
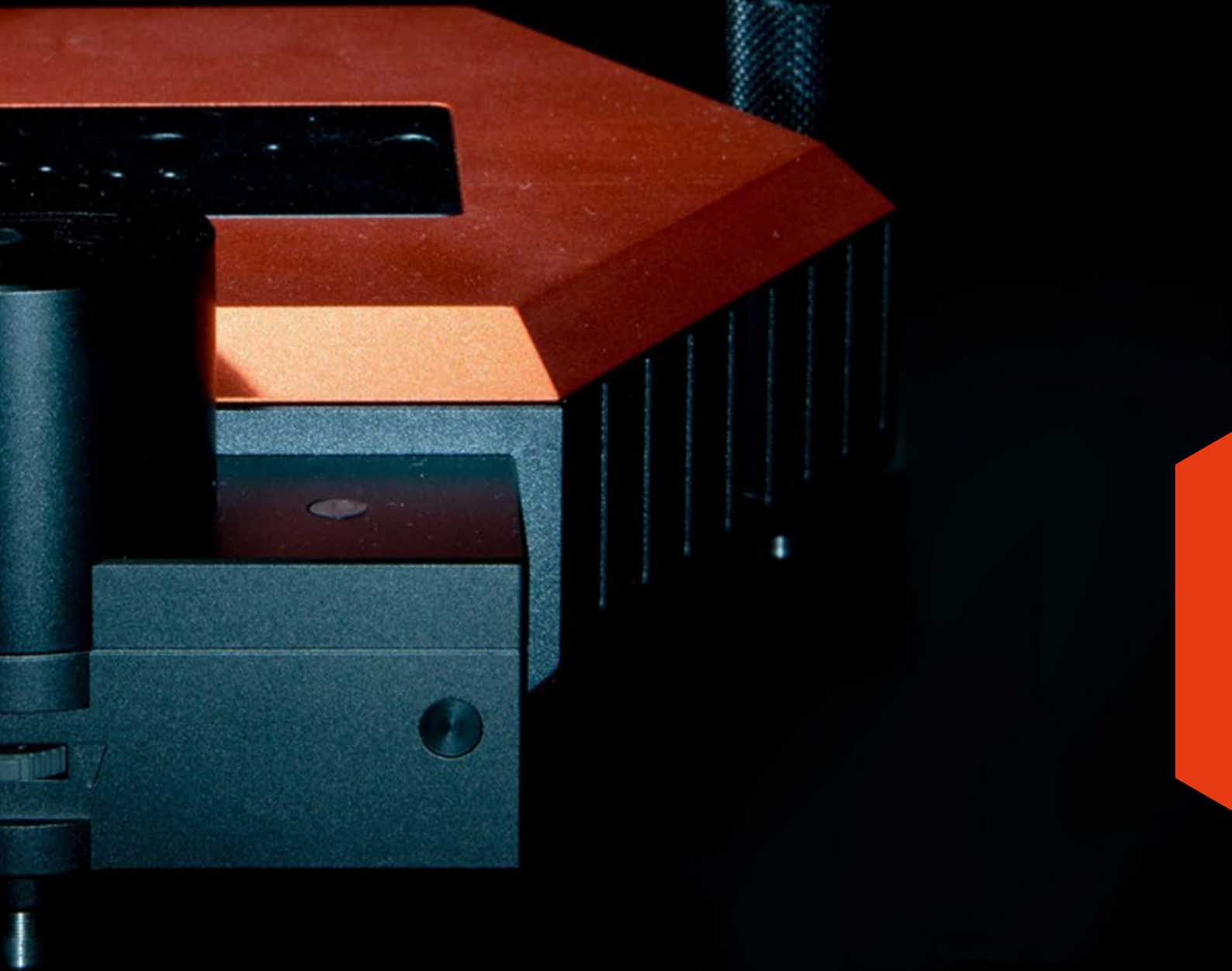
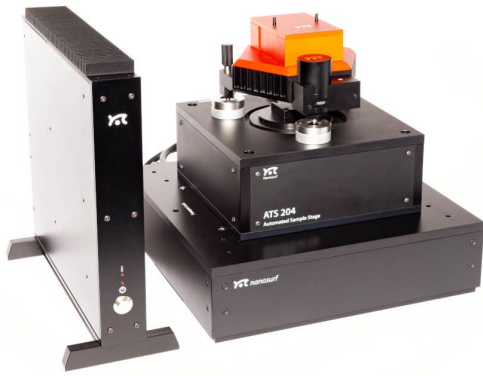


