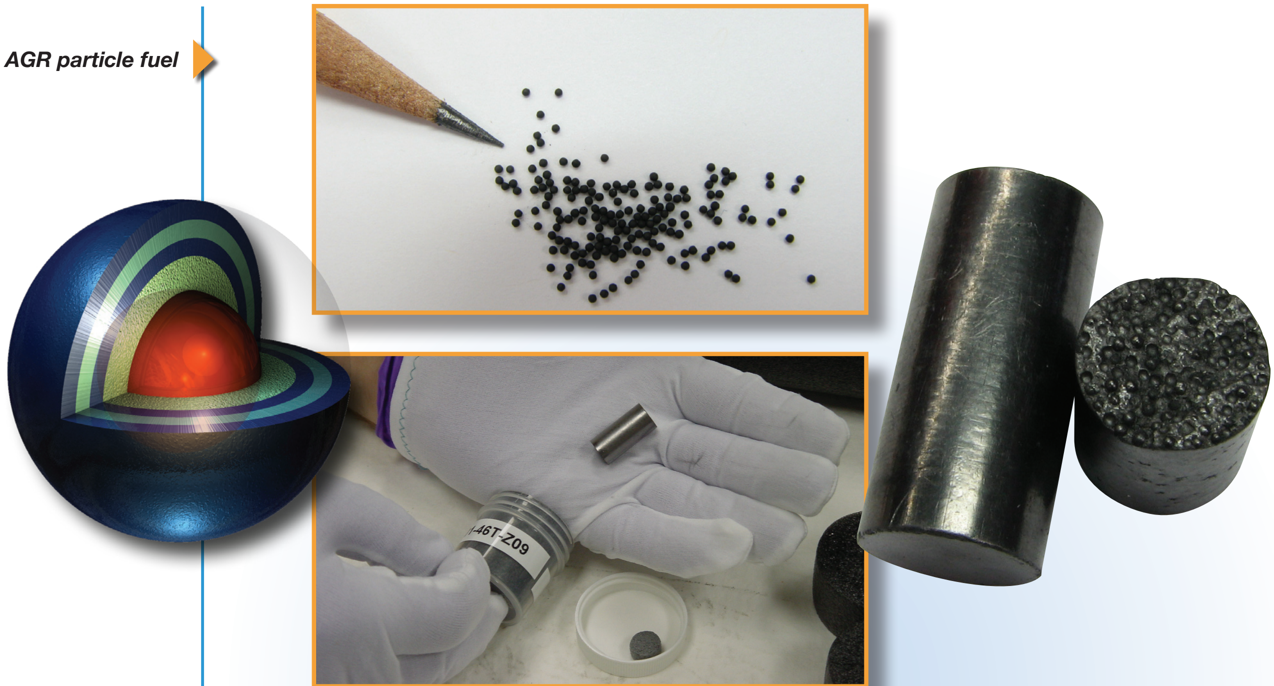
AGR particle fuel



Fuel Fabrication

Next Generation Nuclear Plant

The Very High Temperature Reactor (VHTR) Technology Development Office Program is working to develop high temperature gas-cooled reactor (HTGR) technology that will meet the commercial needs of a wide range of industrial end users. Idaho National Laboratory (INL) manages the research and development of NGNP for the Department of Energy.

A key research and development element of the NGNP is fuel development and qualification. The NGNP/Advanced Gas Reactor (AGR) Fuel Development and Qualification Program was established to provide a baseline fuel qualification data set in support of the licensing and operation of a HTGR. Gas-reactor fuel performance demonstration and qualification comprise the longest duration research and development tasks for HTGR feasibility. The baseline fuel form is to be demonstrated and qualified for a peak time-averaged fuel centerline temperature of 1,250°C.

The ultimate goal for HTGR fuel manufacturing is economical production of ultra high-quality kernels, coated particles, and compacts. The program includes activities to develop and qualify fuel manufacturing processes that can be handed off to industry to serve as the foundation for commercial-scale coated-particle fuel manufacturing in the United States for advanced gas-cooled reactors.

One of the unique features of the HTGR is the tristructural-isotopic (TRISO) fuel used for the fission reaction. Coated-particle fuel fabrication begins with uranium oxycarbide (UCO) or uranium dioxide (UO_2) kernels formed by an internal gelation process in which droplets of a uranium-containing chemical broth are formed into gel spheres in a fluid medium. The resulting gel spheres are then dried and sintered into hard ceramic particles.

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Fuel kernels are coated using fluidized-bed chemical vapor deposition and include a low-density carbon layer, a high-density inner pyrolytic carbon layer, a silicon carbide layer, and a high-density outer pyrolytic carbon layer. These coatings are designed to work together to make each fuel particle a mini pressure vessel that will maintain its integrity and retain fission products during normal reactor operation and accident conditions. The finished coated particle is a carbon and ceramic sphere that is stable at temperatures up to 1,600ºC. These coatings, collectively termed TRISO, produce a very robust fuel form by confining the fission products within the fuel particle under all normal conditions.

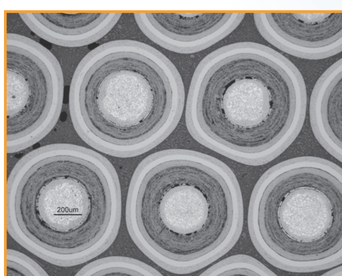
The coated fuel particles are agglomerated into either short, cylindrical-shaped compacts for a prismatic reactor core or billiard-ball-size spheres used in a pebble-bed reactor. For both designs, the particles are overcoated with a carbonaceous matrix composed of graphite powder and a thermosetting resin binder, formed into the desired shape, then carbonized and high-temperature-heat-treated to provide a thermally stable material.

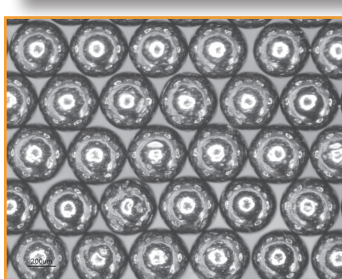
A series of eight irradiation experiments is currently in process at INL to:

- Demonstrate acceptable fuel performance under normal conditions
- Qualify manufacturing processes
- Determine performance characteristics under accident conditions
- Provide a data set to develop enhanced fuel performance modeling capabilities.

TRISO fuel can be irradiated to higher burnups than conventional light water reactor fuel, which translates to better utilization of uranium resources. This, combined with the higher thermal efficiency of a HTGR, causes less waste to be generated per unit of electricity.

Babcock & Wilcox AGR compaction press





Top: AGR-2 coated particles

Bottom: AGR-2 UCO kernels

Babcock & Wilcox AGR overcoater

For more information

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