

ATOMIC FORCE MICROSCOPE Nano-Observer

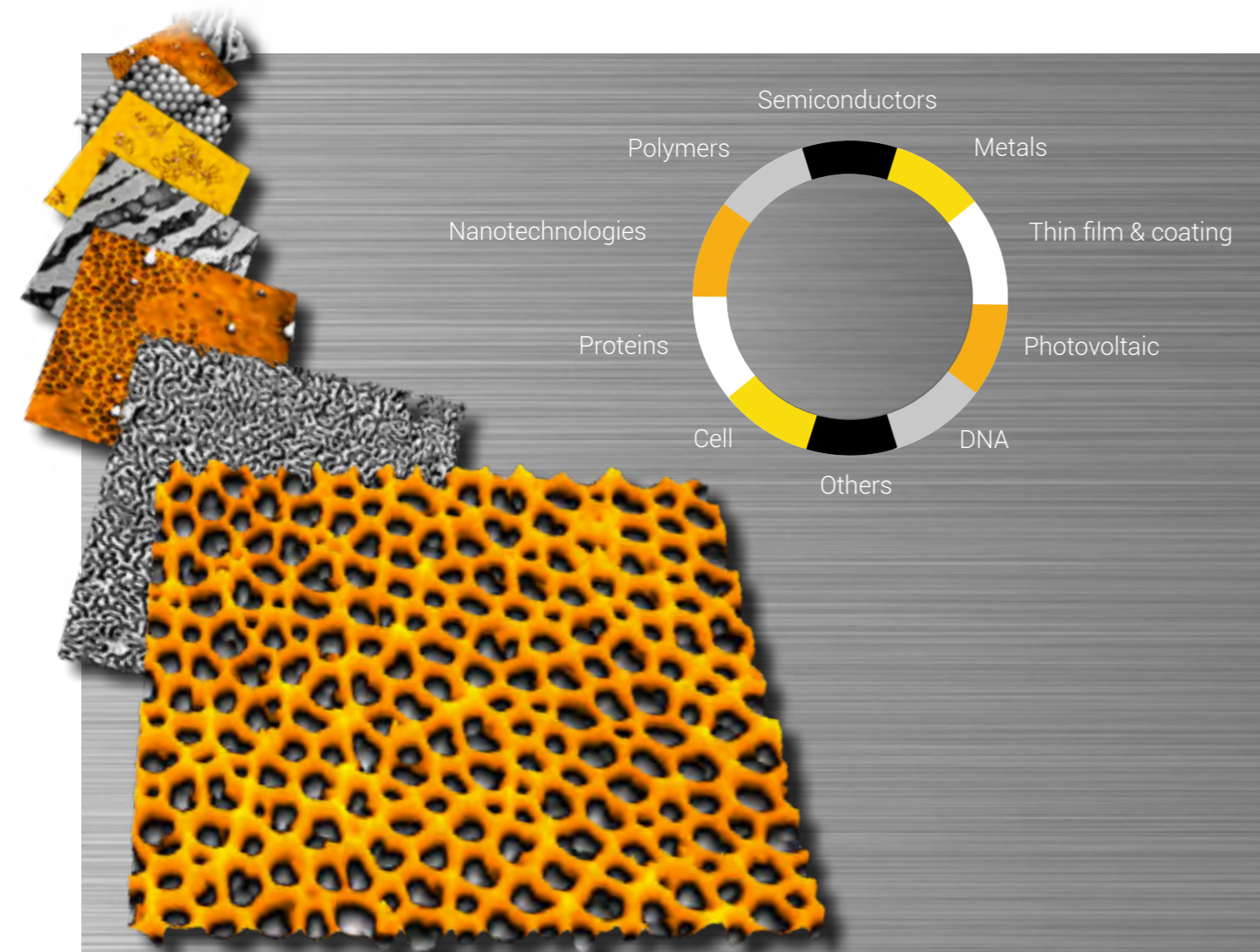
The best cost/effective AFM



COMPLETE CONFIGURATION

HD-KFM™
RESISCOPE™
Soft ResiScope
Soft IC (mechanical,
electrical, SThM...)

Environmental control
EZ TEMPerature
from -40° to 300°C
EZ Liquids (fluids, EC...)
Ease of use



