EMSL

Instrument Series: **Spectroscopy and Diffraction**

XPS Imaging

The X-ray photoelectron spectroscopy (XPS) imaging system provides fast, quantitative, real-time parallel imaging with highest resolution spectroscopy at all analysis areas. In addition, the system is equipped with temperature programmed desorption (TPD), ultraviolet photoelectron spectroscopy (UPS), ion scattering spectroscopy (ISS), a cluster/Ar^+ ion gun, and a five-axis automated stage with variable temperature sample environment at the analysis chamber. The system is also integrated with a radial distribution chamber (RDC), a full-size glove box, and a cold-stage at the sample introduction for air-sensitive, liquid-semisolid, biological and environmental sample transfers. In addition, the RDC has a simple sample transfer mechanism to the analysis position from multiple ports where, in the future, catalysis chambers equipped with Raman and IR spectrometers, deposition sources, and reactive gas manifolds for *in-situ* processing and characterization will be attached.

Research Applications

Photochemistry and photocatalysis – photon illumination of the sample surface at the analysis position through an optical fiber from an external UV-visible light source enables understanding of surface reactions, modifications, and decompositions

Chemical mapping of biological and environmental materials – study the actinide distribution in mineral and biological surfaces as well as transport and migration in ground water

Nanoscience and technology – reveal the surface and interface interactions of nanoparticles with organic ligands, polymers, and biological films

Solar cells based on semiconductors and polymers – provide molecular distribution, the nature of binding and charge transfer, and the resulting electronic structure and energy level alignments

Chemistry, materials science, and engineering – understand the surface chemistry of different materials from various engineering processes, redox reactions, kinetics, and mechanisms

Quick Specs

- Dual Al K_α (1486.6 eV) / Ag L_α (2984.7 eV) monochromatic X-ray sources
- Highest resolution and high-sensitivity spectroscopy and small spot analysis
  - Analysis area: Hybrid mode 700 x 300 µm, small spot modes 110, 55, 27, and 15 m
- Parallel chemical state imaging
  - Predetermined analysis areas of 2 mm as well as 800, 400, and 200 µm fields of view.
  - Guaranteed spatial resolution in imaging mode < 3 µm
- Five-axis Autostage
  - X-axis 130 mm, Y-axis ±15 mm, Z-axis 15 mm, Tilt (θ) ±90°, Rotation 360°
  - Variable temperature sample environment (-150°C to 600°C)
- Fast entry load lock with pre-cooling device and full-size glove box
- Automated Ar^+ and cluster ion gun
  - Enable angle-dependent XPS depth profile with variable sample temperature
  - 300-amu quadrupole with electron multiplier for TPD that is line-of-site to the XPS analysis position to enable simultaneous XPS/TPD measurements
  - Resistive heating sample holders for TPD
- Ultraviolet photoemission spectroscopy (UPS)
  - Sensitivity 1,000,000 cps at 120 meV resolution on Ag 4d
  - He I : He II ratio of 4 : 1
- Ion scattering spectroscopy (ISS)
  - Sensitivity 12,000 cps/nA at 12eV FWHM on Au using 1kV He^+
- Manufacturer: Kratos Analytical

EMSL's XPS Imaging Offers:

Multi-technique XPS system – in addition to XPS imaging and spectroscopy, this system provides UPS, ISS, and TPD from the same sample surface. In the near future Raman, IR, metal deposition sources, and gas manifolds on a RDC will be added

Electron energy analyzer – provides high resolution and sensitivity for both spectroscopy and imaging

Performance on insulators – the FWHM of C=O peak in C 1s for PET is 0.68 eV with 24 cps showing a minimal X-ray damage to the sample surface

Ag L_α (2984.7eV) monochromatic x-ray source – accessible to additional core levels with binding energies ranging from 1400 eV to 2900 eV and increases the probing depth and detection limit, especially for high z elements

Cluster ion gun – possible to obtain chemical state information from XPS depth-profiling of soft materials because of the minimal ion beam modification of the material

Fast entry load lock with glove box and cold stage – enables analysis of air-sensitive materials, liquids, semisolids, and biological materials.

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/

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