NUCLEAR ENERGY RESEARCH INITIATIVE

Optimization of Oxide Compounds for Advanced Inert Matrix Materials

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Collaborators: Imperial College of Science, Technology, and Medicine, Idaho National Laboratory

Project Number: 05-134

Related Program: AFCI

Project Description

This project will model, design, synthesize, and characterize oxide ceramics that have optimized thermophysical properties for potential use as inert matrix fuel (IMF). This will be accomplished through a combined computational and experimental approach. The objective of this research program is to develop oxide compounds and composites that exhibit minimum radiation swelling, high thermal conductivity, and excellent hot water corrosion resistance.

Potential benefits of the optimized IMF materials compared to the UO_2 fuel used in current generation reactors include higher thermal conductivity, which will considerably reduce the centerline temperature of the fuel. Lower stored heat in the fuel will minimize the impact of a loss of coolant accident. Use of an inert matrix will avoid formation of transuranic fission products by neutron capture, thereby allowing higher fuel burnup. Better corrosion resistance will make the IMF compatible with coolant under cladding breach accidents.

The research is being conducted as part of DOE's Advanced Fuel Cycle Initiative program.

Work Scope

The following activities will be completed for this project:

- Develop the experimental and computational infrastructure.
- Develop and optimize the magnesium oxide (MgO)-pyrochlore composite matrix through the following tasks: (1) perform computer simulation to select pyrochlore compounds with optimum thermal conductivity, irradiation tolerance, and thermal transport properties, (2) synthesize and characterize composites selected in Task 1, (3) fabricate MgO-pyrochlore composites, and (4) refine simulation codes and experimental techniques.
- Develop and optimize a single-phase inert matrix compound through the following tasks: (1) use computer simulation to select candidates for single phase IMF, (2) synthesize/characterize the thermo-physical properties and microstructure of selected compounds, (3) perform irradiation testing, and (4) refine simulation codes and experimental techniques.