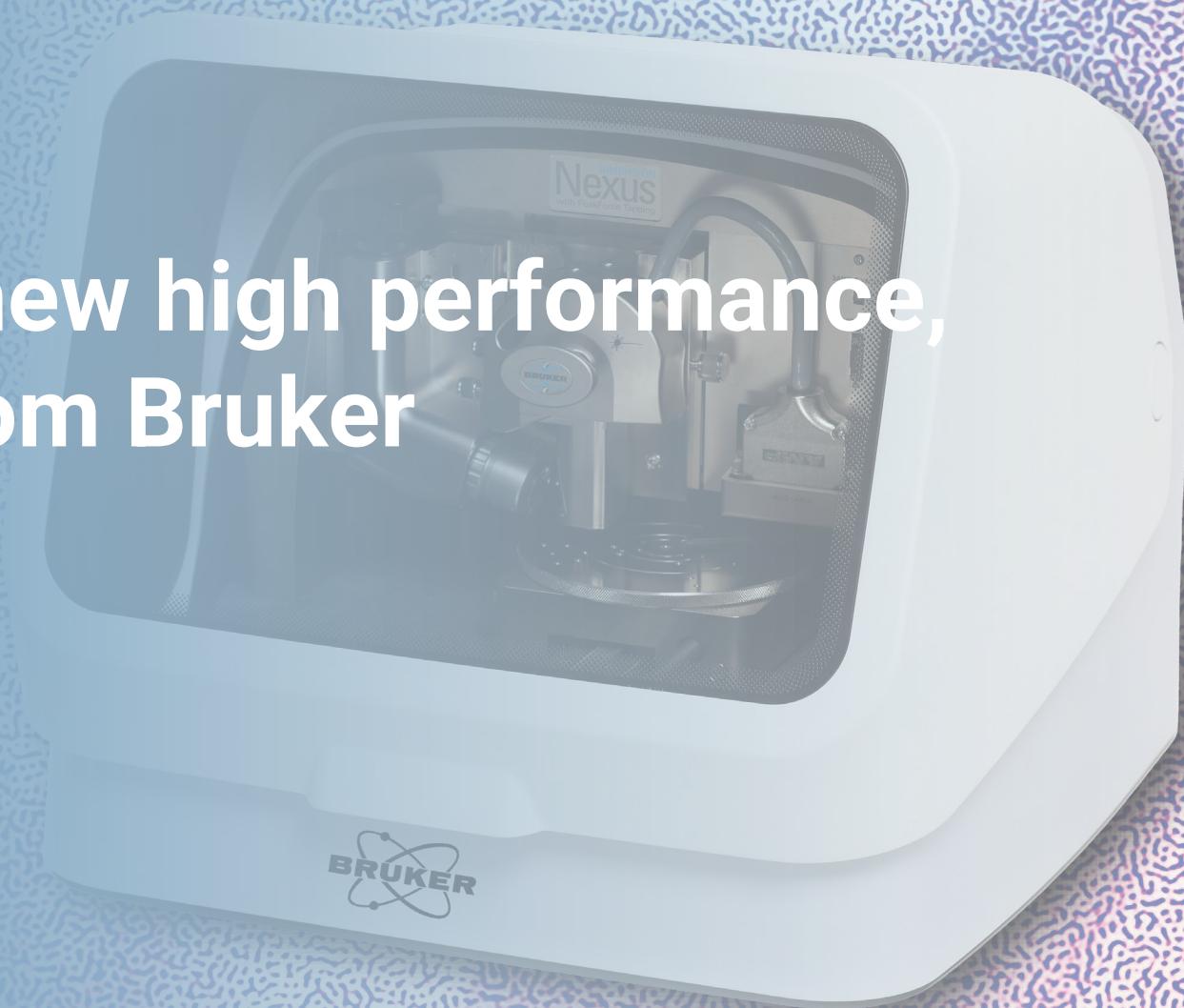




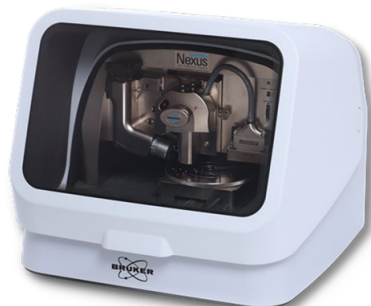
BRUKER DIMENSION NEXUS AFM

Dimension Nexus AFM: new high performance, smaller footprint AFM from Bruker

John Thornton
Sr. Applications Engineer
john.thornton@bruker.com



Latest Addition to the Dimension Product Family



NEW Dimension Nexus



Dimension Icon



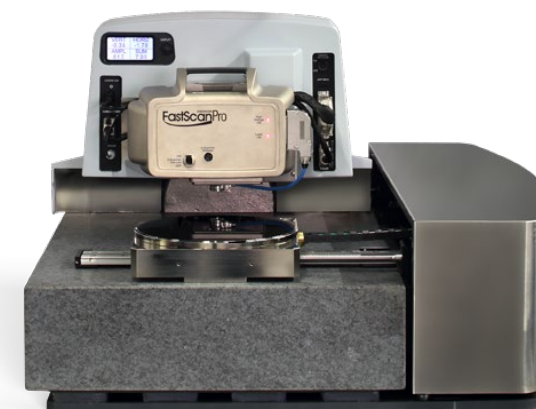
Dimension FastScan



Dimension IconIR



NanoScope 6 Controller



Dimension Pro

Large-sample capabilities in a compact AFM system

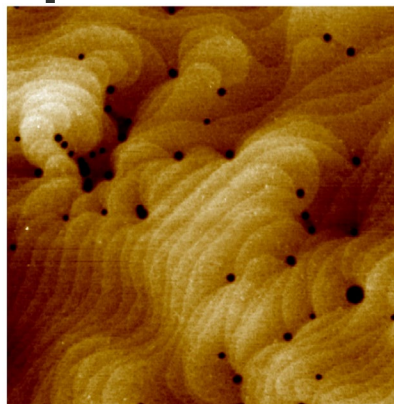
- 150mm diameter sample chuck, compatible with:
 - 6" wafer (maximum)
 - 15mm sample puck (single or multiple)
- Tip scanning design + open access to stage allows range of sample sizes and customized setups.
 - XYZ scan range = $90\mu\text{m} \times 90\mu\text{m} \times 10\mu\text{m}$
