nanoMETRONOM

simplifying
nanoanalytics

Systems

nanoMETRONOM® AFM family

Key features and benefits

PLUG AND PLAY CANTILEVER CHANGE

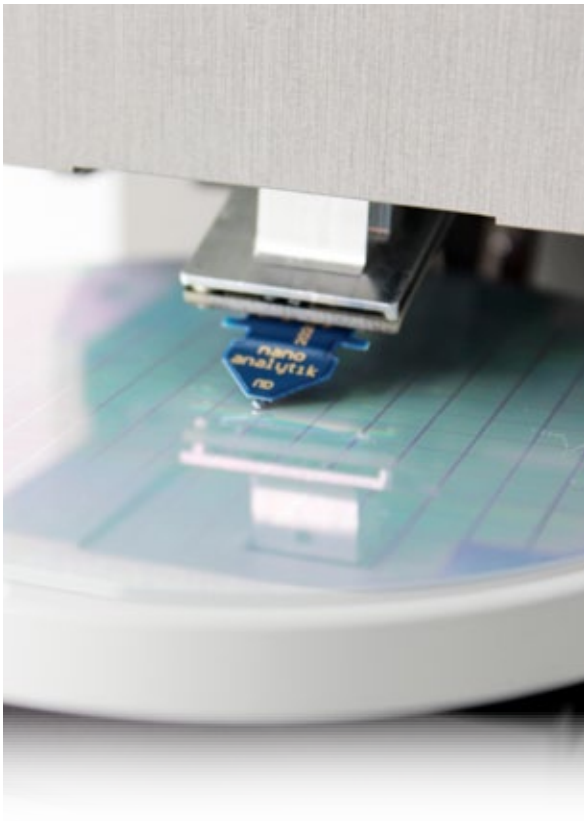
- Plug and play cantilever exchange in 10 seconds
- No groping with tweezers
- No laser beam adjustments
- Pre-qualified and pre-aligned self-transducing and self-sensing cantilevers
- Supplied in an easy-to-load box

INTUITIVE USABILITY

- SmartActiveProbe scanning system in cantilever-scanning configuration
- Scanning head controls the 3D motion of the cantilever tip (tip-scanner)
- Integrated digital upright microscope in the optical axis of the SmartActiveProbe tip provides visual control and navigation

MODULAR SYSTEM

- Our innovative solution can be easily adapted to the customer's individual requirements
- Modular system components including damping, enviromental chamber, positioning stage
- Scanner and probe can be configured in advance or customised



- Fastest SPM system in vacuum, air and liquid
- SmartActiveProbe (cantilever) with active thermomechanical actuation and read-out at few MHz for high speed imaging
- Two-dimensional electron gas (2DEG) based read-out in a full bridge Wheatstone configuration with built-in, atomic-scale sensitivity
- Noise level is at optical read-out level
- Ultra compact design for highest flexibility
- Operation at multi frequency exitation
- SmartActiveProbe in cantilever-scanning configuration with atomic resolution
- Plug and play cantilever exchange in 5 seconds
- Upright digital navigation microscope
- Closed loop configuration, closed loop imaging, drift, creep and hysteresis correction
- Up to 4" sample size with up to 1 kg and up to 0.8" sample-height in standard configuration
- Full control of cantilever smart approach and positioning

The atomic force microscope (AFM) is capable of imaging local material properties such as topology, friction, electrostatic interaction, electrical conductivity, magnetism etc. The image is obtained by scanning a probe over a selected area and detecting the force between the probe and the sample.

To obtain the image, AFMs can generally measure the vertical and lateral deflections of the SmartActiveProbe by using an optical lever. A feedback circuit keeps the cantilever-bending constant by adjusting the voltages applied to the x, y, z scanner.

nano analytik GmbH utilizes novel thermomechanical (self-transduced) and piezoresistive (self-sensed using 2DEG read-out) cantilevers instead of optical read-out. These cantilevers are preferred over optical readout for many applications and can achieve similar performances. In terms of miniaturization, this approach offers very high imaging speed, extremely simple operation in vacuum or non-transparent liquids and a unique capability of parallel AFM operation.

With a static tip displacement of several micrometers (static hub) and an achievable thermal cut-off frequency of several kHz, the thermo-mechanical actuator is used for fast z-axis control instead of the common piezoelectric actuator. This actuator can exitate the SmartActiveProbe at a fundamental or higher order resonant frequency. The static deflection and a feedback loop using the 2DEG read-out sensor yields a faster control for rapid non-contact imaging.

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System Specification

Systems

Standard configuration

- Cantilever head, which provides open view access to the sample and probe for easy and fast exchange operations, as well for the easy insertion of different dedicated active sensors.
- Scanner either for ultra-fast imaging or for large scan range
- Closed loop configuration, fast closed loop imaging, drift, creep and hysteresis correction employing low noise, linear and cost effective micro sensors
- Ultra low-noise high voltage amplifier for ”Pales” scanner
- nanoMETRONOM® 80 MHz FPGA controller
- The cantilever with integrated drive and readout set-up coupled with high definition video system gives a direct top view of probe and sample for the precise probe navigation on the sample
- NANO-COMPASS BASIC software package
- AFM starter kit including 10 SmartActiveProbes®
- One year full update support
- Manual sample positioning stage with 2” movement range

Optional configuration

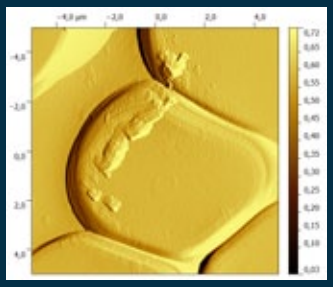
- naB73/naB74 bottom scanner for 60 µm² and 100 µm²
- Two channel 125 MHz Kronos contoller for Scanning Probe Lithography
- Active piezoelectrical damping stage
- Passive mechanical damping stage
- NANO-COMPASS ADVANCED
- Full environmental enclosure
- Manual high precision sample positioning stage with 2” movement range
- Motorized high precision sample positioning stage with 4” movement range

FUNCTIONS	
Operation mode	AC mode / DC mode
Topography imaging	YES
Amplitude / phase imaging	YES
Force curve chart	YES
Sample / probe approach	Automatic
Probe tuning	Automatic
Detection principle	Piezoresistive
Scan range	Pales scanner*: 20 µm × 20 µm × 5 µm (Digital to analog convertion resolution 18-bit)
	Adeona scanner: 15 µm × 15 µm × 4 µm
*X-Y position noise	<85 pm RMS in imaging BW of up to 500 Hz
*Z position noise	<15 pm RMS in imaging BW of up to 1 kHz
*Tip-velocity max.	5 mm/s in X-Y, 11.67 mm/s in Z
*Scan speed	0.01 to >100 Hz
Simultaneous images	Phase, frequency, amplitude, topography
Optional functions	MFM, EFM, PFM, C-AFM, SThM

