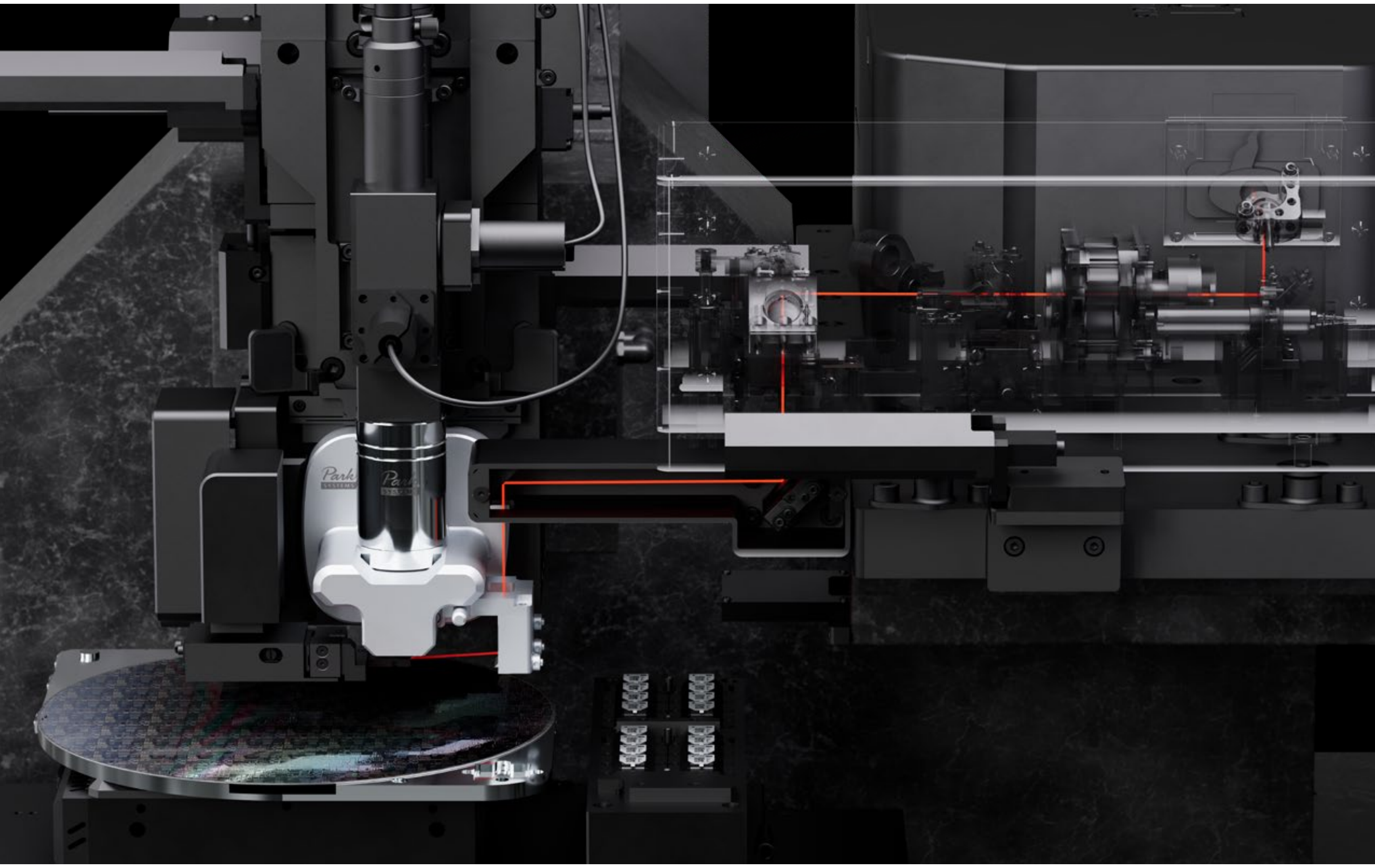
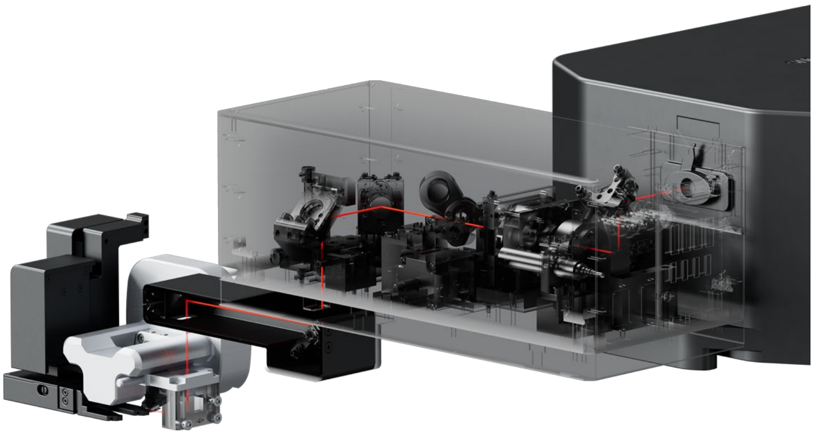
Park Nano-IR Spectrometers

