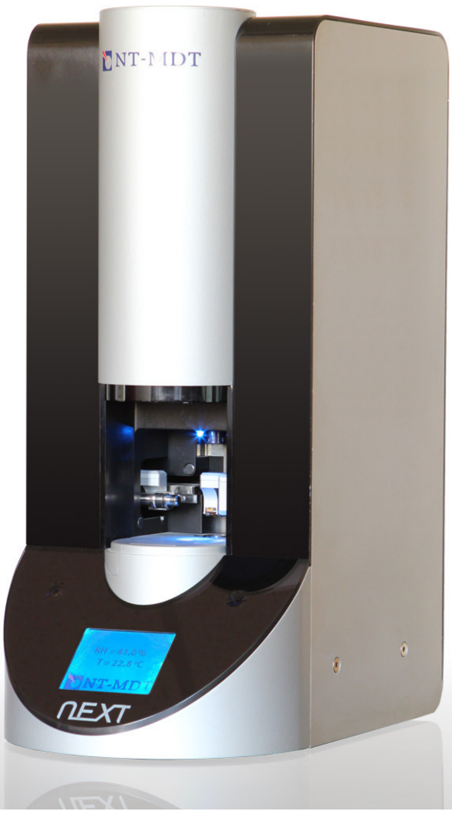
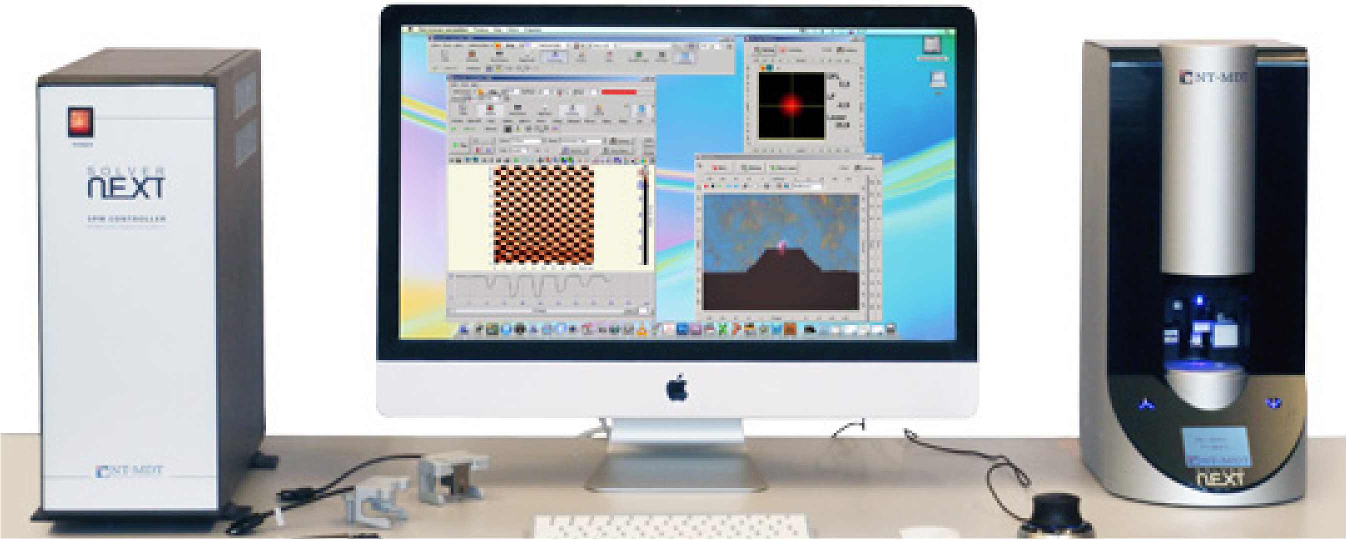
NEXT

Integrated research AFM



NT-MDT



5 years ago NT-MDT introduced the first fully automated desktop AFM. We are now proud to introduce the new generation NEXT product.
NEXT is the perfect integration of automation expertise and a company that for the last 22 years has provided high-resolution, research-performance AFM instruments

High resolution imaging

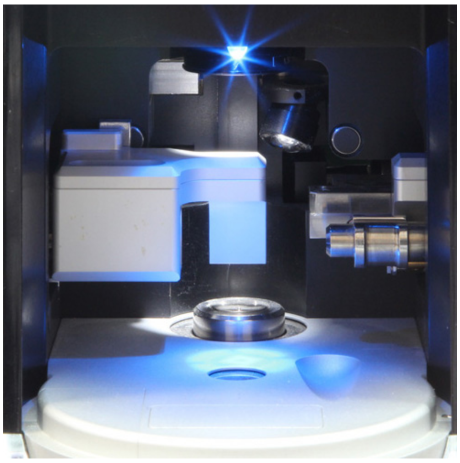
NEXT has 25 fm/√Hz optical deflection noise level. This level of performance is driving advanced high-resolution imaging capabilities. Meticulously elegant NEXT mechanical design, together with the low noise level of the closed loop piezoscanner, thermally stabilized acoustic enclosure and vibration tolerant system makes high resolution imaging a routine procedure.

