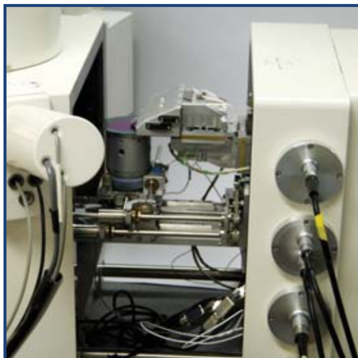
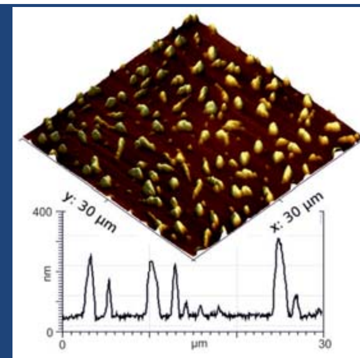
AFSEM™

Atomic Force Scanning Electron Microscope by **GETec Microscopy**

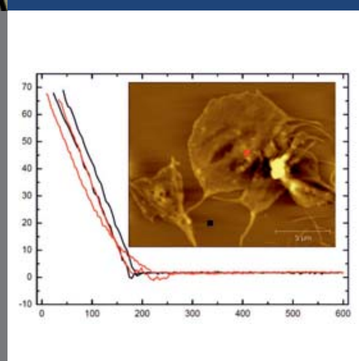


Combined SEM / AFM imaging

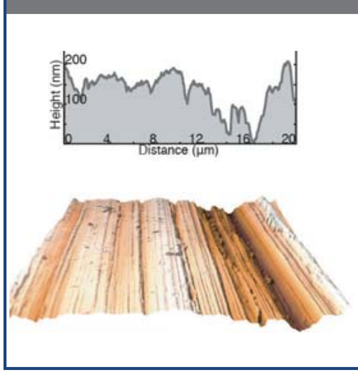


Quantitative height measurements

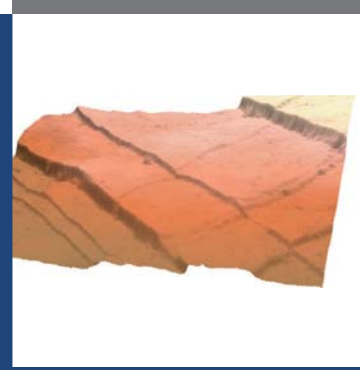
Elasticity coefficient measuring and mapping



Whole wafer imaging



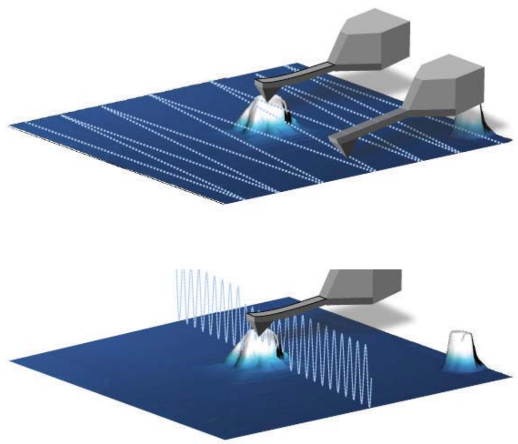
Surface roughness measurements



Sub-nanometer resolution on non-conducting samples

Did you know **YOUR** SEM could do this...?

GETec Microscopy **AFSEM**

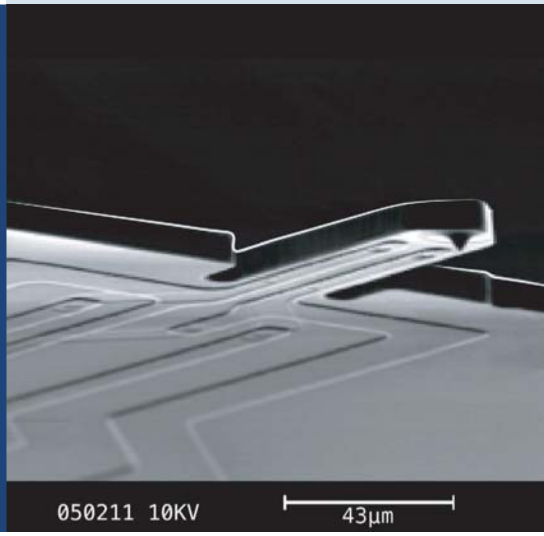


Atomic Force Microscopy (AFM)

