Park NX15

The Versatile Nanometrology Tool for Advanced Research

Park
SYSTEMS

Park NX15 is a versatile atomic force microscope (AFM) engineered for dependable performance. Its sample stage accommodates full coverage of wafers up to 150 mm, providing a reliable platform for nanoscale metrology in semiconductor and materials research.

The core technology of NX15 lies in Park's proprietary orthogonal scan system and True Non-contact™ mode. These innovations virtually eliminate lateral motion artifacts while protecting both tip and sample, enabling artifact-free, high-resolution imaging even for delicate or challenging specimens.

From materials science and semiconductors to polymers and bioengineering, NX15 delivers robust performance and dependable results, making it a trusted platform for advanced nanoscale metrology.

NX15 – Key Features

Outstanding AFM Performance

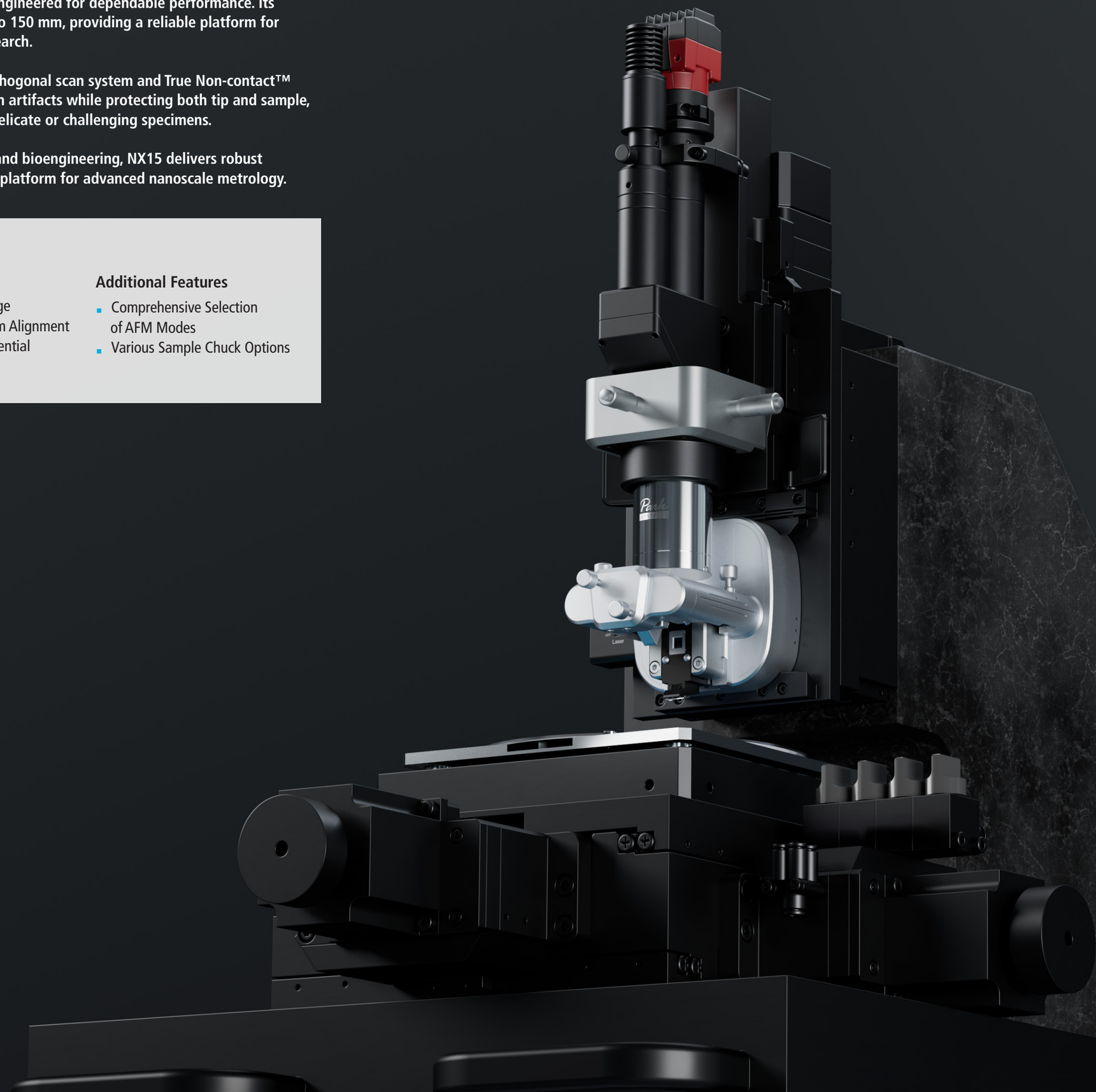
- True Non-Contact™ Mode
- Orthogonal Scan System
- Fast Z-Servo Speed

