Atomic Force Microscope

Park Systems

Nanotechnology Solutions Partner

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XE-70

Nanotechnology Solutions Partner

Affordable

Research-Grade **AFM** with **Flexible Sample Handling**

XE-70 is Park Systems' AFM solution for researchers with limited budget. XE-70 does not compromise any of the innovative technologies of the XE-series that sets it apart from conventional AFMs, supporting the same modes, options, and electronics as all other systems in the XE product line.

1 Artifact Free Imaging by Crosstalk Elimination

- Two independent, closed-loop XY and Z flexure scanners for sample and tip
- Flat and linear XY scan of up to 100 µm x 100 µm with low residual bow
- Out of plane motion of less than 2 nm over entire scan range
- Up to 25 µm Z-scan by high force scanner
- Accurate height measurements

2 Ultimate AFM Resolution by True Non-Contact Mode

- 10 times larger Z-scan bandwidth than a piezotube
- Less tip wear for prolonged high-quality and high-resolution imaging
- Minimized sample damage or modification
- Immunity from parameter-dependent results observed in tapping imaging

3 User Convenience by EZ Design

- Open side access for easy sample or tip exchange
- Dovetail-lock mount for easy head removal
- Direct on-axis optics for high resolution optical viewing

Atomic Force Microscopes

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XE-70

Decoupled XY & Z Scanners

Manual Optics Stage

The focus mechanism for the on-axis optics is adjusted manually

Dovetail Lock Head Mount

The AFM head can be quickly and easily secured onto the dovetail rail with a positioning repeatability of a few microns.

Flexure-guided High Force Z-scanner

A high force multi-stack piezo is used as the Z-scanner; its rigidity allows it to move at higher speeds in the vertical direction than the scanners used in conventional AFMs.

EZ Snap Probe Tip Exchange

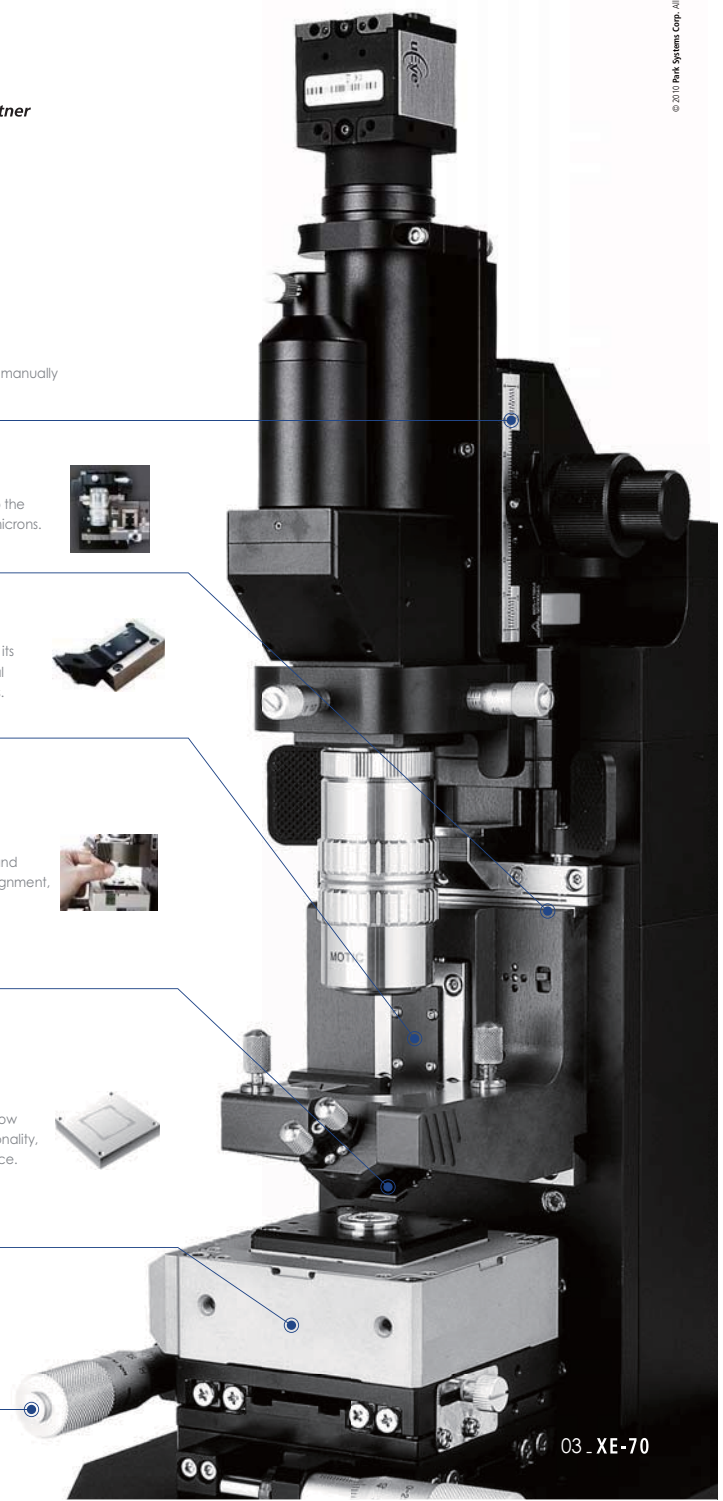
Our pre-aligned cantilevers can be replaced quickly and easily without the need of special tools. Due to pre-alignment, the laser alignment is a snap even for novice users.

