Park NX12

The Ideal Choice for Biological and Electrochemical Studies

NX12 is a specialized atomic force microscope (AFM) for materials science, electrochemical, and biochemical research. It delivers nanoscale imaging and property characterization in both liquid and ambient environments, integrating scanning probe techniques with inverted optical microscopy for comprehensive analysis of dynamic processes.

At its core, NX12 combines Park's True Non-contact™ mode and an orthogonal scan system with nanopipette-based techniques, enabling precise topography and correlative measurements that connect structural, mechanical, electrical, and optical information on the same sample.

NX12 supports a variety of specialized experiments, including non-invasive in-liquid imaging of live cells with SICM and high-resolution mapping of local reactivity with SECM/SECCM. Its digitally controlled environmental chamber maintains stable gas and temperature conditions for reliable, reproducible research.

NX12 – Key Features

Specialized Bio AFM & Electrochemical Capabilities

- Integration with Inverted Optical Microscopy
- In-Liquid AFM Imaging for Biological Applications
- Environmental Control Chamber
- Nanopipette-Based Applications

Outstanding AFM Performance

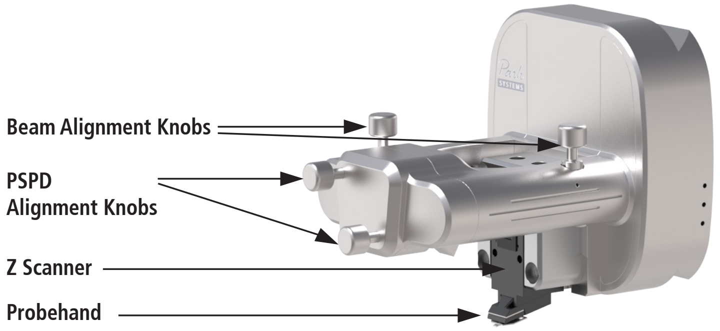
- True Non-Contact™ Mode
- Orthogonal Scan System
- Fast Z-Servo Speed
- Easy Probe Exchange
- Comprehensive Selection of AFM Modes

Park NX12

Next-Generation AFM Integrated with Inverted Optical Microscopy

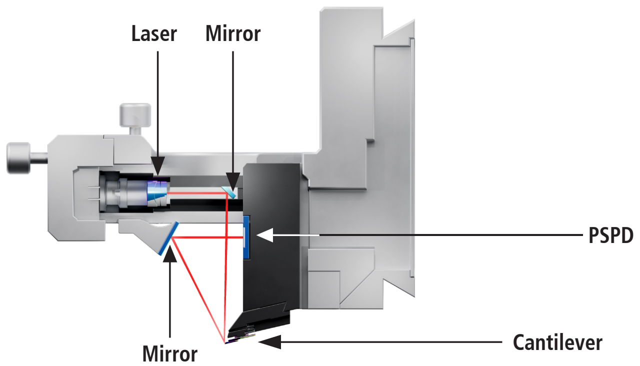
Fast Z Servo and High Resolution

The resolution of the images in Park NX series has been further enhanced. The NX Z scanner, built with a stacked piezo actuator and a strain gauge sensor, delivers fast and precise measurements across a wide range of surfaces.
From extremely flat to rough samples, it maintains consistent roughness linearity regardless of scan size, ensuring reliable results in any measurement.



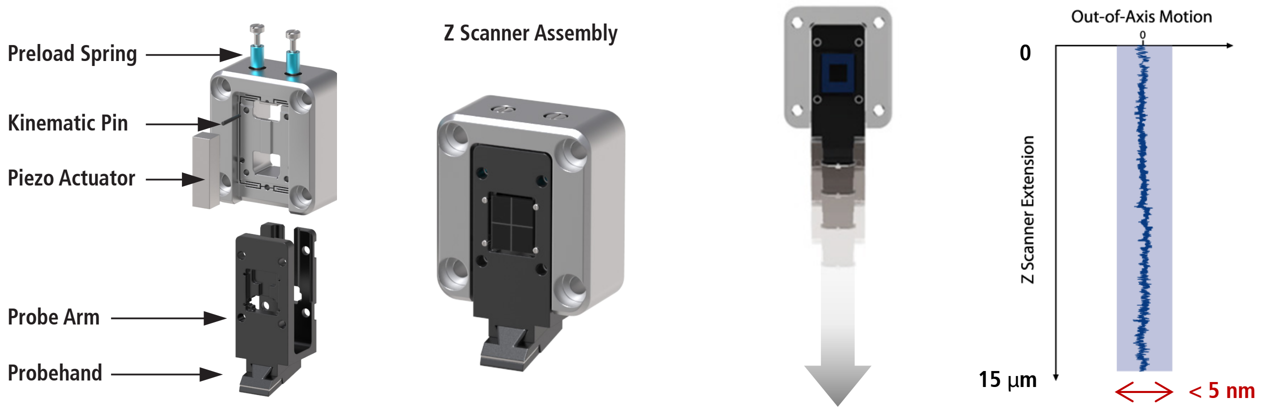
NX Laser Beam Path

The NX head integrates a superluminescent diode that provides low coherence illumination, minimizing interference for stable signal detection. The laser beam is guided through precision mirrors to the cantilever and position-sensitive photodetector (PSPD), ensuring accurate signal alignment.
The knobs move the laser beam directly along the X and Y axes, allowing intuitive adjustment of the beam position and effortless realignment during probe replacement.