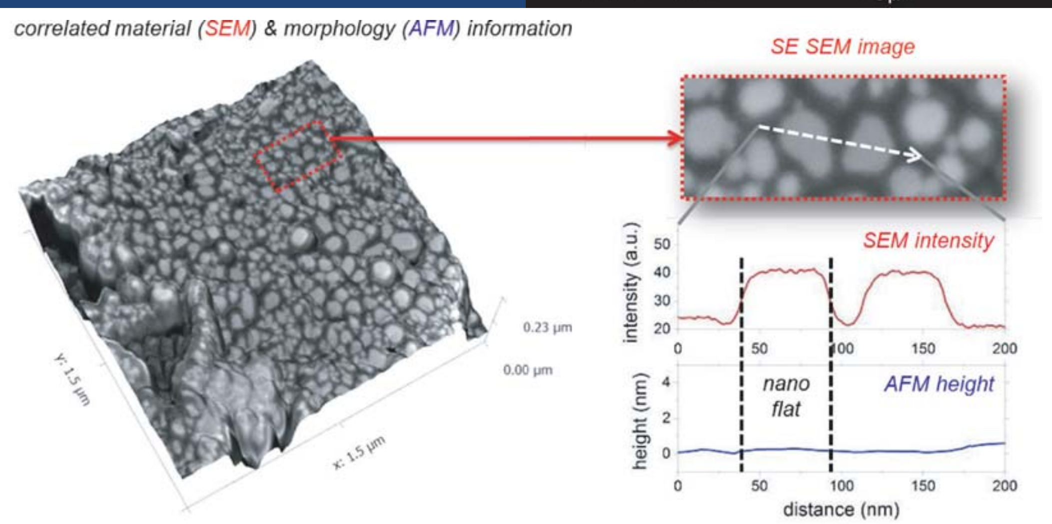
The topography is recorded by rastering a sharp tip at the end of a soft cantilever over the surface.
Contact mode (top): the cantilever is moved in contact over the surface, and the topography can be measured through the height dependent deflection of the cantilever.
AC-mode (bottom): The cantilever is excited to oscillate at its resonance frequency. The topography can be measured through the height dependent oscillation amplitude.

Contact mode
AC-mode
Conductive mode

Low noise self-sensing cantilever



AFSEM Cantilever Technology
allows for high-quality, low-noise detection of the surface topography. This has direct advantages for the performance and ease of usage, letting you record better images with less effort. The self-sensing technology allows maximum access for the electron beam to the cantilever and sample. The achievable low working distance lets you get the most out of your SEM.

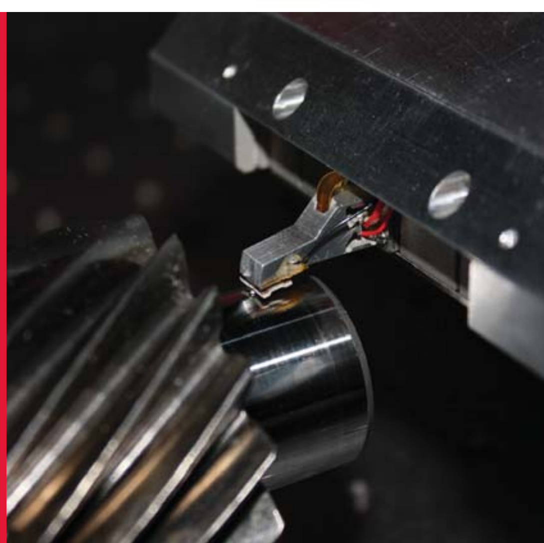


Region selection, characterization and distance measurements in all 3 axes

The combination of the large imaging range of the SEM with the high resolution and quantitative 3D-measurements allows for easy selection of the region of interest (ROI). The ability of the AFM to accurately measure distances in all 3 dimensions can then be used to quantify the size of nanoscale features. This uniquely expands individual SEM or AFM imaging by complementary information.

Any sample size

Compatible with custom stages



The Tip Scanning AFSEM Design
allows for great flexibility in sample size as well as the combination with other custom SEM stages such as Peltier stages, mechanical stretching stages or heating stages. The whole AFM scanner is easily removable and does not interfere with normal SEM operation. The AFSEM can also be used independently, outside the SEM.

Explore the **AFSEM**™

Concept

AFSEM is an innovative instrument concept that combines the benefits of scanning electron microscopy (SEM) and atomic force microscopy (AFM) within one instrument. The AFSEM module is easily integrated into your existing SEM, and due to its unique design lets you use your standard SEM sample stage and other add-ons such as EDX or micro-indenter.

The complimentary capabilities of AFM and SEM allow for unique characterization possibilities of your samples. AFSEM lets you image your sample with high resolution, create true 3D-topography representations and accurately measure heights, distances and even material properties, all while maintaining the large SEM field of view to position your AFSEM cantilever exactly where you want it. Optimized workflow with practically no reduction of the SEM uptime enables you to reach seamless effectivity. The powerful control software allows for optimized measuring system handling and data analysis.

Design

Due to its open access design, AFSEM is capable of imaging almost any sample size that your SEM can image. This is particularly useful when characterizing semiconductor wafers, imaging large fracture surfaces for failure analysis, or when you need to hold your sample in custom sample holders. Because of its design, AFSEM is also compatible with many other add-ons that you may already have for your SEM, such as heating and cooling stages, mechanical stretching devices or mechanical manipulators. It can be removed from the SEM within minutes, and it can even be operated outside the SEM.

The image quality has been given highest priority in the development of AFSEM, and state of the art AFM design concepts have been applied. The design has been optimized for linearity, accuracy and imaging speed using finite element analysis and model-based control algorithms. To optimize S/N ratio, the cantilever readout pre-amplifier has been integrated directly into the scanner unit. This has resulted in the AFSEM being capable of handling even challenging imaging tasks.

