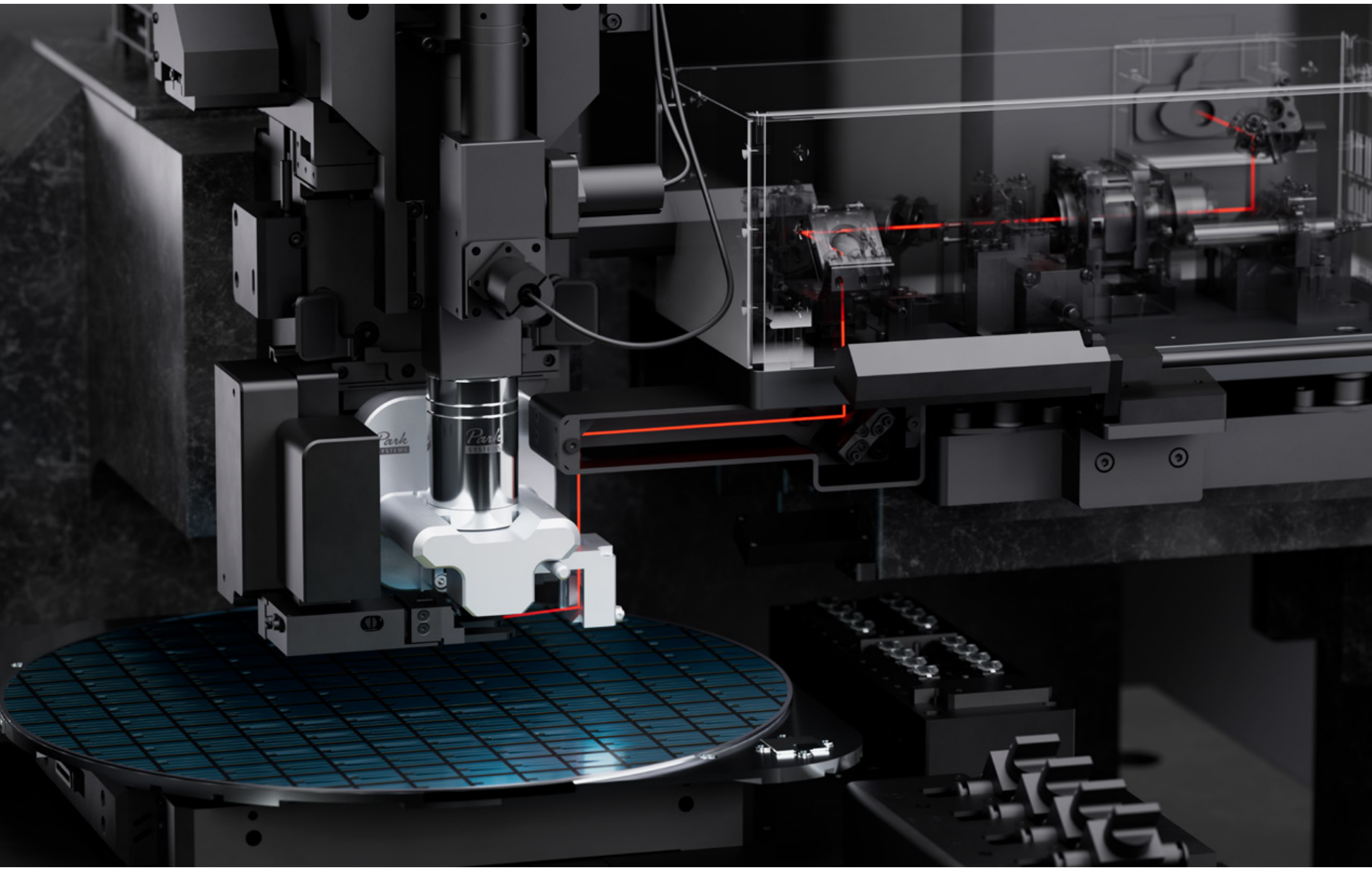
Park FX300 IR

The most advanced 300 mm AFM with IR spectroscopy



Park FX300 IR is Park Systems' advanced AFM solution for nanoscale infrared spectroscopy and imaging, combining chemical and surface characterization. It is built on the proven FX300 platform supporting samples up to 300 mm, with low noise, minimal thermal drift, and high mechanical stability, ensuring reliable high-resolution metrology.

The FX300 IR is a nano-IR spectrometer based on Photo-induced Force Microscopy (PiFM), enabling both IR spectral analysis and chemical imaging at the nanoscale. Like all Park AFMs, it features an orthogonal scan system and True Non-contact™ mode, delivering consistent, non-invasive measurements even on fragile samples.

Automation features such as automatic probe exchange, IR beam alignment, and multi-point measurement streamline operation and simplify workflows.

By combining high-performance AFM with advanced IR capability, the FX300 IR provides a powerful platform for precise and efficient nanoscale chemical characterization.

