

Now with  
PeakForce Tapping



# NANOWizard<sup>®</sup> 4 XP

NANOSCIENCE AFM

Extreme performance high-resolution quantitative imaging  
Fast scanning option with up to 150 lines/sec  
Comprehensive solutions for mechanical and electrical measurements  
Flexible, modular system and widest range of accessories  
Optimized productivity through workflow-based software

**JPK**  
BIOAFM

# NANOWizard<sup>®</sup> 4 XP NANOSCIENCE AFM

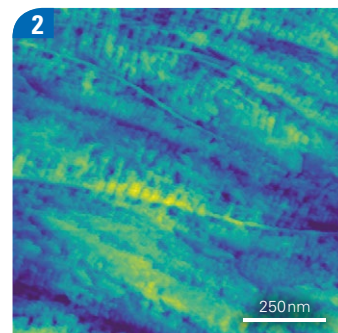
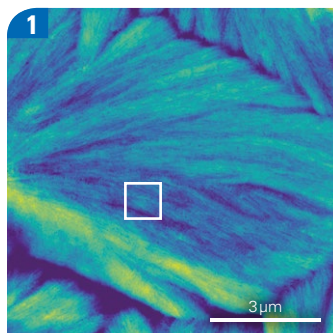
## Extreme Performance meets utmost flexibility

### HIGH RESOLUTION, FAST SCANNING AND CONVENIENCE IN ONE SYSTEM

The new **NanoWizard<sup>®</sup> 4 XP NanoScience AFM** delivers closed-loop atomic resolution and a 100  $\mu\text{m}$  scanner in one system. The large scanner enables flexible movement around the sample and direct access to interesting features. Precision mechanical engineering and state of the art electronics provide unequalled stability and the lowest noise levels available on the market today, delivering unparalleled performance and reliable high-resolution imaging. The new **Vortis<sup>™</sup> 2** controller, with the latest FPGA technology, enables fast signal handling and control. The optional fast scanning package allows scanning capabilities of up to 150 lines/sec.

### PEAKFORCE TAPPING – HOW IMAGING SHOULD BE

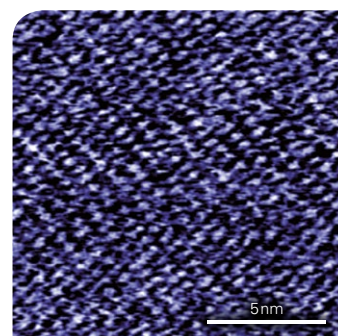
**PeakForce Tapping<sup>®</sup>** has rightly earned its reputation as the one imaging mode for all your needs. It provides superior force control and an uncomplicated setup, no matter what the sample or environment. No expert knowledge or cantilever tuning is necessary. It enables precise control of probe-to-sample interactions and minimizes imaging forces, thereby protecting your tip and ensuring consistent, long-term, high-resolution imaging.



PeakForce Tapping images of Isotactic Polypropylene (IPP) dropcast as a thin film.  
**1** Topography overview image with inset region marked. Height range: 50 nm.  
**2** Topography zoom into marked region. Height range: 25 nm.