Improved Z Scan Straightness

Park NX series Z scanner maintains straightness within 0.1% across the usable range, with out-of-axis motion under 5 nm even at a full 15 µm extension. Its compact assembly, combining a preload spring, kinematic pin, and piezo actuator, minimizes drift and ensures accurate vertical motion for reliable, distortion-free nanoscale measurements.



Integration with Inverted Optical Microscopy

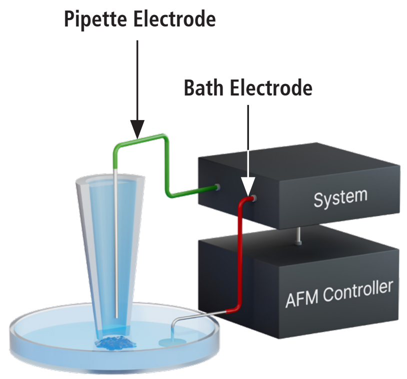
NX12 provides a seamless integration with inverted optical microscopy, offering researchers the ability to combine the large field-of-view of optical imaging with the nanoscale resolution of AFM.
This correlative setup makes it possible to analyze samples across multiple length scales in a single workflow.
It is particularly valuable for transparent samples and biological research, where both cellular-level structures and nanoscale details must be studied together.

Nanopipette-Based Applications

NX12 is not limited to conventional AFM imaging.
It also supports advanced applications such as SICM, SICM-SECM, and SECCM. These techniques allow nanoscale electrochemical and ionic imaging, giving researchers powerful tools to explore new areas.
With these applications, users can go beyond surface topography to investigate ion-related processes, electrochemical activity, and surface reactivity.
This makes the NX12 a versatile platform, suitable not only for materials science but also for biological and electrochemical research.

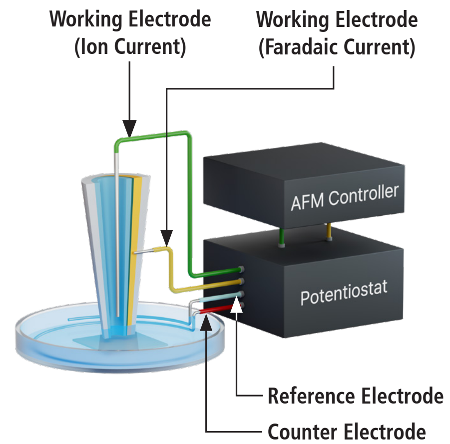
SICM

Measures surface topography of soft, liquid-immersed or biological samples by monitoring ionic current through a nanopipette in liquid environments.



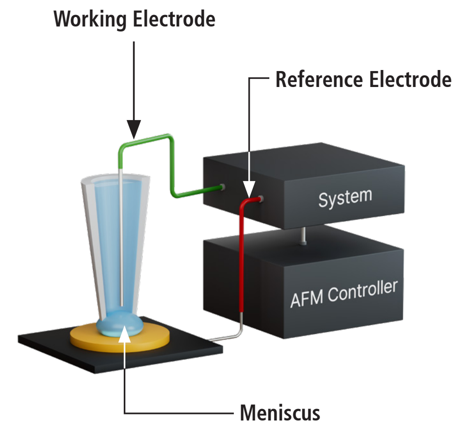
SICM-SECM

Enables simultaneous mapping of surface topography and local electrochemical activity in liquid environments.



SECCM

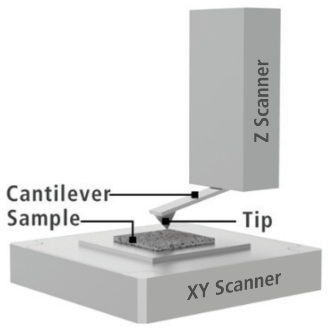
Analyzes localized electrochemical reactions through a nanopipette meniscus without immersing the entire sample in liquid.



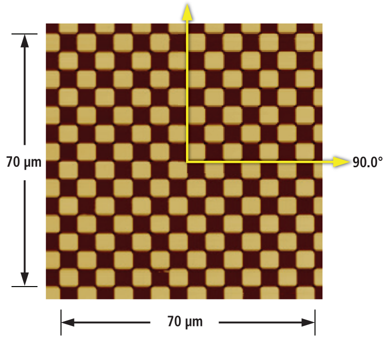
Park AFM Technology

Orthogonal Scan

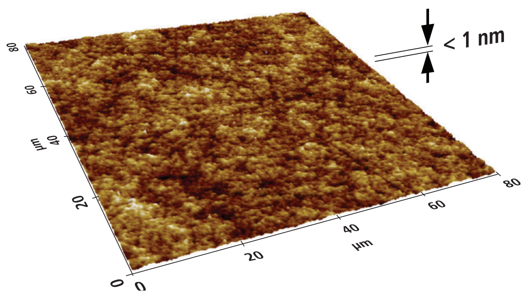
Conventional AFMs with tube scanners suffer from out-of-plane motion and axes crosstalk, resulting in image distortion, especially over large scan areas. NX12, like all Park AFMs, employs an advanced orthogonal scan system featuring a flexure-guided architecture: a 2D flexure scanner moves the sample in the XY plane, while a separate 1D flexure scanner independently controls the probe's Z-axis motion.
Equipped with low-noise optical sensors for XY feedback and an ultra-low-noise strain gauge sensor for Z control, this separated scanner system ensures highly orthogonal, linear scans with minimal out-of-plane motion and fast dynamic performance.



