CSI Concept Scientific Instruments

Empowering Nanoscale Discoveries

NANO-OBSERVER II

THE MOST FLEXIBLE AFM

STANDARD MODES

- Contact Mode
- Oscillating Mode
- Spectroscopy
- Force Modulation Microscopy (FMM)

ELECTRICAL MODES

- ResiScope
- Soft ResiScope
- HD-KFM
- Electric Force Microscopy (EFM)

ENVIRONMENTAL CONTROL

- EZ TEMP
- Environmental Control
- Thermal Analysis
- EZ Liquid

ADDITIONAL MODES

- Piezoresponse Force Microscopy (PFM)
- Conductive AFM (c-AFM)
- STM
- Soft Interaction Control
- Magnetic Force Microscopy (MFM)
- Kelvin Probe Force Micrscopy (KPFM)

WHY CHOOSE THE NANO-OBSERVER II

The Nano-Observer II, a cutting-edge Atomic Force Microscope (AFM) designed for both advanced researchers and newcomers. Its unparalleled versatility and user-friendly software make it the ideal tool for nanoscale imaging and characterization across diverse applications.

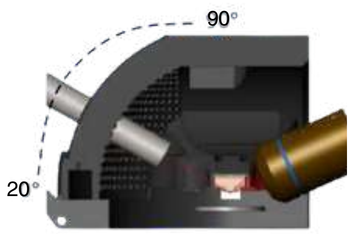
Key Features

- User-Friendly Design (automated electronics)
- Configurable top and side camera for visualization of the tip–sample region for an efficient pre-approach procedure
- Compact AFM head with optional pre-aligned probe holder
- AutoScan Software for easier and faster scans
- Auto Approach: Automated fast and gentle final approach
- AutoGain: Real-time active AFM feedback gains
- Preset Setpoint Conditions for Soft, Medium, or Hard interactions

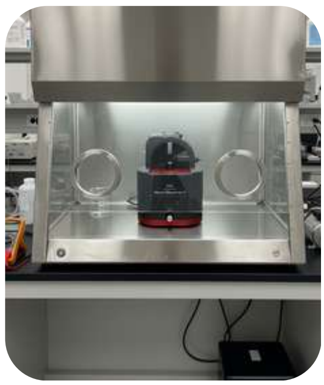
Advanced Technology Integration

- New Galaxy USB 24-bit low-noise AFM controller
- High-quality built-in lock-ins for Phase, PFM, EFM, KFM, and more
- Illumination with angular control for photovoltaic applications and measurements
- Compatibility with optical microscopy techniques (UV, IR, Raman, etc.)
- Integration with glove boxes for controlled environments (e.g., humidity, N_2, Ar)

OPTICAL COUPLING



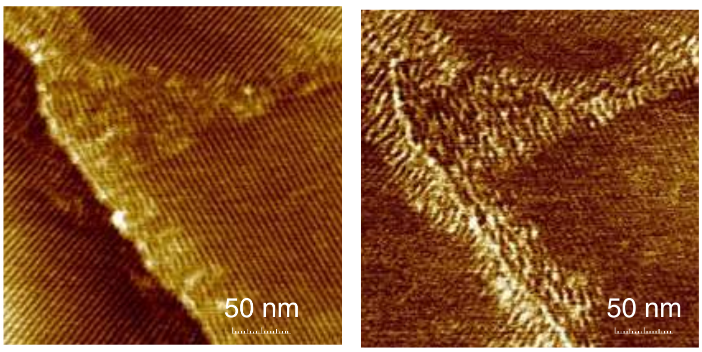
GLOVEBOX COMPATIBILITY



High-Performance Scanning

- Low-noise, high-resolution scanning capabilities
- Large and small area scans with a single scanner
- Consistent resolution across all scan sizes

TOPOGRAPHY PHASE IMAGE



High-Resolution - C_{36} molecules

UNLOCKING NANOSCALE INSIGHTS

The Nano-Observer II sets a new standard in AFM technology with its advanced operating modes, enabling precise electrical, mechanical, and environmental measurements. From high-definition imaging to delicate sample analysis, these modes empower researchers to explore nanoscale phenomena with unmatched precision.

Advanced Modes

ResiScope™ III: Resistance & Current Mapping

- Measures over 10 decades with high sensitivity and resolution
- Features fast auto-ranging driven by a Digital Signal Processor (DSP)
- Compatible with oscillating modes (e.g., MFM, EFM, KFM) for comprehensive sample characterization in a single pass
- Ideal for semiconductors, photovoltaics, metallic structures and 2D materials science applications

10^2 to 10^{12} Ω range

fA to mA range

Real-Time DSP Gain Control

Current range: 50 fA to 1 mA

HD-KFM III: High Definition Kelvin Force Microscopy

- Enhances surface potential resolution and sensitivity beyond standard KFM
- Includes Electric Field Cancelling (EFC) for pure magnetic measurements (MFM)
- Ideal for high-definition surface potential characterization of nanoscale surfaces

