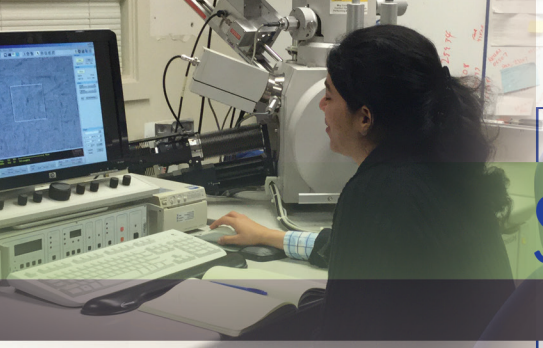
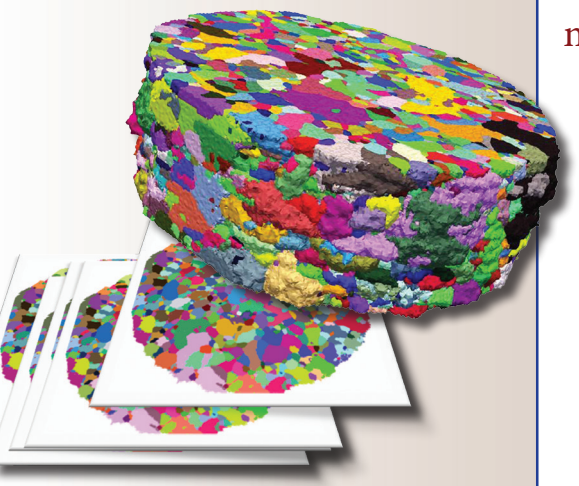


Structural Materials

Lawrence Livermore National Laboratory

Understanding how a material responds to a wide range of physical environments and mechanical conditions, how its microstructure affects performance, and how it ages over time—such knowledge is crucial to supporting the many and diverse missions of Lawrence Livermore National Laboratory.

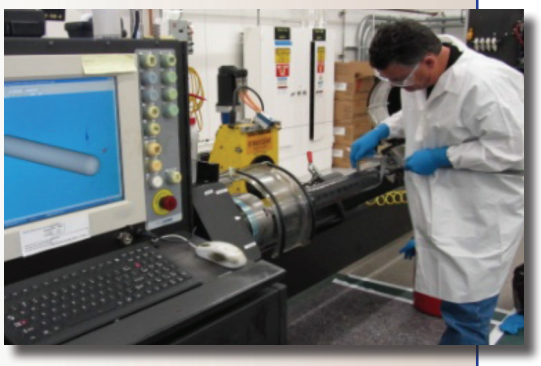


High-energy diffraction microscopy (HEDM). The HEDM microstructures are about 1 millimeter in diameter.

The Laboratory's diverse missions rely heavily on expertise in structural materials, whether assessing the reliability of design concepts, producing materials with specific desired properties, or producing components that are certifiable over their lifetime. We are able to process, synthesize, and fully characterize metallic, composite, and polymeric materials. Additional capabilities range from initial materials processing, to measuring and understanding physical properties, to evaluation of performance in a variety of environments. Our work is carried out synergistically with the computational materials science and mechanics efforts at the Laboratory.

Example Projects

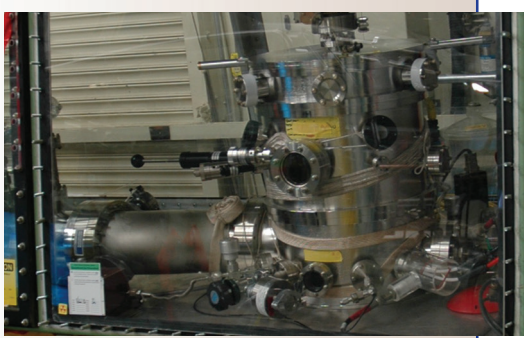
- Dynamic behavior of materials with architected lattice structures
- Development of a data base of materials properties for constitutive models
- Deposition of uranium and uranium alloys
- Development of fiber and metal-based multi-functional composites
- Advanced diagnostics of electron beam welding



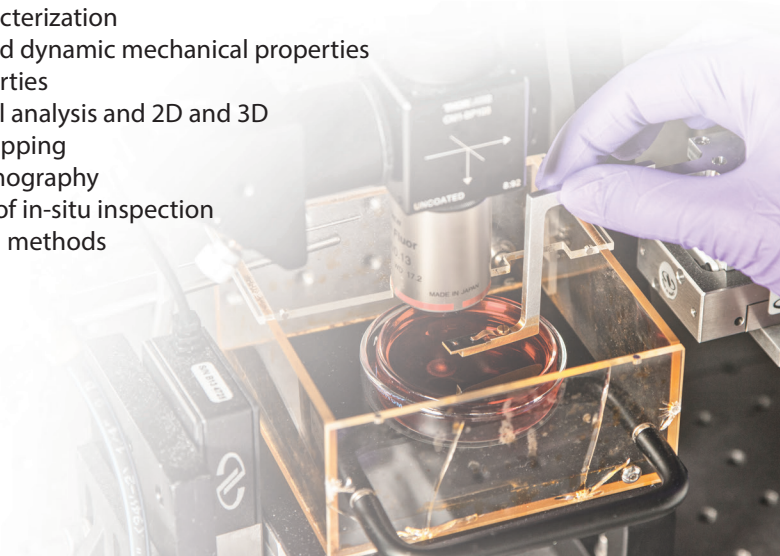
Multiaxis filament-winding machine for manufacturing carbon-fiber composites.

