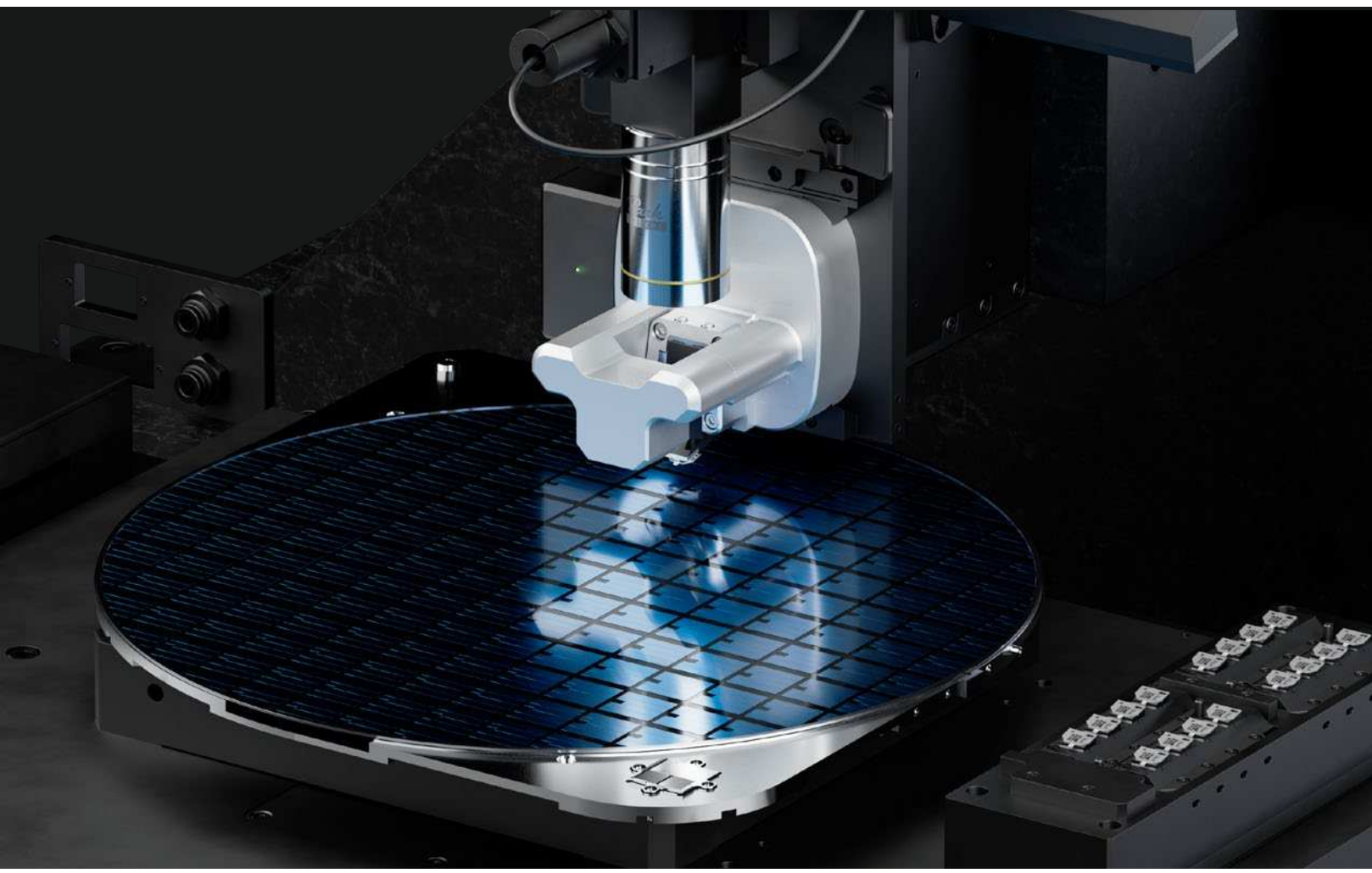
Park FX300

The Most Advanced AFM for 300 mm Samples



Park SYSTEMS

Park FX300 is Park Systems' latest innovation in atomic force microscopy (AFM), designed to accommodate samples up to 300 mm. With a low noise floor, minimal thermal drift, and enhanced mechanical stability, the FX300 delivers unmatched precision and reliability.

