



# XE-NSOM

*Excellence in Nanometrology*

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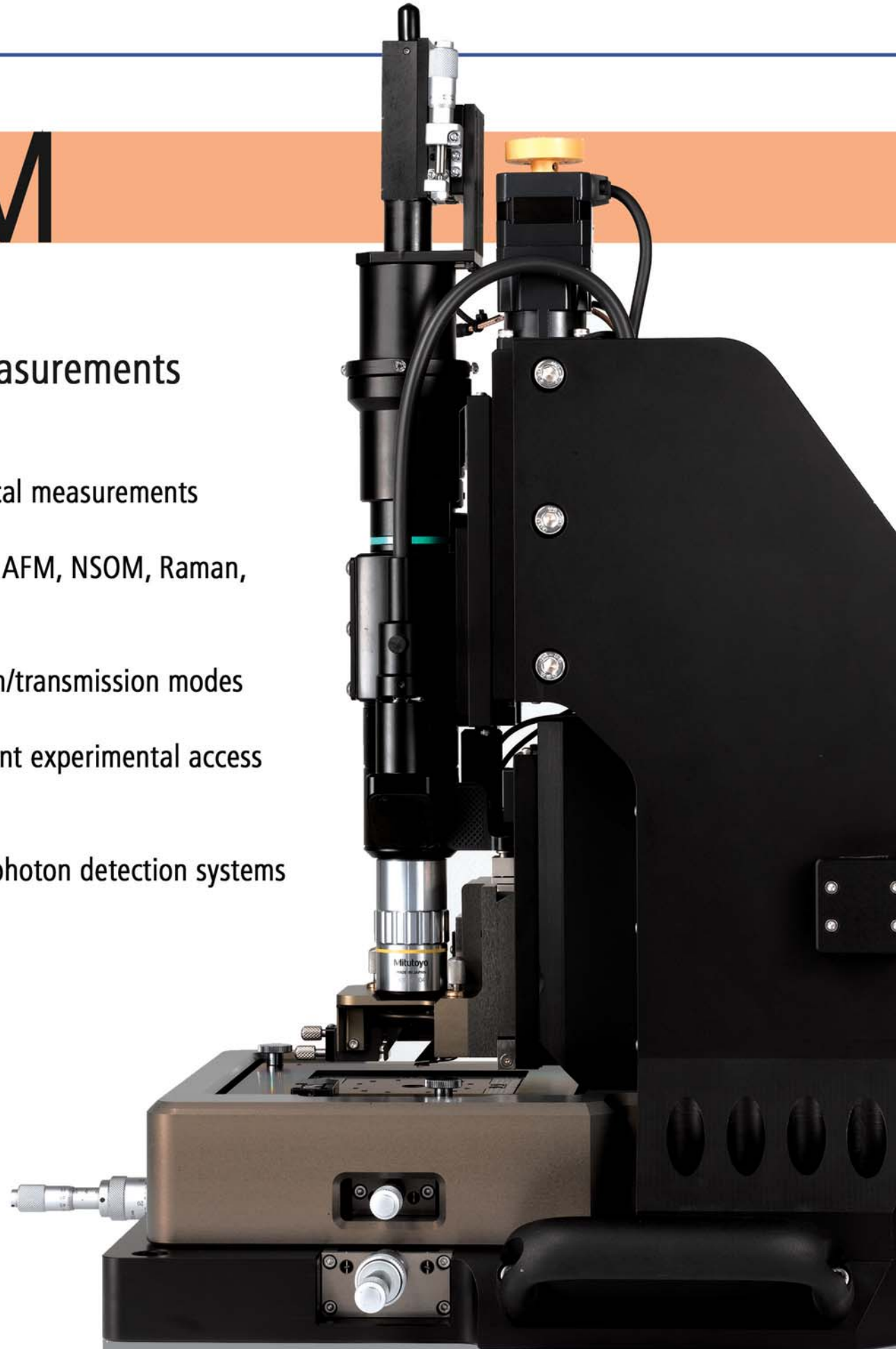
# XE-NSOM

For NSOM or Raman-AFM\* measurements

- Seamless integration of AFM and optical measurements
- Upgradeable modular design supports AFM, NSOM, Raman, and Confocal
- Versatility supporting various reflection/transmission modes
- Optical head design provides convenient experimental access to the sample
- Easy alignment of optical axes to the photon detection systems

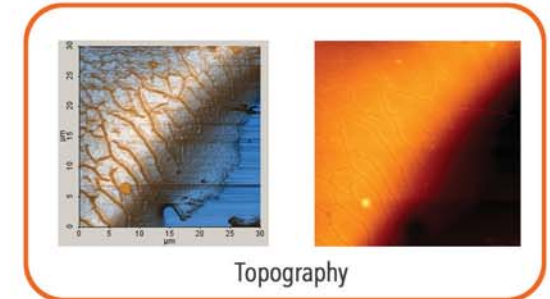
\*See page 10 for Raman mode configuration

XE-NSOM is specially designed and tailored for advanced optical measurements including Near-field Scanning Optical Microscopy (NSOM), Raman Spectrometry, and Confocal Microscopy. XE-NSOM provides a complete AFM system setup with unsurpassed versatility for these optical experiments. The high-performance Z-servo scanner of the XE-NSOM supports True Non-Contact AFM and utilizes cantilever-based closed-loop feedback technology.

