LALP-07-018 Spring 2007

Materials Surface Studies Laboratory

Integrated instrument available for surface science, materials research

The MST-6 Materials Surface Science Investigations Laboratory is home to a one-of-a-kind integrated instrument for surface science and materials research, allowing scientists at Los Alamos National Laboratory the unique opportunity to perform coordinated research using ultra-high vacuum surface measurements, in situ reactions, and materials synthesis tools.

Housed in the Materials Science Laboratory, the surface science instrument features an ultra-clean integrated system for surface analysis and in situ surface modification, thin film deposition, and surface gas reactions. This integrated system is used for analytical surface science; materials electronic structure measurements; surface corrosion measurements; gas solid reaction investigations; integrated materials design, fabrication, and study; and design of materials production and processing methods.

The facility represents an ideal case of capability support and responsive technical infrastructure for the Materials Science and Technology Division and the Laboratory. In addition to being used for analytical work and surface science research, this Laboratory-wide resource supports several core programs as well as additional materials science projects across the Laboratory.

Ongoing work includes surface corrosion investigations using in situ reactions with real time spectroscopic monitoring and equilibrium photoemission measurements. Fundamental work includes band structure measurements on various materials including the actinides.

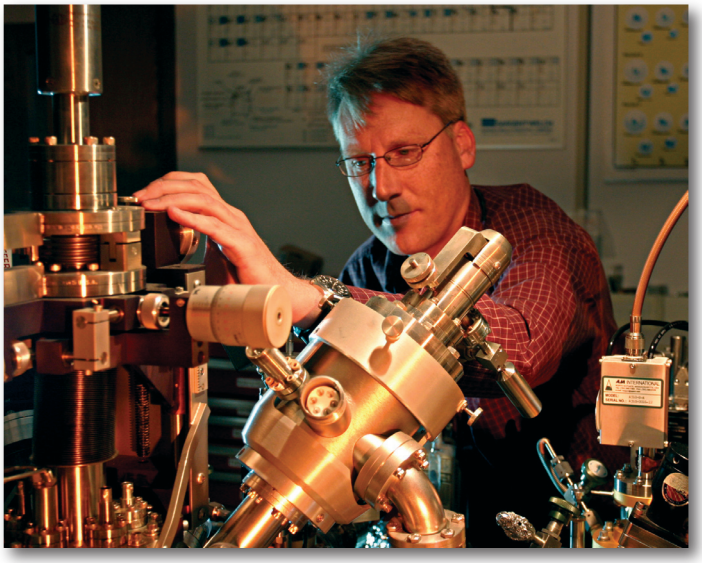


Photo credit: Robb Kramer, LANSCE-UCT

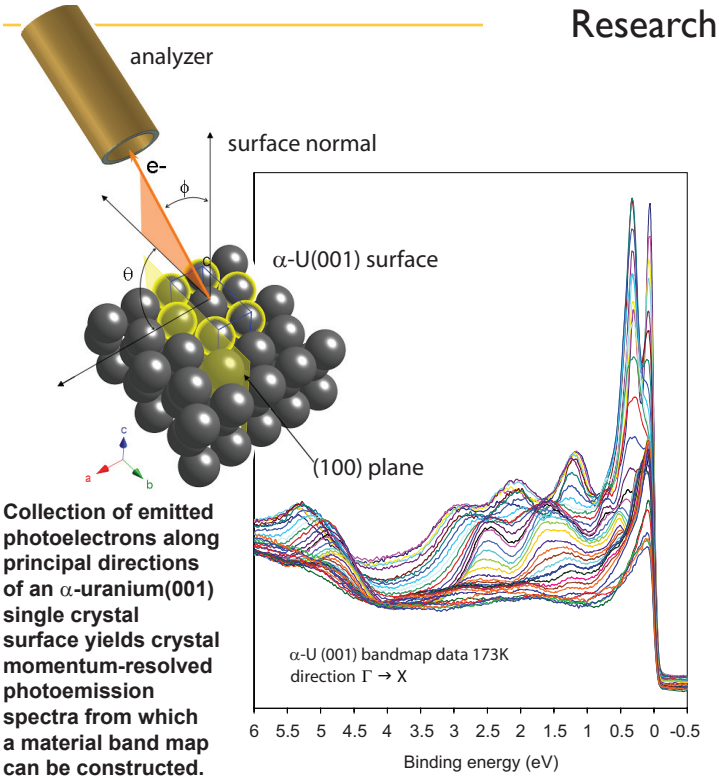
Contacts

Paul Dunn
MST-6 Group Leader
Mail Stop G770
Los Alamos
National Laboratory
Los Alamos, NM 87545

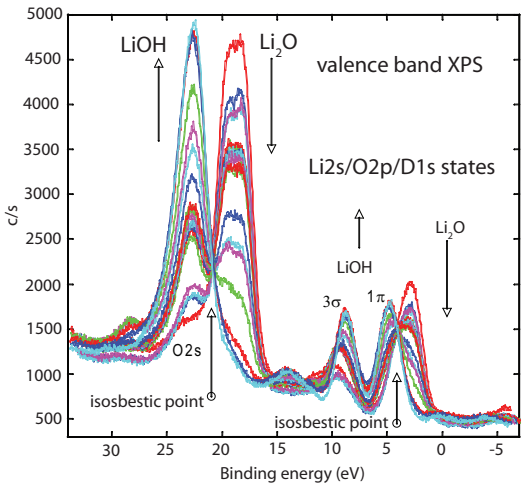
Tel: 505.667.4368
Fax: 505.667.5268
e-mail: pdunn@lanl.gov

Roland Schulze
Mark Paffett
MST-6 Corrosion
and Electrochemistry Team
e-mail: rkschulze@lanl.gov
e-mail: mtp@lanl.gov

