

# Advanced Characterization Capabilities at INL

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**Abstract.** Advanced characterization of the irradiated fuels and materials is crucial to help understanding the material and fuel property changes under irradiation. Microstructural defect evolution down to nanometer scale could strongly affect the material and fuel performance on macroscale. Radiation-induced material and fuel degradation include dimensional instability, hardening and embrittlement, intergranular cracking, radiation-enhanced chemical interaction at the interfaces and breakaway swelling as well as fission gas behavior and bubble growth. To mitigate the radiation damage, advanced characterization on irradiated microstructure, microchemistry, micromechanical property and local thermal property is necessary to identify the controlling mechanisms that are responsible to the degradations.

This presentation provides an updated summary of the advanced characterization capabilities at the Irradiation Materials Characterization Laboratory (IMCL), Materials and Fuels Complex (MFC), Idaho National Laboratory (INL). It highlights the recently established capabilities including shield sample preparation area (SSPA), shield confinement cells for two focused ion beam (FIB) systems, a shielded electron probe microanalysis (EPMA) and the thermal property measurement instruments including a thermal property microscopy (TPM) along with non-shielded instruments like scanning electron microscopy (SEM), X-ray diffractometer, micro X-ray microscopy (XRM), atom probe tomography (APT), physical property measurement system (PPMS) and transmission electron microscopy (TEM). Some examples on advanced characterizations on irradiated structural materials and fuels will be presented. It demonstrates the power of combining sample preparation of highly radioactive materials with the advanced characterization down to atomic resolutions within one facility.

**Key words.** Advanced Characterization, Irradiation Degradation, Fuels and Materials, Microstructure