Advanced AFM and STM characterization techniques

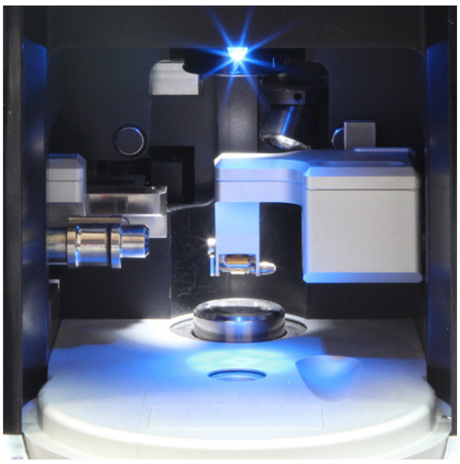
Two automatically interchangeable measuring heads (AFM and STM) are integrated into the NEXT. Driven by the new digital PX Ultra controller the NEXT delivers the broadest range of AFM and STM techniques —for sample topography, electrical, magnetic and nanomechanical properties characterization. Multifrequency AFM techniques dramatically increase the amount of information acquired from single experiment.

Exceptional level of automation for both beginners and experts

NEXT provides motorized sample positioning and integrated high resolution optical microscope positioning, motorized continuous zoom and focusing of the optical microscope. But AFM automation is more than motorization. The Smart automatic alignment algorithm provides fast laser-cantilever-photodiode optical chain alignment turning this routine procedure into single click 10 second operation. Powerful software automation features drive AFM productivity to a new level.



STM measuring head



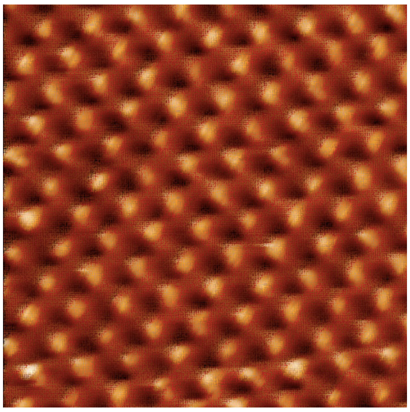
AFM measuring head

High Resolution Imaging

Although the first AFM was introduced more than 25 years ago, high resolution imaging is still driving strong competition amongst AFM manufacturers.
NEXT low noise performance makes high resolution imaging a routine procedure

25 fm/√Hz optical beam deflection (OBD) sensor noise

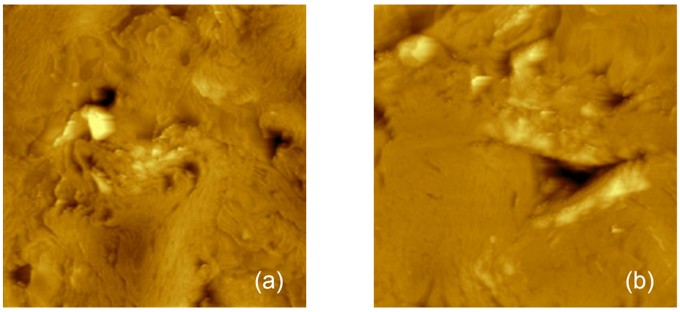
Low OBD sensor noise is essential for high-resolution imaging. 25 fm/√Hz noise level of NEXT OBD sensor allows precise control and minimization of the forces acting between probe and sample, making it possible to operate with sub-nanometer or even sub-angstrom oscillation amplitudes of the cantilever. Ultimate resolution amplitude modulation AFM imaging of wide variety of samples both in liquid and in air is routinely available. Including visualization of individual polymer chains in soft specimens like PTFE thin films.



HOPG atomic lattice resolution, STM. Scan size 2.1×2.1 nm

Gentle approach algorithm

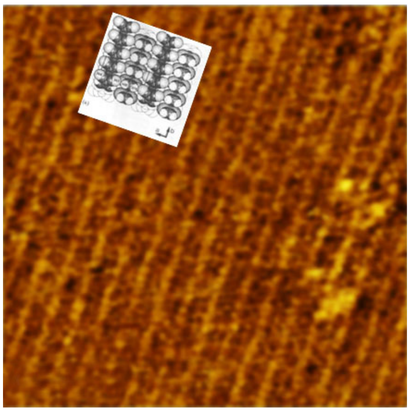
Probe sharpness is critical for acquiring perfect AFM images, but sometimes the probe might be damaged during the approach procedure even before beginning the experiment. NT-MDT has developed a phase sensitive algorithm that guaranties gentle probe approach.



