Researcher studies carbon fibers for nuclear reactor safety

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Carbon fibers that are only one-tenth the size of a human hair, but three times stronger than steel, may hold up to the intense heat and radiation of next generation nuclear power generators, providing a safety mechanism. The “Gen IV” power-generating reactors are being designed to provide low-cost electricity, but with a built-in safety mechanism current reactors do not have.

The Department of Energy (DoE) has awarded chemical engineering professor Amod Ogale, deputy director of the Center for Advanced Engineering Fibers and Films (CAEFF), a $450,000 grant to research carbon fibers embedded into a carbon matrix that do not melt in extreme temperatures for potential use in Gen IV power generators. Presently, about 20 percent of electricity produced in the United States is from nuclear sources.

“One proposed design of the next generation of nuclear plants will consist of a helium-cooled generator that will operate in the range of 1,200 to 1,800 degrees Fahrenheit,” says Ogale. “A critical safety requirement for this reactor is that it can shut down safely in the event of a malfunction where coolant flow is interrupted. Steel alloys currently used internally in reactors melt at the peak temperature of 2500 degrees Fahrenheit, where carbon fiber composites do not.”

Carbon fiber composites are already used successfully in jetliner brake systems because of their ability to withstand high temperatures without melting. However, their performance in a nuclear environment is not adequately understood.

Ogale and his team will study the neutron-radiation damage effects on carbon fibers.

His prior research has shown that including carbon nanotubes (large molecules of carbon that are tube-shaped and 30 nanometers in size) in carbon fibers leads to the development of a more uniform texture that improves the properties of the ultra-thin carbon fibers.

In his research, Ogale expects to generate high graphitic crystallinity, a solid ordered pattern which is evenly distributed so that any changes in fiber properties due to radiation can be minimized.

Irradiation experiments will be conducted in collaboration with researchers at Oak Ridge National Labs. South Carolina State University researchers also will participate in the study.

"This research will lead to a fundamental understanding of how the nanotubes set themselves up to provide radiation-damage tolerance to carbon fibers," said Ogale.

Source: Clemson University