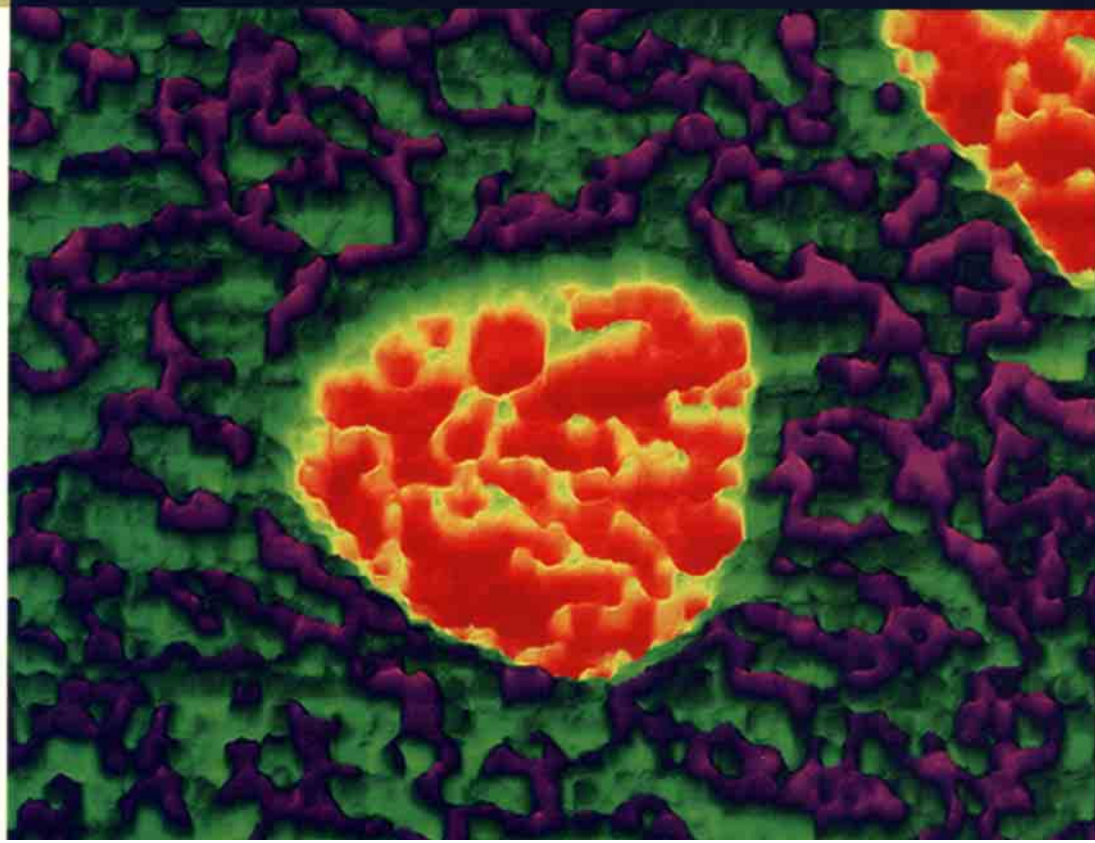
Veeco

di SPM Electrochemistry Solutions

- Larger Current Sensing Range
- Imaging in SECPM
- Modular Environmental Control



Complete Electrochemical System

Application Flexibility and Increased Control

The MultiMode with the SECPM head (left); the MultiMode with the ECAFM head (middle); and ECSTM (right).

Veeco's powerful electrochemical solutions provide researchers with the opportunity to build their own system that is optimum for their application. Each solution offers the spatial resolution, flexibility, and ease of use to study the entire range of real-time, *in-situ* electrochemical processes. Each system is powered by the world's best-selling Digital Instruments NanoScope® controller, and is available with a choice of scanning probe microscope (SPM) platforms. Each package also comes complete with a next-generation bipotentiostat/galvanostat, one or more liquid cells, as well as liquid and electrode provisions.