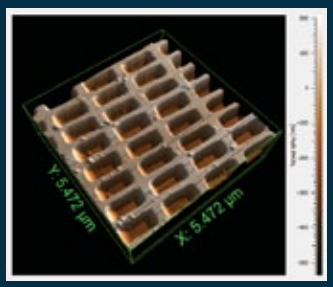
ELECTRONICS	
Resolution Amplitude / phase	16-bit
Feedback control platform	Realtime FPGA
Front end bandwidth	8 MHz
Computer interface	USB, ethernet optional
Sensor conditioning	0 to -4 V programmable bridge supply
Sensor noise floor	<60 pm RMS in imaging BW of up to 1 kHz
Min. measurable displacement	140 pm

SAMPLE	
Sample size	4” in standard configuration
Sample translation	Manual X Y, 25 mm x 25 mm
Auxiliary top view	4.5x manual zoom, 0.8 - 5 magnification, 1,92 MP CMOS Sensor, 0.65 mm² to 27 mm² viewing area

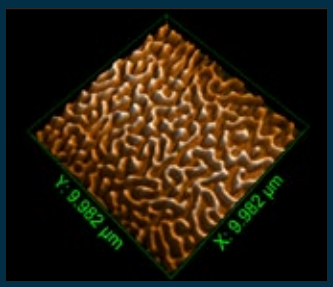
SOFTWARE	
Realtime correction	Line, plane, polynomial
Line profile measurement	YES
Roughness measurement	YES
Contrast / brightness	YES
Multiple color palettes	YES
3D image	YES
Line average	YES
Image export	bmp file, png file, jpg file
Raw data export	txt file
Image size	2 to 1024 pixels
Raw data export	For Matlab, Excel, Gwyddion and WSxM



Imaging of blood cells in liquid



Measurement of critical dimensions in silicon oxide features



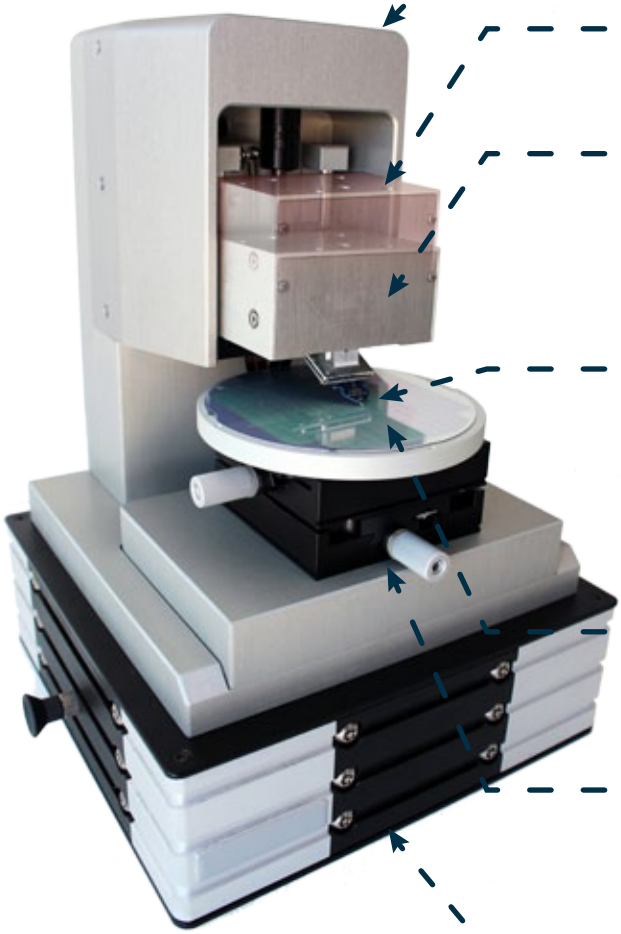
Surface analysis of polymer solar cells

Profilometric measurement of silicon sample

nano analytik

Systems

System Overview

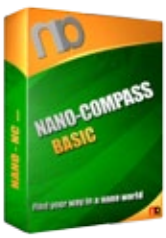


- Robust mechanical set-up
- Fully automatic approach
- x, y, z - cantilever fast scanning head
- The SmartActiveProbe with integrated drive and readout set-up is coupled with a high-definition video system that gives a direct top view of probe and sample for the precise probe navigation over the sample.
- Up to 4” sample size in standard configuration
- Manual or motorized sample positioning stage
- Active piezoelectrical damping stage (optional)

Upright digital navigation microscope

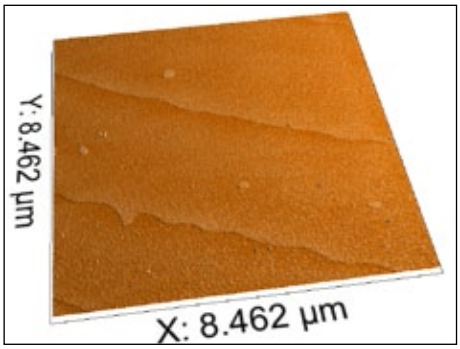
nanoMETRONOM®
80 MHz FPGA controller

nanoMETRONOM®
high voltage amplifier

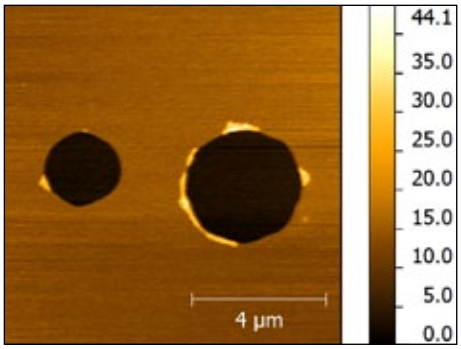


NANO-COMPASS BASIC
software package

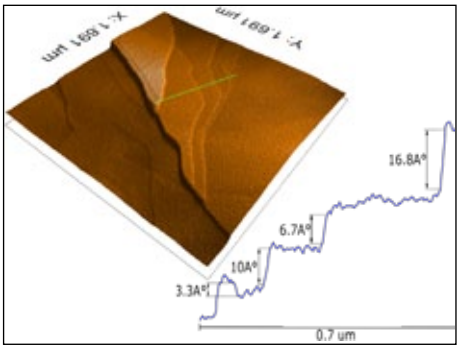
Image gallery



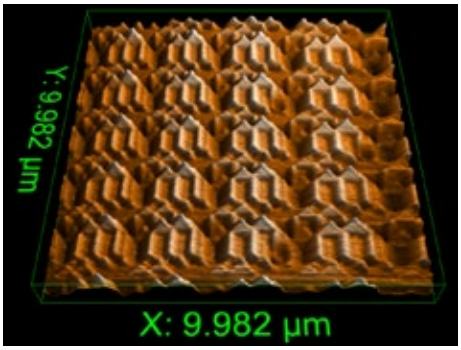
NC-AFM image of atomic steps on Si(111) at air with nanoMETRONOM



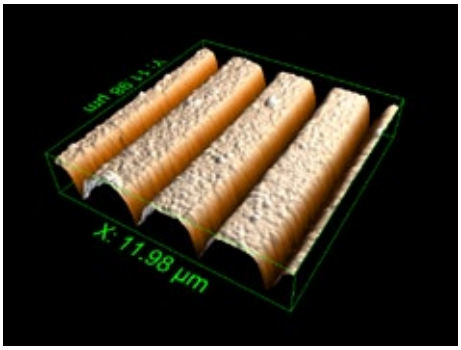
AFM image of side wall nano fences formed in resist after plasma etching



