

NUCLEAR ENERGY RESEARCH INITIATIVE

Determination of Basic Structure-Property Relations for Processing and Modeling in Advanced Nuclear Fuels: Microstructure Evolution and Mechanical Properties

PI: Dr. Pedro D. Peralta, Arizona State University

Project Number: 05-001

Collaborators: Los Alamos National Laboratory

Related Program: AFCI

Project Description

Fuel development under the Advanced Fuel Cycle Initiative (AFCI) will rely heavily on modeling physical mechanisms to predict performance rather than conducting an experimental characterization or using empirical relationships derived from experimental data. This project will investigate a complementary strategy for fuel development. Through performing experimental work on relevant surrogate materials, particularly in the case of inert matrix fuels where less experimental characterization is currently available, researchers will study the structure-property relationship of nitrides and oxides in solid solutions using surrogate elements to simulate the behavior of inert matrix fuels emphasizing zirconium-based materials. The goal is to provide insight into processing fuel that has better performance and greater structural reliability during manufacturing and service and to develop structure-property relations that can be used as input for fuel performance models.

Researchers will explore three key aspects of these materials. They will characterize the microstructure by measuring global texture evolution and local crystallographic variations, determine mechanical properties (including fracture toughness, compression strength, and hardness) as functions of load and temperature, and develop structure-property relations to describe mechanical behavior of the materials based on experimental data. Using crystallographic information in evaluating fuel performance and incorporating statistical variations of microstructural variables into simplified models of mechanical behavior of fuels are new aspects of this research. Work with actual fuels will be carried out in parallel in collaboration with Los Alamos National Laboratory.

Work Scope

- Develop processing procedures for pellet fabrication and characterize their properties.
- Establish appropriate surrogates for plutonium, fabricate samples, and optimize the process.
- Translate techniques from surrogate processing to actual fuel; fabricate and characterize.
- Establish models for high-temperature behavior, characterize properties, perform testing and analysis.