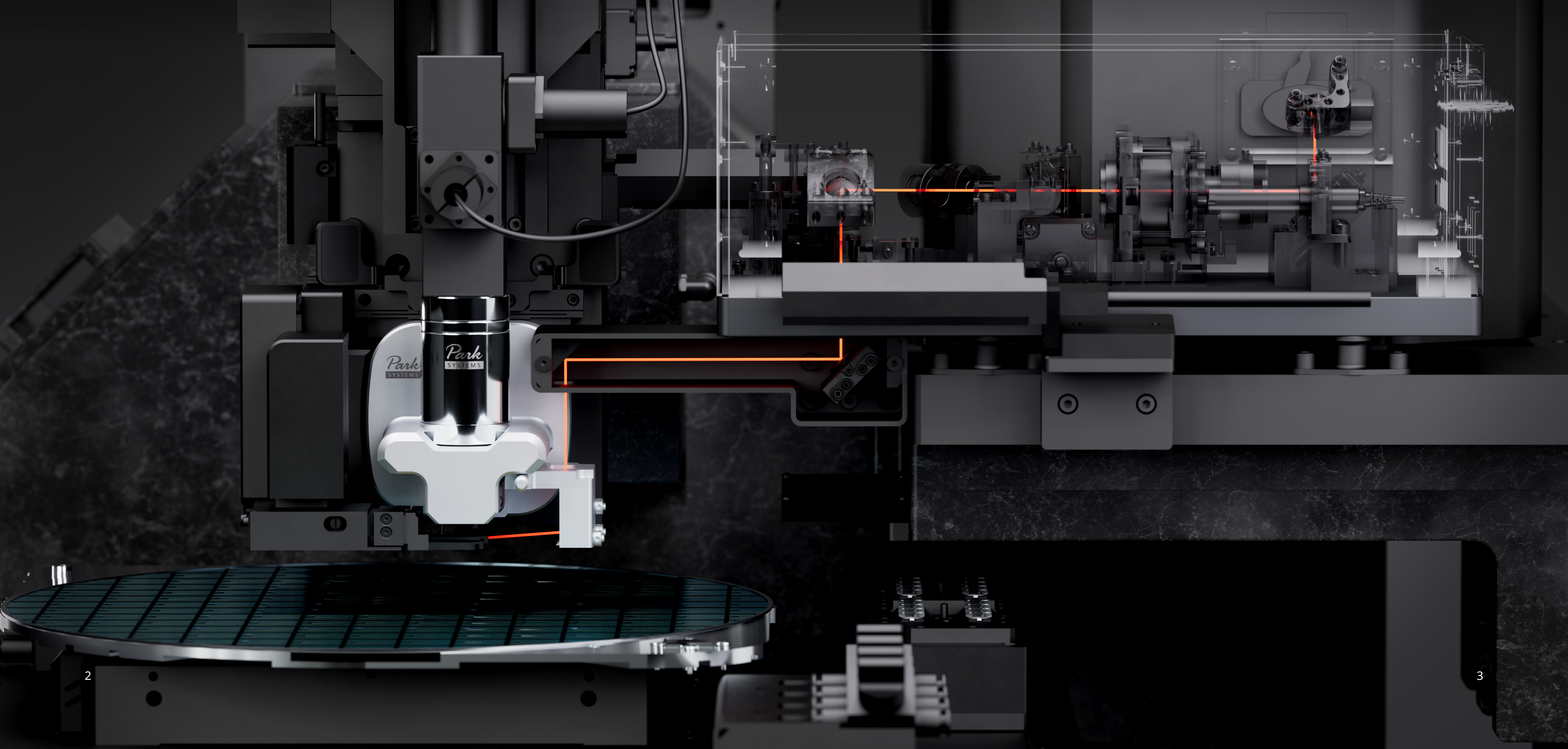
FX300 IR - Key Features

Suitable for Precise Chemical Characterization

- Nano-IR with Non-Contact Detection
- High Spatial Resolution Chemical Imaging
- Comprehensive Material Characterization
- Automatic IR Beam Alignment

FX AFM Advantages

- Superior FX Mechanical Design
- Orthogonal Scan System
- True Non-Contact™ Mode
- Automatic Probe Exchange
- Automatic Laser Beam Alignment



Park FX300 IR

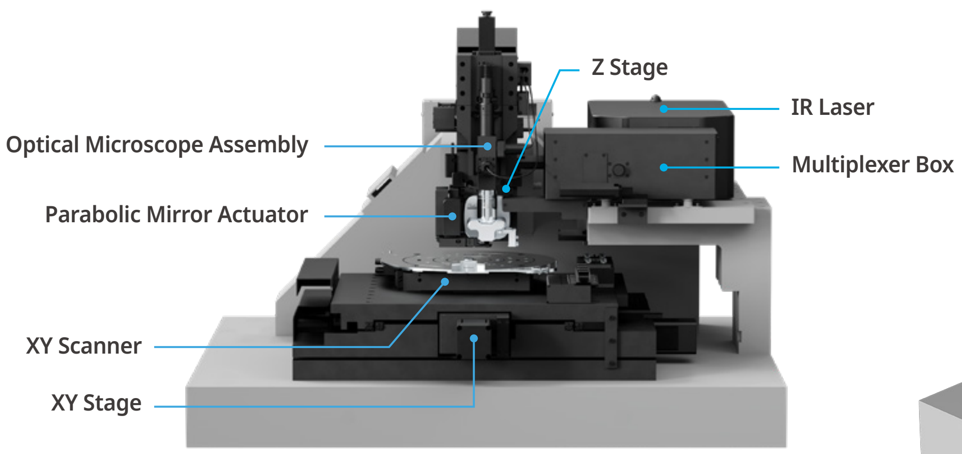
The Most Advanced AFM with Nano-IR for Large Samples

