in a broad range of applications.



Glenn's innovative processing method not only produces higher-quality SiC fiber tows more consistently, it also " heals" poorer-quality fibers that would otherwise be unusable



Glenn's process increases the yield of expensive, high-quality SiC fibers, enabling their increased use in applications such as jet engines

APPLICATIONS

The technology has several potential applications:

- Aerospace (e.g., engines, thermal protection systems, and turbopumps)
- Propulsion (e.g., reusable rocket and thruster nozzles)
- Power (e.g., gas turbine engines, nuclear reactor fuel cladding, radiation blankets)
- Chemical manufacturing (e.g., heat exchangers, reformers, reactors, filters)
- Industrial machinery (e.g., preheaters, recuperators, and radiant tubes)
- Furnaces
- Turbines

PUBLICATIONS

Patent Pending

technology.nasa.gov

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More Information

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