NUCLEAR ENERGY UNIVERSITY PROGRAMS

Development of Diffusion Barrier Coatings and Deposition Technologies for Mitigating Fuel Cladding Chemical Interactions (FCCI)

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Abstract

The goal of this project is to develop diffusion barrier coatings on the inner cladding surface to mitigate fuel-cladding chemical interaction (FCCI). FCCI occurs due to thermal and radiation enhanced inter-diffusion between the cladding and fuel materials, and can have the detrimental effects of reducing the effective cladding wall thickness and lowering the melting points of the fuel and cladding. The research is aimed at the Advanced Burner Reactor (ABR), a sodium-cooled fast reactor, in which higher burn-ups will exacerbate the FCCI problem.

This project will study both diffusion barrier coating materials and deposition technologies. Researchers will investigate pure vanadium, zirconium, and titanium metals, along with their respective oxides, on substrates of HT-9, T91, and oxide dispersion-strengthened (ODS) steels; these materials are leading candidates for ABR fuel cladding. To test the efficacy of the coating materials, the research team will perform high-temperature diffusion couple studies using both a prototypic metallic uranium fuel and a surrogate—the rare-earth element lanthanum. Ion irradiation experiments will test the stability of the coating and the coating-cladding interface.

A critical technological challenge is the ability to deposit uniform coatings on the inner surface of cladding. The team will develop a promising non-line-of-sight approach that uses nanofluids . Recent research has shown the feasibility of this simple yet novel approach to deposit coatings on test flats and inside small sections of claddings. Two approaches will be investigated: 1) modified electrophoretic deposition (MEPD) and 2) boiling nanofluids. The coatings will be evaluated in the as-deposited condition and after sintering.