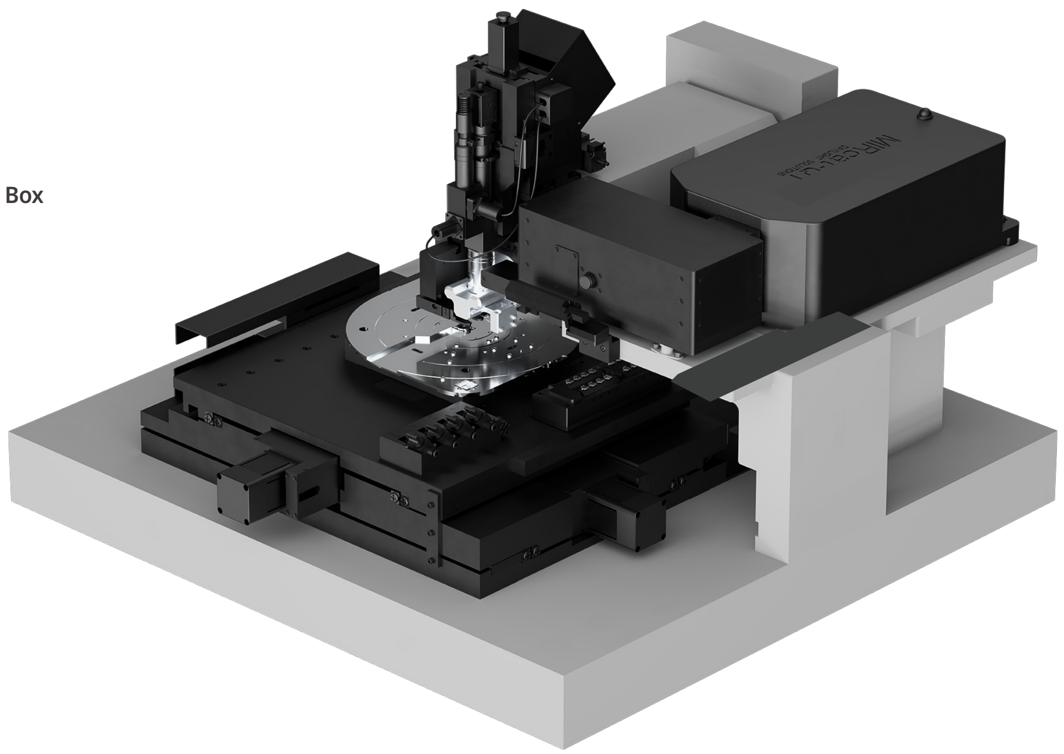
Superior FX Mechanical Design

Built on the superior FX-series AFM mechanical design, the FX300 IR is engineered to minimize 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 IR, while the use of expansion-matched materials with low thermal expansion coefficients mitigates thermal drift, ensuring reliable performance over time.

The FX300 IR integrates dedicated components such as the IR laser, parabolic mirror actuator, multiplex box, and side steering mirror, providing a stable platform for consistent nanoscale IR measurements.





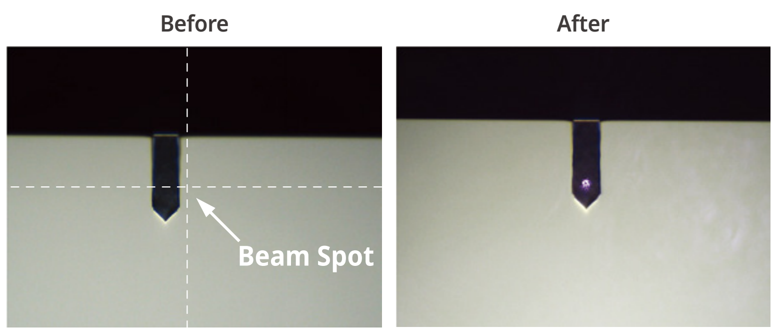
FX Laser Beam Path

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.

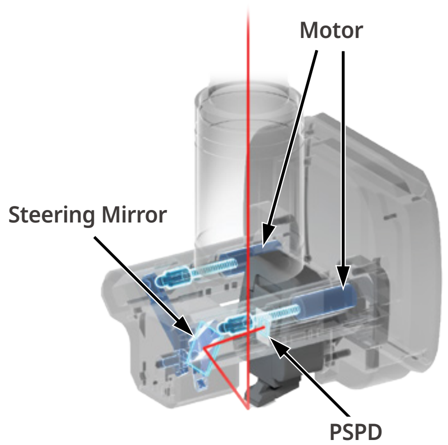
Automatic Laser Beam Alignment

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).

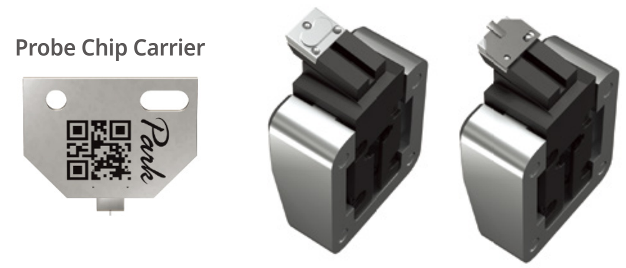


Automatic Probe Exchange

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.

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 occupied or vacant probe slots with a simple mouse click.

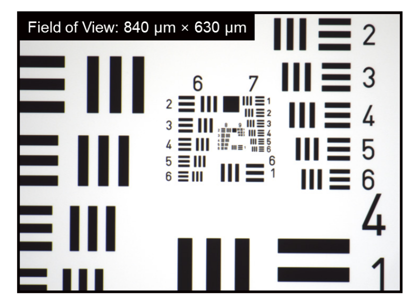
After a slot is selected, the AFM head moves down to pick the probe up from or park the currently mounted probe into the slot, depending on the position of the strong magnet underneath.

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 resolves line widths down to 0.87 µm.