Like all Park AFMs, the FX300 features an orthogonal scan system and True Non-contact™ mode, enabling accurate, high-resolution metrology, even on the most delicate or fragile samples.

Key features of the FX300 include automatic probe exchange and automatic laser beam alignment; the signatures of FX-series AFMs that streamline operation and enhance productivity. Automated AFM scan parameter settings, sequential measurements across multiple coordinates, and powerful data analysis further simplify complex workflows.

With advanced capabilities and upgraded safety features, the FX300 offers a versatile solution for nanoscale imaging and analysis across both research and industrial settings.

FX300 – Key Features

Superior AFM Performance

- Lower Noise Floor
- Minimal Thermal Drift
- Orthogonal Scan System
- True Non-Contact™ Mode

User Convenience

- Automatic Probe Exchange
- Automatic Laser Beam Alignment

Additional Features

- Safety and Facility Features
- Improved Acoustic Enclosure
- Live Monitoring Camera
- Environmental Sensing

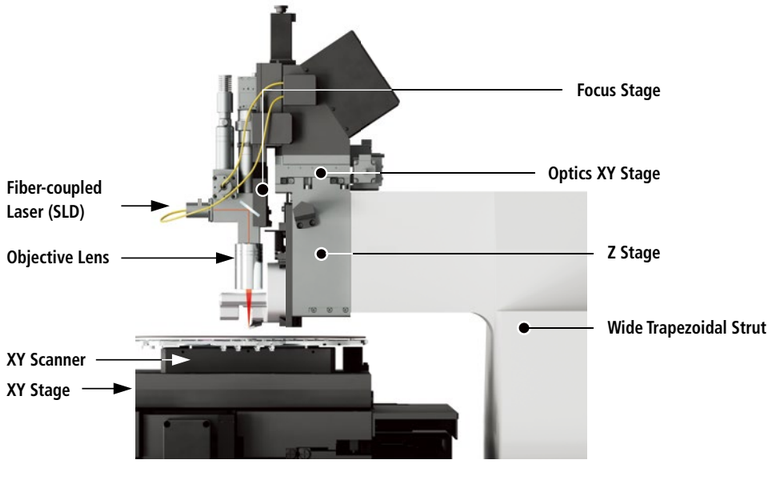
Park FX300

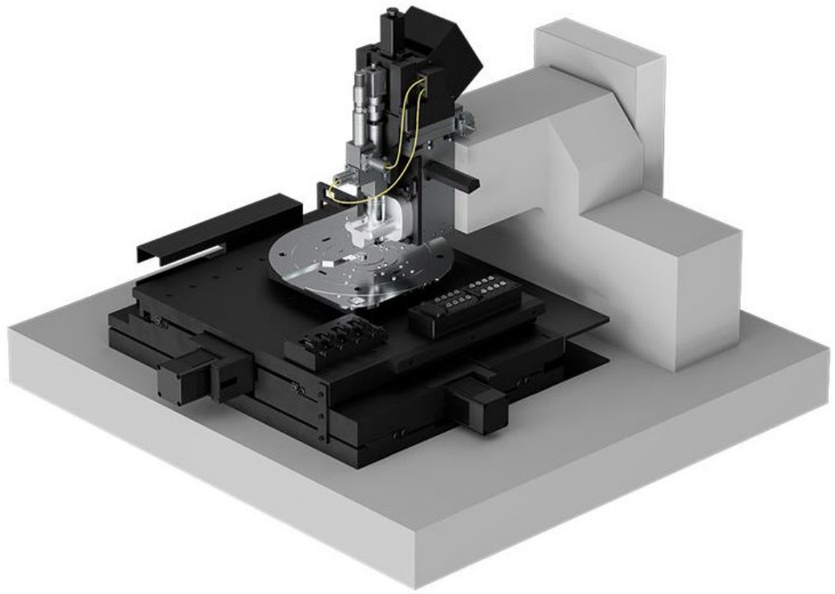
The Most Advanced AFM for 300 mm Samples

Superior FX Mechanical Design

The FX-series AFMs are designed for minimal mechanical noise. The optical microscope is decoupled from the Z stage, lowering the weight on the Z stage and thus reducing susceptibility to mechanical disturbances. The Z stage itself is built more robustly with a high-stiffness cross-roller guide and two bearing blocks.

A wide trapezoidal strut reinforces the mechanical rigidity of the FX300, while the use of expansion-matched materials with low thermal expansion coefficients mitigates thermal drift, ensuring reliable performance over time.



