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RESEARCH

TRISO fuel development progresses at INL, ORNL

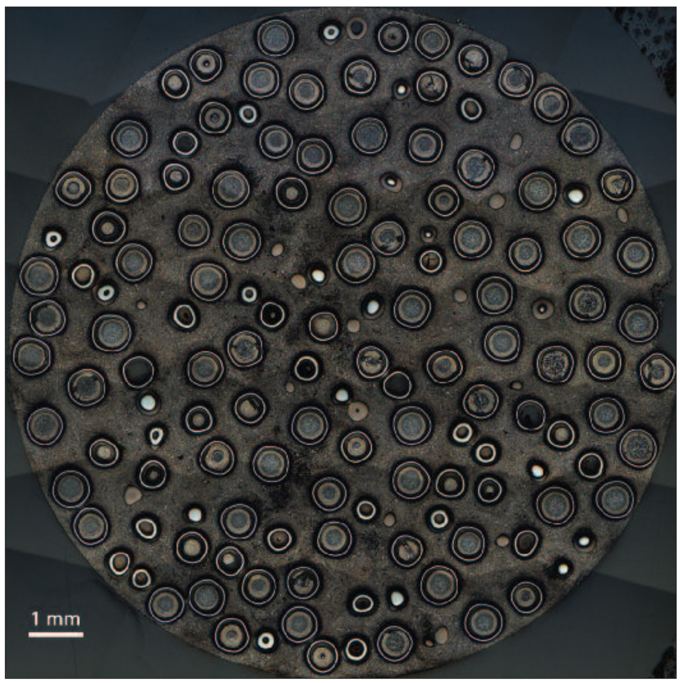
Post-irradiation testing has shown that the latest incarnation of TRISO fuel is able to retain fission products at temperatures of 1800 °C.

Petti, INL's technical director for TRISO fuel research, holds a pellet of TRISO fuel for high-temperature gas-cooled nuclear reactors. (Photos: INL)

Researchers at Idaho National Laboratory and Oak Ridge National Laboratory announced on September 25 that they have reached a new milestone in the development of tristructural-isotropic (TRISO) fuel. According to INL, post-irradiation examination of the fuel has shown that it is more robust than expected, even at temperatures exceeding postulated accident conditions by more than 200 °C.

INL and ORNL have been working together on TRISO fuel development since 2002 and have created a version of the fuel that achieves twice the burnup levels of the TRISO fuel used in Germany in the 1980s. The fourth-generation reactor fuel has been studied for three years in INL's Very High Temperature Reactor Technology Development Office, which is headed by David Petti, an INL Laboratory Fellow and ANS Fellow.

TRISO fuel begins with particles the size of poppy seeds. Each particle has a uranium center surrounded by a layer of carbon, a



Left: Next-generation TRISO fuel particles have several layers of carbon and silicon carbide that serve as the primary containment for radioactive material. **Right:** A cross-section of a fuel pellet containing TRISO particles.

layer of radiation-resistant silicon carbide, and an outer shell of carbon. The particles are embedded within an SiC matrix to form fuel pellets the size of a piece of chalk. Six capsules of fuel were irradiated in INL's Advanced Test Reactor for three years and were then subjected to controlled high-temperature testing in furnaces at INL and ORNL, at temperatures of 1800° C.

Examination of the fuel samples showed that most fission products were contained inside the fuel particles, thanks to the SiC matrix that surrounds the particles. "This first series of TRISO test fuel has performed above the team's expectations, both during its three years in the ATR and throughout the subsequent high-temperature testing," said John Hunn, project lead for TRISO fuel development and post-irradiation examination at ORNL.

Following the irradiation and high-temperature testing of the samples, the matrix containing the particles was dissolved so that particles within the fuel that did release cesium could be isolated for further study.

"We've developed a tool that uses computer-controlled automation to sort through thousands of irradiated particles and identify the rare defects," Hunn said. "Careful study of these few defective particles, along with the numerous particles that perform well, allows us to complete the TRISO fuel development circle by connecting the fabrication process and material properties to performance in the reactor."

Because the temperatures to which the fuel was subjected exceed normal reactor operating temperatures and postulated accident conditions, TRISO fuel could be inherently safer than the fuel currently used in nuclear reactors. Safer fuel could potentially allow new nuclear power plants to be designed and built without the elaborate and expensive safety systems now in use. Used fuel disposal can also be simplified when fission products are safely contained within fuel pellets.

Researchers at ORNL are working on a TRISO fuel called FCM (fully ceramic microencapsulated fuel), which could be used in today's operating reactors. NN