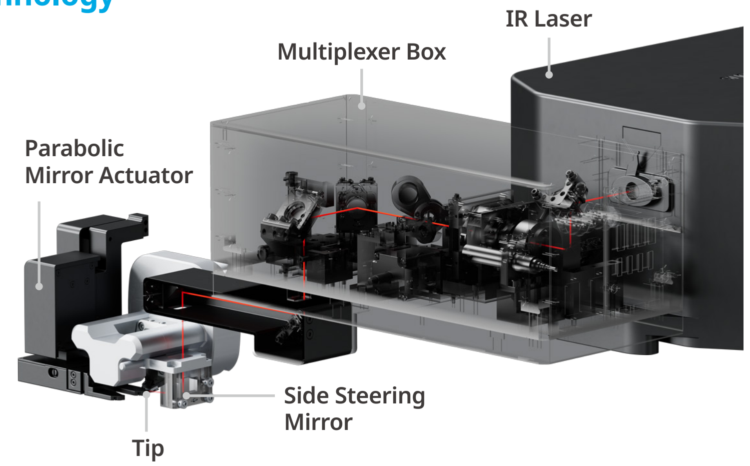


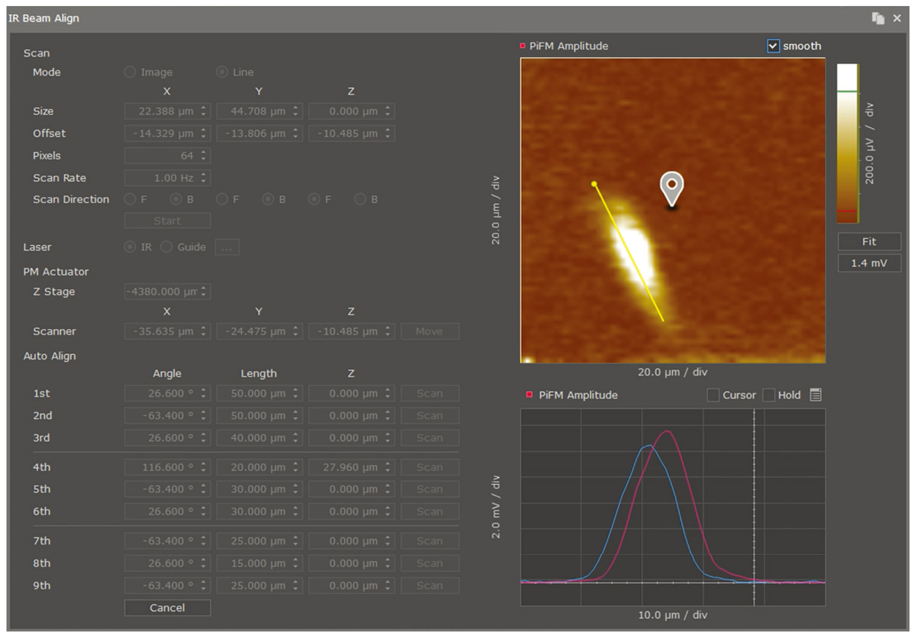
Park FX300 IR

Nanoscale IR Analysis with Advanced AFM Technology

Streamlined Automated Workflow for Nanoscale IR Measurements

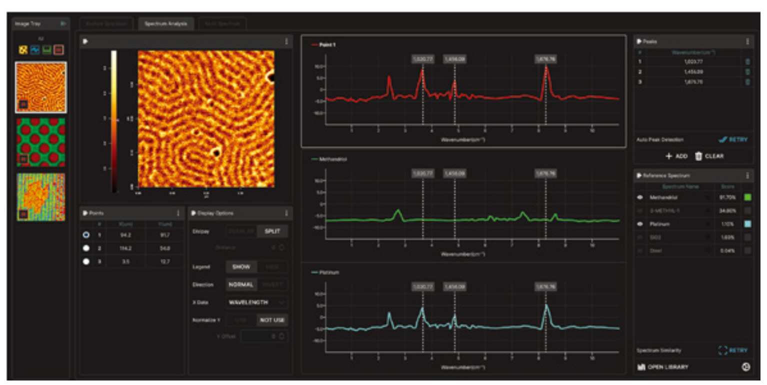
Park FX300 IR builds upon the proven automation of the FX platform, including probe exchange and vision-guided AFM laser alignment, and extends this capability with advanced automation dedicated to IR measurements. In particular, the system features a fully automated IR beam alignment routine that uses the measured nano-IR signal as real-time feedback to locate the optimal beam position.





Automatic IR Beam Alignment Powered by SmartScan™

SmartScan™ performs automatic IR beam alignment. After executing a full-stroke scan using the parabolic mirror (PM) actuator, the FX300 IR automatically identifies the position where the measured nano-IR signal reaches its highest intensity. This ensures accurate alignment and maximizes signal quality with minimal user intervention.



Advanced Spectrum Analysis with SmartAnalysis™

SmartAnalysis™ enables seamless spectrum visualization and image overlay for nano-IR data. Measurement results from SmartScan can be opened with a single click, displaying IR spectra alongside AFM images with chemical contrast overlays. This facilitates efficient interpretation of topographical and spectral information.

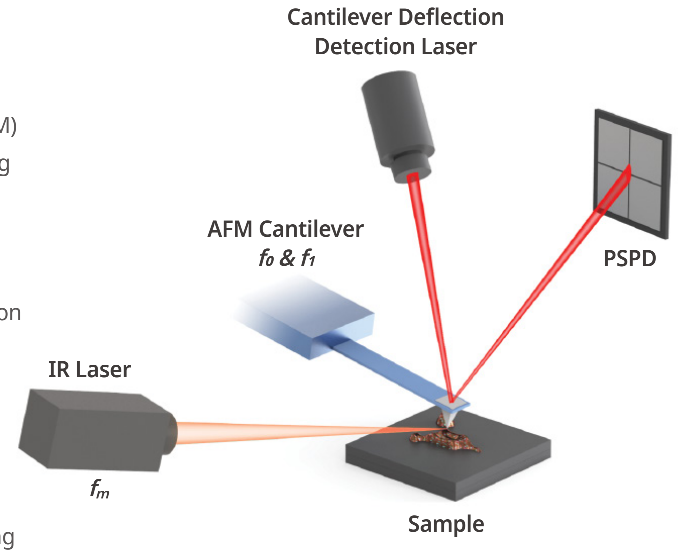
Park FX300 IR

High-Resolution Chemical Imaging without Contact

True Non-Contact™ IR Measurements

Park FX300 IR leverages Photo-induced Force Microscopy (PiFM) to perform fully non-contact infrared measurements, detecting the photo-induced force between the AFM tip and the sample without ever touching the sample surface. This approach eliminates sample damage and tip contamination inherent in contact-based techniques, achieving sub-5 nm spatial resolution and extending probe lifetime.

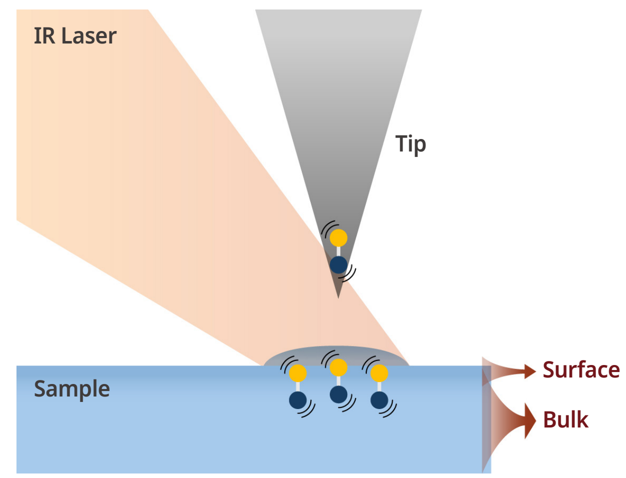
Non-contact mode feedback maintains precise tip–sample separation throughout the measurement, ensuring high reproducibility on soft or delicate materials. With streamlined operation, users can focus on results rather than setup, making nano-IR analysis more reliable and accessible than ever.