Next-Level Nanotechnology Tools  swiss quality

FlexAFM

The flexible research AFM





FlexAFM system inside the Acoustic Enclosure 300, with FlexAFM video camera, FlexAFM sample stage 204 with XY translation capability, Isostage 300, I100 scan head interface and C3000i controller.

The flexible research AFM system

For success in research, scientists depend on professional tools that can readily provide the information needed, regardless of the tasks at hand. By advancing key technologies and designs, Nanosurf has made the FlexAFM system one of the most versatile and flexible atomic force microscopes ever, allowing a large variety of applications to be handled with ease. Together with the C3000i controller anything is possible.

Key features & benefits

Flat and linear scanning thanks to flexure-based scanner technology

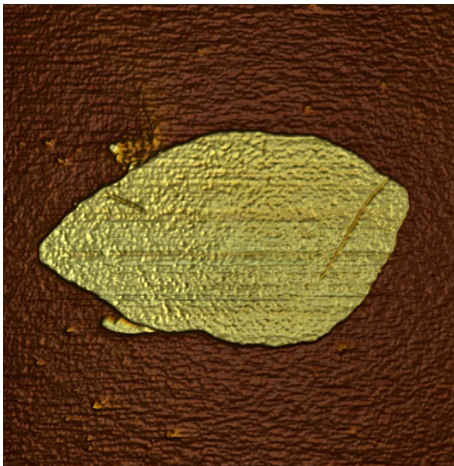
Measurement versatility with the FlexAFM's scanning capabilities in liquid and a multitude of measurement modes

Flexible stage concept allows to extend your system to meet different requirements.

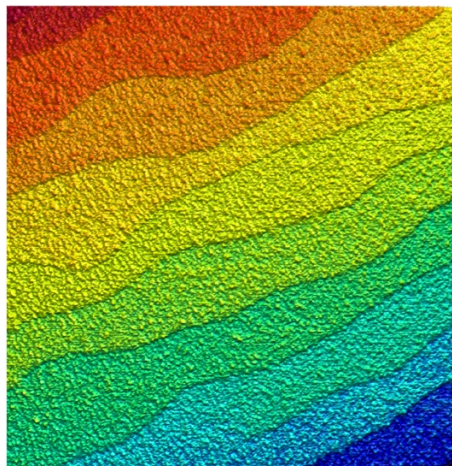
True flexibility with exchangeable cantilever holders that have been optimized for specialized tasks to support all kinds of different applications

For success in materials science...

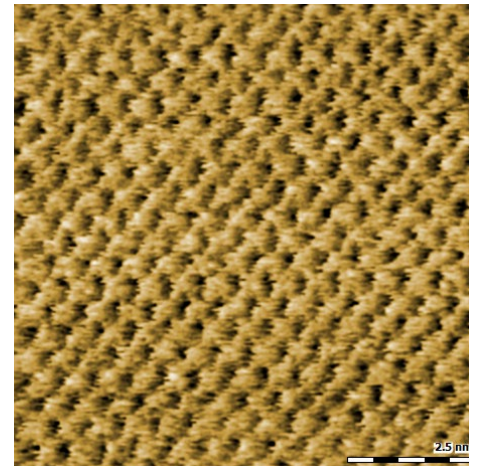
Nanosurf offers different stages designed for specific experimental needs. Every stand-alone stage can be securely attached to the active vibration isolation table. The range begins with simple stages that can be optionally extended with an XY micrometer stage or height extensions to allow thicker samples. For automated movement of the sample in X, Y, and Z, the ATS 204 is available. Many accessories and options are available that seamlessly expand your FlexAFM system's capabilities to cover a virtually infinite number of applications.