High Sensitivity

dC/dz Capability

EFC + MFM Integration

Detailed Surface Mapping

Soft IC Mode (The 3rd AFM Mode)
Soft Interaction Control Mode

- Maintains constant force during measurements for quantitative electrical and mechanical data
- Smart DSP Z-actuation control
- Combines benefits of contact and resonant modes, excelling with soft biological samples, gels or polymers.
- Compatible with advanced techniques like Soft MEKA, Soft ResiScope, Soft PFM, and Soft SThM

Constant Force Control

No Friction

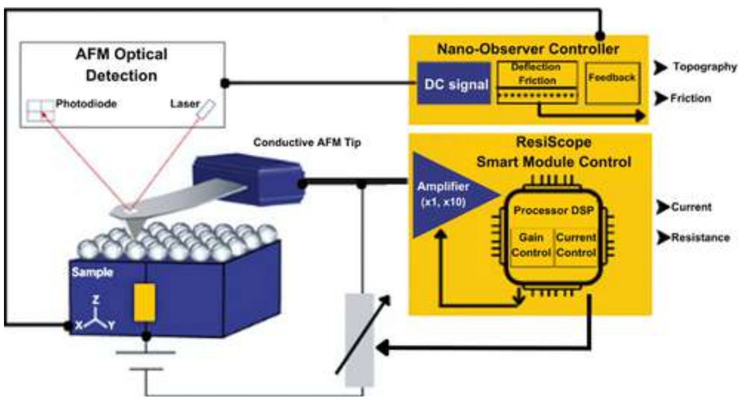
Quantitative Electrical & Thermal Measurements

Gentle Interaction

ResiScope™ III - Current & Resistance Mapping

ResiScope™ III sets a new standard in electrical characterization through high-accuracy resistance and current measurements across an extensive range. Powered by intelligent, real-time adaptive electronics, it delivers artifact-free current/resistance maps with superior accuracy and resolution.

- Resistance range: 10^2 to 10^{12} Ω
- Current range: 50 fA to 1 mA
- DSP-driven auto-ranging
- Real-time adaptive gain control
- Linear gains for reliable measurements

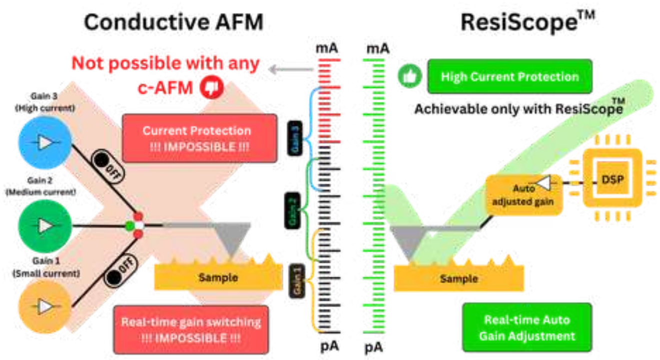


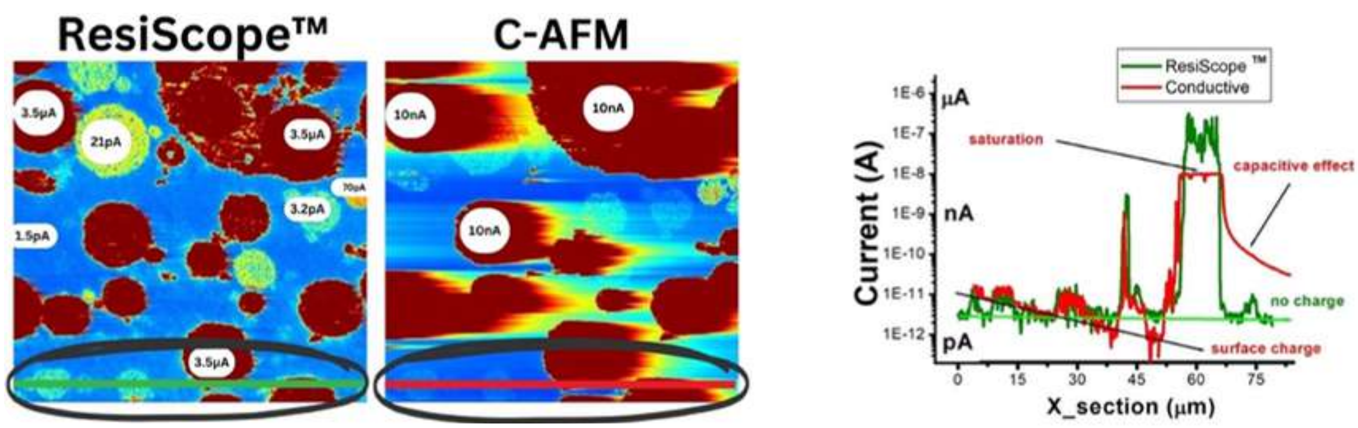
Working principle and system architecture of the ResiScope™ III showing integration with AFM systems

ResiScope™ III VS. Traditional C-AFM

ResiScope™ III represents a fundamental advancement over traditional Conductive AFM techniques, addressing core limitations that have long constrained nanoscale electrical characterization.