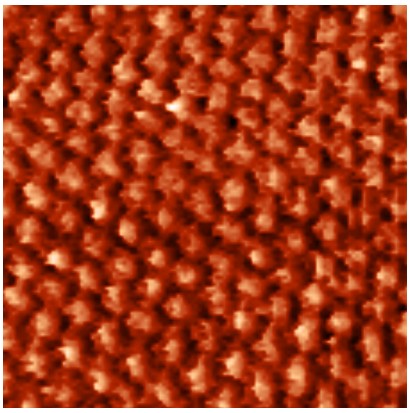
Paraffin wax topography images after probe approach:
(a) – phase control, (b) – amplitude control. 6×6 µm scan

High stability and powerful vibration and acoustic insulation

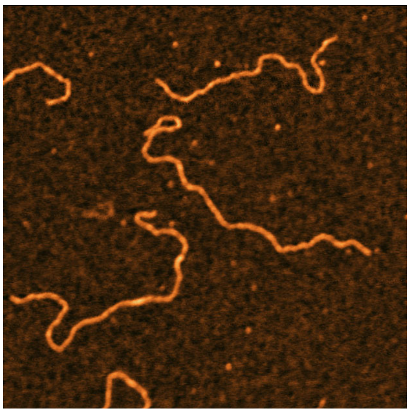
NEXT enclosure provides acoustic insulation and active thermal stabilization of the microscope decreasing thermal drift down to the level of ~10 nm/hour. Integrated active vibration insulation system serves powerful protection form external mechanical noise.



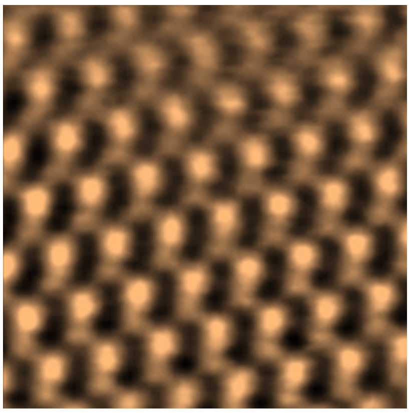
Height image of the ab plane of TTF-TCNQ crystal. AM-AFM. Scan size 9×9 nm



Mica atomic lattice resolution, LFM mode. Scan size 6×6 nm



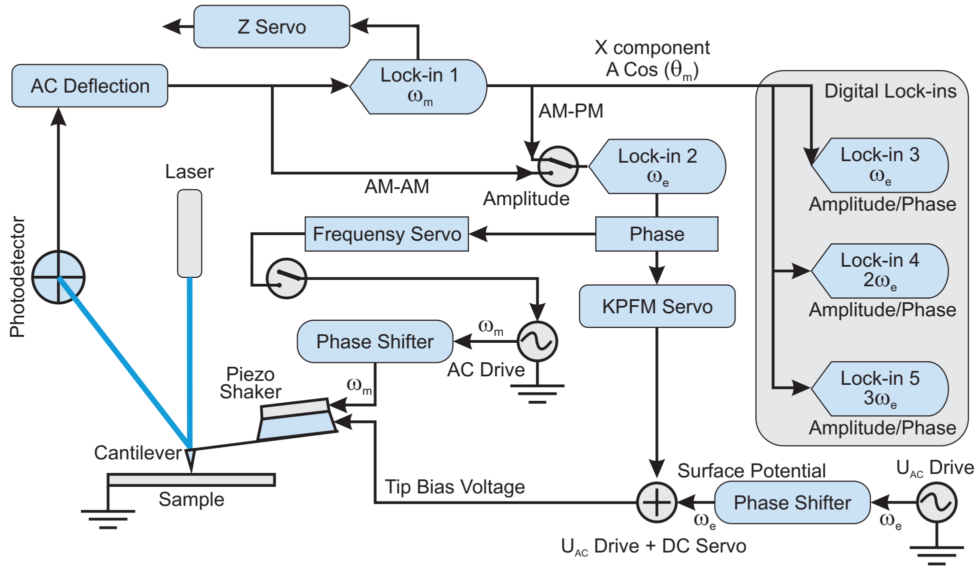
DNA on mica surface, AM-AFM mode. Scan size 1×1 µm