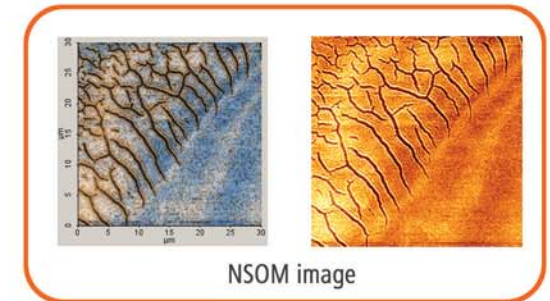


## Superior Imaging Solution

Dried nano-particle cluster

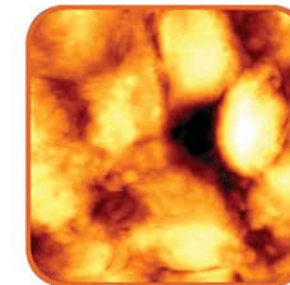


Topography



NSOM image

Human embryonic kidney stem cell, line 293 (fixed and dried)



Topography, scan size: 50  $\mu\text{m}$   
(100 nm aperture cantilever)

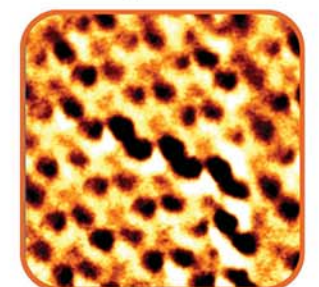


NSOM image, scan size: 50  $\mu\text{m}$   
(100 nm aperture cantilever)

Metal-coated spheres absorbed on glass



Topography, scan size: 2  $\mu\text{m}$   
(100 nm aperture cantilever)



NSOM image, scan size: 2  $\mu\text{m}$   
(100 nm aperture cantilever)

## XE-NSOM Features



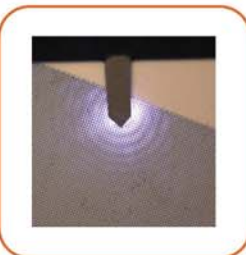
### Dovetail Lock Head Mount

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



### Flexure-guided High Force Z-scanner

For the Z-scanner, a high force multi-stack piezo enables a high speed 1-dimensional actuator, which moves the probe in the vertical direction.



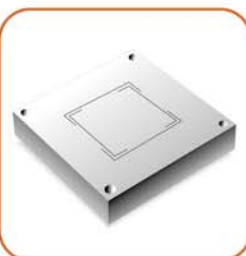
### Super Luminescence Diode (SLD) Head

The low coherency of the Super Luminescence Diode (SLD) enables accurate imaging of highly reflective surfaces and precise measurements for pN Force-distance spectroscopy. An additional advantage of the SLD Head is its compatibility with experiments that utilize light in the visible region of the spectrum.