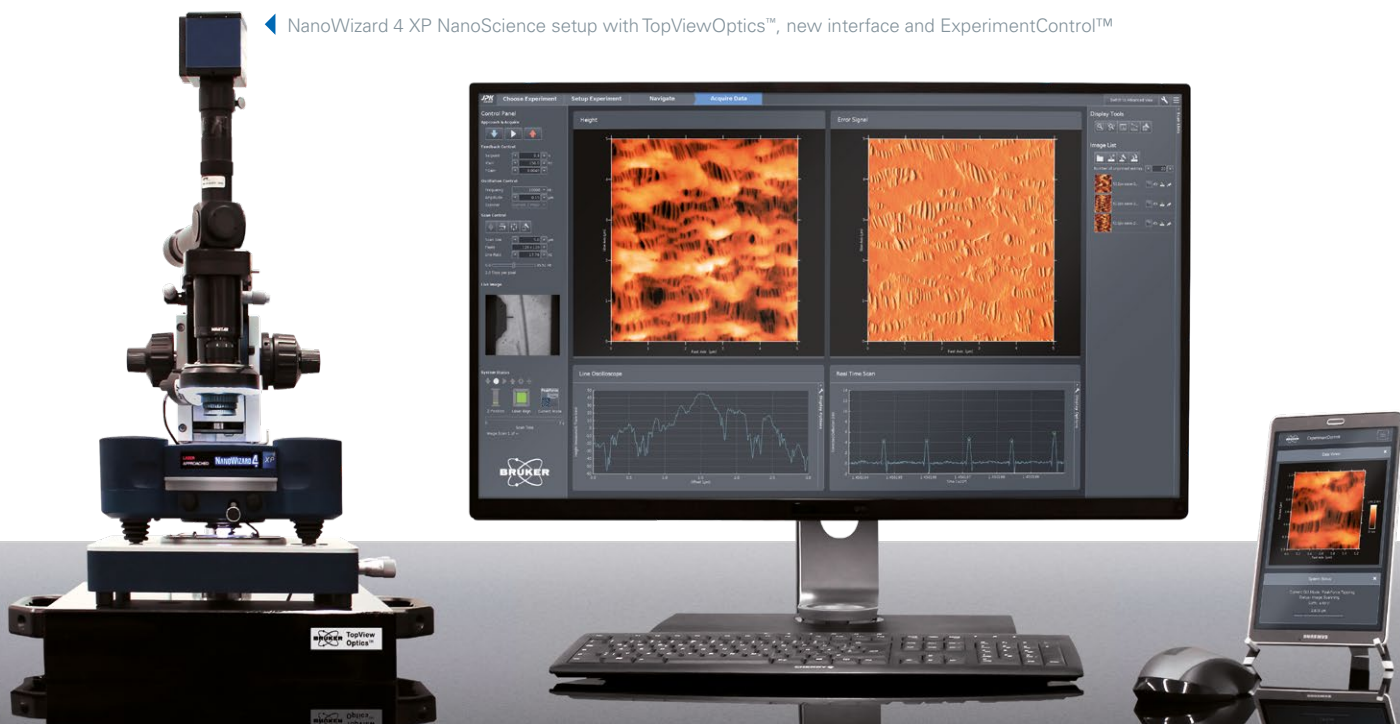
### EASE OF USE: THE FAST ROUTE TO HIGH-QUALITY DATA

JPK's state of the art **software V7** interface enables an optimized workflow, aiding and accelerating scientific output. The straightforward set-up lets non-experts get started quickly, gain reliable and reproducible results, and save valuable time. Its flexible concept allows more experienced users direct access to expert features and advanced feedback modes, while also benefitting from single-click calibration and a streamlined setup for increased productivity.



Atomic lattice resolution on calcite, measured with XY closed loop on an inverted optical microscope in liquid.

◀ NanoWizard 4 XP NanoScience setup with TopViewOptics<sup>™</sup>, new interface and ExperimentControl<sup>™</sup>





# Fast scanning capabilities for increased productivity

## THE BENCHMARK FOR FAST SCANNING WITH A LARGE SCANNER

The proven JPK Fast Scanning technology is now available for the **NanoWizard 4 XP NanoScience** platform. With an imaging speed of 150 lines/sec and a large scan range, the system provides unparalleled performance. It delivers the highest bandwidth for all components, accurate force control and fast feedback.

The earlier limitation that fast scanning was only possible with a restricted scan range has been eliminated. Now, unequalled speed is possible without limiting either access to the sample in XY or access to large topographic height differences in Z. The full 100  $\mu\text{m}$  lateral range remains available for the fastest measurements, and the user can effortlessly switch between sample features without relocating the sample or sacrificing imaging speed.

With the new **NestedScanner™** technology, fast imaging of highly structured sample surfaces with heights of up to 16.5  $\mu\text{m}$  is now possible. Researchers can perform dynamic experiments on highly corrugated samples or steep surface structures with highest spatial and temporal resolution.

## DYNAMICS AND THROUGHPUT – A WORLD OF ADVANTAGES

The fast scanning capabilities deliver the speed and accuracy necessary to understand phenomena such as crystallization, growth, melting, phase separation, domain building, or island formation in real time with highest spatial resolution.

JPK's unique tip-scanner design allows the simultaneous use of a wide range of **NanoWizard** environmental control accessories, which can heat or cool samples, allow gas or fluid exchange or apply external mechanical forces.