AFM-Integrated Nanoscale IR Spectroscopy for Advanced Material Characterization





Park SYSTEMS

Park nano-IR spectrometers seamlessly integrate atomic force microscopy (AFM) with photo-induced force microscopy (PiFM) technology. These innovative platforms deliver molecular vibration mapping at the nanometer scale while maintaining full AFM capabilities for comprehensive topographic, nanomechanical, electrical, and thermal analysis.

With simultaneous acquisition of nano-IR chemical information and surface topography, Park nano-IR spectrometers are ideal for nanoscale IR spectroscopy and imaging in semiconductors, polymers, thin films, 2D materials, and other advanced materials.

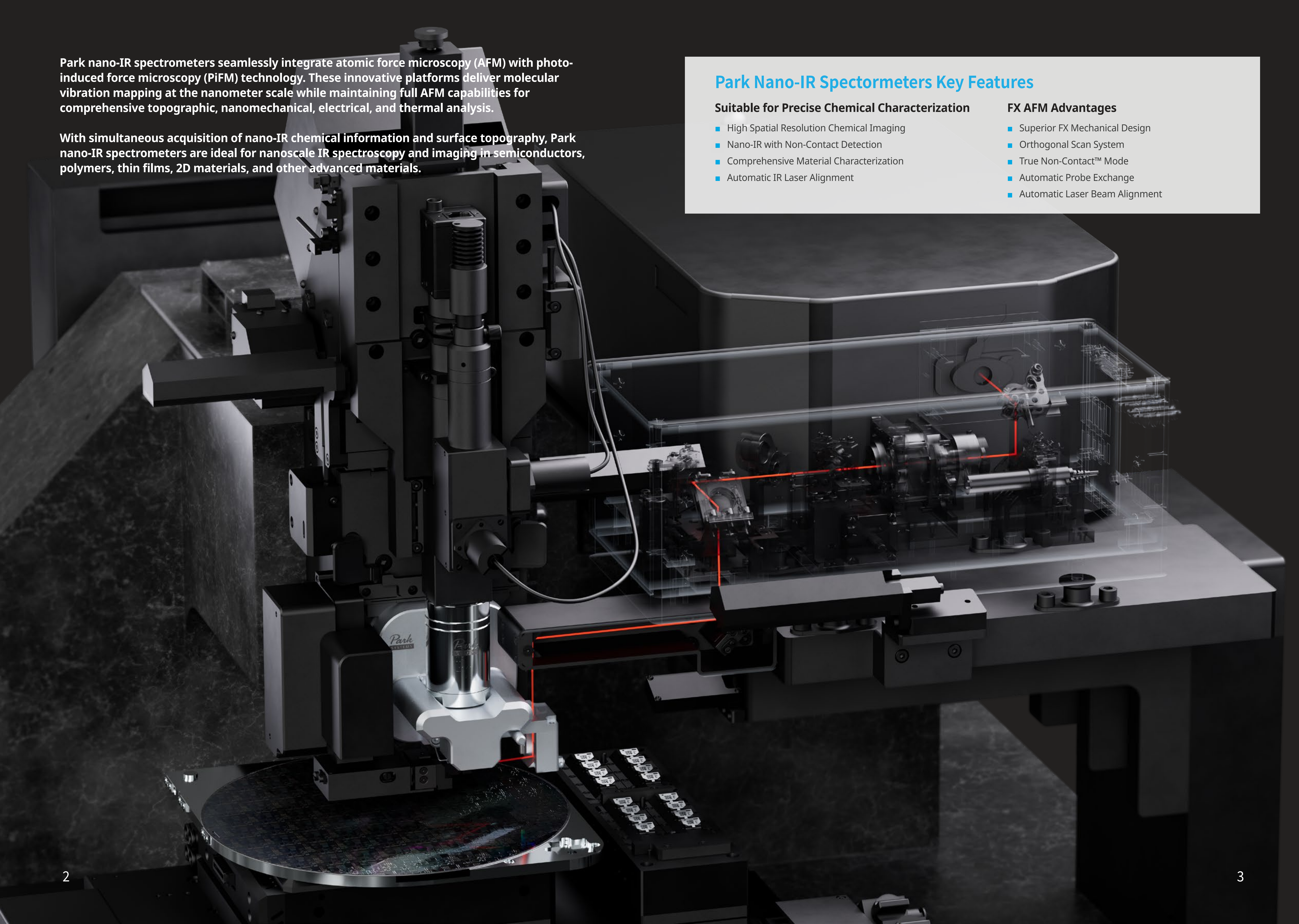
Park Nano-IR Spectormeters Key Features