Traditional C-AFM systems use fixed gain settings with no capacity for dynamic adjustment during scanning, making both current protection and real-time gain switching physically impossible.



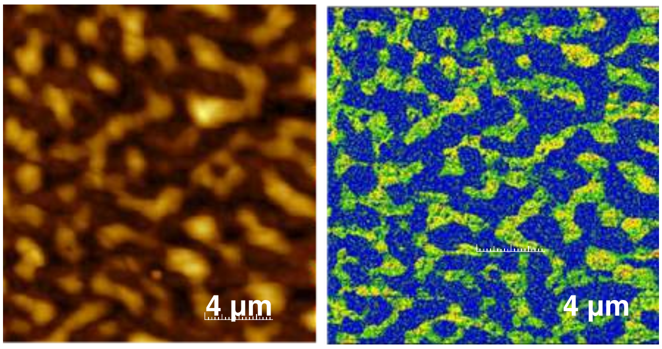


The comparison images demonstrate ResiScope III's superior measurement capabilities. On the left, the ResiScope III result shows a precise conductivity map with clearly defined domains and accurate current values ranging from picoamps to microamps.
The center image displays typical C-AFM results on the same sample, revealing significant artifacts including saturation in highly conductive regions (appearing as flat-topped areas) and trailing effects due to surface charging. The right graph provides a quantitative cross-section comparison, where the green line (ResiScope) accurately tracks the true conductivity variations without distortion, while the red line (C-AFM) shows both saturation plateaus and capacitive effects that compromise measurement integrity.

RESISCOPE™ III
KEY FEATURES & APPLICATIONS

Organic Solar Cells

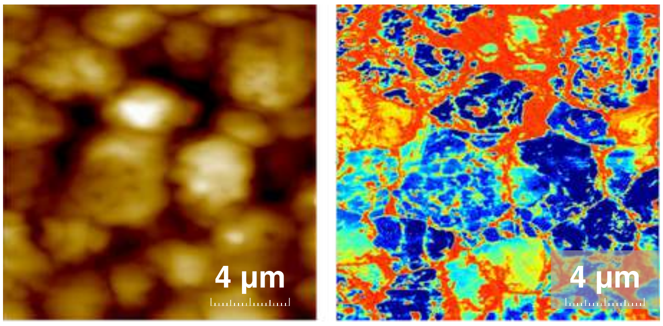
The ResiScope™ III provides critical insights into the sample's electrical behavior by mapping resistance and conductivity at the nanoscale, revealing key functional properties essential for optimizing organic solar cells performance.



Current mapping of a P3HT/PMMA blend using Soft ResiScope showing domain differentiation with minimal sample damage

Perovskite Solar Cells

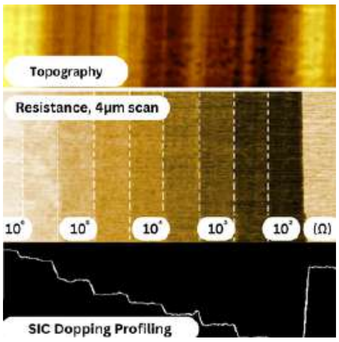
On Perovskite solar cells, ResiScope™ III reveals electrical properties helping to optimize device performance and identify potential defects or inefficiencies.



Left - Topography of a perovskite solar cell; Right - ResiScope™ III mapping showing resistance distribution

Semiconductor Research

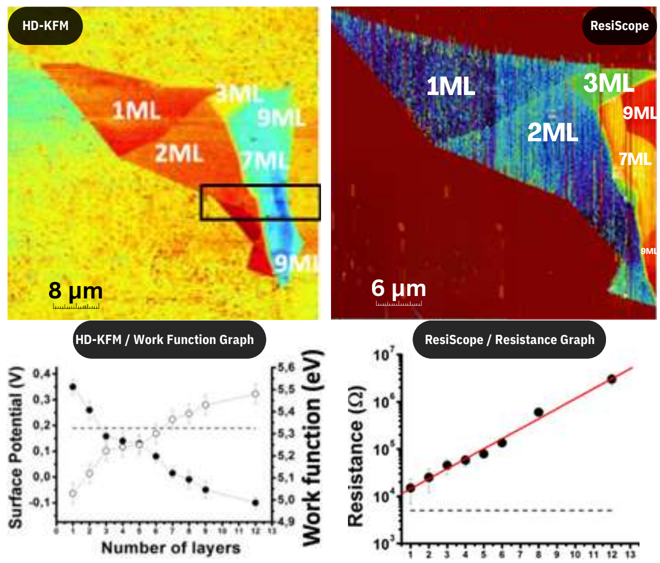
ResiScope™ III provides a powerful solution for semiconductor analysis, enabling high-resolution electrical characterization essential for modern device development. In semiconductor doping studies, the ability to map resistance variations with nanometric precision is critical for understanding dopant distribution and its impact on device performance.



