Park FX40
The Most Advanced AFM for Small Samples

Park
SYSTEMS

Park FX40 is Park Systems' latest innovation in atomic force microscopy (AFM), designed for high-resolution imaging of small samples. With a low noise floor, minimal thermal drift, and enhanced mechanical stability, the FX40 delivers unmatched precision and reliability. Like all Park AFMs, the FX40 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 FX40 include automatic probe exchange and automatic laser beam alignment, and a sample-view camera; the signatures of the FX-series AFMs that streamline operation while significantly enhancing productivity. With the powerful FX AFM controller featuring an 8-channel lock-in amplifier and 5 MHz bandwidth for advanced signal processing, the FX40 supports a wide range of cutting-edge modes and options.

Built for both precision and ease of use, the FX40 is the ideal solution for nanoscale imaging and analysis.

FX40 – 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
- Sample-View Camera

Additional Features

- FX AFM Controller
- Simple Hardware Setup for Option Modes

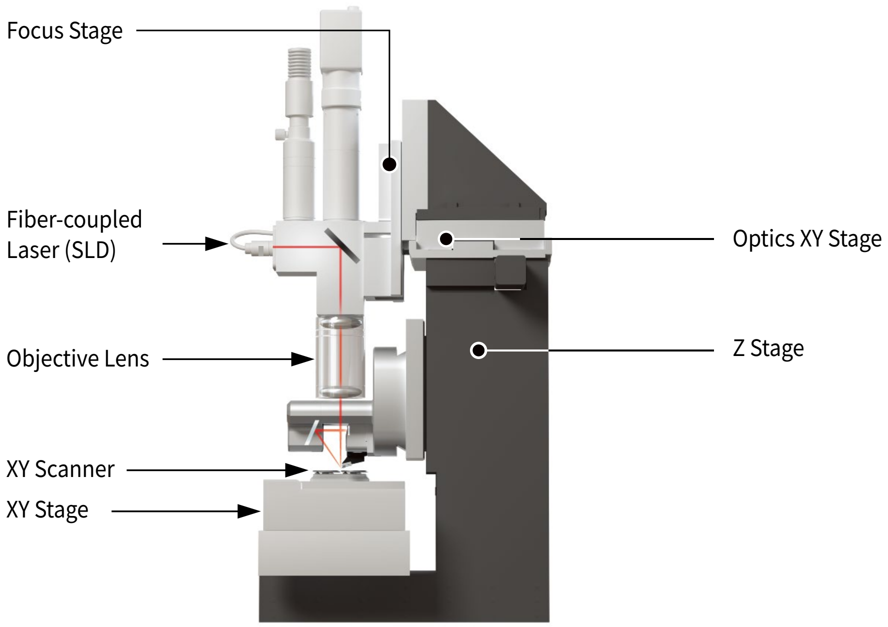
Park FX40

The Most Advanced AFM for Small 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.

Constructed with materials of low thermal expansion coefficients mitigates thermal drift, the FX40 delivers reliable performance over time.



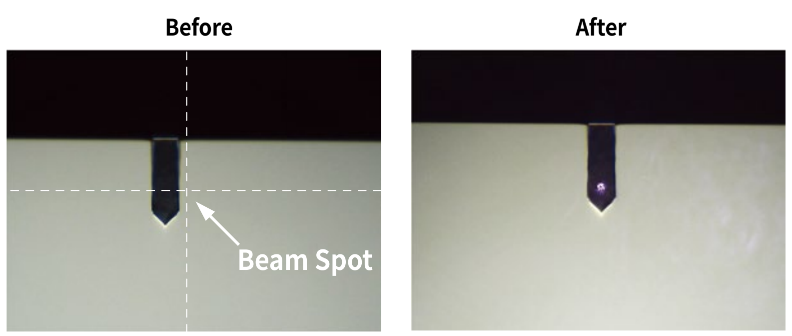
FX Laser Beam Path

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.

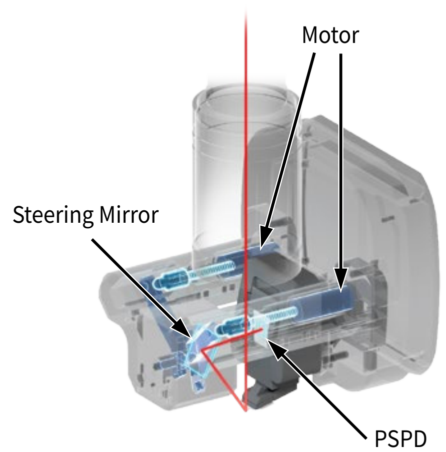
Automatic Laser Beam Alignment

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 antilevers.



