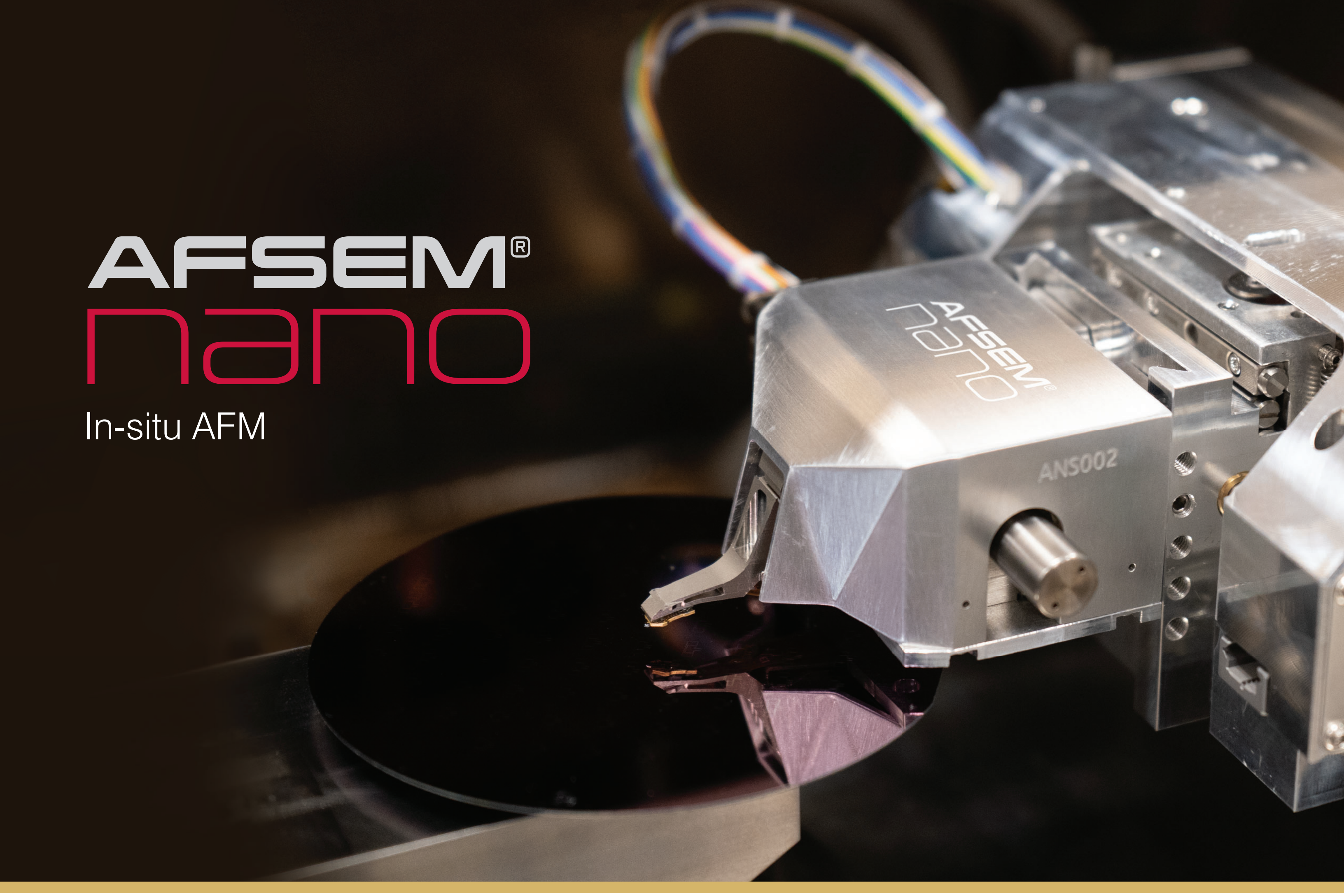
AFSEM® nano

In-situ AFM



Seamless Integration into **SEMs** and **Dual Beam (FIB-SEM) Systems** Allows for Advanced Correlative Microscopy

AFM and SEM analysis in one environment.

Compatible with SEM add-ons including EBSD, EDS, FIB, various stages and more.

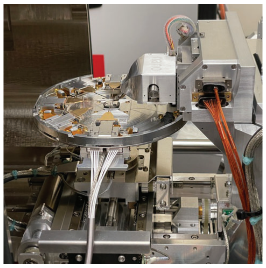
Innovative tip scanning design allows for large sample measurements including wafers.

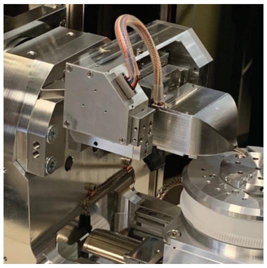
Great for biological sample measurements.