Topography (top) and resistance mapping (bottom) of a SiC sample showing clear differentiation between doping regions

2D Materials & Multi-Mode Analysis

ResiScope™ III & HD-KFM III excels in studying 2D materials like graphene, MoS_2, and other emerging nanomaterials, providing critical insights into layer-dependent conductivity and local variations in electrical properties.



Resistance mapping with ResiScope shows that monolayer regions have higher resistance because charge transport is more limited, while multilayer regions display lower resistance, producing an exponential drop in resistance as layer number increases. Surface-potential mapping with HD-KFM reveals that the potential decreases with added layers, and, using the known tip work function, the work function of MoS_2 multilayers can be determined.

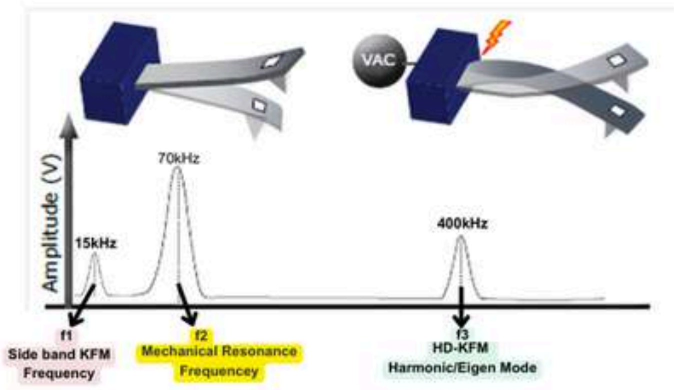
HD-KFM III: High Definition Kelvin Force Microscopy

HD-KFM enables quantitative surface potential mapping with high sensitivity and superior spatial resolution. Unlike conventional KFM techniques, HD-KFM III operates using multifrequency excitation and probes extremely close to the sample surface.

- Single-pass operation - No lift mode required
- Ultra-close measurement - Operates at just 0.1-0.5 nm from surface
- Superior frequency detection - 350-400 kHz (vs. ~15kHz in side-band KFM)
- 20× higher sensitivity - Detects subtle potential variations
- One-click adjustment - Auto tuning driven by precise algorithm
- Enhanced edge resolution - Molecular resolution

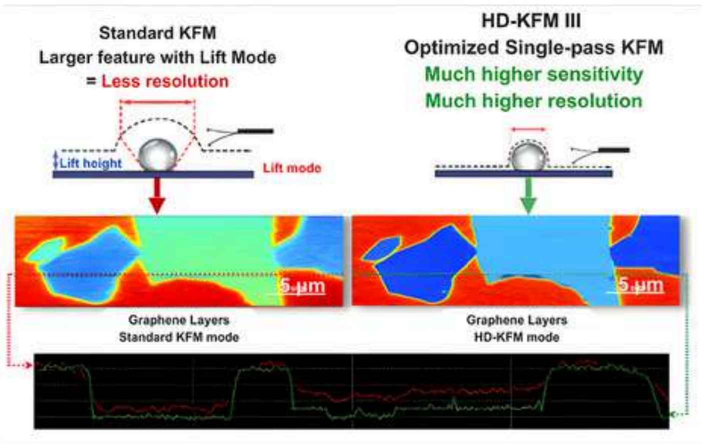
Understanding the HD-KFM III Advantage

Multifrequency Approach: The frequency spectrum shows how HD-KFM III uses multiple resonant frequencies simultaneously. While standard KFM operates at lower frequencies (15kHz side band), HD-KFM III leverages the cantilever's second eigenmode at 400kHz. This higher frequency operation delivers dramatically improved sensitivity through resonance amplification.



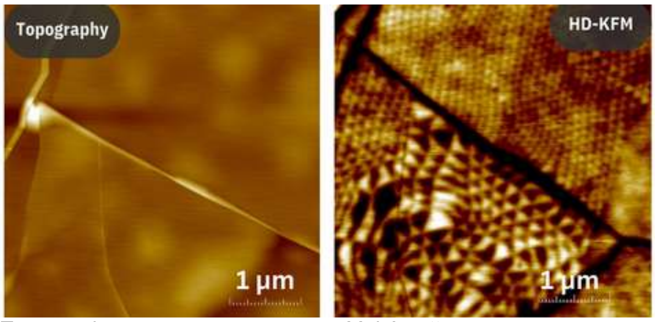
Measurement Technique: The comparison diagrams highlight a critical difference: Standard KFM requires a significant lift height, creating distance between tip and sample that reduces resolution. In contrast, HD-KFM III's optimized single-pass technique maintains ultra-close proximity (0.1-0.5 nm), preserving electrical signal strength and spatial detail.

Performance: The graphene layer images demonstrate the practical impact: Standard KFM (left) shows indistinct boundaries and muted contrast, while HD-KFM III (right) reveals sharper edges, clearer domain separation, and more accurate potential measurement.