User Convenience

- Easy Probe Exchange
- Intuitive Laser Beam Alignment
- Recipe-Based Sequential Measurement

Additional Features

- Comprehensive Selection of AFM Modes
- Various Sample Chuck Options

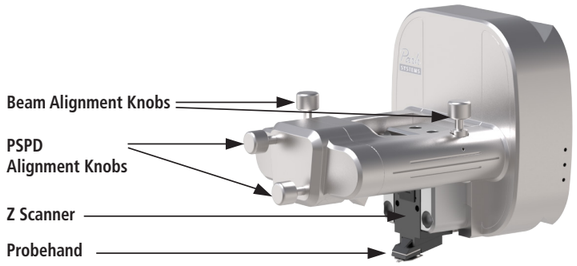


Park NX15

Next-Generation AFM for Large Samples

Fast Z Servo and High Resolution

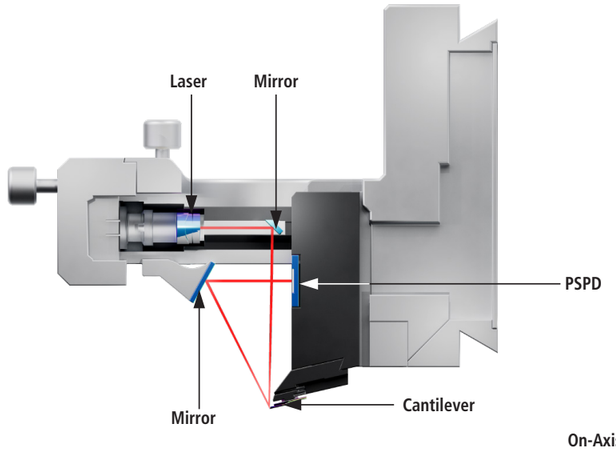
The resolution of the images in Park NX series has been further enhanced. The NX Z scanner, built with a stacked piezo actuator and a strain gauge sensor, delivers fast and precise measurements across a wide range of surfaces. From extremely flat to rough samples, it maintains consistent roughness linearity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



NX Laser Beam Path

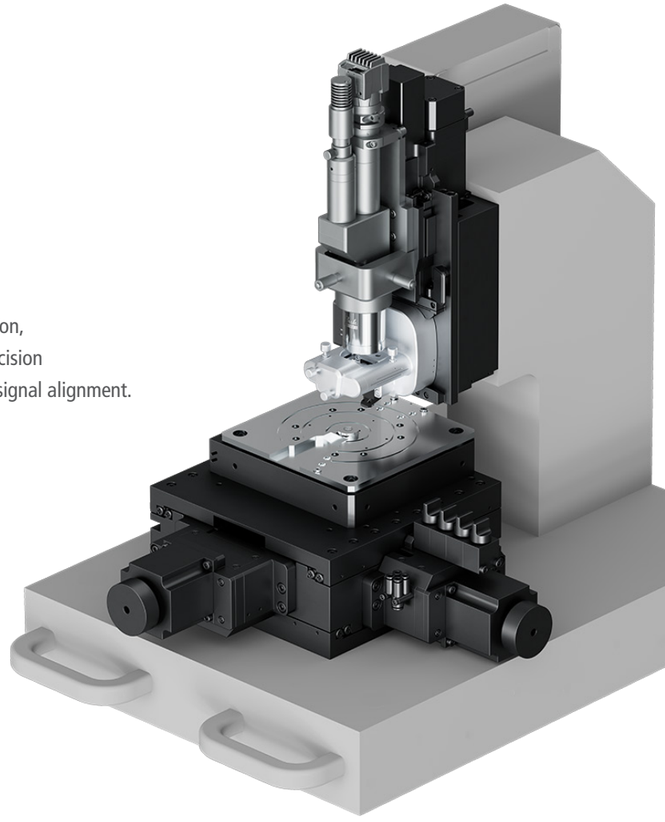
The NX head integrates a superluminescent diode that provides low coherence illumination, minimizing interference for stable signal detection. The laser beam is guided through precision mirrors to the cantilever and position-sensitive photodetector (PSPD), ensuring accurate signal alignment.

