

NX10
Atomic Force Microscope

Park Systems Corp.
KANC 4F, Iui-Dong 906-10,
Suwon, 443-270, Korea
Tel. +82-31-546-6800 Fax. +82-31-546-6805
www.parkAFM.com

Park Systems Japan
NK Dai-ichi Bldg. 5F, 1-17-1 Kanda-Nishikicho,
Chiyoda-ku, Tokyo 101-0054, Japan
Tel. +81-3-3219-1001 Fax. +81-3-3219-1002
www.parkAFM.co.jp

Park Systems Singapore
33 UBI AVE 3 #07-47 VERTEX TOWER A,
SINGAPORE 408868
Tel. +65-6746-8438 Fax. +65-6746-8436
www.parkAFM.com

Park Systems Inc.
3040 Olcott St. Santa Clara,
CA 95054, USA
Tel. +1-408-986-1110 Fax. +1-408-986-1199
www.parkAFM.com

Park
SYSTEMS

NX
THE ACCURATE CHOICE



The World's Most Accurate **AFM**

Data accuracy is of paramount importance to nanotechnology researchers as the credibility of their research depends upon accurate results. The NX10, the world's most accurate AFM, is the flagship AFM of Park Systems' new product line. The NX10 brings unparalleled imaging accuracy, scan speeds, and tip life to the next generation of researchers, all at an affordable price. The NX10 is the world's premium research-grade True Non-Contact AFM, featuring industry-leading Z-servo speed, XYZ scanner linearity, closed-loop detector noise, and minimized thermal drift. As Park Systems' most user-friendly AFM, the NX10 makes AFM convenient and intuitive for new and experienced users alike.

NX10

Accurate AFM Imaging by Crosstalk Elimination

- Industry leading XYZ scan linearity with two independent flexure scanners for sample and tip
- Best out-of-plane motion of less than 1 nm over entire XY scan range
- Z scanner linearity of less than 0.015%
- Reduced XY scanner ringing by forward sine-scan algorithm

Accurate AFM Scan by True Non-Contact Mode™

- Industry leading Z-scanner bandwidth of more than 9 kHz, or Z-servo speed of more than 62 mm/sec tip velocity
- Fastest scan speed in non-contact mode imaging
- Less tip wear for prolonged high-quality scans
- Minimized sample damage or modification

Accurate AFM Measurement by True Sample Topography™

- Sample topography measured by industry leading low noise Z detector
- Industry leading, small forward and backward scan gap of less than 0.15%
- Minimized system drift and hysteresis by thermally matched components
- Active temperature control of acoustic enclosure

NX User Productivity

- Easy tip exchange with wide open side access to the tip and sample
- Easy, intuitive laser alignment with pre-aligned tip mount and patented on-axis, top down view
- Fast automatic tip approach to sample surface within 10 seconds
- 24 bit digital electronics with three internal lock-ins, Q-control, and spring constant calibration



THE ACCURATE CHOICE |



ACCURATE AFM SOLUTIONS

- High background curvature
- Software processing required (processed data)
- Results highly dependent on scan location



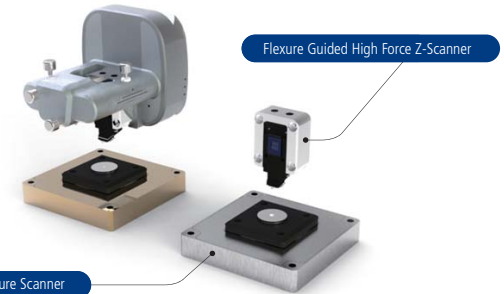
Non-Linear XY Scan

The conventional AFM uses a piezoelectric tube for the x-y-z scanner, where x-y motion relies on the bending of the tube. The bending motion, however, introduces background curvature and causes a high-order and non-linear scan, which is the primary cause for inaccurate and processed images. Software flattening is usually needed for conventional systems to hide the background curvature. A "flat surface" obtained through software flattening, however, cannot produce a truly flat image since the amount of curvature depends on various parameters including scan size, scan speed, x-y offset, z position, etc. Through software flattening, the scan also fails to display orthogonality, and produces significant X and Y shifting.

- Low residual bow
- No need for software processing (raw data)
- Results less dependent on scan location



Parallel Kinematic 2D Flexure Scanner



Park Systems' Solution: Flat Orthogonal XY Scanning Without Scanner Bow

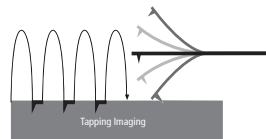
Park Systems' Crosstalk Elimination removes scanner bow, allowing flat orthogonal XY scanning regardless of scan location, scan rate, and scan size. It shows no background curvature even on scans of the flattest samples such as that of an optical flat, even with various scan offsets. This enables very accurate height measurement and precision nanometrology for the most challenging problems in research and industry.

