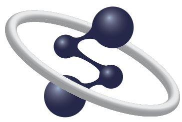
HITACHI
Inspire the Next



SCANNING PROBE MICROSCOPE

AFM5500M

The AFM5500M sets a new benchmark for a midsize-sample AFM platform and introduces exceptional levels of ease of use, automation, accuracy, and correlation for AFM investigations.

Ease of Use

Significantly simplified AFM operation

▶P2

- Wide-open tip and sample access
- Fully addressable 4-inch stage eliminating the need for sample remount/rotation
- Point-and-click function enabling easy and quick camera-based sample navigation
- All built-in accessories allowing seamless and software-controlled mode switching

Automation

Easier, faster, and more precise AFM imaging

▶P2

- Automated cantilever exchange
- Automated laser alignment
- Automated image optimization (RealTune® II)
- Automated AFM measurements following a recipe

Accuracy

Enhanced accuracy of AFM measurements

▶P3

- Flexure-based design providing superior flat and orthogonal scan
- Closed-loop scanner allowing highly linear and accurate imaging
- Low sensor noise yielding high-resolution and high-quality results
- Tip evaluation capability ensuring probe quality and artifact-free images

Correlation

New levels of AFM functions and accessibilities

▶P5

- Comparative and correlative imaging by AFM and SEM
- AFM measurements , as well as investigations of chemical identity
- Improved compositional mapping of heterogeneous thin films
- Comprehensive characterization of complex materials

Significantly simplifying the AFM operation

Automation settings, automation measurements, and automated data processing

Measurement Flow

Conventional AFM*

Manual stage AFM

Difficult to find the measurement position
Changing the position after each scan

▼

Possibly leading to deterioration in the productivity

Manual cantilever exchange

Difficult to handle small cantilevers
Causing damages to the cantilever when attaching

▼

Affecting data results

Manual laser alignment

Unaligned/unfocused laser beam

▼

Affecting data quality

Manual parameter tuning

Requiring certain level of experience

▼

Damaging the sample and/or the cantilever

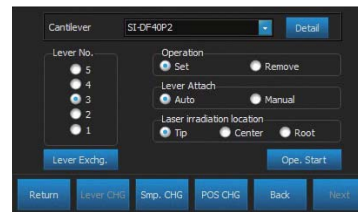
AFM5500M

Automated stage

Easy and quick positioning
Multipoint measurements

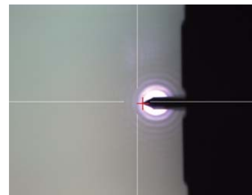
Automated cantilever exchange

Easy to remove/attach



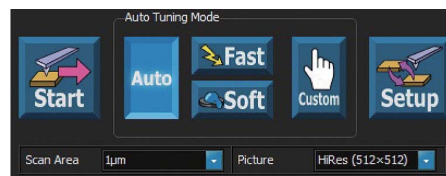
Automated laser alignment

Easy and quick laser alignment



Automated parameter tuning (RealTune® II)

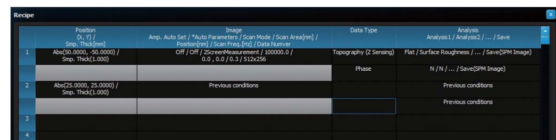
Eliminating human errors



Eliminates uncertainty factors and increases productivity

Batch processing and multipoint measurements

Batch processing and multipoint measurement registration function further enhance the ease of use.