Suitable for Precise Chemical Characterization

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

FX AFM Advantages

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

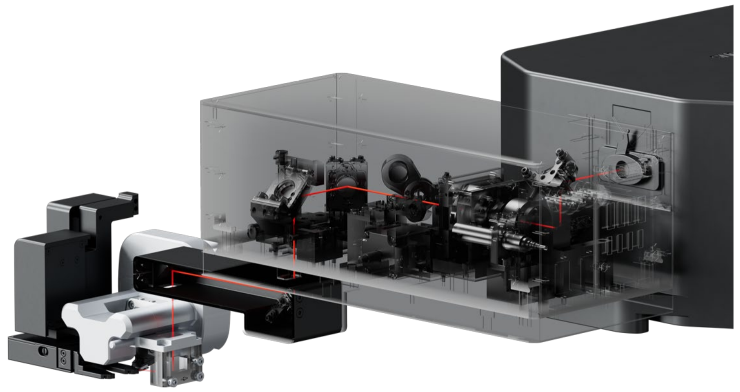


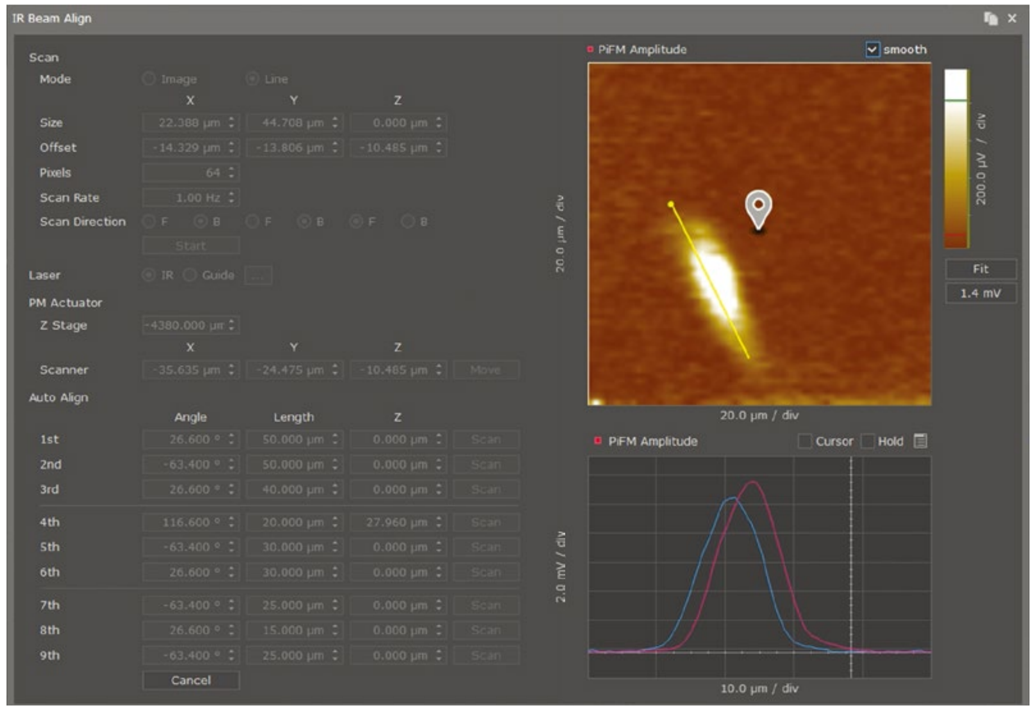
Park Nano-IR Spectrometers

Nanoscale IR Analysis with Advanced AFM Technology

Streamlined Automated Workflow for Nanoscale IR Measurements

Park nano-IR spectrometers build upon the proven automation of the FX platform, including probe exchange and vision-guided AFM laser alignment, and extend it 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 system 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.

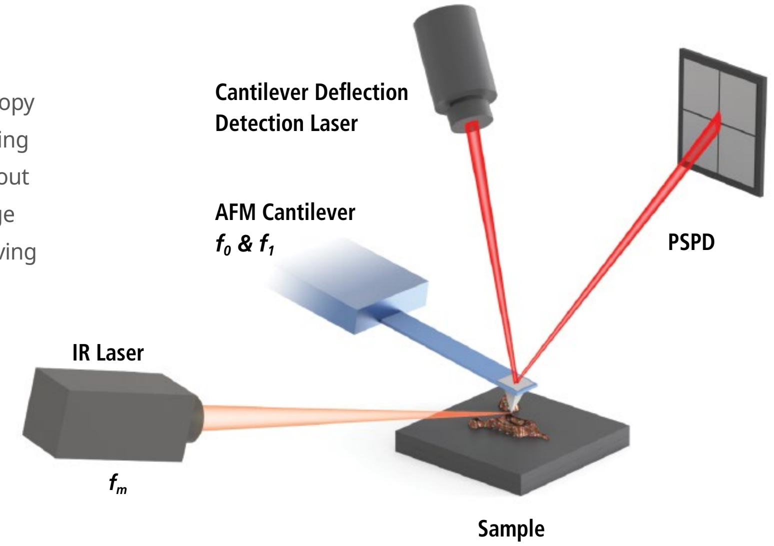
Park Nano-IR Spectrometers

High-Resolution Chemical Imaging without Contact