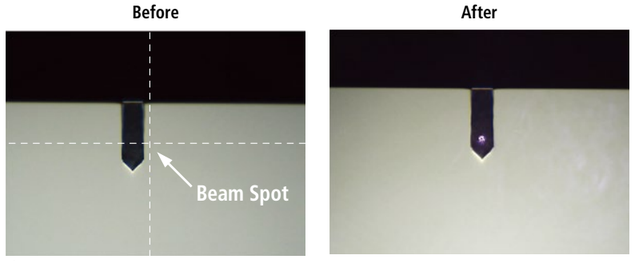


FX Laser Beam Path

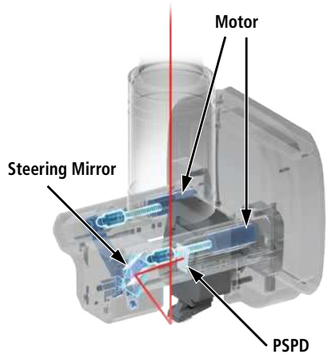
The FX optics structure integrates a fiber-coupled laser (superluminescent diode; SLD) into the optical microscope assembly. The laser beam is focused through the objective lens and remains fixed at the center of the optical field of view.

Automatic Laser Beam Alignment

The vision-guided alignment system detects the cantilever shape and position and then moves the optics XY stage to align the cantilever at the center of the field of view, precisely where the laser beam is focused. The focused beam has a reduced spot size, minimizing spillover and unlocking compatibility with small, high-frequency cantilevers.



Two precision motors in the FX scan head adjust the steering mirror to align the laser beam in the center of the position-sensitive photodetector (PSPD).



Automatic Probe Exchange

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

Each chip carrier is marked with a QR code containing detailed information, including probe type, serial number, date manufactured, and specifications.

Probe Chip Carrier

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

The automatic tip exchanger (ATX) module stores up to 16 pre-mounted probes. After the ATX camera scans the probes' QR codes, the SmartScan™ AFM operating software displays probe information for each slot, allowing the user to select full or vacant probe slots with a simple mouse click.

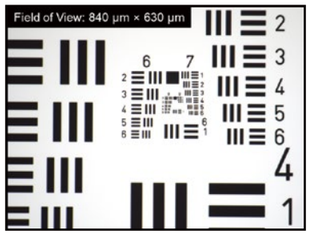
After a slot is selected, the AFM head moves down to pick the probe up from or park the currently mounted probe into the slot, depending on the position of the strong magnet underneath.

FX AFM Controller

The FX AFM controller offers high-speed control via 1 Gbps communication with the PC, enhancing precision by eliminating communication lags. The 8-channel lock-in amplifier enables capturing images with multiple properties in a single scan. The 5 MHz bandwidth for tip bias modulation expands versatility in advanced mode measurements, such as contact resonance PFM and heterodyne KPFM, without attaching extra modules. In addition, the FX controller supports an AFM head crash prevention feature for safe measurements.

Improved On-Axis Optics

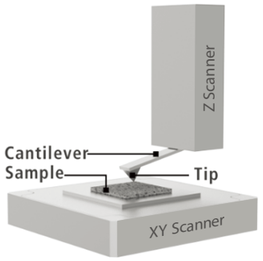
The unobstructed optical microscope provides a clear field of view and can resolve line widths down to 0.87 µm.