＊AFM5100N

Accuracy

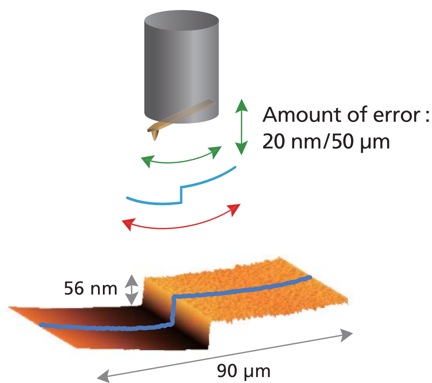
Elimination of systematic errors

Flat Scan

Conventional AFM with a piezoelectric tube scanner requires data flattening or leveling because of its intrinsic curved motion. However, this flattening may distort a sample's micro-surface structure, including its Z value. The newly developed AFM5500M is equipped with a flexure-based scanner that enables well-controlled raster scans along X and Y directions only. As a result, this advanced scanner design can effectively eliminate background curvatures in a wide scan area and improve the accuracy of AFM measurements.

Conventional Scanner*

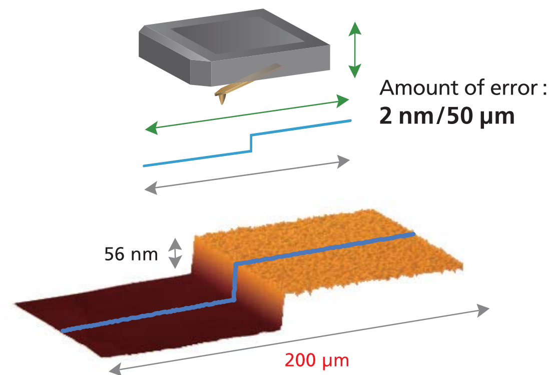
Curved motion



Background curvature due to the curved motion

AFM5500M's Scanner

Translational motion



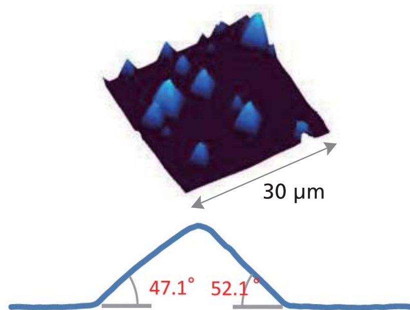
True surface measurement without background curvature

Sample：Amorphous silicon thin film on a sillicon substrate

High Orthogonality

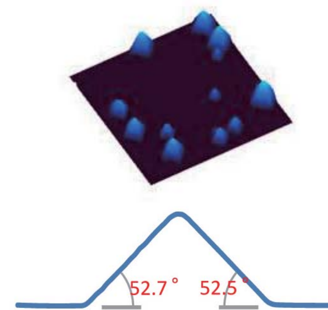
Using a conventional piezoelectric tube scanner can cause cross-talk when bending the scanner. This cross-talk leads to distortions and asymmetrization. The improved AFM5500M's scanner reduces cross-talk making both accurate and symmetric measurements possible.

Conventional Scanner*



Differences between left and right angles and ridges are distorted

AFM5500M's Scanner



High straightness and accurate measurement

Sample : Textured-structure solar battery（having symmetrical structure due to its crystal orientation.）

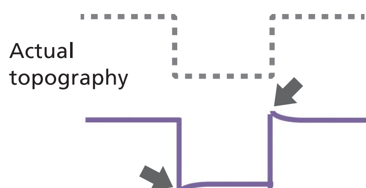
Closed-loop Control

Data acquired by using a conventional piezoelectric tube scanner are sometimes affected by hysteresis and creep artifacts. The AFM5500M's scanner eliminates hysteresis and creep through its closed-loop control and Z displacement sensor.