2D Materials & Moiré Patterns in hBN

HD-KFM III is particularly valuable for studying 2D materials due to its exceptional resolution and sensitivity. The examples highlight the technique's capabilities in this rapidly growing field: Hexagonal Boron Nitride (hBN) and Moiré Patterns.

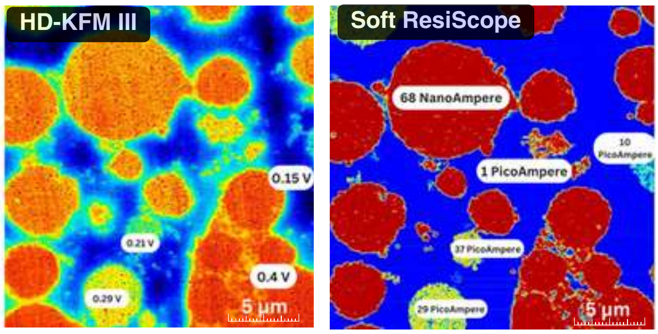


Topography *Moiré pattern*

Battery Sample & Multi-Mode Analysis

HD-KFM™ III is able to measure surface potential with high resolution makes it particularly useful for studying battery materials and interfaces.

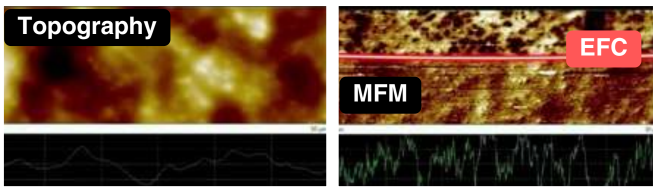
Our technology allows seamless switching between measurement modes with a single click in the software.



Surface Potential (HD-KFM - Left): Displays charge distribution, where warmer colors indicate higher potentials and cooler tones represent lower potentials.
Current Map (Soft ResiScope - Right): Highlights conductivity variations, showing high current regions in red (e.g., 68 nA) and low current zones in blue (e.g., 1 pA).

Electric Field Cancelling (EFC)

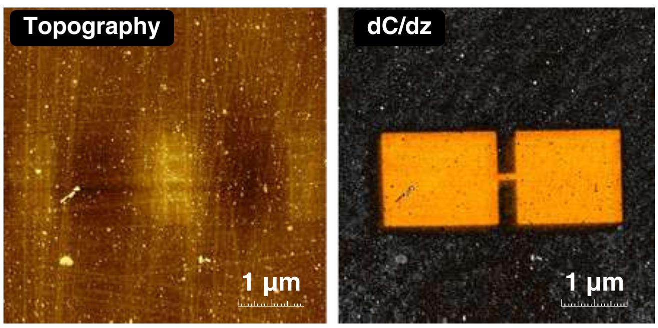
The HD-KFM III introduces the Electric Field Cancelling (EFC) option, which allows for the compensation of electrostatic fields during measurements. This feature is particularly useful with other measurement modes, such as Magnetic Force Microscopy (MFM).



Example of MFM measurement with and without EFC. We can see the topography image (left) and on the right side we can see the separation of EFC switching during the scan (red line).

Capacitance Gradient (dC/dz) Measurements

HD-KFM III can simultaneously measure the capacitance gradient (dC/dz), providing information about the local dielectric permittivity of the sample.

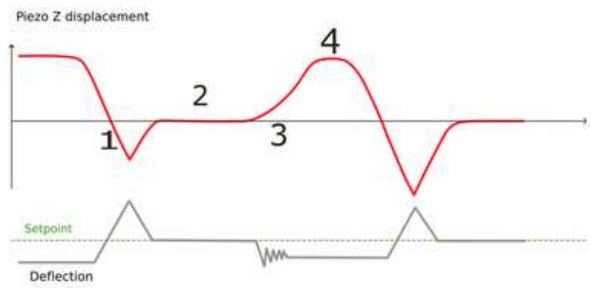


Metallic structure embedded on epoxy.

Bridging the Gap in AFM Technology

Soft Interaction Control (Soft IC) Mode introduces a novel approach that overcomes the limitations of traditional AFM techniques. It effectively bridges the gap between Contact Mode enabling force or conductive measurements and Resonant Mode offering sample preservation. The Soft-IC creates the ideal solution for sensitive sample characterization and quantitative measurements.

- Zero Friction: Eliminates lateral forces typical of Contact Mode that damage delicate samples.
- Quantitative mechanical and electrical measurements on delicate samples.



