NUCLEAR ENERGY RESEARCH INITIATIVE

Computations for Advanced Nuclear Fuels

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Project Number: 07-035

Program Area: AFC R&D

Collaborators: None

Project Description

To successfully implement an efficient and effective nuclear power strategy, it is essential to develop new fuels that can provide optimal performance over long periods of time. This research will develop advanced computational techniques to improve the understanding of fission gas distribution and heat transfer in solid fuel under normal and accident conditions.

In this project, researchers will develop atomistic-scale to continuum-scale models to replace the empirical models used in existing performance codes (such as FRAPCON for oxide fuels and PARFUME for TRISO fuels), which date back to the 1970s. The computational programs of fission product transport will apply to the pyrolytic carbon and silicon carbide coating of TRISO fuels as well. This will help provide estimates for the transport behavior of noble gases, iodine, tellurium, cesium, strontium, silver, palladium, and rare earth fission products in the layers of the TRISO-coated particle fuel under both normal and accident conditions—where measurements are either impractical or cost prohibitive. This work will also help reduce uncertainties and elucidate transport mechanisms.

Workscope

This project will perform the following tasks:

- Construct a computer program for heat transfer in the solid fuel using the direct simulation Monte-Carlo technique
- Construct a computer program for fission gas distribution in the fuel using the direct simulation Monte-Carlo technique
- Combine the two programs and conduct parametric studies to elucidate the role of geometry, materials, and irradiation on both the fission gas distribution and heat transfer
- Compare the computations against available experimental data