## SPRINT THROUGH EXTENDED MEASUREMENTS

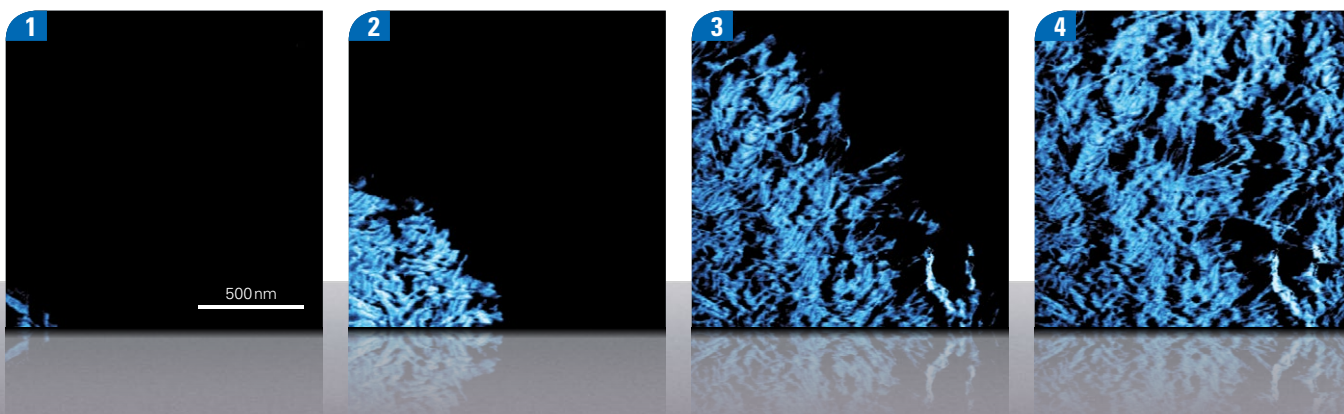
The fast scanning option combined with the **ExperimentPlanner™** software module allow the user to automatically move around a sample from one region of interest to the next using the fully integrated motorized stage to quickly probe more locations and greatly improve productivity.

The movie creator makes data processing easier than ever before.

### BENEFITS OF FAST SCANNING OPTION

- **Enhanced productivity:**  
Capture quick surveys and sample more regions faster
- **Access to high structures or corrugated surfaces with the **NestedScanner** technology**
- **Real-time observation of sample dynamics**
- **Time-lapse studies on, e.g., polymers, thin films or advanced materials**

1-4 Phase images showing dynamic growth front of a poly-hydroxybutyrate-co-valerate (PHB/V) spherulite crystallization. Line rate: 150 lines/sec.



# Comprehensive material property analysis – mechanical, electrical, thermal

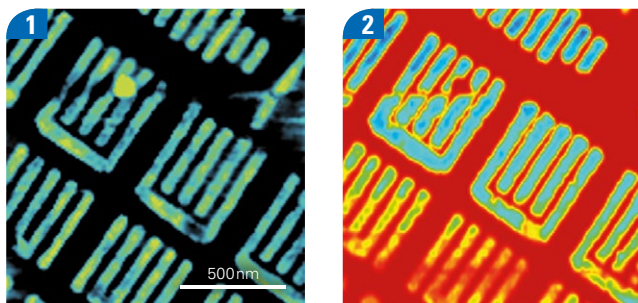
## CHARACTERIZE SAMPLES WITH A FULL RANGE OF ELECTRICAL METHODS

The **NanoWizard 4 XP NanoScience AFM** is supported by a comprehensive range of modes and accessories, each designed for easy handling and to meet the individual needs of researchers.

Many experiments investigating material properties, including electrical properties, benefit from working in an enclosed cell to measure under a controlled inert gas atmosphere.

### CONDUCTIVE AFM (CAFM)

- Current measurement options 0.1 pA to 10  $\mu$ A
- Noise limit 100 fA RMS in imaging bandwidth for low current range
- Compatible with QI™ Advanced option for fragile or challenging samples
- Compatible with inverted opt. microscope for photo-conductive AFM
- Available as enclosed volume option
- Available as tunneling current (TC-CAFM) option for samples with low conductivity

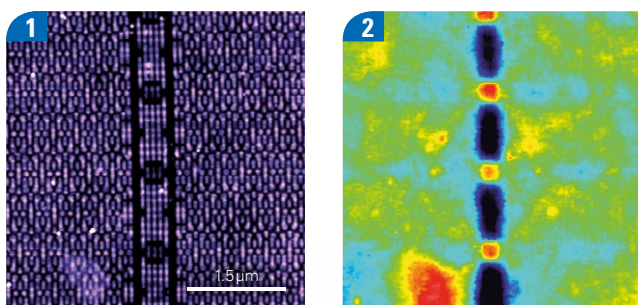


Conductive Atomic Force Microscopy (CAFM-QI) on higher metal layer (core i5 processor, Intel).

