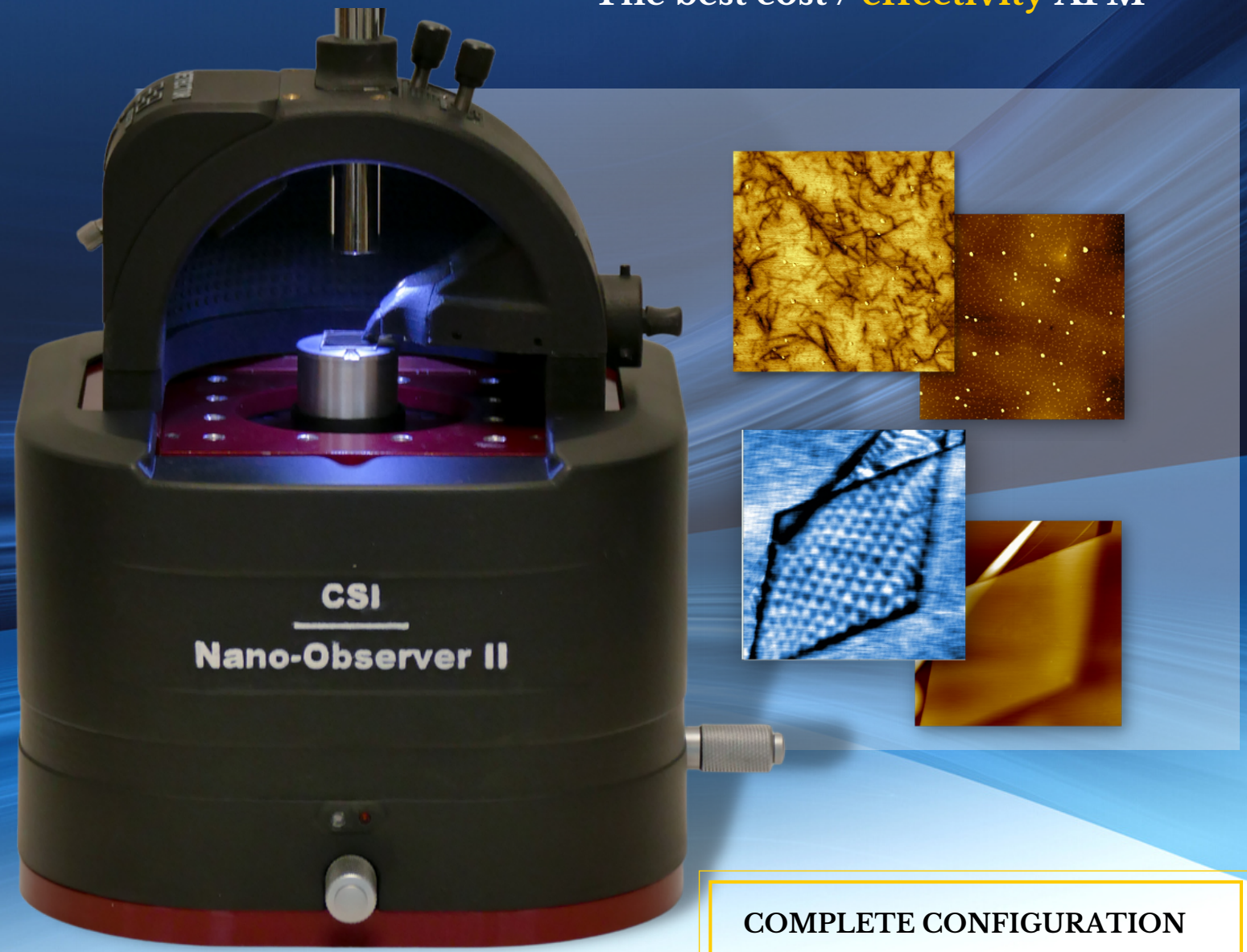
CSI Concept Scientific Instruments
Atomic Force Microscopes

THE NEW AFM
NANO-OBSERVER II

The best cost / effectivity 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

WHY CHOOSE THE NANO-OBSERVER II AFM

The Nano-Observer II is now ready to offer a new AFM accessibility for Nanotechnology research and industry.

After 30 years of AFM expertise and developments from our team, and based upon our years of innovation and field experience, this new AFM is now opening more doors and capabilities by its level of performance, flexibility and ease of use in a competitive value.