Up to 100 µm x 100 µm
Flexure-based Closed-loop XY-scanner

The single module parallel-kinematics XY-scanner has low inertia and minimal run-out, providing the best orthogonality, high responsiveness, and axis-independent performance.

Manual XY Sample Stage

The travel range of the XY sample satge is 25 x 25 mm. The maximum sample size one can place on the stage is 100 x 100 x 25 mm.



A Surface Morphology of GaN Substrate
Scan size: 2 μm

B Block Copolymer (PS-PMMA)
Scan size: 1 μm

C Human red blood cell
Scan size: 12 μm

D Quantum Dots
Scan size: 500 nm

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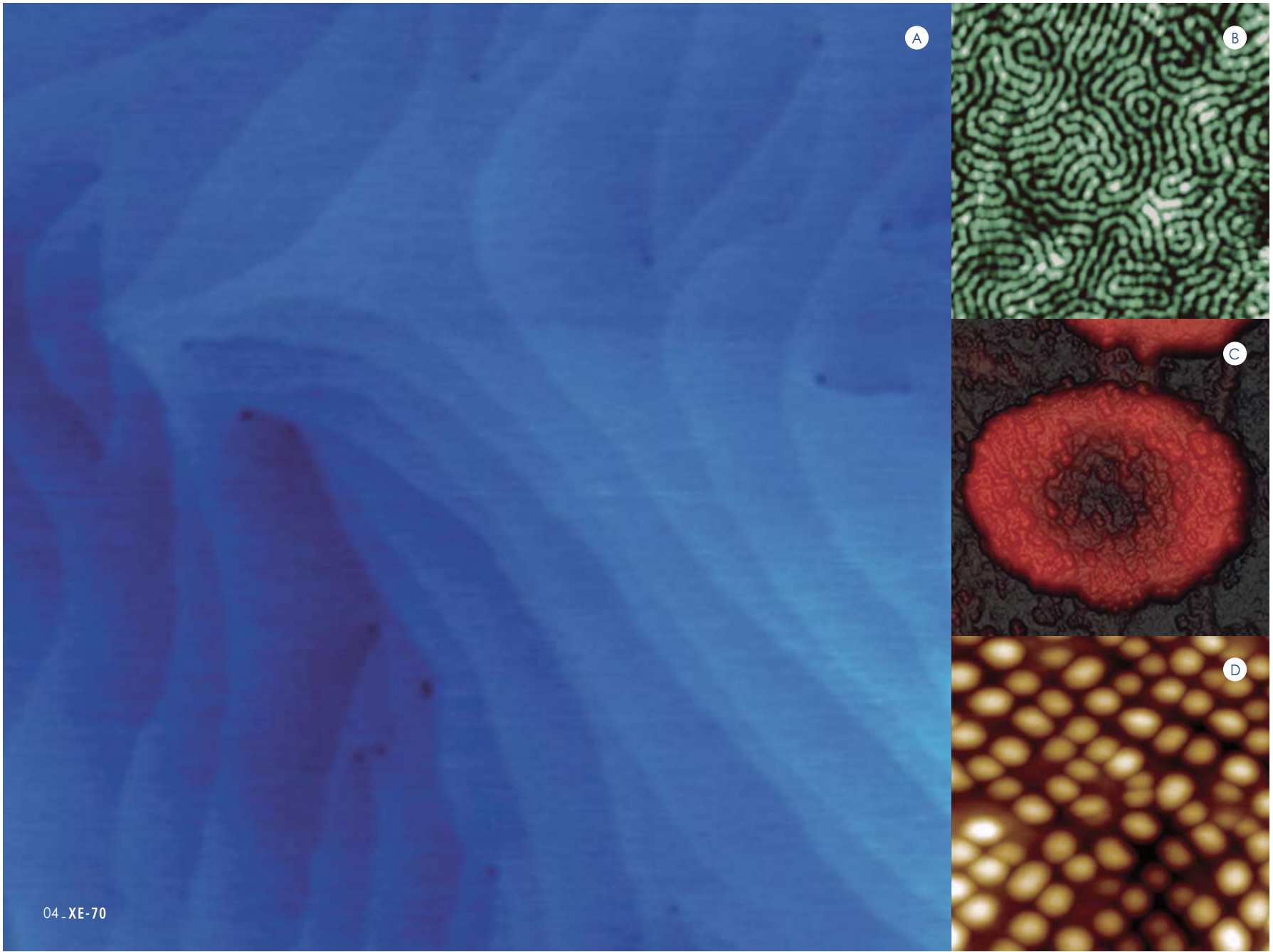
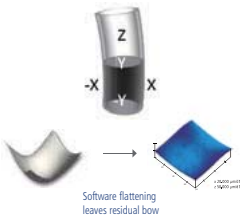