OVERVIEW



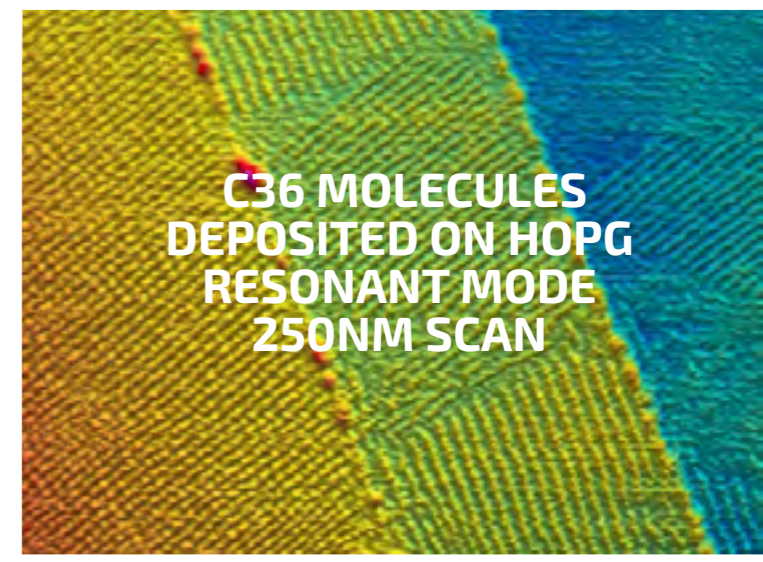
WHY CHOOSE THE NANO-OBSERVER AFM

The Nano-Observer is a powerful AFM for all your AFM measurements (materials, polymers, biology, electrochemistry or electrical measurements).

Coming with latest technologies, it allows to measure quantitatively sample properties at nanometer scale.

- It provides access to a wide range of capacity :
- **Mechanical characterization** (stiffness, adhesion, modulus)
 - **Advanced electrical modes** (ResiScope, HD-KFM, sMIM)
 - **Environments** (Gas control, temperature, liquid)
 - **Optical couplings** (RAMAN, TERS, IR)

HIGH RESOLUTION MEASUREMENTS



QUALITY OF MEASUREMENTS

3 steps for quality AFM and high resolution measurements !



Optical detection : Low noise (quality of detection) and low coherence (to prevent laser/sample interferences) laser.



Electronic : Low noise electronics (controller, power supplies ~50 V for lower noise) and resolution of the scan control (24 bit) for accuracy at any scan size.



Patented flexure stage : Our stage allows from 100µm scan XY (and 15µm Z) from atomic level or molecular resolution without replacing the scanner !

ADVANCED MODES

- **New : Soft IC, The 3rd AFM mode**
The advantages of contact and resonant AFM modes without the drawbacks
- Package of powerful electric modes:
 - **ResiScope**
 - **HD-KFM**
 - **sMIM**
- Different environments :
 - **Temperature** (-40°C to 300°C)
 - **Liquid measurements**
 - **Environment control**

QUICK AND EASY CONTROL

- **Intuitive software :** The pre-configured modes makes it possible to select simply the AFM mode. With a single click, you can switch between all AFM modes. No more additional need, no more mistakes or damage.
- **Top/ side views :** A video color camera offer a helpful view from the top for tip/sample positioning or side view to make the tip/sample approach easier.



LOOKING TO THE FUTURE

The only AFM to answer all your applications

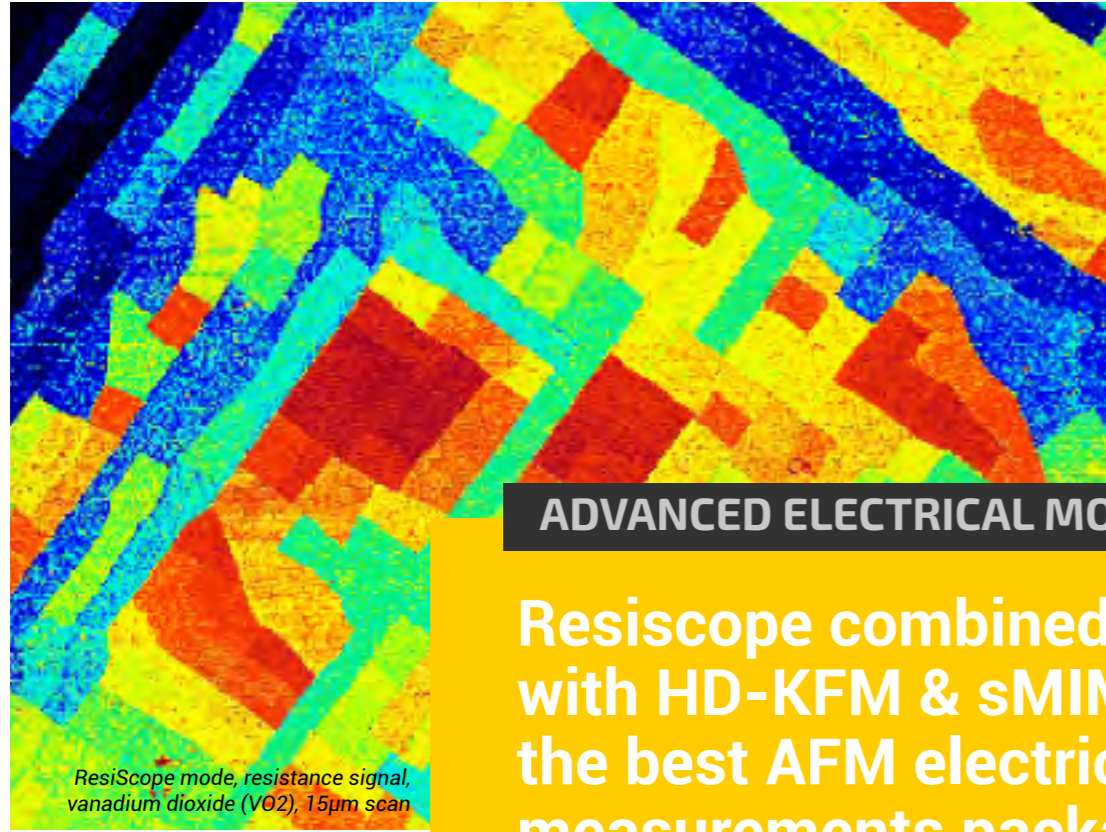
From electrical to mechanical measurements and through different environments, **the Nano-Observer is the AFM you need!**