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

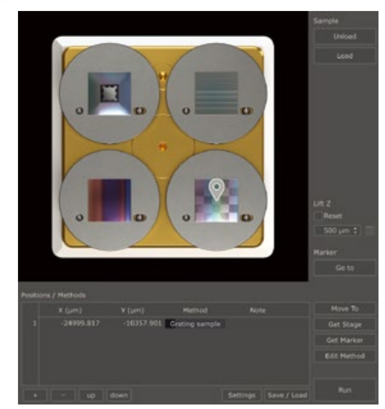
The FX head's Z scanner features three precision ball seats for kinematic mounting, complemented by magnets at the base to ensure a secure, reliable, and repeatable mounting position.

The automatic tip exchanger (ATX) module stores up to 8 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.

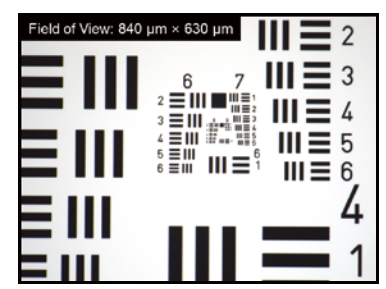
Sample-View Camera

The sample-view camera provides a captured image of the sample, allowing users to simply point and click to move the XY stage. This enables convenient navigation to areas of interest and easy return to the same location.



Improved On-Axis Optics

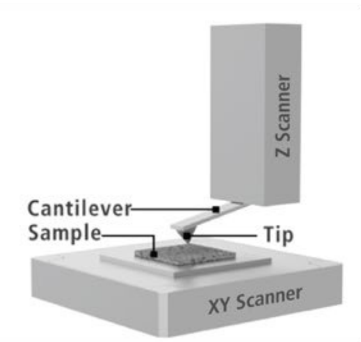
The unobstructed optical microscope provides a clear field of view and can resolve line widths down to 0.87 μm.



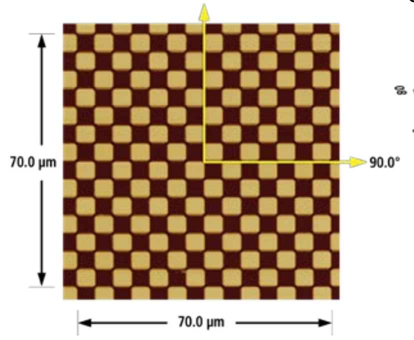
Park AFM Technology

Orthogonal Scan

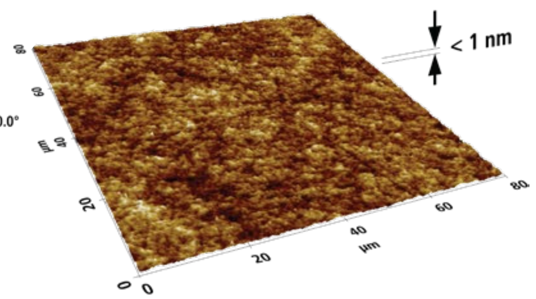
Conventional AFMs with tube scanners suffer from out-of-plane motion and axes crosstalk, resulting in image distortion, especially over large scan areas. The FX40, like all Park AFMs, employs an advanced orthogonal scan system featuring a flexure-guided architecture: a 2D flexure scanner moves the sample 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, this separated scanner system ensures highly orthogonal, linear scans with minimal out-of-plane motion and fast dynamic performance.



10 µm Pitch Calibration Grating

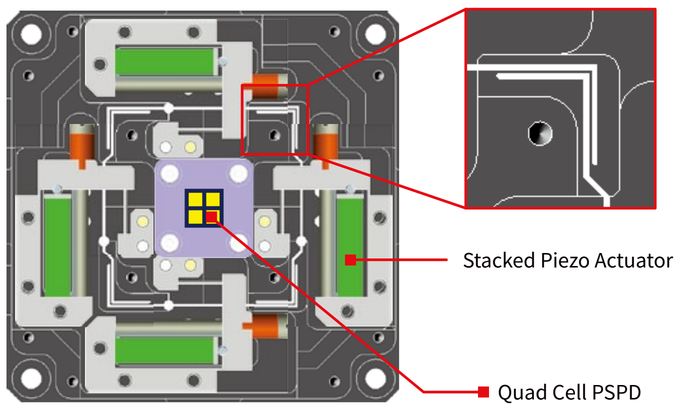


Optical Flat (80 × 80 µm)