XE-70

Decoupled XY & Z Scanners

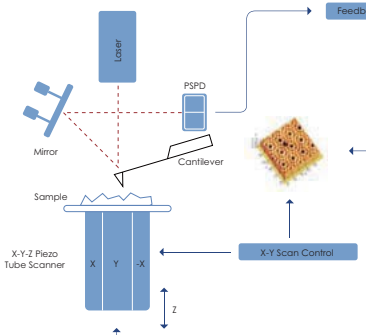
CROSSTALK ELIMINATION (XE)

Challenges of Accurate AFM Measurement



Artifact Free Imaging: Flat XY Scan Without Scanner Bowing

The conventional AFM uses a piezoelectric tube for the x-y-z scanner, where x-y motion relies on the bending of the tube. The bending motion, however, introduces background curvature and therefore causes z position errors. Conventional systems regularly use software flattening to hide the background curvature; this can be an impossible task since the amount of curvature depends not only on scan size and scan speed, but also on x-y offset, z position, etc. Therefore, even after software flattening, a flat surface does not "look" flat as shown in the figure.

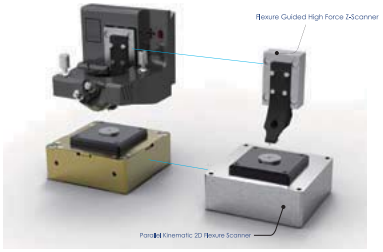


Non-destructive Scan:
Tip and Sample Preservation by Non-Contact AFM

The tube scanner is a slow actuator with highly limited Z-scan bandwidth of only 500 Hz or so. Therefore, the Z-servo response is too slow to implement Non-Contact Mode, a critical requirement for preservation of sharp tips and non-destructive imaging of soft biological samples.

XE Technology: Park Systems' Answer to Accurate AFM Measurement

Challenges of accurate AFM measurement calls for a completely new approach in the design of an AFM. Park Systems developed the Crosstalk Eliminated (XE) AFM based on decoupled flexure scanners where the XY scanner only moves the sample and the Z Scanner drives the probe. The XE-AFM fundamentally removes the scanner bowing, hence attaining flat XY scan, and dramatically improves the Z-servo response, resulting in superb tip preservation by True Non-Contact Mode™.

