
Establishment of In-situ Scanning Electron Microscopy Platform for Irradiated Materials at the University of Tennessee, Knoxville

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Collaborators: N/A

Program: GSI

ABSTRACT:

This Department of Energy (DOE) Nuclear Engineering (NE) Infrastructure proposal plans to initiate the development of an in-situ, high resolution, environmental scanning electron microscope (SEM) focused on structural materials relevant to nuclear engineering, small portions of nuclear fuel, and radiation detectors. The proposal titled “Establishment of In-situ Scanning Electron Microscopy Platform for Irradiated Materials at the University of Tennessee, Knoxville” will be solely led by Prof. Khalid Hattar. Prof. Hattar is an associate professor of Nuclear Engineering at the University of Tennessee, Knoxville (UTK) and director of the Tennessee Ion Beam Materials Laboratory (TIBML).

The objective of this proposal is the purchase and installation of an SEM with chemical mapping capabilities that will be used for three core purposes:

- (1) the evaluation of small-scale, low-activity radioactive samples,
- (2) post irradiation examination, and
- (3) in-situ thermal, mechanical, and irradiation experiments.

This proposal will take advantage of the fact that TIBML is already a radiation control area due to the radiation-generating devices contained within it to permit the SEM characterization of low-level radioactive materials. In addition, the high-resolution nature of the SEM and its chemical mapping capabilities make it ideal for detailed post-irradiation examination and post-mechanical testing fractography. TIBML already contains a 3-MV Tandem Accelerator, a SEM-scale nanoindenter, and a 48-W multiple wavelength laser. When coupled with the environmental capabilities of the proposed SEM, a wide range of in-situ ion irradiation, small-scale mechanical testing, laser-based heating, and environmental gas-controlled SEM experiments will be possible.

The proposed SEM-scale analysis and experiments can provide fundamental understanding, model validation, and coupling to larger nuclear industry standards. The advancement of nuclear materials research is often limited by the disconnect between theory, fundamental experiments, modeling, and reactor-level observations. The proposed in-situ SEM platform for Irradiated Materials provides a tool to bridge these sub-fields and increase the potential for developing predictive models and trusted materials systems for nuclear reactor applications.