Coming with latest technologies, it provides quantitatively sample properties at nanometer scale.

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

ADVANCED MODES

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 :

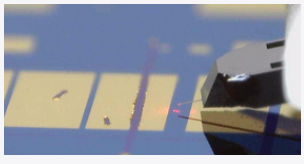
- **Temperature** (-40°C to 300°C)
- **Liquid measurements**
- **Environment control**

QUICK AND EASY CONTROL

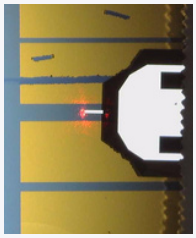
Intuitive software :

The « AFM auto-mode » pre-configured modes open the AFM use to beginners as experts. It performs the coarse and fine approach, gains or setpoint conditions automatically.
With a single click, you can switch between all AFM modes by fully driving the AFM controller and AFM head connections.

Top/ side views : A video color camera offers a helpful view from the top for tip/sample positioning or side view to make the tip/sample approach easier.



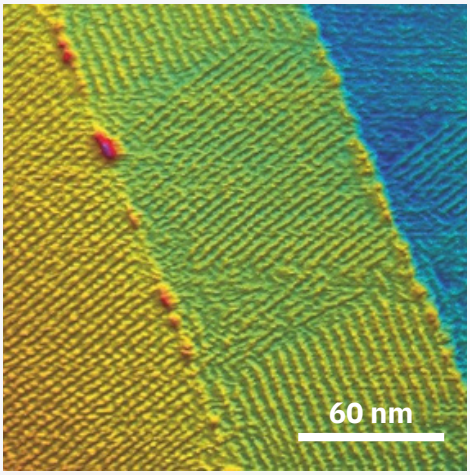
Side view



Top view

OVERVIEW

HIGH RESOLUTION MEASUREMENTS



C36 molecules deposited on HOGP
resonant mode

QUALITY OF MEASUREMENTS

3 STEPS FOR QUALITY AFM AND HIGH RESOLUTION MEASUREMENTS !

Optical detection : A low noise laser, photo detector, and tip holder coupled in a single piece frame for more stability on the optical detection path.

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

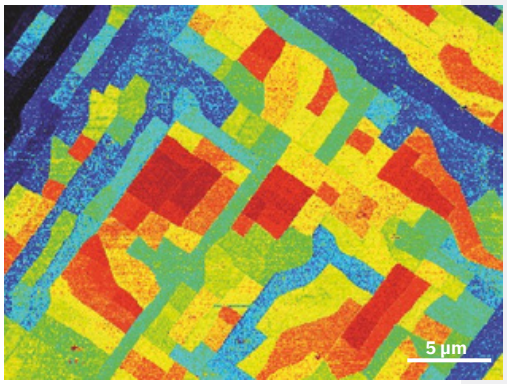
Patented stage : A flexure stage to provide a flat scan and avoid crosstalk. It allows from 100µm scan XY (and 15µm Z) from atomic level or molecular resolution without replacing the scanner !

ADVANCED MODES

HD-KFM , ResiScope , sMIM and Soft IC

THE BEST OF ELECTRICAL MEASUREMENTS

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



ResiScope mode, resistance signal, vanadium dioxide (VO2)

ADVANCED ELECTRICAL MODES

ResiScope combined with HD-KFM, MFM with EFC & Soft IC
=
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

Soft IC:

- Electrical measurement (Soft ResiScope and Soft PFM)
- Thermal measurement (Soft SThM)
- Mechanical measurement (Soft MEKA)

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.

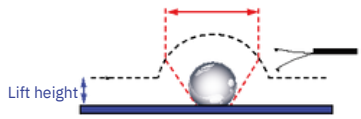
The HD-KFM offers an unrival sensitivity and resolution due to several parameters :

- The optimized single pass technique
- Harmonic mode working at several hundred kHz offering much more detection cycles for more accuracy and a better signal to noise ratio.
- Fast automatic KFM algorithm feedback

Standard KFM mode

Longer distance with lift mode = Less sensitivity

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

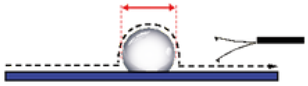


Typical lift height separation: 10-50 nm
F electrical up to 100 times weaker on traditional KFM

