

# Analysis of Materials Physical Properties

## The nano-scale morphology and electromagnetic property measurement solution

Electric/magnetic field, morphology, etc. in a variety of environments



“ Want to verify degree of perfection for semiconductor process ? ”

“ Want to imaging corrosion of the metal at nano-scale ? ”

“ Want to observe morphology in a variety of environments and temperature ? ”

Yes, we can support for you!

The nano-scale morphology / properties analysis solution by using N9417S AFM (Atomic Force Microscope) and N9795A NanoNavigator software.

### Non-destructive failure analysis of semiconductor

Electrical property verification is available.

With Keysight's network analyzer, in addition to surface morphology, imaging of carrier concentration is also available with SMM\*1. This helps verification of the semiconductor process for SRAM, LED, solar cell, etc.

\*1 SMM : Scanning Microwave Microscopy

### 20yrs+ of expertise in Electrochemical SPM

In-situ observation of electrochemical process is available.

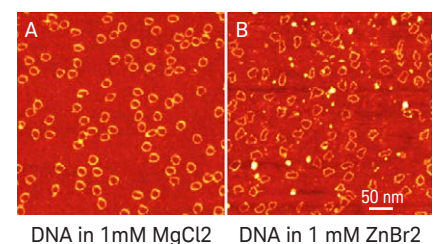
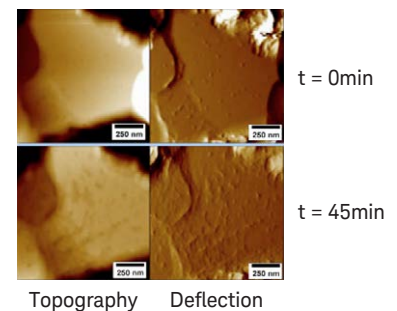
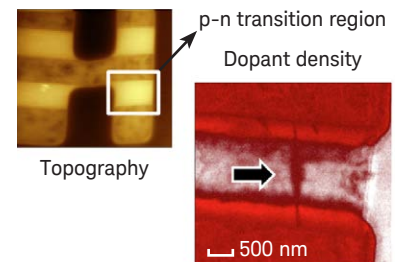
Keysight pioneered the best commercial ECSTM/ECAFM designed with ease of use and highest resolution for in situ imaging of electrochemical process. The latest addition of SECM\*2 combined with AFM can sense redox reactions at the electrode surface at the micro / nano scale.

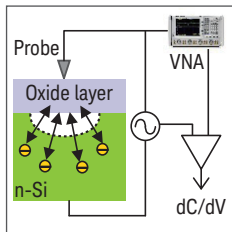
\*2 SECM : Scanning ElectroChemical Microscopy

### Environmental and temperature control

Keysight patented technology (MAC\*3 mode) resolved the resolution challenge from very soft samples in fluid such as biological and polymer surfaces with very gentle tip force by oscillating the cantilever only. Morphology observation of biomaterials like cells, DNA or protein in the liquid can now be imaged easily with the highest resolution.. In addition, atmosphere like inert gases, organic vapor, humidity, and temperature are controllable.

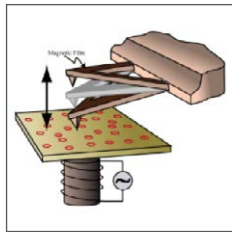
\*3 MAC : Magnetic AC





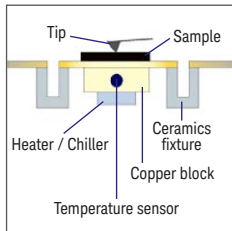
### SMM mode

Carrier concentration measurement by detecting capacitance changes. P/N discrimination is also available from phase response to the bias polarity.



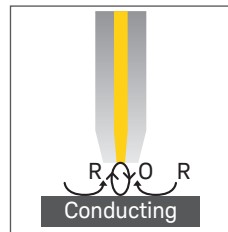
### MAC mode

Keysight patented technology for vibrating the tip directly to achieve very small amplitude. It enables the high resolution amplitude and phase imaging along with the topography of biological samples in liquid.



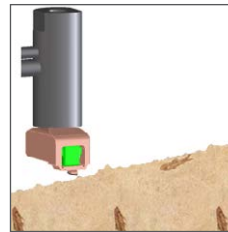
### Temperature control

Heating and peltier sample plates are built with U shape compensation for minimizing the thermal drift for controlled temperature between -30 to +250 degree Celsius.



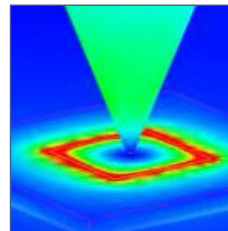
### SECM mode

Imaging of the activity of the electrochemical reaction by measuring Faradaic current between the tip and sample is available in addition to morphology observation.



### QuickScan

Two stage piezo-actuators realize navigation imaging speed up to 2sec/frame @256x256 pixels. Fast feedback is automatically controlled during the imaging.



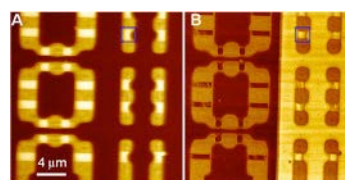
### Interpolation and quantification of SMM by EM simulation

Good correlation between EMPro-FEM simulation and SMM mode measurement is confirmed\*4. Simulation can be used for interpolation of observation results and quantitative meaning.

## Major specification (N9417S 9500 system)

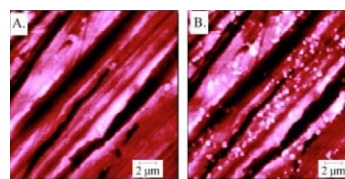
Scanner	
XY scan range	90 x 90 $\mu\text{m}$
Z scan range	12 $\mu\text{m}$
XY linearity	< 1%
XY positioning noise	< 0.15 nm
Z positioning noise	< 0.075 nm
Microscope dimensions	
Size	191 (W) x 191 (D) x 201 (H) mm
Weight	7.5 kg
Sample stage size	
Manual XY stage	10 mm travel
Motorized Z stage	10 mm travel
Max sample diameter	25 mm
Max sample height	8 mm
Controller	
QuickScan mode	120 line / sec (2 sec / 1 frame @ 256 x 256 pix)
Data collection speed	XY: 1 MHz, Z: 10 MHz
Observation mode	
Standard	Contact, LFM, AAC, Phase, Quick Sense, CS-AFM, MFM, EFM, KFM, Liftmode, F-d Spectroscopy, F-V Spectroscopy, Flexgrid, Force Plugins, Thermal K PFM, AutoDrive
Optional	MAC, STM, Scripting, QuickScan, SECM, (SMM)

## Observation example



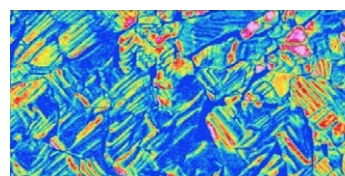
### Electrical properties (Semiconductor)

Topography (left) and carrier concentration dC/dV (right) of SRAM.



### Electrochemistry (Batteries)

Zinc foil in aqueous electrolyte after zero (left) and two stripping and re-deposition cycles (right).



### Material science (Thin film)

Piezoresponse image of PZT film.

\*4 References

Application Note: SMM EMPro

<http://literature.cdn.keysight.com/litweb/pdf/5991-2907EN.pdf>

Application Note: SMM - Solutions for Quantitative Semiconductor Device Characterization

<http://literature.cdn.keysight.com/litweb/pdf/5992-1659EN.pdf>

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