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.

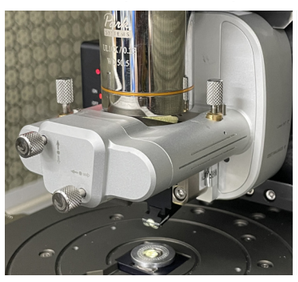


On-Axis Optical Microscope

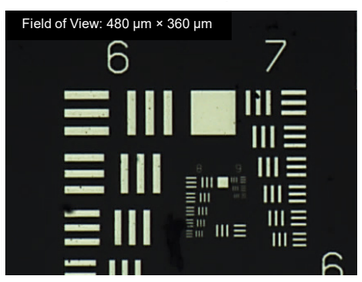
The high-power on-axis optical microscope provides a clear view of the sample surface. A software-controlled LED light source illuminates the sample surface for better observation.



On-Axis Optical Microscope



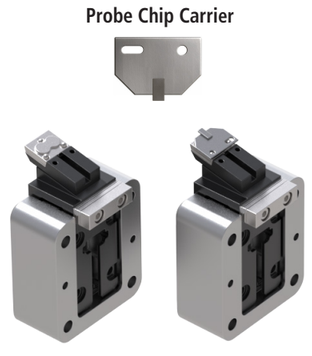
Vision from NX Optics

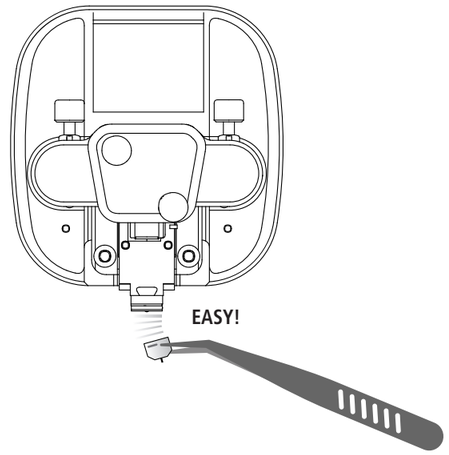


Pre-Mounted Probe

AFM probe exchange can be challenging, even for experienced users, often resulting in cantilever breakage. Park AFM addresses this by using pre-aligned probe chip carriers with kinematic mounting points, ensuring reliable and consistent tip positioning.

The NX head's Z scanner features three precision balls for kinematic mounting, complemented by magnets at the base to ensure a secure, reliable, and repeatable mounting position.

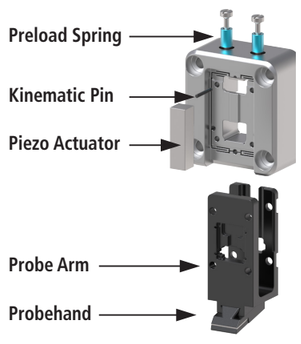




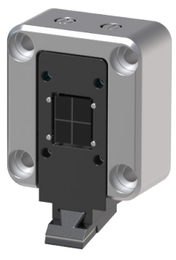
Improved Z Scan Straightness

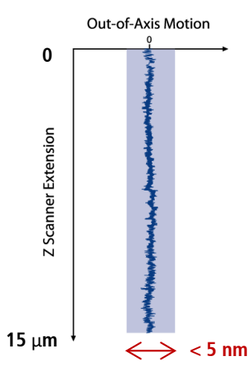
Park NX series Z scanner maintains straightness within 0.1% across the usable range, with out-of-axis motion under 5 nm even at a full 15 µm extension.

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.



Z Scanner Assembly

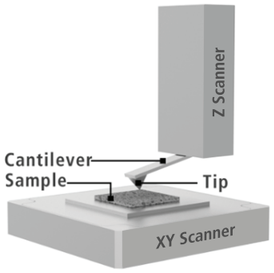




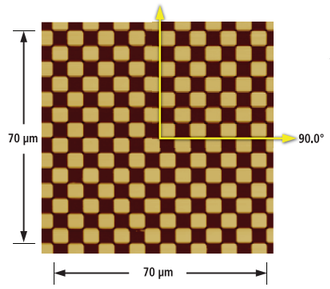
Park AFM Technology

Orthogonal Scan

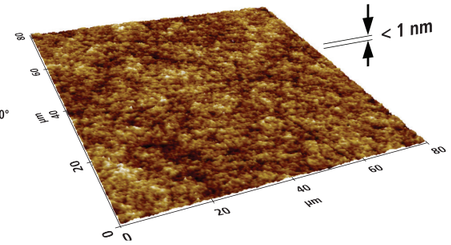
Conventional AFMs with tube scanners suffer from out-of-plane motion and axes crosstalk, resulting in image distortion, especially over large scan areas. NX15, like all Park AFMs, employs an advanced orthogonal scan system featuring a flexure-guided architecture: a 2D flexure scanner moves the sample 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.

