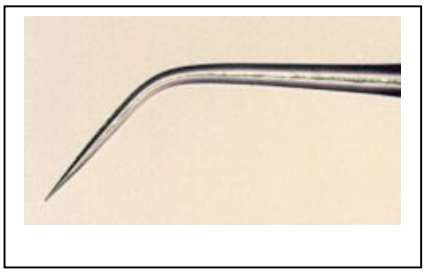
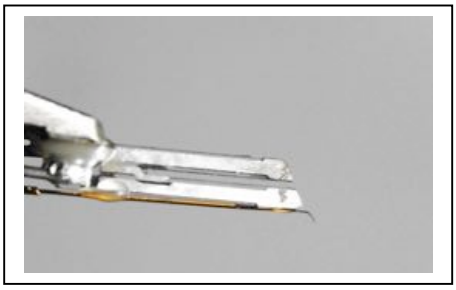
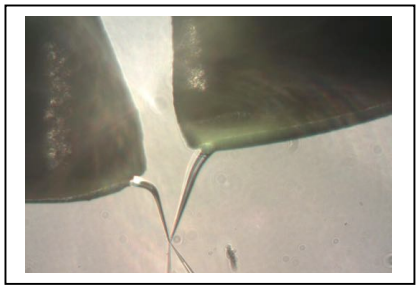


Cantilevered Nanometric
SECM Probes
With
UltraSensitive
Tuning Fork Feedback



Multiprobe
Operation Option



Scanning Electrochemical Microscopy With Normal Force Feedback

- Full Optical Integration
- Optically Friendly Probes
- Integration with Raman, Fluorescence and Lifetime Measurement

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The Next Evolution In SECM™

The First Integrated SECM Solution Providing Excellence In SECM With Spectroscopic Chemical Characterization

SECM has always been limited by the ability to have accurate and controlled probe surface separation. Standard SECM probes use the current for the dual purpose of feedback so that the probe will not crash into the surface while simultaneously monitoring the electrochemistry of the surface. This method both limits the resolution and compromises the electrochemical information obtained. In addition, the probes straight geometry obstructs viewing the sample - probe placement and limits on-line optical integrations

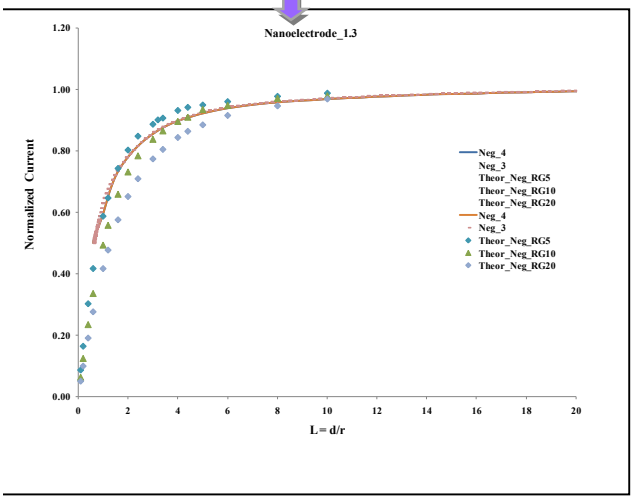
Nanonics has developed a unique SECM probe that solves these problems by integrating an optically friendly-cantilevered SECM probe. Designed for the Nanonics MultiView systems traditional AFM feedback can be employed allowing accurate monitoring of the height sample distanced keeping the probe at a fixed distance, allowing for high resolution SECM imaging with no artifacts. Allowing for accurate correlation of topography with the electrochemical signal, AFM based SECM is an important step in understanding the relationship between the samples structure and electrochemistry.

Finally the optically friendly design permits easy and complete optical integration, allowing for integration of SECM with methods not previously available such as Raman and other spectroscopies. All of this is accomplished with the ultimate in force sensitivity.

The Nanonics SECM Solution effectively marries the control of AFM, the rich information of optical spectroscopies with the power of SECM.

