EMSL

Instrument Series: **Microscopy**

Ultra-High Vacuum, Variable-Temperature Scanning Probe Microscope

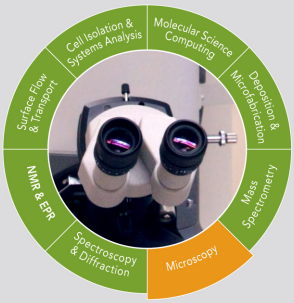
EMSL's ultra-high vacuum, variable-temperature scanning probe microscope system, or UHV VT SPM, is a state-of-the-art surface science tool comprising multiple complementary probes. It offers atomic-resolution imaging in a temperature range of 50-500 K with a continuous and fast temperature variation and under UHV conditions. This instrument is primarily used to study model catalytic systems and associated surface thermal and photochemistry at ambient and elevated temperatures, including various manifestations of adsorption dynamics, such as precursor states, transient motion of dissociated fragments, and thermal diffusion of individual adsorbates. It enables measurements at specific catalytic reaction sites and of spatially resolved reaction kinetics and dynamics. The VT SPM also combines *in situ* operation with ensemble-averaging surface analytical tools, providing a unique capability.

Research Applications

Surface structure, dynamics, and reactivity – understanding reconstruction, phase transitions, chemisorption, diffusion, and desorption

Surface characterization of advanced materials – studying elemental and compound semiconductors, layered materials (graphene), and formation of self-assembled monolayers.

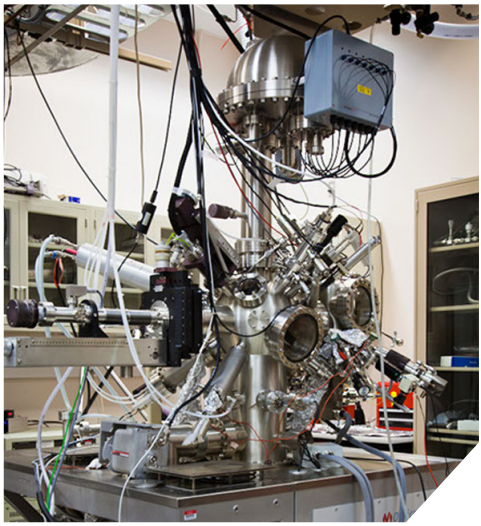
Thin film and cluster growth – characterizing nucleation, self-assembly of nanostructures, and epitaxy



Quick Specs

- Vertical Resolution: ≤ 0.01 nm
- Lateral Resolution: ≤ 0.3 nm
- Vacuum Conditions: 10^{-11} Torr Range
- Continuously Variable Temperature Range: 50–500 K
- Maximum Imaging Speed: ≥ 5 µm/s
- Minimal Tunneling Current: ≤ 1 pA
- Combined STM and NC AFM Operations
- Includes AES, XPS, and LEED
- Sample Preparation: Thin Film Growth, Ion Sputtering, and Annealing
- Vibration Isolation: Internal Eddy Current Dumping Combined with Quiet Wing Placement
- Manufacturer: Omicron NanoTechnology

EMSL's UHV VT SPM Offers:



Atomic-level imaging – allows the study of both electrically conductive and insulating materials using a combination of scanning tunneling microscopy/spectroscopy (STM/S) and non-contact atomic force microscopy/spectroscopy (NC-AFM/S) in one instrument.

SPM stage-integrated capabilities – offers molecular dosing, UV-light irradiation, and evaporation on sample.

Additional analytical capabilities – provides X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), and low energy electron diffraction (LEED).

***In situ* sample preparation** – offers heating up to 1100 K, cooling down to 100 K, ion sputtering, evaporation sources for film growth, and oxygen plasma source.

Control system – supports true pA STM, optimal STS, and provides an unprecedented level of sensitivity, measurement speed, 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/.

IGOR LYUBINETSKY
Senior Research Scientist
Igor.lyubinetsky@pnnl.gov
(509) 371-6267

PNNL-SA-88096