



*The Irradiated Materials Characterization Laboratory is home to a variety of high-end instruments that allow researchers to study irradiated fuels and materials at the micro, nano and atomic levels, which is where irradiation damage occurs.*

## Irradiated Materials Characterization Laboratory

### *Advanced Post-Irradiation Examination*

**T**he Irradiated Materials Characterization Laboratory (IMCL) is a unique, 12,000-square-foot facility located at Idaho National Laboratory's Materials and Fuels Complex. The hazard category 2 facility incorporates many features designed to allow researchers to prepare and conduct microstructural-level investigations on irradiated fuel safely and efficiently.

IMCL focuses on microstructural, microchemical, and micromechanical analysis and thermophysical characterization of irradiated nuclear fuels and materials. IMCL's unique design incorporates advanced characterization instruments that are sensitive to vibration, temperature, and electromagnetic

interference into modular radiological shielding and confinement systems. The shielded instruments allow characterization of highly radioactive fuels and materials at the micro, nano, and atomic levels, the scale at which irradiation damage processes occur.

Enabled by its modular design, IMCL will continue to evolve and improve capability throughout its 40-year design life to meet the national and international user demand for high-end characterization instruments for the study of nuclear fuel and materials.

Combined with INL's advanced computer modeling techniques, this understanding will enable advanced fuel designs, and reduce the time needed for fuel development and licensing.

#### **BASIC CAPABILITIES:**

- Preparation of high-activity samples
- Optical microscopy
- Electron probe microanalysis (EPMA)
- Dual-beam focused ion beam (FIB)
- Transmission electron microscopy (TEM)
- Local electrode atom probe (LEAP)
- Scanning electron microscopy (SEM)
- Measurement of material physical and thermal properties
- X-ray microscopy (XRM)
- X-ray diffractometer (XRD)



## KEY CAPABILITIES/INSTRUMENTS:

Application	Instrument	Capabilities	Configuration
Sample Preparation	SSPA - Shielded sample preparation area	Optical microscope, polishing and grinding, sample cutting in hot cell, glovebox, and hood	Shielded
Advanced Microscopy, Microchemistry, Micromechanical Testing	SEM - JEOL 7600	High-resolution scanning electron microscope (SEM) equipped with electron back-scatter diffraction, energy dispersive X-ray spectroscopy (EDS) and wavelength dispersive spectroscopy (WDS) detectors	Benchtop
	EPMA - Shielded Cameca SX100R	Quantitative compositional analysis of solid specimens on a micrometer spatial scale. Detectors and electronics are shielded to 3 Ci of <sup>137</sup> Cs to allow for trace element detection. Measures elements from B to Cm.	Shielded
	STEM - FEI Titan Scanning Transmission Electron Microscope	Equipped with probe corrector, super-X EDS, electron energy loss spectroscopy (EELS), DENSolutions D6 heating holder (1573 K), tomography holders, vacuum transfer holder, Hysitron PI-95 PicoIndenter	Benchtop
	APT - LEAP 5000 Atom Probe	3D imaging and chemical analysis at sub-nanometer scale	Benchtop
	FIB - FEI Quanta 3D FEG Focus Ion Beam	Preparation of minute samples for TEM, APT, and micromechanical testing	Shielded
	FIB - Thermo G3 Plasma Focus Ion Beam	Preparation of block samples for rapid 3D reconstruction, micromechanical testing, and microscale thermal property testing	Shielded
	FIB - Thermo G4 Helios Hydra Plasma Focus Ion Beam with TOF-SIMS	Equipped with secondary ion mass spectrometer (SIMS), EDS, and electron backscatter diffraction (EBSD) for sample preparation, imaging, microstructural, and chemical analysis	Benchtop
Thermophysical property measurement	LFA - Netzsch LFA 427 laser flash analyzer	Thermal diffusivity, contact resistance from room temperature to 2000 C, specific heat, thermal conductivity (under development)	Shielded
	TGA/MS - Simultaneous TGA/DSC+MS Netzsch STA 409C Skimmer	Measure specific heat, phase transformation temperatures and enthalpies, fission off-gas composition, mass change from room temperature to 2000 C	Shielded
	TCM - Thermal conductivity microscope	Spatial resolved thermal diffusivity, thermal conductivity with a spatial resolution of 50 μm from room temperature to 300 C	Shielded
	PPMS - Quantum Design Physical Property Measurement System	Electrical, thermal, thermodynamic and magnetic property measurement at temperatures from 1.8 K to 400 K and magnetic field range 0-9 T	Benchtop
Structure analysis and tomography	XRD - PANalytical powder X-ray diffractometer	Bulk X-ray diffraction with heating stage	Benchtop
	XRM - ZEISS Xradia 520 Versa X-ray microscope	Nondestructive 3D imaging of materials over 4 orders of magnitude in length scales (0.1-100 cm)	Benchtop
Mechanical testing	Mini-tensile tester	Tensile testing with digital image correlation (DIC)	Shielded

### FOR MORE INFORMATION

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