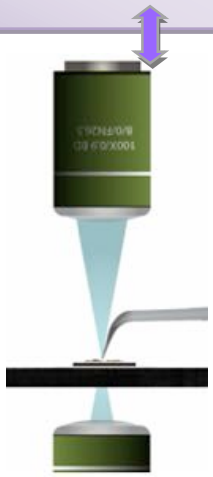
Negative Feedback Approach Curve of a Nanonics Nano-Electrode SECM Probe

Experimental approach curve (points) fitted with theoretical approach curve (lines). A determination of the effective radius is 180-200nm



A Breakthrough in SECM

Water Immersion Objective for Maximal Optical Signals Such As Raman In Liquid



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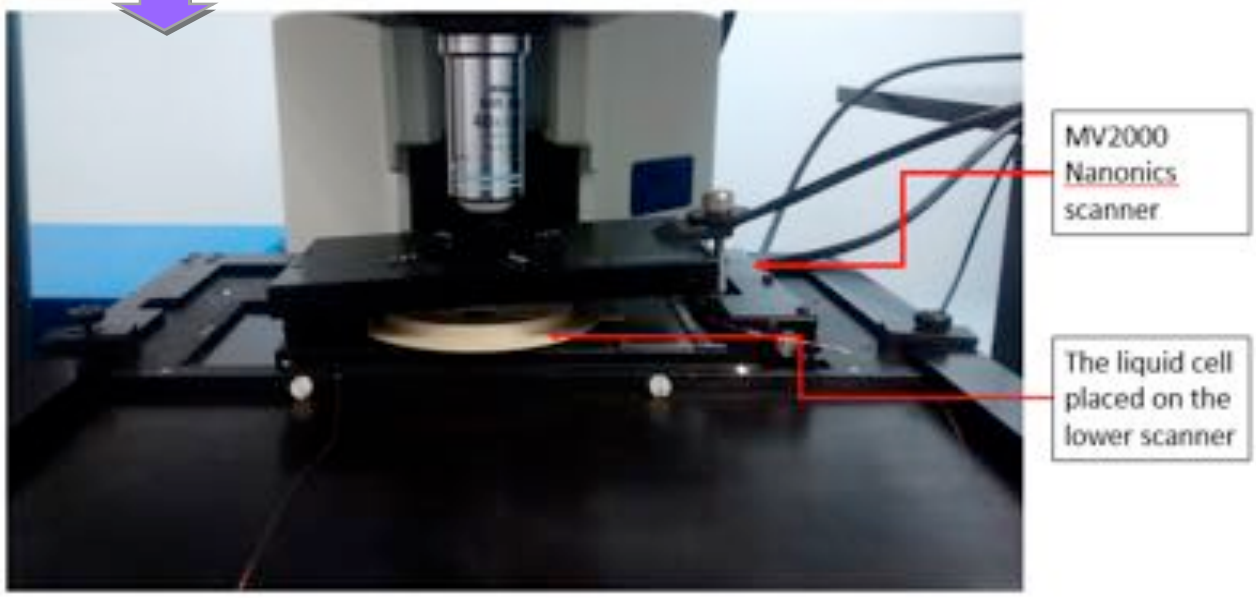
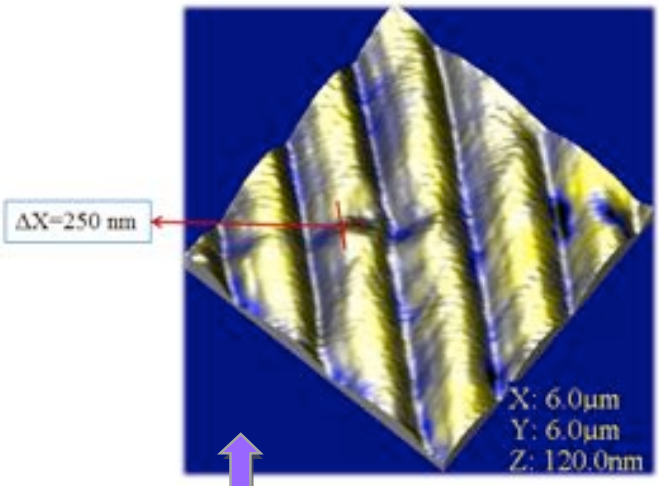
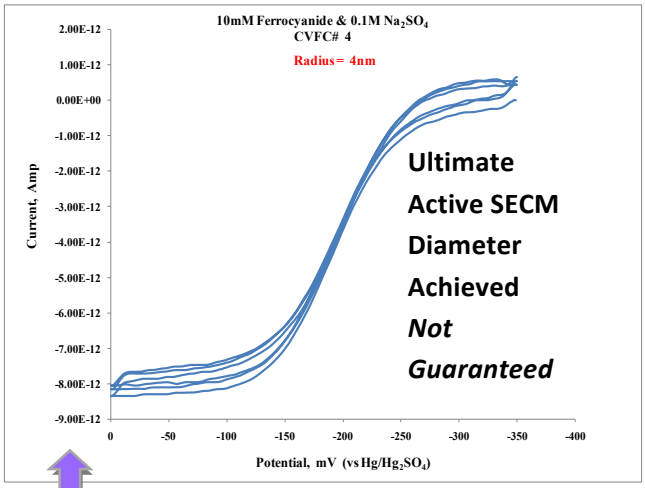
AFM-SECM setup with microRaman Integration applied at a Fuel Cell Research Lab