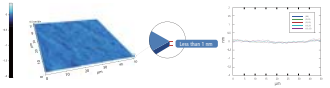


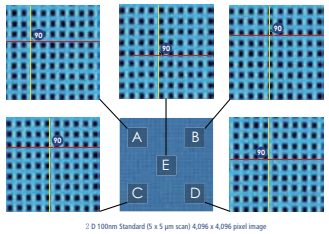
Mechanical Design	Features	Advantages
Decoupled XY and Z Scanners	XY scanner only moves the sample and the Z scanner drives the probe	Flat XY Scan Without Scanner Bow
2D XY Flexure Scanner	Minimal Z Runout (Out-of-plane Motion)	Highly Linear and Orthogonal XY Scan
High Force Z Scanner	Large Z Servo Bandwidth	Enabling True Non-Contact Mode™
Super Luminescent Diode (SLD)	Low Optical Coherence	Eliminates Optical Interference

ACCURATE AFM RESULTS BY CROSSTALK ELIMINATION (XE)

Artifact Free Imaging

- Low residual bow
- Results less dependent on scan location
- No need for software processing (raw data)
- Accurate height measurements and sample imaging





2 D 100nm Standard (5 x 5 μm scan) 4,096 x 4,096 pixel image

Flat XY Scan Without Scanner Bowing

The Crosstalk Elimination (XE) fundamentally removes the scanner bowing, hence attaining flat XY scan with out-of-plane motion less than 1 nm regardless of scan locations, scan rates, and scan sizes. It shows no background curvature even on scans of the flattest samples such as that of an optical flat as shown in the figure, also with various scan offsets. Thus, the XE-AFM enables very accurate height measurement and precision nanometrology for the most challenging problems in research and industry.

Highly Linear and Orthogonal XY Scan

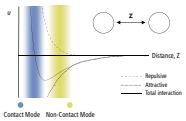
The flexure XY scanner decouples the X and Y scan motion so that the coupling between X and Y movement is minimized regardless of scan locations, scan rates, and scan sizes. Position sensors provide linear feedback control for the high accuracy and high precision measurements.

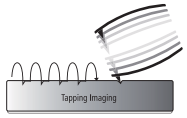
Non-destructive Scan

- Less tip wear for prolonged high-resolution imaging
- Minimized sample damage or modification
- Immunity from parameter-dependent results
- Imaging of soft sample surface

True Non-Contact Mode™ is Now a Reality

True Non-Contact Mode™, one of the distinctive advantages only realized by Park Systems' Crosstalk Eliminated (XE) AFM, is a powerful method that enables AFM users to image and measure samples.





In True Non-Contact Mode™, the tip-sample distance is successfully maintained at a few nanometers in the net attractive regime of inter-atomic force. The small amplitude of tip oscillation minimizes the tip-sample interaction, resulting in superb tip preservation and negligible sample modification.

Longer Tip Life and Less Sample Damage

The sharp end of an AFM tip is so brittle that once it touches a sample, it becomes instantly blunt and limits the resolution of an AFM and reduces the quality of the image. For softer samples, the tip will damage the sample and also result in inaccuracies of sample height measurements. Consequently, preserving tip integrity enables consistent high resolution and accurate data. True Non-Contact Mode™ of the XE-AFM superbly preserves the tip, resulting in much longer tip life and less sample damage. The figure, displayed in 1:1 aspect ratio, shows the unprocessed raw data image of a shallow trench isolation sample imaged by the XE-AFM, whose depth is also confirmed by scanning electron microscope (SEM). The same tip used in the imaging of the sample shows no tip wear even after taking 20 images.

