NUCLEAR ENERGY RESEARCH INITIATIVE

Radiation Damage in Nuclear Fuel for Advanced Burner Reactors: Modeling and Experimental Validation

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Collaborators:
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Program Area: Advanced Fuel Cycle R&D

Project Description

In this joint project, researchers will study radiation damage of nuclear fuels through modeling, simulation, and experimental characterization. They will focus on the behavior, structure, and properties of fuel materials under conditions relevant to Advanced Burner Reactor (ABR) service, addressing issues such as 1) fission product and ion range distributions modeled through simplified Molecular Dynamics methods, 2) understanding interatomic force fields through first-principles calculations, 3) crystal defect and noble gas diffusion and aggregation through Kinetic Monte Carlo simulations, 4) crystal damage evolution through molecular modeling and empirical relationships between energy deposition and defects, and 5) experimental characterization aimed at validating multi-scale models.

Efficient predictive modeling requires integration of a range of materials modeling and numerical methods, spanning multiple length and time scales. This work will produce new simulation tools for predicting active ion transport and damage evolution in nuclear materials, new insights into interatomic force fields relevant for modeling the physical properties of nuclear fuel, an evaluation of bubble formation in crystalline materials, and novel experimental characterization of damage and defect distributions in active materials through (Scanning) Transmission Electron Microscopy. The tools and research resulting from this research will provide specific predictions of relevant materials behavior in nuclear fuel for a closed fuel cycle in a fast burner reactor, as well as new and validated computational tools that can be applied for further research.