3D Collage of a simultaneously obtained Topographic and SECM Images on an Etched CD (Colors correspond to the SECM signal, Background corresponds to the topography)



Cyclic Voltammogram

4 nm radius Nanonics SECM Nanoelectrode Probe 10mM Ferrocyanide and 0.1M $Na_2(SO4)$

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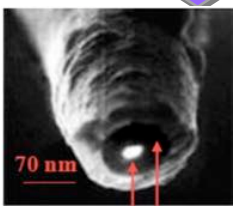
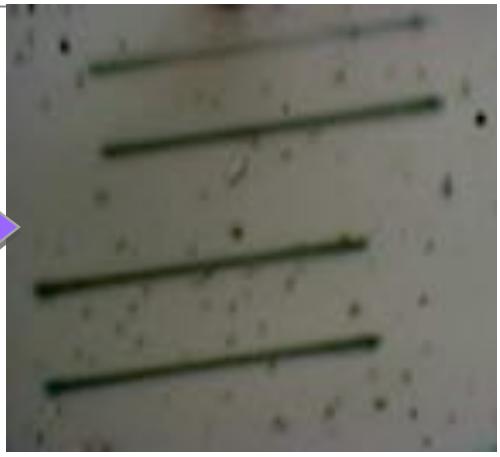
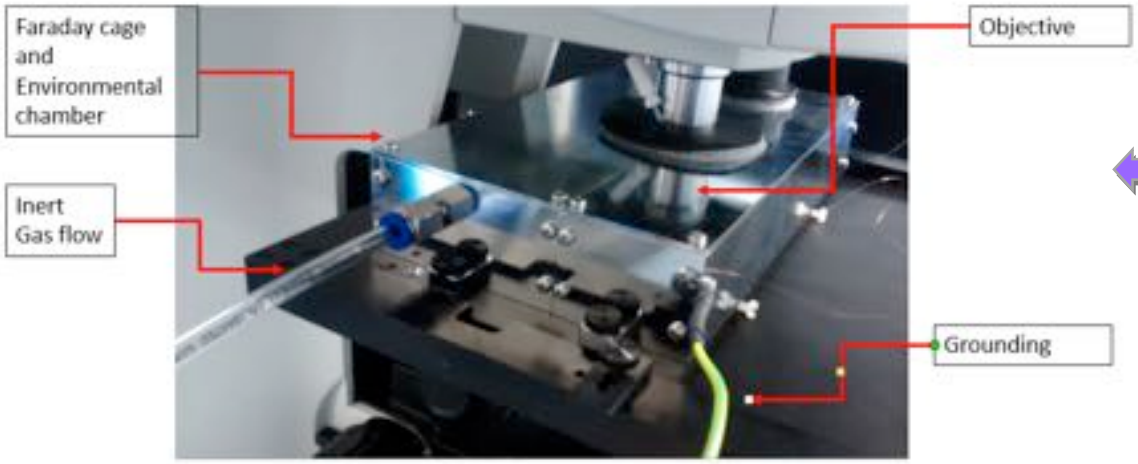
SEM of an SECM Nanoelectode Tip.

Pt electrode with glass insulation.