Selectable Detection Modes for Nano-IR Measurements

Park FX300 IR offers two distinct detection modes, enabling users to optimize measurements based on sample characteristics and analysis goals. Direct mode tunes the laser to the cantilever's resonance frequency, maximizing signal strength and making it effective for probing broader or deeper sample responses.

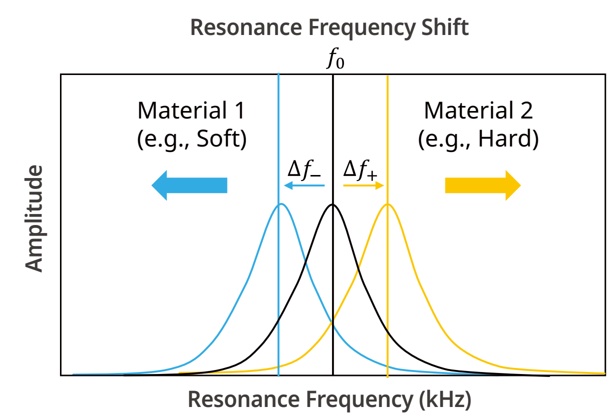
Sideband mode modulates the laser at the difference frequency ($f_1 - f_0$), selectively detecting nonlinear interactions at the tip–sample interface. This allows for highly localized chemical contrast with minimal background, ideal for resolving fine features on complex or heterogeneous surfaces.



Optimized Detection Frequency for Stable Nano-IR Imaging

Consistent, high-resolution nano-IR imaging requires more than just resonance. It requires precise frequency tracking. As the AFM tip scans across materials with varying mechanical properties, the tip–sample interaction can shift the cantilever's resonance frequency. If not properly adjusted, this detuning may lead to signal degradation and mechanical artifacts.

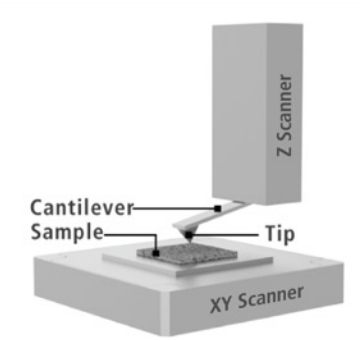
Park FX300 IR addresses this by automatically scanning a narrow frequency range at every pixel and selecting the optimal detection frequency. This ensures the system stays aligned with the actual resonance condition throughout the scan, maintaining strong signals, reducing artifacts, and improving signal-to-noise ratio (SNR) for reliable chemical imaging on heterogeneous samples.



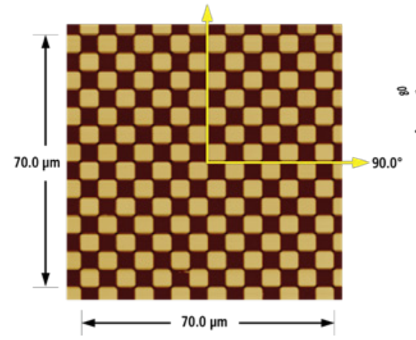
Park AFM Technology

Orthogonal Scan

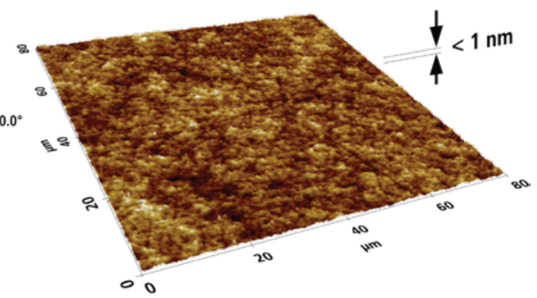
Conventional AFMs with tube scanners suffer from out-of-plane motion and axes crosstalk, resulting in image distortion, especially over large scan areas. The FX300 IR, like all Park AFMs, employs an advanced orthogonal scan system featuring a flexure-guided architecture: a 2D flexure scanner moves the 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

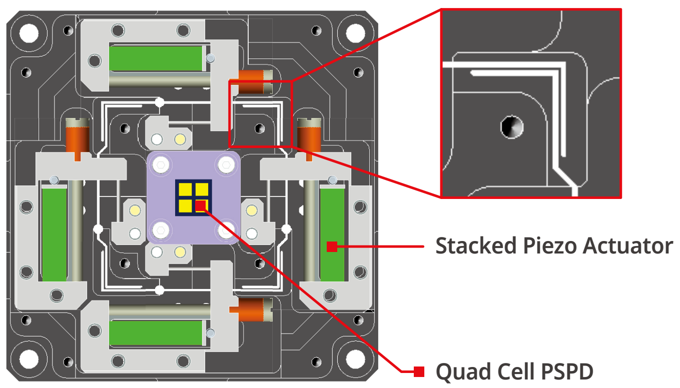


Optical Flat (80 µm × 80 µm)



Inside View of XY Scanner

Flexure Hinge

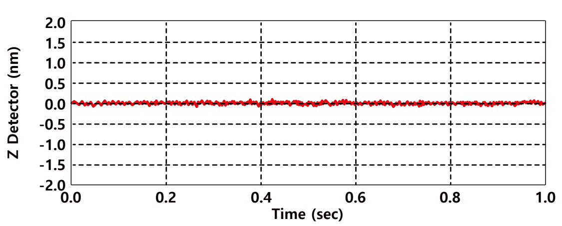


The XY scanner is designed to achieve flat, purely horizontal motion without vertical interference by using stacked piezo actuators and flexure hinge structures. A position sensor is located at the center of the scanner to provide direct feedback for servo control, minimizing positioning errors across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

Low Z Detector Noise

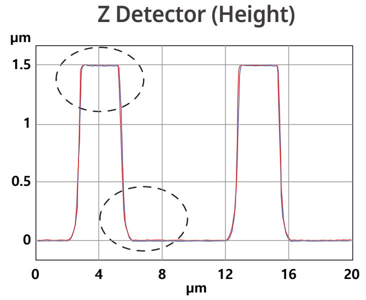
The Z detector has a noise level of less than 0.02 nm, enabling height measurements with sub-nanometer accuracy, down to 0.1 nm. Unlike conventional Z voltage mapping, which often overshoots at stiff walls, the Z detector provides precise, conformal surface tracing.