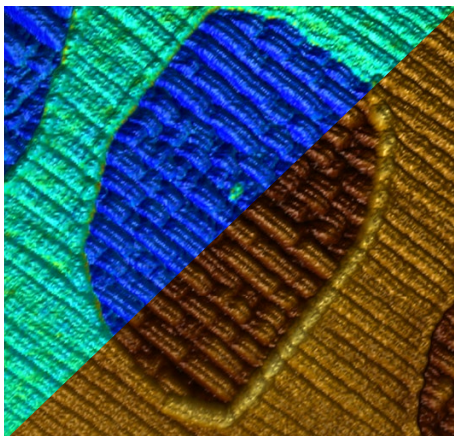
Topography of single pyrene nanosheet (adapted with permission from Chem. Mater. 27, 1426–31. Copyright 2015 American Chemical Society)



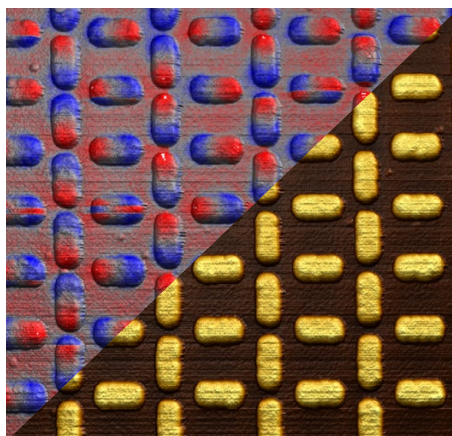
Topography of SrTiO₃ in dynamic mode. Scan size: 1 µm



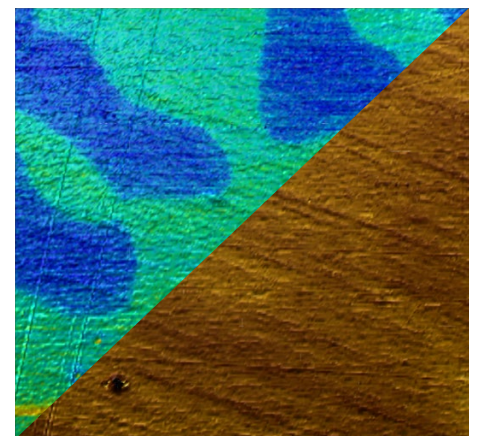
Atomic grid on mica measured with lateral force microscopy



Quality control of CVD-grown graphene flakes on post-oxidized copper measured by friction (data courtesy: Newtec engineering A/S)



MFM and topography on artificial spin ice (data courtesy: Prof. S. Ferreira)



KPFM and topography recorded in a single run

...as well as life science research

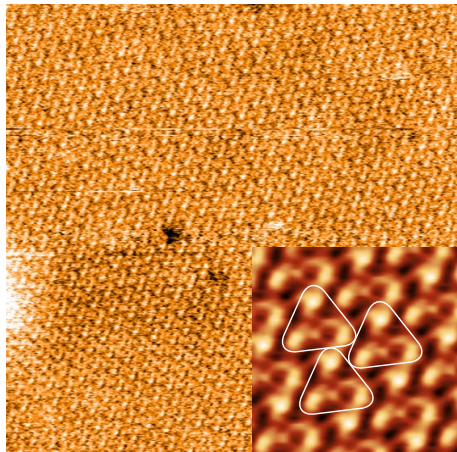
With the inverted microscope option the NIR FlexAFM version integrates well with many types of microscopes, allowing easy handling of biological experiments, and even the combination of AFM and optical data (fluorescence/phase contrast/bright field).