- Integrated acoustic enclosure = compact footprint

*High performance tabletop AFM
with large sample capabilities*

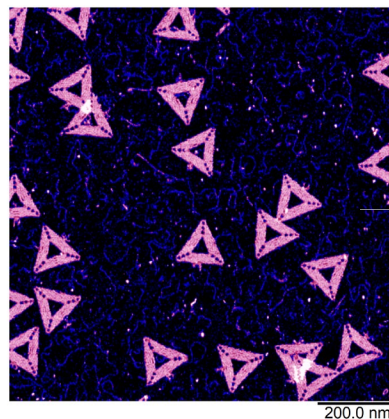


Wide range of measurement techniques

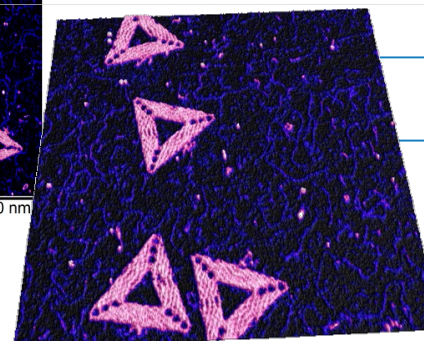
- Highly configurable with full range of advanced AFM modes
- Addresses all major application areas in materials research
- Many modes are unique to Bruker, including:
 - Full suite of PeakForce Tapping modes
 - ScanAsyst self-optimizing imaging
 - ScanAsyst Plus for Contact, Tapping, PeakForce
 - Torsional Resonance (TR-Mode)/ TR-DFM
 - Environmental control: Fluid imaging, heating stages, ...



GaN on Silicon Carbide
(10um)



DNA origami and
individual strands
of DNA in liquid



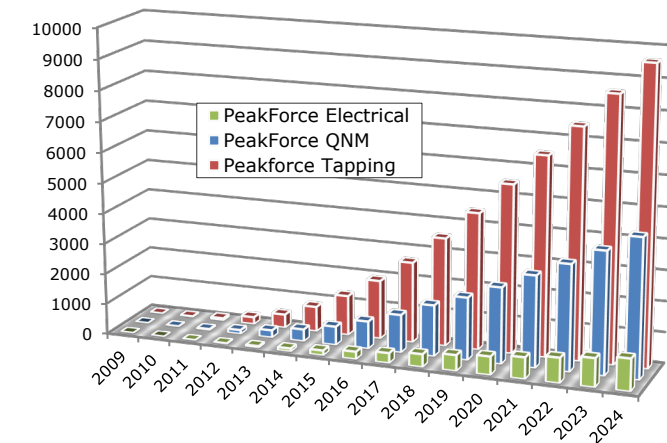
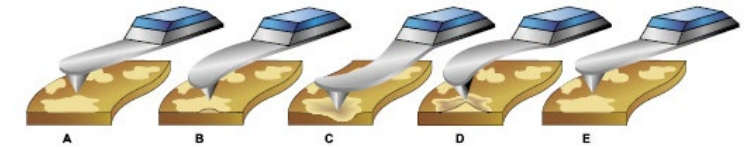
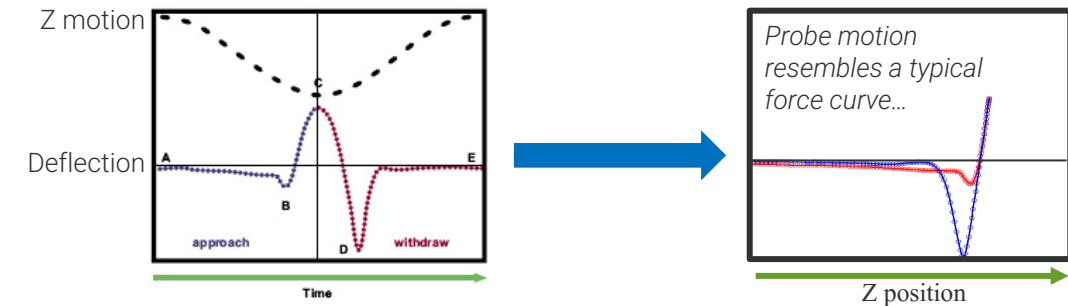
AFM Modes and Capabilities Available