True Non-Contact™ IR Measurements

Park nano-IR spectrometers leverage 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 surface. This approach eliminates sample damage and tip contamination inherent in contact-based techniques, achieving sub-5 nm spatial resolution and extending probe lifetime.

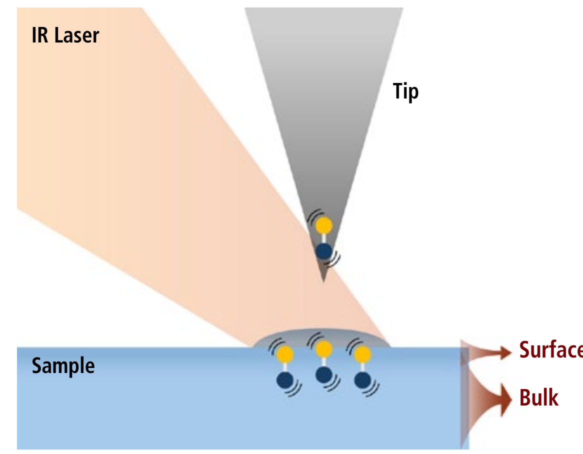
Non-contact mode feedback maintains precise tip–sample separation throughout the measurement, ensuring high reproducibility on soft or delicate materials. With streamlined operation, users can focus on results rather than setup, making nano-IR analysis more reliable and accessible than ever.



Selectable Detection Modes for Nano-IR Measurements

Park nano-IR spectrometers offer 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.