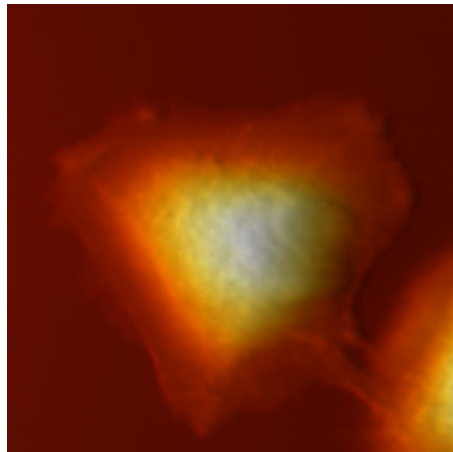
The FlexAFM is fully compatible with **FluidFM**[®], allowing experiments involving micro-manipulation of single cells and other small objects, surfaces and tissues.



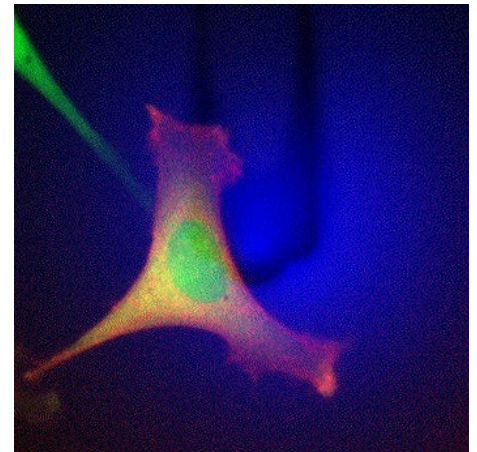
FlexAFM is also compatible with the **ANA package** for nanomechanical tissue diagnostics and soft material analysis. It gives you the tools for fully automated measurements on rough and non-even surfaces, and you can perform quantitative analyses of tissues and soft materials alike.



Unfiltered overview image of BR from *Halobacterium salinarium* with linear background correction. Scan size: 140 nm. Inset: Correlation average, with 3 trimers highlighted in white.



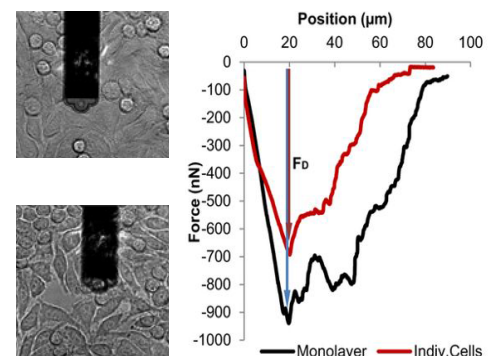
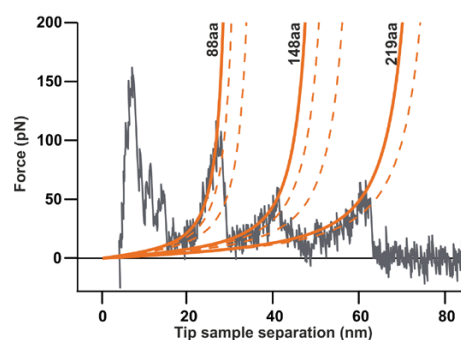
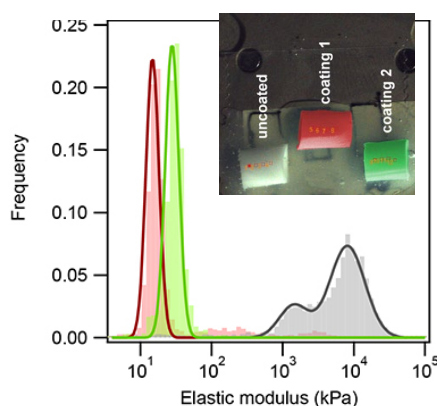
HeLa cell. Image width: 80 μm
Z-height: 10,26 μm



Top view of cell on inverted microscope
Image courtesy: O. Guillaume-Gentil, ETH Zürich, Switzerland

A powerful tool for force spectroscopy

FluidFM and ANA are just two examples that show the FlexAFM's capabilities that go beyond imaging. As can be expected for a research AFM, more conventional spectroscopy and lithography functionalities are a routine task for the FlexAFM, whether it is to record force curves, perform voltage spectroscopy, or modify a sample by force or oxidative reaction. For force curve analysis the ANA offline software, including histogram creation, is freely available.