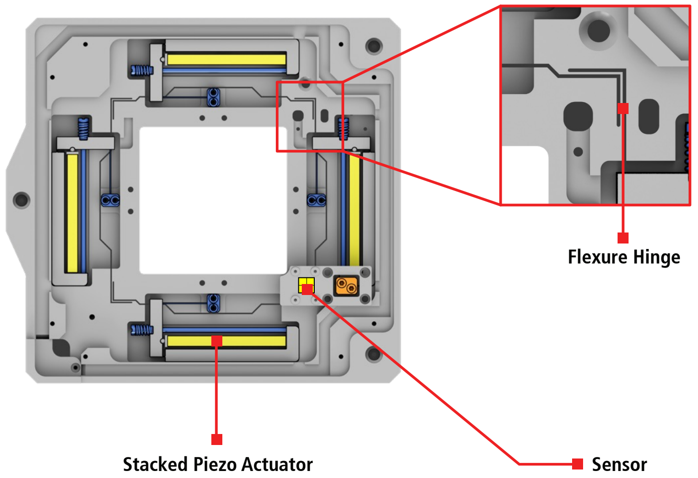
10 µm Pitch Calibration Grating



Optical Flat (80 × 80 µm)



Inside View of XY Scanner

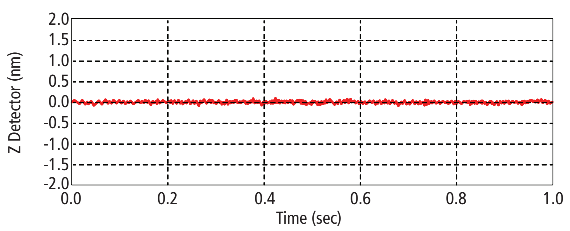


The XY scanner is designed to achieve flat, purely horizontal motion without vertical interference by using stacked piezo actuators and flexure hinge structures.
A position sensor provides direct feedback for servo control, minimizing positioning errors across the scan area. This design ensures consistent accuracy and stability, even when scanning large samples.

Low Z Detector Noise

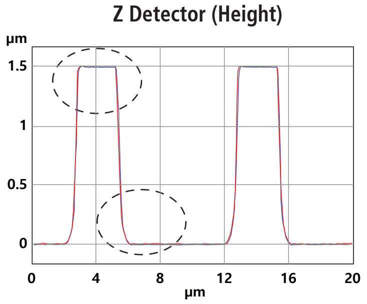
The Z detector has a noise level of less than 0.02 nm, enabling height measurements with sub-nanometer accuracy, down to 0.1 nm. Unlike conventional Z voltage mapping, which often overshoots at stiff walls, the Z detector provides precise, conformal surface tracing.

Z Detector Noise

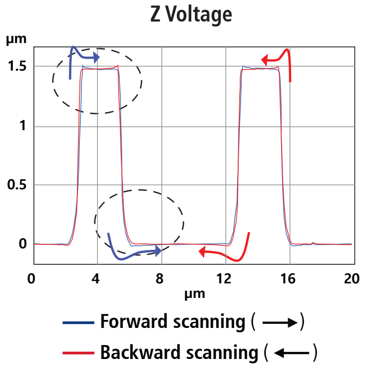


0.02 nm (rms), 1 kHz BW

Z Detector (Height)

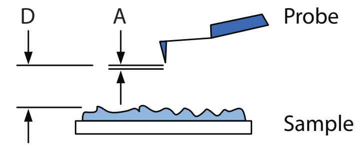


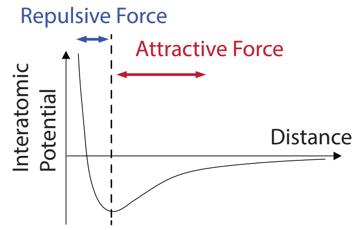
Z Voltage

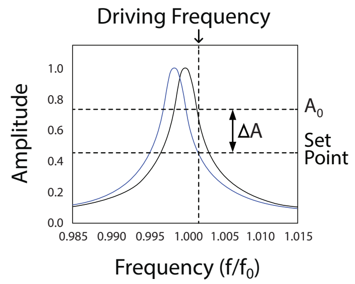


True Non-Contact™ Mode

NX12 features True Non-contact™ mode, a proprietary technology exclusively offered by Park Systems. True Non-contact mode obtains topography by detecting the attractive van der Waals force between the AFM tip and the sample surface.



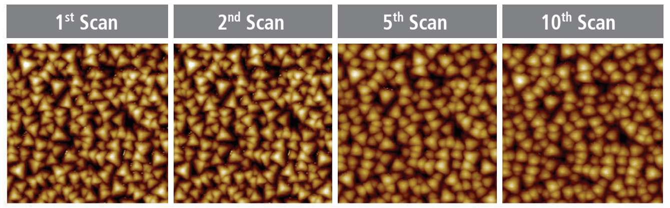




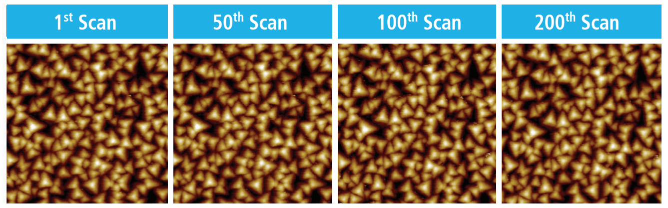
In True Non-contact mode, the tip oscillates at a frequency slightly higher than its resonance frequency, where the amplitude-frequency curve has its steepest slope.