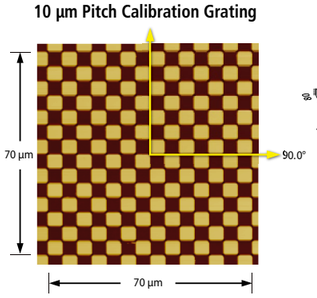


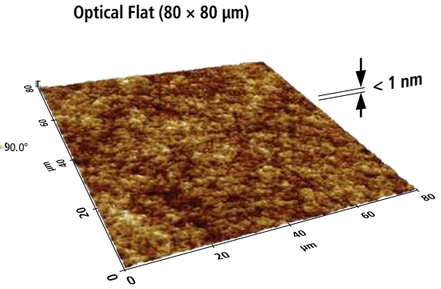
Park AFM Technology

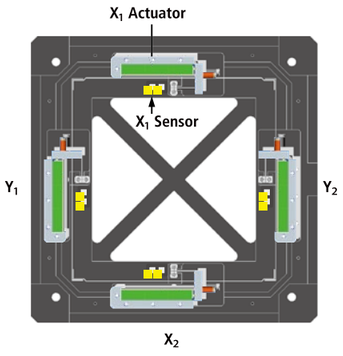
Orthogonal Scan

Conventional AFMs with tube scanners suffer from out-of-plane motion and axes crosstalk, resulting in image distortion, especially over large scan areas. The FX300, 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. This separated scanner system ensures highly orthogonal, linear scans with minimal out-of-plane motion and fast dynamic performance. Equipped with low-noise optical sensors for XY feedback and an ultra-low-noise strain gauge sensor for Z control, a closed-loop servo control system ensures precise and repeatable scanning across all axes.









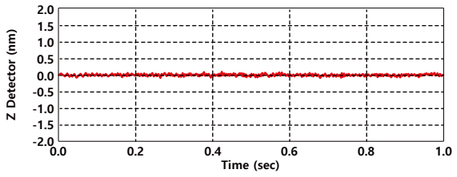
For large samples, a single-servo XY scan architecture can be vulnerable to the rotational motion of the sample chuck. This rotational motion can introduce positioning errors that increase with distance from the position sensor.

The FX300 resolves this issue with a dual-servo XY scanner architecture, with two pairs of actuators and position sensors mounted on opposite sides of each axis. All four actuators are controlled independently to ensure accurate positioning across the entire 300 × 300 mm^2 sample area.

Low Z Detector Noise

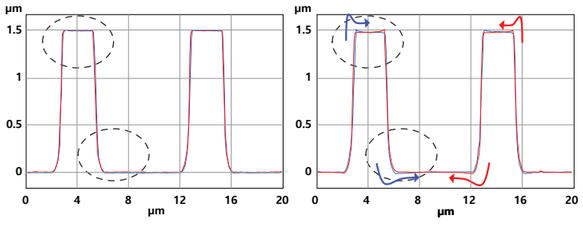
The Z detector has a noise level of less than 0.02 nm, enabling height measurements with sub-nanometer accuracy, down to 0.1 nm. Unlike conventional Z voltage mapping, which often overshoots at stiff walls, the Z detector provides precise, conformal surface tracing.

Z Detector Noise



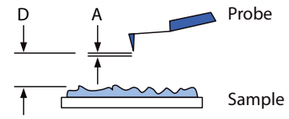
0.02 nm (rms), 1 kHz BW

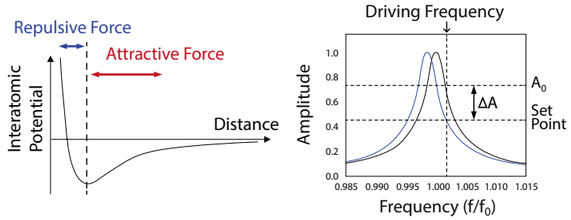
Z Detector (Height) Z Voltage



True Non-Contact™ Mode

The FX300 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.

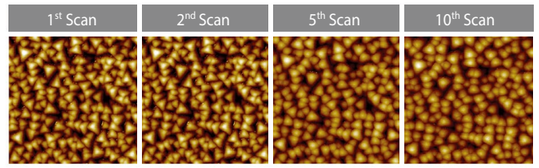




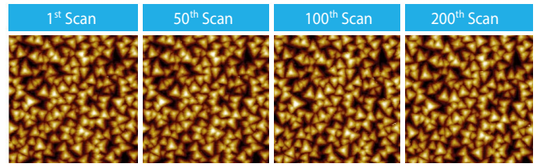
In True Non-contact mode, the tip oscillates at a frequency slightly higher than its resonance frequency, where the amplitude-frequency curve has its steepest slope. As the tip approaches the sample, the attractive force causes a downshift in the effective resonance frequency, leading to a decrease in 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.

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.