Z Detector Noise

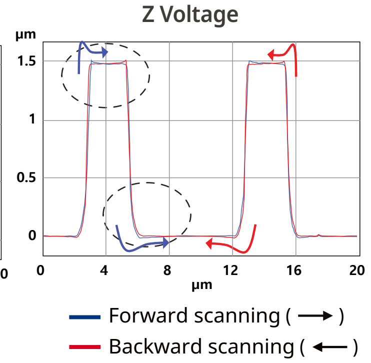


0.02 nm (rms), 1 kHz BW

Z Detector (Height)

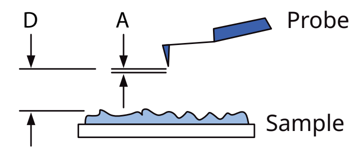


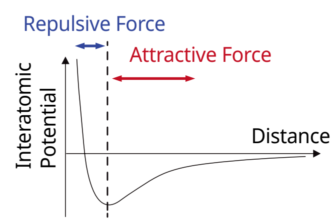
Z Voltage

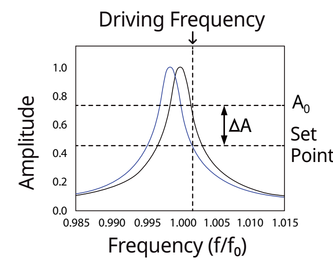


True Non-Contact™ Mode

The FX300 IR 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.



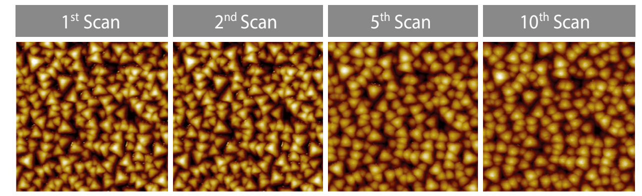




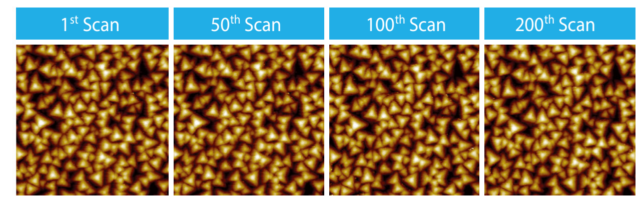
In True Non-contact mode, the tip oscillates at a frequency slightly higher than its resonance frequency, where the amplitude-frequency curve has its steepest slope. As the tip approaches the sample, the attractive force causes a downshift in the effective resonance frequency, leading to a decrease in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

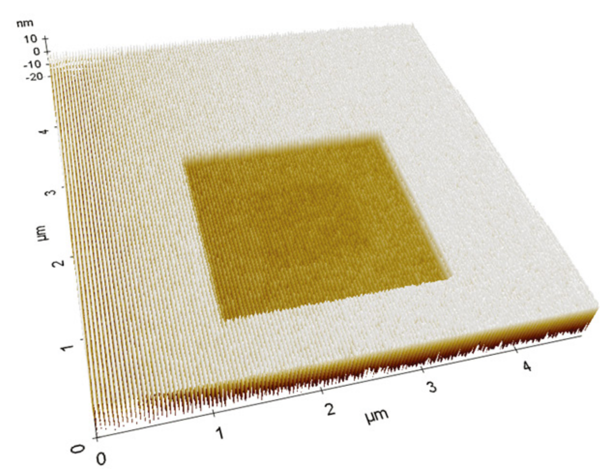


CrN Tip-Checking Sample

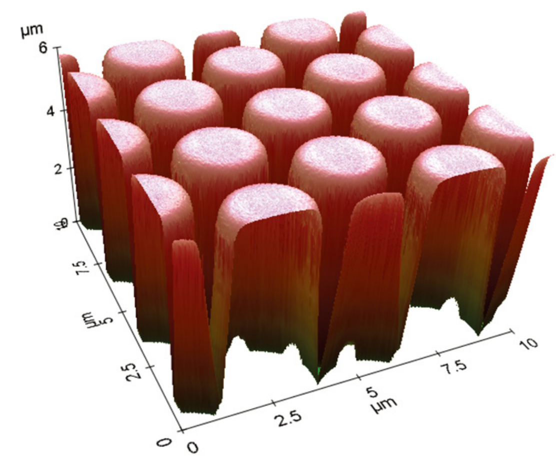
True Non-contact mode can measure soft and sticky samples as well as the most delicate and brittle samples, which cannot be imaged with tapping mode AFM. The image below is the topography of an unbaked photoresist acquired with True Non-contact mode, showing damages induced by electron beam irradiation 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 FX300 IR

Designed for Your Applications

Defect-Specific Chemical Characterization

Nano-IR imaging allows precise chemical identification of nanoscale defects such as contamination, residues, or process anomalies. In the example shown, nano-IR analysis indicates a defect spectrum consistent with PTFE (Teflon). This capability is particularly valuable for advanced failure analysis and semiconductor process monitoring. Support for KLARF file integration further enables targeted analysis by guiding measurements to registered defect locations.