Standard	Optional
PeakForce Tapping	PeakForce QNM (PF-QNM)
ScanAsyst	PeakForce TUNA (PF-TUNA)
TappingMode	PeakForce KPFM™ (PF-KPFM)
Contact Mode	PeakForce EFM (PF-EFM)
Lateral Force Microscopy (LFM™)	DataCube Modes
PhaseImaging™	Ramp & Hold
LiftMode™	Nanolithography
Force Spectroscopy	Dark Lift Mode
Force Volume	Conductive AFM (C-AFM™)
Surface Potential (KPFM)	Tunneling AFM (TUNA)
Piezoresponse Microscopy (PFM)	Fast Tapping
Electrostatic Microscopy (EFM)	Torsional Resonance Mode (TR-Mode™)
	Torsional Resonance Dynamic Friction Microscopy (TR-DFM)
	Fluid Imaging (PeakForce Tapping, TappingMode, Contact Mode)

Inquire for additional modes and capabilities

PeakForce Tapping mode

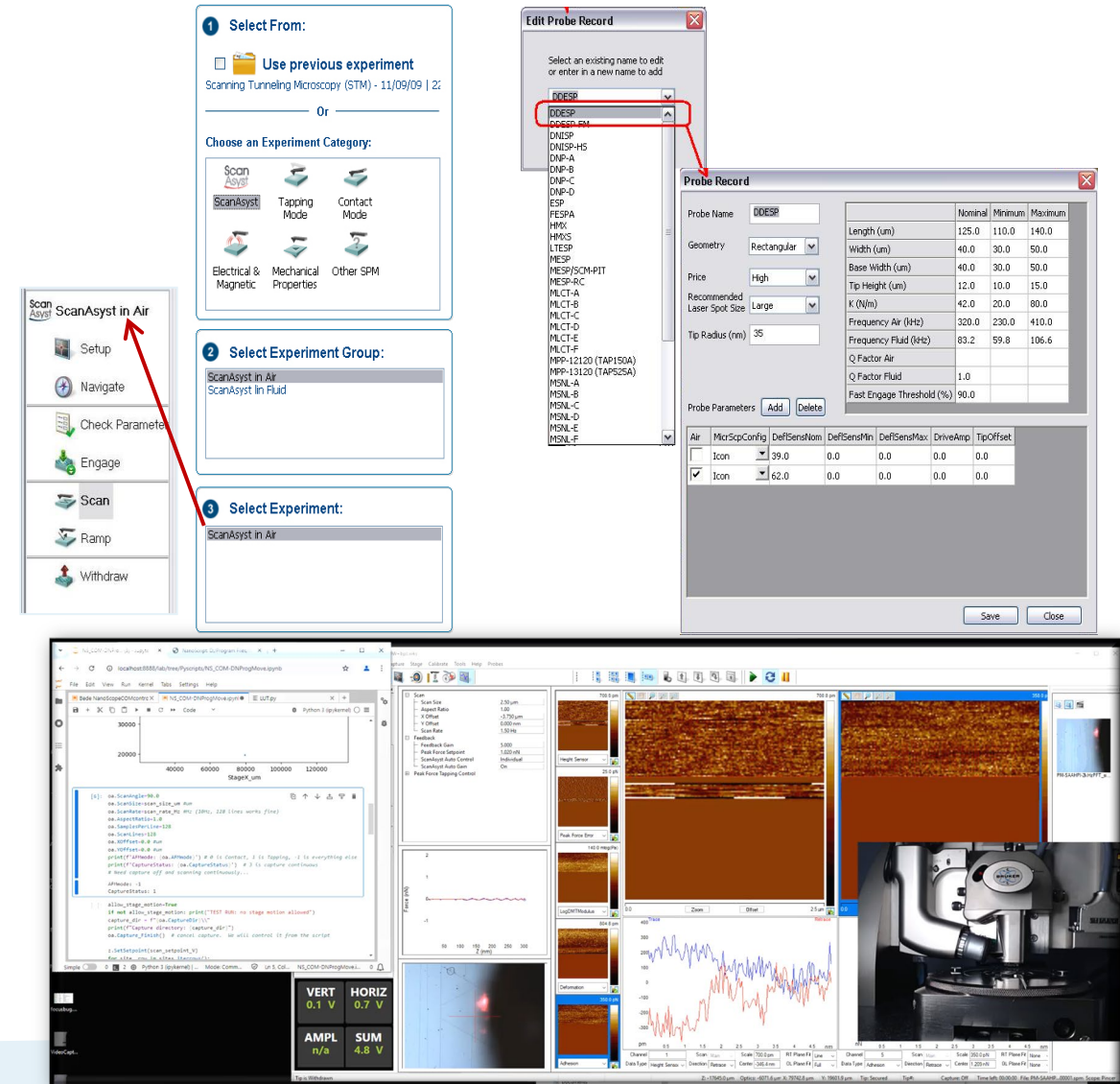
- Probe oscillated at low amplitudes at sub-resonant frequencies (e.g. 1-2kHz), Feedback on “peak” force
- Benefits:
 - Precise control of tip-sample interactions enables lowest imaging forces
 - Tip and sample integrity maintained over extended periods
 - Consistent, repeatable high-resolution imaging
 - Images acquired at standard imaging rates
 - Simultaneous acquisition of quantitative nanoscale sample properties (mechanical, electrical, etc.)
 - PeakForce Tapping/ScanAsyst
 - PeakForce QNM
 - PeakForce TUNA
 - PeakForce KPFM
 - PeakForce MFM
 - PeakForce sMIM
 - ...