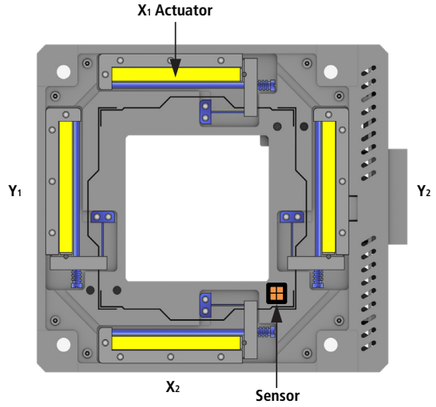


10 µm Pitch Calibration Grating



Optical Flat (80 × 80 µm)



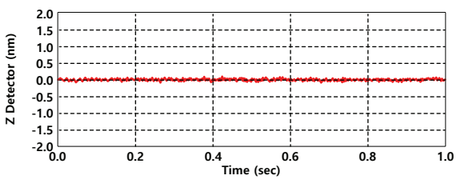


The XY scanner is designed to achieve flat, purely horizontal motion without vertical interference by using stacked piezo actuators and flexure hinge structures. A position sensor provides direct feedback for servo control, minimizing positioning errors across the scan area. This design ensures consistent accuracy and stability across the entire 150 × 150 mm^2 sample area.

Low Z Detector Noise

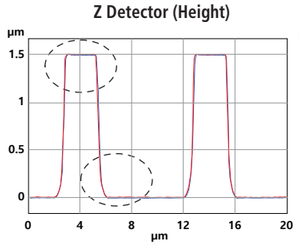
The Z detector has a noise level of less than 0.02 nm, enabling height measurements with sub-nanometer accuracy, down to 0.1 nm. Unlike conventional Z voltage mapping, which often overshoots at stiff walls, the Z detector provides precise, conformal surface tracing.

Z Detector Noise

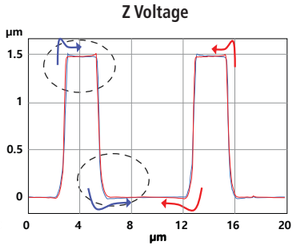


0.02 nm (rms), 1 kHz BW

Z Detector (Height)



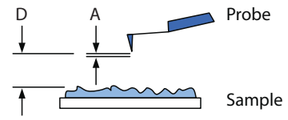
Z Voltage

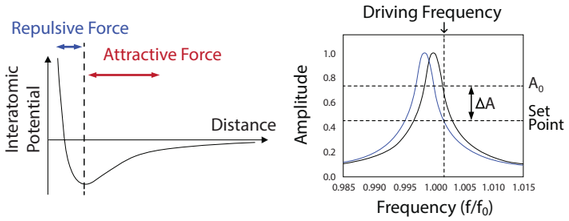


Forward scanning (⟶)
Backward scanning (⟵)

True Non-Contact™ Mode

NX15 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.

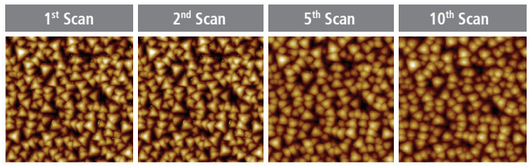




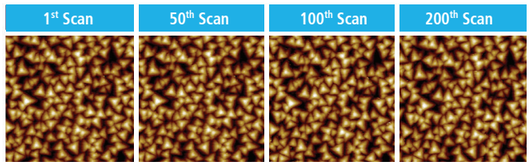
In True Non-contact mode, the tip oscillates at a frequency slightly higher than its resonance frequency, where the amplitude-frequency curve has its steepest slope.

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

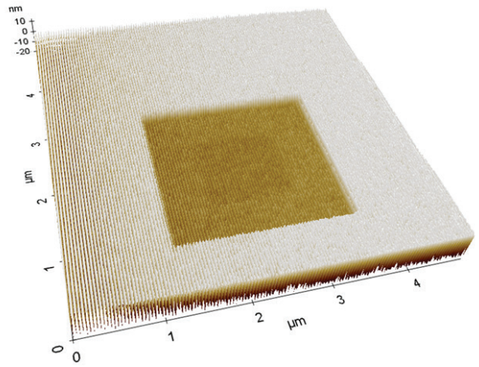


CrN Tip-checking Sample

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.