As the tip approaches the sample, the attractive force causes a downshift in the effective resonance frequency, leading to a decrease in oscillation amplitude at the driving frequency. The Z-servo maintains this new amplitude as the set point, keeping a constant tip-sample interaction while the tip scans in the XY direction.

Tapping Mode



True Non-Contact Mode



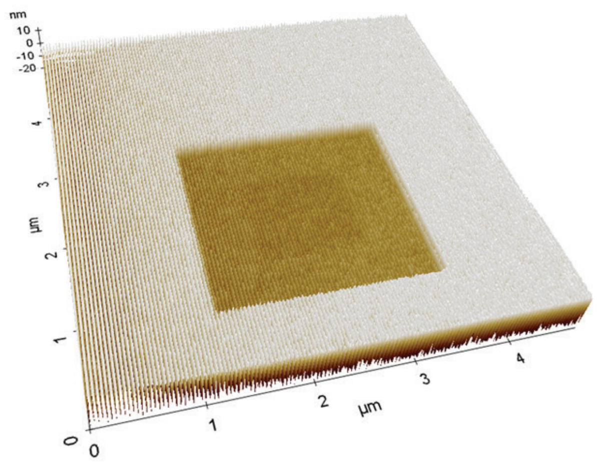
CrN Tip-checking Sample

An important advantage of True Non-contact mode, compared to tapping mode, is the prevention of tip wear and sample damage. The results of repetitive scans on a chromium nitride (CrN) tip-checking sample show that while the tapping mode image became blurry after just a few scans due to tip wear, the True Non-contact mode image remained sharp even after 200 scans.

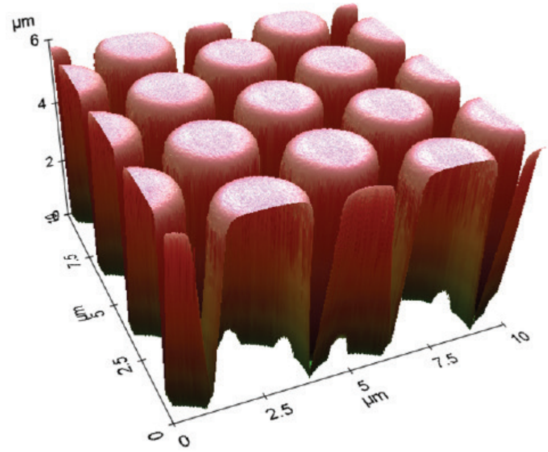
True Non-contact mode can measure soft and sticky samples as well as the most delicate and brittle samples, which cannot be imaged with tapping mode AFM. The image below is the topography of an unbaked photoresist acquired with True Non-contact mode, showing damages induced by electron beam irradiation during SEM scanning.

True Non-contact mode can also scan tall features. By sensing attractive forces not only at the apex of the tip but also along its sides, the Z-servo quickly retracts the tip as it approaches vertical features. With True Non-contact mode, deep holes and tall pillars like molds for nanoimprint can be measured, as in the image below.