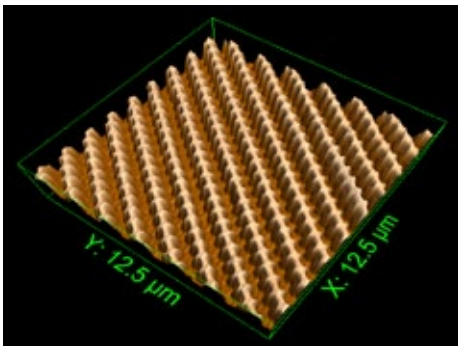
NC-AFM image of HOPG done with active cantilever operated in air[*1]



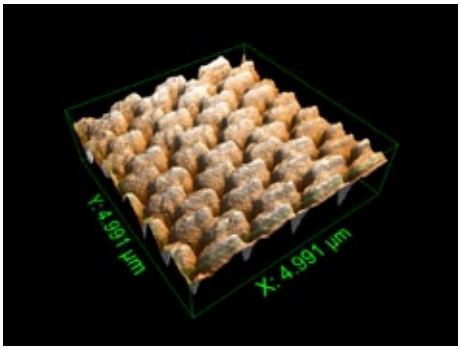
AFM, inspection image of MEMS wafer



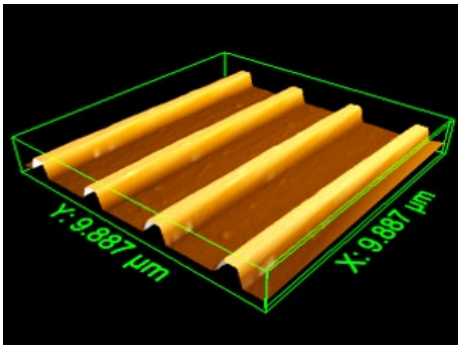
AFM detailed image of IC-chip



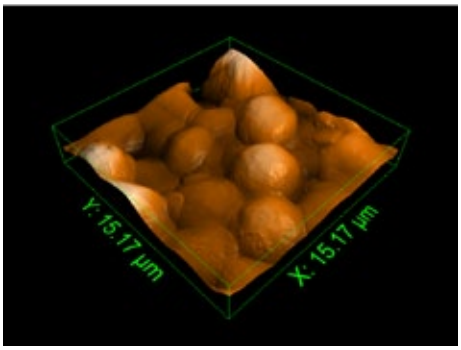
AFM image of a quartz test specimen[*3]



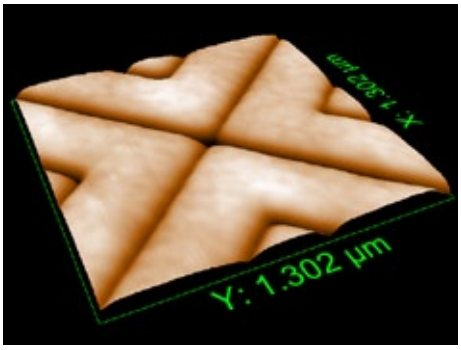
AFM image of NIL (Nano Imprint Lithography) template



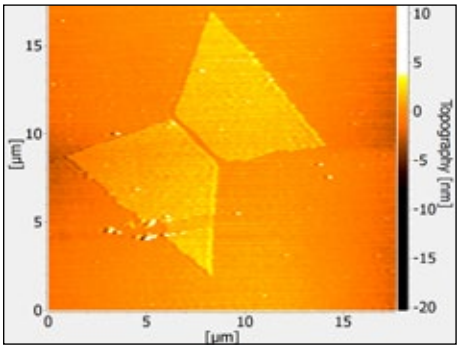
Fast NC-AFM image of lithographic features obtained with nanoMETRONOM[*3]



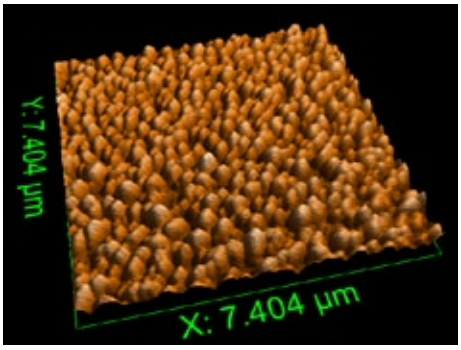
AFM image of yeast done in liquid



NC-AFM image of lithographic aligment mark obtained with AFMinSEM



Topographic AFM image of MoS_2 with AFMinSEM[*2]



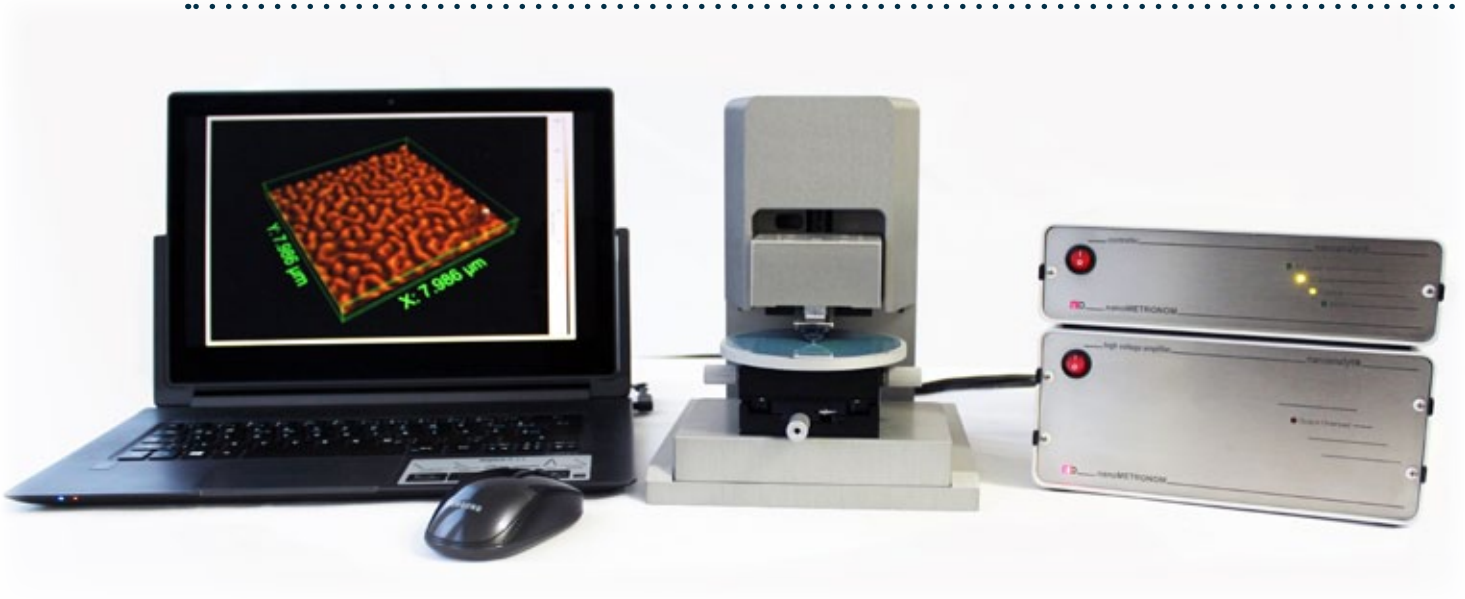
NC-AFM image of BN film

*1 doi: 10.1116/1.4966556 / *2 doi: 10.1116/1.4964290 / *3 doi: 10.1117/12.2085760