ADVANCED ELECTRICAL MODES



RESISCOPE - HD-KFM - SMIM THE BEST OF ELECTRICAL MEASUREMENTS

All AFM electrical measurements combine into one powerful and easy-to-use AFM microscope



ADVANCED ELECTRICAL MODES

Resiscope combined with HD-KFM & sMIM = the best AFM electrical measurements package !

+ ResiScope : The best tool for AFM electrical characterization

- Current/ Resistance from 10^2 to 10^{12} ohms
- Current control & auto range driven by fast processor
- High sensitivity over the full range

+ HD-KFM : Auto optimized single-pass KFM

- One pass - NO LIFT
- Very high sensitivity
- Higher spatial resolution

+ sMIM : Scanning microwave impedance microscopy

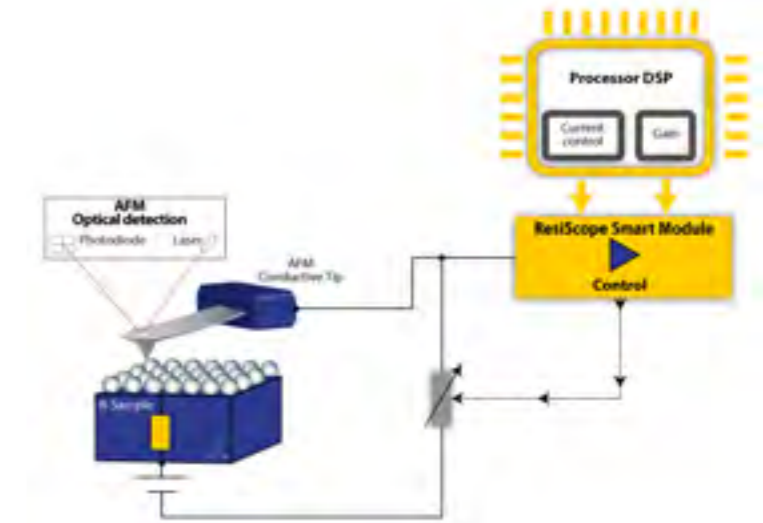
- Nanoscale permittivity & conductivity mapping
- Capacitance/ permittivity
- Resistivity/ conductivity variations

+ RESISCOPE : CURRENT & RESISTANCE MAPPING

What is ResiScope ?

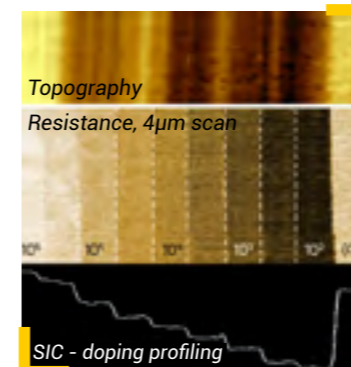
The ResiScope is the unique system able to measure Resistance over 10 decades with a high sensitivity and resolution. True fast auto ranging driven by DSP. It can be combined with several dynamic modes as MFM/EFM or KFM single pass providing several sample characterizations on the same scan area.

- Resistance & Current mapping over **10 orders of magnitude** in one module and one pass
- **Current control**
- High sensitivity over the full range
- Compatible with :
 - Oscillating mode / AC mode
 - EFM / MFM or HD-KFM



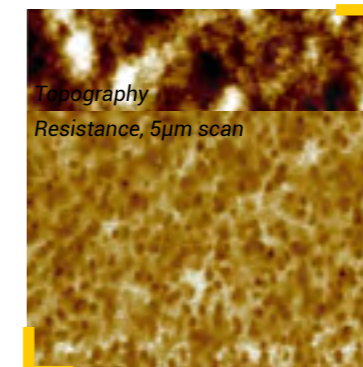
Main 3 applications

Semiconductors



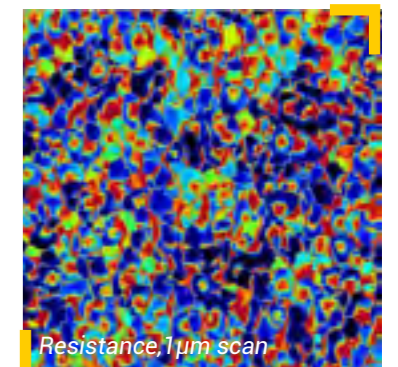
« Stair case » sample showing clear different doping concentration (each step is about 400nm). No cross talk with topography and very clean and define electrical measurement !