HD-KFM mode

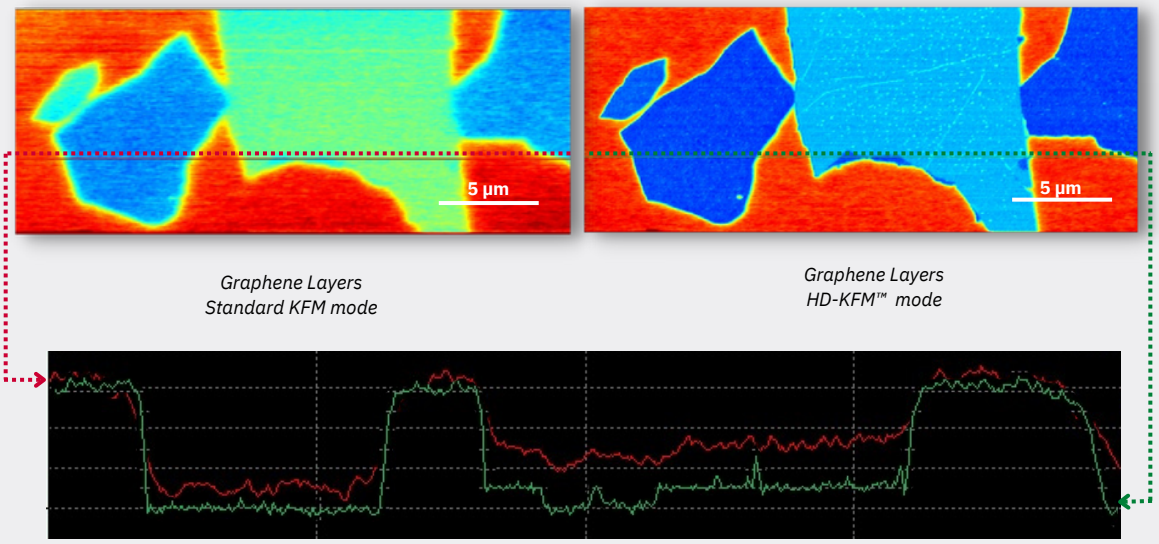
One pass - NO LIFT

Very high sensitivity & higher spatial resolution



Typical minimum separation : 0.1 nm -0.3 nm
F electrical ~ 1/distance^2

This graphene sample is much better resolved using HD-KFM either on lateral resolution and vertical sensitivity provided by the harmonic mode KFM technique.

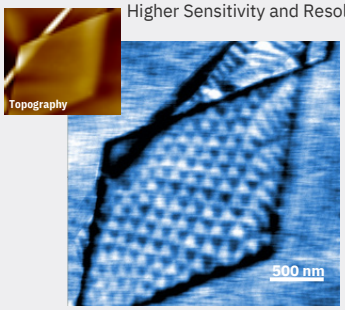


Graphene Layers
Standard KFM mode

Graphene Layers
HD-KFM™ mode

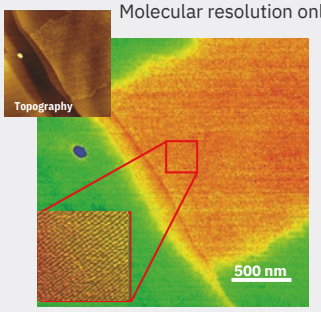
HD-KFM Applications

2D materials
Higher Sensitivity and Resolution



hexagonal Boron Nitride Moiré (hBN)

Molecular electronic
Molecular resolution only with HD-KFM !

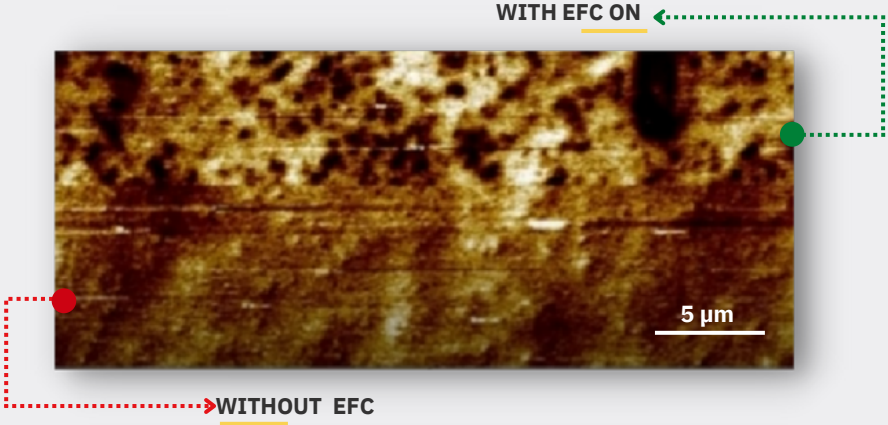


Bio molecules deposited on HOPG

HD-KFM + MFM WITH EFC

WHAT IS MFM WITH EFC ?