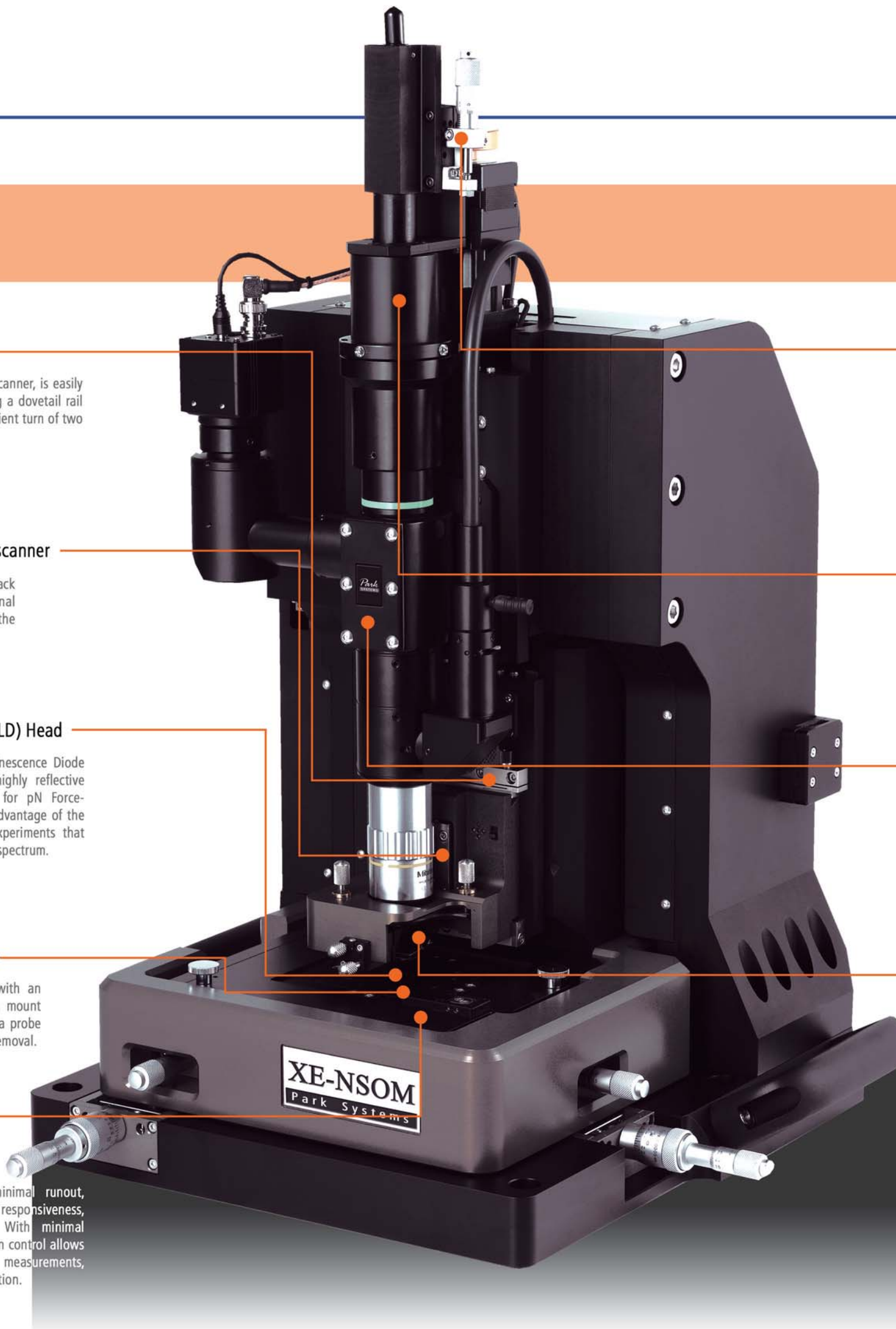
### EZ Snap Probe Tip Exchange

Probe tip exchange is just a snap with an advanced pre-aligned kinematic chip mount that guarantees the same position of a probe tip without the need of tools or head removal.



### Flexure-based Closed-loop XY-scanner

This single module parallel-kinematics XY-scanner has low inertia and minimal runout, providing the best orthogonality, high responsiveness, and axis-independent performance. With minimal coupling, hardware closed-loop position control allows for the absolute scaling of AFM measurements, attaining 6 Å closed-loop lateral resolution.



### Easy Laser Alignment with Fixed NSOM Laser Path

Every time a cantilever is changed, the NSOM laser must be aligned with respect to the cantilever. Since the NSOM laser path remains fixed in the XE-NSOM, the entire scanning system can be easily aligned to the laser by rotating two positioning knobs.

### Direct On-Axis NSOM Laser Feed

The Direct On-Axis NSOM Laser Feed maintains a stable and fixed NSOM laser path, supporting easy laser alignment with respect to the cantilever.

### On-Axis CCD Camera & Light Source

A high resolution on-axis optical view of the sample and probe is conveniently displayed.

### Optical Head Design Facilitates Sample Access

The XE-NSOM's optical head, designed to provide open access to the sample (58 degree cone angle), supports transmission or reflection mode for Raman, Near-field Fluorescence and NSOM.

### Photon Detector Counter Module

Two channels with 16bit counters support a maximum pulse width of 10 ns and a photon spectral range of 185 nm to 900 nm.



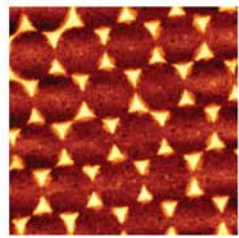
## XE Advantages

## XE Innovation

# A

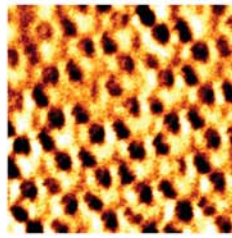
## ccurate

True Non-Contact AFM Image



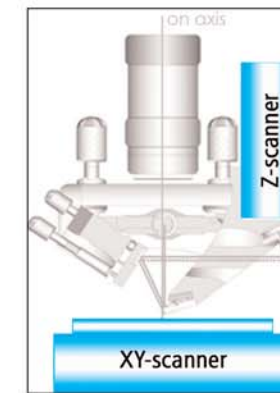
2 x 2 μm scan of monolayer of 429 nm metal-coated spheres absorbed on glass.