Molecular electronic, Organic Photovoltaic...



Example on a very thin OPV sample. A normal conductive AFM was burning the layer. Due to its sensitivity with current control. The ResiScope is the unique able to image such OPV samples

Materials, metals, alloys, oxides



Map of the electrical resistance of the oxide film grown on stainless steel in high temperature water.

ADVANCED ELECTRICAL MODES

+ HD-KFM MODE : HIGH DEFINITION KFM

What is HD-KFM ?

In addition to standard KFM, the Nano-Observer can offer **High Definition KFM** mode to highly enhance the resolution and increase the sensitivity of the surface potential.

Standard KFM mode

Longer distance with lift mode = Less sensitivity

Larger feature with lift mode = **Less resolution**

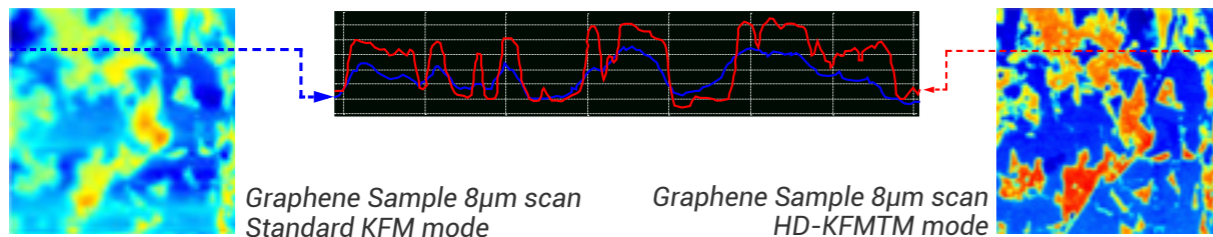
Lift height

Typical lift height separation: 10-50 nm
F electrical up to 100 times weaker on traditional KFM

HD-KFM mode

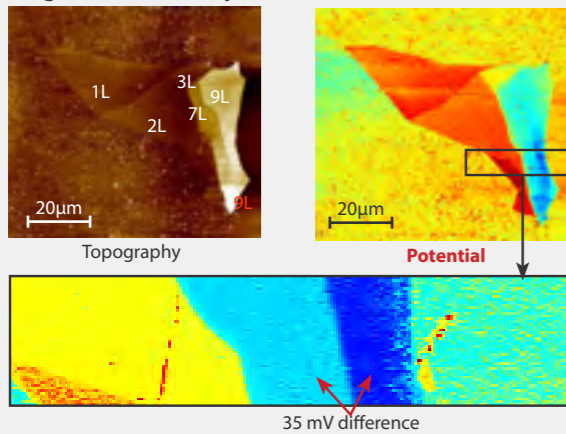
One pass - NO LIFT :
Very high sensitivity & higher spatial resolution

Typical minimum separation : 0.1 nm - 0.3 nm
F electrical $\sim 1/\text{distance}^2$



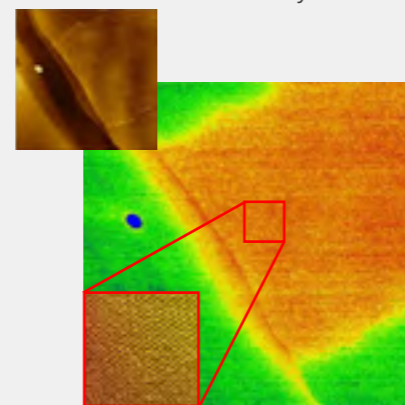
HD-KFM Applications

2D materials
Higher Sensitivity and Resolution



Molybdenum disulfide (MoS₂) on gold substrate, HD-KFM mode

Molecular electronic
Molecular resolution only with HD-KFM !

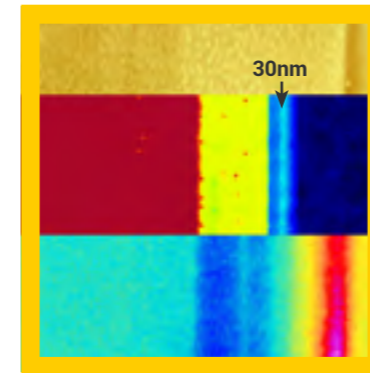


Bio molecules deposited on HOPG
1µm scan



HD-KFM & RESISCOPE MODES ON THE SAME SCAN AREA

With the Nano-Observer it is possible to perform at the same time measurements of resiscope and HD-KFM.



