Investigating Grain Dynamics in Irradiated Materials with High-Energy X-rays

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ABSTRACT:

This project aims to develop the capability for conducting a multiscale experiment on an irradiated material enabled by high-energy X-rays. *In situ* thermal-mechanical testing of an activated specimen will be integrated with a suite of high-energy X-ray techniques developed by the X-ray community with the focus on 3D microstructural characterization by far-field high-energy diffraction microscopy (HEDM) (also known as 3D XRD) to investigate grain dynamics in irradiated materials. We will improve and refine the hardware interfaced with the MTS load frame equipped at the beamline for *in situ* thermal-mechanical testing of an activated sample. Software development will also be pursued with the focus on characterizing radiation damage and damage evolution by HEDM. This new capability will allow (1) *in situ* test of a neutron-irradiated specimen under uniaxial loading at elevated temperature; (2) in-grip rotation of a sample to enable 3D X-ray characterization under a tensile load; (3) concurrent applications of wide-angle X-ray scattering (WAXS), small-angle X-ray scattering (SAXS), far-field HEDM and X-ray micro-tomography. It will open up new opportunities for the nuclear material community to study complex reactor materials at multiple length scales in a single experiment, and bridge a wide range of length scales that are inherent in the deformation and failure processes in irradiated materials. We also propose to develop an activated specimen holder library that will facilitate the access to these advanced characterization tools by the user community, particularly for effective use of the sample library provided by the DOE Nuclear Science User Facilities (NSUF).