- ► Electrochemistry combined with TappingMode™
  - **Prevents sample damage**
- ► Images in SECPM
  - **Offers potential profiling of electrical double layer and *in-situ* imaging or potential mapping of sample surface**
  - **Delivers nanometer-scale resolution**
- ► New Bipotentiostat Controller
  - **Large current sensing range from 0.1 nA to 100 mA**
- ► EnviroScope™ for electrochemistry
  - **Controls the atmosphere above fluid cells**
  - **Prevents reactivity between fluid and sample from the gaseous environment**

Multiple Modes for Detailed EC Imaging

Scanning Electrochemical Potential Microscopy (SECPM) for *in-situ* potential profiling of the electrical double layer, nanometer-resolution potential mapping and topographic imaging of sample surfaces is the newest electrochemical SPM mode. It features a patented technique exclusively available from Veeco.

The electrochemical potential changes with distance across the electrical double layer at solid/liquid interfaces. SECPM measures the potential difference between its potentiometric probe and the sample in an electrolyte solution or a polar liquid. Moreover, STM and ECSTM are integrated with SECPM, offering combined power, flexibility and comparison of images and data captured with the two techniques.

SECPM has three modes of operation:

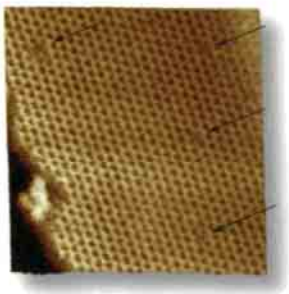
- **Constant Potential Mode**, which uses SPM feedback to adjust the position (height) of the probe relative to the sample surface to maintain a constant value of Φ. When the probe raster-scans the sample surface (in X and Y), SECPM captures topographic images of the sample surface.
- Constant Height Mode, which turns off the feedback and maps the electrochemical potential distribution across the sample surface when the probe is raster scanned.
- **Spectroscopic Mode** (or Potential Profiling), which disables raster-scanning (in X,Y) and instead scans (in Z) across the electrical double layer, recording a plot of the measured potential versus the distance traveled.

Electrochemical Scanning Tunneling Microscopy (ECSTM)

Electrochemical Atomic Force Microscopy (ECAFM) enables nanometer-resolution AFM imaging of electrode surfaces. Both the ECSTM and ECAFM systems allow real-time *in-situ* STM or AFM imaging of the electrode surface in solution under electrochemical control. The ECAFM supports LFM functions and TappingMode. These systems offer researchers integrated electrochemistry software and ease of use to study a wide range of electrochemical processes including Under Potential Deposition (UPD), absorption/desorption, corrosion, electroplating *in-situ* and in real-time.

s for Every Requirement

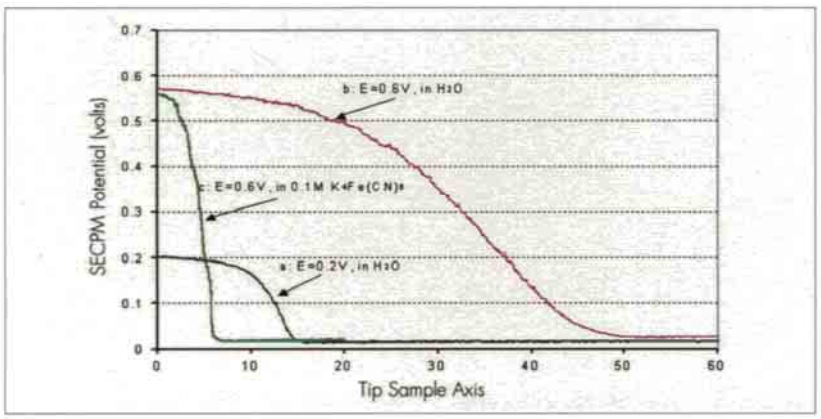
Each Electrochemical option is compatible with a variety of SPM platforms and may be purchased as a complete system, or as add-ons to an existing system. The flexibility and modularity provided by the Digital Instruments NanoScope digital feedback control system allows the electrochemical microscope to be added easily. Further flexibility can be provided with the optional Signal Access Module™ which provides easy access to numerous input and output signals of the SPM control system.