Inside View of XY Scanner

Flexure Hinge

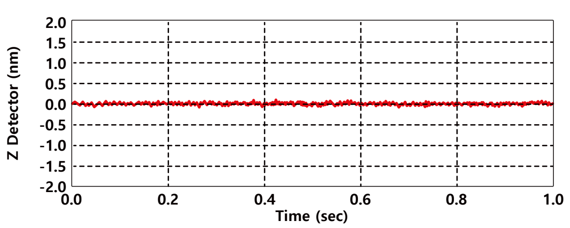


The XY scanner is designed to achieve flat, purely horizontal motion without vertical interference by using stacked piezo actuators and flexure hinge structures. A position sensor is located at the center of the scanner to provide direct feedback for servo control, minimizing positioning errors across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

Low Z Detector Noise

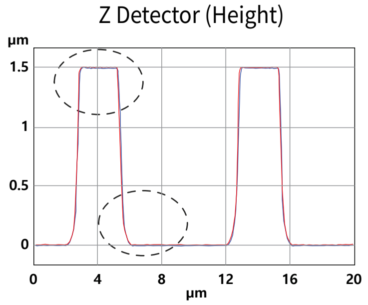
The Z detector has a noise level of less than 0.02 nm, enabling height measurements with sub-nanometer accuracy, down to 0.1 nm. Unlike conventional Z voltage mapping, which often overshoots at stiff walls, the Z detector provides precise, conformal surface tracing.

Z Detector Noise

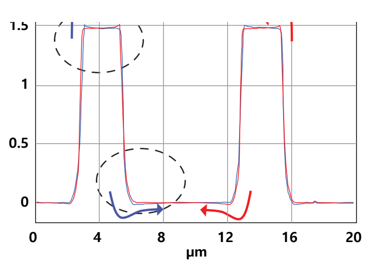


0.02 nm (rms), 1 kHz BW

Z Detector (Height)



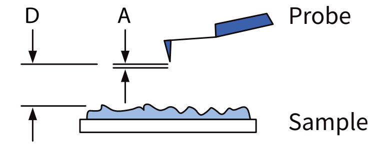
Z Voltage

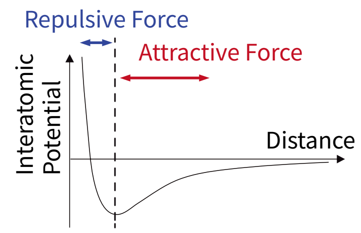


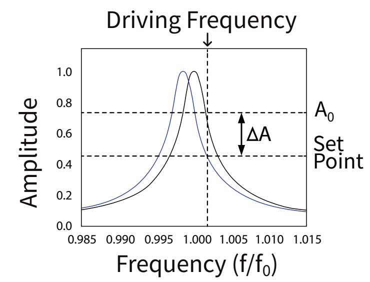
Forward scanning (⟶)
Backward scanning (⟵)

True Non-Contact™ Mode

The FX40 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.



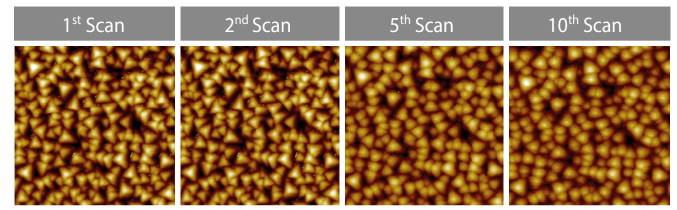




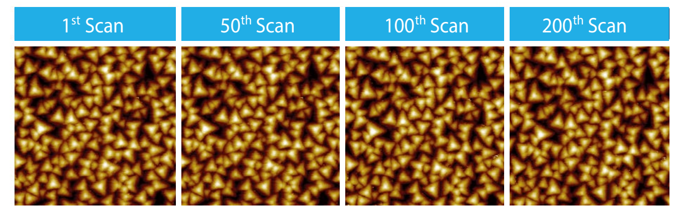
In True Non-contact mode, the tip oscillates at a frequency slightly higher than its resonance frequency, where the amplitude-frequency curve has its steepest slope. As the tip approaches the sample, the attractive force causes a downshift in the effective resonance frequency, leading to a decrease in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