1.Topography & stiffness
2. Constant Force = Quantitative Measurements
Soft IC is compatible with:
ResiScope, SThM, PFM and c-AFM
3. Adhesion
4. Next point

Advantages Over Traditional Modes:

Soft IC Mode offers distinct improvements over traditional AFM approaches:

Compared to Contact Mode:

- Enhanced sample preservation and measurement quality
- No shear forces (zero friction)
- Reduced sample damage and extended tip lifetime
- Retained high-resolution imaging capabilities

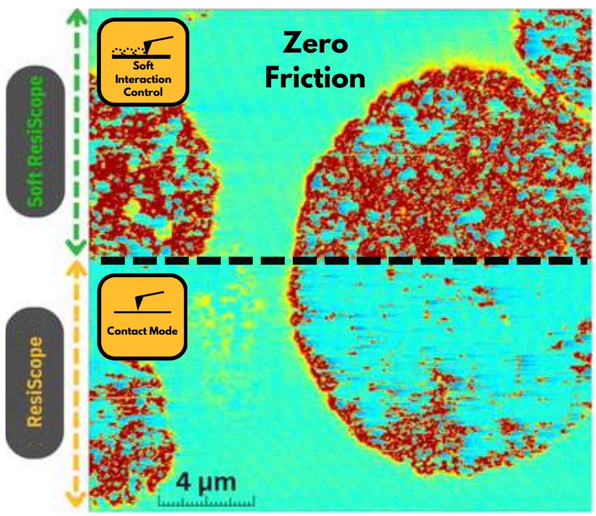
Compared to Resonant Mode:

- Simplified operation with single-parameter (deflection) control
- Direct force calculations via Hooke's law
- Quantitative measurements without complex interpretation
- Precise topography with operational ease

Soft ResiScope (Soft IC + ResiScope™)

Soft ResiScope integrates Soft IC Mode with ResiScope™ III's electrical measurement capabilities, enabling precise electrical characterization without compromising sample integrity.

This advanced technique maintains minimal contact force during scanning, allowing researchers to analyze sensitive materials with resistance domains spanning from few Ω to GΩ while significantly reducing mechanical artifacts that typically distort conductivity measurements.

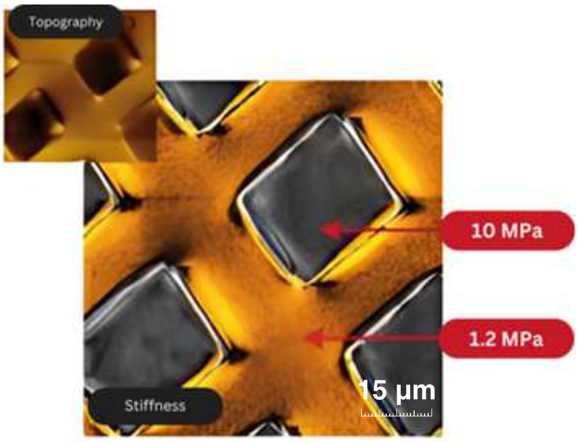


Solid-state Battery Sample
This scan compares ResiScope III (lower half) with Soft ResiScope (upper half), revealing sharper structures and optimized current paths. The Soft ResiScope mode significantly reduces contact artifacts, enhancing accuracy in conductivity mapping.

Soft MEKA
Mapping Mechanical Properties

Soft MEKA enables precise mechanical property mapping without friction forces.
This mode provides detailed mapping of adhesion, stiffness and allow Young's modulus determinaton.

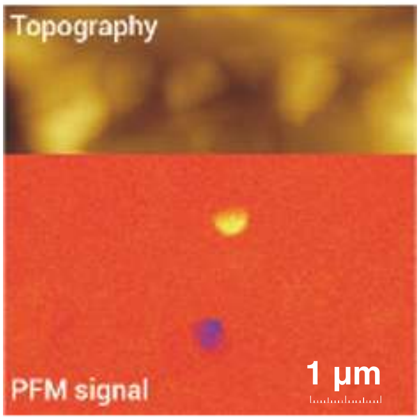
✓ Phase and stiffness mapping for polymers and composites
✓ Quantitative adhesion and modulus measurements across interfaces
✓ Friction-free operation to preserve delicate material structures



Topography and stiffness scan of PDMS.
The stiffness map distinctly highlights regions with different mechanical properties, ranging from 1.2 MPa to 10 MPa.

Soft PFM:
Piezoelectric Characterization

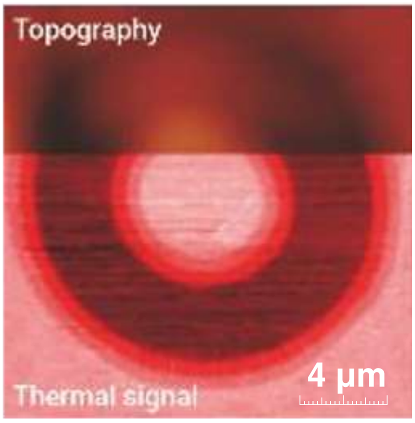
- High-sensitivity piezoresponse detection
- Local polarization mapping capability
- Domain structure analysis
- Minimal sample perturbation during measurement