- 1 Height image (range: 10 nm)
- 2 Current image (range: 15 nA)

### KELVIN PROBE AFM (KPM AFM)

- Electrical surface potential measurements
- Available as enclosed volume option



Kelvin Probe Microscopy (KPM, one-pass) on SRAM (Core i5 processor, Intel).

- 1 Height image (range: 10 nm).
- 2 Surface potential (range: 50 mV).

## ELECTROCHEMISTRY AND SCANNING

### ELECTROCHEMISTRY (SECM)

- 3- or 4-electrode cell, including miniature reference electrode
- Suitable for conductive films or substrates, transparent or non-transparent samples
- Temperature control and perfusion
- Compatible with common potentiostats

### SCANNING TUNNELING MICROSCOPY (STM)

- Surface electronic state measurements using a tunneling current between tip and sample
- Noise limit of 100 fA RMS in imaging bandwidth

### SCANNING THERMAL AFM WITH QI ADVANCED MODE

- Probes thermal properties of the sample with highest resolution
- Uses nanofabricated thermal probes to achieve unprecedented high spatial and thermal resolution and sensitivity

### PIEZORESPONSE FORCE MICROSCOPY (PFM)

- Piezoelectric response measurements on the sample
- High-voltage amplifier option



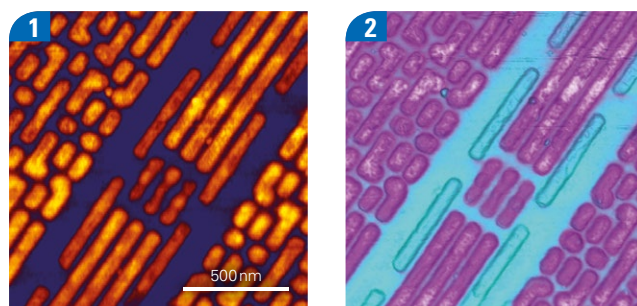
Piezoresponse Force Microscopy (PFM) of a ferroelectric polymer (P(VDF-TrFE)).

A sequence of voltage pulses (+/- 20 V range) was generated from a bitmap to write the pattern into the piezoelectric polarization of the sample.

Vertical PFM-phase image (range: 180°).

### ELECTRICAL FORCE MICROSCOPY (EFM)

- Electrical force gradient measurements between tip and sample
- Compatible with enclosed volume electrical module



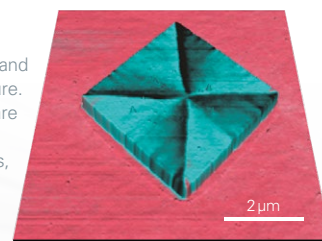
Electrostatic force microscopy (EFM, one-pass) on SRAM (Core i5 processor, Intel). 1 Height image (range: 10 nm). 2 Overlay of electrostatic force signal (color texture range: 30 mV) and 3D topography.

### MAGNETIC FORCE AFM (MFM)

Local magnetic force gradient measurements between magnetic tip and sample

Overlay of magnetic force information and 3D height image on NiFe square structure. Magnetic domains and Landau pattern are clearly visible.

Sample courtesy: Dr. Katrin Schultheiss, Institute of Ion beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Germany





# Follow your features – sample property analysis at your fingertips

## THE NEW STANDARD IN USABILITY ASSURES QUALITY AND EFFICIENCY

The new **V7 software** provides an intuitive workflow for experiments. Easy selection of predefined and recent experiments, as well as one-click probe calibration, lead to quick navigation and data acquisition. On-screen, context-sensitive help, and status feedback on alignment and set-up make it simple to generate valuable data and get an instant overview of vital information.