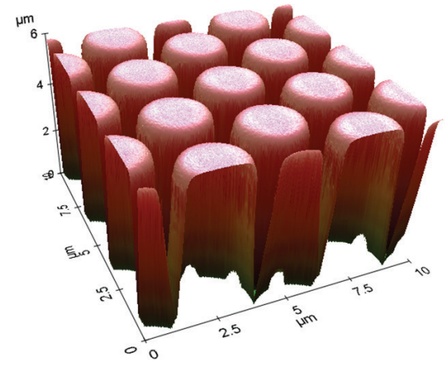
True Non-contact mode can measure soft and sticky samples as well as the most delicate and brittle samples, which cannot be imaged with tapping mode AFM. The image below is the topography of an unbaked photoresist acquired with True Non-contact mode, showing damages induced by electron beam irradiation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

Unbaked Photoresist



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.

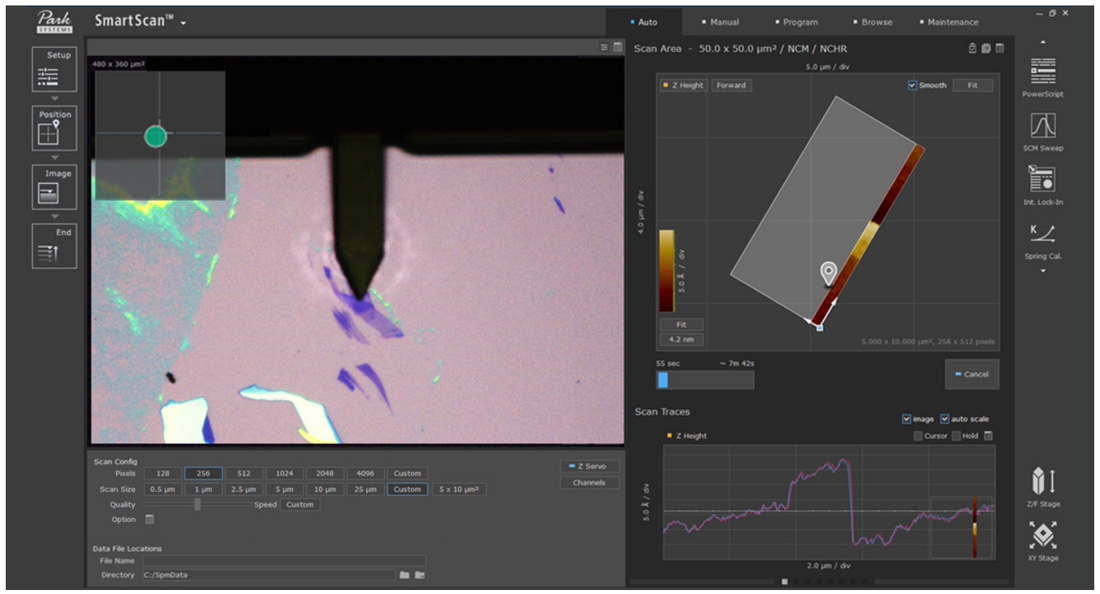
Mold for Nanoimprint



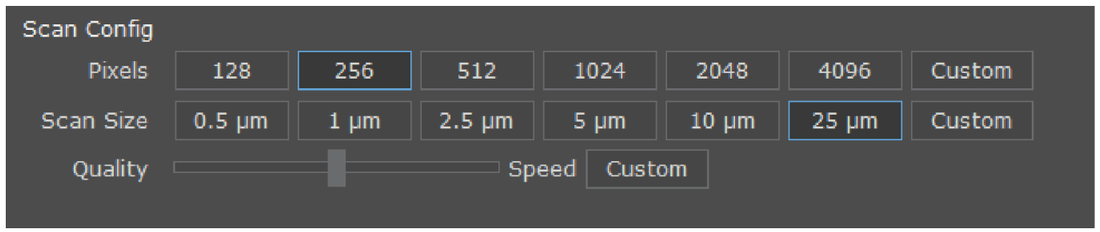
Park SmartScan™

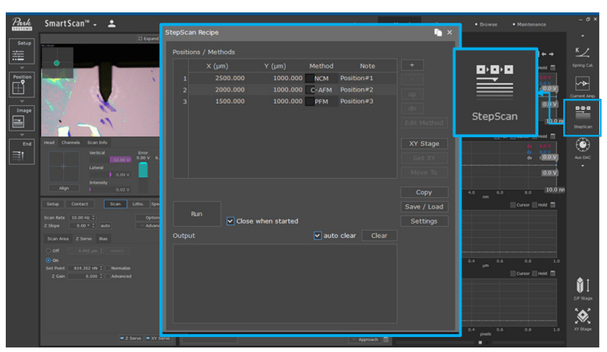
Bringing the Power and Versatility of AFM Technology to Everyone

NX15 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 set point, 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.