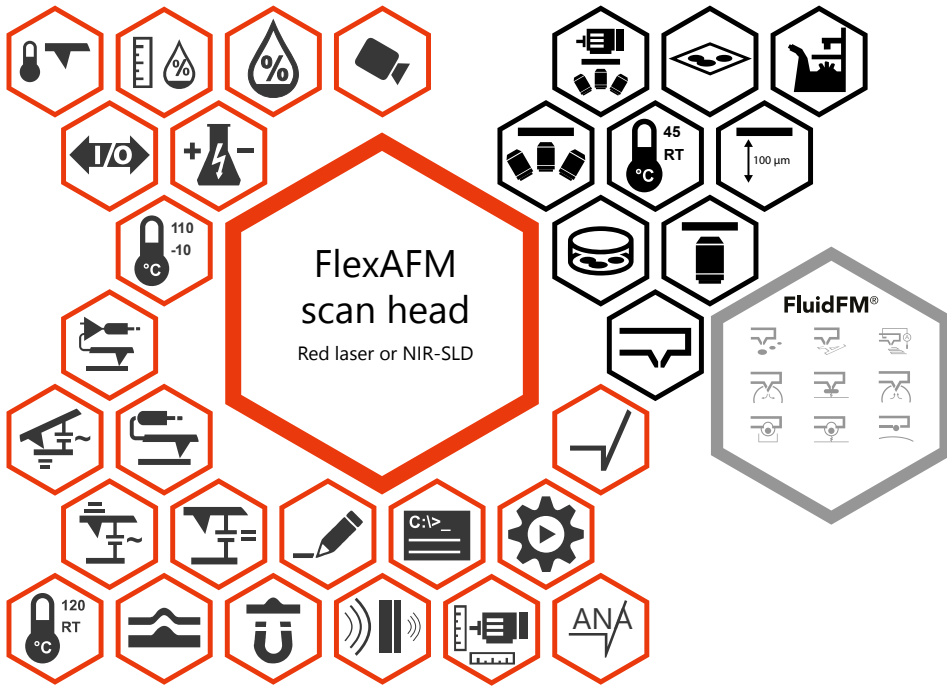
Left: ANA was used to investigate the mechanical properties of three different medical tubings in a single run. The inset shows the three pieces of tubing overlaid with the locations at which the system will automatically perform the mechanical testing experiments. The histogram shows the pooled results of at least three different areas probed on each tubing.

Middle: Single molecule force spectroscopy of bacteriorhodopsin (BR) reports the controlled C-terminal unfolding of a single membrane protein from its native environment. Solid and dashed orange lines represent the worm-like chain curves corresponding to the major and minor unfolding peaks observed upon unfolding BR, respectively.

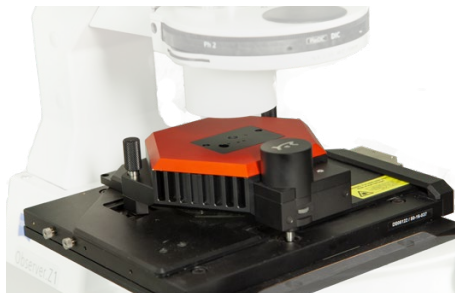
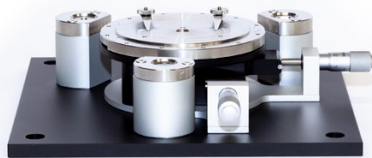
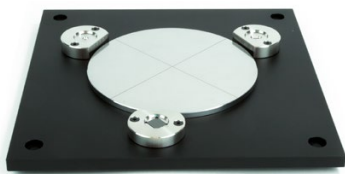
Right: Single cell adhesion studies on human endothelial cells from the umbilical artery reveal strong intercellular forces. **Left:** Confluent layer of cells, where one is pulled out by FluidFM. **Right:** Typical single cell force curves of individual cells or cells in a confluent layer, depicting the increase in adhesion force by cell-cell interactions [Scientific Reports 7, 46152].