Solar Cell (BSF), 3x0.9 µm, Topography

Solar Cell (BSF), 3x0.9 µm, ResiScope mode, Current signal

Solar Cell (BSF), 3x0.9 µm, HD-KFM mode, Potential signal



SMIM : SCANNING MICROWAVE IMPEDANCE MICROSCOPY

What is sMIM ?

sMIM is a new mode for AFM to measure electrical properties (permittivity, conductivity, dC/dV, dR/dV on conductive, semiconducting and insulating materials) simultaneously.

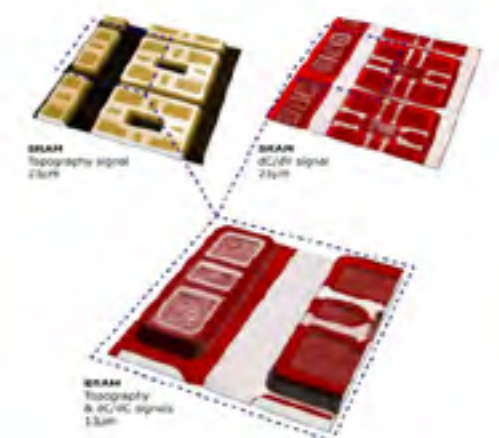


What are you measuring

- **Direct measurement of electrical properties**
Image local variation of ϵ (permittivity) and s (conductivity)
< 100 nm lateral resolution (50 nm typical, 20 nm for some modes/materials)
- **Compatible with all materials**
Images dielectrics, insulators, semiconductors & metals
Measure with contact, tapping mode (resonant and non-resonant) and non-contact imaging
- **Sub-surface sensitivity**
Can image through ~100 nm over-layers

ScanWave advantages

- **Optimized design- Best SNR**
Single frequency allows for most sensitive electronics detection
Shielded probes improve signal isolation
- **Linear response to dielectric constant**
Next step towards quantification of dielectrics and insulators
- **Linear response to Log doping concentration**
Differentiate doping concentration on a scale
Apply calibration reference samples to quantify doping concentration
- **Measure non-linear samples**
Measure doping concentration and carrier type
Measure Silicon and III-V materials with less sample prep and more easily



THE 3RD AFM MODE

NEW

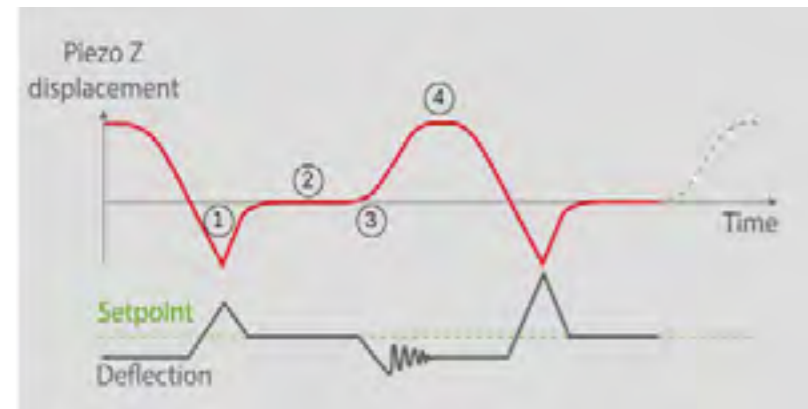
SOFT IC : New AFM mode

SOFT INTERMITTENT CONTACT

Soft IC mode combines the advantages of contact AFM and resonant AFM modes without the drawbacks. Indeed, it is perfectly adapted for soft or abrasive samples and allows quantitative electrical and mechanical measurements. The Soft-IC mode intermittently distant the tip of the surface at frequencies much lower than those used in resonant AFM allowing sufficient time to measure local mechanical and electrical properties. The Soft IC apply a specific Z piezo movement that keeps a tip in contact with the surface at constant force and then leave the surface to measure the next point. Any type of tips can be potentially use with the Soft IC.

Advantages

- Static contact
- No friction
- Constant force



1. Stiffness
2. Topography & **Constant Force** = Quantitative Measurements
SIC is compatible with Soft Resiscope, Soft SThM, Soft PFM, Soft CAFM...
3. Adhesion
4. Next point

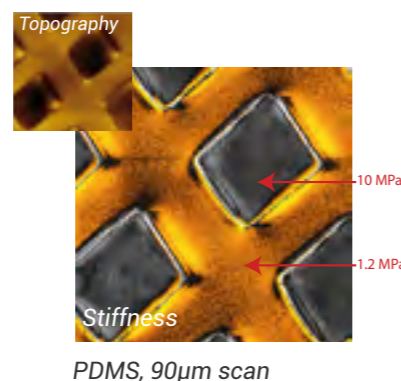
SOFT IC + Mechanical measurement

Soft MEKA

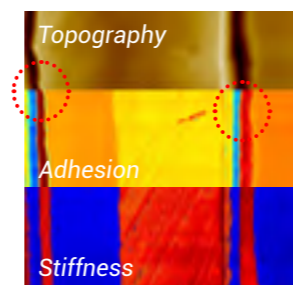
Soft Meka allows to obtain high resolution imaging of stiffness or adhesion. By setting a lift height higher than the adhesion force, tip can be totally disengaged from the surface and permit to obtain stiffness and adhesion from every measured point. In addition, the stiffness can be used in combination with a software module to calculate the Young modulus.