Unbaked Photoresist



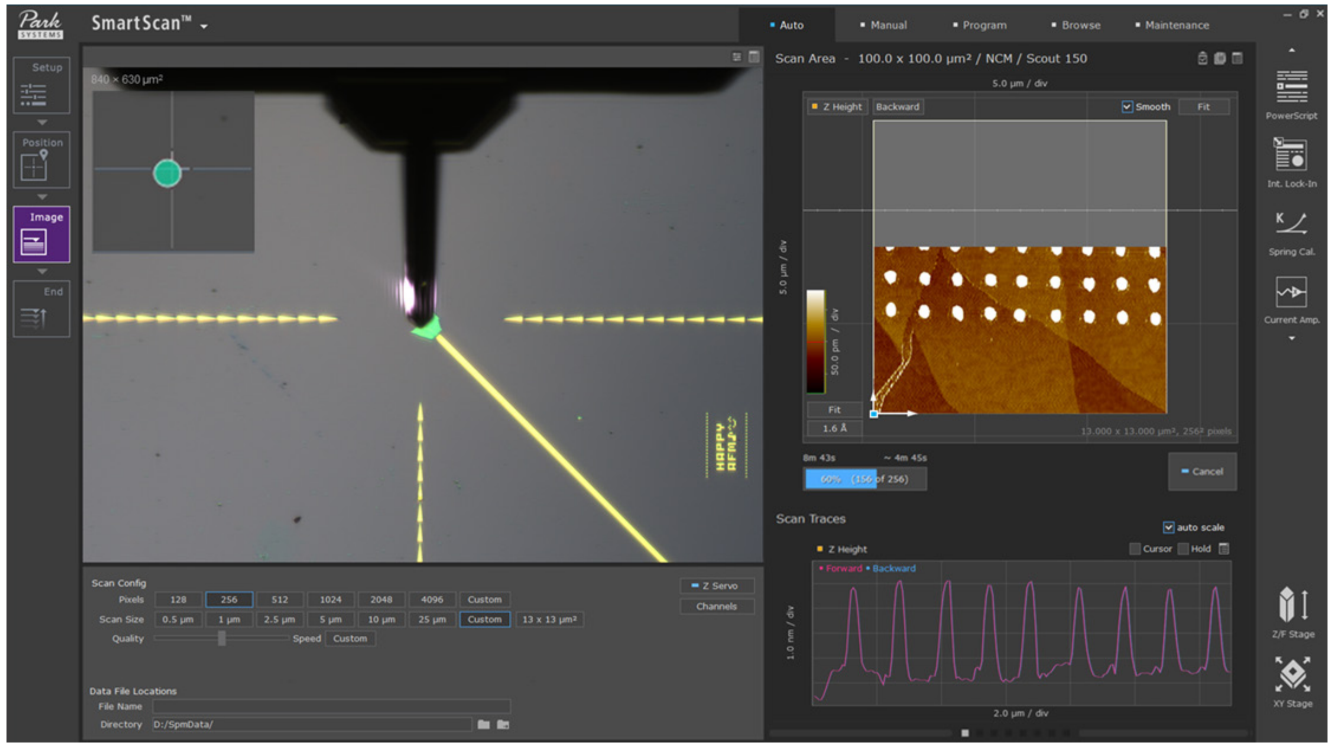
Mold for Nanoimprint



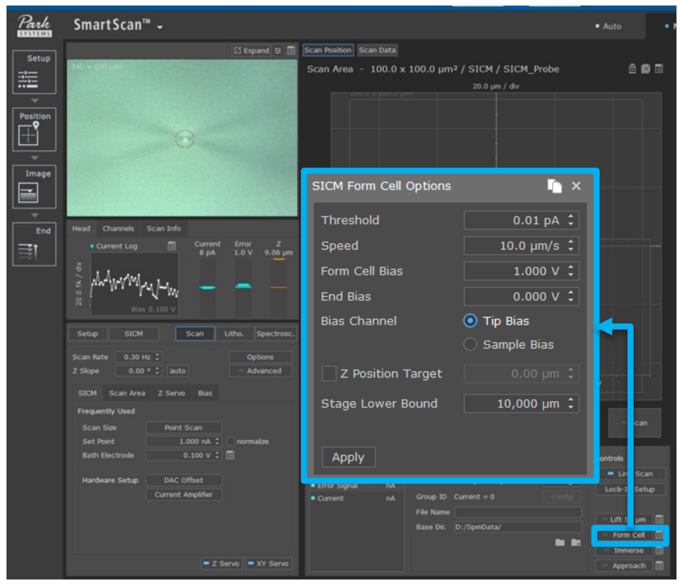
Park SmartScan™

Bringing the Power and Versatility of AFM Technology to Everyone

NX12 comes with Park SmartScan™, an advanced AFM operating software that simplifies image acquisition and enhances usability with its intuitive interface and powerful automation features.



In conventional AFM systems, users must manually adjust numerous parameters, such as Z servo gains, force setpoint, and XY scan speed, often through trial and error. SmartScan eliminates this complexity by allowing users to choose only three parameters: pixel density, scan size, and quality vs. speed preference. Then, all other settings are automatically optimized in real time by analyzing sample geometry and obtaining the best possible AFM images. SmartScan reduces the operational burden and makes high-quality imaging accessible to users of all experience levels.



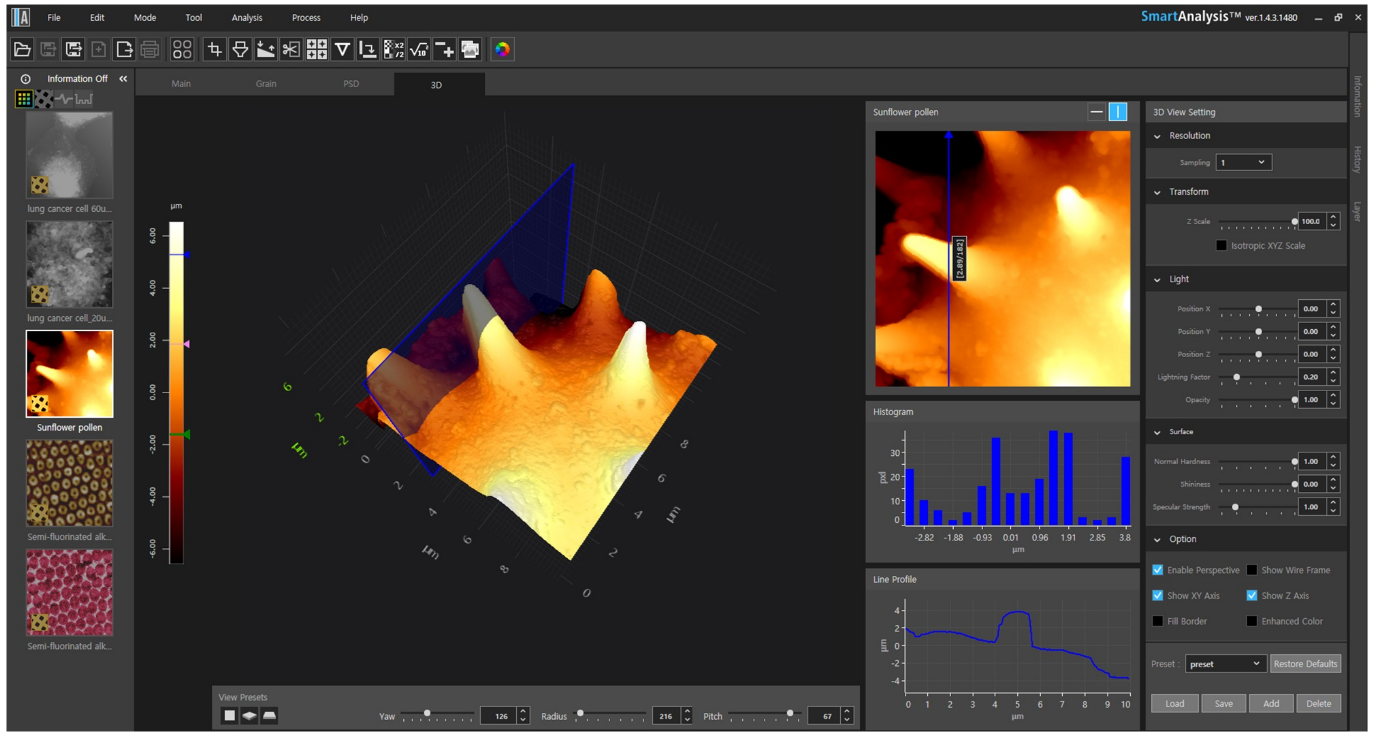
Intuitive Interface for Nanopipette-based Applications