Calcite atomic resolution, AM-AFM mode in liqud. Scan size 6×6 nm

Advanced characterization techniques

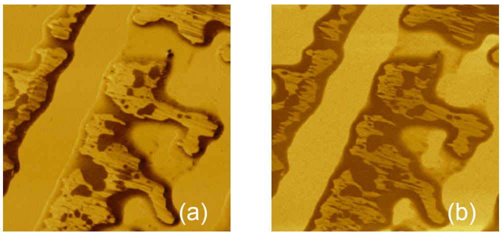
Modern AFM instruments are much more than just a tool for topography imaging. Coupled with the PX Ultra controller the NEXT realizes the largest suite of multifrequency AFM techniques

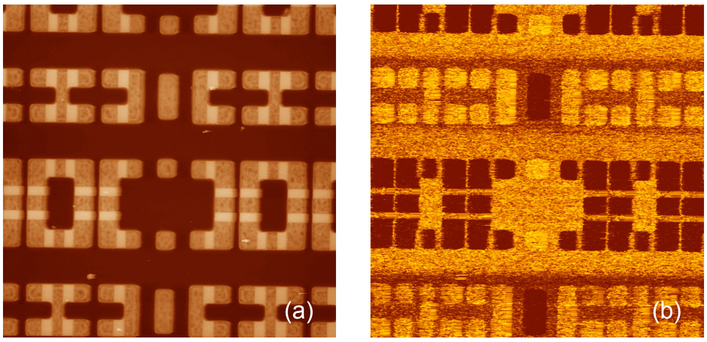


NEXT multifrequency configuration schematics

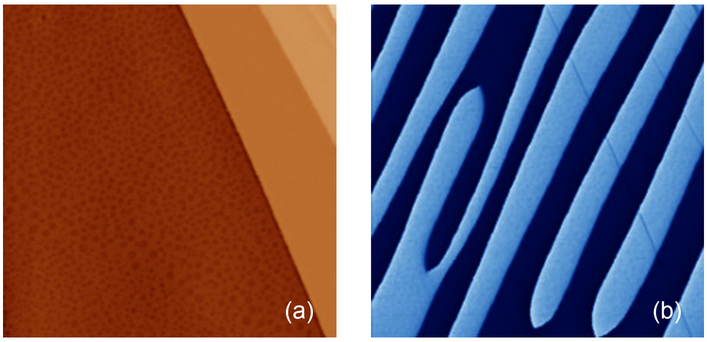
Multifrequency drive and Phase imaging

Mesomorphic Poly(diethyl siloxane) on a Si substrate. Additional sample details are seen in the second flexural image. 20×20 μm scans. Phase image, 1st flexural mode (a), phase image, 2nd flexural mode (b).



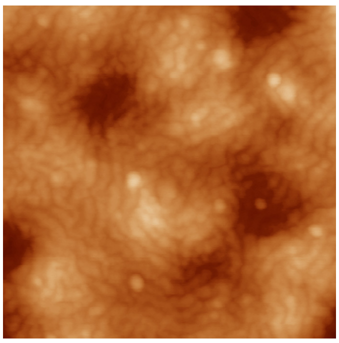


SDRAM structure, AM-KPFM mode: (a) topography, (b) surface potential. Scan size 40×40 μm

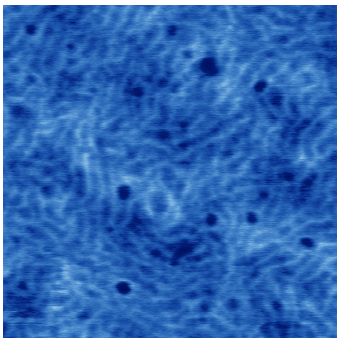


TGS crystal, PFM mode: (a) topography, (b) VPFM phase. Scan size 40×40 μm

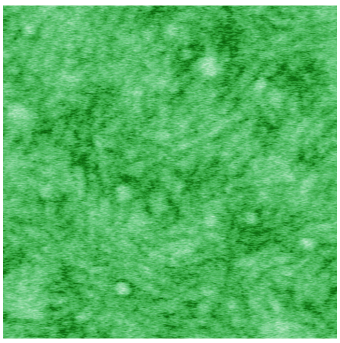
P3HT/PCBM blend film deposited on ITO glass. Scan size 600×600 nm