***In-situ* STM image of ($\sqrt{3}$ x $\sqrt{3}$)R30 adlayer structure formed by underpotential deposition (UPD) of a sub-monolayer of Cu on Au(111)/mica in 0.1M H_2SO_4 + 5mM $CuSO_4$ at -105mV vs. Ag/AgCl. Arrows locate four atomic point defects.**

The new EnviroScope AFM.

The NEW EnviroScope Atomic Force Microscope was designed for the observation of sample reactions to a variety of complex environmental changes. It combines a hermetically sealed sample chamber with the world's leading scanning tip atomic force microscope. High vacuum, gas, or liquid, as well as heating can be introduced into the system's environmental chamber so users can observe sample reactions to a variety of environmental conditions while scanning. The EnviroScope utilizes a specially designed cell for electrochemistry applications in liquid environments, and allows precise software-controlled sample temperature. Combined with a sealed sample chamber, the EnviroScope also allows gas flow above the electrochemistry fluid cell to control sample evaporation and chemistry.



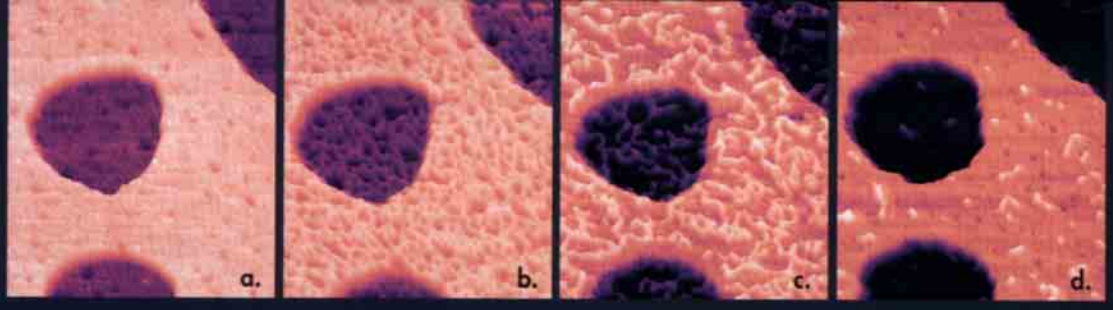
SECPM measures the potential drop across the electric double layer in the vicinity of a solid-liquid interface. Plot a and b are taken in the same liquid (water) but at different DC potentials applied to the sample (HOPG). Plot b and c are taken at the same DC potential (0.6V) applied to the HOPG sample, but in b) water and in c) 0.1M concentration K4 Fe (CN)6.

The new Universal Bipotentiostat controls electrochemical functions on microscopes and modes.

Advanced Engineering and the World's Best Controllers

The Digital Instruments Electrochemical Systems can be controlled with either the industry-standard NanoScope IIIa controller or NanoScope IV controller. The NanoScope IIIa controller combines advanced analog and digital circuit designs with premium software and hardware to precisely control the SPM depending on microscope model. It can scan from about 100 micrometers (microscope dependent) to a few nanometers with full, 16-bit resolution on all scan waveforms and on each axis. The world-class NanoScope IV features ten-times-faster scanning, as well as increased functionality, bandwidth, flexibility, and expandability, making it the most advanced SPM controller in the world.

All of the systems utilize the new universal bipotentiostat. This conveniently allows one controller to operate, via software control, the electrochemical functions on microscopes and modes. The universal bipotentiostat/galvanostat enables researchers to control electrochemical processes either potentiostatically or galvanostatically. Electrochemical control and data acquisition is integrated into the software. Topographical and electrochemical data are recorded simultaneously, thus correlation of the two is readily available.



In-situ EC-STM images show a monolayer of copper, about 2.5 Angstroms tall, being stripped off the gold substrate (underpotential stripping) in a C5SH electrolyte, as a researcher changes the electrochemical cell potential from 125mV to 270mV using the integrated bipotentiostat and cyclic voltametry software built into the Scanning Probe Microscope package for electrochemical research. 300nm scans, courtesy Dr. Joseph Campbell.