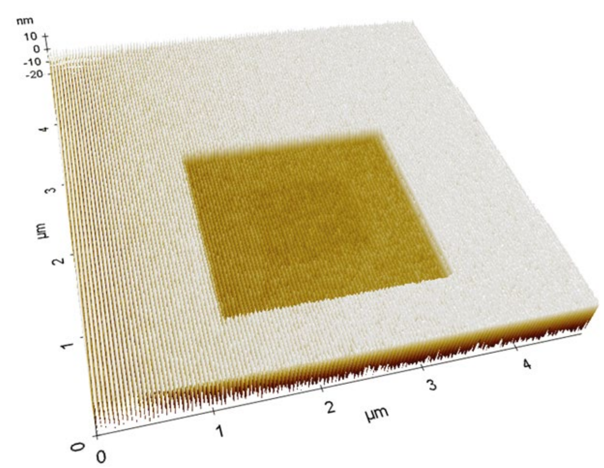


CrN Tip-checking Sample

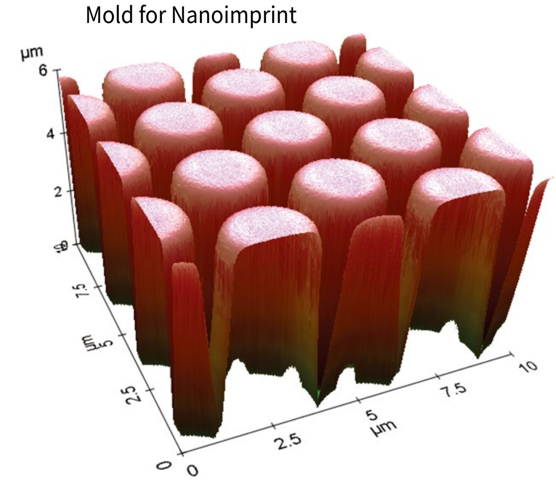
True Non-contact mode can measure soft and sticky samples as well as the most delicate and brittle samples, which cannot be imaged with tapping mode AFM. The image below is the topography of an unbaked photoresist acquired with True Non-contact mode, showing damages induced by electron beam irradiation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