- Quick tip wear = Blurred low-resolution scan
- Destructive tip-sample interaction = Sample damage and modification
- Highly parameter-dependent



Difficulty in Tip and Sample Preservation

Conventional AFM uses a tube scanner with a slow actuator that has highly limited Z-scan bandwidth of only 500 Hz or so. The Z-servo response is too slow to implement Non-Contact Mode, a critical requirement for preservation of tip sharpness and non-destructive imaging of soft biological samples.



- Less tip wear = Prolonged high-resolution scan
- Non-destructive tip-sample interaction = Minimized sample modification
- Immunity from parameter-dependent results



Park Systems' Solution: Non-destructive Scanning by Non-Contact AFM

Park Systems' development of Crosstalk Elimination and high force Z-scanner with large Z-servo bandwidth enables True Non-Contact Mode™. It minimizes tip and sample damage and prolongs high-resolution imaging, ultimately producing the most accurate and reproducible AFM results.



- Applied voltage to Z scanner is used for Topography
- Hysteresis of piezoelectric actuators causes errors
- Edge overshoot at the leading and trailing edges
- Requires regular calibrations as the piezoelectric actuator ages



Position Error by Piezo Creep

Conventional AFM calibrates the applied voltage to the Z scanner and uses it for the Topography signal. However, the hysteresis of piezoelectric actuators in the Z scanner causes positional errors, especially when the cantilever moves in the direction perpendicular to the surface, resulting in edge overshoots at the leading and trailing edges. Hence, the piezo creep affects the accuracy of the height measurement. Moreover, the initial calibration will change over time as the piezoelectric material ages and requires laborious recalibration.



- Z detector signal is used for Topography
- Industry leading low noise XYZ position sensors
- No edge overshoot at the leading and trailing edges
- Calibration needs to be done only once at the factory



Park Systems' Solution: Sample Topography Measured by Low Noise Closed-Loop Sensors

Piezo creep error can only be corrected by independent position sensors, whose noise level is low enough to be used as the Topography signal. The Park Systems' advanced XYZ closed-loop scanning is based on industry-leading low-noise Z position sensor. By using a Z position sensor to monitor the real-time extension of the Z scanner, the true heights of sample surface features are recorded, even during high-speed scanning, without the effects of piezo creep or edge overshoot. With its advanced closed-loop scanning design, True Sample Topography™ is obtained without any need for frequent and cumbersome recalibration.



FEATURES

1 2D Flexure-Guided XY Scanner with 50 μm x 50 μm Scan Range

The XY scanner consisting of symmetrical 2-dimensional flexure and high-force piezoelectric stacks provides high orthogonal movement of minimal out-of-plane motion as well as high responsiveness essential for precise sample scanning in the nanometer scale. An XY scanner with optional scan size is available and has up to 100 μm wide scan range.

2 High Speed Z Scanner with 15 μm Scan Range

Driven by high-force piezoelectric stack and guided by a flexure structure, the standard Z scanner has a high resonant frequency of more than 9 kHz (typically 10.5 kHz), or Z-servo speed of more than 62 mm/sec tip velocity, which enables accurate feedback. An optional Z scanner with longer scan range is available and has up to 40 μm scan range.

3 Fast Automatic Tip Approach

After a cantilever is loaded, the AFM head automatically approaches to a sample surface within 10 seconds by monitoring the cantilever response to the approaching surface. Fast feedback by the high speed Z scanner and low noise signal processing by the NX electronics controller enable the quick engagement to the sample surface without any intervention from a user.

4 Low Noise XYZ Position Sensors

The industry leading low noise Z detector replaces the applied Z voltage as the Topography signal. In addition, the low noise XY closed loop scan minimizes the forward and backward scan gap to be less than 0.15%.

5 Embedded Motorized XY Sample Stage

The measurement location of the sample is easily and precisely controlled by the integrated motorized XY stage. The travel range of the XY sample stage is 20 mm x 20 mm.

6 Accessible Sample Holder

The unique head design allows an open side access to a sample and the tip. The maximum sample size one can place on the stage is 50 mm x 50 mm x 20 mm.

