

# Keysight Technologies

## EC-AFM: Engineered for Electrochemistry

Data Sheet



## Engineered for Electrochemistry

The 5500 and 7500 atomic force microscopes from Keysight Technologies, Inc. are the only commercially available scientific-grade AFM systems specifically engineered from the ground up for advanced electrochemistry at the nanoscale (sub-10-nm resolution). Indicative of our singular EC-STM heritage, Keysight now boasts more published papers relating to electrochemistry than any other SPM company – over 1,000 and counting.

Unlike other AFM systems, which offer environmental chambers as add-on components, Keysight's modular platform designs incorporate a true built-in environmental isolation chamber to give researchers comprehensive control of gaseous environments for *in situ* electrochemistry experiments. Multiple ports permit the flow of many different gases into or out of the built-in chamber's sealed sample compartment. Humidity levels can be controlled, oxygen levels monitored and controlled, and reactive gases easily introduced into and purged from the chamber.

Scanners utilized with these Keysight systems reside outside the environmental isolation chamber, so they are protected from contamination, harsh gases, solvents, caustic liquids, and other damaging experimental conditions. Keysight's 9 $\mu$ m and 90 $\mu$ m scanners offer outstanding linearity, accuracy, and ease of use for EC-AFM and new SECM mode. These top-down scanners are ideal for imaging in fluids or in air, as well as under controlled temperature and environmental conditions. Alternatively, Keysight's low-current and ultra-low-current STM scanners deliver excellent results on a variety of conducting materials, providing stable imaging at pico-ampere and sub-pico-ampere currents to resolve individual atoms and molecules.

Keysight EC-AFM systems for electrochemistry also include a built-in potentiostat; a temperature controller (250°C to -30°C) that utilizes a patented thermal insulation and compensation design to provide the industry's most precise and stable heating and cooling; and an easy-to-clean liquid cell sample plate that enables faster, more convenient sample loading and handling.

## Features and Benefits

- The only scientific-grade AFM system designed specifically for electrochemistry
- Built-in environmental chamber offers complete control of gaseous environments
- STM scanners for EC-STM; 9 $\mu$ m or 90 $\mu$ m scanners for EC-AFM and new SECM mode
- Head electronics box with built-in potentiostat
- Liquid cell sample plate simplifies loading and cleaning
- Industry-leading, high-precision temperature control

## Primary Applications

- Fuel cells and energy storage (e.g., lithium ion batteries)
- Visualization of electrochemical metallization
- Organic photovoltaics
- Corrosion studies
- Semiconductors
- Nanofabrication

## Software for EC

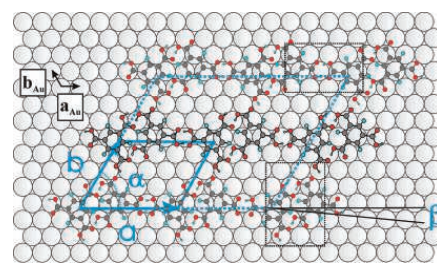
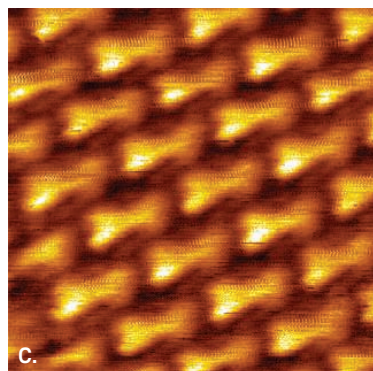
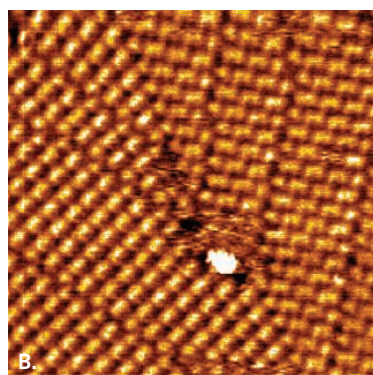
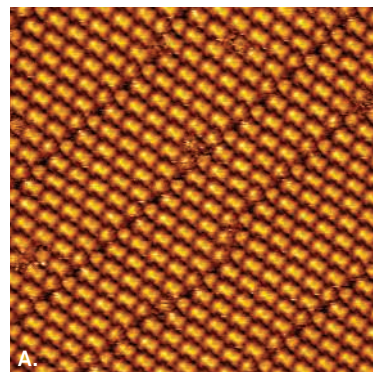
The systems utilize Keysight's PicoView and Pico Image, a post-process imaging and analysis software package. PicoView allows complete control of all scanning parameters and provides the flexibility required for more complex EC-AFM, SECM, and EC-STM experiments. Our EC-friendly version of PicoView provides an easier-to-use interface, a greater number of control parameters (with expanded ranges), and cyclic voltammetry (CV) using tip or sample.