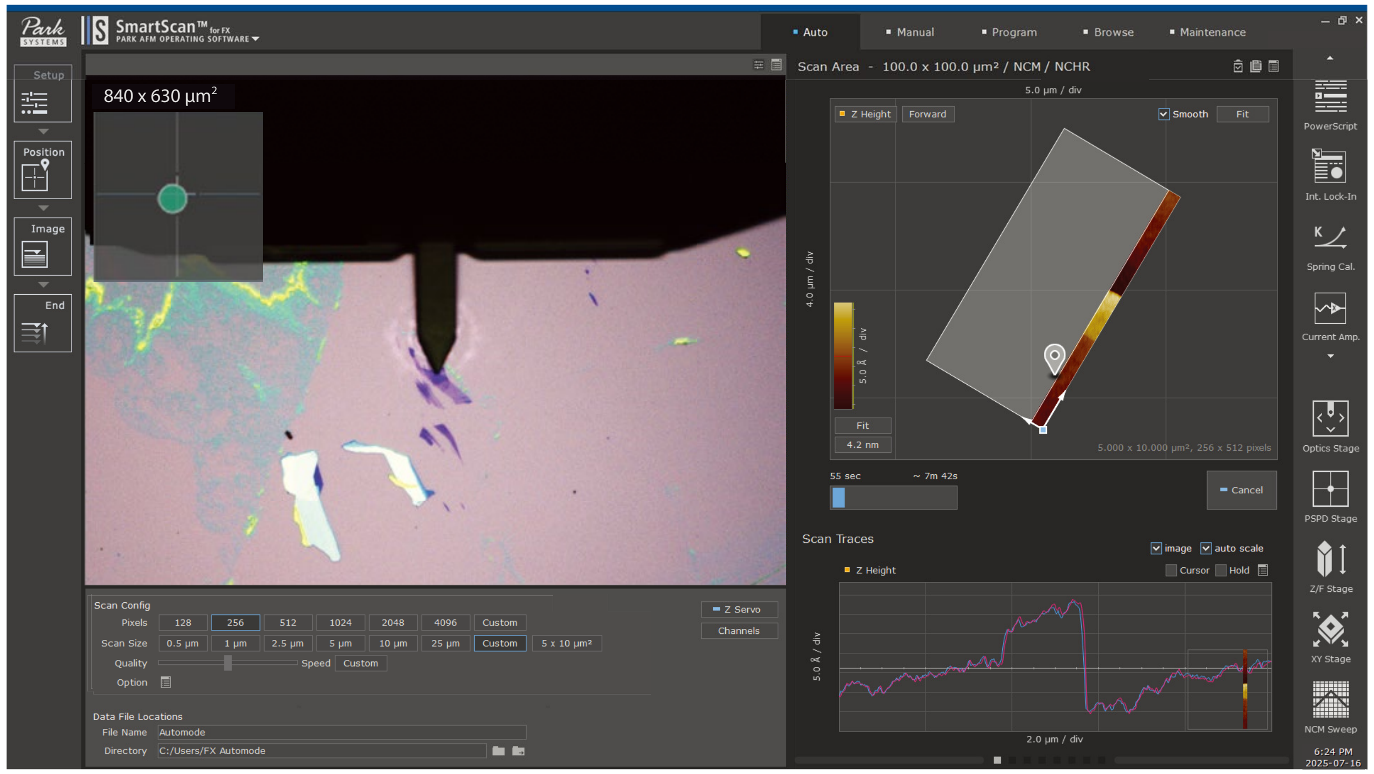
Mold for Nanoimprint



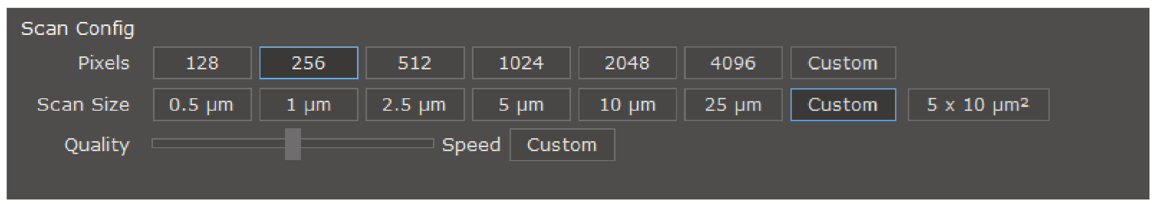
Park SmartScan™

Bringing the Power and Versatility of AFM Technology to Everyone

The FX40 comes with Park SmartScan™, an advanced AFM operating software that simplifies image acquisition and enhances usability with its intuitive interface and powerful automation features.

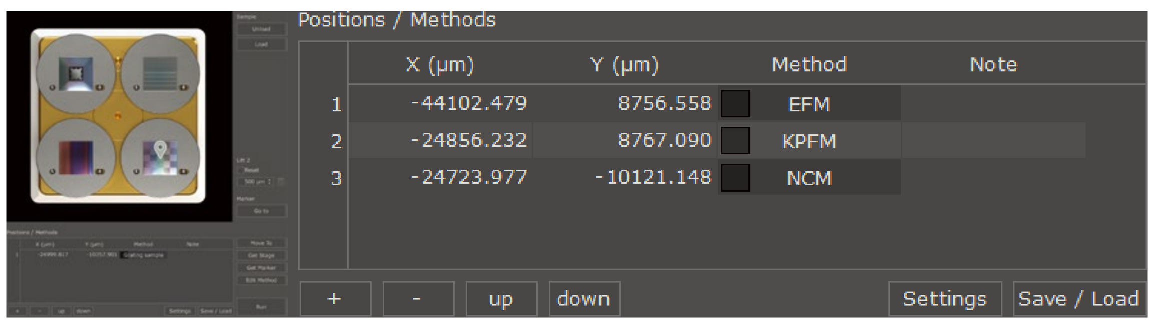


In conventional AFM systems, users must manually adjust numerous parameters, such as Z servo gains, force set point, and XY scan speed, often through trial and error. SmartScan eliminates this complexity by allowing users to choose only three parameters: pixel density, scan size, and quality vs. speed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