7 Expansion Slot for Advanced SPM Modes and Options

Advanced SPM modes are enabled by simply plugging an option module to the expansion slot. The modular design of the NX-series AFM allows the option compatibility throughout its product line.

Low-profile XY Scanner

Low-profile XY Stage



Minimal Thermal Drift and Hysteresis

Low thermal drift requires a careful electrical and mechanical design to reduce the undesired motion of the tip relative to the sample. Designed to be mechanically and thermally stable, the AFM body of the new NX-series AFM is optimized with thermally matched components and materials and provides the optimal condition for precise AFM measurements. A typical thermal drift rate is less than 100 nm/°C for the lateral and 200 nm/°C for the vertical.

Steel

Stainless Steel

Maraging Steel

Al Alloy*

* Thermal expansion coefficient compensated

Steel

8 Vertically Aligned Motorized Z Stage and Focus Stage

The focus mechanism for the on-axis optical microscope is motorized and software controlled. The flexibility of the motorized focus stage provides easy approach capabilities essential for transparent samples and liquid cell applications. The motorized Z stage and focus stage move the AFM head to engage the cantilever onto the sample surface. Aligned to the axis of vision in parallel, the Z stage and focus stage maintain the field-of-view while approaching the head.

9 High resolution CCD

The enlarged sensor size of the CCD has the resolution of 0.4 μm , optically limiting, for sample observation.

10 Integrated LED illumination

The software-controlled LED light source provides ample illumination onto the sample surface for clear sample observation.

11 Direct On-axis High Power Optics

Custom designed objective lens with ultra long working distance (50 mm) allows direct on-axis optical view with unprecedented clarity. With EL20X objective lens of Long Travel Head, the enlarged sensor size of the CCD provides the resolution of 0.7 μm for sample observation without compromising the vision quality.

NX USER PRODUCTIVITY



* Easy Tip Exchange

The AFM head is easily inserted or removed by sliding it along a dovetail rail, automatically locking into its pre-aligned position. The unique head design of the crosstalk elimination allows a wide open side access to a sample and the tip. With our advanced pre-aligned cantilever holder, the same probe tip position is guaranteed, time after time, without the need of special tools or head removal. Hence, probe tip and sample exchange are just an easy snap by hand.



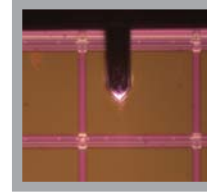
Auto Engage by Slide-to-Connect AFM Head

The AFM head is easily inserted or removed by sliding it along a dovetail rail, automatically locking into its pre-aligned position and connecting to the control electronics with a positioning repeatability of a few microns.



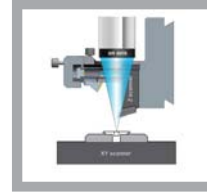
Super Luminescence Diode Head with Wide Side Access

The low coherency of the Super Luminescence Diode (SLD) enables accurate imaging of highly reflective surfaces and precise measurements for pN Force-distance spectroscopy. An additional advantage of the SLD Head is its compatibility with experiments that utilize light in the visible region of the spectrum. The unique head design of the crosstalk elimination allows a wide open side access to a sample and the tip.



* Easy, Intuitive Laser Beam Alignment

With our advanced pre-aligned cantilever holder, the laser beam is focused on the cantilever upon replacement. The natural on-axis top-down view, the first in the industry, allows the user to easily find the laser spot. Since the laser beam falls vertically on a cantilever, the laser spot moves intuitively along X and Y by rotating two positioning knobs. As a result, the laser is easy to find and easy to position on PSPD using our beam alignment user interface. A minor adjustment to maximize the signal is all that is required to start acquiring data - a simple exercise for even a novice.



Direct on-axis optics

The intuitive direct sample view from the top allows users to navigate the sample surface easily to find the target area.



Pre-aligned Cantilever Holder

Pre-mounted on a cantilever carrier, the laser beam is focused on the cantilever upon replacement and the cantilever is ready for scanning without any need of tricky laser beam alignment.



Step-and-Scan Automation

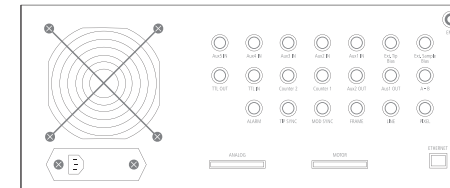
Using the motorized sample stage, Step-and-Scan enables user programmed imaging on multiple regions. The Step-and-Scan process consists of,

- 1) Scan an image
- 2) Lift the cantilever
- 3) Move the motorized stage to a user defined coordinate
- 4) Approach
- 5) Repeat the scan

This automated feature minimizes user's interruption during the repetitive imaging.