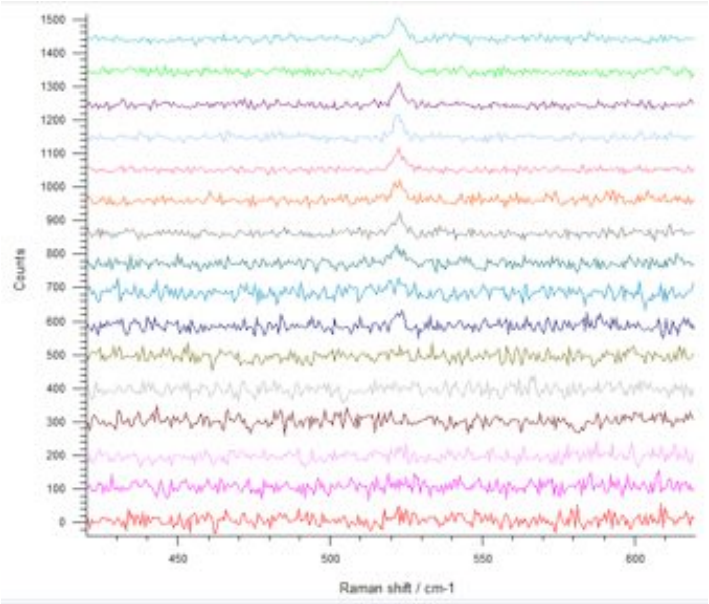


Etching of a 50nm Cu thin film as seen through a Water Immersion 40X NA=0.8 Objective





SECM Environmental Chambers That Are Glove Box Compatible



Simultaneous SECM Raman Results of The Etching of a Copper Layer On Silicon

A time gap was observed between the time the current was measured and the Raman signal of the exposed Si beneath the copper was observed. This time delay was found to be dependent of the probe-substrate vertical distance.

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AFM-SECM Specifications

Probe

The probe is made of a glass nanopipette with a Pt nanowire electrode.

Dimension at Apex	Diameter [nm]
Electrode	50-1000
Ratio of Glass To Metal Electrode (Rg)	~10

Compatibility

Nanonics SPM Systems	Objective	Scan	Notes
MV_4000	Air\Water immersion	Probe\Sample	
MV_2000	Air\Water immersion	Probe\Sample	
MV_1000	Air	Sample	With Tuning Fork adaptor

Microscope Configurations

	Objective	Notes
Upright	Air\Water immersion	
Dual	Air\Water immersion	The Dual Microscope is a combined upright and inverted microscope, special configuration of Nanonics
Inverted	Air	View of substrate from below with an air objective assuming substrate isn't opaque.

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Resolution

	Resolution	Notes
Topography XY	~250 nm	
Topography Z	1-2 nm	
Sensitivity (Amps/V)	10^{-12} to 0.1	Depending on model of Potensiostat

Liquid Cell

		Notes
Material	PEEK	Resistant to various solution environments
Counter\reference electrodes	Up to 4	These electrodes can be connected from the sides of the cell. Roughly 2mm in diam. and 3 cm long. A standard miniature Ag/AgCl can be mounted above the liquid cell.
Protective rim	Provided	Protects from spillage onto the sample scanner
Free optical access	Above and Below	With back contact it is possible to view from above
Back contact	Provided	Screw mounting for ease of use

Faraday Cage Provided

- Strongly recommended for low current measurements.

Environmental Chamber Option

The Faraday cage can be upgraded to an environmental chamber.

Inlet connected for inserting inert gases (e.g. N_2 or Ar).

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Potentiostat

		Notes
Series	700E CHI	Any of the 700 series can be used with the Nanonics MultiView series.
Main techniques	CV, CA, OCPT	More common techniques are available
Potential (V)	-10 to +10	
Current (A)	0 to ±0.25 (one channel only)	
Current (A)	0 to ±0.125 (dual channel)	
Sensitivity (A/V)	10^{-12} to 0.1 (both channels)	

The Potentiostat and the Nanonics system are connected. The Nanonics hardware and software read the voltage and current which are monitored in real time and displayed in correlation with the AFM image.

Software

- SPM: NWS11\Quartz. Lift mode possible with Hybrid system.
- Potentiostat: CHI software

Data can be saved as an .stp or ASCII file to create a map of AFM-SECM.

Integrating with other systems

The Nanonics system provides for ultimate versatility and can be integrated with many other systems.

An important example is integration with microRaman spectrometers such that AFM-SECM-Raman signal can be obtained in situ. Other optical measurements can be integrated as well.

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