Soft PFM scan of a BTO-PVDF sample

Soft SThM:
Thermal Analysis

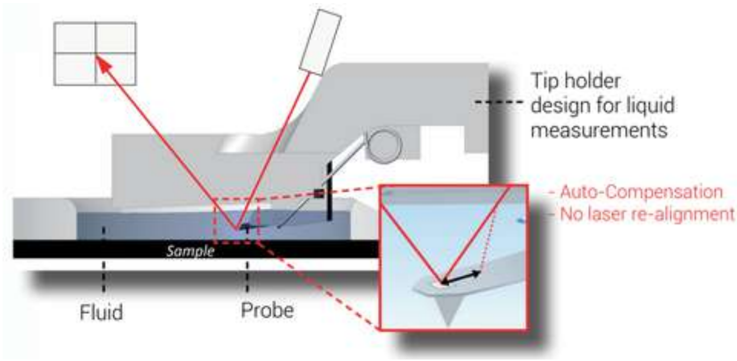
- Temperature mapping with nanoscale resolution
- Local thermal analysis with minimal sample damage
- Detection of subsurface thermal properties
- Preservation of heat-sensitive samples during measurement

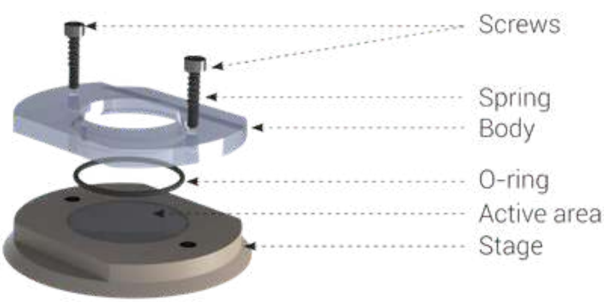


Soft SThM scan of silicon steps beneath SiO layer.
Temperature mapping with nanoscale resolution, providing highly sensitive local thermal analysis while minimizing thermal perturbation of the sample.

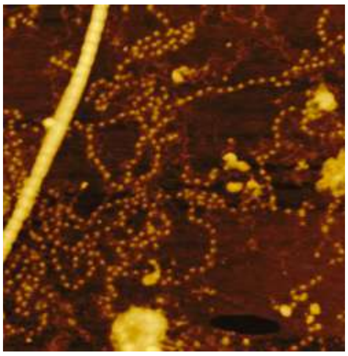
EZ Liquid AFM Accessory

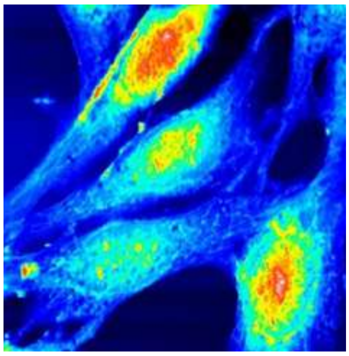
The EZ Liquid accessory enables liquid environment imaging with the Nano-Observer II.
The specially designed cell and tip holder support both contact and resonant modes, with an optional connector for electrochemistry experiments via bi-potentiostat.



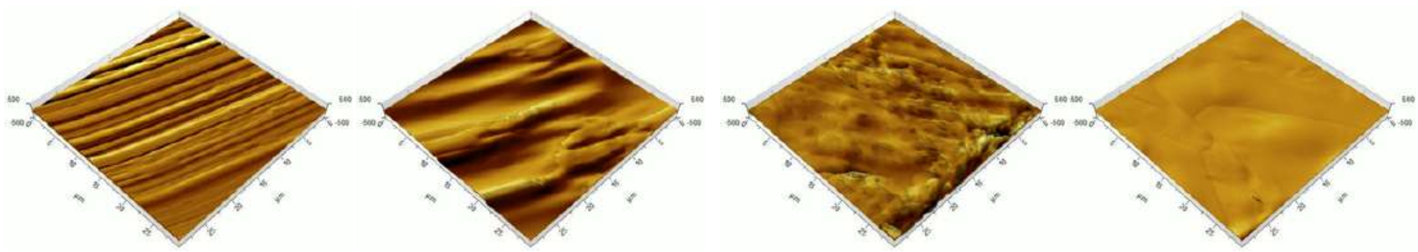


Liquid Cell


Proteins


Embryonic Fibroblast

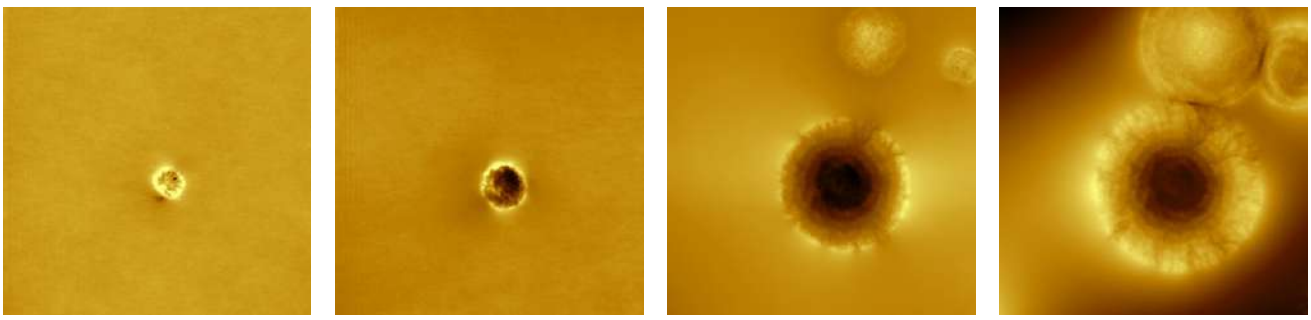
Electrochemical AFM (EC-AFM)