NSOM Image



### True Non-Contact AFM Minimizes Tip-Sample Interaction and Improves Resolution

In True Non-Contact mode, the high performance Z-servo maintains the tip-sample distance at just a few nanometers and preserves the sharpness of the tip. With minimized tip-sample interaction, the XE-platform yields the ultimate AFM resolution.

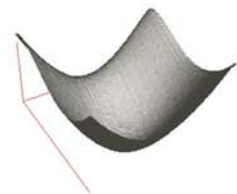


### Decoupled XY and Z-scanners

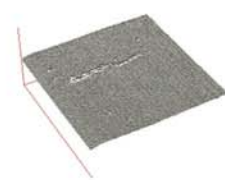
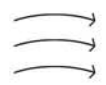
In the XE-platform, the Z-scanner is completely decoupled from the XY-scanner. A specially designed 2-dimensional flexure stage is used as an XY-scanner, which moves the sample in the horizontal plane. This configuration provides a flat X-Y scan with high orthogonality.

# R

## eproducible



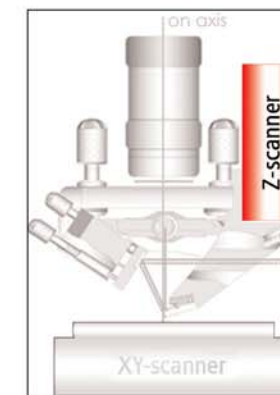
Conventional AFM  
(tube scanner)



XE-AFM  
(XY flexure scanner)

### Flat XY Scan Without Bowing

The award-winning XE-platform, which stands for cross-talk elimination, completely eliminates background scanner curvature and shows no bowing, even on scans of the flattest samples, thus enabling precision nanometrology. The raw data images of a bare silicon wafer are shown on the left. The out-of-plane motion from the conventional AFM is about 80 nanometers over a 15 μm scan range, while that of the XE-AFM is less than 1 nm over 100 μm.



### Fast Z-servo Response

The ultra high force Z-scanner, the key innovation that enables True Non-Contact mode, allows a significantly higher resonance frequency than those of conventional piezoelectric tube scanners. In addition, the mass load to the Z-scanner is minimized to increase the Z-servo response.

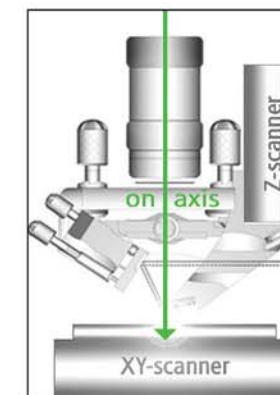
# R

## eliable



### More Than 25 Years of Experience

The strength and know-how of Park Systems come from our more than 25 years of experience in the commercial AFM/SPM business. With years of experience, Park Systems continues to innovate and expand its product line to meet the needs of present and future AFM/SPM applications.

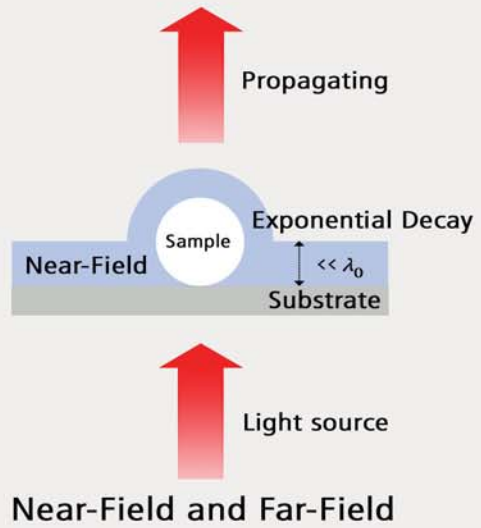


### On-Axis Optics

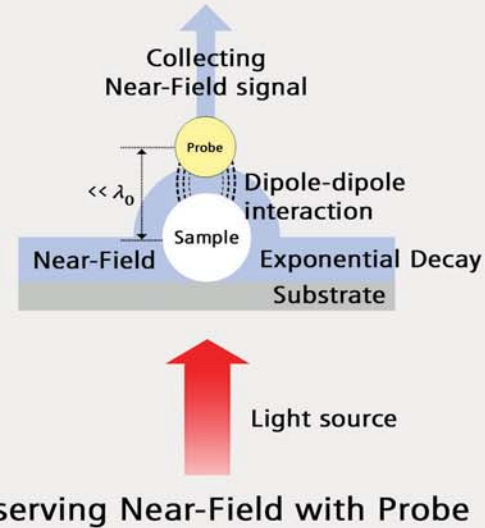
The revolutionary optics design is the first to provide AFM users with an on-axis view of their sample. The optical path from the sample to the CCD camera is an on-axis line that provides the industry's highest optical resolution (1 μm), allowing users to quickly find features of interest for AFM measurements.

