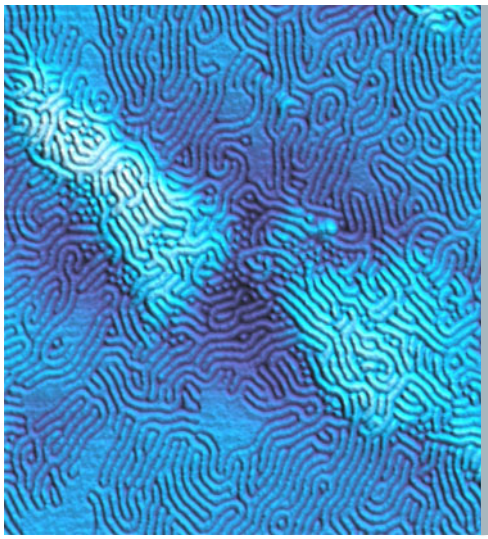
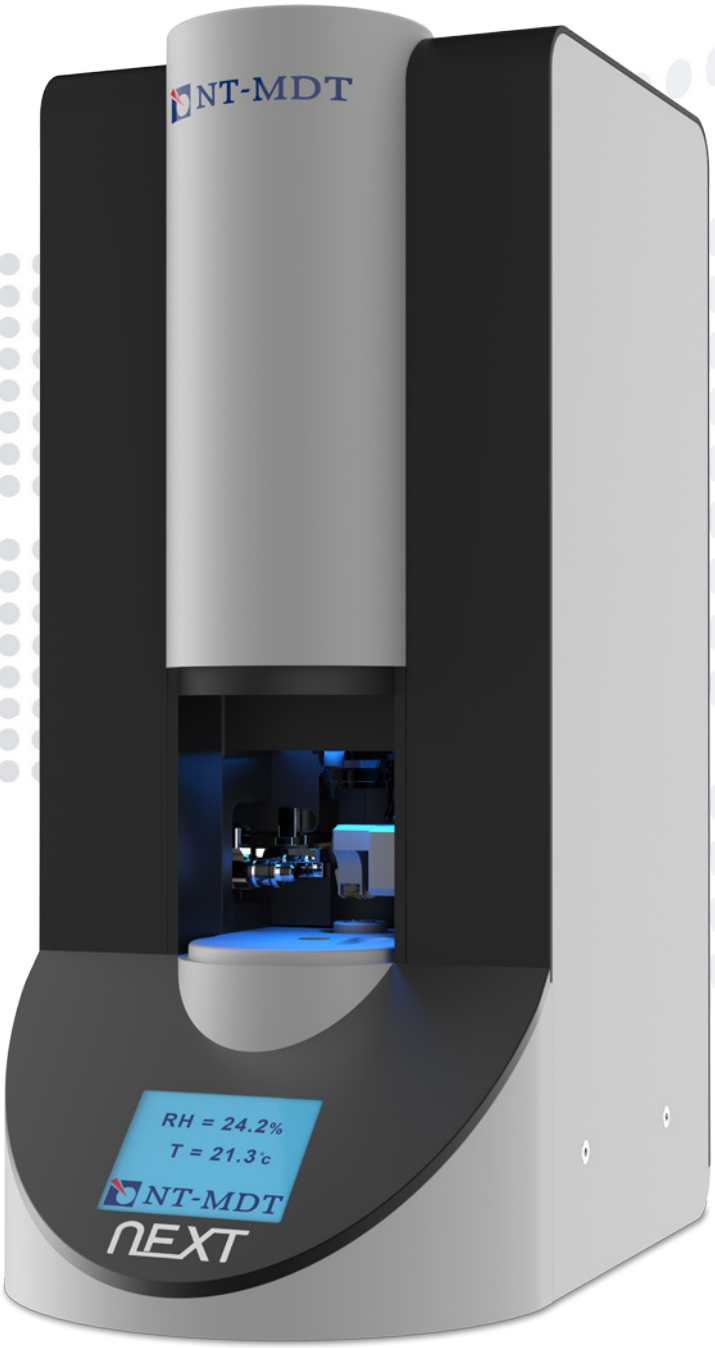
NT-MDT
Spectrum Instruments