Phase 1 ***Phase 2*** ***Phase 3*** ***Phase 4***

Application - Electropolishing of stainless steel (316L)

EZ TEMP - Temperature Control from -40°C to 300°C



PCL Spherulite growing under controlled temperature

MODES & KEY APPLICATIONS

Imaging Modes
- Soft Interaction Control
- Contact/Friction
- Resonant/Oscillating

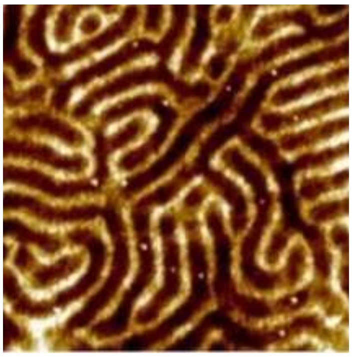
Electrical Modes (DC)
- ResiScope™ III
- Conductive AFM (C-AFM)
- Piezo Response Force Microscopy (PFM)
- Scanning Microwave Impedance Microscopy (sMIM)

Electrical Modes (AC)
- HD-KFM™ III
- Kelvin Force Microscopy (KFM)
- Electrostatic Force Microscopy (EFM)

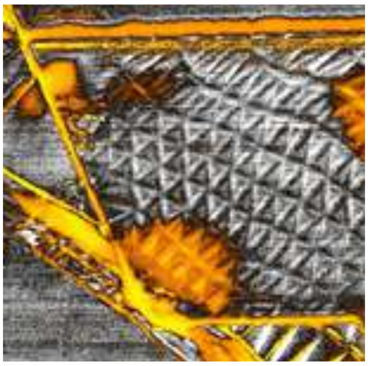
Magnetic Modes (AC)
- Magnetic Force Microscopy (MFM)
- Variable Magnetic Field Module

NanoMechanical Modes
- Phase (AC Mechanical Contrast)
- Force Modulation
- Soft MEKA
- Nano-Indentation
- Friction (LFM)
- Force Spectroscopy

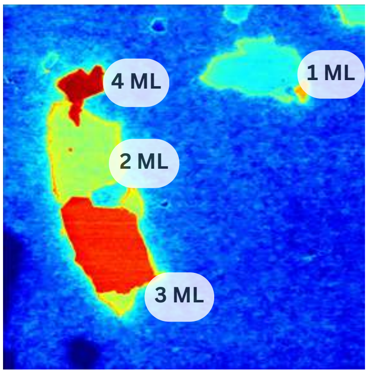
Environmental Control
- EZ Temperature
- EZ Liquids
- Electrochemistry Cell
- Gas/Humidity Control
- Scanning Thermal Microscopy (SThM)



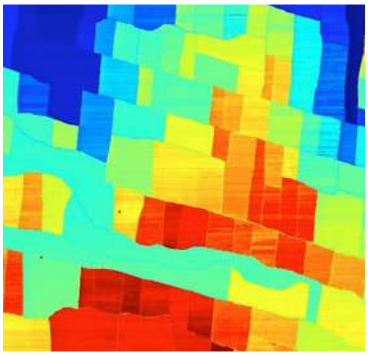
Block Copolymer - Resonant Mode
Block Copolymer showing lamellar structure with separation of 80 nm



Folded hBN sample - PFM Mode
2x2 µm PFM Scan of hBN Moiré



Graphene Sample on Si - HD-KFM
Stacks of Graphene monolayers are clearly detected by HD-KFM.



VO2 - ResiScope
Vanadium dioxide blocks with different resistance separated by insulating VO2 walls.

Controller Specifications

XY scan range	100 µm (tolerance +/- 10%)
Z range	15µm (tolerance +/- 10%)
XY drive resolution	24-bit control - 0.06 Å
Z drive resolution	24-bit control - 0.006 Å
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)
Interface	USB 2.0
Controller Power	AC 100 – 240V - 47-63 Hz
Operating System	Windows 11

Accessories

- Liquid cell
- Temperature control
- Thermal analysis
- Environmental chamber
- Magnetic field generator

CSInstruments is a French scientific equipment manufacturer specializing in the design of Atomic Force Microscopes and options designed for existing AFMs. The company was founded by a team of experts working in the AFM field for more than 30 years, starting as pioneers with some historical manufacturers. Taking the best of this experience to create the Nano-Observer, a high-quality research AFM giving life to an affordable solution for any research laboratory or industry.

Local contact: