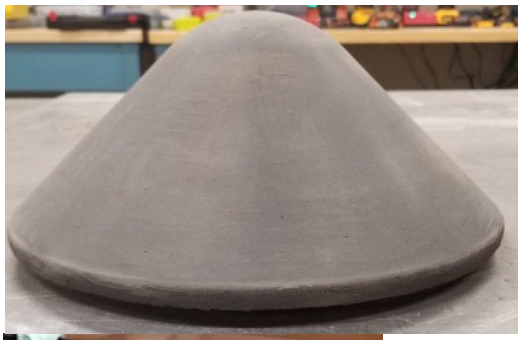
OAK RIDGE NATIONAL LABORATORY

Extreme Environment Materials Process Group

Developing novel processes to manufacture extreme heat resistant carbon-carbon composites and ceramic matrix composites at all scales

Technical Area Overview

Carbon-carbon and ceramic matrix composites are well suited to high temperature and chemically harsh environments. However, the manufacturing and production of these parts is difficult, resulting in low production rates, limited geometries, and high costs. Using advanced preform manufacture and processing, the Extreme Environment Materials Process Group aims to open the design space, decrease production time, and decrease costs. Lower cost and higher throughput production of carbon and ceramic matrix composites will expand market opportunities.



Additively manufactured a nose shroud and combined hybrid manufacturing using machining, launched August 2019 from NASA's Wallops Island, Maryland test facility.

Research and Development

Advanced Preform Manufacturing

- Building on trends in additive manufacturing, automated fiber placement, and robotic material deposition, researchers produce near net shape preforms with control of fiber orientation.
- Exploring use of various fiber types such as carbon or ceramic fibers and utilizing DOE's Carbon Fiber Technology Facility at ORNL to produce custom fiber in-house at scale (up to 50 T/yr).

Advanced Processings

- Utilizing novel techniques to reduce processing times
- Utilizing novel chemistry to tailor system properties to application

Research Highlights/Impacts

- Manufactured a nose cone and fins embedded with temperature sensors designed to expose the material to the harsh environment of high-speed flight during a U.S. Navy rocket launch in fall 2021.
- Created the first 3D-printed thermal protection system for use in a spacecraft mission, launched August 10, 2021, to the International Space Station. The heat shield's sensors provided data upon reentry.

APPLICATION AREAS

- HIGH TEMPERATURE
- SPACE
- NUCLEAR ENERGY
- ADVANCED TURBINES
- DEFENSE RELATED
- NEXT GENERATION AM

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