Triblock copolymer film on Si, 2 x 2 µm



NEXT

Easy to use technology enabling multiple SPM modes and delivering world class performance

Easy to use fully automated AFM / STM system for a wide range of research

R&D 100
Award Winner 2009

HIGH RESOLUTION IMAGING:

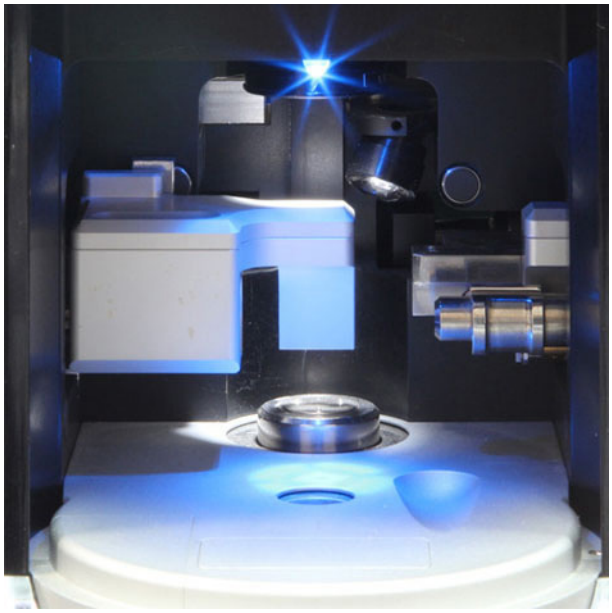
NEXT has 25 fm/√Hz optical deflection noise level. This level of performance is driving advanced high-resolution imaging capabilities. Meticulously elegant NEXT mechanical design, together with the low noise level of the closed loop piezoscanner, thermally stabilized acoustic enclosure and high vibration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

ADVANCED AFM AND STM CHARACTERIZATION TECHNIQUES

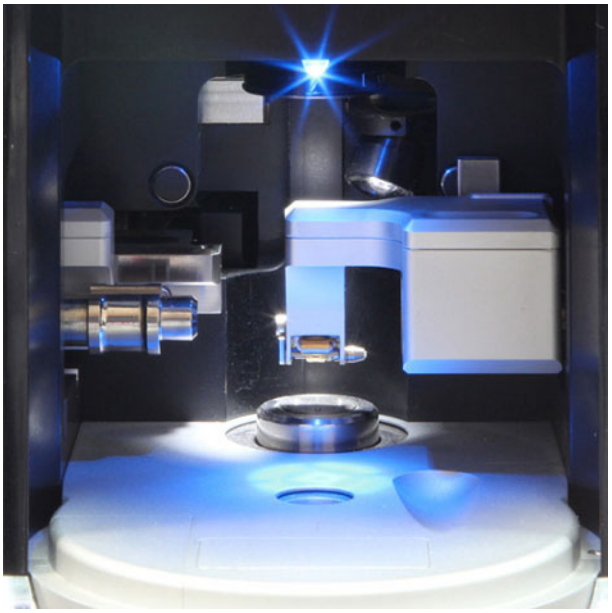
Two automatically interchangeable measuring heads (AFM and STM) are integrated into the NEXT. Driven by the new digital PX Ultra controller the NEXT delivers the broadest range of AFM and STM techniques - for sample topography, electrical, magnetic and nanomechanical properties characterization. Multifrequency 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

25 FM/√HZ OPTICAL BEAM DEFLECTION (OBD) SENSOR NOISE

Low OBD sensor noise is essential for high-resolution imaging. The ultra low noise level of the NEXT OBD sensor allows precise control and minimization of the forces acting between the probe and sample, making it possible to operate with angstrom level cantilever oscillation amplitudes. The NEXT system routinely delivers this high performance AFM imaging in liquid and air including soft specimens of individual polymer chains in PTFE thin films.

