NUCLEAR ENERGY RESEARCH INITIATIVE

Synthesis and Optimization of the Sintering Kinetics of Actinide Nitrides

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Collaborators: None Related Program: AFCI

Project Description

Nitride-based nuclear fuels, particularly those based on uranium mononitride (UN) and plutonium mononitride (PuN), are candidate fuels for the Advanced Fuel Cycle Initiative (AFCI). These fuels have a combination of higher uranium loadings with lower enrichments and higher thermal conductivity compared to other fuel forms. It is possible to produce inert matrix fuels from these nitrides because of their compatibility with candidate matrices such as ZrN and refractory metals. Although several processes have been developed for synthesizing powder and monolithic forms of actinide nitrides, the sintering kinetics and mechanisms are not understood. Having a quantitative understanding of the kinetics and mechanisms of densification and grain coarsening is critical to both the outcome economics and product performance of any ceramic fabrication process. Through optimized processing conditions, sintering temperatures and equipment size can be greatly reduced, production rates can be increased, and properties can be improved and more precisely controlled.

Work Scope

In this project, the investigators will synthesize actinide and surrogate powders of varying morphologies and particle size. Powders will be thoroughly characterized and pressed into fuel forms. Researchers will conduct detailed sintering studies to assess the specific rate equations and kinetics models as a function of time, temperature, grain size, and other processing variables. Researchers will determine rate limiting and process controlling mechanisms by applying fundamental models, characterizing microstructures, and comparing transport properties including solid state diffusion and gas transport. An end result of these studies will be a processing model and economic analysis that will enable fuel processing to be done at lower temperatures, shorter times, and with less costly infrastructure.