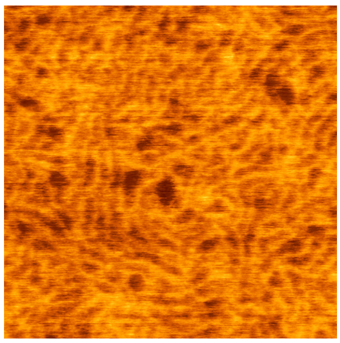
Topography



Phase image, 2nd pass. Double-pass EFM



Amplitude, 2nd pass. Double-pass EFM



Surface potential. Single-pass PM-KPFM

Multifrequency EFM and KPFM

Amplitude (AM) and phase modulation (PM) single pass EFM and KPFM

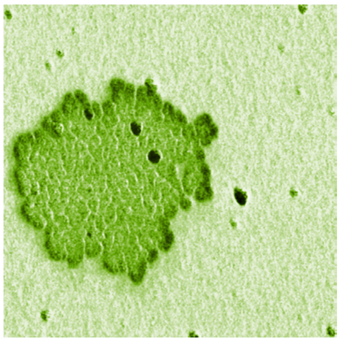
Flexible and easy configuration of feedback loops allows simultaneous multifrequency measurements using up to 5 lock-ins (2 high frequency, 3 low frequency) for operation in both AM and PM electrical AFM modes. This gives the widest range of sample measurement capabilities, from single macromolecules to photovoltaic structures.

Pre-defined software settings

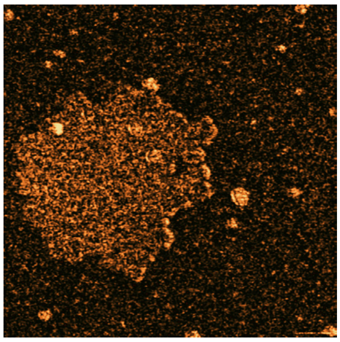
Nova PX software contains pre-defined settings for fast configuration of the NEXT operation — in single pass AM/PM KPFM, single pass AM/PM EFM, dual pass EFM, MFM and KPFM modes.

Flexibility to match the correct technique to the sample

Along with fast configuration of predefined modes Nova PX software allows researchers to have unlimited experiment flexibility.

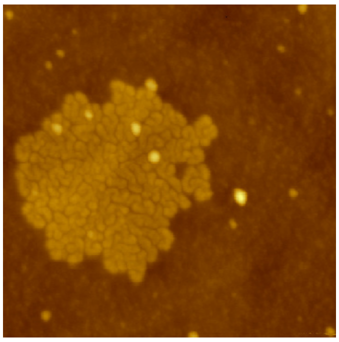


dC/dZ contrast

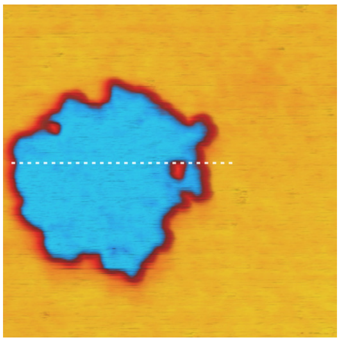


dC/dV contrast

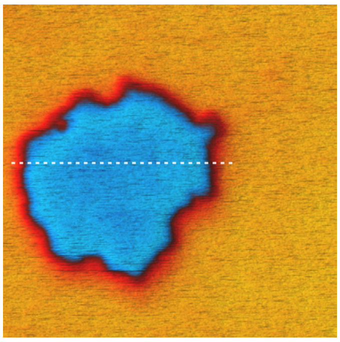
$F_{14}H_{20}$ self-assembly on Si surface. Scan size 1x1 µm



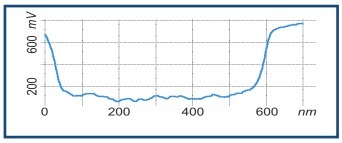
Height



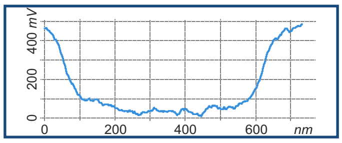
Potential, PM-KPFM



Potential, AM-KPFM



Surface Potential, PM

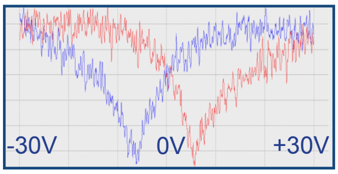


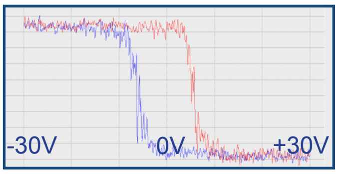
Surface Potential, AM

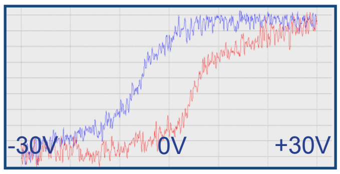
Multifrequency PFM

Piezoresponce Force Microscopy (PFM) is attracting a strong growing interest led by applications of piezo materials and by research of electromechanical properties of biological systems. Along with domain structure, a number of specific ferroelectric properties (coercive field, residual polarization, etc.) can be revealed using Switching Spectroscopy. The NEXT guarantees high quality of PFM scans by eliminating cross-talk interference of the normal and the lateral components of the cantilever deflection signal.