Functionality overview

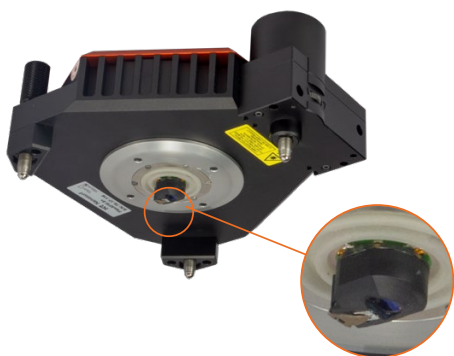
The standard FlexAFM system can be modified to best suit different requirements.



By adding different accessories, the FlexAFM scan head can be enhanced to fulfil your requirements. The modular concept allows you to quickly and easily change your system's setup to perform virtually any kind of AFM measurement.



Different stage solutions allow the FlexAFM to be adapted to perfectly match your requirements

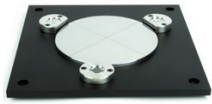


The cantilever holder

As central part of the AFM detection system, the standard cantilever holder contains alignment structures for exact cantilever positioning and all optics related to Nanosurf's top and side view technology. It is magnetically attached to the scanner unit to allow quick removal from the scan head for easy cleaning and fast cantilever exchange. Multiple cantilever holder models are currently available, each optimized for its own specific task.

- Sample Heating
- Electrochemistry
- Signal I/O
- Scanning Thermal Microscopy
- Environmental Control
- Top & Side-View Camera
- Relative Humidity
- Inverted Microscope Stage
- Motorized Inverted Microscope Stage
- Petri Dish
- Petri Dish Heating
- 100 µm Z-Stage
- Digital Inverted Microscope
- Coverslip Holder
- Advanced Optics
- Cantilever Holder FluidFM®
- Spotting
- Nanolithography
- SICM
- Single Cell Injection
- Single Bacteria Adhesion
- Single Cell Extraction
- Single Cell Isolation
- Single Cell Adhesion
- Colloidal Spectroscopy
- Advanced Spectroscopy
- ANA Add-On
- Automation
- Motorized Translation Stage
- Scripting Interface
- Acoustic Enclosure 150
- Variable Magnetic Field Sample Holder
- Advanced Lithography
- Contour Following Mode
- Heater/Cooler
- Conductive AFM
- Advanced Conductive AFM
- PFM Mode
- EFM Mode
- KPFM Mode

Accessories and upgrades



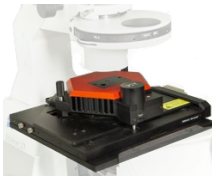
Sample stage 204

Simple stage with sample holder, fits on Isostage 300



Motorized translation stage 204

Motorized xyz sample positioning with 32 mm x 32 mm x 5 mm xyz range
Automated measurements using stage control, scripting and batch manager



Sample stage for inverted microscopes

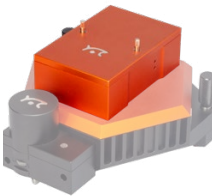
Available for Zeiss, Nikon, Olympus, Leica

Parallel AFM and optical image axes



Cantilever holders

With / without alignment grooves for topography in air and liquid, for electrical measurements, for FluidFM® and for SThM



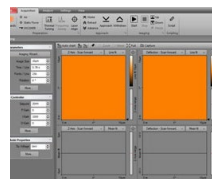
FlexAFM video camera

Simultaneous top and side view:
5 MP, 1.5 x 1.1 mm, color top view and 5 MP, 3.2 x 3.2 mm, color side view of sample and cantilever



Signal I/O module

Adds BNC-based additional user input and output channels, digital synchronization and gives access to many other signals like photodetector signals and FPGA internal signals.