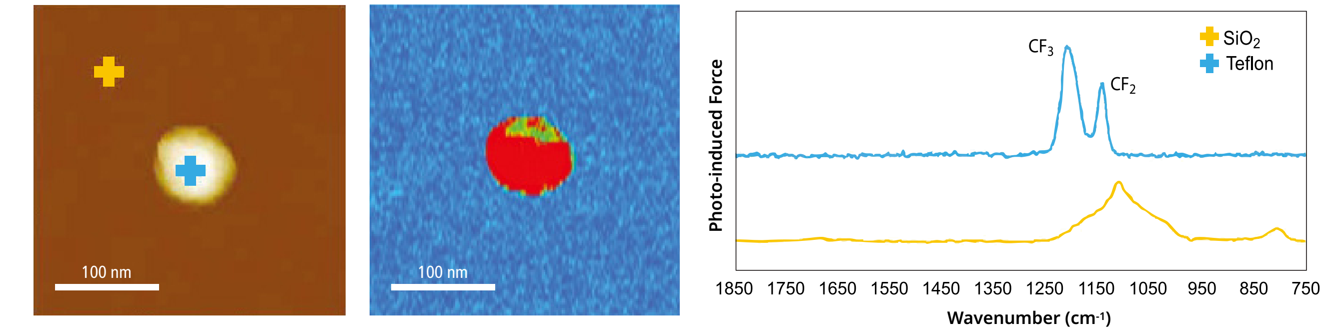
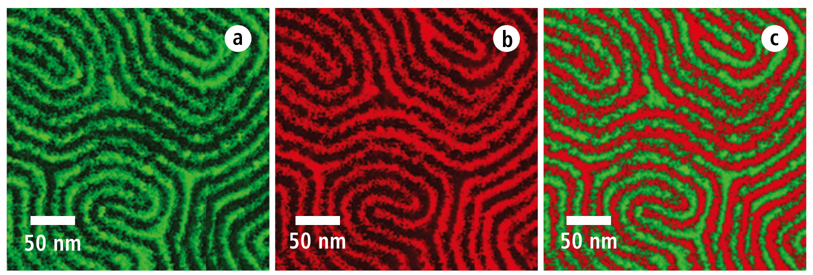


Image Overlay for Chemical Mapping

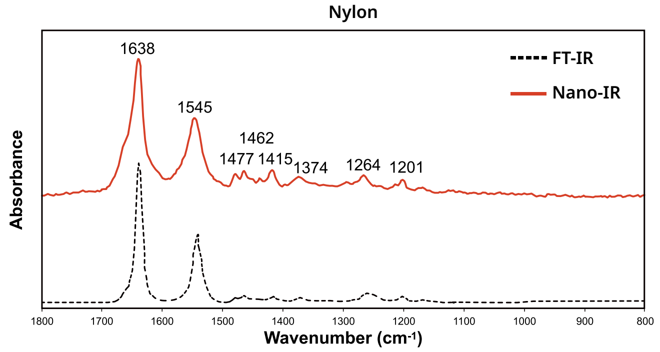
Park FX300 IR acquires images at specific wavenumbers that match characteristic absorption bands, so each acquisition emphasizes materials that exhibit absorption at those bands. When these images are opened and overlaid in SmartAnalysis, the combined view renders clear chemical contrast and reveals the nanoscale distribution of constituents alongside AFM topography. This wavenumber-selective overlay turns a set of images at specific wavenumbers into a coherent nanoscale chemical map suitable for interpretation and reporting.

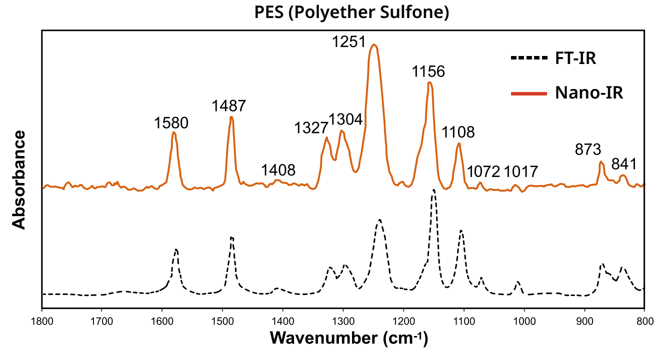


- PS-b-PMMA
- a Nano-IR image of PS material at 1493 cm^{-1}
- b Nano-IR image of PMMA material at 1731 cm^{-1}
- c Overlay nano-IR image of PS & PMMA

Nano-IR Spectra Consistent with FT-IR

Nano-IR spectra show close agreement with conventional Fourier Transform IR Spectroscopy (FT-IR) results, including alignment in peak positions and comparable relative band profiles. In side-by-side measurements on the same sample under matched conditions, nano-IR reproduces the key spectral features observed by FT-IR while adding nanoscale localization. This consistency supports reliable chemical identification at the nanoscale and offers a familiar point of reference for FT-IR results.



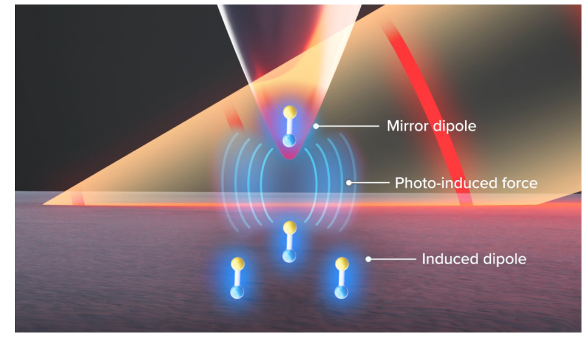


Park FX300 IR

Nano-IR Technology for Precise Chemical Analysis

High Resolution Chemical Imaging with Nano-IR

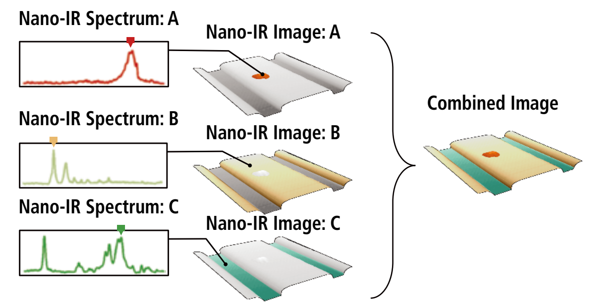
Photo-induced Force Microscopy (PiFM) exploits the photo-induced force generated when a tunable IR laser excites molecular vibrations at their resonant frequencies. In the FX300 IR, the AFM cantilever operates in Non-contact mode to detect these forces without ever touching the sample surface. As the laser wavelength is swept, changes in cantilever oscillation amplitude directly reflect local IR absorption, producing both spectral and chemical maps. This fully non-invasive approach delivers true nanoscale chemical characterization—capable of achieving sub-5 nm spatial resolution and monolayer sensitivity—enabling researchers to visualize molecular composition at the nanoscale.