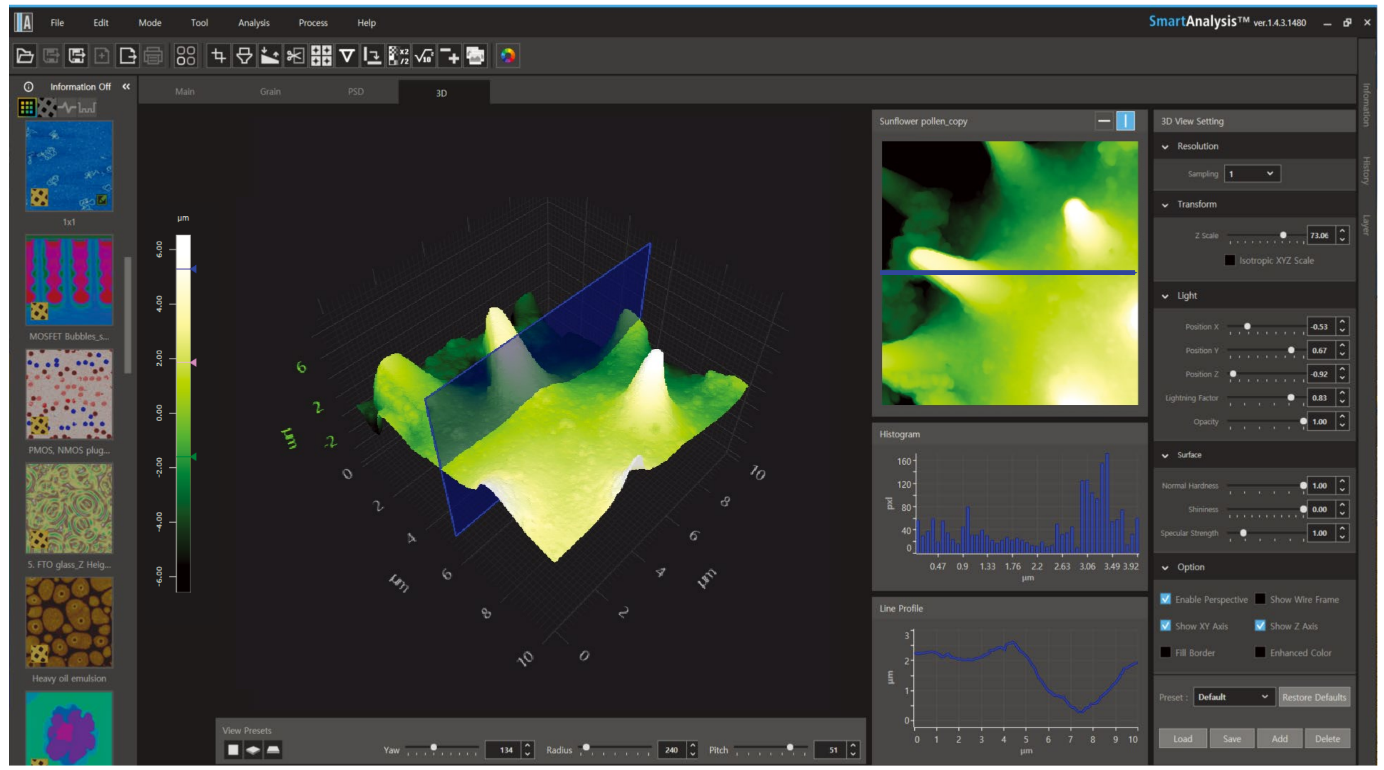
StepScan™ allows users to select multiple points on the sample image, assign specific scan recipes to each location, and automatically carry out sequential measurements.



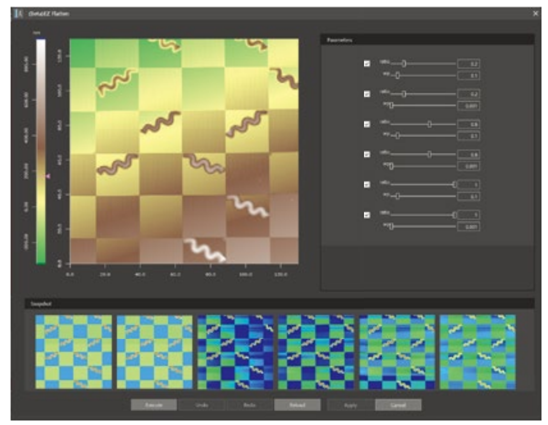
Park SmartAnalysis™

Streamlining AFM Data Workflow

Scan data from the FX40 can be analyzed with Park SmartAnalysis™, a powerful AFM image analysis software that enables fast image processing, comprehensive data analysis, and efficient result publication.



