NUCLEAR ENERGY UNIVERSITY PROGRAMS

Improved LWR Cladding Performance by EPD Surface Modification Technique

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Abstract

This project will utilize the electro-phoretic deposition technique (EPD) in conjunction with nanofluids to deposit oxide coatings on prototypic zirconium alloy cladding surfaces. After demonstrating that this surface modification is reproducible and robust, the team will subject the modified surface to boiling and corrosion tests to characterize the improved nucleate boiling behavior and superior corrosion performance. The scope of work consists of the following three tasks:

- The first task will employ the EPD surface modification technique to coat the surface of a prototypic set of zirconium alloy cladding tube materials (e.g. Zircaloy and advanced alloys such as M5) with a micron-thick layer of zirconium oxide nanoparticles. The team will characterize the modified surface for uniformity using optical microscopy and scanning-electron microscopy, and for robustness using standard hardness measurements.
- After zirconium alloy cladding samples have been prepared and characterized using the EPD technique, the team will begin a set of boiling experiments to measure the heat transfer coefficient and critical heat flux (CHF) limit for each prepared sample and its control sample. This work will provide a relative comparison of the heat transfer performance for each alloy and the surface modification technique employed.
- As the boiling heat transfer experiments begin, the team will also begin corrosion tests for these zirconium alloy samples using a water corrosion test loop that can mimic light water reactor (LWR) operational environments. They will perform extended corrosion tests on the surface-modified zirconium alloy samples and control samples to examine the robustness of the modified surface, as well as the effect on surface oxidation.