MFM with EFC is Magnetic Field Microscopy with Electric Field Cancelling. The Electric Field Cancelling is a technique to compensate in real time the electrostatic field between the tip and the sample to achieve a pure magnetic measurement (MFM).



Magnetic particles embedded in polymer, HD-KFM + MFM with EFC mode

ADVANCED MODES

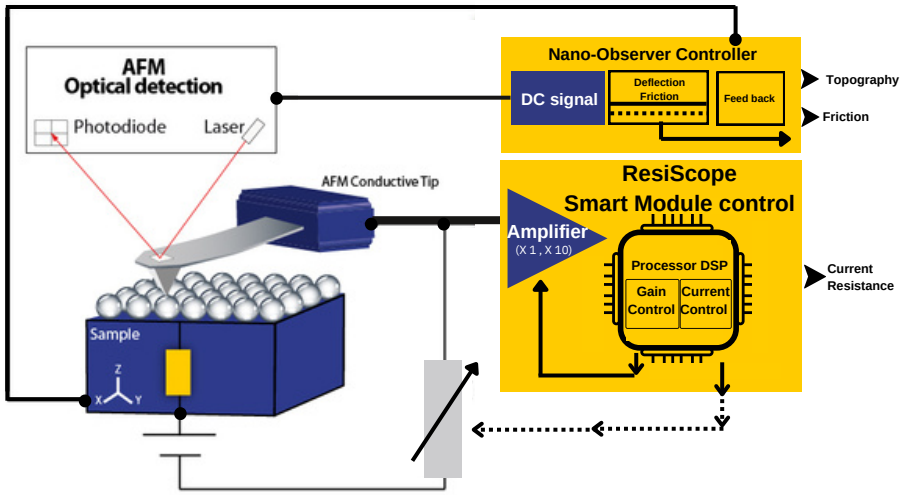
ResiScope : CURRENT & RESISTANCE MAPPING

What is ResiScope ?

The ResiScope is a unique, true active and fast system, able to measure resistance over 10 decades with a high sensitivity and resolution. True fast auto ranging driven by DSP.

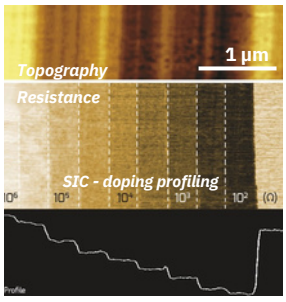
It can be combined with several dynamic modes as MFM/EFM or KFM single pass providing several sample characterizations on the same scan area.

- 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



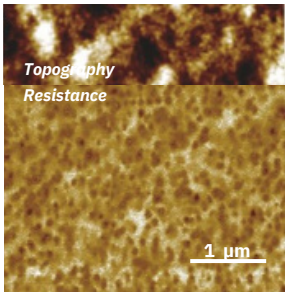
RESISCOPE MAIN APPLICATIONS

Semiconductors



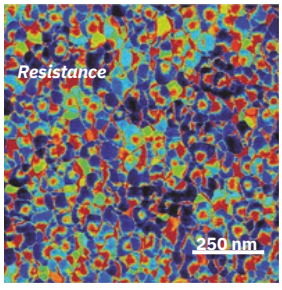
« Stair case » sample showing clear different doping concentration (each step is about 400nm).
No cross talk with topography and very clean and defined electrical measurement !

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, ResiScope is a unique device able to image such OPV samples.

Materials, metals, alloys, oxydes



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

sMIM : SCANNING MICROWAVE IMPEDANCE MICROSCOPY

What is sMIM ?

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

What are you measuring ?