Systems

Configuration HS

nanoMETRONOM-HS (high speed)



Standard configuration

- Cantilever head for fast plug-and-play cantilever exchange
- Pales® scanner for ultra-fast imaging
- Closed loop configuration, fast closed loop imaging, drift, creep and hysteresis correction employing low noise, linear and cost-effective micro sensors
- Ultra low-noise high voltage amplifier for Pales® scanner
- nanoMETRONOM® 80 MHz FPGA controller
- Full nanoMETRONOM hardware configuration including automatic approach configuration
- NANO-COMPASS BASIC software package
- AFM starter kit including 10 SmartActiveProbes®
- Manual sample positioning stage with 2” movement range
- Navigation camera in the optional configuration: 4.5x manual zoom, 0.8 - 5 magnification, 1,92 MP CMOS Sensor, 0.65 mm² to 27 mm² viewing area
- Standard nano analytik GmbH PC or comparable Laptop
- Housing for reducing environmental influences

FUNCTIONS	
Operation mode	AC mode / DC mode
Topography imaging	YES
Amplitude / phase imaging	YES
Force curve chart	YES
Sample / probe approach	Automatic
Probe tuning	Automatic
Detection principle	Piezoresistive
Scan range	Pales scanner: 20 µm × 20 µm × 5 µm (Digital to analog convertion resolution 18-bit)
X-Y position noise	<85 pm RMS in imaging BW of up to 500 Hz
Z position noise	<15 pm RMS in imaging BW of up to 1 kHz
Tip-velocity max.	5 mm/s in X-Y, 11.67 mm/s in Z
Scan speed	**0.01 to >200 Hz**
Resolution Amplitude / phase	16-bit
Scanner closed loop	DMS based
Feedback control platform	Realtime FPGA
Front end bandwidth	8 MHz
Simultaneous images	Phase, frequency, amplitude, topography
Measurement modes	MFM, EFM, PFM, C-AFM, SThM

SAMPLE	
Sample size	4” in std. configuration, 10 mm max height
Sample translation	Manual X Y, 25 mm x 25 mm

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Configuration PJ

Systems

nanoMETRONOM-PJ

Standard configuration

- Cantilever head for fast plug-and-play cantilever exchange
- PJ scanner for closed loop operation up to 30µm x 30µm x 10µm
- Ultra low-noise high voltage amplifier for PJ scanner
- Closed loop configuration, fast closed loop imaging, drift, creep and hysteresis correction employing low noise, linear and cost-effective micro sensors
- nanoMETRONOM® 80 MHz FPGA controller
- Full nanoMETRONOM hardware configuration including automatic approach configuration
- NANO-COMPASS BASIC software package
- AFM starter kit including 10 SmartActiveProbes®
- Manual sample positioning stage with 2” movement range
- Navigation camera in the optional configuration: 4.5x manual zoom, 0.8 - 5 magnification, 1,92 MP CMOS Sensor, 0.65 mm² to 27 mm² viewing area
- Standard nano analytik GmbH PC or comparable Laptop
- Housing for reducing environmental influences

FUNCTIONS	
Operation mode	AC mode / DC mode
Topography imaging	YES
Amplitude / phase imaging	YES
Force curve chart	YES
Sample / probe approach	Automatic
Probe tuning	Automatic
Detection principle	Piezoresistive
Scan range	Pales scanner: 30 µm × 30 µm × 10 µm (Digital to analog convertion resolution 18-bit)
X-Y position noise	<95 pm RMS in imaging BW of up to 400 Hz
Z position noise	<27 pm RMS in imaging BW of up to 500 Hz
Tip-velocity max.	1.7 mm/s in X-Y, 3.1 mm/s in Z
Scan speed	0.01 to 40 Hz
Resolution Amplitude / phase	16-bit
Scanner closed loop	DMS based
Feedback control platform	Realtime FPGA
Front end bandwidth	8 MHz
Simultaneous images	Phase, frequency, amplitude, topography
Measurement modes	MFM, EFM, PFM, C-AFM, SThM

SAMPLE	
Sample size	4” in std. configuration, 10 mm max height
Sample translation	Manual X Y, 25 mm x 25 mm

Systems

Configuration S2

nanoMETRONOM-S2 (sample scanning)

Standard configuration

- Cantilever head for fast plug-and-play cantilever exchange
- S2 closed loop sample scanner
- Closed loop configuration, fast closed loop imaging, drift, creep and hysteresis correction employing low noise, linear and cost-effective micro sensors
- Ultra low-noise high voltage amplifier for S2® scanner
- nanoMETRONOM® 80 MHz FPGA controller
- Full nanoMETRONOM hardware configuration including automatic approach configuration
- NANO-COMPASS BASIC software package
- AFM starter kit including 10 SmartActiveProbes®
- Manual sample positioning stage with 2” movement range
- Navigation camera in the optional configuration: 4.5x manual zoom, 0.8 - 5 magnification, 1,92 MP CMOS Sensor, 0.65 mm^2 to 27 mm^2 viewing area
- Standard nano analytik GmbH PC or comparable Laptop
- Housing for reducing environmental influences

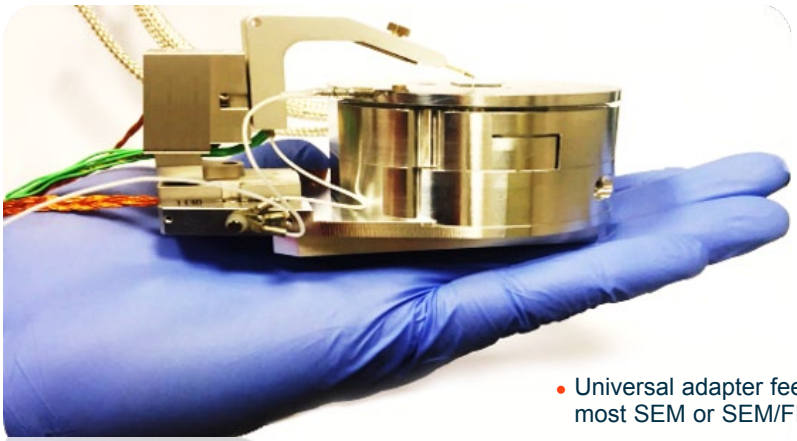
FUNCTIONS	
Operation mode	AC mode / DC mode
Topography imaging	YES
Amplitude / phase imaging	YES
Force curve chart	YES
Sample / probe approach	Automatic
Probe tuning	Automatic
Detection principle	Piezoresistive
Scan range	Pales scanner: 10 µm × 10 µm × 10 µm (Digital to analog convertion resolution 18-bit)
X-Y position noise	<15 pm RMS in imaging BW of up to 400 Hz
Z position noise	<15 pm RMS in imaging BW of up to 400 Hz
Tip-velocity max.	1.6 mm/s in X-Y, 1.6 mm/s in Z
Scan speed	0.01 to >20 Hz
Resolution Amplitude / phase	16-bit
Scanner closed loop	No closed loop
Feedback control platform	Realtime FPGA
Front end bandwidth	8 MHz
Simultaneous images	Phase, frequency, amplitude, topography
Measurement modes	MFM - EFM - PFM - C-AFM - SThM