High Speed 24-bit Digital Electronics

All the NX-series AFMs are controlled and processed by the same NX electronics controller. The controller is an all digital, 24-bit high speed electronics which successfully realizes the True Non-Contact Mode™ for accuracy and speed. With its low noise design and high speed processing unit, the controller is also ideal for precise voltage and current measurement as well as nanoscale imaging. The embedded digital signal processing capability adds to the functionality and the economics of our AFM solutions for advanced researchers.



24-bit signal resolution for XY and Z detectors

- 0.003 nm resolution in XY (50 μm XY)
- 0.001 nm resolution in Z (15 μm Z)

Embedded digital signal processing capability

- 3 channels of flexible digital lock-ins
- Spring constant calibration (thermal method)
- Digital Q control included

Integrated signal access ports

- Dedicated and programmable signal input/output ports
- 7 inputs and 3 outputs

NX MODES

Today's AFM users need to characterize a wide range of physical properties. The choice of the appropriate SPM mode depends on the specific sample and application of a customer. Park Systems provides the most extensive range of the SPM modes in the industry for the measurement of different sample properties.

Standard Imaging

- True Non-Contact AFM
- Basic Contact AFM and DFM
- Lateral Force Microscopy (LFM)
- Phase Imaging

Chemical Properties

- Chemical Force Microscopy with Functionalized Tip
- Electrochemical Microscopy (EC-STM and EC-AFM)

Dielectric/Piezoelectric Properties

- Electric Force Microscopy (EFM)
- Dynamic Contact EFM (DC-EFM)
- Piezoelectric Force Microscopy (PFM)
- PFM with High Voltage

Force Measurement

- Force Distance (F-D) Spectroscopy
- Force Volume Imaging
- Spring Constant Calibration by Thermal Method

Electrical Properties

- Conductive AFM
- I-V Spectroscopy
- Scanning Kelvin Probe Microscopy (SKPM/KPM)
- SKPM with High Voltage
- Scanning Capacitance Microscopy (SCM)
- Scanning Spreading-Resistance Microscopy (SSRM)
- Scanning Tunneling Microscopy (STM)
- Scanning Tunneling Spectroscopy (STS)
- Time-Resolved PhotoCurrent Mapping (Tr-PCM)

Magnetic Properties

- Magnetic Force Microscopy (MFM)
- Tunable MFM

Mechanical Properties

- Force Modulation Microscopy (FMM)
- Nanoindentation
- Nanolithography
- Nanolithography with High Voltage
- Nanomanipulation
- Piezoelectric Force Microscopy (PFM)

Optical Properties

- Tip-Enhanced Raman Spectroscopy (TERS)
- Time-Resolved PhotoCurrent Mapping (Tr-PCM)

Thermal Properties

- Scanning Thermal Microscopy (SThM)

NX OPTIONS

Modern AFM operation relies on advanced characterization techniques, for imaging samples under such as electrical, magnetic, mechanical, and thermal characterization. Park Systems provides the largest number of AFM options and the best option compatibility and upgradeability in the industry to facilitate the diverse measurement conditions and sample environments for today's AFM users.

Magnetic Field Generator



- Applying external magnetic field parallel to sample surface
- Tunable magnetic field
- Range: -300 – 300 gauss, -1500 – 1500 gauss
- Composed of pure iron core & two solenoid coils

Liquid Probehead



- Designed for imaging in general liquid environment
- Resistant to most buffer solutions including acid
- Contact and Non-contact AFM imaging in liquid

Clip-type Probehead



- Unmounted cantilever can be used
- Tip bias range: -10 V – 10 V
- Tip bias function available for EFM and Conductive AFM
- Support all the standard and advanced modes but STM, SCM, and in-liquid imaging

Temperature Control Stages



- Type 1: 0 °C – 180 °C
- Type 2: Ambient – 250 °C
- Type 3: Ambient – 600 °C

Liquid Cell



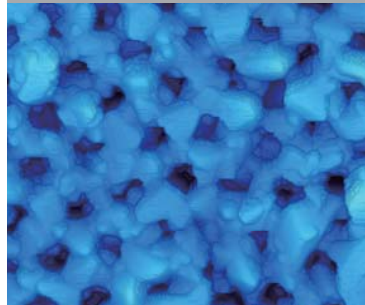
- Universal liquid cell
- Open or closed liquid cell with liquid/gas perfusion
- Temperature control range: 4 °C – 110 °C (in air), 4 °C – 70 °C (with liquid)
- Open/closed liquid cell
- Electrochemistry cell