SW options

Options for advanced imaging, advanced lithography, advanced modes, advanced spectroscopy, cantilever calibration, KPFM, PFM, scripting interface, stage control



Micrometer translation stage (on sample stage 204)

Manual sample positioning with 13 mm x 13 mm xy range, 10 µm positioning accuracy



Height extension for FlexAFM sample stage

For measuring samples from 0 to 12 mm thickness



Electrochemistry sample holder

For in situ surface characterization under potentiostatic or galvanostatic control



Environmental control option

Perform sample measurements under controlled, dry and/or inert gas atmospheres



Isostage 300

Active vibration isolation

Spike-Guard: detects anomalies and automatically rescans the line



Acoustic Enclosure 350

For use with FlexAFM systems with or without Isostage active vibration isolation table



Acoustic Enclosure 1100

For use with FlexAFM systems on an inverted optical microscope. Temperature control is optionally available.

For more information on accessories and expanding functionality, please see the Accessories brochure.

Controller

The versatility and performance of the FlexAFM scan head is brought to its full potential by its controller. The Nanosurf C3000i Controller features fully digital internal data processing, 24-bit ADC/DAC conversion depth, and programmable FPGA CPU. It allows dynamic filtering and analysis, and real-time signal monitoring directly from within the control software.

Through soft- and firmware updates, the controller can be upgraded to support new options and features at any time!

Main features

All digital data processing in FPGA

24-bit DACs for accurate scanning with widely varying scan ranges

24-bit ADCs and adaptive filters for high-resolution and low-noise data

Fast and sensitive digital Z-feedback and spectroscopy

Fully equipped with integrated thermal tuning, data monitoring, user I/O and signal access, advanced operating modes



Standard functionality

Standard imaging modes	Static force, dynamic force, phase contrast, MFM, friction force, force modulation, spreading resistance
Imaging functions	Up to 8000×8000 data points with 24-bit zoom in 8 acquisition channels with dynamic digital filters X/Y sample slope correction
Standard spectroscopy modes	Force–distance, amplitude–distance, phase–distance Tip current–tip voltage
Spectroscopy functions	Setup wizard for each spectroscopy mode XY-position table: point, line, and grid (max. 64 positions) 3 distinct spectroscopy phases
Standard lithography modes	Free vector objects drawing or real-time drawing by mouse Tip lift or force control during movement from point to point
Sample approach	Fast home, retract, and advance movement Automatic approach with definable final end position Continuous or step-by-step approach mode

C3000i controller — hardware specifications

X/Y/Z-axis scan and position controller	3× 24-bit DAC (200 kHz)
X/Y/Z-axis position measurement	1× 24-bit ADC (200 kHz)
Excitation & modulation outputs	2× 16-bit DAC (20 MHz)
Analog signal input bandwidth	0–5 MHz
Main input signal capturing	2× 16-bit ADC (20 MHz) 2× 24-bit ADC (200 kHz)
Additional user signal inputs	1× 24-bit ADC (200 kHz)
Digital synchronization	Sync Out 1/2: digital outputs, signal range 0/5V TTL pulses
FPGA module and embedded processor	ALTERA FPGA, 32-bit NIOS-CPU, 80 MHz, 256 MB RAM, multitasking OS
Communication	USB 2.0 hi-speed to PC
System clock	Internal quartz (10 MHz) or external clock
Power	90–240 V AC, 70 W, 50/60Hz



Scan head specifications

FlexAFM 5 scan head features

General design	Tripod stand-alone scan head with tip scanner; Flexure-based electro-magnetically actuated XY-scanner with superb linearity; Piezo-based Z-actuator; Optical Z-position sensor; Closed loop Z-control
Laser / detector	High-speed, low-noise 4-quadrant photodiode detector; Choice between red laser and near-infrared SLD; Laser on/off through software and scan head tilting; Optical filters for use with optical microscope phase contrast and fluorescence
Approach	Approach with continuous DC-motor; Up/down arrows on scan head for manual approach; Software-driven automated final approach
Cantilever holder	Automatic self-alignment for cantilevers with alignment grooves. Manual laser adjustment possible for special cantilevers.
Sample observation	Top and side view in air and liquid; White LEDs (brightness 0–100%); Axial illumination for top view
Operating modes	Static Force, Lateral Force, Dynamic Force, Phase Contrast, MFM, EFM, KPFM, Piezo Force, Force Modulation, Scanning Thermal, Spreading Resistance, Multiple Spectroscopy modes, Lithography and Manipulation modes. Some modes may require additional hardware and/or activating of the respective C3000i controller options.