Almost 10k publications = 2 each day for the past fifteen years!

Designed to be productive and easy to use

- Ease of use features benefit new and experienced users
 - Tip alignment station
 - Intuitive UI, guided workflow
 - Probes Database
 - Automated tip-surface engagement
 - ScanAsyst self-optimizing imaging
- Programmable, motorized XY-Stage for multi-site and multi-sample measurements (150mm x 150mm)
- Scripting capabilities for automation of XYZ movement and data collection (NanoScript)

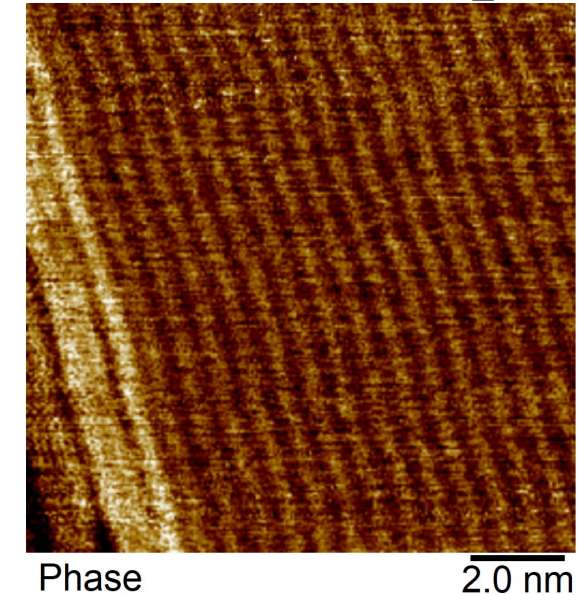
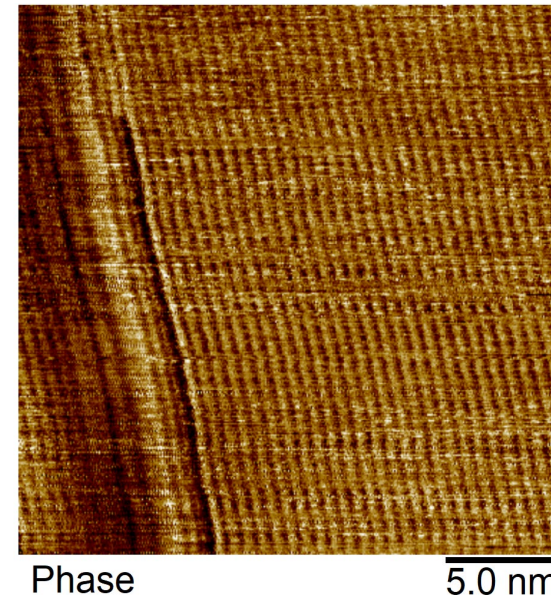
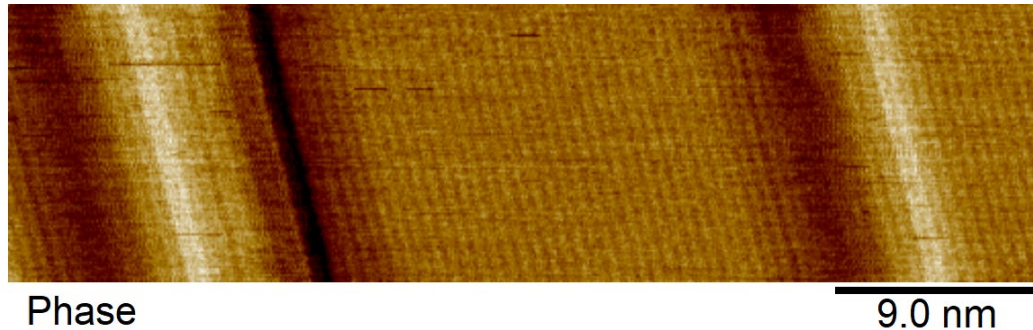
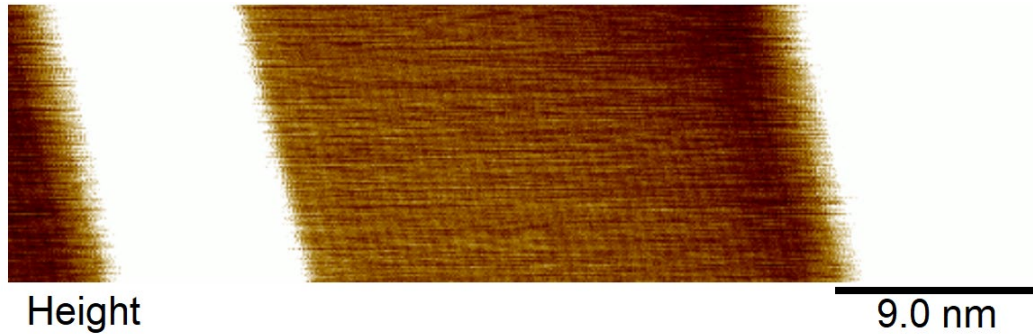
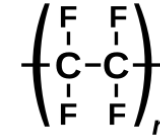


BRUKER DIMENSION NEXUS AFM

Application Examples

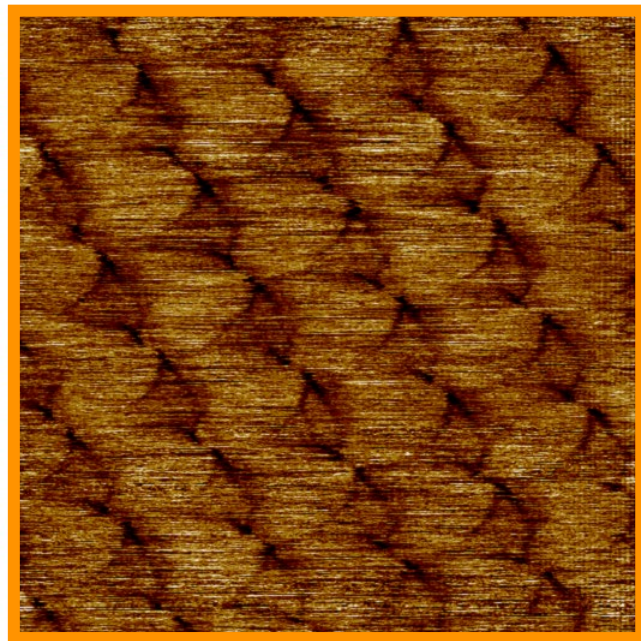
Tapping Mode on PTFE crystal lattice

- Sample: Polytetrafluoroethylene (PTFE) or Teflon, rubbed on surface.
- High spatial resolution: lattice spacing is 0.5 nm, visible in height, height sensor and phase channels



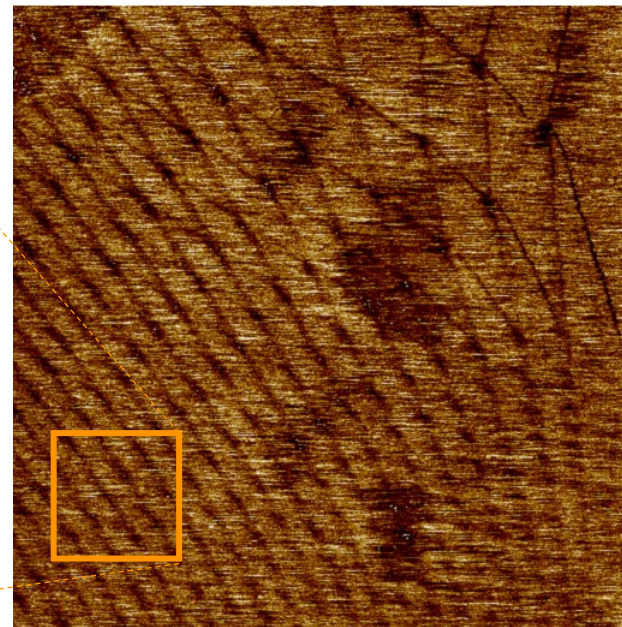
TR-DFM on 2D with Moiré Pattern

- Torsional Resonance Dynamic Friction Mode (TR-DFM) = contact mode feedback with small lateral tip oscillation at the cantilever torsional resonance.
- Images collected at 10 Hz linerate



