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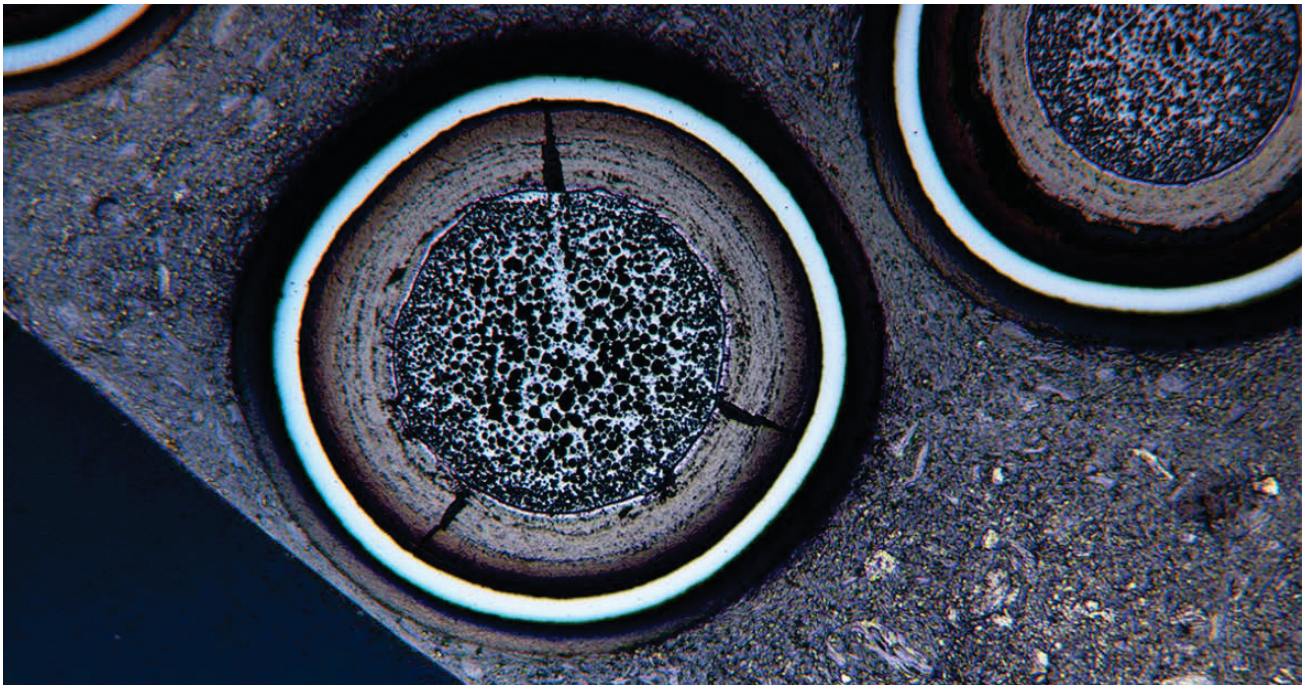
Office of Nuclear Energy

TRISO Particles: The Most Robust Nuclear Fuel on Earth

JULY 9, 2019



TRISO particles cannot melt in a reactor and can withstand extreme temperatures well beyond the threshold of current nuclear fuels.

There's a lot of buzz around advanced nuclear.

These technologies are going to completely change the way we think about nuclear reactors.

More than 70 projects are underway in the United States with new designs that are expected to be more economical to build and operate.

Some of them will require a new fuel that's tough enough handle the higher operating temperatures of these advanced reactors.

Enter TRISO fuel—the most robust nuclear fuel on earth.

What is TRISO Fuel?

TRISO stands for TRi-structural ISOtropic particle fuel.

Each TRISO particle is made up of a uranium, carbon and oxygen fuel kernel. The kernel is encaps

ceramic-based materials that prevent the release of radioactive fission products.

The particles are incredibly small (about the size of a poppy seed) and very robust.

They can be fabricated into cylindrical pellets or billiard ball-sized spheres called "pebbles" for use in either high temperature gas or molten salt-cooled reactors.

TRISO fuels are structurally more resistant to neutron irradiation, corrosion, oxidation and high temperatures (the factors that most impact fuel performance) than traditional reactor fuels.

Each particle acts as its own containment system thanks to its triple-coated layers. This allows them to retain fission products under all reactor conditions.

Simply put, **TRISO particles cannot melt in a reactor** and can withstand extreme temperatures that are well beyond the threshold of current nuclear fuels.

Robust TRISO Fuel Research

TRISO fuel was first developed in the United States and United Kingdom in the 1960s with uranium dioxide fuel. In 2002, the Department of Energy (DOE) focused on improving TRISO fuel using uranium oxycarbide fuel kernels and enhancing its irradiation performance and manufacturing methods in order to further develop advanced high-temperature gas reactors.

In 2009, this improved TRISO fuel set an international record by achieving a 19% maximum burnup during a three-year test at Idaho

National Laboratory (INL). This is nearly double the previous mark set by the Germans in the 1980s and is three times the burnup that current light-water fuels can achieve—demonstrating its long-life capability.

The irradiated fuel was then exposed to more than 300 hours of testing at temperatures up to 1800° Celsius (more than 3,000° Fahrenheit). These tests exceeded the predicted worst-case accident conditions for high-temperature gas reactors and showed **no to minimal damage of the particles with full fission product retention**.

Continued TRISO fuel qualification testing is currently underway at INL. With support from DOE, the Electric Power Research Institute worked with INL and industry stakeholders to submit a licensing topical report to the U.S. Nuclear Regulatory Commission (NRC) for official review. Future test results will be submitted to the NRC for licensing TRISO fuel and reactor vendors.

What's Next?

TRISO fuel testing is gaining a lot of interest from the advanced reactor community. Some reactor vendors such as X-energy and Kairos Power, along with the Department of Defense, are planning to use TRISO fuel for their designs—including some small modular and micro-reactor concepts.

DOE is also supporting X-energy's efforts to design and submit a NRC license application for a new fabrication facility. The project would ultimately use high assay low enriched uranium to produce the TRISO fuel pellets and pebbles for future high-temperature gas and molten salt reactors.

Learn More

TRISO fuel research is supported through the Office of Nuclear Energy's Advanced Reactor Technologies (ART) program. ART sponsors collaborative efforts with universities and industry partners to accelerate research on various advanced reactor designs.

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