- **Direct measurement of electrical properties**

  Imaging local variation of e (permittivity) and s (conductivity)
  < 100 nm lateral resolution (50 nm typical, 20 nm for some modes / materials)

- **Compatible with all materials**

  Imaging dielectrics, insulators, semiconductors & metals
  Measuring with contact, tapping mode (resonant and non-resonant) and non-contact imaging

- **Sub-surface sensitivity**

  Imaging 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**

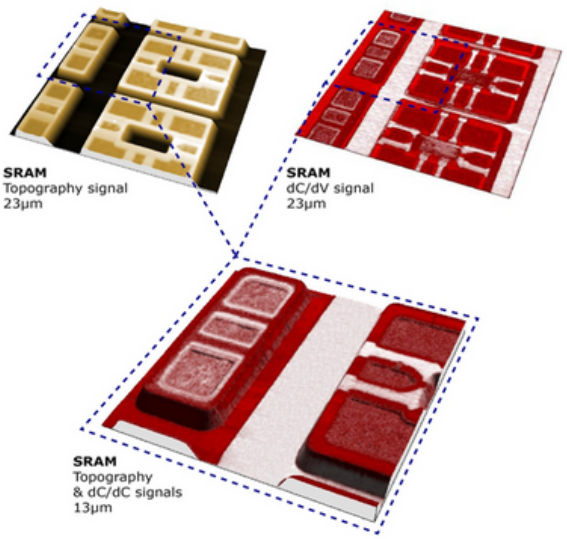
  Next step towards quantification of dielectrics and insulators

- **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



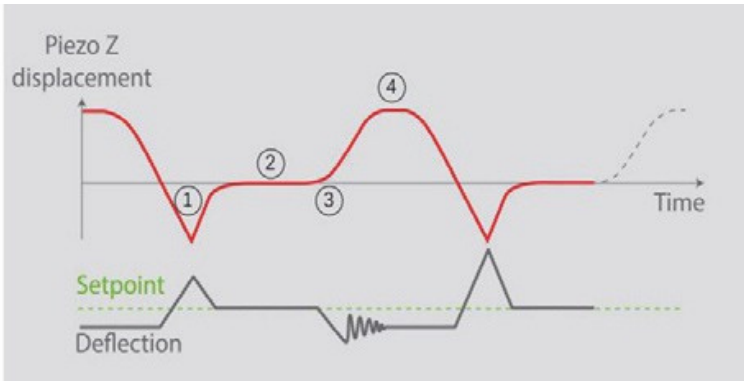
THE 4th AFM MODE

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 distances 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 leaves the surface to measure the next point. Any type of tips can be potentially used with the Soft IC.

Advantages

- Static contact
- No friction
- Constant force



Nom Figure?

More information about Soft IC mode

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

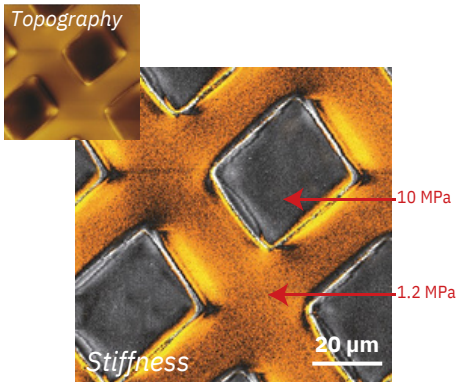
Soft IC + Mechanical measurement = Soft MEKA

Soft MEKA

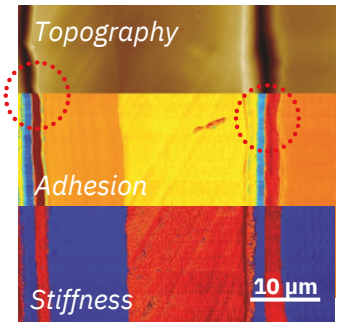
Soft Meka allows to obtain high resolution imaging of stiffness or adhesion. By setting a lift height higher than the adhesion force, tip can be totally disengaged from the surface and permit to obtain stiffness and adhesion from every measured point. In addition, the stiffness can be used in combination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

Benefits of Soft Meka

- No friction
- Topography, **stiffness, adhesion & Young's modulus**
- Fast measurement
- Excellent sensitivity and lateral resolution
- Quantitative modulus mapping



PDMS

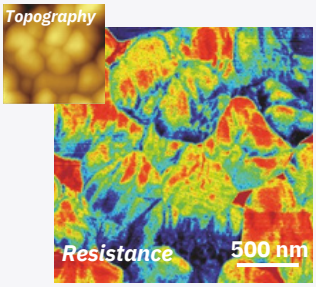


PS/PMMA

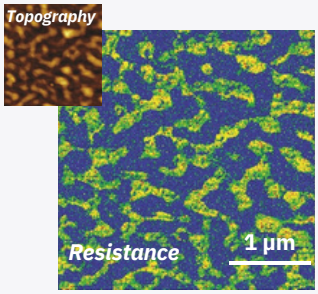
Soft IC + ResiScope = Soft ResiScope

Soft ResiScope

The Soft ResiScope allows resistance and current measurement 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.