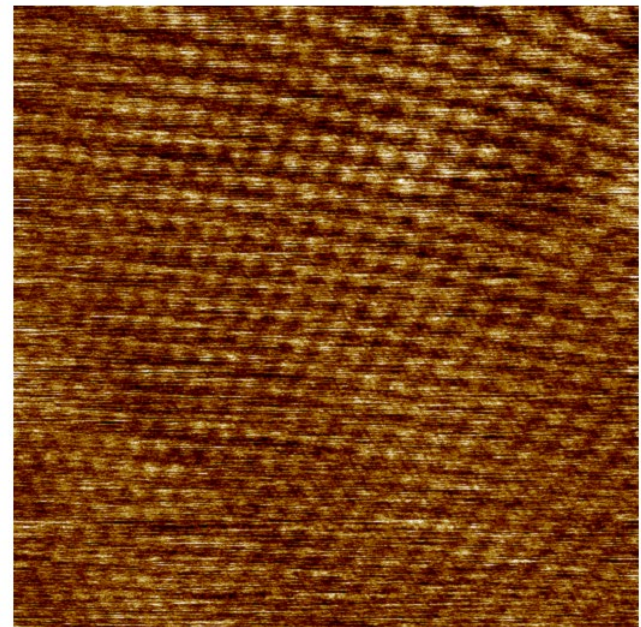
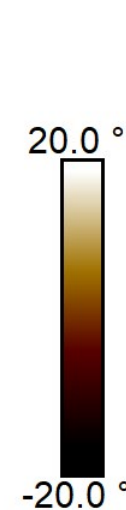
TR Phase

40.0 nm



TR Phase

200.0 nm

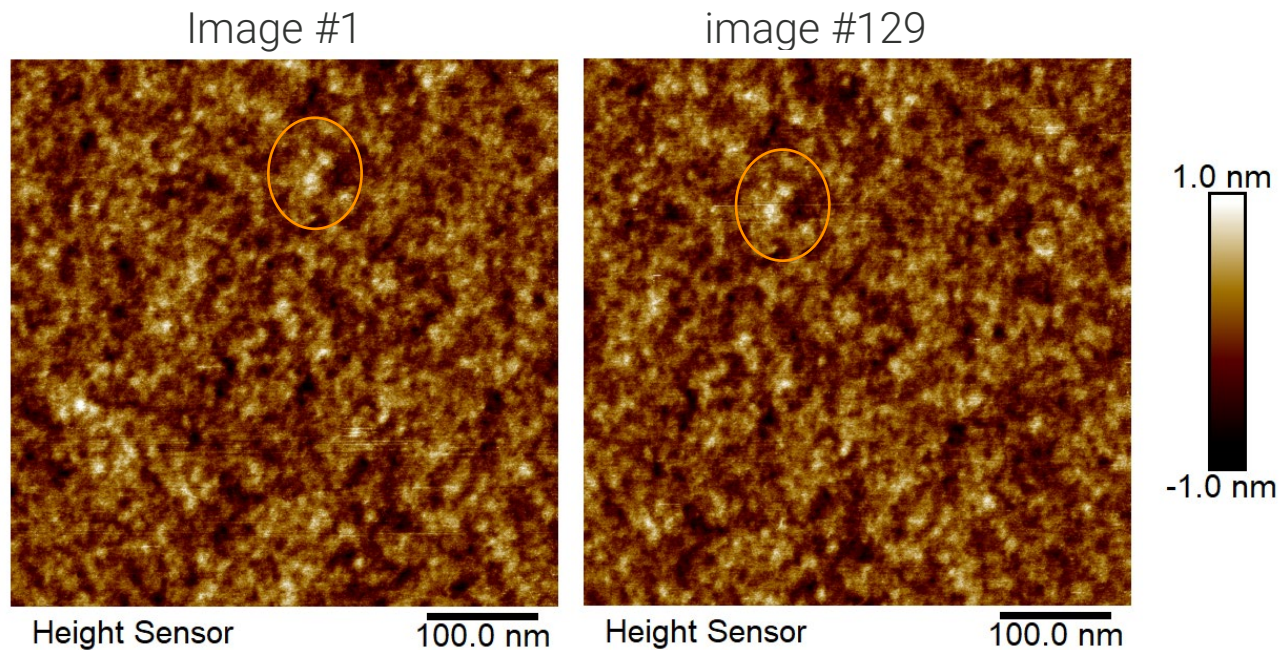


TR Phase

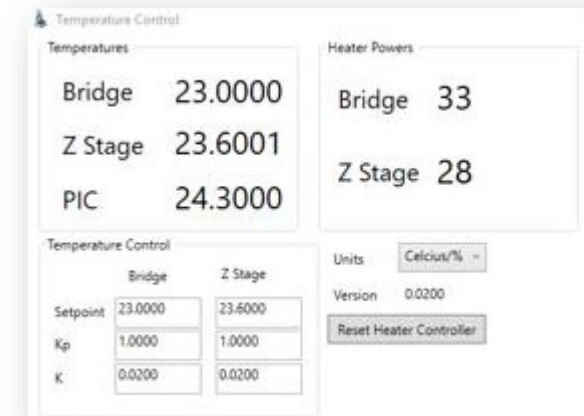
200.0 nm

PeakForce Tapping on SiO₂ 6" Wafer (500 nm scans)