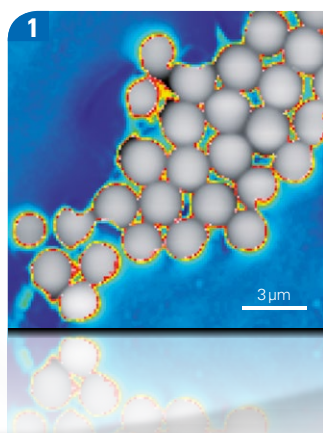


## SMART AUTOMATION SPEEDS UP SUCCESS

The fastest and easiest way to navigate is to see where you want to go. **DirectOverlay™ 2** provides instant navigation, with direct selection of measurement positions anywhere within the scanner range. The **Motorized Precision Stage** and **HybridStage™** free experiments of the lateral constraints of the AFM piezo range, and allow direct motorized movement to selected positions. The new **DirectTiling** feature automatically creates a large optical overview to accelerate this process. **Multiscan** enables tiling of high-resolution images to build up a comprehensive overview of the sample. Repetitive or complicated measurement sequences can be automated using **ExperimentPlanner** macros.

## POWERFUL QUANTITATIVE MECHANICAL PROPERTIES WITH QI AND FORCE MAPPING

QI Advanced mode, using a linear force curve movement, effortlessly generates highest resolution topographic, mechanical and electrical data quickly. Each pixel contains all the data necessary for a complete quantitative analysis of elasticity, adhesion, dissipation, chemical forces, or conductivity. Powerful batch-processing, comprehensive fitting routines, and modulus fitting with multiple models deliver unsurpassed performance. Fast force mapping and single molecule or single cell force spectroscopy modes are also available with the **NanoWizard 4 XP**.

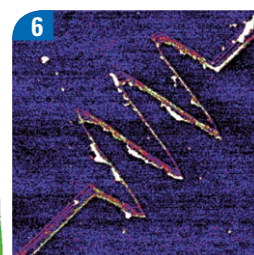
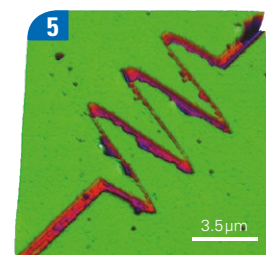
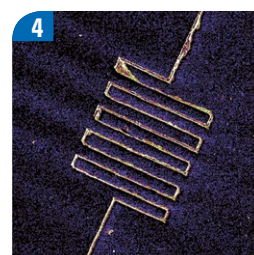
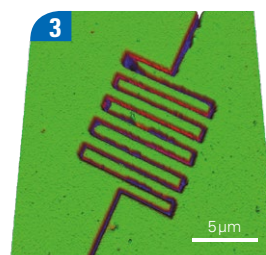
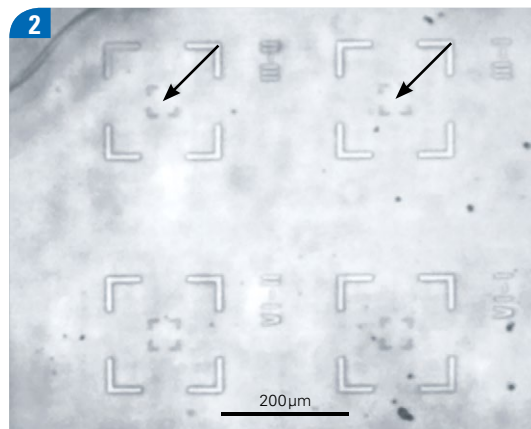


**1** Microrheology on silica beads ( $d=2\mu\text{m}$ ) partially embedded into PDMS: Overlay of topography (gray-scale) and loss modulus  $G''$  (color texture) recorded at a modulation frequency of 100 Hz.

PDMS stamped surface pattern, sample courtesy of Dr. Claudio Canale, University of Genoa, Italy. **2** Optical image of reference pattern from TopViewOptics™, a region of  $835\mu\text{m} \times 670\mu\text{m}$  is shown. Four square regions are marked with a concentric corner pattern, the inner corners form a 50 micron square with test patterns printed in the center, but not visible in the optics. Imported into the SPM software with DirectOverlay, such images allow single-click navigation between reference positions separated by many times the piezo range. QI Advanced images of two such reference patterns (see arrows), topography and adhesion images. **3** 3D topography image. Height range 270 nm. **4** Adhesion image. Range 3-5 nN. **5** 3D topography image. Height range 280 nm. **6** Adhesion image. Range 3-5 nN.