Benefits Soft Meka

- No Friction
- Topography, **stiffness, adhesion & modulus**
- Fast measurements
- Excellent sensitivity and lateral resolution
- Quantitative module mapping



PDMS, 90µm scan



PS/PMMA, 50µm scan

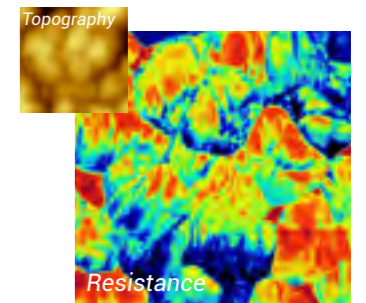
SOFT IC + Electrical properties

Soft ResiScope

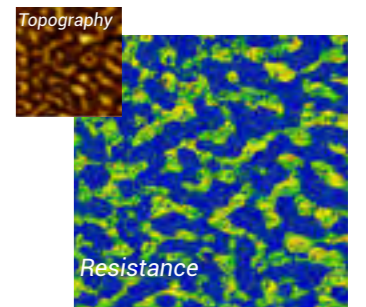
The soft resiscope allows to measure resistance and current on fragile conductive samples. The specific vertical movement applied to the tip in Soft Resiscope mode optimizes the electrical measurement at the time of contact and preserves the tip and the sample. Unlike other oscillating techniques available on the market, the Soft Resiscope measures current / resistance by keeping static tip and maintaining a renewable electrical measurements. The electrical measurements are then comparable to those made in AFM contact mode but with the advantage of being able to measure fragile samples.

Benefits Soft Resiscope

- Fragile & soft conductive samples
- Resistance / Current
- From 10^2 to 10^{12} ohms



Conductive composite materials in powder form, 2.5µm scan



P3HT, 5µm scan

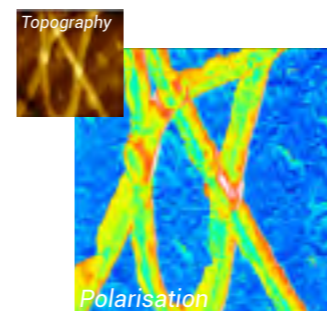
SOFT IC COMPATIBLE MODES

The SoftIC is also compatible with other AFM modes such as SThM (Scanning Thermal Microscopy) and PFM (Piezo Force Mode) that require sufficiently long contact with the surface to record information (local temperature and thermal conductivity for SThM and polarization of piezoelectric materials for PFM)

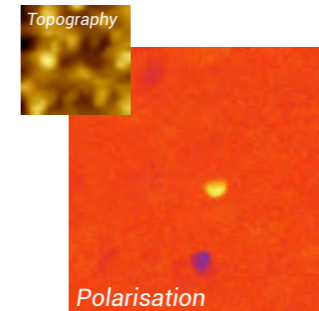
Piezoelectric domains mapping

Measuring amplitude and phase signals for fragile samples

- Intermittent mode + electrical AC modulation



Fiber, 10 µm scan

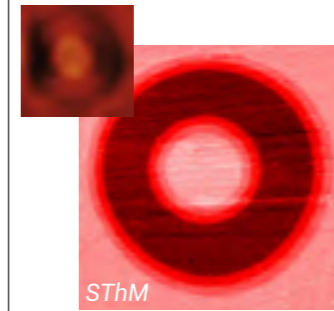


BTO - PVDF, 5 µm scan

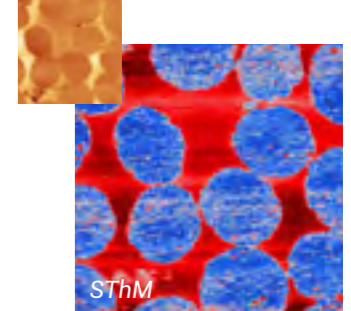
Thermal measurements

Temperature and conductivity measurements for delicate samples

- Material science
- Polymers



Single crystalline Si steps under polished CVD SiO₂, 20 µm scan



Carbon Fibers in epoxy, 30 µm scan

MULTIPLE AFM MODES



VERSATILE AFM MICROSCOPE

The uniqueness of Nano-Observer is defined by its versatility in allowing different types of analysis to be performed with a single microscope. In addition to these new AFM mode & advanced electrical modes, the Nano-Observer AFM also combines other AFM modes and different environments...



Advanced electrical modes

- ResiScope (Current & resistance mapping)
- HD-KFM (auto optimised single pass KFM)
- sMIM (capacitance/permittivity & resistivity/conductivity variations...)