SAMPLE	
Sample size	(15 x 15 x 10) mm in std. configuration
Sample translation	Manual X Y, 5 mm x 5 mm

AFM in SEM

Systems

Nanoanalytics in a new dimension



- Capable to work in vacuum and air, no operational dead-time
- Compact form factor of (L x W x H): 110 x 70 x 45 mm
- SmartProbe with integrated readout and actuation
- Allows shortest distances between detector and sample in SEM, FIB-SEM, and EPMA
- Closed loop configuration, fast closed loop imaging, drift, creep and hysteresis correction employing low noise, capacitive sensors.
- Universal adapter feed for easy application in most SEM or SEM/FIB chambers
- In situ Atomic Force Microscopy and Secondary Electron Microscopy capability for contact / non-contact modes in vacuum. Capable for in situ operation of FIB, Energy Dispersive Spectroscopy (EDS), Electron Backscatter Diffraction (EBSD), Wavelength Dispersive Spectrometry (WDS), Micro X-ray Fluorescence (Micro-XRF), X-ray Metrology, and Electron Probe Microanalysis (EPMA)
- Best available take-off angle for SEM for high-resolution imaging
- High precision AFM-tip addressing with fully integrated 3D-motor for precise positioning within 18 x 18 x 10 mm (of < 5 nm and a closed loop repeatability of +/- 25 nm)

The AFM in SEM from nano analytik GmbH is not only used for imaging, but can be employed for metrology as well. For this purpose, we are offering a compact AFM system, applicable in any SEM without chamber modification for micro manipulation and metrology scanning. The naB73 scanner is a non-magnetic, closed loop XYZ nanopositioner with 60 µm x 60 µm x 20 µm range of motion (Position noise (nm): x, y = 0.4; z = 0.2) and extremely low out-of-plane motion.

It has a high resonant frequency in x, y of 750 Hz and z of 2000 Hz. It is designed for space-constrained applications that require high precision positioning. Furthermore, the specially developed 3-axes cantilever head-positioning system is offering motion capabilities in the range of 18 mm in X, Y and 10 mm in Z with a closed loop **accuracy of < 5 nm** and a closed loop **repeatability of +/- 25 nm**.

nano analytik GmbH employs self-transduced and self-sensed (2DEG read-out) cantilevers in SEM, which meet the following criteria: (I) low spring constant (low longitudinal stiffness), (II) high resonance frequency, (III) high quality factor of the cantilever, (IV) high lateral spring constant (high transversal stiffness), arranged for electronic read-out actuation and conductive tip ensures that no electric charging can occur.

For more information see:

Six-axis AFM in SEM with self-sensing and self-transduced cantilever for high speed analysis and nanolithography; *T. Angelov et al., Journal of Vakuum Science & Technology B34, 06KB01 (2016); doi: 10.1116/1.4964290*

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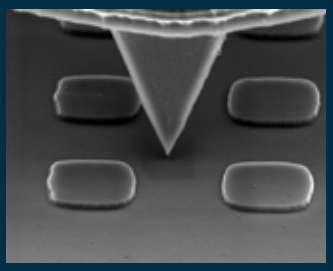
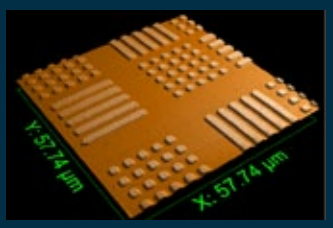
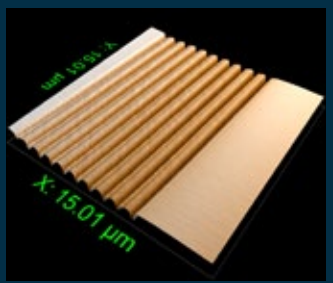
SmartActiveProbe for AFMinSEM



Navigation of AFM-tip in SEM



Fragment of NIL template imaged with AFMinSEM

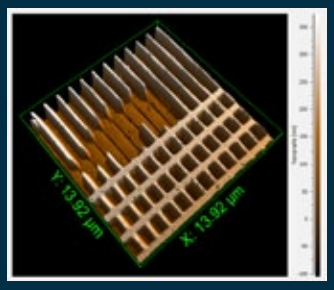


AFM image of resist features done with AFMinSEM

AFM in SEM

Systems

Dynamic *insitu* vacuum analysis



AFM in SEM MEMS inspection

AFM SmartActiveProbe in SEM

Phoebus® 125 MHz controller for most nano analytik GmbH applications including AFM in SEM

Standard configuration

- naB73 bottom scanner for vacuum operation
- High adressing accuracy of the AFM-tip by integrated 3D-positioner (of < 5 nm and a closed loop repeatability of +/- 25 nm)
- High voltage amplifier
- In head readout electronics
- Kronos® 125 MHz Controller
- AFM-Starterkit including 10 SmartActiveProbes® for easy probe exchange system

Optional configuration

- Extended scan range for up to 100 µm²
- Windows dll, com-port for independent function access and programming
- Ambient operating AFM mount
- 2-channel 125 MHz Kronos® contoller for multiple applications
- Upright digital navigation microscope for ambient use
- Acoustic enclosure for ambient operation
- Active piezoelectrical damping stage for ambient operation
- Passive mechanical damping stage for ambient operation
- Full environmental enclosure for ambient operation

FUNCTIONS	
Operation mode	AC mode / DC mode
Topography imaging	YES
Amplitude / phase imaging	YES
Force curve chart	YES
Sample / probe approach	Automatic
Probe tuning	Automatic
Detection principle	Piezoresistive
Scan range	naB73 scanner: 60 µm × 60 µm × 20 µm*
	naB74 scanner: 100 µm × 100 µm × 10 µm
*Background noise	0.01 nm rms in vertical direction
*Lateral accuracy	99.7 % closed loop scanning
*Scan speed	0.01 to 10 Hz
Simultaneous images	Phase, frequency, amplitude, topography
Measurement modes	MFM, EFM, PFM, C-AFM, SThM, Nanolithography

ELECTRONICS	
Resolution amplitude / phase	16-bit
Feedback control platform	Real-time FPGA
Bandwith	8 MHz
Computer interface	USB, ethernet optional
Sensor conditioning	0 to - 4 V programable bridge supply

AFM-TIP POSITIONER	
Motion range (x, y, z)	18 x 18 x 10 mm
Accuracy	< 5 nm
Repeatability	+/- 25 nm

SOFTWARE	
Realtime correction	Line, Plane, Polynomial
Line profile measurement	YES
Roughness measurement	YES
Contrast / brightness	YES
Multiple color palettes	YES
3D image	YES
Line average	YES
Image export	bmp file, png file, jpg file
Raw data export	txt file
Image size	2 to 1024 pixels
Raw data export	For Matlab, Excel, Gwyddion and WSxM