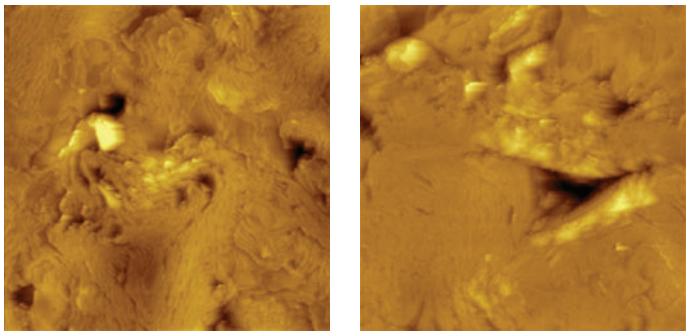
HIGH STABILITY AND POWERFUL VIBRATION AND ACOUSTIC ISOLATION

With a superior internal design, the use of high quality materials, and precision engineering, the NEXT system decreases thermal drift down to the level of ~ 10 nm/hour. An additional active vibration isolation system minimizes external acoustic and mechanical noise.

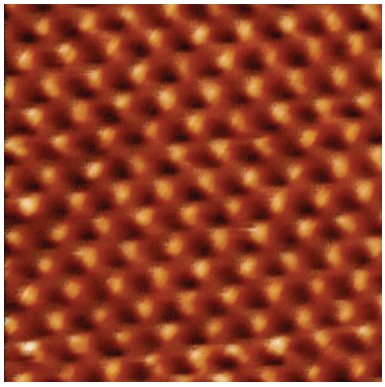
GENTLE APPROACH ALGORITHM

Probe sharpness is critical for acquiring high resolution AFM images, however the probe can be easily damaged during the approach procedure costing you time and money. NT-MDT has developed a phase sensitive algorithm that ensures a gentle probe approach and a sharp tip.

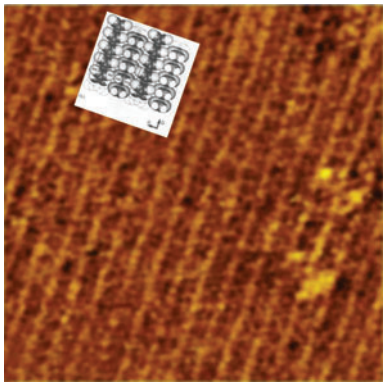
NT-MDT phase control *Standard amplitude control*



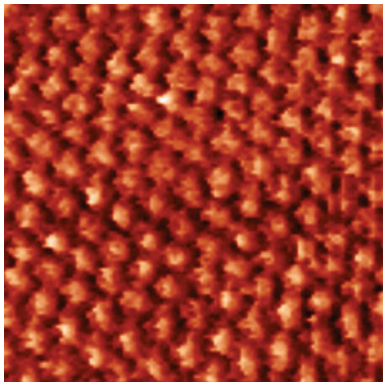
Paraffin wax topography images after probe approach. 6×6 μm scan



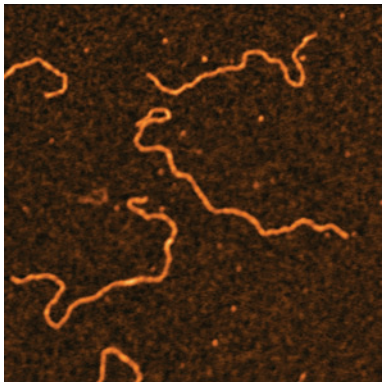
HOPG atomic lattice, STM Scan size 2.1×2.1 nm



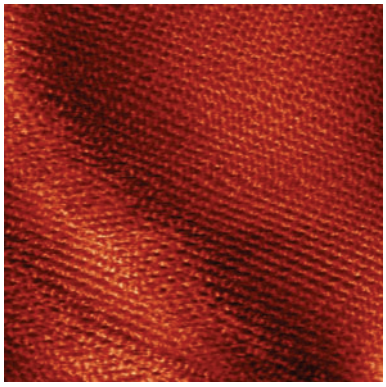
TTF-TCNQ crystal a-b plane Amplitude Modulation AFM Scan size 9×9 nm