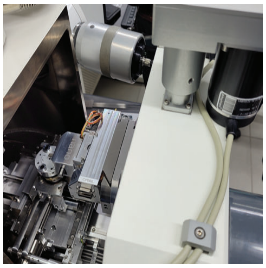
SEM Integration

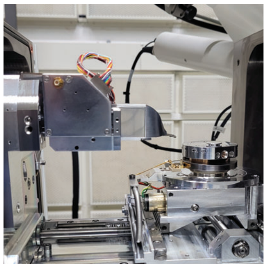
AFSEM®nano can be mounted into most SEM chambers without restricting access to the electron beam, detectors, or standard sample holders.

Examples of current SEM integrations:


Thermo


Tescan


Zeiss


Zeiss

The AFSEM®nano allows users to:

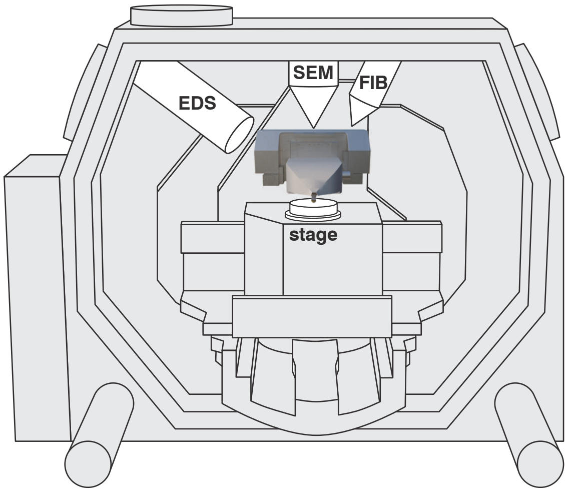
- Perform in-situ AFM measurements on full wafers, large fracture surfaces, or irregularly shaped samples within a variety of different SEM environments.
- Accurately measure step heights or trench depths using AFM for precise FIB cutting rate evaluation.
- Perform 3D subtractive tomography to study mechanical, electric, or magnetic properties of samples.
- Use the electron and ion beams to define regions of interest, then inspect deformation or structural changes of nanoindentation or micromachining via AFM.
- Install and detach the AFSEM®nano within minutes, requiring no permanent hardware modification.
- Operate the AFM independently outside the SEM, enabling in-air measurements and maximizing system utilization.

Full Compatibility with In-Situ Devices

AFSEM®nano is compatible with a wide range of third-party sample stages and in-situ devices including:

- Heating and Cooling Stages
- Tensile Stages
- Shuttle and Transfer Systems
- Custom Sample Holders and Manipulators

This open and modular compatibility ensures that AFSEM®nano fits seamlessly into existing SEM lab infrastructure, reducing the need for additional equipment and enabling complex multi-modal experiments with minimal workflow disruption.

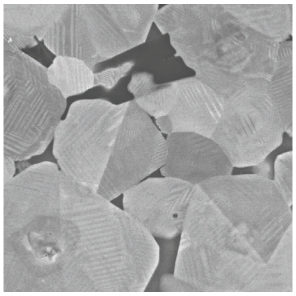


Scematic showing AFSEM®nano installed in a typical SEM chamber.

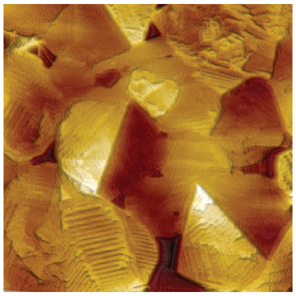
Key Applications of in-situ AFM in SEM

Materials Characterization

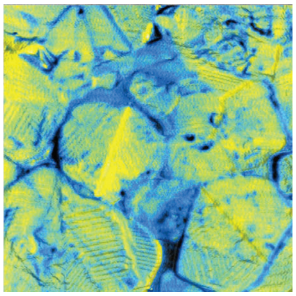
Evaluate barriers in materials using Electrostatic Force Microscopy (EFM).



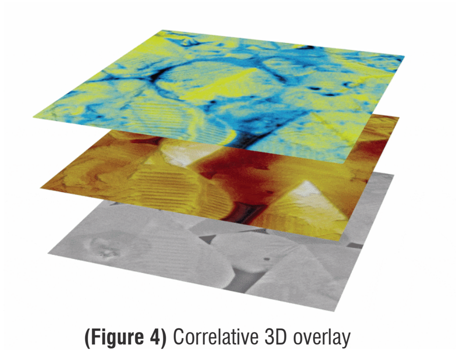
(Figure 1) SEM image of $BaTiO_3$ sample.



(Figure 2) AFM topography image of $BaTiO_3$ sample.



(Figure 3) EFM phase image of $BaTiO_3$ sample (+1.5V).



(Figure 4) Correlative 3D overlay of SEM, topography, and EFM signal.

Ferroelectric $BaTiO_3$ is a non-linear positive-temperature-coefficient (PTC) material and is used in resistors. Polycrystalline doped barium titanate exhibits a wide range of electrical resistance depending on the temperature employed in sensors and actuators.