Mycelium growth on pattern 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.

Cast Iron 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 FX40

Additional Features

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.

Internal Advanced Options without Additional Hardware

Powered by an integrated 8-channel lock-in amplifier, the FX AFM offers a wide range of advanced options without requiring any additional hardware. Core features are seamlessly built in, making the system more compact, efficient, and easier to use than ever before.

Easy Head Extension Module (HEM) Setup

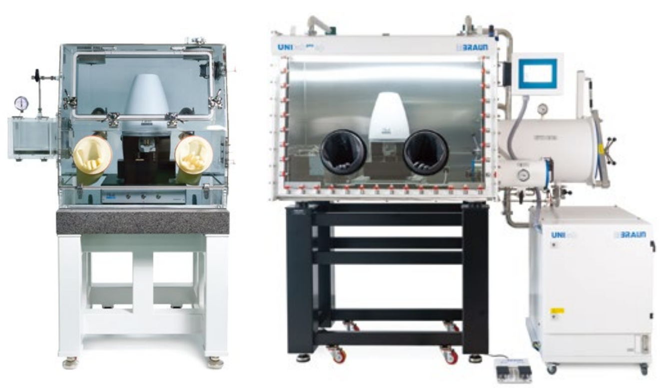
The newly designed FX AFM head allows for easier head extension module (HEM) setup. Without detaching the AFM head from the AFM body, HEM can be slid into the port on the AFM head and tightened with a knob. Furthermore, the design of the HEM port allows for tip bias control without additional wires attached.

Multi Sample Chuck

The FX40 is equipped a multi sample chuck that supports up to four coupon-sized samples. The magnetic samples chucks have kinematic mounts for repeatable positioning. With using special type of sample disk which has one hole and one slot, positioning errors are less than 5 µm. This can give users to make sure that the position after re-preparing the sample or re-approaching the tip is precisely done on almost the same spot as they expected.

Glove Box for Environmental Control

With its advanced automation, the FX40 delivers exceptional synergy when integrated inside a glove box. One of the main inconveniences of operating an AFM in a glove box is the need to wear gloves every time the system is accessed. With the FX40, all operations can be performed without wearing gloves, eliminating time-consuming steps and greatly enhancing convenience.

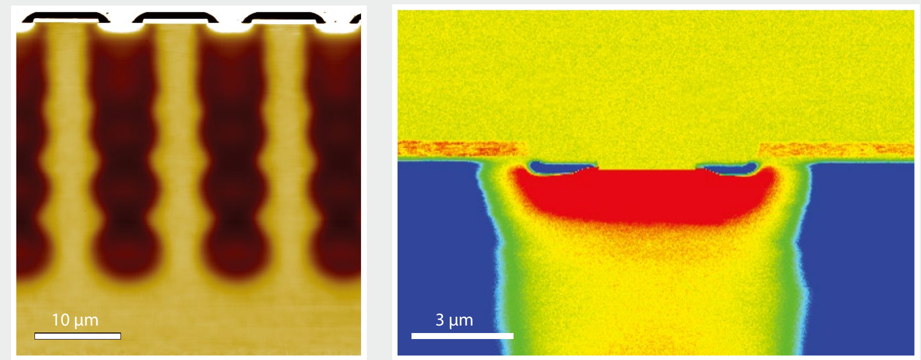


Park FX40

Designed for Your Applications

Park FX40 provides precise measurements for small samples, making it the ideal solution in research applications.

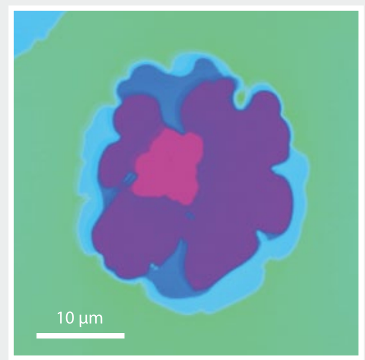
Semiconductor



Super-junction MOSFET

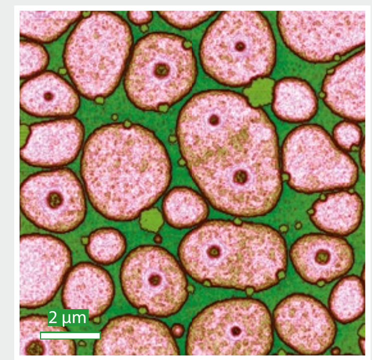
A Super-junction MOSFET was measured in Microwave Impedance Microscopy (MIM) mode to acquire surface capacitance. The image shows the Capacitance difference of the Super-junction MOSFET.