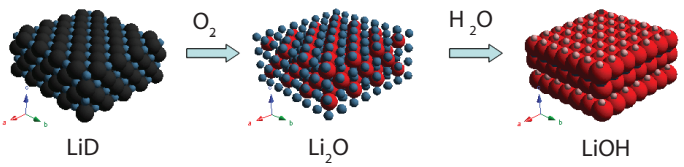
Research highlights

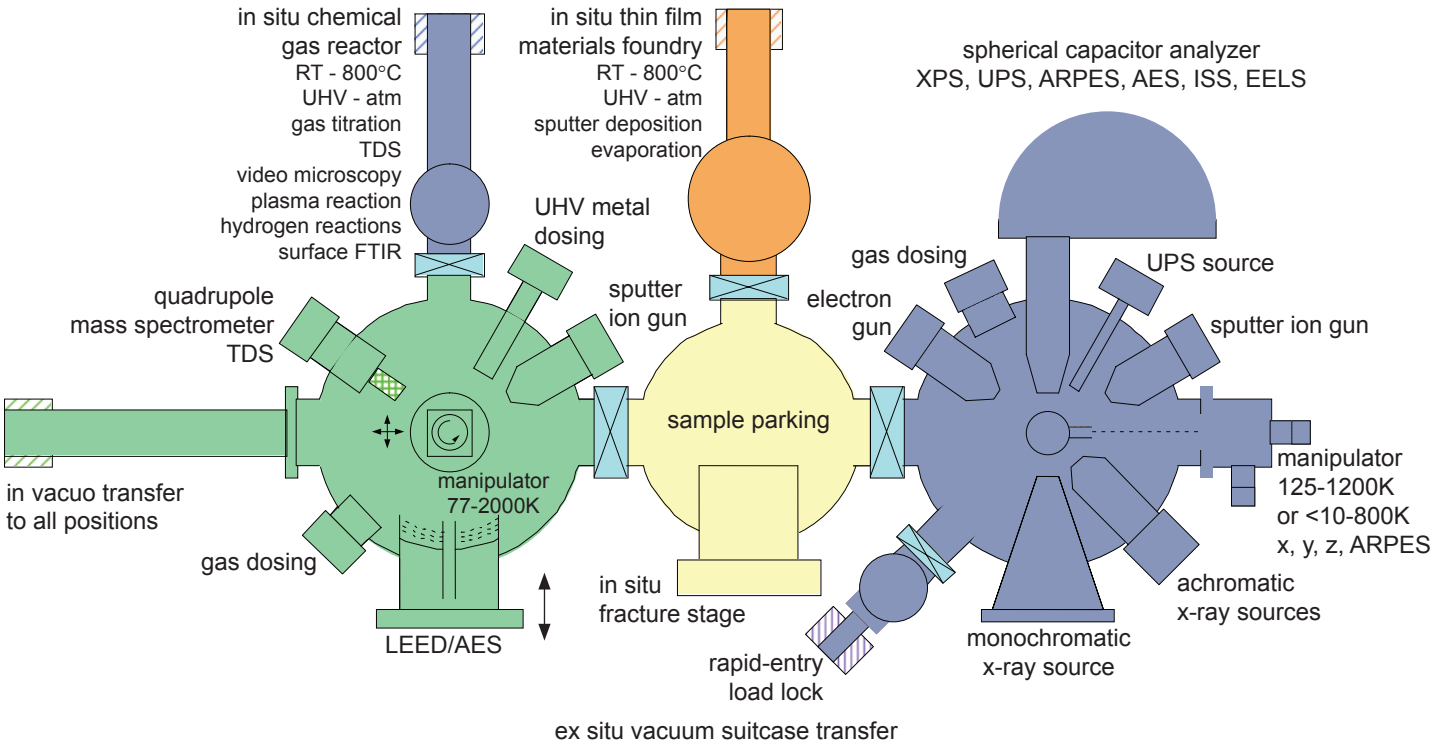


Collection of emitted photoelectrons along principal directions of an α-uranium(001) single crystal surface yields crystal momentum-resolved photoemission spectra from which a material band map can be constructed.

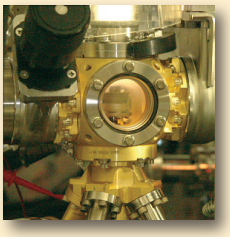


Ultra-thin film investigations of first surface reactions at a lithium hydride surface with oxygen and water. XPS valence band spectral evolution with precisely controlled water exposure indicates the clean conversion of Li_2O to LiOH and provides reaction kinetics information.





Surface science instrument capabilities



- Ultra high vacuum (UHV) surface science
- UHV heating and cooling 150K-1273K or 10K-900K
- X-ray photoelectron spectroscopy (XPS) including XPS elemental, chemical state mapping (30 micron resolution)
- Auger spectroscopy including Auger elemental, chemical state mapping (1000 angstrom resolution)
- Ultraviolet photoelectron spectroscopy (UPS) for examination of surface valence band electronic structure
- Ion sputter depth profiling analysis, XPS and Auger spectroscopy (with Zalar rotation)
- Angle-resolved XPS analysis for non-destructive thin-layer profiling
- Electronic structure measurements, materials band mapping
- UHV thermal desorption mass spectrometry (TDMS)
- Single crystal low energy electron diffraction (LEED) surface structural investigations
- In vacuo specimen fracture followed by surface science interrogation of fracture surfaces
- Controlled atmosphere (vacuum or inert gas) transfer (vacuum suitcase) of specimens from process environments into analytical surface science instrument without exposure to contaminating atmosphere
- In situ (vacuum sample transfer) atmospheric pressure reactor—sample heating to >600C, reactions in oxidizing and reducing gases, non-equilibrium RF plasma surface reactions—real world reactions followed by analytical surface interrogations
- UHV metal atom deposition
- UHV gas exposure reaction experiments
- Materials synthesis reactor (thin film materials foundry) for in situ production of new materials
- Ability to add other types of in-situ reactors: electrochemical, optical characterization, high pressure, etc.

www.lanl.gov/orgs/mst/

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