Conventional Scanner*

Overshoot at an edge

Actual topography



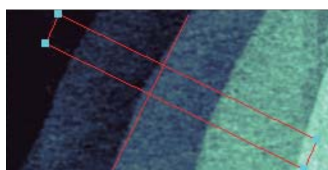
AFM5500M's Scanner

Eliminating overshooting by its Z displacement sensor

Actual topography

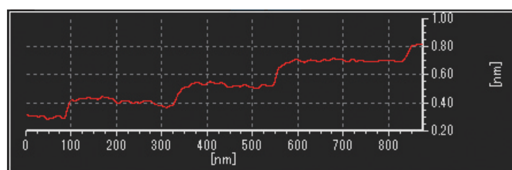
Low Noise Level

Newly developed low-noise sensor enables atomic step observations with its closed control



900 nm

Atomic steps on sapphire (step height: 0.25 nm)

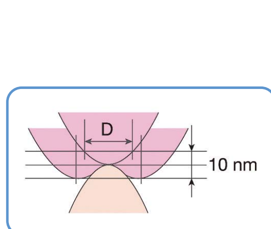


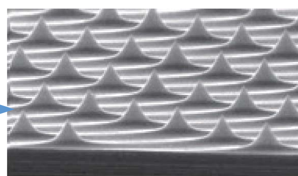
From wide (200 μm) to small area, high-resolution observations with its closed-loop scanner

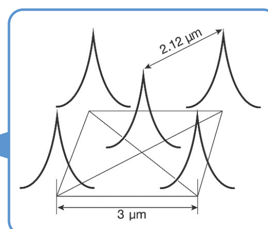
Tip Evaluation

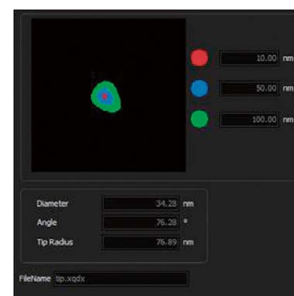
The cantilever tip radius greatly influences AFM measurement results. In the conventional method, it depends on the operator's expertise to determine when to exchange the cantilever. In the AFM5500M, the tip radius evaluation functron displays the tip radius and assists the operator to determine the tip life, improving data reliability.

Tip calibration standard sample









*AFM5100N (with an open-loop scanner)

Correlative AFM and SEM Imaging

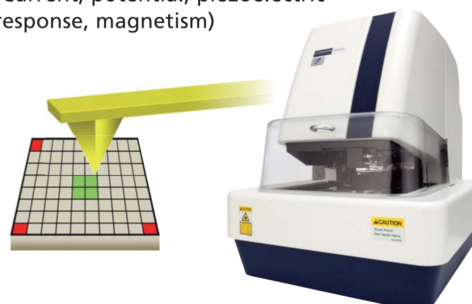
The Hitachi-proprietary AFM/SEM shared alignment holder provides quick and easy measurements and analysis of topography, structures, composition, and surface property.

SEM

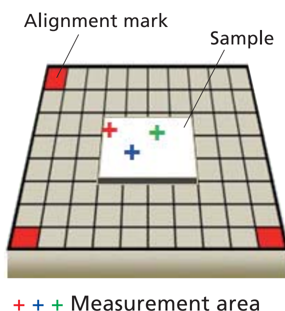
Secondary electron (SE)
Back-scattered electron (BSE)
Characteristic X-ray (EDX)
Crystal orientation analysis (EBSD)

AFM

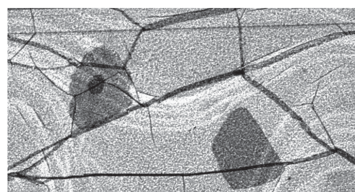
Topography and high-precision 3D measurements
Mechanical property (hardness, friction, adhesiveness, phase) Electromagnetic property (Current, potential, piezoelectric response, magnetism)



AFM and SEM shared sample holder

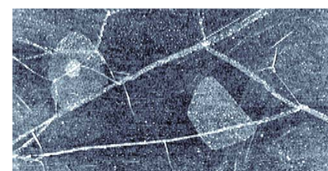


Selecting the target area from SEM image for subsequent AFM studies >>>



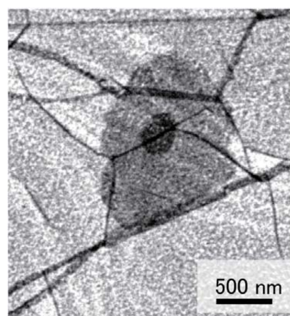
SEM imaging of the same area after AFM measurements