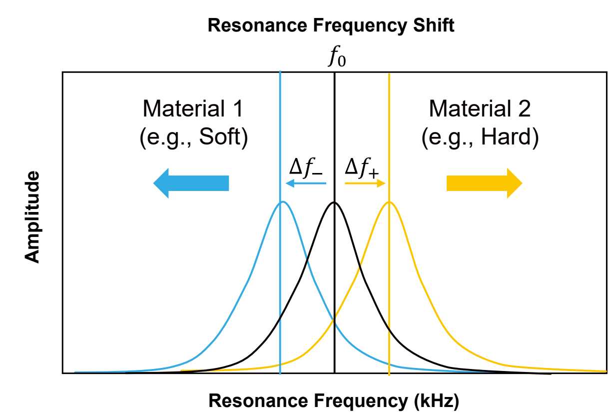
Sideband mode modulates the laser at the difference frequency (f1 − f0), selectively detecting nonlinear interactions at the tip–sample interface. This allows for highly localized chemical contrast with minimal background, ideal for resolving fine features on complex or heterogeneous surfaces.



Optimized Detection Frequency for Stable Nano-IR Imaging

Consistent, high-resolution nano-IR imaging requires more than just resonance. It demands 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 nano-IR spectrometers address 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 Nano-IR Spectrometers

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.

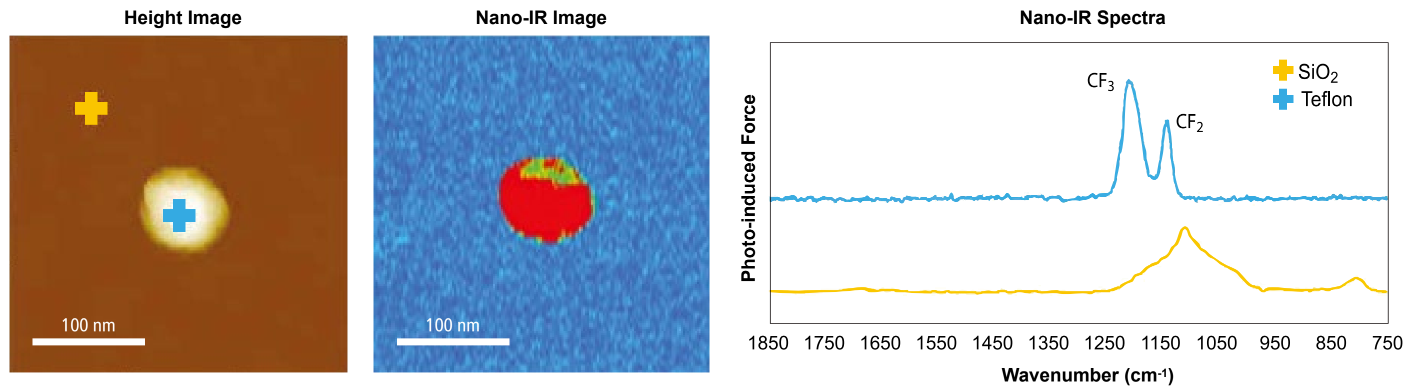
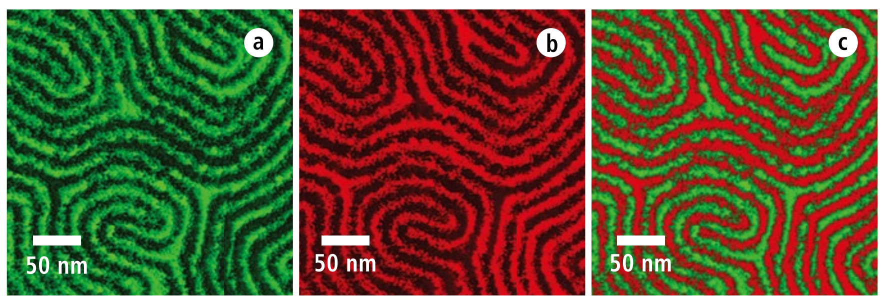


Image Overlay for Chemical Mapping

Park nano-IR spectrometers 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.