SmartScan provides an intuitive interface for SICM, SICM-SECM, and SECCM applications, offering precise control and real-time monitoring of nanopipette-based measurements for electrochemical and biological studies.

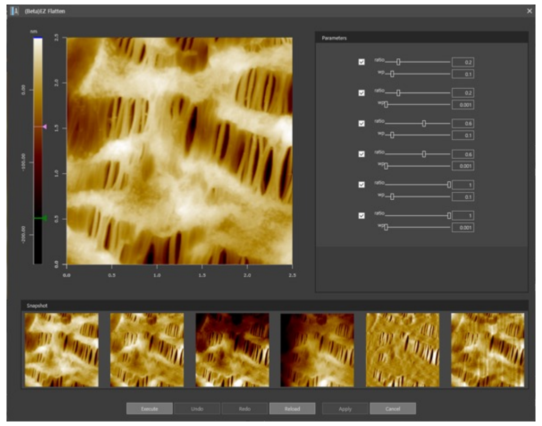
Park SmartAnalysis™

Streamlining AFM Data Workflow

Scan data from NX12 can be analyzed with Park SmartAnalysis™, a powerful AFM image analysis software that enables fast image processing, comprehensive data analysis, and efficient result publication.



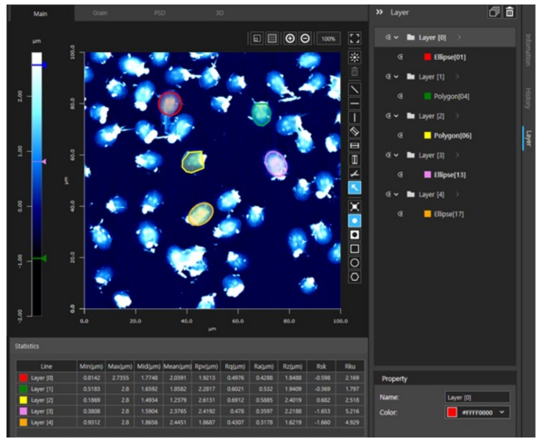
Cellguard Topography
Postprocessed with EZ Flatten



EZ Flatten

Postprocessing AFM data to correct artifacts such as noise, sample tilt, and surface irregularities is a manual, tedious, and time-consuming task. SmartAnalysis simplifies this process through the EZ Flatten function. With six automatically flattened results using different flattening parameter sets, users can choose the version that most accurately represents the data.

Giardia in Liquid Topography
Multiple Areas of Interest Assigned



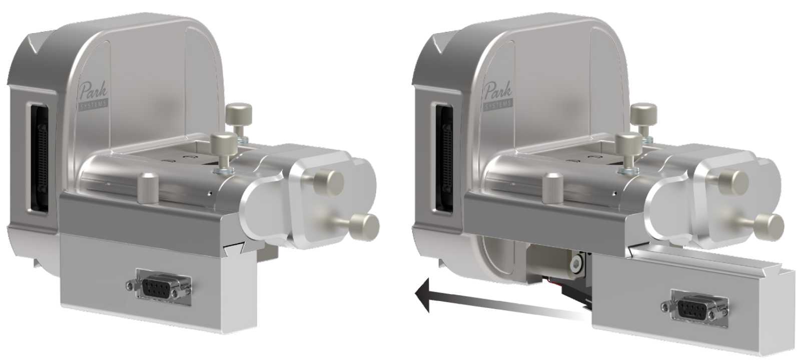
Multilayer Analysis

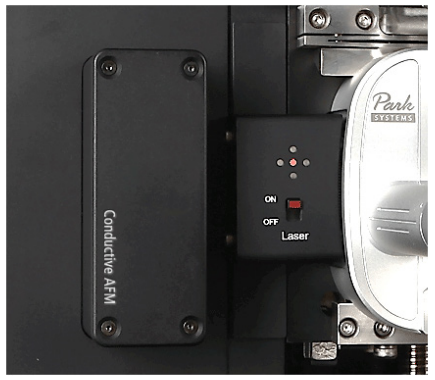
Users can analyze and compare multiple areas of interest at once using a polygonal freeform area drawing tool. Unlike conventional AFM data analysis software that allows inspection of one region at a time, SmartAnalysis provides various metrics for all selected areas simultaneously.

