NUCLEAR ENERGY RESEARCH INITIATIVE

Development of Nanostructured Materials with Improved Radiation Tolerance for Advanced Nuclear Systems

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Project Number: 05-088

Collaborators: Los Alamos National Laboratory

Related Program: AFCI

Project Description

This project will explore the fundamental mechanisms through which interfaces in nanolayered structures and grain boundaries of bulk nanomaterials are able to attract and rapidly eliminate point defects and unwanted foreign species. Candidate materials that will be studied include both nanostructured multilayer composites synthesized by magnetron sputtering (a bottom-up approach) and structural bulk nanomaterials produced by severe plastic deformation, equal channel angular extrusion (a top-down approach).

This project will have profound and broad impact on the understanding of the fundamental science of improving radiation resistance by inducing interfaces and grain boundaries in nanomaterials and by designing and engineering structural nanomaterials for advanced nuclear reactors. Data from this study will be used for estimating defect capture rates and lifetimes of multilayered structures and bulk nanomaterials in conditions that would seriously degrade conventional microstructures. Researchers expect this project to benefit a broad spectrum of DOE programs associated with fission technology research and development.

Work Scope

This study will evaluate the thermal stability of nanomaterials via differential scanning calorimetry (DSC), resistivity measurements, and long-term annealing studies. The project will also explore the corrosion resistance of multilayer coatings. Experiments will then focus on detailed examination of ion-irradiated multilayered nanocomposites and bulk nanomaterials via high-resolution transmission electron microscopy (HRTEM), scanning transmission electron microscopy (STEM), and x-ray diffraction (XRD). These experiments will examine the development of stable defect clusters as a function of proximity to interfaces and grain boundaries and the evolution of interface undulations that develop with IR radiation. Microscopy studies on defect accumulation and migration will be correlated with available simulations on the energetics of point defect migration to and within interfaces and grain boundaries and the stability of layered structures during various perturbations, including radiation-induced mixing. This research will also explore the role of the atomic structure of the interface in eliminating damage.