Polymer



Block Copolymer

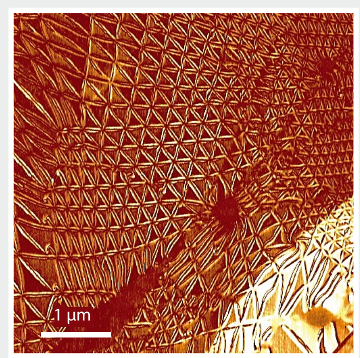
A Block Copolymer was measured in True Non-contact mode to acquire surface topography. The scan data revealed a peak-to-valley height difference of 150 nm, and the image shows the floral-pattern of the Block Copolymer.



Polymer Composite

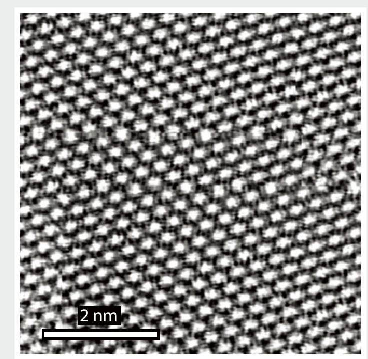
A Polymer Composite was measured in True Non-contact mode to acquire surface topography. The scan data revealed a peak-to-valley height difference of 8.2 nm, and the image shows the numerous round islands of Polymer Composites.

2D Material



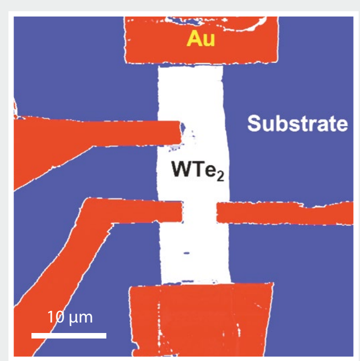
Twisted hBN Bilayer

A Twisted hBN Bilayer was measured in Contact resonance Piezoresponse Force Microscopy to acquire Piezoresponse signals. The image shows the fractal pattern of the Twisted hBN Bilayer.



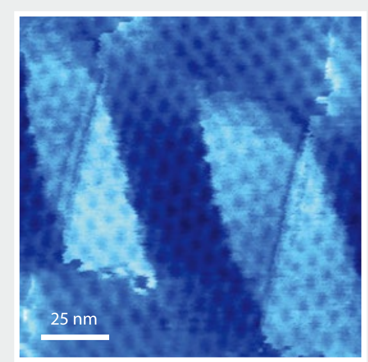
MoS2 Atomic Lattice

A MoS2 Atomic Lattice was measured in Lateral Force Microscopy to acquire the frictional force image. The scan data revealed a reference lattice constant of ~3.16Å, and the image shows the wonderful moire pattern image of MoS2 Atomic Lattice.



WTe_2 on Au Electrode

A WTe2 on Au Electrode was measured in Conductive AFM to acquire current image. The scan data revealed a peak-to-valley height difference of 158 µA, and the image shows the current distribution of WTe2 on Au Electrode.



Twisted Bilayer Graphene

A Twisted Bilayer Graphene on hBN was measured in Conductive AFM to acquire current image. The image shows the morie pattern between Twisted Bilayer Graphene and hexagonal boron nitride.

Park FX40

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 Spreading Resistance Microscopy (SSRM) *
  - 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)
- 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

- XY scanner (100 µm × 100 µm, 50 µm × 50 µm or 5 µm × 5 µm)
- Flexure-guided high-force Z scanner (15 µm or 30 µm)

Sample Mount

- Up to 4 small samples with magnetic sample chuck
- 20 mm × 20 mm (w × d), up to 20 mm thickness
- Up to 40 mm × 40 mm (w × d) w/o multi-sample chuck

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

Sample-View Camera

- View of four sample holders
- Field of view: 172 mm × 97 mm
- Resolution: 13 M pixels

Stage

- XY stage: 105 mm × 40 mm
- Z stage: 22 mm

Automatic Tip Exchanger

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

Dimension and Weight

- AE(Outer): 780 mm × 830 mm × 1,540 mm
- Desk: 1,410 mm × 810 mm x 740 mm
- Total weight: 390 kg (AFM Body + 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*
*** Consult with Park Systems*