# XE-NSOM Modes

## Near-Field Detection 1

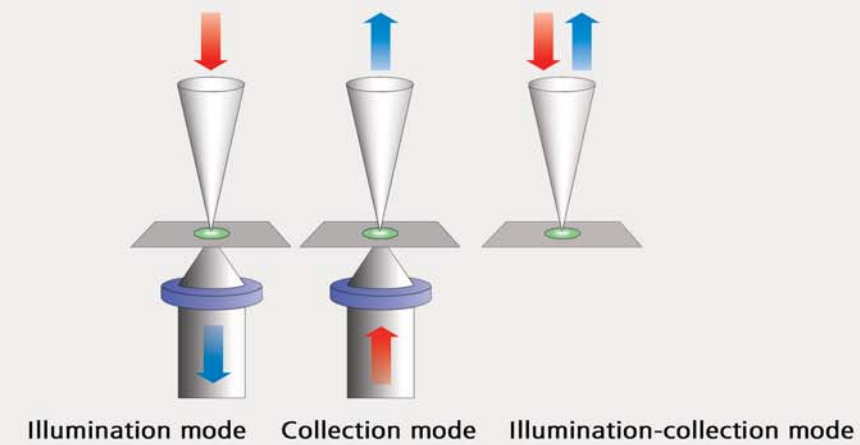


## Near-Field Detection 2

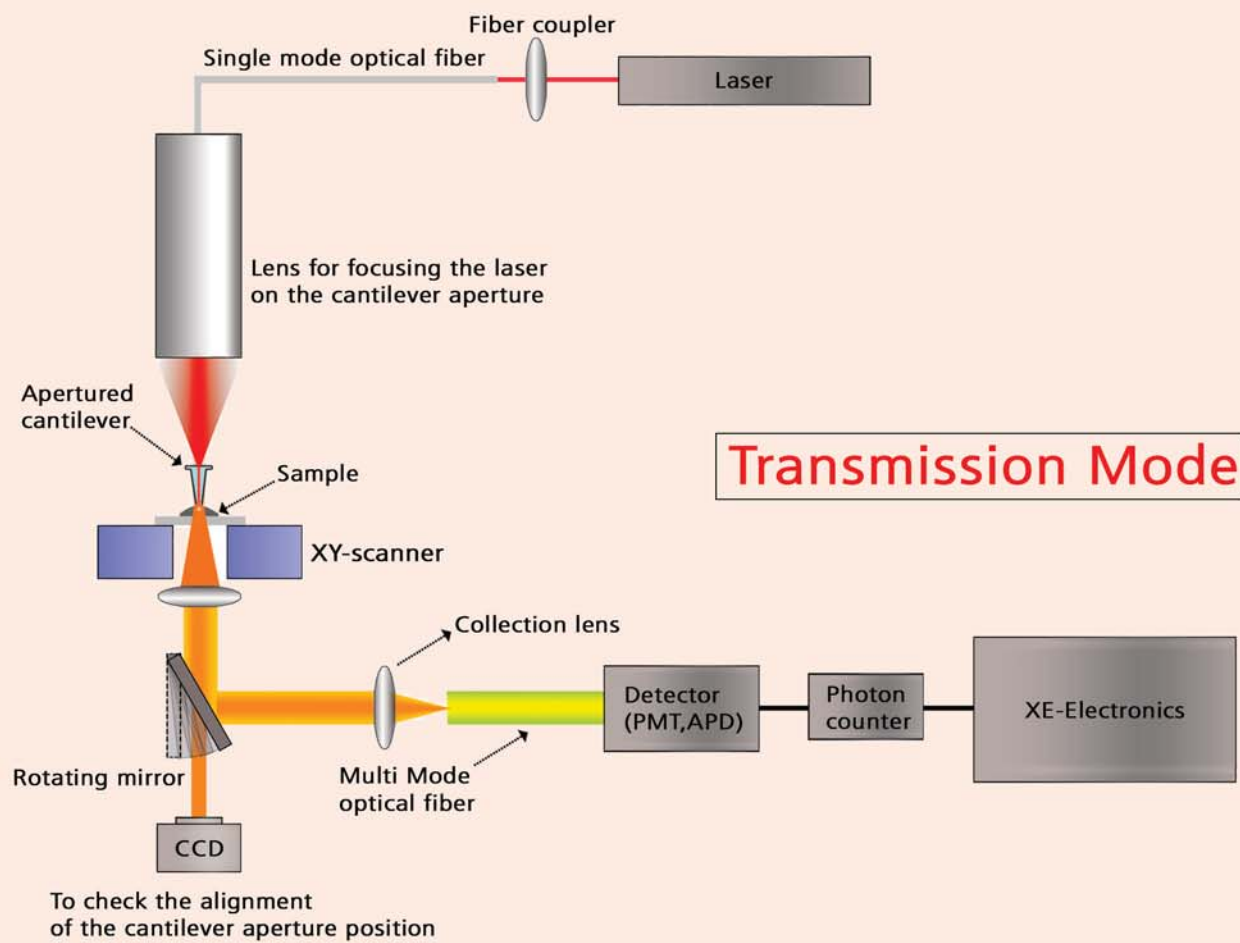
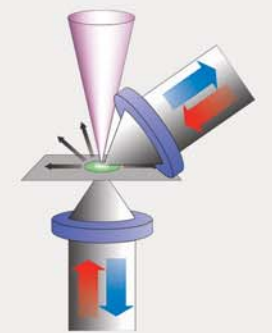


