NUCLEAR ENERGY RESEARCH INITIATIVE

Development of High-Temperature Ferritic Alloys and Performance Prediction Methods for Advanced Fission Energy Systems

PI: Dr. G. R. Odette, University of California- Santa Barbara

Project Number: 05-074

Collaborators: None

Related Program: Gen IV

Project Description

This project will focus on developing and evaluating a high-temperature alloy class, known as "nanostructured ferritic alloys" (NFAs), building on previous reactor materials research and ongoing fusion and fission materials programs. These alloys possess remarkable creep strength, excellent ductility, good fracture toughness potential, and may mitigate many radiation damage problems. The study will consider the combined effects of high service temperatures (up to 900 °C or more) and high dose irradiations on NFAs. At these temperatures, material instabilities and degradation present great challenges. This study will focus on commercial-type alloys like MA957. However, model alloy experiments will be continued to help researchers obtain a better understanding NFAs and to optimize NFA processing paths and their balance of performance sustaining properties.

Work Scope

- Develop a comprehensive mechanical property and microstructural database on MA957 and other commercial NFAs. Develop semi-empirical constitutive models, including high- temperature irradiation effects, and assess the applicability of the master fracture toughness-temperature curve-shifts method to these alloys.
- Continue to establishing a fundamental nano-microstructural and property database to support processing models that will help optimize properties and minimize costs. Conduct thermal aging studies and post irradiation examinations.
- Investigate advanced joining methods (e.g., solid-state welding and diffusion bonding) for MA957 that will have the least disruption on the beneficial NFA micro-nanostructures.
- Develop a semi-empirical model of the high-temperature thermal and irradiation stability of the nm-scale precipitates in NFAs and compare the predictions to the results of thermal aging and irradiation experiments.
- Conduct other activities, including collaboration on additional irradiation studies and design of an advanced reactor surveillance-component monitoring program.