Signal Access Module (SAM)

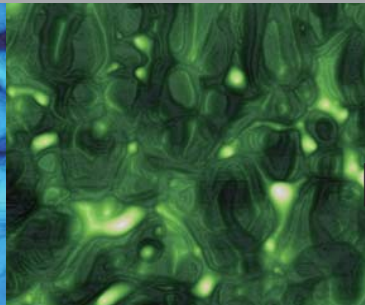


- Enables access to various input/output signals for AFM
- Scanner driving signal for the XY and Z scanners
- Position signal for the XY and Z scanners
- Cantilever deflection signals of the vertical/lateral direction
- Bias signal for the sample and the cantilever
- Driving signal for NX10
- Auxiliary input signal to the system

Anodized aluminum oxide
Scan size: 1 µm



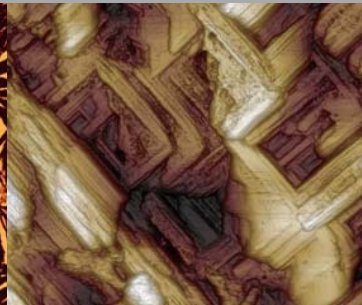
Amorphous silicon
Scan size: 2 µm



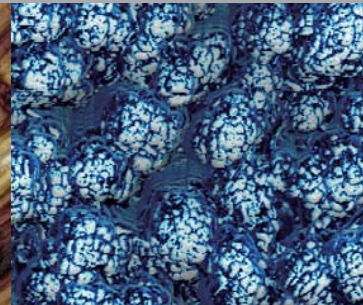
Phase image of Pyrene Carbonate
Scan size: 30 µm



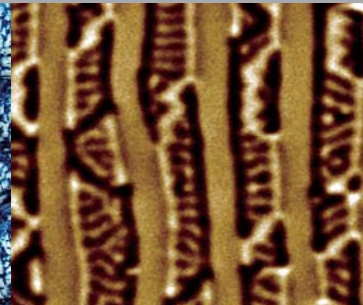
STM image of YBCO super conductor
Scan size: 2 µm



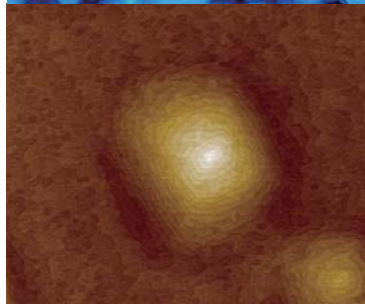
LiCoO2 coating on a glass substrate
Scan size: 1 µm



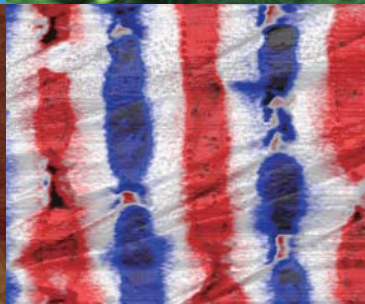
Magnetic domain of MnAs
Scan size: 5 µm



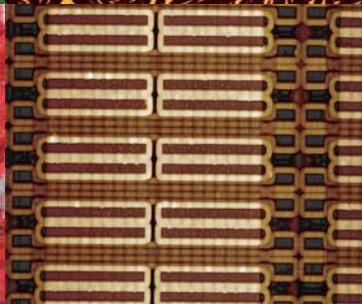
Atomic steps of InAs on GaSb substrate
Scan size: 2 µm