- Extreme low drift is observed: X: 0.10 nm/min, Y: 0.02 nm/min
- Excellent repeatability: 129 repeats: Ra roughness = 208 pm, std dev = 2 pm

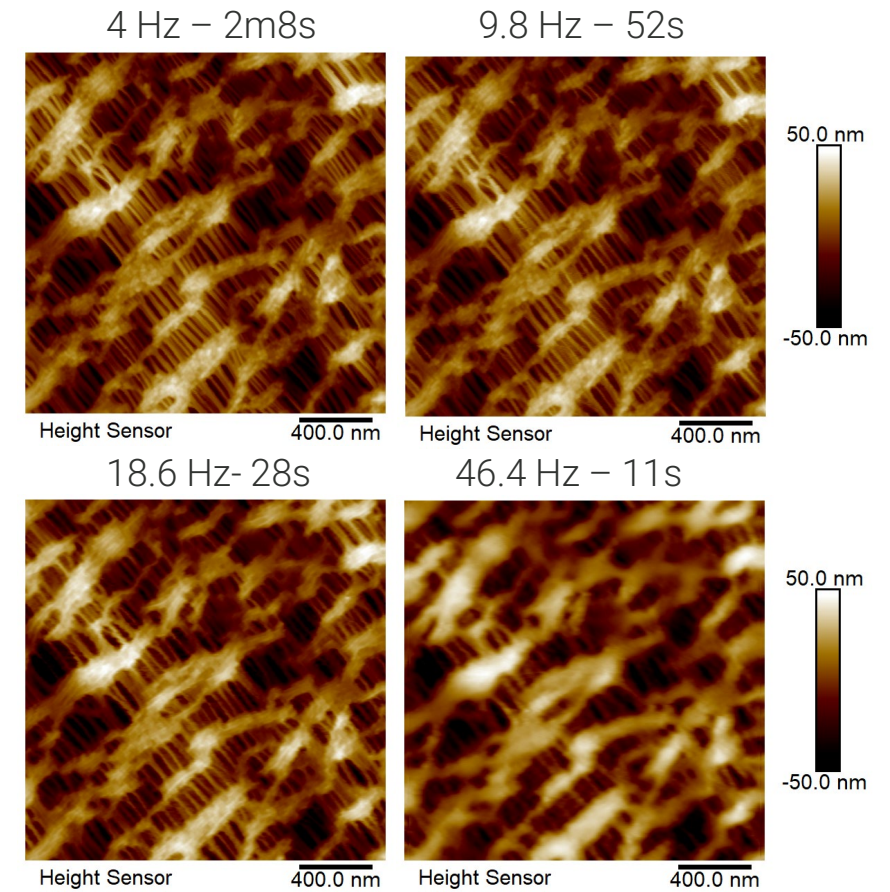
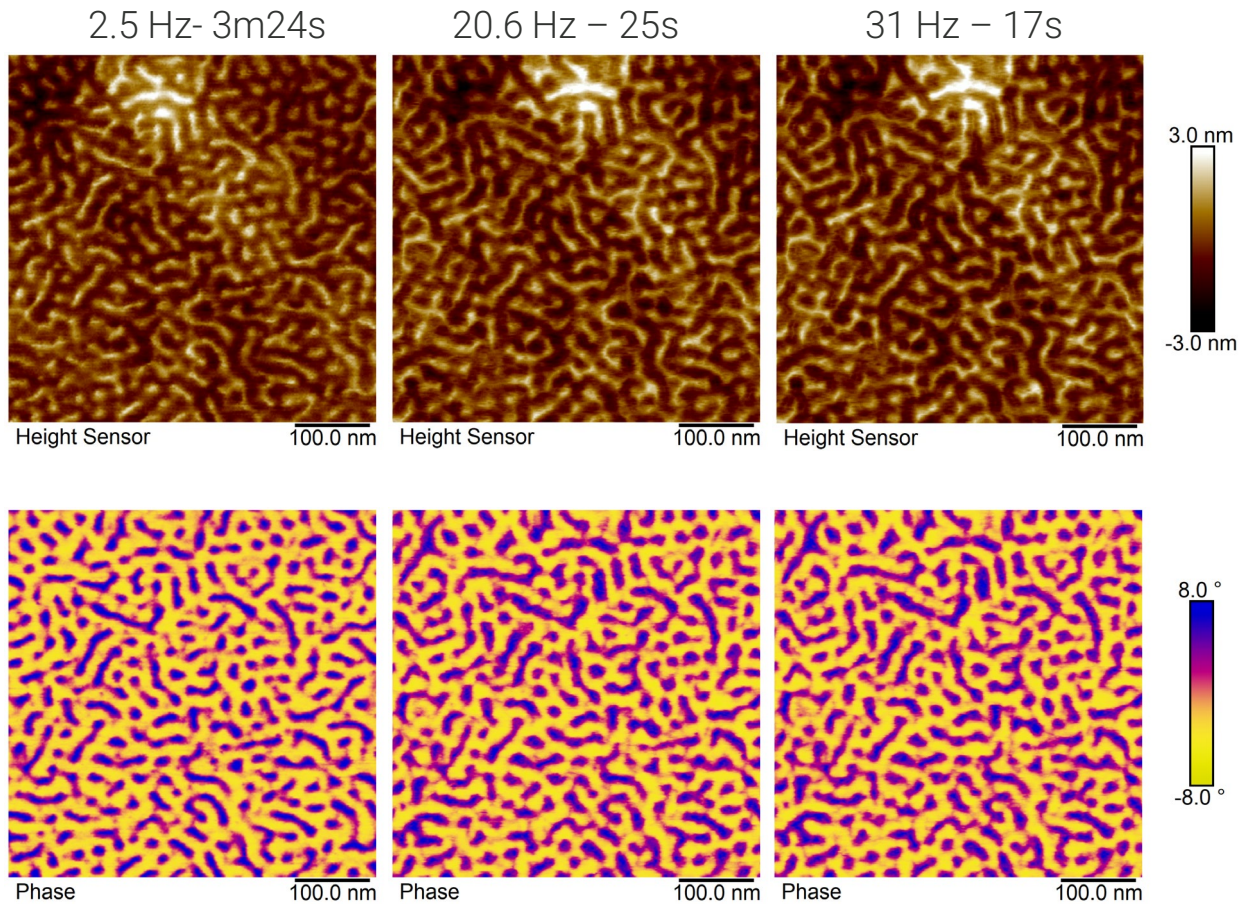