Conductive composite materials in powder form



P3HT

Benefits Soft ResiScope

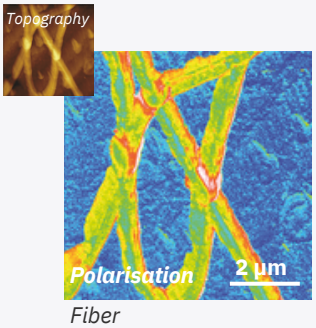
- Fragile & soft conductive
- Samples Resistance / Current
- From 10^2 to 10^{12} ohms

Soft IC + PFM or SThM

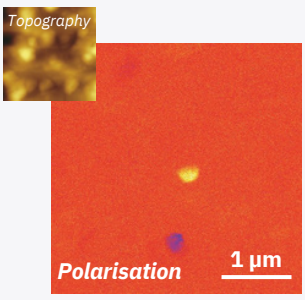
The Soft IC is also compatible with other AFM modes such as SThM (Scanning Thermal Microscopy) and PFM (Piezo Force Mode) that require sufficiently long contact with the surface to record information (local temperature and thermal conductivity for STHM and polarization of piezoelectric materials for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

Piezoelectric domains mapping

Measuring amplitude and phase signals for fragile samples
• Intermittent mode + electrical AC modulation



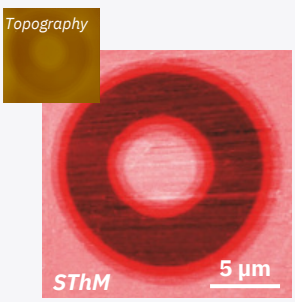
Fiber



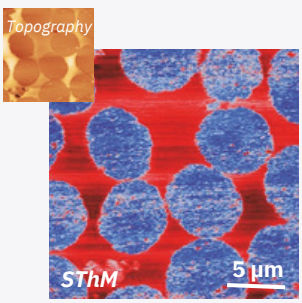
BTO - PVDF

Thermal measurements

Temperature and conductivity measurements for delicats samples
• Material science
• Polymers



Single crystalline Si steps under polished CVD, (SiO2)



Carbon Fibers in epoxy

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. It gives you the possibility to shift from one mode (HD-KFM, ResiScope, sMIM or Soft IC) to another without changing any configuration.

In addition to these new AFM modes & 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 opti-mised single pass KFM)
- sMIM (capacitance/ permittivity & resistivity/ conductivity variations...)

Mechanical properties

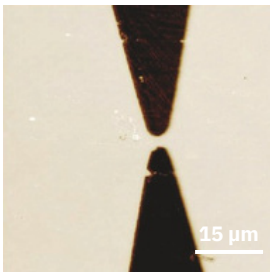
- Soft IC mode (stiffness & adhesion)
- Force modulation mode (elastic and viscoelasticity)

Atomic Force Microscpy modes

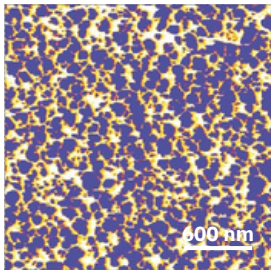
- Electric Force
- Conductive AFM (current mapping)
- Contact & no contact modes

Magnetical properties

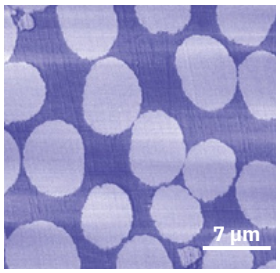
- Magnetic Force microscopy mode (gradient electric field mapping)
- Magnetic Lateral Force Microscopy mode (MFM under temperature rampe)