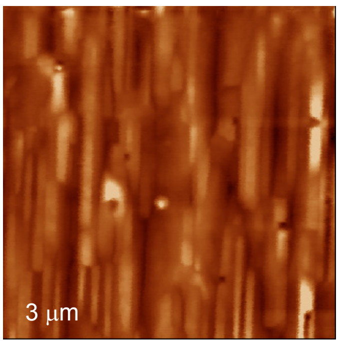
Switching Spectroscopy:
1 - amplitude, 2 - phase,
3 - piezoresponce







BFO sample with a central 2 µm area polarized by a scanning probe.



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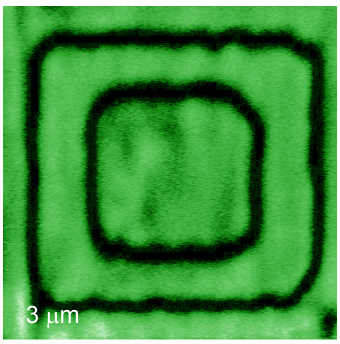
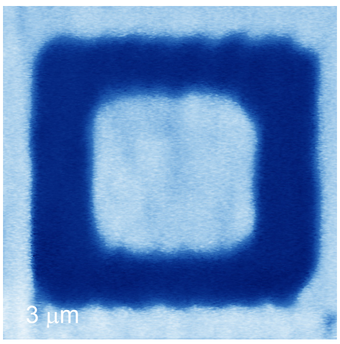
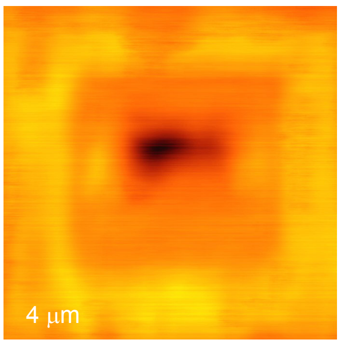


VPFM, Amplitude



VPFM, Phase

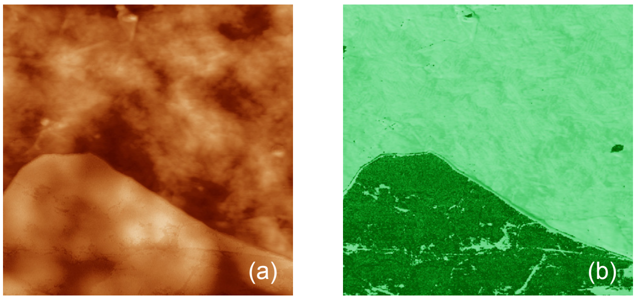


Surface Potential

Nanomechanics - Nanoindentation

Nanomechanical Studies in Contact Mode

AFM based nanoindentation provides:
Acquire images of topography, phase, electrical properties of the sample surface prior to indentation
Acquire force-displacement curves on nanoscale sample regions. Perform nano-indentation or scratch-testing with further scanning of the indented region
Analyze plastic deformation or viscoelastic recovery

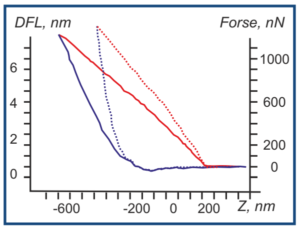


Flake of graphite on polyethylene. Height image (a), Contact-resonance technique image (b). Scan size 5×5 μm

AFM based nanoindentation

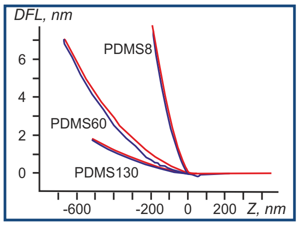
PS Elastic Modulus measured on the basis of the DFL curves (solid lines) and FvH curves (dashed lines) obtained on PS surface. DvZ, FvH curves: red – loading, blue – unloading traces

Polymer Material	Elastic Modulus	
	Macro	AFM
LDPE	152 - 290 MPa	204 MPa
PC	1.79 - 3.24 GPa	2.30 GPa
SiLK™	2.45 GPa	2.25 GPa



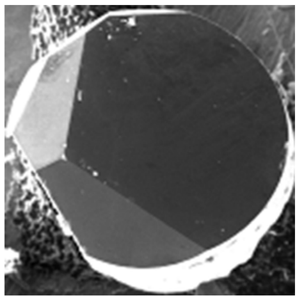
Work of Adhesion measured on the basis of the DFL curves on films of PDMS8, PDMS60 and PDMS130. DvZ curves: red – loading, blue – unloading traces