## FULL SET OF NANOMECHANICS MODES

- QI Advanced with Contact Point Imaging (CPI)
- RampDesigner™ for single molecule force spectroscopy with ramp & clamp
- Fast force mapping
- MicroRheology
- Friction force microscopy
- Contact resonance imaging
- Higher harmonics (AM, PM and FM)
- Force modulation
- Nanoindentation & Nanomanipulation



# Control your environment to ensure success across all applications

Here are just a few examples from the range of accessories that enable researchers perform experiments under an extensive range of environmental conditions. See the **Accessories Handbook** for a comprehensive list. All accessories available for the NanoWizard platform are compatible with the **NanoWizard 4 XP NanoScience system**, including solutions for life science environmental control and advanced optics.

TEMPERATURE CONTROL	TEMPERATURE RANGE	FEATURES
High Temperature Heating Stage (HTHS™)	Ambient to 300 °C	Stage module, drift-minimized design, top-down optical access
Heating-Cooling Module (HCM™)	-30 to 120 °C	Stage module, water cooling system, drift-minimized design, top-down optical access
Heating-Cooling Stage (HCS™)	0 to 100 °C	Full sample stage, passive cooling via heatpipe, drift-minimized design, top-down optical access
CryoStage	-120 to 220 °C	Full sample stage, liquid nitrogen cooling, drift-minimized design, top-down optical access

ELECTROCHEMISTRY	TEMPERATURE RANGE	FEATURES
Electrochemistry cell (ECCell™)	Ambient to 60 °C	Electrical tip connection, fluid/gas exchange, suitable for aggressive liquids, coverslip optics and top-down optical access
HCS with Electrochemistry	0 to 100 °C	Electrical tip connection, fluid/gas exchange, suitable for aggressive liquids, top-down optical access

SMALL VOLUME CELLS	TEMPERATURE OPTIONS	FEATURES
SmallCell™ (< 150 µl)	Compatible with HCS, HTHS, HCM	Closed cell for fluid/gas exchange, suitable for aggressive liquids, suitable for inverted and top-down optical access
3-port small volume SmallCell (< 60 µl)	Compatible with HCS, HTHS, HCM	Closed cell for fluid/gas exchange, suitable for inverted and top-down optical access

ELECTRICAL PROPERTIES UNDER LIQUID/GAS	FEATURES
Conductive AFM module – enclosed volume	Electrical tip connection, closed cell for gas exchange, suitable for inverted and top-down optical access
CoverslipHolder with electrical sample connection	Electrical tip connection, gas exchange, coverslip inverted optics and top-down optical access
Sample Humidifier	Gas exchange, coverslip optics and top-down optical access

Topography image of crystalline polyethylene (Height range: 15 nm) measured at -120°C with JPK CryoStage





# A true multi-purpose tool that grows with your needs

## FLEXIBILITY AND MODULARITY: ESSENTIAL REQUIREMENTS FOR A MODERN RESEARCH LAB

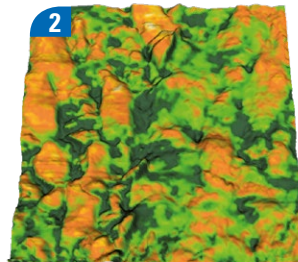
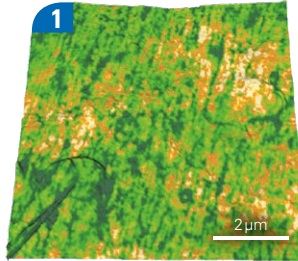
The NanoWizard AFM family is renowned for its modular design philosophy, maximizing the compatibility of all components. AFM heads that can be used with accessories, stages, and modules of different generations ensure continuity and enable cost effective upgrades allowing imaging facilities extreme flexibility to match the changing requirements of their users. The **NanoWizard 4 XP** is the most versatile AFM system yet. It delivers perfect optical integration and the largest number of accessories and modes available today, along with the guarantee of easy upgrades to keep up with new advances.

## EASY AND COST-EFFECTIVE UPGRADE SCHEME

- Vortis 2 controller or Vortis 2 Advanced option
- Range of different measurement heads
- Powerful software modules
- Largest number of accessories and modes

## MODIFY YOUR SAMPLE DURING IN-SITU MEASUREMENTS BY APPLYING:

- High voltages with Piezo-Response Microscopy (PFM)
- External loads with the StretchingStage
- External magnetic fields
- Potential differences in liquid for electro-chemistry (including SECM)
- Localized forces using NanoLithography and NanoManipulation
- Optical stimulation for photo-conductive AFM



NanoWizard 4 XP head on StretchingStage ▲

QI images of plastic film (1) before (color texture, range: 40 MPa) and (2) after (color texture, range: 400 kPa) stretching.