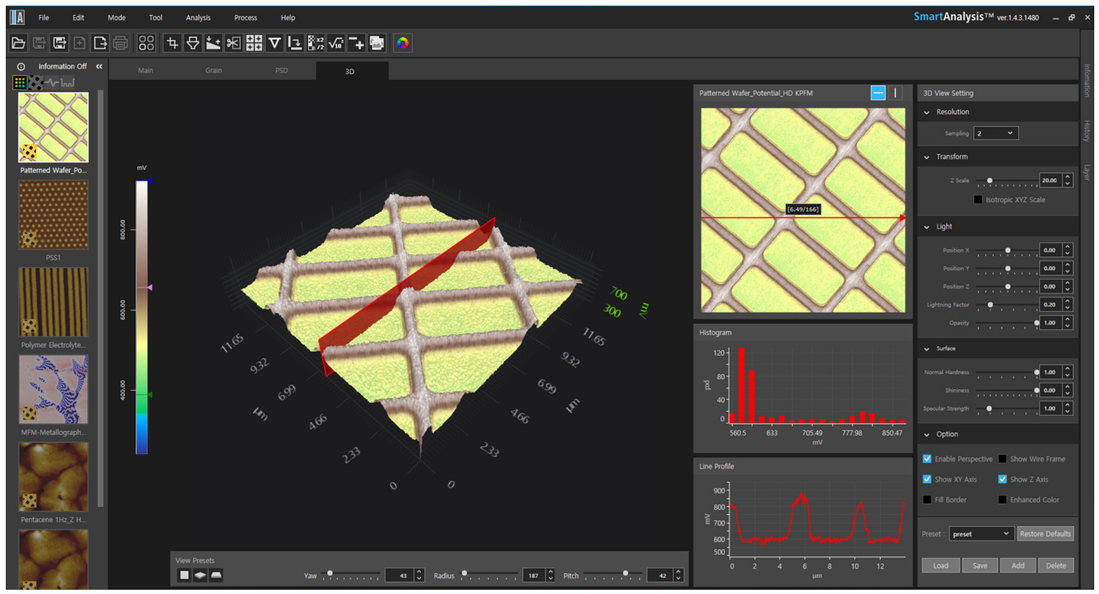
StepScan™

StepScan™ is an advanced Park SmartScan™ feature to pre-define measurement locations and recipes for efficient and consistent data acquisition.

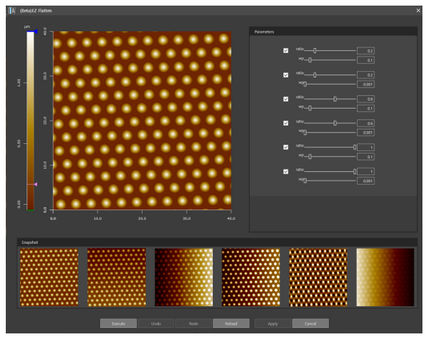
Park SmartAnalysis™

Streamlining AFM Data Workflow

Scan data from NX15 can be analyzed with Park SmartAnalysis™, a powerful AFM image analysis software that enables fast image processing, comprehensive data analysis, and efficient result publication.



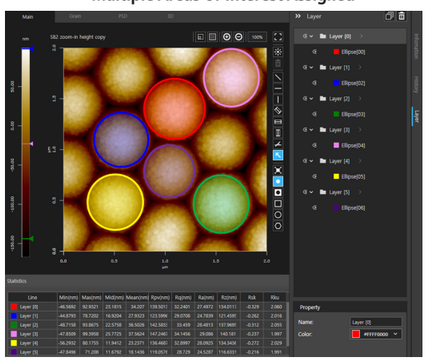
Patterned Sapphire Substrate Topography
Postprocessed with EZ Flatten



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.