Tapping Mode



True Non-Contact Mode

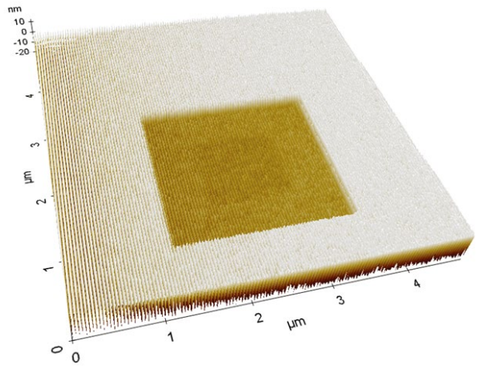


CrN Tip-checking Sample

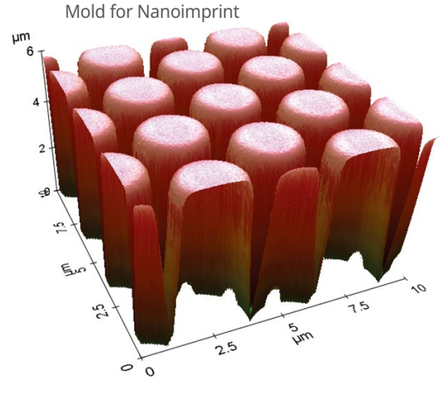
True Non-contact mode can measure soft and sticky samples as well as the most delicate and brittle samples, which cannot be imaged with tapping mode AFM. The image below is the topography of an unbaked photoresist acquired with True Non-contact mode, showing damages induced by electron beam irradiation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



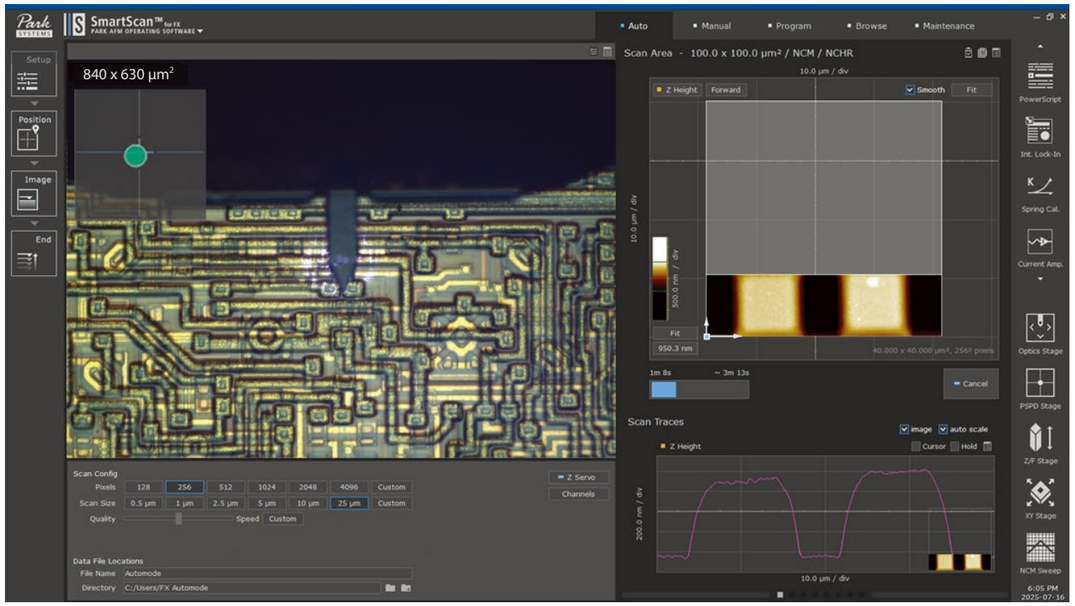
Mold for Nanoimprint



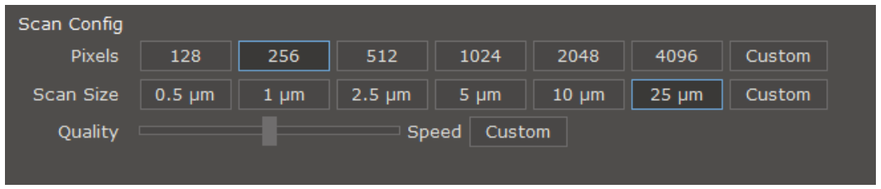
Park SmartScan™

Bringing the Power and Versatility of AFM Technology to Everyone

The FX300 comes with Park SmartScan™, an advanced AFM operating software that simplifies image acquisition and enhances usability with its intuitive interface and powerful automation features.