Polymer Material	Work of Adhesion	
	Macro	AFM
PDMS-8	49	32
PDMS-60	58	52.2
PDMS-130	47 - 58	42.1

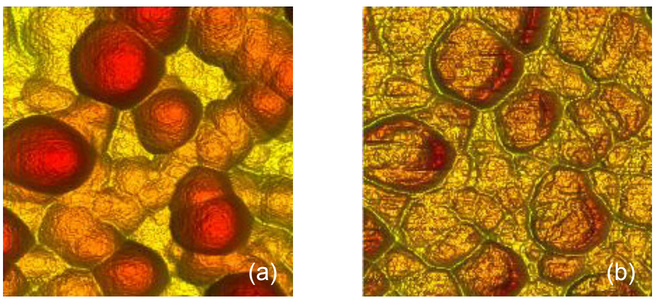


The nanosclerometry module

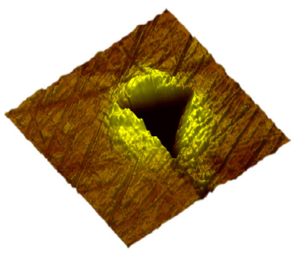
The NEXT diamond probe nanoindentor measuring head is optimized for hard samples (1-1000 GPa). It allows acquiring sample topography, distribution of mechanical properties over the sample (measuring of elasticity modulus) and is able to perform micro-, nanoindentation or scratch-testing with further scanning of the indented region.



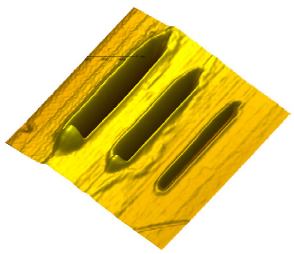
Indentor: diamond pyramid of Berkovich type



Zr ceramics. Topography (a) and elastic modulus map (b), 1×1 μm



AFM image of indentation imprint, 18×18 μm



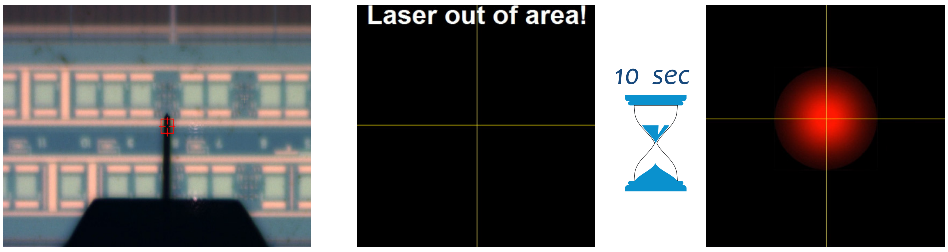
AFM image of scratches, 5×5 μm

Exceptional Level of Automation

NEXT is a fully automated AFM. Exceptional level of automation makes routine procedures much faster and easier. Powerful software algorithms provide high experiment productivity for both beginners and experts

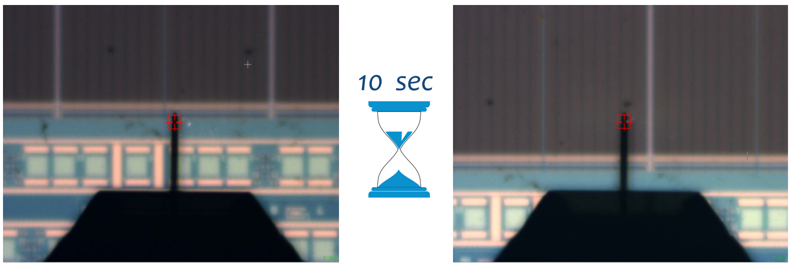
Laser – cantilever – photodiode autoalignment within 10 seconds

A single click on the cantilever in the optical image is enough. NEXT will automatically complete the alignment in 10 seconds. This algorithm works independently of the optical zoom value and optical field of view position relative to the cantilever. Actually it takes about 30% less time than it takes to read this paragraph.