Styrene Beads 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 NX15
Additional Features

Expanding Research Possibilities

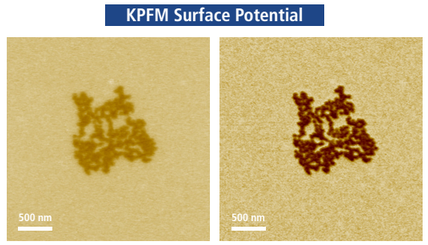
NX15 supports advanced AFM modes beyond topography, including electrical property measurements. Heterodyne KPFM provides higher sensitivity and resolution for quantitative surface potential mapping, while Contact Resonance PFM improves piezoresponse detection with much clearer contrast compared to conventional PFM.

Heterodyne KPFM

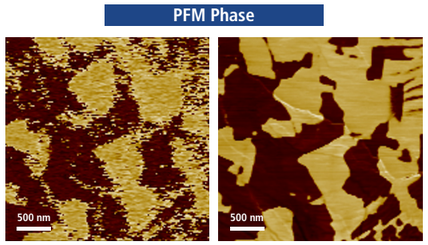
Provides higher sensitivity and spatial resolution for quantitative surface potential measurements.

Contact Resonance PFM

Enhances piezoresponse detection with improved sensitivity at contact resonance.



Conventional KPFM | Heterodyne KPFM

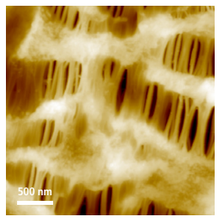


Conventional PFM | Contact Resonance PFM

For mechanical properties, NX15 offers Fast PinPoint™ for high-speed nanomechanical mapping, Dynamic Mechanical Analysis for nanoscale viscoelastic behavior, and Torsional Force Microscopy to study lateral interactions. These modes together expand AFM research capabilities well beyond imaging, supporting advanced studies across various materials.

Fast PinPoint™

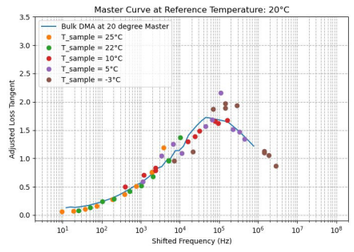
Enables high-speed quantitative measurement of nanomechanical properties such as modulus and adhesion



Fast PinPoint imaging on Cell guard

Dynamic Mechanical Analysis

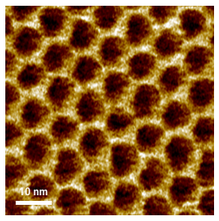
Measures nanoscale viscoelastic behavior by applying dynamic excitation to the sample



Loss Tangent Master curve

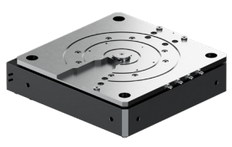
Torsional Force Microscopy

Analyzes lateral interactions by detecting the cantilever's torsional resonance response

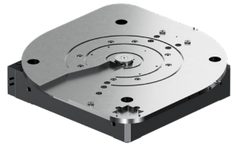


TFM Phase of tBG on hBN

Sample Chuck Options



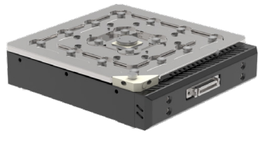
150 mm Sample Chuck



200 mm Sample Chuck

Vacuum Sample Chuck

The vacuum sample chuck provides stable and flat mounting for wafers up to 150 mm as the standard configuration, with an optional 200 mm version available. It supports various sample sizes, including small samples as well as 50 mm, 100 mm, and 150 mm wafers, ensuring consistent measurement quality.



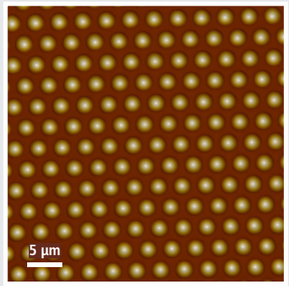
Multi-Sample Chuck

The multi-sample chuck enables automated sequential scanning of multiple small samples, accommodating up to 16 samples.

Park NX15
Designed for Your Applications

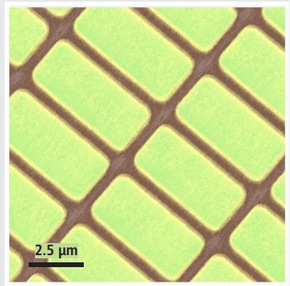
Park NX15 offers precise measurements for large samples, making it the ideal solution in research applications.

