Instrument Series: **Microscopy**

Ultra-High Vacuum, Low-Temperature Scanning Probe Microscope

EMSL's ultra-high vacuum, low-temperature scanning probe microscope instrument, or UHV LT SPM, is the preeminent system dedicated to surface chemistry and physics at low temperatures down to 5 K. Operating at low temperatures provides high mechanical stability, superior vacuum conditions, and negligible drift for long-term experiments. With thermal diffusion being entirely suppressed, stable imaging becomes possible even for weakly bound species. The system is primarily used for probing single-site chemical reactivity, while the combination with a hyperthermal molecular beam allows the study of important chemical processes at energies corresponding to the operational temperatures well beyond typical UHV studies. The LT SPM provides a unique combination of tools (including ensemble-averaging surface analytical techniques) to examine the molecular-level details of heterogeneous catalysis and photocatalysis. Among them are the static aspects of adsorption, direct identification of adsorbate sites, and ordered structures; and adsorbate-adsorbate and adsorbate-substrate interactions.

Research Applications

Surface reactivity – insights into heterogeneous catalysis and corrosion

Surface modification – employing nanomodification with SPM tip; nanolithography; and atom-scale manipulations with atoms, molecules, and clusters

Superconductive materials – understanding surface and electronic structures (local tunneling spectra of superconducting gap)

Quick Specs

- Lowest Temperature: ≤ 5 K
- Vacuum Conditions: 10^{-11} Torr Range
- Vertical Resolution: ≤ 0.01 nm
- Lateral Resolution: ≤ 0.3 nm
- Thermal Drift: < 0.1 nm/h
- Combined STM and NC AFM Operations
- Additional Capabilities (at ≤ 50 K): XPS, UPS, ISS, LEED, and AES
- Sample Preparation: Thin Film Growth, Ion Sputtering, and Annealing
- Vibration Isolation: Internal Eddy Current Dumping Combined with Quiet Wing Placement
- Combined *In Situ* with Hyperthermal Molecular Beam
- Single Molecule Elastic and Inelastic Spectroscopies
- Manufacturer: Omicron NanoTechnology

EMSL's UHV LT SPM Offers:

True cryo atomic-scale imaging – provides ultimate drift-free performance of scanning tunneling microscopy/spectroscopy (STM/S), inelastic electron tunneling spectroscopy (IETS), and non-contact atomic force microscopy/spectroscopy (NC-AFM/S).

SPM stage-integrated capabilities – allows molecular exposure (from both molecular beam and directional doser) and UV-light irradiation.

Full range of surface analytical techniques at low temperature – enables ultra-violet/X-ray photoelectron spectroscopy (UPS/XPS), Auger electron spectroscopy (AES), ion scattering spectroscopy (ISS), and low energy electron diffraction (LEED).

***In situ* sample preparation** – offers heating up to 1500 K, cooling down to 50 K, sample cleaving, ion sputtering, evaporation sources for film growth, and oxygen plasma source.

Control system – supports true pA STM, optimal STS/IETS, and provides an unprecedented level of sensitivity, instantaneous parameter change, and experimental flexibility.

To learn more about EMSL's capabilities and how they are being applied to EMSL users' research, see: http://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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