AFM measurements of the same area after SEM imaging

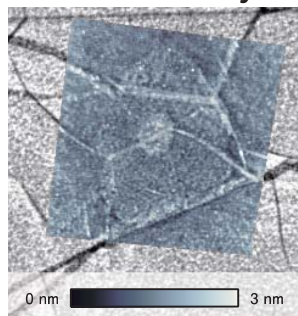


<<< Exporting AFM data to SEM

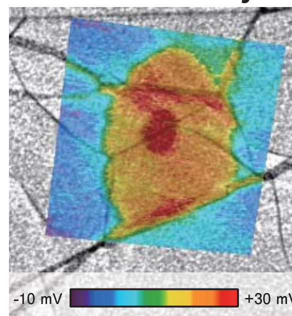
SEM



AFM/SEM overlay



KFM/SEM overlay



The overlay images created by using AZblend Ver.2.1, ASTRON Inc.

AFM and SEM Measurements of the Same Area (Sample：Graphene/SiO_2)

Overlay images of SEM, AFM (topography), and KFM (surface potential)

- It can be concluded from AFM cross-session height measurements that those contrast differences in the SEM image are corresponding to the variation of graphene layers in the AFM image.
- It indicates that surface potential (work function) of graphene sheets is highly dependent on the sample thickness, i.e., the number of graphene layers.
- High-precision 3D topographic data in conjunction with the electrical property examination provide strong evidence for identifying the root cause of captured variations in SEM contrasts.

Hitachi High-Tech Science will continue to develop AFM-correlated systems with other types of microscopes and inspection equipment.

Size and weight*	
Size	750 mm(W) × 874 mm(D) × 1,400 mm(H), approximately 361 kg
Specialized Probe Station Controller Size	340 mm(W) × 478 mm(D) × 550 mm(H), approximately 31.6 kg

Detection system	
Detection	Optical Beam Deflection
Light source	Low-coherence LED (Center Wavelength: 830 nm)

Automated stage	
Observable area	100 mm (4 inch) entire area
Stroke	XY ≥ 100 mm, Z ≥ 21 mm
Minimum step	XY 2 μm, Z 0.04 μm

Probe station exclusively for AFM5500M	
RealTune® II	Automatic tuning of cantilever amplitude (DFM), contact force, scan speed, and feedback gains
Various Functions	Operating instructions; Tab structure (Measurement / Analysis); Measurement area indicator / Measurement area tracking window); Batch processing; and Tip calibration
X,Y,Z, Axis Scan Voltage	0 ～ 150 V
Simultaneous Measurements (Measurement Data Points)	4 channels (Max 2,048 × 2,048) 4 channels (Max 4,096 × 4,096)
Rectangular Scan	2:1, 4:1, 8:1, 16:1, 32:1, 64:1, 128:1, 256:1, 512:1, 1,024:1
Analysis Software	3D display and overlay, Roughness, Cross-section, Average cross-section
Automated Functions	Automated cantilever exchange, laser alignment and photo detector alignment

Specifications	
Scan Range	200 μm × 200 μm × 15 μm (XY: closed-Loop control / Z: displacement Sensor)
Sample Saize	Diameter 100 mm (4 inch) × Thickness 20 mm / 2 Kg
Optical Microscope	Zoom Mag: 1～7 × Max Field of Vision: 910 um × 650 um Min Field of Vision: 130 um × 90 um
RMS noise Level*	≤ 0.04 nm (High-resolution Mode)
XY repeatability*	XY ≤ 15 nm (3σ, Measuring 10 μm Pitch) / Z ≦ 1 nm (3σ, Measuring 100 nm depth)
XY-Orthogonality	90° ± 0.5° (0scan, 90scan, 45scan)
XY Scan Flatness*	≤ 2 nm / 50 μm
OS	Windows 10
Measurement mode (standard)	AFM, DFM, PM (Phase Mode), FFM
Measurement mode (optional)	SIS-Topo, SIS-Property, LM-FFM, VE-AFM, Adheasin, Current, Pico-Current, SSRM, PRM, KFM, EFM (AC), EFM (DC), MFM, SIS-ACCESS, SIS-QuantiMech