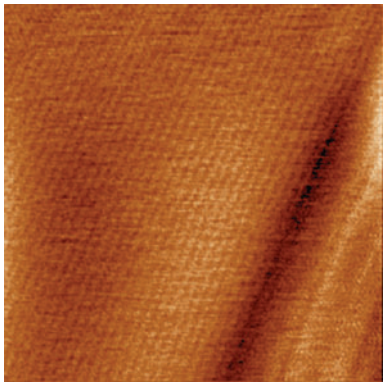
Mica atomic lattice, LFM Scan size 6×6 nm



DNA on mica surface Amplitude Modulation AFM Scan size 1×1 μm



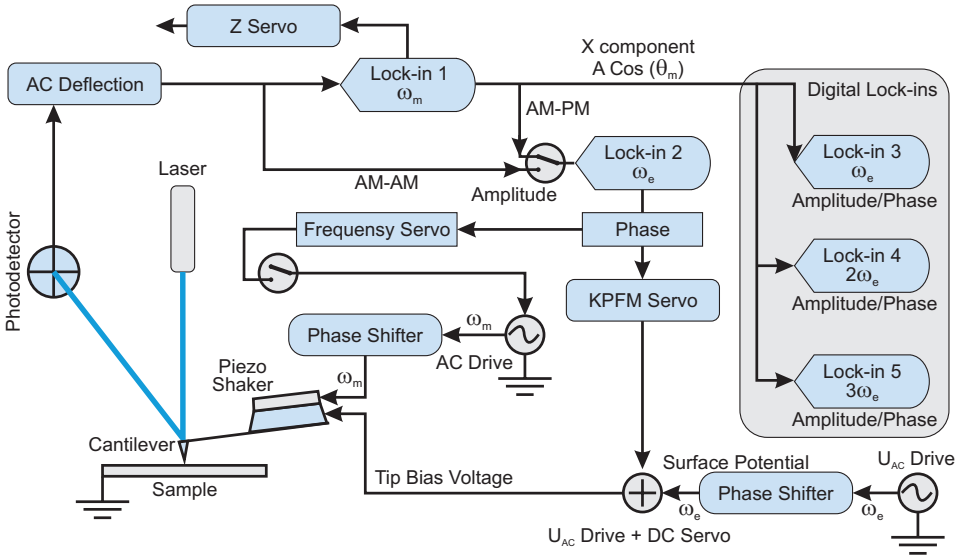
Calcite atomic lattice in liquid Amplitude Modulation AFM Scan size 20×20 nm



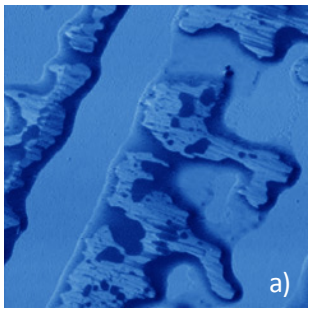
PTFE layer Amplitude Modulation AFM Scan size 18×18 nm

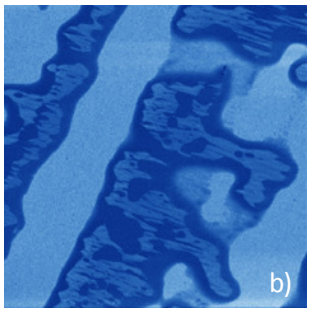
Highly Advanced Single Pass Characterization Techniques

Coupled with the New PX Ultra controller, the NEXT realizes the largest suite of multifrequency AFM techniques