## Various NSOM Modes

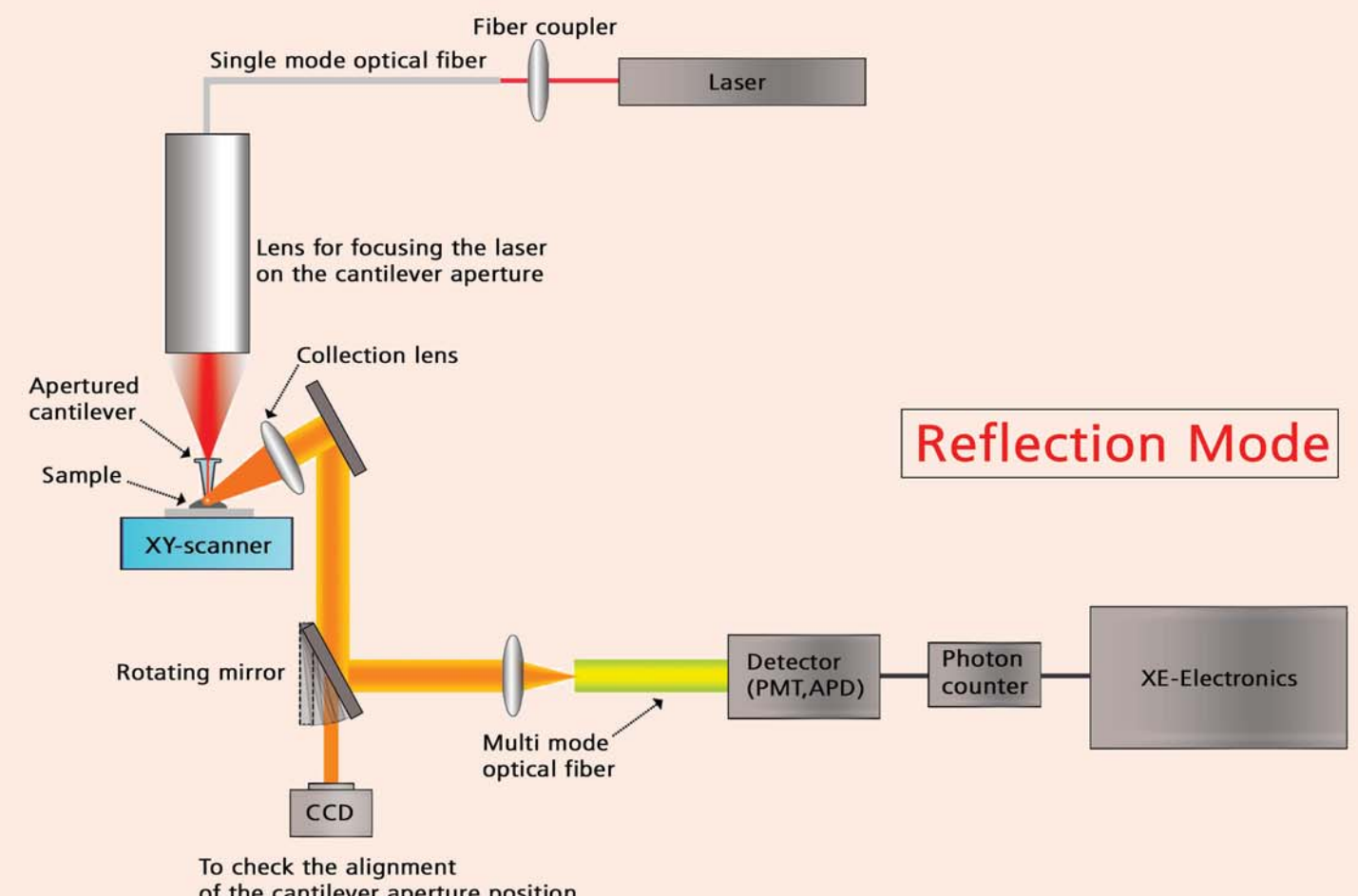
### NSOM with Apertured Probe



### Apertureless NSOM



## Transmission Mode

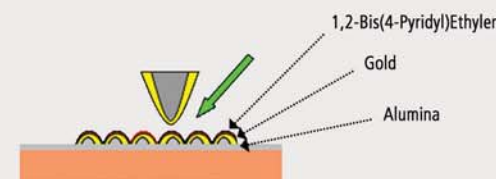