Park NX12
Expanding Research Possibilities

Easy Hardware Setup for Option Modes

NX12 features a modular design that enables a wide range of expansion options for advanced AFM capabilities.
Head Extension Modules (HEMs) can be easily integrated with the NX AFM head to enhance functionality, while option modules plug directly into the expansion slot, simplifying setup for advanced modes.
These modules are cross-compatible within the NX series, allowing for easy sharing and flexibility across different systems.



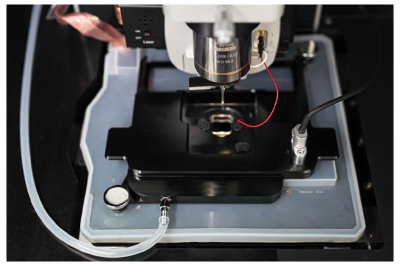


Environmental Control Chamber

The Live Cell Chamber (LCC) is an environmental control solution developed for NX12 to enable long-term in-liquid AFM studies of living cells. It functions as an incubator-like system that maintains stable temperature, humidity, and CO_2 conditions, ensuring cell viability during extended imaging sessions. With compatibility for different sample formats such as cover glass and 7 mm petri dishes, the LCC provides researchers with a versatile setup for studying cell behavior, growth, and response in physiologically relevant environments.

Live Cell Chamber Control System

Live Cell Chamber Installed on NX12



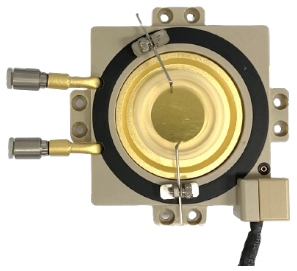
In-Liquid AFM Imaging

NX12 enables stable nanoscale imaging in liquid environments while preserving the native state of biological and electrochemical samples. This capability is compatible with electrochemical AFM (EC-AFM) experiments, enabling researchers to study dynamic processes under physiologically relevant conditions.

Liquid Probehand

Open Liquid Cell

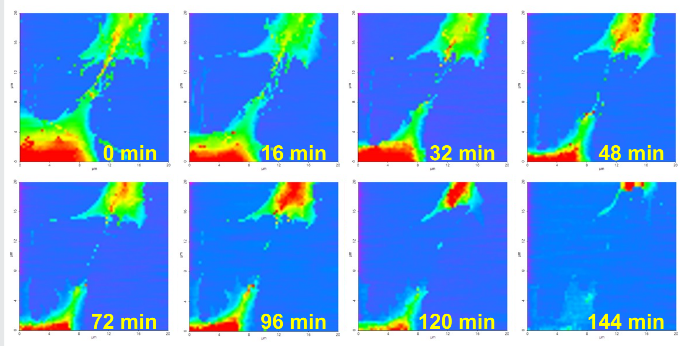
Universal Liquid Cell



Park NX12
Designed for Your Applications

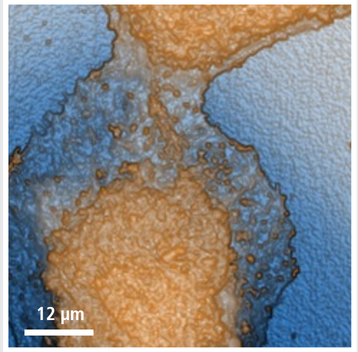
NX12 offers precise measurements for materials science, electrochemical, and biochemical research.

Biological Materials



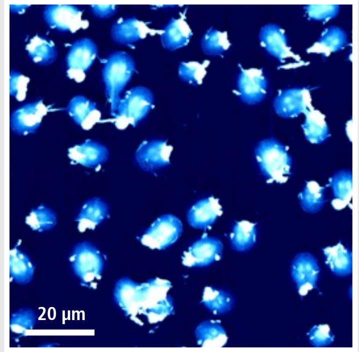
Live Fibroblast Cell

A live fibroblast cell was imaged using scanning ion conductance microscopy (SICM). Sequential topographical images reveal the mobility and shape changes of the living cell, with a peak-to-valley height variation of approximately 13 µm.



Lung Cancer Cell

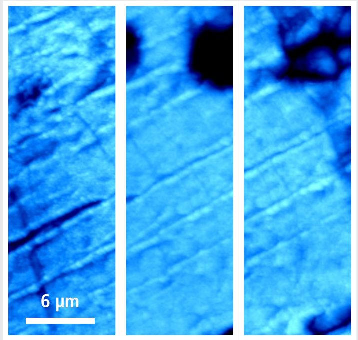
A lung cancer cell was imaged using scanning ion conductance microscopy (SICM).
The topographical image reveals detailed surface structures of the cell, showing a peak-to-valley height variation of approximately 8.17 µm.



Giardia in Liquid

A Giardia sample in liquid was imaged using Tapping mode. The topographical image clearly shows the surface structure of the microorganism, with a peak-to-valley height variation of approximately 2.8 µm.