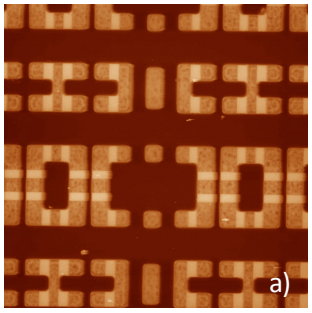


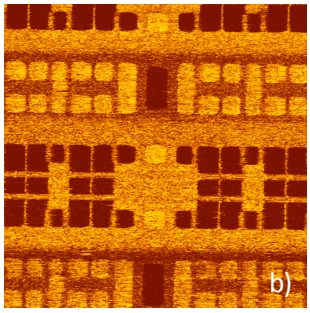
MULTI FREQUENCY DRIVE AND PHASE IMAGING



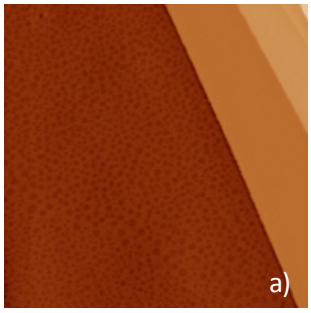


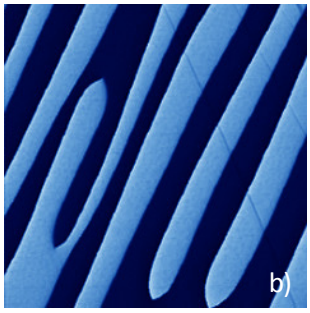
Mesomorphic Poly (diethyl siloxane) on a Si substrate. Additional sample details are seen in the second harmonic image. 20×20 µm scans. a) Phase image, 1st flexural mode, b) phase image, 2nd flexural mode.





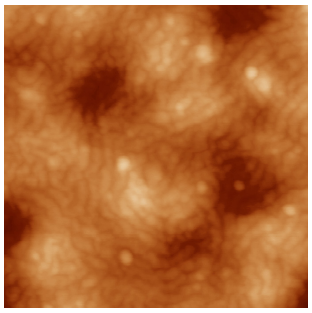
SDRAM structure, AM-KPFM mode: a) topography, b) surface potential. Scan size 40×40 µm



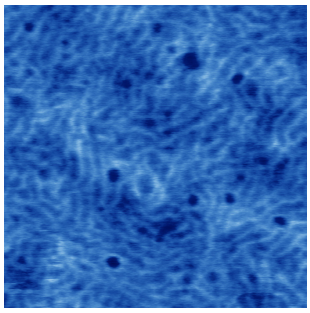


TGS crystal, PFM mode: a) topography, b) VPFM phase. Scan size 40×40 µm

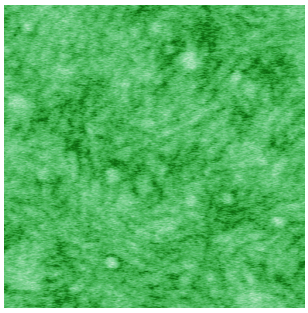
P3HT/PCBM BLEND FILM DEPOSITED ON ITO GLASS. (SCAN SIZE: 600 X 600 NM)



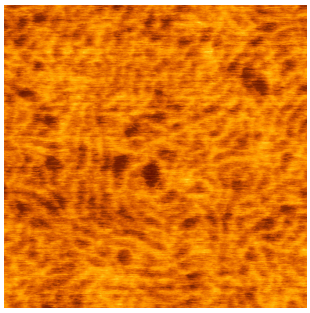
Topography



Phase image, Double-pass EFM



Amplitude, Double-pass EFM



Surface potential. Single-pass AM-KPFM

Multifrequency EFM and KPFM

AMPLITUDE (AM) AND PHASE MODULATION (PM) SINGLE PASS EFM AND KPFM

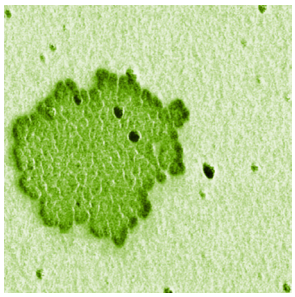
Flexible and easy configuration of feedback loops allows simultaneous multifrequency measurements using up to 5 lock-ins (2 high frequency, 3 low frequency) for operation in both AM and PM electrical AFM modes. This gives the widest range of sample measurement capabilities, from single macromolecules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