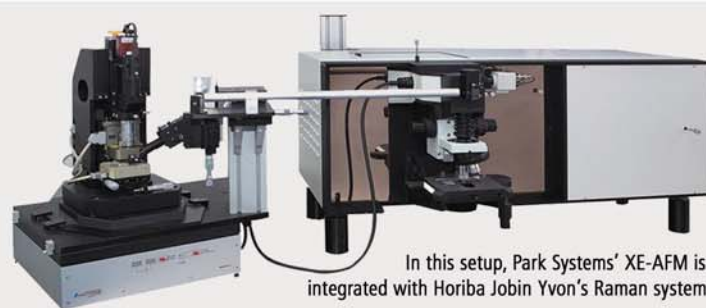
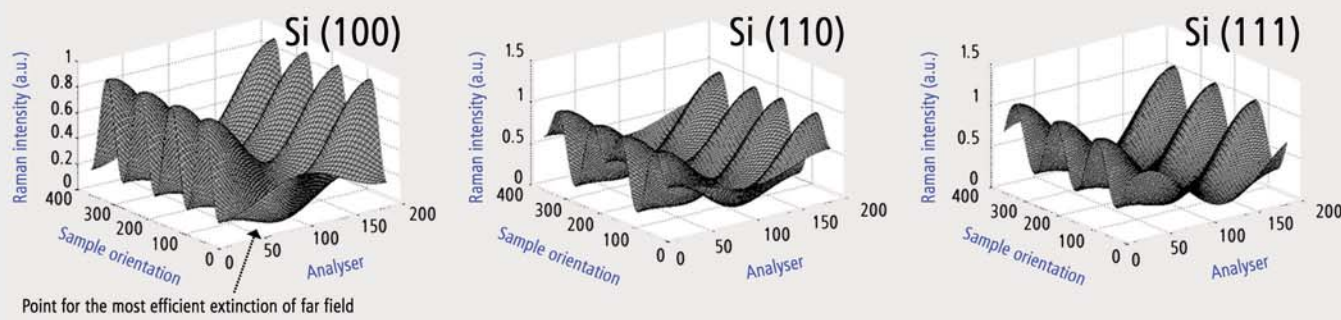
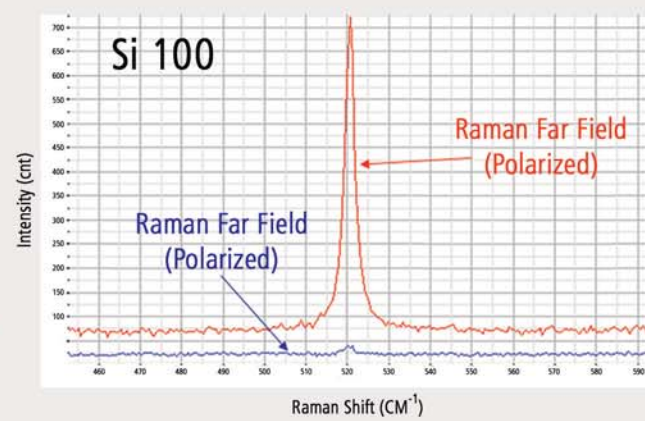
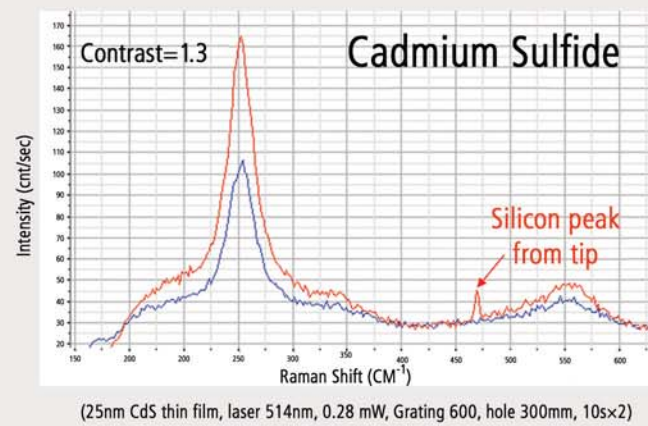
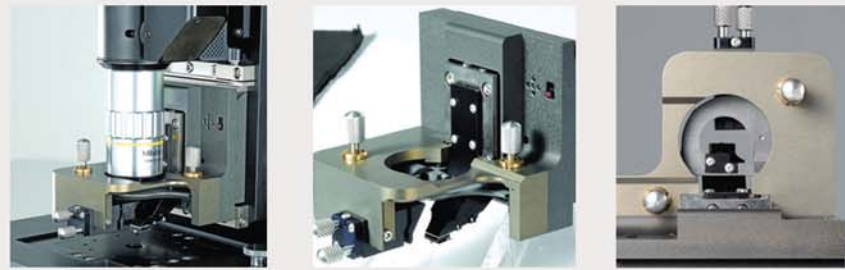