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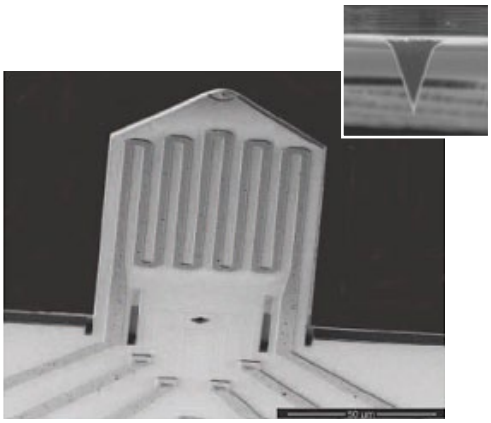
nano analytik GmbH's SmartActiveProbes®

Standard cantilever:
integrated 2DEG readout
and actuation

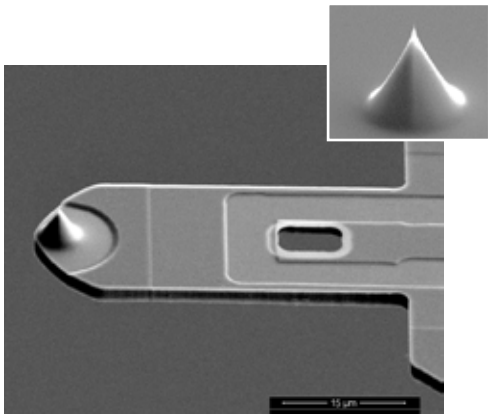
L: 350µm; W: 120µm
T: 4µm ±1
Force constant: 20N/m ±2
f_{Res}: 50kHz ±5



Application:
- Multifrequency operation
- High eigenmode operation
- Contact mode
- Non-contact mode

Fast cantilever:
integrated 2DEG readout
and actuation

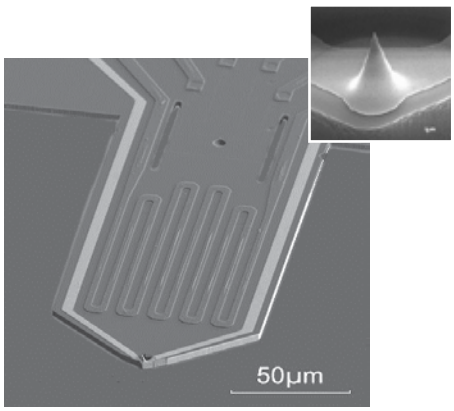
L: 50µm; W: 20µm
T: 2-3µm
Force constant: 100N/m ±5
f_{Res}: 200kHz ±10



Application:
- Multifrequency operation
- High eigenmode operation
- Contact mode
- Non-contact mode

Electric cantilever:
integrated 2DEG readout
and actuation

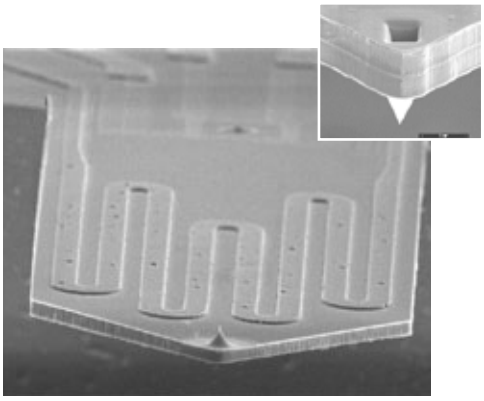
Conductive tip
L: 350µm; W: 120µm
T: 3-5µm
Force constant: 20N/m ±2
f_{Res}: 50kHz ±2.5



Application:
- Multifrequency operation
- High eigenmode operation
- Contact mode
- Non-contact mode
- Kelvin-mode
- Spreading resistance
- Field-Emission mode
  (lithography mode)

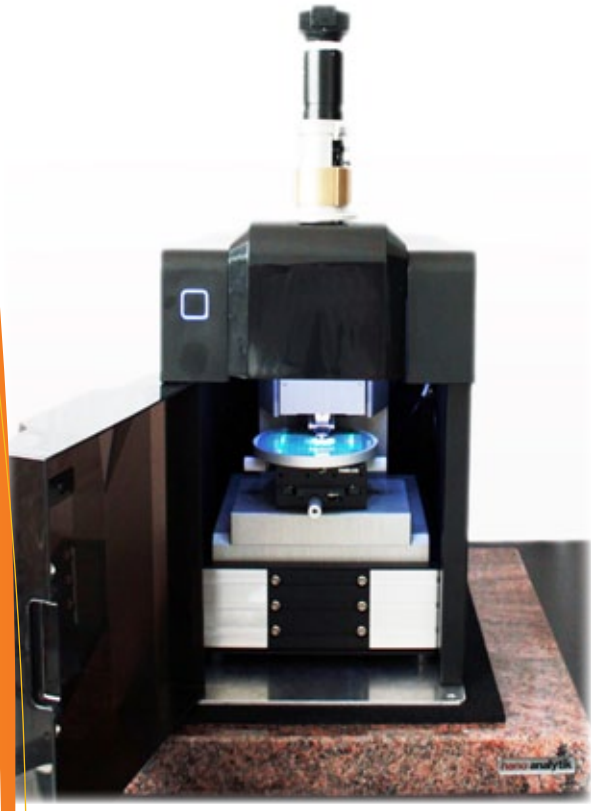
Cantilever as "atomic assembler"
integrated 2DEG readout
and actuation

L: 350µm; W: 120µm
T: 3-5µm
Force constant: 20N/m ±2
f_{Res}: 70kHz ±2.5



Application:
"The heart" of the Toolkit for Silicon- or Diamond-based Quantum Computing

- Single-ion-implantation
- Contact mode
- Non-contact mode
- SNOM



Technology working for you

NANO ANALYTIK GMBH SELF-SENSING AND SELF-

The nano analytik GmbH measurement read-out circuit was proposed in 1993 by Ivo W. Rangelow (Microelectronic Engineering 23, 365-368) where all four resistors are mechanically loaded. This approach provides the highest possible z-sensitivity (atomic resolution) and first-order temperature compensation. nano analytik GmbH employed a full Wheatstone bridge design with two longitudinal and two transverse piezoresistors to increase the read-out sensitivity and compensate

flexible solutions fo
your scanning-probe re

SmartActiveProbes® SOLUTIONS

In comparison to other probe-makers, nano analytik GmbH attempts to achieve full customer satisfaction by tracking a complete technical approach that combines specialized expertise with exceptional service and professional technological support. We provide our customers with extensive technological assistance throughout the complete product development cycle - from design support to prototyping and fabrication support.

Send us your request: info@nanoanalytik.net

INNOVATIVE SCANNING READ-OUT

nano analytik GmbH's SmartActiveProbes® are capable of sensing and detecting forces and displacements on an atomic scale at a high-speed imaging. The SPM-sensor with piezoresistive read-out achieves temperature compensation, allows offset compansation of the Wheatstone bridge and is comparable with the capabilities of conventional optical force measurement instruments.