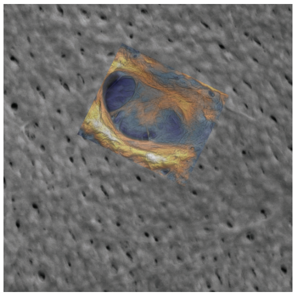
The macroscopic electronic properties of polycrystalline $BaTiO_3$ ceramics are governed by potential barriers forming between single grains. To reach a better understanding of the overall resistance of barium titanate it is essential to be able to characterize the potential differences in the crystalline material at the nanoscale. This characterization can be done with Electrostatic Force Microscopy (EFM).

Biological Analysis

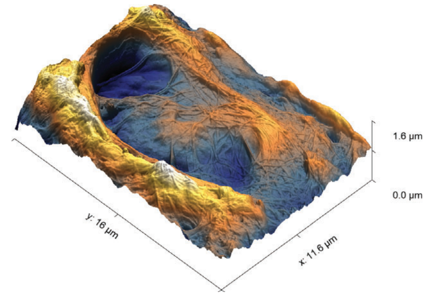
Analyze hard-to-reach sample areas using Atomic Force Microscopy (AFM).

(Figure 1) Cantilever positioned over bone structure.

(Figure 2) SEM image of bone surface with cantilever.



(Figure 3) SEM image of lacunae structure.

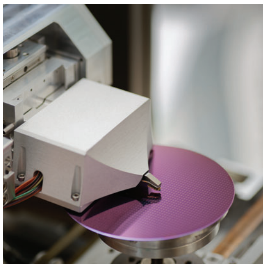


(Figure 4) 3D AFM topography image of lacunae structure.

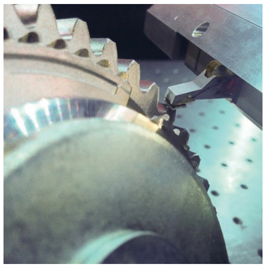
The correlative analysis of hard-to-reach sample areas is always a challenging task. One example is the analysis of bone tissue, especially the detailed measurements of lacunae and collagen fibers on the bone surface.

AFSEM® nano allows fast and easy identification and imaging of lacunae structures. Using the large field of view of the SEM, the lacunae can be identified, and the cantilever positioned directly on the lacunae structures. Using AFM the 3D topography of the lacunae and the collagen fibers can be extracted with sub-nm resolution.

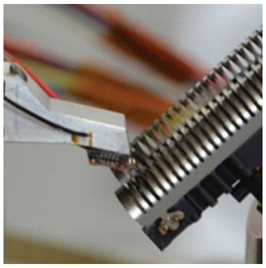
Other applications include large wafers and complex geometries:



Semiconductor Wafer



Gear Wheel



Razor Blade

AFSEM® nano Capabilities:

- Topography and morphology
- Precise tip navigation
- Non-flat or tilted samples
- Electrical measurements
- 3D nanomechanical mapping
- Failure analysis

Specifications*

Scanner	
AFSEM®nano scanner dimensions:	L/W/H = 61 mm x 61 mm x 28 mm
Scanner weight:	125 g
Scan range:	x/y: 22 μm x 22 μm (closed loop) z = 11 μm
HV compatibility:	1 x 10^{-7} mbar
Scan mode:	AC-mode, Contact mode, C-AFM,
	MFM, EFM, Force-Volume mode
Positioning Stage	
Travel distance:	x = 12 mm y = 12 mm z = 12 mm
Coarse resolution:	x/y/z: step size 100 nm (minimum, user controllable)
High-Speed Controller	
Input:	6 channels (200 kHz, 24 bit, with predefined functions)
Output:	7 channels (200 kHz, 24 bit, with predefined functions)
High voltage amplifier:	3 high-bandwidth channels (x, y: 10 kHz, z: >400 kHz)
Fast feedback loop:	16 bit ADC > 500 MHz sampling rate, 20 bit DAC with < 1 μs settling time
Closed loop operation	
3-axes coarse positioning control	
High-end support PC with PCIe lock-in card	
PCIe card specifications:	4 channels dual phase lock-in amplifier Sampling rate: >500 MS/s Bandwidth: 10 MHz
Monitor Outputs for All Sensor Signals	
Operating System Specifications and Features	
Software:	SXM control and imaging software.
	Q-control for fast scanning, especially in vacuum.
	Scanner positioning stage control.
	Proprietary data analysis software included.
	File formats fully compatible with Gwyddion and SPIP.
	Windows 11/64 bit operating system included.

*Specifications subject to change without notice. 1012-200 Rev. A0

Service and Support:

Since 1982, Quantum Design has been a long-standing manufacturer of scientific instrumentation, with a strong service and support history. Our global expansion in 1995, and the establishment of our distribution network in 1997, laid the foundation for comprehensive service and support, meeting our customers' needs both geographically and in their distinct research endeavors. This commitment to our customers' unique needs drives our continuous innovation and excellence, resulting in a strong service and support relationship with our partners and customers.

Quantum Design

Quantum Design, Inc.
10307 Pacific Center Court, San Diego, CA 92121
Tel: 858-481-4400 Fax: 858-481-7410
www.qdusa.com | info@qdusa.com