Cover image: recolored/cropped image of (c.) left.

SPECIFICATIONS

BIPOTENTIOSTAT

- **Compliance voltage:** – ±12V
- **Potential range:** – -10 to +10V
- **Potentiostat rise time:** – <100µs
- **Scan rate:** – 0.0003 to 10 V/s
- **Minimum potential increment in CV:** – 0.3mV
- **Potential update rate:** – 1kHz
- **Current range:** – 0 to 100mA
- **Current sensitivity:** – 10nA to 10mA/V
- **Current measurement resolution:** – <50pA
- **Input impedance of reference electrode:** – $<10^{12}\Omega$
- **Maximum sampling rate:** – 100Hz
- **Band width:** – 10kHz at 10mA/V, 1kHz at 10nA/V
- **Techniques:** – CV, LSV

Potentiostat Amplifier Gain	Sensitivity (mV/V)	Electrochemical Potential Measurement Resolution (mV)	Maximum Measured Electrochemical Potential (V)
1	1000	0.5	10.0
10	100	<0.1	1.0
50	20	<0.1	0.2
100	10	<0.1	0.1

Table 1

SPM Specifications

ENVIROSCOPE

- **Sample stage range:** – 6mm X-Y, 14mm Z sample movement range while maintaining vacuum
- **Sample size:** – 30mm X-Y; 12mm Z
- **Sample leveling:** – Automatic mechanical
- **Temperature range while imaging:** – 185°C in ambient environment, ambient to 300°C in vacuum, ambient to 60°C in fluid (including EC)
- **Temperature stability:** – ±1°C
- **Scan size:** – 90µm X-Y; 5µm Z
- **Noise level:** – <0.05nm at ambient pressure**
- **Linearity:** – Software-corrected
- **Optics:** – Integral top-view video microscope fixed ~0.5mm field of view at the sample
- **Ports:** – Gas purging, vacuum, or interface plate for user customization
- **Electronics Controller:** – Digital Instruments NanoScope IIIa with Quadrex or NanoScope IV
- **Imaging Modes:** – Fluid*, Contact, Tapping, Phase, EC AFM*, FFM/LFM, MFM, Nano-Indentation**
- **Vacuum Level*:** – 10^{-5} Torr

*Requires optional purchase. ** In appropriate environment.

MULTIMODE® PLATFORM PERFORMANCE

- **Noise:** – <0.3A RMA in vertical (Z) dimension w/vibration isolation
- **Sample size:** – <15mm diameter; <5mm thick

HARDWARE OPTIONS

- **Optical viewing system:** – Provides vertical view of tip and sample surface w/optical microscope, color CCD camera, and color monitor
  – Two models available w/ max. magnifications of 800X and 450X
- **Signal Access Module:** – Provides access to every input and output signal between controller and microscope
- **Quadrex™ Electronics Module:** – Provides phase and frequency detection hardware for Phase Imaging, MFM, EFM
- **Scanners:** – See Table 2

Scanner	Lateral (X-Y) Range	Vertical (Z) Range
AS-0.5, AS-0.5MF ("A")	0.4µm x 0.4µm	0.4µm
AS-12, AS-12MF, AS-12NM ("E") AS-12V, AS-12VMF ("EV")	10µm x 10µm	2.5µm
AS-130, AS-130MF, AS-130NM ("J") AS-130V, AS-130VMF ("JV")	125µm x 125µm	5.0µm
PF50	40µm x 40µm	20µm

Table 2 MF= Magnet Free, NM= Non-Magnetic, V= Vertical engage

STANDARD STM PLATFORM

- **Sample size:** – <12mm X 3mm
- **ECSTM Scanner:** – See Table 3

ECSTM Scanner	Lateral (X-Y) Range	Vertical (Z) Range
HD-0.5I	0.4µm x 0.4µm	0.4µm
HD-8I	12µm x 12µm	2.5µm

Table 3

Note: Performance specifications are typical and subject to change without notice.

LASER RADIATION
Do not stare into the beam or view directly with optical instruments
class 2M laser product
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