NEW STANDARDS FOR KNOWN TECHNOLOGY

The piezoresistive effect in p-type 3D Si was carefully investigated in the case of the tensile stress. We discovered that along that direction a fully confined hole wave function conducts the loss of the translation invariance. Today, nano analytik GmbH sensors have about two times higher piezoresistive coefficients in comparison to standard piezoresistors.

ACTUATED SPM/SPL CANTILEVERS

resistance drift due to temperature. When only one resistor in the bridge is mechanically loaded, the stress sensitivity of the sensor is reduced by a factor of four from the 4-wire configuration. nano analytik GmbH introduced for the first time the piezoresistive quantum size effect and developed the most sensitive piezoresistive cantilever readout system.

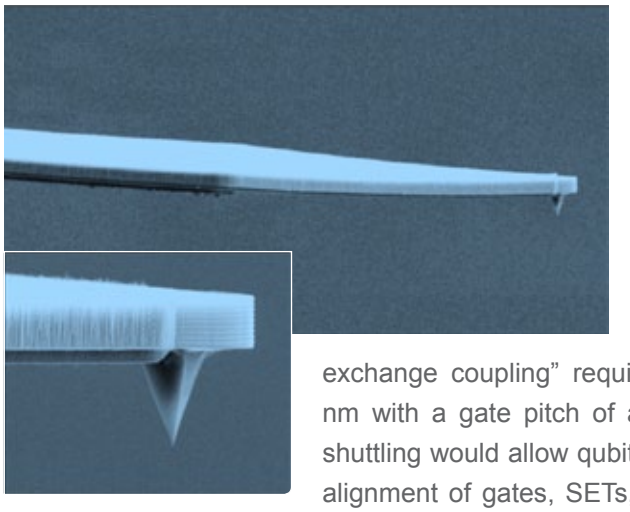
The SmartActiveProbe uses the thermomechanical principle for actuation (see: *Surf. Interface Anal. 33, 59–64 and SPIE. 9424, doi: 10.1117/12.2085760*). These cantilevers could be incorporated into every SPM tool. AFM Integrations for operation in vacuum, liquids and extreme temperatures can be realized for many customer-specific applications.

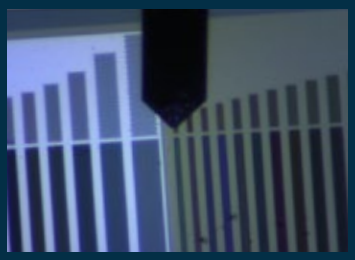
research

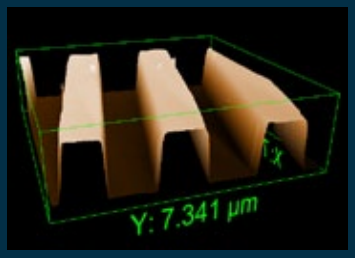
The geometry of an AFM tip plays a crucial role when imaging surfaces. nano analytik GmbH employs a conical shape, which is especially favorable when imaging well-defined features or randomly generated topological structures. The tips are formed in highly doped, single crystal silicon, and offer long operational life in case of Scanning Probe Lithography (SPL) (see: *Journal of Vacuum Science and Technology B34 (6); doi: 10.1116/1.4966556*).

Cantilever as atomic assembler

In comparison to other probe- and AFM- makers, nano analytik GmbH attempts to achieve full customer satisfaction by tracking a complete technical approach that combines specialized expertise with exceptional service and professional technological support. We provide our customers with extensive technological assistance throughout the complete product development cycle - from design to system prototyping and fabrication support. For example, nano analytik GmbH established a method for qubit formation by deterministic single ion implantation. Solid state implementations of quantum computers scaled to hundreds of quantum bits (“Qbits”) promise to revolutionize the information technology. A “direct Qbits exchange coupling” requires a qubit spacing of ~20 nm with a gate pitch of about 7 nm, while electron shuttling would allow qubit spacings of ~100 nm. The alignment of gates, SETs, and single donors represent the task for the formation of single atom devices. nano analytik GmbH has developed an AFM-instrument in which single ions can be aligned to sample qubit-read-out features. It has been shown that the spatial resolution of ion implantation is now approaching the nanometer level.







CUSTOM SOLUTIONS

Research and development areas:

- Intelligent surface scanning
- Multi-Cantilever Concept
- High-Speed cantilever imaging
- Advanced applications in sensor systems
- Next-Generation AFM systems
- Nano-Marking readout systems
- High-Performance AFM image processing
- New sensor technologies
- Ion-positioning technology
- Health & environment
- Biomedical & biomolecular health care solutions
- Tip-Transistor for molecular diagnostics
- Biomedical systems environmental sensors
- Technologies innovation

WEB www.nanoanalytik.net

Research and technology Services

- □ Research services
- □ MEMS prototyping
- □ Security by design
- □ Sensor engineering
- □ Prototypes und demos
- □ Emerging technologies
- □ New sensor technologies
- □ Nanoresonators
- □ Attobalance
- □ Chip design for intelligent AFM sensor
- □ Integration of multisensor AFM systems
- □ Sensor technology
- □ Hardware technology
- □ Software technology and regulation
- □ High speed scanning systeme
- □ Advanced technologies for nanostructuring and nanofabrication
- □ Next generation AFM sensors
- □ Advanced single ion implantation solutions
- □ Research and innovation strategies
- □ Innovation dynamics and Innovation strategies

The nano analytik GmbH's SmartActiveProbes® are extremely user friendly. Manual cantilever exchange is possible in less than 10sec, tip-approach in 5sec (from 2.5mm over the sample) and in 20sec an image is ready for the highest AFM productivity.

The stiff mechanical design ensures very low noise and high stability during all imaging and lithography processes providing sub-nanometer resolution on large scanning extents.

Scanning speed of 100 l/sec, (10 x 10 µm for 50 nm topology height) is established using nano analytik GmbH Controller and Scanner. No more groping with tweezers, no more laser beam adjustments are required. Pre-qualified, pre-aligned, self-actuated, and self-sensing cantilevers are supplied in an easy-to-load box and make them very easy for use.

References:

Six-axis AFM in SEM with self-sensing and self-transduced cantilever for high speed analysis and nanolithography; *Journal of Vakuum Science & Technology B34, 06KB01 (2016); doi: 10.1116/1.4964290 (October 04, 2016) T. Angelov et al.*

Pattern-generation and pattern-transfer for single-digit nano devices; *Journal of Vacuum Science and Technology and Microelectronics 34 (6); doi: 10.1116/1.4966556 (November 03, 2016) I. W. Rangelowet al.*

Large area fast-AFM scanning with active "Quattro" cantilever arrays; *Journal of Vacuum Science & Technology B34, 06KM03 (2016) doi: 10.1116/1.4967159 (November 09, 2016); A. Ahmad et al.*

Advanced electric-field scanning probe lithography on molecular resist using active cantilever; *J. Micro/Nanolith. MEMS MOEMS, 14(3), 031202 (2015) doi:10.1117/1.JMM.14.3.031202; M. Kaestner et al.*

Self-actuated, self-sensing cantilever for fast CD measurement; *Proc. SPIE. 9424, Metrology, Inspection, and Process Control for Microlithography XXIX, 94240P. doi: 10.1117/12.2085760 (March 19, 2015); A. Ahmad*