Semiconductors & Devices



Patterned Sapphire Substrate (PSS)

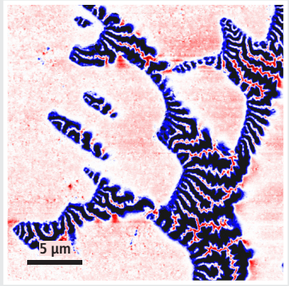
The patterned sapphire substrate was characterized in True Non-contact mode. The scan image reveals a regular array of surface structures with a peak-to-valley height of about 1.47 µm.



Patterned Wafer

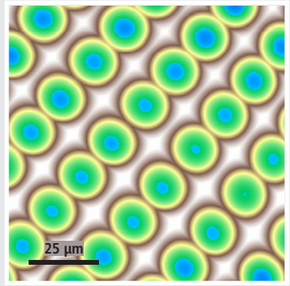
The patterned wafer was characterized using Heterodyne KPFM. The scan image clearly reveals the patterned structures with a peak-to-valley potential difference of about 681 mV.

Metals & Ceramics



2205 Stainless Steel

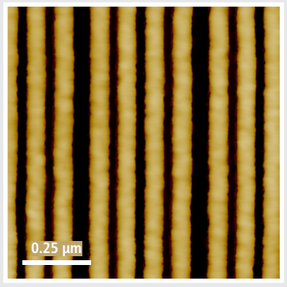
2205 stainless steel sample was characterized by Magnetic Force Microscopy (MFM). The MFM phase image highlights the magnetic domain patterns across the surface.



Microlens Array

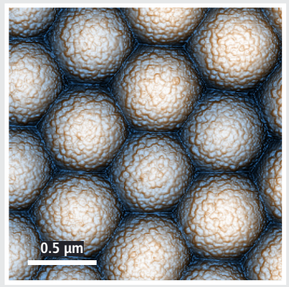
The microlens array was characterized in True Non-contact mode. The scan image clearly shows the periodic lens structures with a peak-to-valley height of about 12.7 µm.

Polymers & Organics



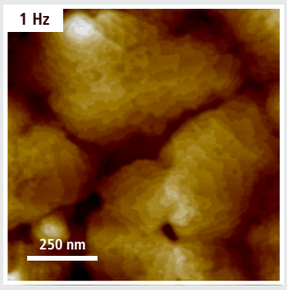
Polymer Electrolyte Membrane (PEM)

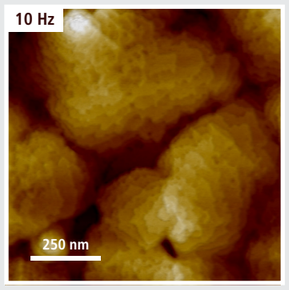
The polymer electrolyte membrane was characterized in True Non-contact mode. The scan image reveals striped surface patterns with a peak-to-valley height of about 113.2 nm.



Styrene Beads

The styrene beads sample was characterized in True Non-contact mode. The scan image clearly shows spherical beads distributed across the surface, with a peak-to-valley height of about 267 nm.





Pentacene

A pentacene sample was measured using True Non-contact mode at scan rates of 1 Hz and 10 Hz. The topography images reveal distinct step-like morphology with peak-to-valley variations of about 27 nm, and no noticeable differences were observed between the two scan speeds.

Park NX15
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
    - Photocurrent Mapping (PCM) *
  - 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)
  - Microwave Impedance Microscopy (MIM) **
- Magnetic Properties
  - Magnetic Force Microscopy (MFM)
    - Frequency Modulation MFM (FM-MFM)
    - Amplitude Modulation MFM (AM-MFM)
- Nanolithography & Manipulation
  - Nanolithography *
  - Nanomachining *
- In-liquid Operation
  - In-liquid Topography *
- Electrochemical Properties
  - Electrochemical AFM (EC-AFM) *

Scanner

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

Sample Mount

- Vacuum grooves for wafers (up to 150 mm)
- Magnetic mount for 16 small samples (optional)

Stage

- XY stage : 150 mm × 150 mm
- Z stage: 25 mm
- Focus stage: 8 mm

Dimension and Weight

- AE (Outer): 820 mm × 920 mm × 1,486 mm
- Desk: 1,410 mm × 810 mm × 740 mm
- Total weight: 470 kg (AFM Body + AE)

On-axis Optical Microscope

- Direct on-axis vision of sample surface and cantilever
- Field of view: 480 µm × 360 µm (w/ 10× objective lens)
- CCD: 1.2 M Pixel
  5 M Pixel (optional)

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*
*** Consult with Park Systems*

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