PRE-DEFINED SOFTWARE SETTINGS

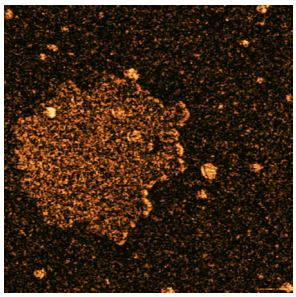
Nova PX software contains pre-defined settings for fast configuration of the NEXT operation in single pass AM/PM KPFM, single pass AM/PM EFM, dual pass EFM, MFM and KPFM modes.

FLEXIBILITY TO MATCH THE CORRECT TECHNIQUE TO THE SAMPLE

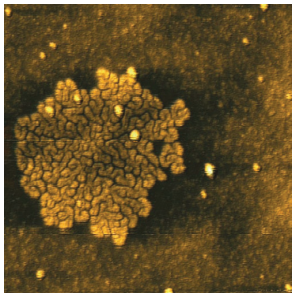
Along with fast configuration of predefined modes Nova PX software allows researchers to have unlimited experiment flexibility.



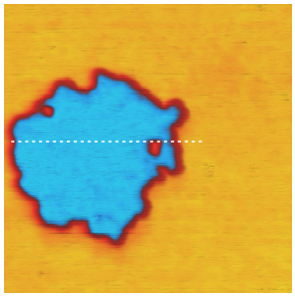
dC/dZ contrast



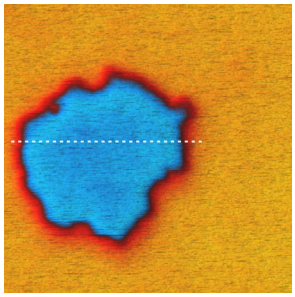
dC/dV contrast



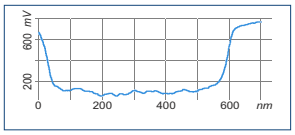
Height



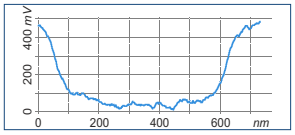
Potential, PM-KPFM



Potential, AM-KPFM



Surface Potential, PM



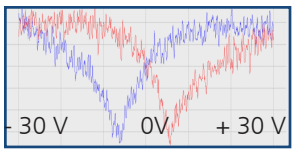
Surface Potential, AM

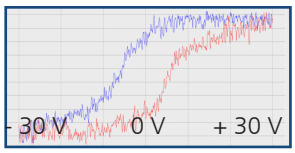
F14H20 self-assembly on Si surface. Scan size 1x1 µm

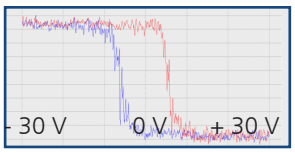
Multifrequency PFM

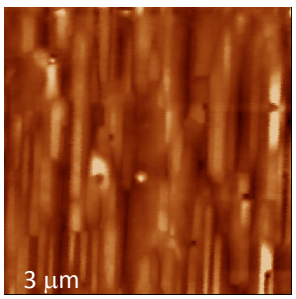
Piezoresponce Force Microscopy (PFM) is attracting a strong growing interest led by applications of piezo materials and by research of electromechanical properties of biological systems. Along with domain structure, a number of specific ferroelectric properties (coercive field, residual polarization, 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