XE-70
Decoupled XY & Z Scanners

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XE MODES

Standard Imaging
- Basic Contact AFM and DFM
- Lateral Force Microscopy (LFM)
- Phase Imaging
- True Non-Contact AFM

Chemical Properties
- Chemical Force Microscopy with Functionalized Tip
- Electrochemical Microscopy (EC-STM and EC-AFM)

Dielectric/Piezoelectric Properties
- Electric Force Microscopy (EFM)
- Dynamic Contact EFM (DC-EFM)
- Piezoelectric Force Microscopy (PFM)
- PFM with High Voltage

Force Measurement
- Force Distance (F-D) Spectroscopy
- Force Volume Imaging
- Spring Constant Calibration by Thermal Method

Electrical Properties
- Conductive AFM (Ultra Low Current and Variable Current)
- I-V Spectroscopy
- Scanning Kelvin Probe Microscopy (SKPM/KPM)
- SKPM with High Voltage
- Scanning Capacitance Microscopy (SCM)
- Scanning Spreading-Resistance Microscopy (SSRM)
- Scanning Tunneling Microscopy (STM)
- Scanning Tunneling Spectroscopy (STS)
- Time-Resolved PhotoCurrent Mapping (Tr-PCM)

In-liquid Imaging
- Ion Conductance Microscopy (ICM)
- I-D Spectroscopy

Magnetic Propertie
- Magnetic Force Microscopy (MFM)
- Tunable MFM

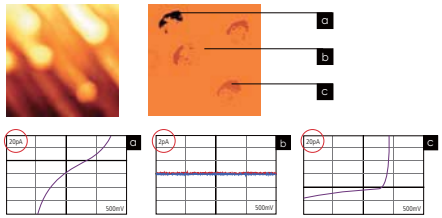
Mechanical Properties
- Force Modulation Microscopy (FMM)
- Nanoindentation
- Nanolithography
- Nanolithography with High Voltage
- Nanomanipulation
- Piezoelectric Force Microscopy (PFM)

Optical Properties
- Aperture NSOM
- Apertureless NSOM
- Raman Spectroscopy (Nano-Raman)
- Tip-Enhanced Raman Spectroscopy (TERS)
- Time-Resolved PhotoCurrent Mapping (Tr-PCM)

Thermal Properties
- Scanning Thermal Microscopy (SThM)

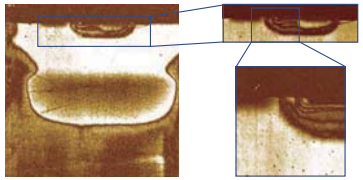
XE-Conductive AFM: Current Image and I-V Curves of VLSI Contact Plugs

Topography (1 μm x 1 μm) Current Image at -0.5 V



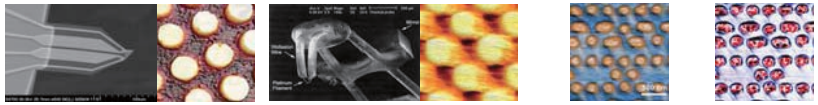
XE-SCM: Transistor Gate Oxide Junction

SCM Image (25 μm x 25 μm)



XE-SThM vs Conventional SThM: Nickel Nanodots on Glass Substrate

XE Thermal Probe (4 μm x 4 μm) Wollaston Wire Probe (4 μm x 4 μm) Topography (2 μm x 2 μm) Thermal Image

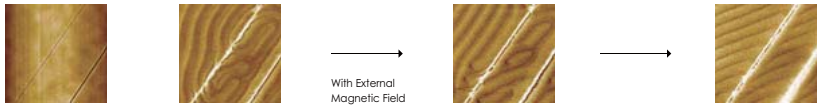


Tip diameter less than 100 nm

Tip diameter around 3 μm

XE-MFM: YIG (Yttrium Iron Garnet) with External Magnetic Field

Topography (30 μm x 30 μm) MFM Image



170G 270G

XE OPTIONS

25 μm Z-scanner Head
- Z scan range: 25 μm
- Resonant frequency: 1.7 kHz
- Laser type: LD (630 nm) or SLD (830 nm)
- Noise floor: 0.03 nm (typical), 0.05 nm (maximum)

XE Optical Head
- Optical access: top and side
- Z scan range: 12 μm or 25 μm
- Resonant frequency: 3 kHz (12 μm XE Head), 1.7 kHz (25 μm XE Head)
- Laser type: LD (630 μm) or SLD (830 μm)
- Noise floor: 0.03 nm (typical), 0.05 nm (maximum)