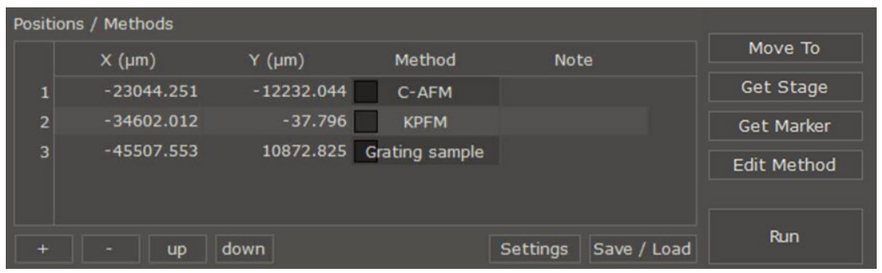


In conventional AFM systems, users must manually adjust numerous parameters, such as Z servo gains, force set point, and XY scan speed, often through trial and error. SmartScan eliminates this complexity by allowing users to choose only three parameters: pixel density, scan size, and quality vs. speed 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™

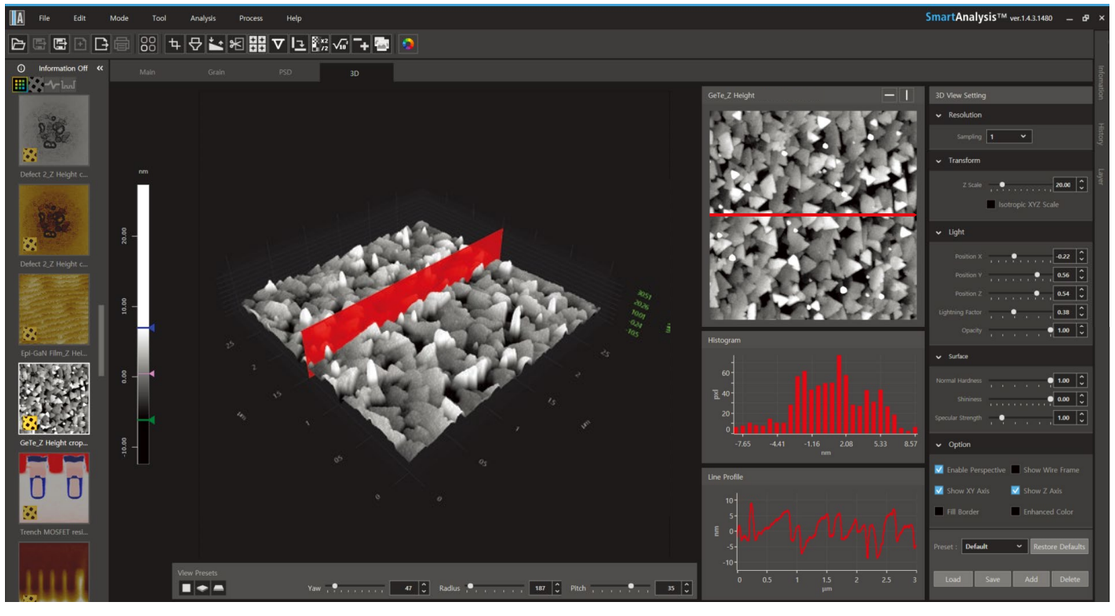
StepScan™ allows users to select multiple points on the sample image, assign specific scan recipes to each location, and automatically carry out sequential measurements.



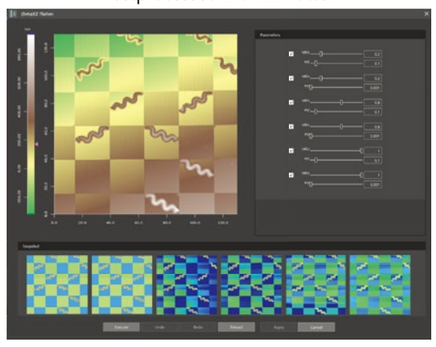
Park SmartAnalysis™

Streamlining AFM Data Workflow

Scan data from the FX300 can be analyzed with Park SmartAnalysis™, a powerful AFM image analysis software that enables fast image processing, comprehensive data analysis, and efficient result publication.



LCD panel 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.