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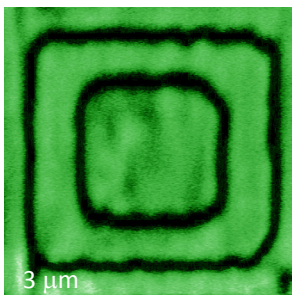
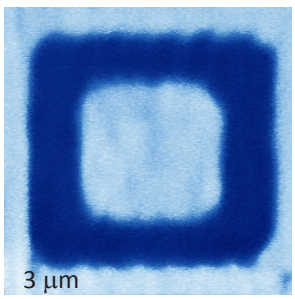
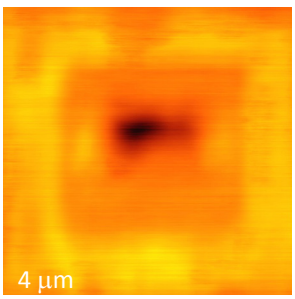


VPFM, Amplitude



VPFM, Phase



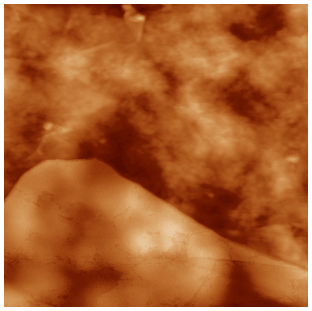
Surface Potential

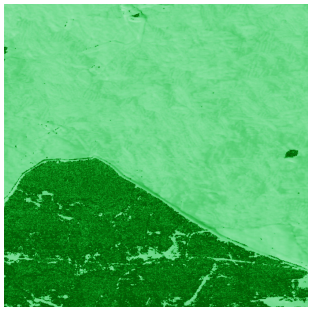
BFO sample with a central 2 µm area polarized by a scanning probe

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

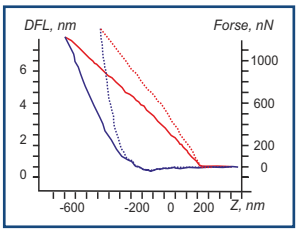




a) Flake of graphite on polyethylene. Height image,
b) Contact resonance technique image.
Scan size 5×5 µm

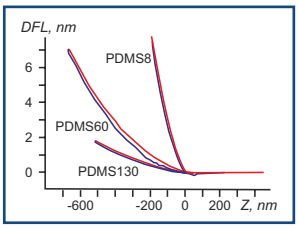
AFM BASED NANOINDENTATION

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



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.

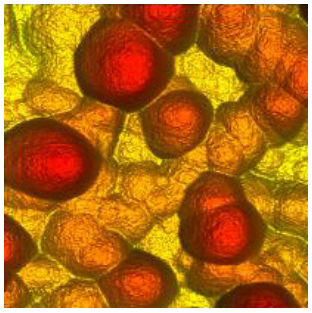
Polymer Material	Work of Adhesion	
	Macro	AFM
PDMS-8	49	32
PDMS-60	58	52.2
PDMS-130	47 - 58	42.1

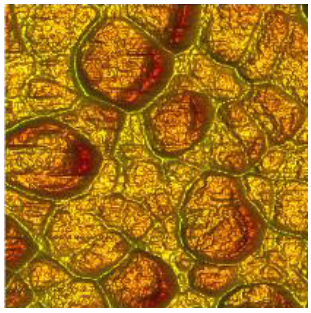


Work of Adhesion measured on the basis of the DFL curves on films of PDMS8, PDMS60 and PDMS130. DvZ curves: red – loading, blue – unloading traces.

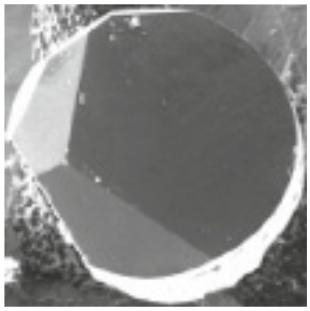
THE NANOSCLEROMETRY MODULE

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.