Imaging Modes

AFSEM supports the two most common AFM imaging modes, contact mode and AC-mode, with the standard package. Additional modes can be implemented with special cantilevers and add-ons (such as force-volume, KPFM, temperature mapping, etc.).

In contact mode, the AFSEM cantilever is scanned in contact over the sample, and the topography is measured through the deflection of the cantilever. This mode is easy to operate and quite fast. The drawback of this mode is that the cantilever applies significant forces on the sample that can wear down the sample as well as the tip.

In AC-mode the cantilever oscillates and only touches the sample intermittently. This mode is much gentler than contact mode and lets you image even fragile samples without damaging them.

AFSEM is based around the combination of dedicated AFM instrument and cantilever design. Optimizing these two components together results in excellent imaging performance. The AFSEM cantilevers are equipped with low-noise piezo-resistive deflection sensors and are available in a variety of sizes, spring constants and resonance frequencies. Further, a variety of special application cantilevers is available on request. Alternatively, the AFSEM can be modified to use self-sensing cantilevers from third party vendors.

Applications

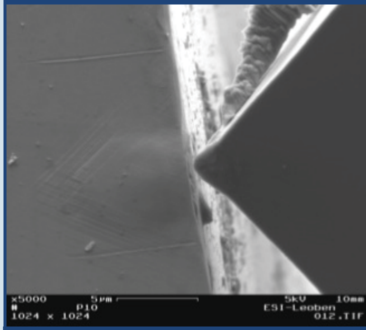
Whole wafer inspection: With AFSEM you can select an area anywhere on your wafer to make overview SEM images and high resolution AFM images. From the 3D-representation of the surface area you can extract accurate distance and height measurements, as well as surface roughness to optimally characterize your process.

Imaging of large objects such as machine parts for failure analysis: AFSEM can handle almost any sample size that your SEM can. This makes it ideally suited for nanometer inspection of fracture surfaces or wear patterns on precision machined parts, without having to cut down the sample.

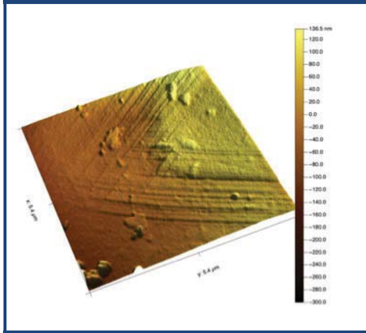
Nanomechanical testing: AFSEM is an ideal tool to characterize deformations and slip steps on samples that have been mechanically loaded. The SEM can be used to position the tip even on micrometer sized pillars and beams. The combination with third party in-situ tensile and compression stages makes it possible to perform real time deformations with quantitative characterization of slip step dislocations.

Calibration of FIB cutting rates: The accurate height measurements of AFSEM are ideally suited to easily characterize the cutting rates of your focussed ion beam, even for insulating samples.

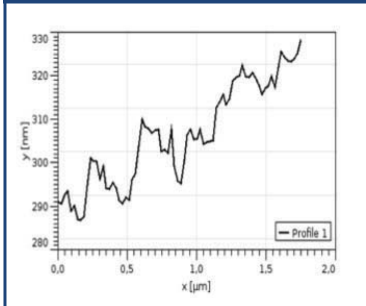
AFSEM



Simultaneous Imaging



nm-depth Resolution



Scanner Specifications	
AFSEM scanner dimensions	H = 41 mm L = 110 mm W = 77 mm
Scanner weight	500 g
Scan range	x/y: 35 μm x 35 μm (closed loop) z = 5 μm
HV compatibility	1 x 10^{-6} mbar
Scan mode	AC-mode, Contact mode
Positioning Stage Specifications	
Travel distance	x = ± 4 mm (± 7.5 mm on request) y = ± 4 mm z = 25 mm
Coarse resolution	x/y/z: step size 50 nm (minimum, user controllable)
High-Speed Controller Specifications	
Input:	8 channels (156 kHz, 24 bit, on demand user configurable)
Output:	8 channels (156 kHz, 24 bit, on demand user configurable)
High voltage amplifier:	3 high-bandwidth channels (x, y: 10 kHz, z: 300 kHz)
Fast feedback loop	(ADC > 500 MHz sampling rate, DAC with < 1 μs settling time)
Closed loop operation	
3-axes coarse positioning control	
High-end support PC with PCI lock-in card	
PCI card specifications:	4 channels dual phase lock-in amplifier Sampling rate: 500 MS/s Bandwidth: 10 MHz
AFSEM Operation System Specifications and Features	
Software:	SXM control and imaging software Q-control for fast scanning, especially in vacuum On the fly drift compensation Life imaging history Scanner positioning stage control
Supported modes:	
• Contact mode	
• AC-mode	Proprietary data analysis software included
• Conductive mode	File formats fully compatible with Gwyddion and SPIP
• Force-volume mode	Windows 7 operating system included
• Kelvin probe	
• Thermal probe	

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Specifications subject to change.
Distributed by:

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