NUCLEAR ENERGY RESEARCH INITIATIVE

Solution-Based Synthesis of Nitride Fuels

PI: Ken Czerwinski, Thomas Hartmann, University of Nevada, Las Vegas

Collaborators: Los Alamos National Laboratory

Project Number: 06-012

Program Area: Advanced Fuel Cycle Initiative

Project Description

The synthesis of nitride fuels for advanced reactor designs entails carbothermic reduction from the oxide to the nitride. This process step is based on solid-phase reactions involving a stepwise process from the metal oxide, to the carbide, and finally the nitride. This high- temperature, solid-phase synthesis process is plagued by impurities in the final nitride product and difficulties in production, creating major drawbacks in using nitride fuels for advanced reactor designs. If the nitride could be synthesized directly by a solution route, then the impurities and other synthesis problems could be eliminated, or at least minimized. The proposed solution route to nitride would also have the added benefit of providing several adjustable parameters that would allow control over the properties of the final solid product.

The objective of the proposed project is to develop a solution-phase process for synthesizing actinide nitrides for use in nuclear fuels. Recent work by the Los Alamos National Laboratory collaborators has investigated amido reactions in non-aqueous solvents. The non-aqueous synthetic route based on amido chemistry potentially provides property control over the nitride product similar to the sol-gel methods for actinide oxides. The resulting nitride product should be free of the impurities inherent in the carbothermic reduction technique.

Workscope

The project is divided into three primary tasks as outlined below:

- Perform non-aqueous coordination chemistry, involving development of amido coordination with uranium, neptunium, and transneptunium actinides
- Formation and characterization of uranium nitride, neptunium nitride, and transneptunium nitrides from amido species
- Develop methods for the synthesis of actinide nitrides
    - Identify crucial parameter of the solution-based synthesis of uranium nitride, neptunium nitride, and transneptunium nitride
    - Compare solution synthesis for uranium and neptunium nitride and initial identification of required methods for solid-solution synthesis
    - Perform experiments on the synthesis of uranium-neptunium solid solutions if large variations are identified
    - Compare solution synthesis methods for actinide nitride and identify required methods for solid-solution synthesis with different actinides