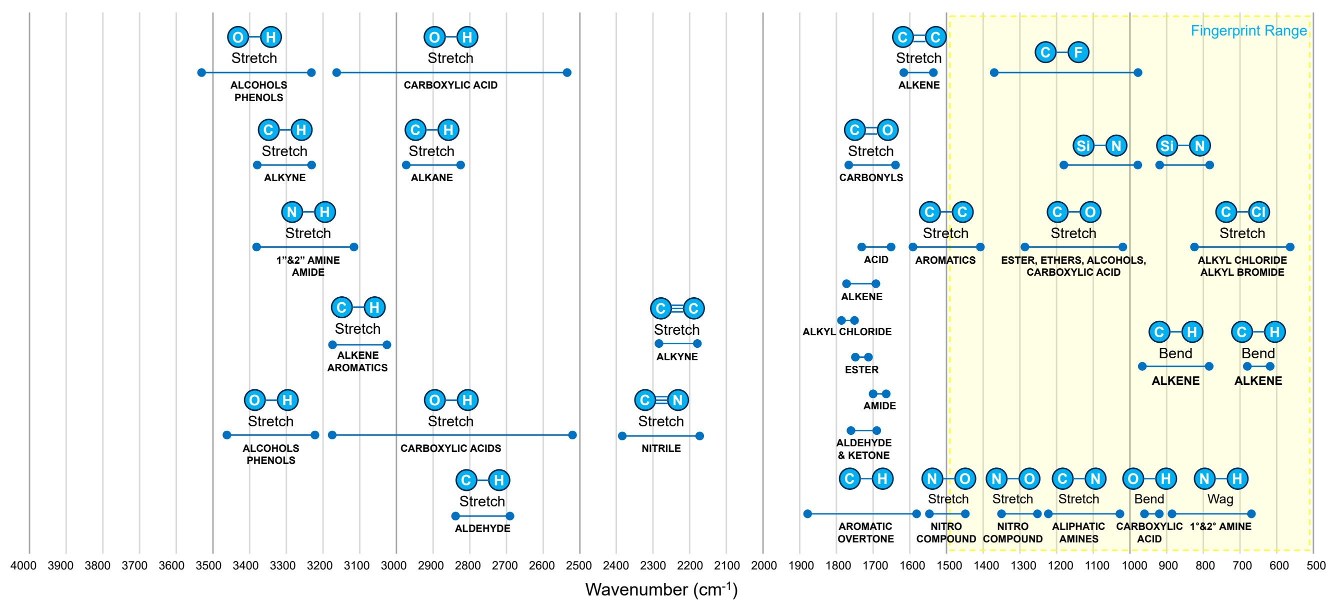
IR Spectroscopy and Chemical Mapping at the Nanoscale

Park FX300 IR supports both point spectroscopy and chemical imaging. IR absorption spectra acquired at specific sample locations allow material identification, while fixed wavenumber imaging reveals the spatial distribution of molecular vibrations.

Park FX300 IR software provides intuitive tools to explore spectra, overlay chemical maps at selected peaks, and correlate spectral and spatial information, thereby enhancing interpretability and accelerating material analysis at the nanoscale.



Functional Group Vibrational Mode Table



Park FX300 IR
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)
  - Lateral Force Microscopy (LFM)
- Electrical Properties
  - Conductive AFM (C-AFM) *
    - Current-Voltage (I-V) Spectroscopy
  - Scanning Spreading Resistance Microscopy (SSRM) *
  - Piezoresponse Force Microscopy (PFM)
    - Piezoresponse Spectroscopy
    - Off-resonance PFM
    - Contact Resonance PFM (CR-PFM)
    - Dual Frequency Resonance Tracking PFM (DFRT-PFM) **
  - PinPoint™ Nanoelectrical Modes *
  - Electrostatic Force Microscopy (EFM)
  - Kelvin Probe Force Microscopy (KPFM)
    - Heterodyne KPFM
    - Sideband KPFM
    - Amplitude Modulation KPFM (AM-KPFM)
- Magnetic Properties
  - Magnetic Force Microscopy (MFM)
    - Frequency Modulation MFM (FM-MFM)
    - Amplitude Modulation MFM (AM-MFM)
- Thermal Properties
  - Scanning Thermal Microscopy (SThM) *
    - Temperature Mapping
    - Thermal Conductivity Mapping
- Nanolithography & Manipulation
  - Nanolithography *
  - Nanomachining *

IR Laser

- QCL Laser (3 modules): 1,800 – 770 cm^{-1} typical
- Extended QCL Laser (4 modules)*: 2,395 – 1,995 cm^{-1} and 1,800 – 770 cm^{-1} typical
- OPO Laser*: 7,117 cm^{-1} – 4,950 cm^{-1} and 4,385 cm^{-1} – 2,281 cm^{-1} typical
- OPO/DFG Laser*: 7,117 cm^{-1} – 4,950 cm^{-1} and 4,385 cm^{-1} – 2,281 cm^{-1}, 806 cm^{-1} – 589 cm^{-1} typical

Scanner

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

Sample Mount

- Vacuum grooves for wafers (up to 300 mm)
- Up to 16 small samples with vacuum chuck (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 Pixel

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

Dimension and Weight ***

- AE (Outer): 1,250 mm × 1,280 mm × 1,570 mm
- Cabinet: 1,280 mm × 1,280 mm × 1,890 mm
- Total weight: 1,850 kg (AFM Body + AE)

Required Environment

- Required acoustic noise level: Below 65 dB
- Required floor vibration level: VC-D (6.25 µm/sec)
- Power: 2.3 kW (Maximum)

** Requires additional options*
*** Consult with Park Systems*
**** Dimensions and weight may vary depending on the laser configuration.*