Hysitron Triboscope Adaptor Head
- Adaptor to combine the Triboscope nanoindenter of Hysitron, Inc. with the XE-Series
- Z scan range: 12 μm or 25 μm
- Resonant frequency: 3 kHz (12 μm XE Head) 1.7 kHz (25 μm XE Head)
- Vertical drift rate: < 1 nm/min

Universal Liquid Cell
- Open or closed cell with liquid/gas perfusion
- Temperature control range: 4 °C - 110 °C (in air), 4 °C - 70 °C (with liquid)
- Chemically resistive to acid/base
- Sample size: 20 mm in diameter / 5 mm in thickness
- Electrochemistry upgrade
- Applicable sample bias voltage: -10 V - 10 V

Magnetic Field Generator
- Applying external magnetic field parallel to sample surface
- Tunable magnetic field
- Range: -300 - 300 gauss
- Composed of pure iron core & two solenoid coils

Temperature Control Stages
- Type 1: 0 °C - 180 °C
- Type 2: Ambient - 280 °C
- Type 3: Ambient - 600 °C

Clip-type Probehand
- Unmounted cantilever can be used
- Tip bias range: -10 V - 10 V
- Tip bias function available for EFM and Conductive AFM
- Support all the standard and advanced modes but STM, SCM, and in-liquid imaging

Liquid Probehand
- Designed for imaging in general liquid environment
- Resistant to most buffer solutions including acid
- Contact and Non-contact AFM imaging in liquid

Signal Access Module (SAM)
- Enables access to various input/output signals for AFM
- Scanner driving signal for the XY and Z scanners
- Position signal for the XY and Z scanners
- Cantilever deflection signals of the vertical/lateral direction
- Bias signal for the sample and the cantilever
- Driving signal for XE-AFM
- Auxiliary input signal to the system

Acoustic Enclosure

XE-Heads	12 μm XE-Head	25 μm XE-Head	XE Optical Head	Hysitron Triboscope Adaptor Head
XY-scanners	5 μm x 5 μm	50 μm x 50 μm	100 μm x 100 μm	
Probehands	Clip-type Probehand	Liquid Probehands	SCM Probehand	STM Probehand
Liquid Cells	Universal Liquid Cell	Open Liquid Cell	Electrochemistry Cell	
Environmental Control	Heating & Cooling Stage	Heating Stage	Environmental Chamber	Humidity Control System
Acoustic Enclosure	Enhanced Acoustic	Standard Acoustic	Acoustic Foam box	
Accessories	Signal Access Module	Q Controller	Magnetic Field Generator	Non-magnetic Sample Holder
	Cross-sectional Sample Holder	High Voltage Toolkit	Vacuum Chuck	

XE-70 Decoupled XY & Z Scanners

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XE PERFORMANCE FOR EVERYONE

Our XE-series AFMs are not only the most advanced AFM on the market, but also the most user-friendly. The intuitive user interface minimizes the time and effort necessary to learn AFM operation, and reflects our dedication to user-oriented product development. From industry's first direct on-axis optics and EZ snap tip exchange, Park Systems has led trend-setting and market leading innovation in user convenience. At Park Systems, the ease of use is the first line of support we provide to our valued customers.

In addition, the XE-series have the most extensive range of modes and options and the best option compatibility and upgradeability in the industry. Our complete AFM solution allows customers of all experience levels to obtain the most accurate AFM results in their experiments.

EZ Snap Tip Exchange

The unique head design of the XE-series allows an open side access to a sample and the tip. Hence, probe tip and sample exchange are just an easy snap by hand. With our advanced pre-aligned kinematic tip mount, the same probe tip position is guaranteed, time after time, without the need of special tools or head removal.

EZ Laser Beam Alignment

In our patented laser beam aligning mechanism, the laser beam falls on a cantilever from the vertical direction, and the laser spot moves intuitively along X and Y by rotating two positioning knobs. As a result, the laser is easy to find and easy to position on the PSPD using our beam alignment user interface. Also, our cantilevers are pre-aligned to have the laser beam focused on the cantilever upon replacement. A minor adjustment to maximize the signal is all that is required to start acquiring data - a simple exercise for even a novice.

