Instrument Series: **Microscopy**

Atom Probe

The LEAP® 4000 XHR local electrode atom probe tomography instrument enabled the first-ever comprehensive and accurate 3-D chemical imaging studies of low electrical conductivity materials, such as ceramics, semiconductors and oxides. The LEAP capability is assisting EMSL's efforts to further scientific advancements in interface analysis and microstructural characterization, providing a new tool for understanding the relationship between the nanoscale structure of materials and their macroscopic properties.

Research Applications

Geochemistry – Studying chemical processes that compose rocks and soils has long been used to determine matter cycles and transport in the environment, which supports critical EMSL research in areas including bioremediation.

Metallurgy – A clear picture of the atomic-level physical and chemical interactions of metallic elements, intermetallic compounds and alloys shows how processes, such as mechanical and thermal treatments, alter properties to potentially improve creep and fatigue resistance, toughness and hardness of metallic materials.

Oxides and ceramics – A close look at the crystalline structures and heat-resistant capabilities of these inorganic, non-metallic materials opens doors to replacing traditional engineering materials, such as metals.

Biomineralization – An improved understanding of how macromolecules work with diverse living organisms to produce complex mineral structures with multifunctional properties improves the efficiency of synthetic nanomaterial production.

Quick Specs

- Maximum Pulse Repetition Rate–Voltage Mode: 200 kHz
- Maximum Pulse Repetition Rate–Laser Mode: 1 MHz
- Laser Power: > 300 mW
- Laser Wavelength: 355 nm
- Sample Temperature: 25–150K
- Laser Spot Size: < 1 µm
- Maximum Energy per Pulse: 0.5 nJ
- Dynamic Range: >1000X
- Field-of-View: > 200 nm (limited by the specimen geometry)
- Collection Rate: > 50 M ions per hour
- Lateral Resolution: 0.2 nm (using W-tip)
- Depth Resolution: 0.1 nm (using W-tip)
- Mass Resolution: Full FoV is ≥ 60° solid angle as measured from position of poles in the aluminum ion-desorption image (all results stem from using Al specimen)
  - Full Width at Half Maximum: 1/1000
  - Full Width at 10% Maximum: 1/475
  - Full Width at 1% Maximum: 1/300
- Manufacturer: Cameca Instruments Inc.

EMSL's LEAP Offers:

Availability – the first local electrode atom probe available for global research at a national scientific user facility

Unique capability – images low electrical conductivity materials, such as ceramics, semiconductors and oxides

True 3-D imaging – ~0.5 nm spatial resolution and ppm elemental sensitivity with an unprecedented field-of-view

Very high mass resolution – large area detector with a reflectron lens achieves excellent mass resolution and eliminates chromatic aberration

Sample optimization – tips can be mounted on convenient multiple, presharp microtip array

Accurate spatial reconstruction – conducted with Imago Visualization and Analysis Software (IVAS)

Diverse impact – supports studies in materials science, ceramics, metallurgy, geochemistry and biomineralization.

To learn more about LEAP and how it is being applied to EMSL users' research, see: http://www.emsl.pnnl.gov/capabilities/viewInstrument.jsp?id=34110.

EMSL, a national scientific user facility, provides free instrument access for open-source research. Learn how to become a user and about upcoming proposal calls at http://www.emsl.pnnl.gov/access/calls/.

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PNNL-SA-73718