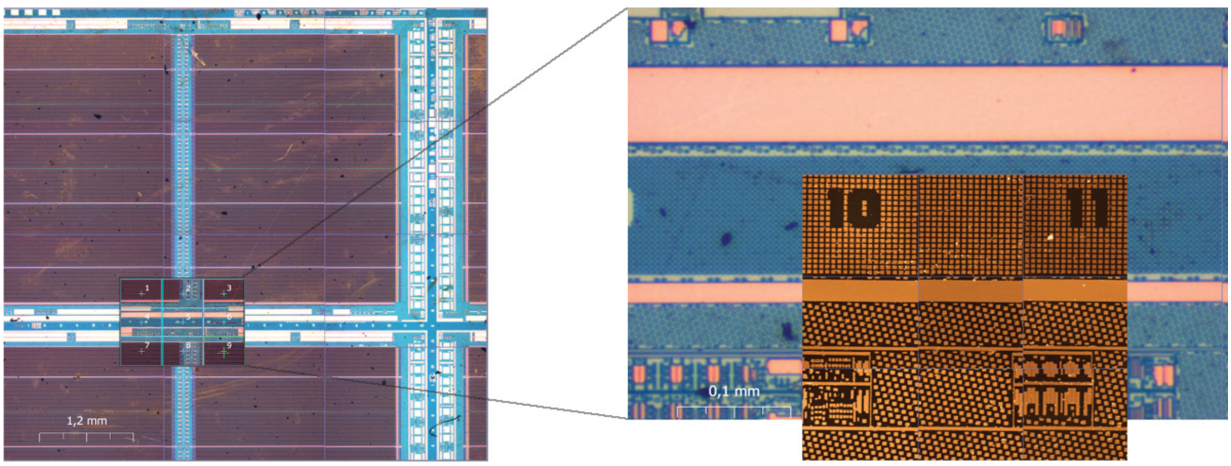
Point-and-click motorized precise sample positioning

Precise sample positioning in the NEXT is done by motorized XY sample stage. It is very convenient to just select an area of interest directly on the optical image. The NEXT will automatically move it to cantilever and begin scanning.



Panoramic optical view, Multiscan and ScanStitch

A 2 μm resolution optical microscope is integrated into the NEXT. The optical microscope is placed on 5×5 mm XY precise motorized stage. Both optics and sample stages can move independently relative to the cantilever. Nova PX software provides many convenient features based on these properties of the NEXT hardware.
Panoramic optical view allows collection of high resolution, large scale images of the sample and then operation with this data as the same as one operates with interactive maps.
Multiscan and ScanStitch provides easy acquisition of scans with ~ mm scan size within a reasonable time and overlay AFM scans with the optical image



Panoramic 6×6 mm optical image of IC stitched from a number of smaller images (central green restangle). Picture file contains 50 MP (2 μm optical resolution).

3×3 AFM multiscan (consist of stitched 95x95 μm scans) overlayed with optical image

Specifications

Measuring heads
- **Built-in, with the automatically interchangeable:** AFM and STM
- **Optional:** for measurement in liquid and nanoindentation.
- **OBD system,** with automated alignment and targeting

Sample
- **Dimensions:** up to 20/10 mm in diameter/height
- **Sample weight:** up to 40 g
- **Heating:** from RT to 150 °C

Scanning system
- **Scanning type:** by sample
- **Range:** 100 × 100 × 10 µm (CL)
  3 × 3 × 2 µm in HR mode

Resolution
- **Noise XY:** not more than 0.3 nm (with closed loop sensors)
- **Noise Z (RMS, 10-1000 Hz bandwidth):** 15 pm (typical)

Sample positioning system
- **Movement:** automated, binded with the positioning system of the videomicroscope
- **Range, XY:** 5 × 5 mm
- **Minimal step:** 0.3 µm

Video monitoring system
- **Resolution:** 2 µm
- **Focusing:** motorized
- **Zoom:** continuous, motorized

Nanosclerometry
- **Hardness:** 1...80 GPa
- **Elasticity modulus:** 1...1000 GPa

Size and weight
- **Size:** 470 × 210 × 260 mm
- **Weight:** 25 kg

Modes

Contact AFM
- Topography
- Feedback
- Lateral Force (LFM)
- Force Modulation (FMM)

Amplitude modulation AFM
- Topography
- Phase
- Feedback

AFM spectroscopy
- Force-distance
- Amplitude-distance
- Phase-distance
- I(V)

Raster Spring Imaging

Spreading Resistance Imaging

Magnetic Force Microscopy
- Two-pass DC/AC
- Lift DC/AC

Electrostatic Force Microscopy
- Single-pass, Two-pass
- Amplitude Modulation
- Frequency Modulation
- dC/dZ imaging
- dC/dV imaging

Kelvin Probe Force Microscopy
- Single-pass, Two-pass
- Amplitude Modulation
- Phase Modulation

PFM & Switching Spectroscopy

Nanolithography
- Voltage
- Current
- Force

Nanosclerometry
- Elastic modulus mapping
- Scratch hardness
- Nanoindentation

STM

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