Mechanical properties

- Soft IC mode (stiffness & adhesion)
- Force modulation mode (elastic and viscoelasticity)



Atomic Force Microscopy modes

- Electric Force Microscopy (gradient electric field mapping)
- Conductive AFM (current mapping)
- Contact & no contact modes

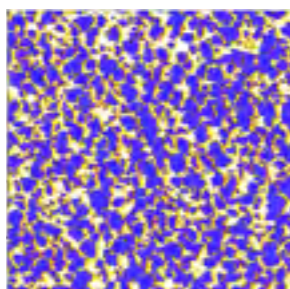


Magnetical properties

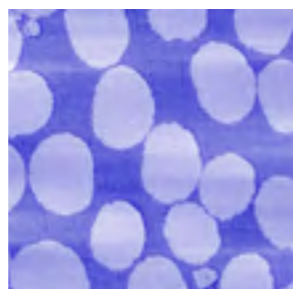
- Magnetic Force microscopy mode (gradient electric field mapping)
- Magnetic Lateral Force Microscopy mode (MFM under temperature rampe)



EFM mode, Gold electrodes, 60µm scan



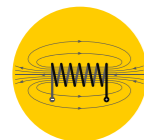
C-AFM mode, Titanium / tungsten, 2.5µm scan



FMM mode, Carbon Fibers in epoxy, 30µm scan



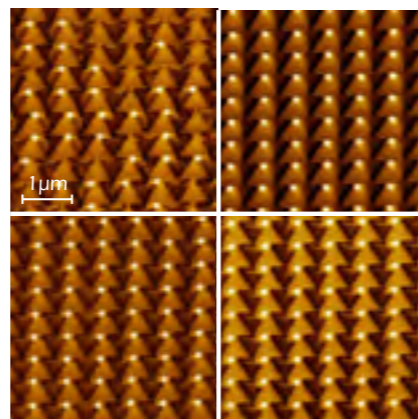
MFM mode, Soft magnetic nanostructures, 25µm scan



Variable Magnetic Field Module

Variable Magnetic Field module (VMF) is the most advanced mode for magnetic characterization in AFM. It combines Magnetic Force Microscopy (MFM) mode with an external in-plane magnetic field generator allowing dynamic characterization like displacement of domain walls or rotation of magnetization reversal can be mapped.

- MFM under magnetic field
- In-situ magnetic field control
- From 0 to 3000 Gauss.

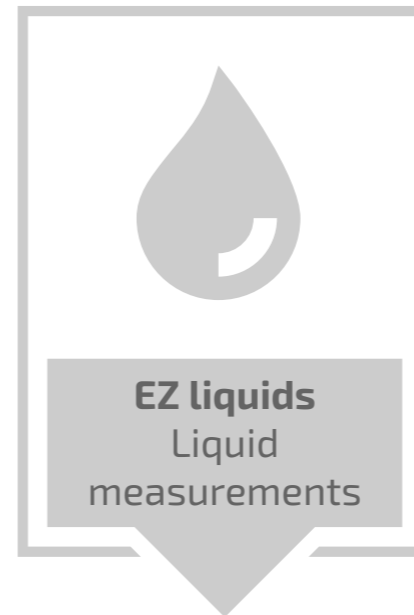


Rotation of magnetic domains and domain walls on magnetic triangular structures under in-plane magnetic field variation from 50 to 470 Gauss

AFM ENVIRONMENTS



MULTIPLE ENVIRONMENTS



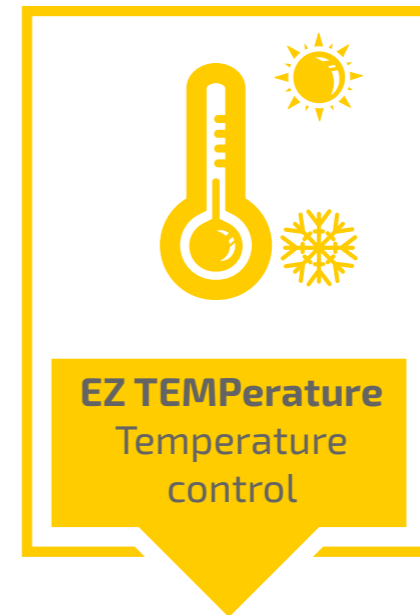
EZ liquids Liquid measurements

A liquid cell and tip holder is available for imaging in solution or force spectroscopy. An optical correction system avoids laser re-alignment when tip is into liquid solution.

- Laser angle compensation
- No additional adjustment
- Very stable oscillating mode in fluids
- Electrochemistry compatible



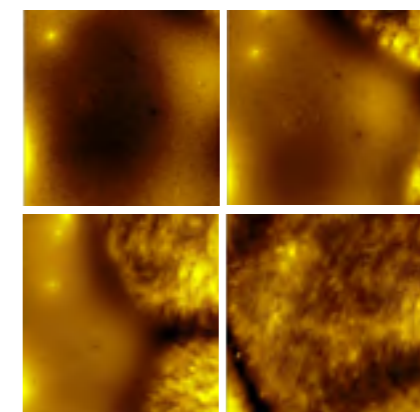
Electrochemical liquid cell.