## Extending EC Capabilities

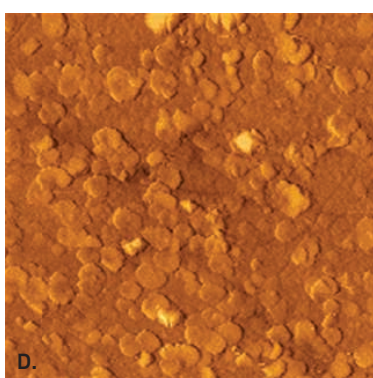
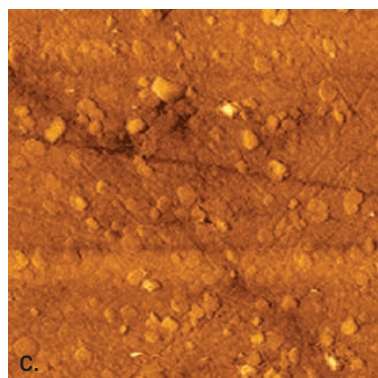
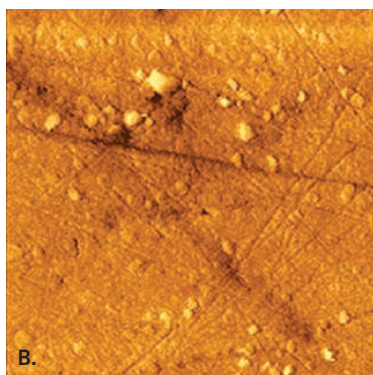
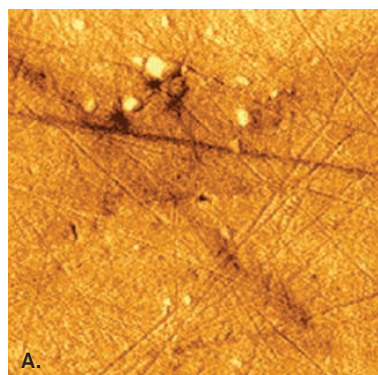
Keysight's patented MAC Mode III option provides three user-configurable lock-in amplifiers, affording researchers virtually limitless application possibilities and unprecedented speed. It also provides two expansion slots. MAC Mode III has been designed to allow single-pass imaging concurrent with KFM on dry samples. Simultaneous, high-accuracy topography and surface potential measurements are enabled by a servo-on-height cantilever approach that is not susceptible to scanner drift.

Another unique Keysight system option is SECM, a new mode of AFM operation that allows scanning electrochemical microscopy to be performed quickly and reliably with nanoscale resolution. SECM mode provides great utility for a broad range of applications, including investigations of homogeneous and heterogeneous electron transfer reactions, imaging of biologically active processes, surface modification, analysis of thin films (e.g., pinhole detection, conformality), screening of catalytic material (e.g., fuel cell catalysts), and studies of corrosion processes.

Other system options include a salt-bridge sample plate (for very accurate reference potential) and a glove box (for precisely loading air- or moisture-sensitive samples on the microscope without ever exposing them to the external atmosphere).



TMA on Au (111) in electrolyte.  
A. Transitional domain boundary;  
B. Rotational domain boundary;  
C. High resolution image;  
D. Structural model.



Corrosion study of a polished metal surface: A. rest potential, B. after two cycles, C. after three cycles, and D. after six cycles.

## 5500 and 7500 EC AFM Specifications

Note: Specifications shown are for open-loop operation. Closed-loop scanners are also available.

### 5500 Large Scanner

|              |                                               |
|--------------|-----------------------------------------------|
| Scan range:  | 90 $\mu\text{m}$ in XY, 7 $\mu\text{m}$ in Z  |
| Noise level: | <5 $\text{\AA}$ in XY, <0.5 $\text{\AA}$ in Z |

### 7500 Large Scanner

|              |                                                 |
|--------------|-------------------------------------------------|
| Scan range:  | 90 $\mu\text{m}$ in X Y, >12 $\mu\text{m}$ in Z |
| Noise level: | <0.03 nm in Z                                   |

### 5500 Small Scanner

|              |                                               |
|--------------|-----------------------------------------------|
| Scan range:  | 9 $\mu\text{m}$ in XY, 2 $\mu\text{m}$ in Z   |
| Noise level: | <1 $\text{\AA}$ in XY, <0.2 $\text{\AA}$ in Z |

### 5500 STM Scanner

|              |                                                  |
|--------------|--------------------------------------------------|
| Scan range:  | 1 $\mu\text{m}$ in XY, 0.7 $\mu\text{m}$ in Z    |
| Noise level: | <0.6 $\text{\AA}$ in XY, <0.06 $\text{\AA}$ in Z |
| Sensitivity: | 1 nA/V, or 10 nA/V, optional log preamp          |

### 7500 STM Scanner

|              |                                               |
|--------------|-----------------------------------------------|
| Scan range:  | 1.5 $\mu\text{m}$ in XYZ                      |
| Noise level: | <1 $\text{\AA}$ in XY, <0.2 $\text{\AA}$ in Z |
| Sensitivity: | 0.1 nA/V, 1 nA/V (standard), or 10 nA/V       |
| STM probe:   | 0.25 mm Pt-Ir or W wire                       |

|                           |                                    |
|---------------------------|------------------------------------|
| <b>Sample Plate Sizes</b> | Kinematic mount translatable plate |
|---------------------------|------------------------------------|

|               |                      |
|---------------|----------------------|
| <b>Optics</b> | Navitar video camera |
|---------------|----------------------|

### Controller

|            |                                          |
|------------|------------------------------------------|
| Input:     | Ten 16-bit channels                      |
| Drive:     | 5 channels $\pm$ 215 V, 24-bits          |
| Output:    | Four 24-bit channels, $\pm$ 10 V         |
| Interface: | USB                                      |
| Power:     | 100–120 VAC or 220–240 VAC 1 A; 50–60 Hz |

### Facilities Specifications

|                        |                              |
|------------------------|------------------------------|
| Acoustic noise:        | <75 dBc                      |
| Temperature variation: | Does not exceed $\pm$ 2°F    |
| Humidity variation:    | Does not exceed $\pm$ 20% RH |

## AFM Instrumentation from Keysight Technologies

Keysight Technologies offers high precision, modular AFM solutions for research, industry, and education. Exceptional worldwide support is provided by experienced application scientists and technical service personnel. Keysight's leading-edge R&D laboratories are dedicated to the timely introduction and optimization of innovative, easy-to-use AFM technologies.

[www.keysight.com/find/afm](http://www.keysight.com/find/afm)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:

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