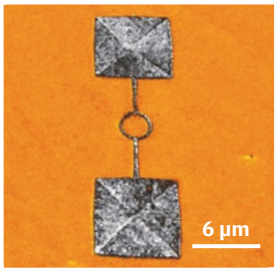
EFM mode, Gold electrodes



C-AFM mode, Titanium / tungsten



FMM mode, Carbon Fibers in epoxy

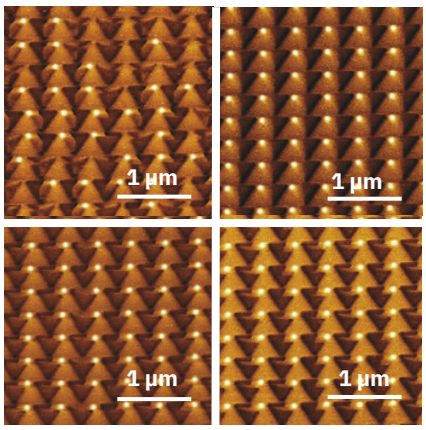


MFM mode, Soft magnetic nanostructures

Magnetic Lateral Field Module

Lateral Magnetic Force Microscopy (LMFM) 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 realignment when tip is into liquid solution.

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

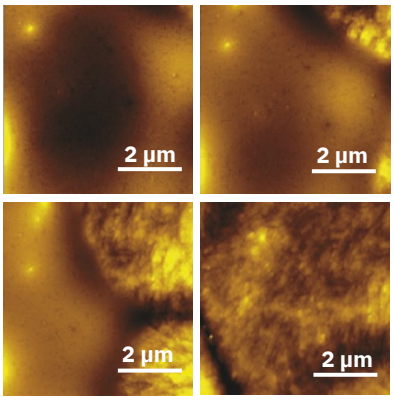
Electrochemical liquid cell

More information about EZ liquid

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



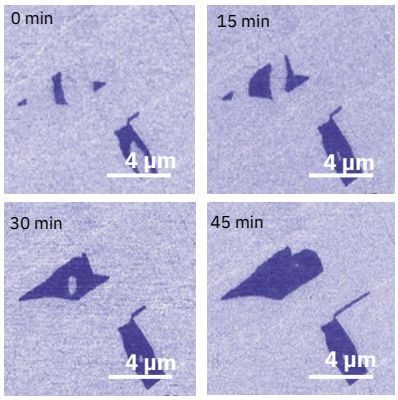
Real time acquisition, polymer crystallization under temperature control

More information about EZ TEMPerature

Atmosphere control

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

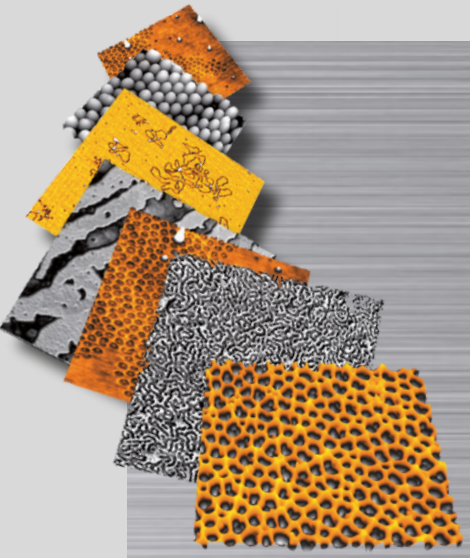
•Prevention of contamination, sample oxydation...
- Stable measurement for electrical characterization
- Gases, humidity