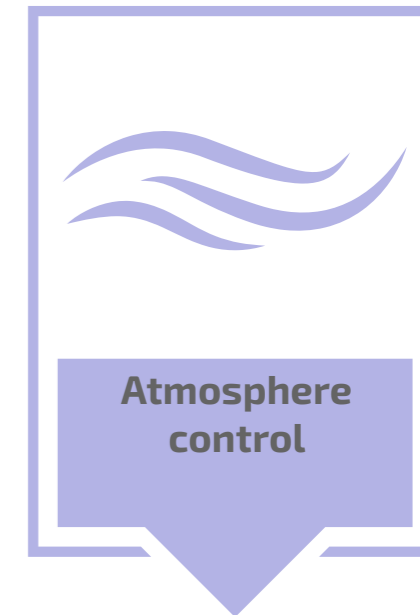
EZ TEMPERATURE Temperature control

The temperature control is made to deliver precise temperature control and imaging during temperature rampe. It is compatible with all AFM modes.

- -40°C to 300°C
- Limited thermal expansion



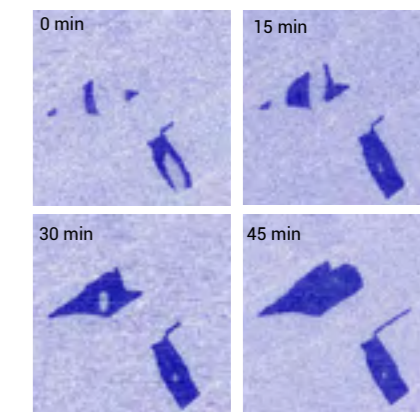
Real time acquisition, polymer crystallization under temperature control, 10 µm scan



Atmosphere control

The Nano-Observer is designed to offer environmental control (gases, humidity...) to improve your electrical measurements or protect your sample from oxidation.

- Prevents the contamination, sample oxydation...
- Stable measurement for electrical characterization
- Gases, humidity



HD-KFM on HOPG sample, 15 µm scan, humidity control

AFM COUPLING

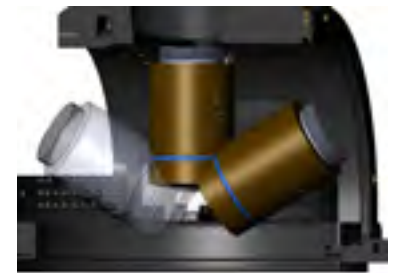
AFM + Glove box

Exploring the properties of many materials requires working in a controlled environment to protect the samples from environmental influences (2D, organic or photovoltaic materials).



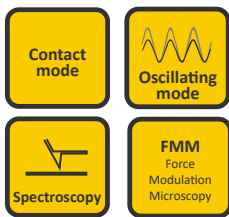
AFM + optical technic

The Nano-Observer allows the integration of the optical microscopy technique to allow additional metrics in the physical, biological and materials sciences.

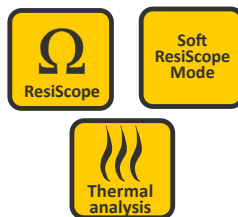


Multiple modes

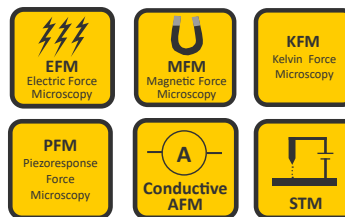
Standard modes



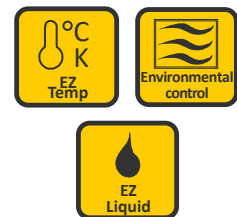
Additional modules



Additional modes



Environments



Specifications

XY scan range	100 μm (+/- 10%)
Z range	15 μm (+/- 10%)
XY drive resolution	24 bit control - 0.06 Angströms
Z drive resolution	24 bit control - 0.006 Angströms
Ultra low noise HV	Typ : <0.01 mV RMS
6 DAC Outputs	6 D/A Converters – 24 bit (XYZ drive, bias, aux...)
8 ADC Inputs	8 A/D Converters – 16 bit
Data points	Up to 8192
Integrated Lock-in	Up to 6 MHz (software limited) 2nd lock-in (6 MHz-optional)
Interface	USB (2.0 - 3.0 compatible)
Controller Power	AC 100 – 240 V - 47-63 Hz
Operating System	Windows 7 to 10

Accessories

- > Liquid cell
- > Temperature plate
- > Thermal analysis
- > Environmental chamber
- > EFM/MFM plate
- > Magnetic field generator
- > Others...

CSI Concept Scientific Instruments

PHONE
+33 (0)1 64 53 36 30

EMAIL
info@csiafm.com

WEB
www.csiafm.com