## Reflection Mode

## XE-Raman Modes

### Combined Solution for

- Atomic Force Microscopy
- Raman Spectroscopy
- TERS investigations for near-field Raman measurements



### References

- "Contrast Enhancement on Crystalline Silicon in Polarized Reflection Mode Tip-Enhanced Raman Spectroscopy," Nguyen et al., Optics Communication 274, 231 (2007)
- "Simple model for the polarization effects in tip-enhanced Raman spectroscopy" Ossikovski et al., Physical Review B 75, 0454412 (2007)

## Specification | XE-NSOM

### ● XE-NSOM Optics Specification

#### Supported Modes

- Transmission, Reflection, Fluorescence, and Illumination/Collection mode
- Confocal Raman Spectroscopy
- Collection, Polarization

#### Lasers

- 405 nm (diode laser)
- 488 nm (Ar laser)
- Changeable by customer's request
- Delivered to the sample by 3-branch tube
  - Path efficiency: 20% transmission
  - 100× collection lens (N.A.: 0.85)
- Laser coupling by optical fiber (single mode/multi mode)

#### Resolution

- NSOM resolution: 100 nm (depending on the aperture size of the cantilever used)
- Topography resolution: 1 nm (typical) in horizontal, 0.1 nm (typical) in vertical direction
  - Resolution depending on the cantilever used

#### Probes

- Apertured cantilever
  - Aperture size: 30, 50, 100 nm (selectable by user)
- Apertureless cantilever

#### Photon Detection

- Detector type: PMT, APD (selectable by user)
- Spectral range: 185 nm ~ 900 nm (depending on the detector used)
- Sensitivity
- Frequency bandwidth
- Photon counter: 2 channels of 216 (16 bit) counters
  - Maximum pulse width: 10 nsec
  - Time constant: 1 μsec ~ 214 μsec

### ● XE-NSOM Mechanical Specification

#### XE Optical Head for NSOM Configuration

- Wide optical access to the sample from the side: 58° (cone-angle)
- Sample-distance feedback control method: Cantilever deflection
- Zero scan noise in Z: 0.02 nm (typical)
  - Better performance than a tuning fork (0.5 nm, typical)

- Detection of cantilever deflection: Super luminescent diode (SLD, 830 nm)
  - Low coherent light to eliminate interference noise
  - Avoids wavelength of other applications using visual optics region
- Automated cantilever approach to the sample surface

#### XY-scanner

- Scan size: 100 μm × 100 μm (10 × 10 μm in low voltage mode)
- Resolution
  - Open-loop: < 0.15 nm (< 0.02 nm in low voltage mode)
  - Closed-loop: 1.0 nm
- Closed-loop scan for precise position control

#### Z-scanner

- Guided flexure stage
- Scan size: 12 μm (1.7 μm in low voltage mode)
- Resolution: 0.05 nm (0.01 nm in low voltage mode)
- Resolution of closed-loop height sensor: 0.2 nm

#### Stage

- XY stage: 4 mm × 4 mm, manual
- Z stage: 27.5 mm, motorized
  - 0.08 μm resolution, 2 μm repeatability
- Optical focus stage: 20 mm, motorized

#### Sample Limitation

- 100 mm × 100 mm, 20 mm thick
- 500 g

#### Optical Display

- On-axis optical view of the sample and probe
- Field of view: 480 μm × 360 μm (Objective lens: 10×)
- Magnification on screen: 780× (Objective lens: 10×)
- Optical resolution: 1 μm

### ● Electronics

- Closed-loop feedback for X and Y axes
- Maximum image size: 4096 × 4096 pixels
- Maximum data channels: 16 images simultaneously
- DSP: 600 MHz, 4800 MIPS processing power
- ADC: 16 channels of 16 bit at 500 kHz
- DAC: 16 channels of 16 bit at 500 kHz
- Signal access: On-board 3 inputs and 1 output
- Synchronous signals for simultaneous external data acquisition
  - End-of-pixel, end-of-line, and end-of-frame TTL signals
- External Signal Access Module for access to low-level system signals (optional)

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