

SURFACE SCIENCE

- Surface analysis techniques take advantage of unique emission phenomena to probe Ångstrom to nanometer depths of the near surface region.
- These advanced techniques provide a breadth of information not obtainable with other analytical techniques including information on the composition, chemistry, electronics, and topography of surfaces.
- Imaging and depth profiling capabilities on all techniques expand the role of surface science to microscopy and bulk analysis.



AVAILABLE TECHNIQUES

XPS	X-ray photoelectron spectroscopy
UPS	UV photoelectron spectroscopy
ToF-SIMS	Time-of-flight secondary ion mass spectrometry
AES	Auger electron spectroscopy
ISS	Ion scattering spectroscopy
AFM	Atomic force microscopy
Profiler	Profilometry
*NEXAFS	Near edge x-ray absorption fine spectra
*Imaging NEXAFS	Imaging near edge x-ray absorption fine spectra
*VKE-XPS	Variable kinetic energy XPS

*Available through collaboration with NIST at the National Synchrotron Light Source at Brookhaven NL.



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10+ yrs. in materials, surface sci., and analytical chem.
Interests in chemical and electronic characterization of interfaces, photovoltaics, energy storage materials
Langmuir, **23** (22) 11089-99, 2007.
J. Phys. Chem. C, **112** (8) 3142-51, 2008.



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20+ yrs. in materials and surface analysis
Interests in data processing, multivariate analysis, spectral imaging, aging analysis of materials
Surf. Interface. Anal., **40** (8) 1176-82, 2008.
J. Vac. Sci. Tech. A, **24** (4) 1172-8, 2006.



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30+ yrs. experience in surface analysis
Interests in High Resolution Auger, metal diffusion in electrical contacts, depth profiling
J. Am. Chem. Soc., **129** (38) 11708-19, 2007.
J. Vac. Sci. Tech. A, **7** (1) 9-16, 1989.

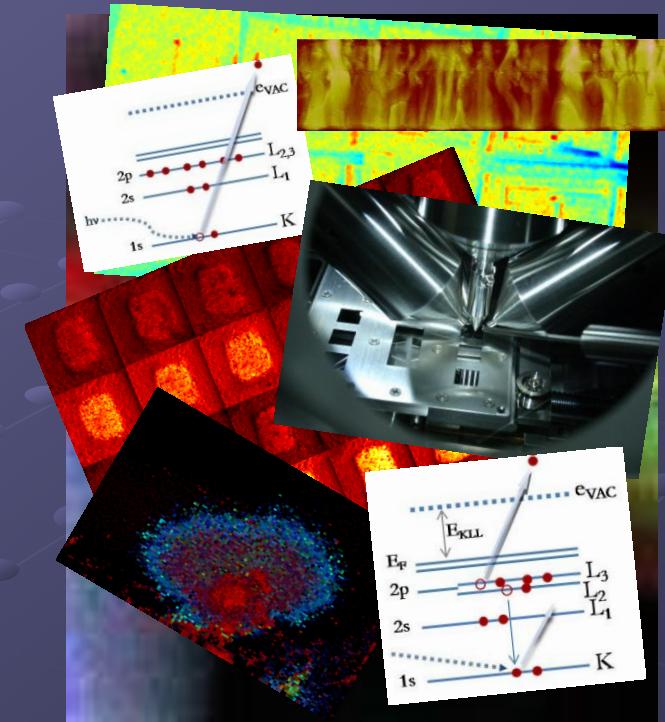
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SURFACE ANALYSIS

SAND2010-3614P

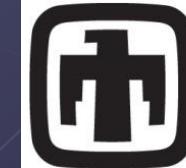
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SENSITIVITY

Secondary Ion Mass Spectrometry (SIMS)

- Highest sensitivity technique (ppm to ppb detection limits). All elements detectable. -



Time-of-Flight Secondary Ion Mass Spectrometer (ToF-SIMS) Ion-TOF.SIMS 5

◆ **Capability Highlights**

- ◆ High mass resolution and accuracy
- ◆ Ion imaging (200nm resolution)
- ◆ Monolayer analysis, depth profiling (highest depth resolution)
- ◆ Isotopic ratios
- ◆ Molecular detection

MORPHOLOGY/MECHANICS

Atomic Force Microscopy (AFM)

- Atomic level lateral and vertical image resolution -

◆ **Capability Highlights**

- ◆ Sensitive topographical imaging
- ◆ Electrical mapping (TUNA)
- ◆ Elastic modulus, adhesion
- ◆ Large sample automated analyses
- ◆ State-of-the-art hardware and feedback software interfacing



Scanning Probe Microscopy (SPM) Veeco Dimension Icon

CHEMISTRY

Photoelectron Spectroscopy (PES)

- Oxidation state, chemical environment, and electronic characterization -



**Photoelectron Spectrometer
Kratos Axis Ultra DLD**

◆ **Capability Highlights**

- ◆ High energy resolution
- ◆ Oxidation state information
- ◆ Local bonding environment
- ◆ Quantitative analysis
- ◆ Valence band analysis
- ◆ Work function, ionization potential

Surface Science is Relevant for Nearly Any Application

- *Surfaces and Interfaces Strongly Influence Performance* -

Differentiating Capabilities

thin layer analyses,
surfaces/interfaces,
small spot size, sensitivity,
total periodic table analysis,
depth profiling,
chemical state information,
bonding,
electronic information, etc.

All Classes of Materials

Unique Information on Difficult Problems

adhesion, corrosion, catalysis, thin films,
contamination, surface modification,
buried interfaces, oxidation state,
local environment, etc.



**Scanning Auger Electron Spectrometer
Physical Electronics Nanoprobe 690**

◆ **Capability Highlights**

- ◆ High resolution spatial elemental analysis
- ◆ SEM imaging
- ◆ Compositional mapping
- ◆ Semi-quantitative depth profiling
- ◆ *in situ* fracture analysis
- ◆ Next generation charge compensation