FlexAFM 5 scan head with C3000i controller

Scan head type	100- μm	10- μm
Sample size	Unlimited w/o sample stage 100 mm on sample stage	
Maximum Petri dish height (fluid level)	9 mm (6 mm)	
Manual height adjustment range	6 mm	
Motorized approach range (at tip position)	2 mm	
Maximum scan range	100 μm ⁽¹⁾	10 μm ⁽¹⁾
Maximum Z-range	10 μm ⁽²⁾	3 μm ⁽¹⁾
XY-linearity mean error	< 0.1%	
XY-flatness at maximum scan range	typ. 5 nm	typ. 1 nm
Detector bandwidth	DC – 4 MHz	
Detector noise level	typ. 60 pm / max. 100 pm (3,4)	
Z-sensor noise level (RMS)	typ. 180 pm / max. 200 pm ⁽³⁾	
Z-measurement noise level (RMS, static mode in air)	typ. 100 pm / max. 200 pm	
Z-measurement noise level (RMS, dynamic mode in air)	typ. 35 pm / max. 50 pm	
Scan head dimensions	143 × 158 × 53 mm	
Scan head weight	1.25 kg	

(1) Manufacturing tolerances \pm 5%

(2) Manufacturing tolerances \pm 10%

(3) Measured at 2 kHz

(4) Measured with XYContr cantilever

Software options

Stage control option

Drivers	Direct control for all supported stage controllers
Manual move	Via buttons in the C3000i control software
Batch Manager	Automated movement via position list and scripts

Cantilever calibration option

Spring constant calibration	Free resonance detection via thermal tuning Q-Factor calculation Spring constant calculation by Sader method FFT spectrum analyzer, many windowing modes, averaging
Deflection sensitivity calibration	Wizard for deflection sensitivity calculation from force–distance measurements Automatic mode or user-defined parameters

Advanced spectroscopy option

Additional spectroscopy functions	Additional “Stop by input value reached” modulation mode Automatic cantilever drift recalibration Unlimited number of spectroscopy data points 5 distinct spectroscopy phases
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Advanced lithography option

Additional lithography modes	Vector-based lithography with objects on layers with different lithography parameters Bitmap-based lithography Nano printing
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Scripting interface option

Internal scripting	Visual Basic script editor Ribbon drop-down menu to access user scripts
COM-API	Control of measurement process and data analysis
Compatibility	All applications that support the Microsoft COM Automation standard: Python, C++, LabVIEW, C#, and more.

Advanced modes option

Additional operating modes	Enables advanced measurement modes via an additional digital 2-channel Lock-In. Measure amplitude and phase of an additional signal from many inputs. (e.g higher harmonics, higher resonances, torsional cantilever oscillations, tip voltage modulation, etc.) during imaging and spectroscopy
Secondary lock-in amplifier	Frequency range: 1 kHz–5 MHz Demodulation bandwidth: 11 Hz–23 kHz Amplitude resolution: 20 bit; Phase range: $\pm 180^\circ$ Reference phase shift: 0–360° (digital) Excitation: tip voltage, 2× user output

KPFM work package

Extends the advanced modes option with the Kelvin probe force microscopy (KPFM) mode. In addition to the Lock-In, it provides a tip voltage feedback controller through a special user interface. In addition to the standard signals, contact potential can be measured during imaging and spectroscopy.

PFM work package

Extends the advanced modes option with the Piezoresponse force microscopy (PFM) mode through a special user interface. In addition to the standard signals, amplitude and phase of the piezo response signal can be measured during imaging and spectroscopy

Advanced dual pass option

Unlocks the contour-following mode and advanced AFM parameter settings for the second scan pass

FluidFM pressure control option

Unlocks nanofluidic pressure control for FluidFM integration.



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