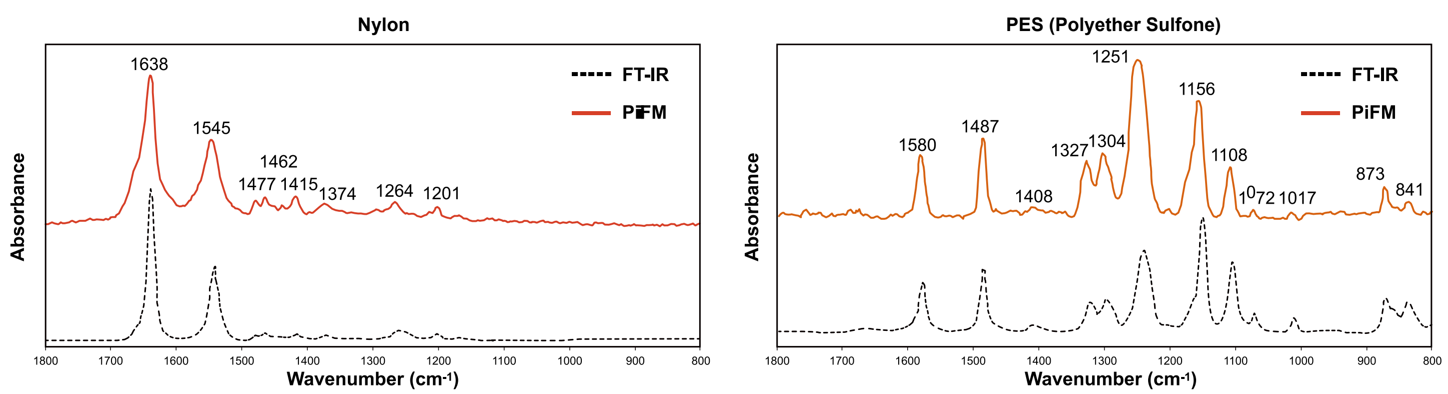


- PS-b-PMMA

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.

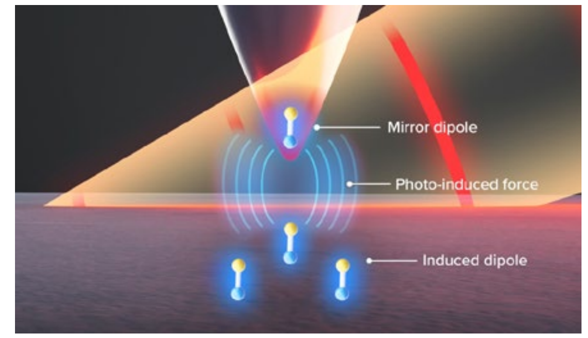


Park Nano-IR Spectrometers

Nano-IR Technology for Precise Chemical Analysis

High Resolution Chemical Imaging with Nano-IR

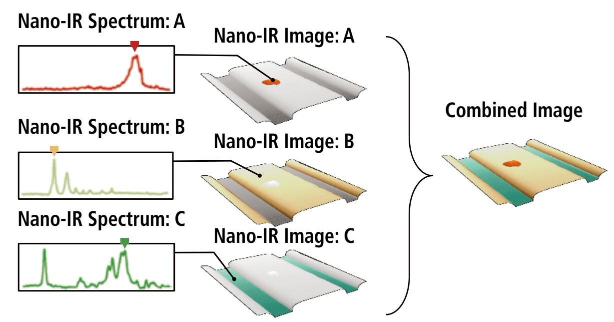
Photo-induced Force Microscopy (PiFM) exploits the photo-induced force generated when a tunable IR laser excites molecular vibrations at their resonant frequencies. In the Park nano-IR spectrometers, the AFM cantilever operates in Non-contact mode to detect these forces without ever touching the sample 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—achieving sub-5 nm spatial resolution and monolayer sensitivity—enabling researchers to visualize molecular composition at the atomic scale.