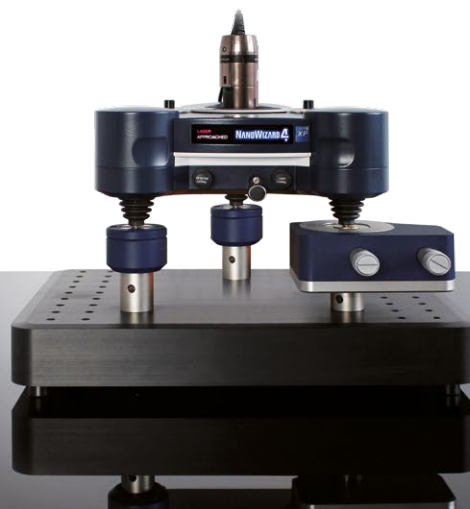
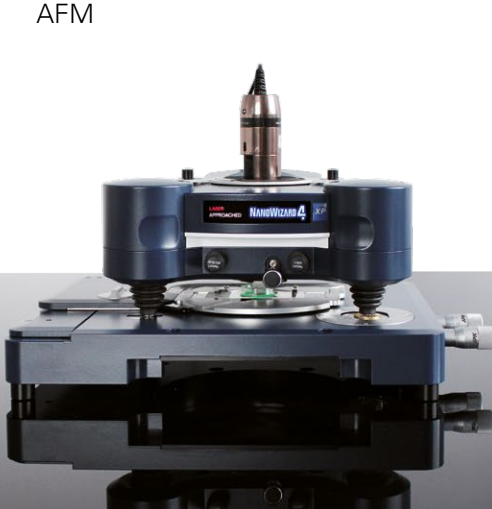
3D height image is overlaid with Young's modulus information. After stretching, the plastic film shows a 100 times lower E-modulus and strong changes in topography.

## HIGHLIGHTS FOR ACCESS AND USABILITY

- **TopViewOptics** module for opaque samples, can also be used on an inverted microscope
- **Head-up stage** for tall samples (up to 14 cm in height)
- **HybridStage**, a motorized sample scanner combined with a 3-axis piezo sample scanner (> 100 μm in z-range)

## OPTICAL INTEGRATION

- Inverted optical microscopy
  - Wide-field and confocal (CLSM) fluorescence
  - Optical superresolution (STED, TIRF, PALM/STORM)
  - Fluorescence spectroscopy (FLIM, FRET, FCS, FRAP...)
  - Raman spectroscopy
  - Side-view of the sample (50x objective)
- Upright optical microscopy
  - Upright Fluorescence Kit (UFK)
  - BioMaterials Workstation BioMAT™
- Near field optical experiments (even TERS)



Left: NanoWizard 4 XP on motorized stage with TopViewOptics™ module

Right: NanoWizard 4 XP on Head-up stage

# Specifications for the NanoWizard 4 XP NanoScience AFM

## System specifications

- Atomic lattice resolution on inverted microscope in closed-loop (<0.030nm RMS z height noise level)
- Ultra-low noise level of cantilever deflection detection system <2pm RMS free (0.1 Hz-1 kHz)
- Highest detector bandwidth of 8MHz for high speed signal capture
- Tip-scanning, stand-alone system, with a rigid low-noise design and drift-minimized mechanics
- The only liquid-safe AFM with integrated vapor barrier, special encapsulated piezo drives and tip-moving design
- IR deflection detection light source with low coherence
- Transmission illumination with standard condensers for precise brightfield, DIC and phase contrast
- Scanner unit
  - 100 × 100 × 15 μm<sup>3</sup> scan range with 1.5 μm extra z range with high-speed option
  - Sensor noise level <0.09nm RMS in xy
  - 0.04 nm RMS sensor noise level in z

## Vortis 2 SPMControl electronics

- State-of-the-art digital controller with lowest noise levels and highest flexibility

## New workflow-based V7 SPMControl software

- True multi-user platform, perfect for imaging facilities
- User-programmable software
- Fully automated sensitivity and spring constant calibration using thermal noise or Sader method
- New DirectOverlay 2 for combined optical and AFM information
- Improved ForceWatch™ and TipSaver™ mode for force spectroscopy and imaging
- Advanced spectroscopy modes such as various force clamp modes or ramp designs
- Powerful Data Processing (DP) with full functionality for data export, fitting, filtering, edge detection, 3D rendering, FFT, cross section, etc.
- Powerful batch processing of force curves and images including WLC, FJC, step-fitting, JKR, DMT model and other analyses