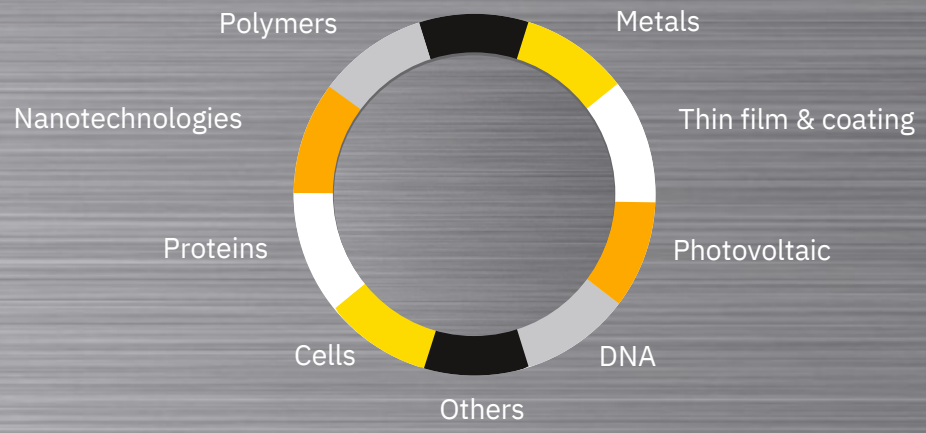


HD-KFM on HOPG sample, humidity control

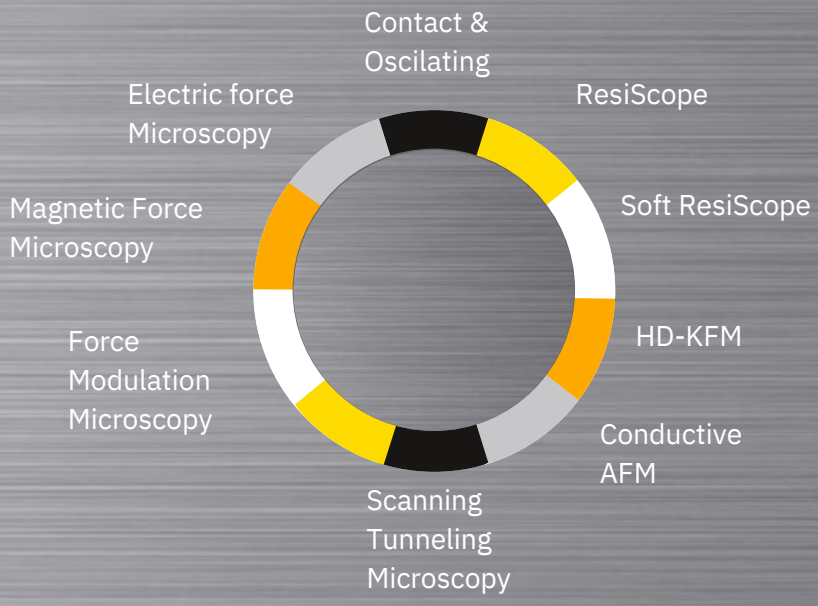
More information about Environment control

Various applications





Multiple modes



LOOKING TO THE FUTURE

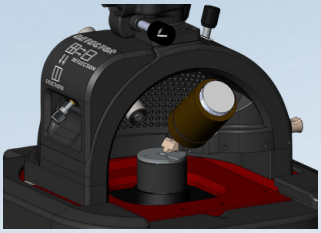
The only AFM to answer all your applications

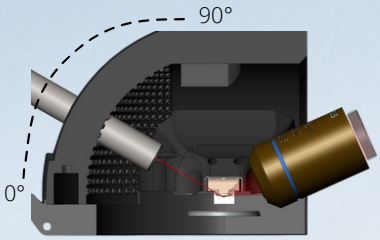
From electrical to mechanical measurements and through different environments, **the Nano-Observer is the AFM you need!**

AFM COUPLING

AFM + optical coupling

The Nano-Observer provides an integration for optical microscopy techniques to allow additional path for light illumination or collection (UV, IR, Raman...) or to achieve photovoltaic illumination with selective angles.





AFM + Glove box

Exploring the properties of many materials requires working in a controlled environment.
A glove box provides humidity or gas control (N2, Ar...) to protect the samples from environmental influences (2D materials, lithium, organic or photovoltaic materials).

Multiple modes

Standard modes

- Contact mode
- Oscillating mode
- Spectroscopy
- FMM Force Modulation Microscopy

Additional modules

- ResiScope
- Soft ResiScope Mode
- Thermal analysis

Additional modes

- EFM Electric Force Microscopy
- MFM Magnetic Force Microscopy
- KFM Kelvin Force Microscopy
- PFM Piezoresponse Force Microscopy
- Conductive AFM
- STM

Environments

- TeEmZ p
- Environmental control
- EZ Liquid

Specifications

XY scan range	100 µm (+/- 10%)
Z range	15 µm (+/- 10%)
low noise HV	Angströms 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 , 10 and 11

Accessories

- Liquid cell
- Temperature plate
- Thermal analysis
- Environmental
- Chamber EFM/MFM
- Magnetic field plate
- Generator
- Others...

CSI Concept Scientific Instruments
Atomic Force Microscopes

More information about Nano-Observer AFM

EMAIL info@csinstruments.eu

WEB www.csinstruments.eu