Scanning probes in nanostructure fabrication; *Journal of Vacuum Science & Technology B 32, 06F101 (2014); doi: 10.1116/1.4897500 M. Kaestner et al.*

Nanolithography by scanning probes on calixarene molecular glass resist using mix-and-match lithography; *J. Micro/Nanolith. MEMS MOEMS Vol. 12(3), 031111-1, (2013) M. Kaestner et al.*

Micromachined AFM sensor with integrated piezoresistive sensor and thermal bimorph actuator for high-speed tapping-mode AFM and phase-imaging in higher eigenmodes; *J. Vav. Sci. Technology, B 21N60, Nov/Dec pp. 3102-3107 (2003),R. Pedrak et al.*

An optimized piezoresistive AFM sensor for three-dimensional surface characterization; *J. Vac. Sci. Technology, A0, (1) pp., (2002) T. Gotszalk et al.*

A Novel High Resolution Scanning Thermal Probe; *J. Vac. Sci. Technology, B19, pp. 2856-2860 (2001) K. Edinger et. al*

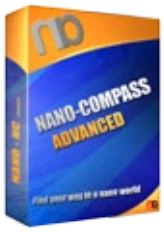
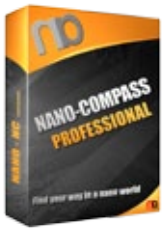
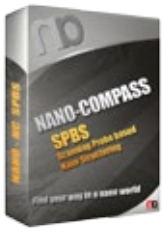
Micromachined piezoresistive cantilever array with integrated resistive microheater for colorimetry and mass detection; *J. Vac. Sci. Technology A,19(6), Nov/Dec, pp. 2884-2888 (2001) N. Abedinov et al.*

Evalution and Fabrication of AFM array for ESA-Midas/Rosetta Space Mission; *Microelectronic Engineering 57-58, pp. 824-883 (2000) W. Barth et al.*

nano analytik GmbH software

Software

All AFM-system parameters e.g. the used hardware, the operation mode, parameter control, display control, video control, speed control of the stage, the timing and the actuation of the SmartActiveProbe are configured and controlled by a simple mouse click. Parameters are controlled and clearly displayed giving the user the possibility to follow the acquiring operation and simultaneously monitor and adjust multiple data signal channels in real-time. The software runs under Microsoft Windows.

VALUE / Version	NANO-COMPASS BASIC	NANO-COMPASS ADVANCED	NANO-COMPASS PROFESSIONAL	NANO-COMPASS SPBS
NANO-COMPASS				
Semi-automatic cantilever set-up	▬	▬	▬	▬
Full-automatic fast surface approach	▬	▬	▬	▬
Non-contact mode support	▬	▬	▬	▬
Export to image formats	▬	▬	▬	▬
2d scan image view	▬	▬	▬	▬
Multi-user support (per-user settings)	▬	▬	▬	▬
Graphical sample navigation	-	▬	▬	▬
3d scan image view	-	▬	▬	▬
Export to raw formats	-	▬	▬	▬
Live signal display (oscilloscope)	-	▬	▬	▬
Selective screen capture	-	-	▬	▬
Multi-monitor support	-	-	▬	▬
Direct camera integration (selected models)	-	-	▬	▬
Scripting language	-	-	▬	▬
Point-and-click tip positioning	-	-	▬	▬
Contact mode support	▭	▭	▬	▬
Adaptive scan speed technology	-	-	▬	▬
2nd level positioning stage integration (selected models)	-	-	-	▬
Basic SPBS support (Scanning Probe Based nano Structuring)	-	-	-	▬
SPBS pattern editor	-	-	-	▬
Parallel scan channels	1	1	2 + n	2 + n
Update support (months)	6	12	24	24
Interface library	-	-	▭	▭
Compatible controllers (probably not all features available)	Attogram, Zelos, nanoMETRONOM, Phoebus, Kronos	Zelos, nanoMETRONOM, Phoebus, Kronos	Phoebus, Kronos	Kronos
Recommended controllers	nanoMETRONOM	nanoMETRONOM	Phoebus	Kronos

▬ standard features ▭ available on request - not available

Controller

nano analytik GmbH controllers

VALUE / MODEL	ATTOGRAM	ZELOS	nanoMETRONOM	PHOEBUS	KRONOS
					
Input channels	125 MHz 2 x 16 bit	80 MHz 1 x 16 bit	80 MHz 1 x 16 bit	125 MHz (2 + N) x 16 bit	125 MHz (2 + N) x 16 bit
Bandwidth (input channels)	500 Hz - 10 MHz	500 Hz - 2 MHz	500 Hz - 6 MHz	0 - 10 MHz	0 - 10 MHz
Excitation sources	2 x 16 bit (250 MS/s)	1 x 16 bit (250 MS/s)	1 x 16 bit (250 MS/s)	(2 + N) x 16 bit (250 MS/s)	(2 + N) x 16 bit (250 MS/s)
Bandwidth (excitation sources)	10 MHz	2 MHz	6 MHz	12 MHz	12 MHz
PLL	▬	-	-	▬	▬
Lock-In amplifier	2	1	1	2 + N	2 + N
Input channel noise	< 10 nV/√Hz	< 12 nV/√Hz	< 10 nV/√Hz	< 8 nV/√Hz	< 8 nV/√Hz
X/Y/Z-axis DAC	-	3 x 18 bit (250 kS/s)	3 x 18 bit (250 kS/s)	3 x 18 bit (250 kS/s)	3 x 18 bit (250 kS/s)
X/Y/Z-axis closed loop-ADC	-	-	3 x 18 bit (250 kS/s)	3 x 18 bit (250 kS/s)	3 x 18 bit (250 kS/s)
Number of PID controllers	-	1	4	5 + N	5 + N
Genearl purpose input channels	-	-	-	-	1 x 12 bit (250 kS/s) BW: 0 - 10 kHz
Genearl purpose output channels	-	-	-	-	2 x 12 bit (500 kS/s) BW: 0 - 40 kHz
Motor drivers	-	Stepper motor	Stepper motor	3 Stepper motors 1 DC/Stepper motors	3 Stepper motors 1 DC/Stepper motors
Front panel indication	-	LCD	-	LED	LED
Digital outputs	-	-	-	Up to 8	Up to 8
PC connection	USB 2.0	USB 2.0	USB 2.0	USB 2.0	USB 2.0
Additional interface	-	-	UART (RS232)	UART (RS232)	UART (RS232)
Peripherial supply	±12V / 500 mA	±12V / 500 mA	±12V / 300 mA	±12V / 800 mA	±12V / 800 mA
Possible applications:					
Scanning Probe Based nano Structuring SPBS	-	-	-	-	▬
Single Ion Implantation	-	-	-	▭	▬
AFM in SEM	-	-	-	▬	▬
Inspection AFM	-	-	▭	▬	▬
Q-Control AFM	-	-	▭	▬	▬
Shear-Force AFM	-	▬	▭	▬	▬
Fast AFM	-	▬	▬	▬	▬
Junior AFM	-	▬	▬	▬	▬
Attobalance	▬	▬	▬	▬	▬

▬ **standard features** ▭ **available on request** **- not available**

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