## Stages and sample holders

- Stages are available for all major inverted optical microscope manufacturers such as Zeiss, Nikon, Olympus and Leica
- Motorized precision stage with 20 × 20 mm<sup>2</sup> travel range with joystick or software control
- Manual precision stage with 20 × 20 mm<sup>2</sup> travel range
- Holders for Petri dishes, coverslips, microscope slides or metal SPM discs are available
- Special holders and liquid cells possible
- Large Ø140 × 18 mm<sup>3</sup> free sample volume up to 14cm in z with new Head-Up stage

## Largest number of accessories and probes

(see accessories handbook)

- Large choice of temperature controls (for ambient, liquid and gas), liquid cells even for aggressive solvents
- Vibration and acoustic isolation from leading suppliers

## Optical configurations

- Fits on inverted microscopes from
  - Zeiss (Axio Observer, Axio Vert 100/200, Axio Vert A1)
  - Olympus (IX line)
  - Nikon (TE 2000, Ti/Ti2 line)
  - and Leica (DMi line)
- AFM simultaneously with optical microscopy
  - Fully simultaneous operation with optical phase contrast and DIC using standard condensers
  - Combine AFM with advanced commercial confocal microscopes and fluorescence optical techniques such as FCS, FRET, TIRF, FLIM, FRAP, STED, STORM/PALM, SIM and more
- TopViewOptics video optics for opaque samples with 12× zoom
- BioMAT option (see BioMAT brochure)
  - For high-NA upright fluorescence optics combined with AFM on opaque samples
  - Supports upright research microscopes such as Zeiss Axio Imager and Axioscope, Olympus BX51/53 and BX FM, LEXT, Leica DM 4000/5000
- Upright Fluorescence Microscope (UFM) Kit
  - Enables the combined use of AFM and upright optical fluorescence microscopes such as Zeiss Axio Zoom V16, Leica MacroScope Z16 ApoA, Leica M100/200 Line, Olympus MVX 10 MacroView
- Large range of supported cameras
  - High-end EM-CCD cameras such as models from Andor (iXon)<sup>1</sup>, Hamamatsu<sup>3</sup> and Photometrics (Evolve)<sup>3</sup>
  - sCMOS cameras from Andor (Zyla)<sup>1</sup>, Hamamatsu (Orca)<sup>3</sup>, PCO<sup>2</sup>
  - CCD and CMOS cameras from Jenoptik<sup>2</sup>, IDS<sup>1</sup>, µEye<sup>1</sup> or PCO<sup>2</sup>



(1) Native  
(2) On-board  
(3) Communication link

NanoWizard 4 XP AFM on a Leica DMi inverted microscope

## STANDARD OPERATING MODES

### Imaging modes

- Now with PeakForce Tapping
- Contact mode with lateral force microscopy (LFM)
- Tapping Mode™ with PhaseImaging™

### Force measurements

- Static and dynamic spectroscopy
- Advanced Force Mapping

## OPTIONAL MODES

- High-speed scanning option up to 150 lines/sec **NEW**
- Fast QI Advanced mode for quantitative data, perfect for soft samples
  - Mechanical properties such as adhesion, elasticity, stiffness, deformation
  - Conductivity and charge distribution mapping
  - Contact Point Imaging (CPI) with zero force
  - Molecular recognition imaging for binding site mapping
- Advanced AC modes such as FM and PM with Q-control & Active Gain Control
- Higher harmonics imaging
- Kelvin Probe Microscopy and SCM
- MFM and EFM (see also QI mode)
- Conductive AFM (see also QI mode)
- STM
- Electrical spectroscopy modes
- Piezoresponse Microscopy for high voltages
- Electrochemistry with temperature control and optical microscopy
- NanoLithography
- NanoManipulation
- Nanoindentation
- Scanning Thermal AFM
- FluidFM® solution from Cytosurge **NEW**
- ExperimentPlanner for designing a specific measurement workflow
- RampDesigner for custom designed clamp and ramp experiments
- ExperimentControl feature for remote experiment control
- DirectOverlay 2 for combined AFM and optical microscopy **NEW**
- Additional XY or Z sample movement stages available with CellHesion, TAO™ and HybridStage module

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