LTPS TFT backplane Topography
Multiple Areas of Interest Assigned

Multilayer Analysis

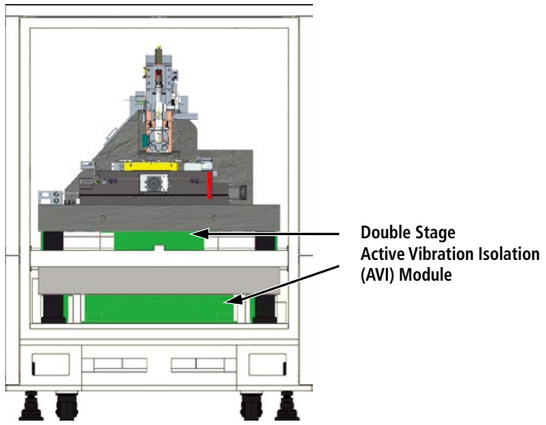
Users can analyze and compare multiple areas of interest at once using a polygonal freeform area drawing tool. Unlike conventional AFM data analysis software that allows inspection of one region at a time, SmartAnalysis provides various metrics for all selected areas simultaneously.

Park FX300

Additional Features

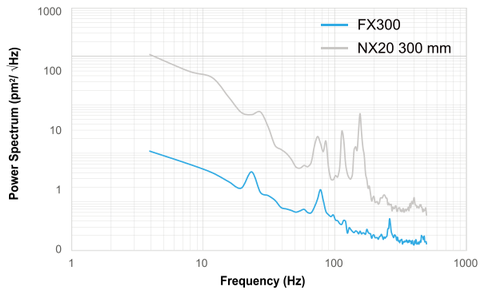
Upgraded Vibration Isolation & Acoustic Enclosure

The FX300 is equipped with an upgraded vibration isolation system and a redesigned acoustic enclosure. The double-layer modulator isolation elements and reinforced base frame significantly reduce the noise floor.



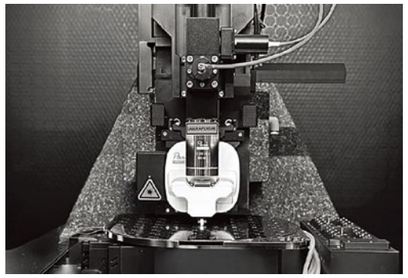
Combined with the advanced mechanical design of the FX series, the FX300 delivers substantially lower noise levels than the previous flagship model, the NX20 300mm.

Noise Floor Comparison between FX300 and NX20 300mm



Live Monitoring Camera

The live monitoring camera is attached to the acoustic enclosure door to allow users to observe inside the enclosure in real time, even when the acoustic enclosure door is closed.



Sample Chuck Options

Two sample chuck options are available: a wafer chuck for wafers up to 300 mm in diameter, and a multi-sample chuck that accommodates up to three 150 mm wafers. Both chucks are equipped with vacuum systems to ensure secure sample positioning.

Safety and Facility Features

A range of default safety features, including a Facility Controller, Photo Ionizer with signal light, emergency machine off (EMO) button and signal tower with buzzer. For enhanced environmental control, an optional fan filter unit (FFU) is available to meet facility requirements.

EMO Button

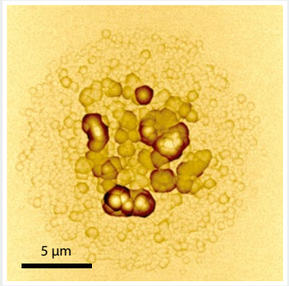
Signal Tower

Park FX300

Designed for Your Applications

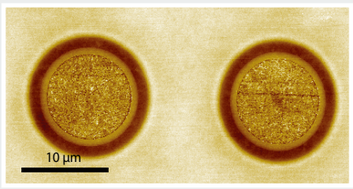
The FX300 offers precise measurements for a wide range of research and industrial applications, from small samples to full 300 mm wafers.

Semiconductors & Devices



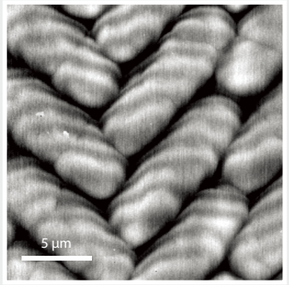
Defects on Si Wafer

Defects on Si wafer surface was measured in True Non-contact mode to acquire surface topography. The scan data revealed a peak-to-valley height difference of 33.6 nm, and the image shows the dimension and shape of the defects.



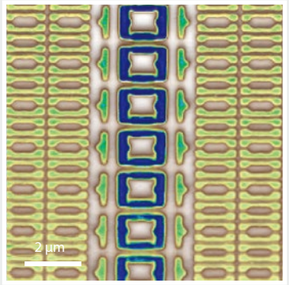
Cu Pad

A Cu pad of semiconductor device was measured in True Non-contact mode to acquire surface topography. The scan data revealed a peak-to-valley height difference of 4.2nm, and the image shows the surface morphology to study dishing.