Direct On-Axis Optics

The direct on-axis optics is the first in the industry that revolutionizes the way AFM users view their samples. The optical path from the sample to the CCD camera is an unobstructed straight line. The natural on-axis, top-down view allows the user to quickly find features of interest for AFM measurements. This unique configuration enables the best quality and highest resolution (<1μm) optical view available in the AFM market.

Dovetail Lock Head Mount

The AFM head, which includes the Z-scanner, is easily inserted or removed by sliding it along a dovetail rail. The head is locked into place with a convenient turn of two thumb locks.

XEP – Data Acquisition

All the user controls on AFM measurements are operated through XEP, the data acquisition program. The user-oriented interface provides easy operation of AFM.

- Simultaneous data acquisition of up to 16 images
- Maximum 4096 × 4096 image size
- Dedicated Force-distance and I-V spectroscopy with batch processing
- Cantilever spring constant calibration
- Script-level control through external program (LabVIEW, C++)

XEI – Image Processing and Analysis

XEI is the AFM image processing and analysis program. The powerful processing algorithms make the analysis easy and streamlined. With its most advanced and versatile imaging features, XE users can obtain essential and critical information from their experiment.

- Image analysis of line profile, region, 3D rendering
- Spectroscopy data analysis module (F-d, I-V)
- Directly copy/paste to presentation program
- Multiple image comparison
- Image overlay of two different images

SPECIFICATIONS

• Scanner

Decoupled XY and Z-scanner
Single module flexure XY-scanner with closed-loop control
Scan range of XY-scanner: 5 μm, 50 μm, or 100 μm
Working distance of Z-scanner: 12 μm or 25 μm

• Stage

Working range of XY stage:
- 25 mm × 25 mm, manual precision movement

Working range of Z stage:
- 27.5 mm, motorized movement

Sample size:
- Up to 100 mm × 100mm, 20 mm thick, and up to 500 g

• Head

Detection of cantilever deflection
- Super Luminescent Diode (standard): 830 nm with low coherency
- Laser Diode (option): 650 nm

Open side optical access
- Accessible solid angle: 58° of cone angle

• Optics

Direct on-axis vision of sample surface and cantilever
Focus range: 30 mm, manual
Magnification: 780× (optional 390×, or 1500×)
Field of view: 480 μm × 360 μm
Optical resolution: 1 μm

• Electronics

High performance DSP: 600 MHz with 4800 MIPS
Maximum 16 data images
Maximum data size: 4096 × 4096 pixels
Signal inputs: 20 channels of 16 bit ADC at 500 kHz sampling
Signal outputs: 21 channels of 16 bit DAC at 500 kHz settling
Synchronous signal: End-of-image, end-of-line, and end-of-pixel TTL signals
Active Q control (optional)
Cantilever spring constant calibration (optional)
CE Compliant
Power: 120 W

• Software

XEP
- Dedicated system control and data acquisition software
- Adjusting feedback gain, set point in real time
- Script-level control through external programs such as LabVIEW (optional)

XEI
AFM data analysis software (running on Windows, MacOS X, and Linux)

• Supported Modes

Standard Imaging
- Basic Contact AFM and DFM
- Lateral Force Microscopy (LFM)
- Phase Imaging
- True Non-Contact AFM

Chemical Properties
- Chemical Force Microscopy with Functionalized Tip
- Electrochemical Microscopy (EC-STM and EC-AFM)

Dielectric/Piezoelectric Properties
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- Force Modulation Microscopy (FMM)
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- Nanolithography with High Voltage
- Nanomanipulation
- Piezoelectric Force Microscopy (PFM)

Optical Properties
- Raman Spectroscopy (Nano-Raman)
- Tip-Enhanced Raman Spectroscopy (TERS)
- Time-Resolved PhotoCurrent Mapping (Tr-PCM)

Thermal Properties
- Scanning Thermal Microscopy (SThM)

• Accessories

Electrochemistry Cell
Universal Liquid Cell with heating/cooling stage
Temperature Control Stages
Magnetic Field Generator

• Microscope Unit

Dimension: 175 mm x 245 mm x 470 mm (W x D X H)
Weight: 11.6 kg

XE-70
Decoupled XY & Z Scanners

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