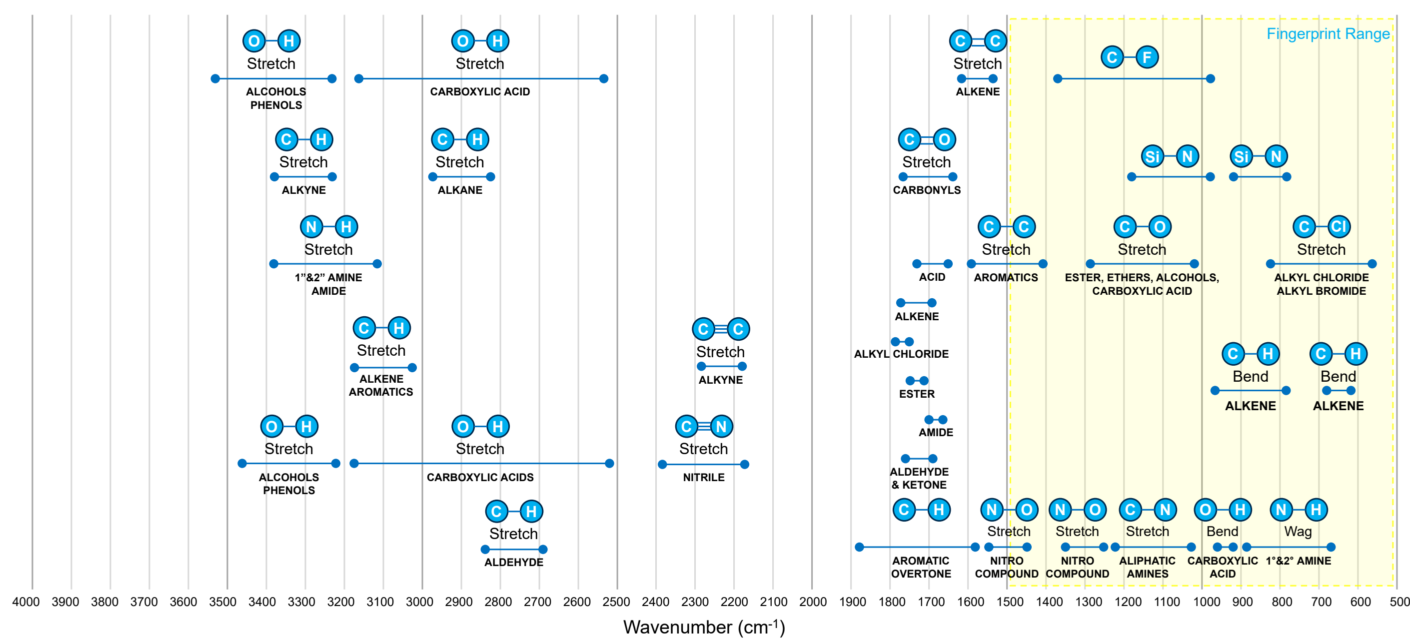
IR Spectroscopy and Chemical Mapping at the Nanoscale

Park nano-IR spectrometers support 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 nano-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 Nano-IR Spectrometers

Technical Specifications

● Default ○ Optional – Not available

		FX40 IR	FX200 IR	FX300 IR
IR Laser Options	QCL Laser (3 modules)	●	●	●
	Extended QCL Laser (4 modules)	○	○	○
	QCL + OPO Laser	–	○	○
	QCL + OPO/DFG Laser	–	○	○
Available Options	Facility Controller	○	●	●
	XEA Software	–	○	○
	KnowItAll Software	○	○	○
Dimension and Weight	Acoustic Enclosure (Outer)	970 mm × 990 mm × 1,530 mm	1,250 mm × 1,280 mm × 1,570 mm	1,250 mm × 1,280 mm × 1,570 mm
	Cabinet	1,200 mm × 900 mm × 1,700 mm	1,200 mm × 900 mm × 1,890 mm	1,200 mm × 900 mm × 1,890 mm
	Total Weight (AFM Body + AE)	920 kg	2,290 kg	2,340 kg
Required Environment	Acoustic Noise Level	65 dB		
	Floor Vibration Level	VC-D (6.25 μm/sec)		
	Power	2.3 kW (Maximum)		

- Specifications, including dimensions and weight, may differ depending on the laser configuration.
- 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 – 4,950 cm-1 and 4,385 – 2,281 cm-1 typical
- OPO/DFG Laser: 7,117 – 4,950 cm-1, 4,385 – 2,281 cm-1 and 806 – 589 cm-1 typical

AFM Modes

- Topographic Imaging
  - Contact Mode
    - Constant Height Mode
    - Constant Force Mode
    - Fast imaging Mode (FiM) ** (Only for FX200 IR / FX300 IR)
  - 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)
- Thermal Properties
  - Scanning Thermal Microscopy (SThM) *
    - Temperature Mapping
    - Thermal Conductivity Mapping
- Nanolithography & Manipulation
  - Nanolithography *
  - Nanomachining *
- 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)

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

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