EMSL

Instrument Series: **Spectroscopy & Diffraction**

High-Resolution RBS System: Ion Accelerator, Beam Lines, and End Stations

EMSL's Ion Beam Materials Analysis Laboratory is a collaborative research environment, where experienced staff work with users to develop customized research strategies that address the nation's scientific and technological challenges. The facility and equipment offer a unique combination of characterization tools, computational facilities, and ion beam capabilities. The newly developed High-Resolution RBS System provides the tools to develop a fundamental scientific understanding of ion, electron, and photon interactions with solids.

Research Applications

Thin film analysis – non destructive and quantitative elemental depth profiling (sub nanometer depth resolution) of thin films for spintronics, photonics, energy, electronic, and environmental applications

Buried interface analysis – understanding the structure and stability of buried interfaces as a function of processing conditions, including high-temperature environments

Radiation effects in solids – studying defects/damage characteristics to develop materials for next-generation nuclear reactors; understanding mechanisms in self-healing materials

Ion beam modification and synthesis of nanostructures – modification of materials, synthesizing embedded nanoclusters for catalysis applications, and ion implantation of species in different materials

Atmospheric aerosol characterization – aerosol chemical (quantitative) composition; quantitative measurement of hydrogen in aerosols, and measurement of total aerosol mass

Quantitative trace elemental analysis – providing quantitative elemental analysis with high sensitivities (ppm)

Quick Specs

- Non-destructive and quantitative
- Elements Detected: C – U
- Detection limits:
  1 – 10 at% (Z<20);
  0.01 – 1 at% (20<Z<70);
  0.001 – 0.01 at % (Z>70)
- Depth resolution: Sub nanometer ~ 0.5 nm
- Beam energy: 400 keV to 4000 keV
- High beam stability (~ 50 eV)
- Multi-axial channeling measurements
- Sample heating (1300K) and cooling (130K)
- Triple beam (ion, photon, and electron) radiation and characterization facility
- Aerosol samples analyzed using PIXE, PESA, and STIM
- Surface analysis and ion beam analysis in one UHV chamber
- Manufacturer: NEC

EMSL's High-Resolution RBS System and Accelerator Lab Offer:

Ultra-high depth resolution – depth profiling of ultrathin films with sub nanometer depth resolution

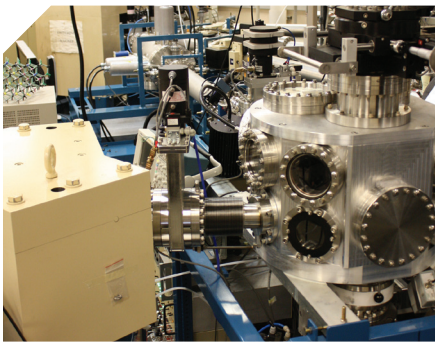
Quantitative analysis – composition of thin films with sub-monolayer sensitivity (for high Z elements)

Nuclear Reaction Analysis (NRA) – quantitative analysis of light elements (including hydrogen) and their isotopes

Proton Induced X-ray Emission (PIXE) – trace element quantification with ppm sensitivity

Multi-axial channeling – multi-axial channeling measurements to study single crystal materials and epitaxial thin films

***In situ* ion beam analysis capability –** *in situ* ion beam analysis under radiation and thermal environments



Radiation damage analysis – quantification of ion-beam-induced atomic displacements in single crystals; *in situ* characterization of interfacial diffusion and atomic mixing induced by ion irradiation

Surface and ion beam analysis in one chamber – suite of surface analysis capabilities (XPS, ISS, oxygen plasma source, and sputter cleaning) and ion beam analysis (RBS/channeling, NRA, PIXE, and PIGE) in one chamber

Ion Accelerator – various ion beams (from H^+ to Au^+) at energies ranging from 200 keV to 10 MeV with excellent beam stability (~50 eV).

To learn more about EMSL's capabilities and how they are being applied to EMSL users' research, see: www.emsl.pnl.gov/capabilities.

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.pnl.gov/access/calls/

SHUTTHA SHUTTHANANDAN
Senior Research Scientist
shuttha@pnl.gov — (509) 371-6530

WEILIN JIANG
Senior Research Scientist
Weilin.jiang@pnl.gov— (509) 371-6491

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