Expertise

- Materials Synthesis and Processing
  - Thin films/multilayers
  - Advanced composites
  - Laser and electron beam welding/processing
  - Polymers/plastics
  - Uranium metallurgy
  - Alloy development/metal processing
- Testing and Characterization
  - Quasi-static and dynamic mechanical properties
  - Thermal properties
  - Microstructural analysis and 2D and 3D orientation mapping
  - Computed tomography
  - Development of in-situ inspection and evaluation methods



Magnetron Sputtering System, used to deposit thin films of uranium.



Facilities and Technologies

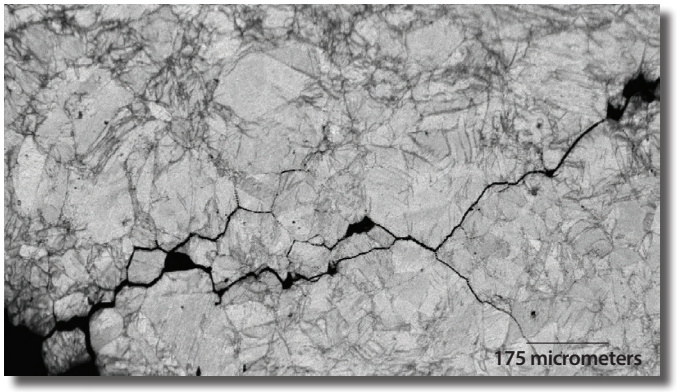
- Diverse static and dynamic mechanical and thermal testing capabilities
- Mechanical testing capability over a broad range of loads and strain rates
- Physical vapor deposition capabilities
- Forming and fabrication of unique polymers and plastics
- Thermomechanical processing of metals and alloys
- Filament winding and thermal processing of fiber composites

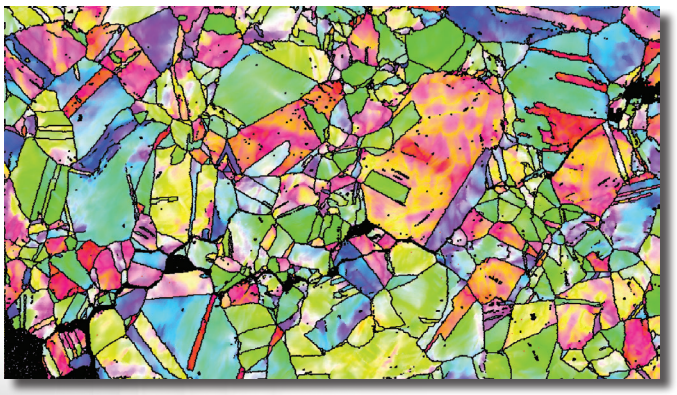
Sponsors

DOE National Nuclear Security Administration (NNSA)
DOE Office of Science
DOE Office of Nuclear Energy
DOD/DOE Joint Munitions Program
Air Force Office of Scientific Research
U.S. Air Force
National Aeronautics and Space Administration (NASA)

Academic/Industry Alliances

Institute for Shock Physics and School of Mechanical and Materials Engineering, Washington State University
Advanced Light Source at Lawrence Berkeley National Laboratory
Colorado School of Mines
Dynamic Compression Sector at the Advanced Photon Source, Argonne National Laboratory
University of California, Berkeley
University of California, Davis
University of California, Irvine
Stanford University
Johns Hopkins University





Livermore scientists used SEM-based electron backscatter diffraction to study crack propagation. This technique reveals how cracks travel through different microstructures, allowing researchers to predict when and where fractures will form and what paths they will follow—information that helps pinpoint where a component is most likely to fail. In the bottom image, colors indicate grain orientation.

Capability Leaders

Mukul Kumar **925-422-0600** **kumar3@llnl.gov**

Mukul leads the Mechanics of Materials Group within the Materials Engineering Division. The broad breadth of project work has spanned materials development for high temperature and radiation environments, dynamic behavior of materials, in-situ monitoring of materials response under various loading conditions, and microstructural characterization using various microscopy tools. He earned his PhD from the University of Cincinnati and also spent time at Johns Hopkins University as a post-doctoral fellow prior to joining LLNL.

Gil Gallegos **925-422-7002** **gallegos2@llnl.gov**

Gil leads the Materials Engineering and Nondestructive Evaluation Section of the Materials Engineering Division. He has led materials development activities for dynamic characterization of alloys, materials processes for actinide alloys, and unique properties for advanced diagnostics. Gil has an M.S. in Materials Science and Engineering from Stanford.

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