Surface potential of a charged ceramic capacitor
Scan size: 8 µm



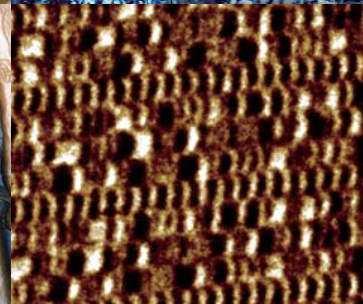
EEPROM surface
Scan size: 40 µm



Paper surface
Scan size: 80 µm



Magnetic domain of High-density HDD media
Scan size: 2 µm



Phase image of block copolymer
Scan size: 5 µm



SPECIFICATION

Scanner	XY scanner	Z scanner	Stage
	Single module flexure XY-scanner with closed-loop control Scan range: 50 µm × 50 µm (optional 100 µm × 100 µm) Resolution: 0.05 nm Position detector noise: < 0.3 nm (bandwidth: 1 kHz) Out-of-plane motion: < 1 nm (over 40 µm scan)	Guided high-force flexure scanner Scan range: 15 µm (optional 40 µm) Resolution: 0.001 nm Position detector noise: 0.03 nm (bandwidth: 1 kHz) Resonant frequency: > 9 kHz (typically 10.5 kHz) Topography noise: < 0.03 nm (0.02 nm typical)	Sample size: up to 50 mm x 50 mm, up to 20 mm thickness Sample weight: up to 500 g XY stage travel: 20 mm x 20 mm Z stage travel: 25 mm Focus stage travel: 15 mm
Vision		Objective lens	Software
	Direct on-axis vision of sample surface and cantilever Field-of-view: 480 × 360 µm (with 10x objective lens) CCD: 1 Mpixel (pixel resolution: 0.4 µm)	10x (0.21NA) ultra-long working distance lens (1 µm resolution) 20x (0.42 NA) high-resolution, long working distance lens (0.6 µm resolution)	NXP Dedicated system control and data acquisition software Adjusting feedback parameters in real time Script-level control through external programs (optional)
Electronics	Signal processing	Integrated functions	External signal access
	ADC: 18 channels 4 high-speed ADC channels (50 MSPS) 24-bit ADCs for X, Y, and Z scanner position sensor DAC: 12 channels 2 high-speed DAC channels (50 MSPS) 20-bit DACs for X, Y, and Z scanner positioning Maximum data size: 4096 x 4096 pixels	3 channels of flexible digital lock-in amplifier Spring constant calibration (Thermal method) Digital Q control	20 embedded signal input/output ports 5 TTL outputs: EOF, EOL, EOP, Modulation, and AC bias
			Microscope Unit
			Dimension: 245 mm × 294 mm × 443 mm (WxDxH) Weight: 26 kg Power: 200 W Installation environment: VC-E (vibration), < 65 dB (acoustic) Certification: CE
Options/Modes	Standard Imaging	Chemical Properties	Dielectric/Piezoelectric Properties
	<ul style="list-style-type: none"> • True Non-Contact AFM • Basic Contact AFM and DFM • Lateral Force Microscopy (LFM) • Phase Imaging 	<ul style="list-style-type: none"> • Chemical Force Microscopy with Functionalized Tip • Electrochemical Microscopy (EC-STM and EC-AFM) 	<ul style="list-style-type: none"> • Electric Force Microscopy (EFM) • Dynamic Contact EFM (DC-EFM) • Piezoelectric Force Microscopy (PFM) • PFM with High Voltage
	Force Measurement	Magnetic Properties	Optical Properties
	<ul style="list-style-type: none"> • Force Distance (F-D) Spectroscopy • Force Volume Imaging 	<ul style="list-style-type: none"> • Magnetic Force Microscopy (MFM) • Tunable MFM 	<ul style="list-style-type: none"> • Tip-Enhanced Raman Spectroscopy (TERS) • Time-Resolved PhotoCurrent Mapping (Tr-PCM)
	Electrical Properties	Mechanical Properties	Thermal Properties
	<ul style="list-style-type: none"> • Conductive AFM • I-V Spectroscopy • Scanning Kelvin Probe Microscopy (SKPM/KPM) • SKPM with High Voltage • Scanning Capacitance Microscopy (SCM) • Scanning Spreading-Resistance Microscopy (SSRM) • Scanning Tunneling Microscopy (STM) • Scanning Tunneling Spectroscopy (STS) • Time-Resolved PhotoCurrent Mapping (Tr-PCM) 	<ul style="list-style-type: none"> • Force Modulation Microscopy (FMM) • Nanoindentation • Nanolithography • Nanolithography with High Voltage • Nanomanipulation • Piezoelectric Force Microscopy (PFM) 	<ul style="list-style-type: none"> • Scanning Thermal Microscopy (SThM)



Active Temperature Controlled, Standard Acoustic Enclosure

Designed exclusively for the NX series, the Standard Acoustic Enclosure is actively temperature-controlled for a thermally stable environment. It isolates the NX system from external acoustic and light noise for ultimate performance, and provides increased vibration isolation when used with Active Vibration Isolation Table.

- Innovative control design brings the enclosure quickly to its temperature equilibrium
- Temperature stability of less than 0.05 °C within 10 minutes of closing AE door
- Includes a granite table for increased vibration isolation
- Ergonomic design for convenient access to the instrument
- Dimensions: 700 × 900 × 1,300 mm (outer)