SEM-AFM Linkage System (Optional)	
Sample holder size	41 mm(W) × 29 mm(D) × 16 mm(H)
Maximum mounted sample size	φ20 mm × 7 mm
Alignment accuracy	±10 μm (AFM Alignment accuracy)
SEM compatible model	Regulus 8100, Regulus 8220, Regulus 8230, Regulus 8240, SU8220, SU8230, SU8240, SU5000

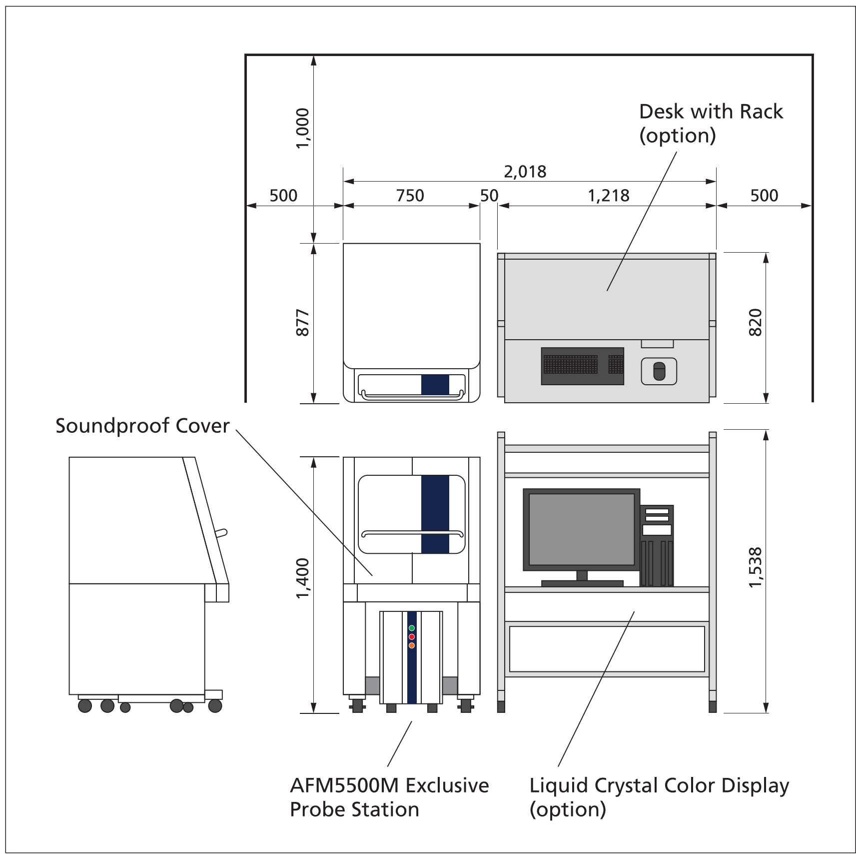
Power Supply Equipment	
Power Supply	AC100～240 V±10 %

Note ●The dimensions and weight aforementioned are typical values (with assembly tolerances taken into consideration) for reference, they may change with repect to the system configuration.

●The microscope field size is the maximum measurement area according to a designed value. It may change due to manufacturing variations of the element.

●The system performance depends on configration and installation enviroment. (*)

●Please refer to the product specifications for further details



The Science Ring demonstrates our desire to contribute to the betterment of society through Hitachi's innovative scientific instruments and expertise.

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Notice: For correct operation, follow the instruction manual when using the instrument.

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