Magnetic Device

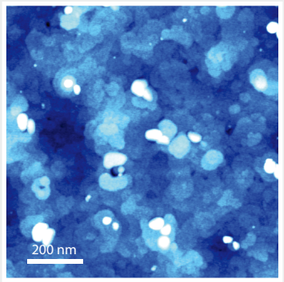
A magnetic device was measured in Magnetic Force Microscopy (MFM) mode to acquire both surface topography and magnetic signal simultaneously. The image shows the magnetic signal distribution on magnetic device.



Silicon Device

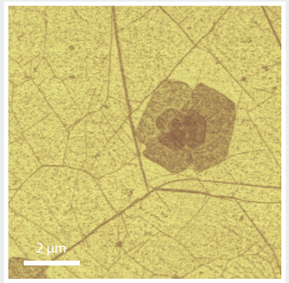
A patterned semiconductor device was measured in Microwave Impedance Microscopy (MIM) mode to obtain both surface topography and doping concentration. The image shows the capacitance map of the patterned device.

Functional & Advanced Materials



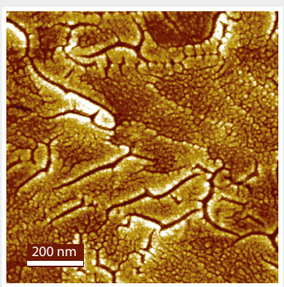
Barium Titanate (BaTiO3, BTO)

Barium Titanate was measured in True Non-contact mode to acquire surface topography. The scan data revealed a peak-to-valley height difference of 13.6 nm, and the image shows fine surface features and roughness.



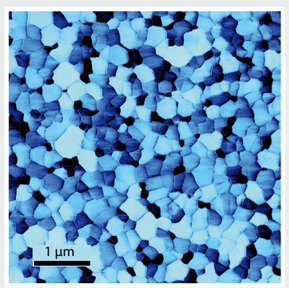
Multi-layer Graphene

Multi-layer Graphene on Si substrate was imaged using KPFM mode to acquire surface potential contrast. The scan image revealed the surface potential distribution of the multi-layer graphene.



Gallium Nitride (GaN) Film

Gallium Nitride (GaN) film was measured in True Non-contact mode to acquire surface topography. The scan data revealed a peak-to-valley height difference of 6.4 nm, and the image shows surface roughness and grain-like domains and cracks.



Perovskite

Perovskite was measured in Conductive AFM to acquire electrical properties. The scan data revealed a peak-to-valley resistance value of 190 GΩ, and the image shows the polygonal shape morphology.

Park FX300

Technical Specifications

AFM Modes

- Topographic Imaging
  - Contact Mode
    - Constant Height Mode
    - Constant Force Mode
    - Fast imaging Mode (FiM) *
  - 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 Capacitance Microscopy (SCM) *
  - Piezoresponse Force Microscopy (PFM)
    - Piezoreseponse 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)
- Thermal Properties
  - Scanning Thermal Microscopy (SThM) *
    - Temperature Mapping
    - Thermal Conductivity Mapping
- Nanolithography & Manipulation
  - Nanolithography *
  - Nanomachining *
- In-liquid Operation
  - In-liquid Topography *
  - Electrochemical AFM (EC-AFM) *

Scanner

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

Sample Mount

- Vacuum grooves for wafers (up to 300 mm)
- Multi-wafer chuck for 150 mm wafers (optional)

On-Axis Optics

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

Stage

- XY stage: 350 mm × 300 mm
- Z stage: 22 mm

Automatic Tip Exchanger

- 16 pre-aligned probes with kinematic mount and QR code chip carrier

Safety and Facility Features

- Photo Ionizer
- Facility controller
- Emergency Machine Off (EMO) button
- Fan Filter Unit (FFU) *

Dimension and Weight

- AE(Outer): 1,250 mm × 1,280 mm × 1,560 mm
- Cabinet: 1,176 mm × 900 mm x 2,038 mm
- Total weight: 2,225 kg (AFM Body + AE)

Required Environment

- Required acoustic noise level: Below 65 dB
- Required floor vibration level: VC-D (6.25 µm/sec)
- Power: 3 kW (Maximum)

** Requires additional options*
*** Consult with Park Systems*

Park SYSTEMS
www.parksystems.com