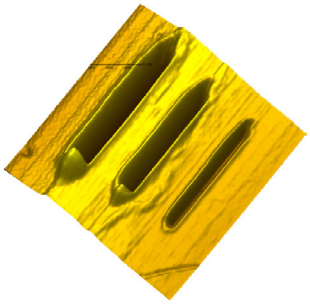




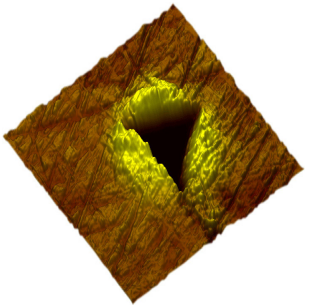
Zr ceramics. a) Topography and b) elastic modulus map,
Scan size:1×1 µm



Indentor: diamond pyramid of Berkovich type



AFM image of scratches, 5×5 µm



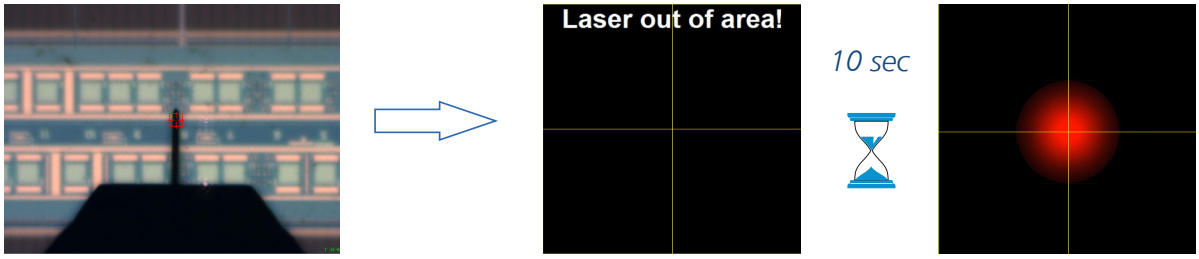
AFM image indentation imprint, 18×18 µm

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

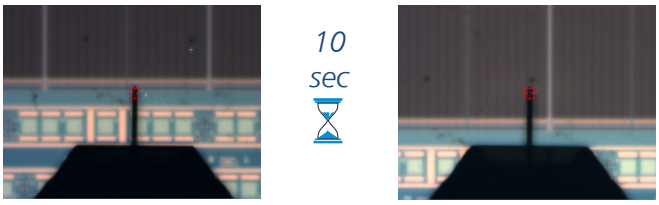
LASER – CANTILEVER – PHOTODIODE AUTOALIGNMENT WITHIN 10 SECONDS

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

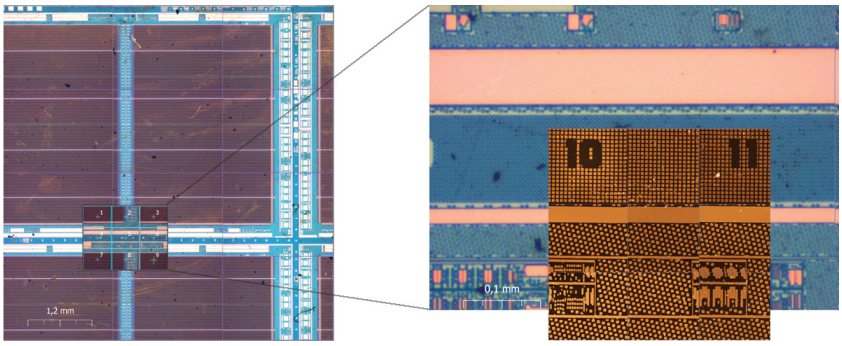
Precise sample positioning in the NEXT is done by motorized XY sample stage. It is very convenient to just select an area of interest directly on the optical image. The NEXT will automatically move it to cantilever and begin scanning.



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 in the same as one operates with interactive maps. Multiscan and ScanStitch provides automated multiple scanning on 5x5 mm range and stitching of overlapping scans



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) overlaid 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 × 10µm (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
Field of view: up to 7x7 panoramic optical view

Nanosclerometry

Hardness: 1...80 GPa
Elasticity modulus: 1...1000 GPa

Size and weight

Size: 470 × 210 × 260 mm
Weight: 25 kg

Modes

HybriD

Topography
Adhesion
Elastisity
Conductivity

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
Permittivity mapping

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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