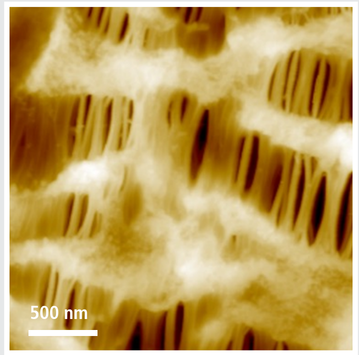
Energy & Advanced Materials



Height of fresh surface | after 5 min stripping | after 5 min plating

Li Surface

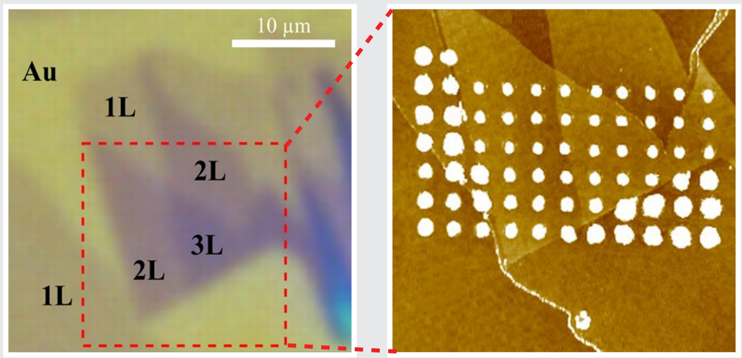
The Li surface was observed using electrochemical atomic force microscopy (EC-AFM) during the stripping–plating process. Sequential height images show the surface evolution from the fresh Li surface to after 5 minutes of stripping and after 5 minutes of plating, visualizing nanoscale changes induced by electrochemical cycling.



Cellguard

A Cellguard sample was imaged using Fast PinPoint™ mode. The topographical image shows nanoscale surface features of the material, with a peak-to-valley height variation of approximately 313 nm.

2D Materials



Footprints of Electrochemical Reaction on $MoSe_2$ Crystals

$MoSe_2$ crystals with varying layer numbers were characterized in True Non-contact mode after scanning electrochemical cell microscopy (SECCM).
The AFM height image (right), acquired from the red box indicated in the optical image (left), reveals nanoscale footprints of localized electrochemical reactions formed during SECCM mapping across the crystal surface.

Park NX12
Technical Specifications

AFM Modes

- Topographic Imaging
  - Contact Mode
    - Constant Height Mode
    - Constant Force Mode
  - True Non-Contact™ Mode
  - Tapping Mode
  - PinPoint™ Mode
  - Fast PinPoint™ Mode
- Mechanical Properties
  - PinPoint™ Nanomechanical Mode
  - Fast PinPoint™ Nanomechanical Mode *
  - Force-Distance (F-D) Spectroscopy
  - Nanoindentation
  - Force Modulation Microscopy (FMM)
  - Dynamic Mechanical Analysis (DMA) *
  - Torsional Force Microscopy (TFM) *
  - Lateral Force Microscopy (LFM)
- Electrical Properties
  - Conductive AFM (C-AFM) *
    - Current-Voltage (I-V) Spectroscopy
  - Scanning Spreading Resistance Microscopy (SSRM) *
  - Scanning Tunneling Microscopy (STM) *
  - Scanning Capacitance Microscopy (SCM) *
  - Piezoresponse Force Microscopy (PFM)
    - Piezoresponse Spectroscopy
    - Off-resonance PFM
    - Contact Resonance PFM (CR-PFM) *
    - Dual Frequency Resonance Tracking PFM (DFRT-PFM) *
  - PinPoint™ Nanoelectrical Modes *
  - Electrostatic Force Microscopy (EFM)
  - Kelvin Probe Force Microscopy (KPFM)
    - Heterodyne KPFM *
    - Sideband KPFM
    - Amplitude Modulation KPFM (AM-KPFM)
- Magnetic Properties
  - Magnetic Force Microscopy (MFM)
    - Frequency Modulation MFM (FM-MFM)
    - Amplitude Modulation MFM (AM-MFM)
- Thermal Properties
  - Scanning Thermal Microscopy (SThM) *
    - Temperature Mapping
    - Thermal Conductivity Mapping
- Nanolithography & Manipulation
  - Nanolithography *
  - Nanomachining *
- In-liquid Operation
  - In-liquid Topography *
  - Scanning Ion Conductance Microscopy (SICM) *
- Electrochemical Properties
  - Electrochemical AFM (EC-AFM) *
  - Scanning Ion Conductance Microscopy-Scanning Electrochemical Microscopy (SICM-SECM) *
  - Scanning Electrochemical Cell Microscopy (SECCM) *

Scanner

- XY scanner (100 µm × 100 µm)
- Flexure-guided high-force Z scanner (15 µm or 30 µm)

Sample Mount

- 50 mm x 50 mm (w × d), up to 20 mm thickness

On-axis Optics Microscope

- Direct on-axis vision of sample surface and cantilever
- Field of view: 840 µm × 630 µm (w/ 10× objective lens)
- CCD: 5 M Pixel

Stage

- XY stage: 10 mm × 10 mm
- Z stage: 25 mm
- Focus stage: 15 mm

Dimension and Weight

- AE (Outer): 880 mm × 1,000 mm × 1,500 mm
- Desk: 1,410 mm × 810 mm × 740 mm
- Total weight: 420 kg (AFM Body + IOM + AE)

Required Environment

- Required acoustic noise level: Below 65 dB
- Required floor vibration level: VC-D (6.25 µm/sec)
- Power: 1 kW (Maximum)

** Requires additional options*