Scanning Electron Microscope for nuclear materials investigation enabling in-situ techniques and novel characterization for the nuclear energy community

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ABSTRACT:

Scanning Electron Microscopy and associated techniques such as Electron Backscatter Diffraction (EBSD) and Energy Dispersive X-ray spectroscopy (EDS) are state of the art techniques to investigate nuclear materials. It allows to characterize structural and fuel materials microstructure and composition in great detail. Modern SEM has come a long way allowing to push the envelope on what is possible to obtain using this technique. In recent times new techniques such as Electron Channeling Contrast Imaging (ECCI) as well as high speed EBSD allows for new investigation methods on nuclear materials.

This proposal features the purchase of a new state of the art SEM with EDS and EBSD enabling conventional and new materials investigation techniques. The tool will be housed in the nuclear materials laboratory and available to users within campus and outside through the Nuclear Science User Facility (NSUF). Radioactive sample investigation will be featured in close collaboration with UCB's Environmental Health and Safety team.

The tool proposed here will enable in-situ measurements (straining, heating, etc.) during investigation with EBSD and advanced imaging methods such as ECCI. Further it will allow fast throughput investigation of Scanning Transmission Electron Microscopy in High Angular Dark Field Mode (STEM-HAADF) enhancing sample throughput. The tool does not aim to substitute conventional TEM but it does provide a high throughput avenue complementing conventional TEM. The new beam optics and beam deceleration available allow to image at higher resolution, high precision of metals and ceramics. Several show cases are presented in the full proposals bringing new insight into nuclear materials investigations. We aim to evaluate radiation damage using the new ECCI technique and EBSD to evaluate dislocation densities, precipitates and strain in materials. Implementing the already existing in-situ straining using either the in-situ nanoindenter or the in-situ tensile stage will enable observation of the materials deformation and microstructural changes as they occur.

This proposal is a cost share collaboration between DOE NEUP and UCB allowing to purchase a state of the art tool to investigate nuclear materials and irradiated materials.