Active control of temperature of key instrument components



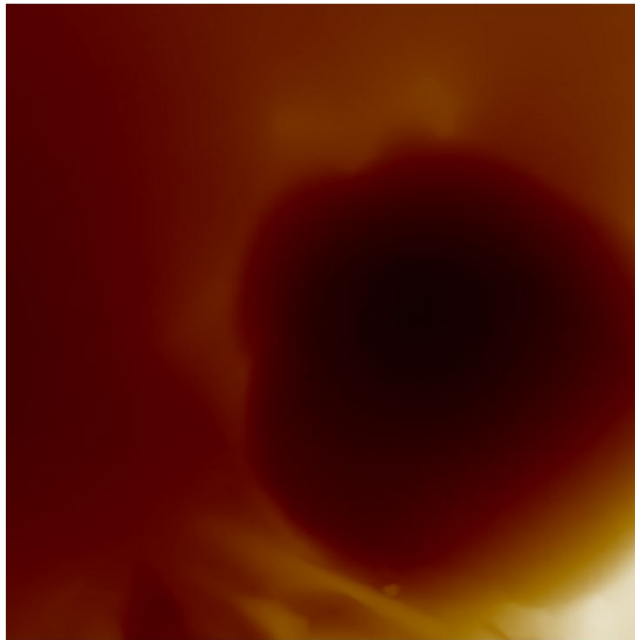
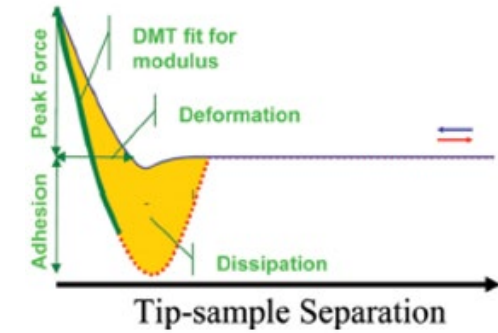
Tapping on SBC Polymer & Celgard

- Good throughput can be obtained. All images 512x512 pixels.

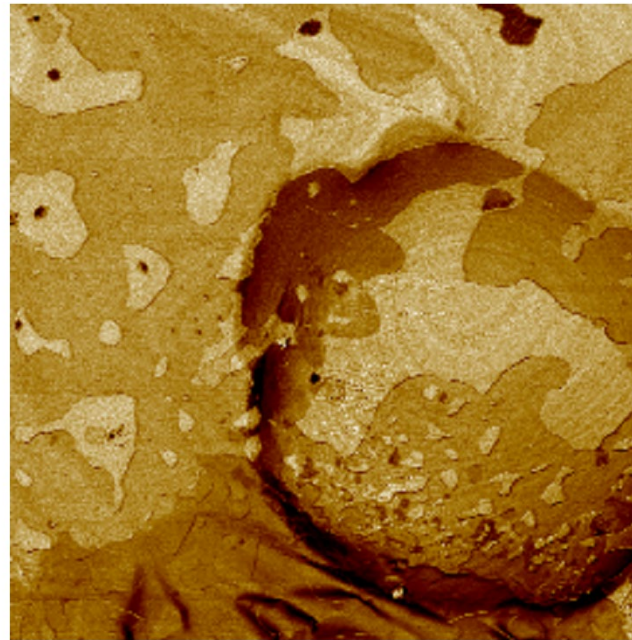


PeakForce QNM on PS-PMMA-PVC blend

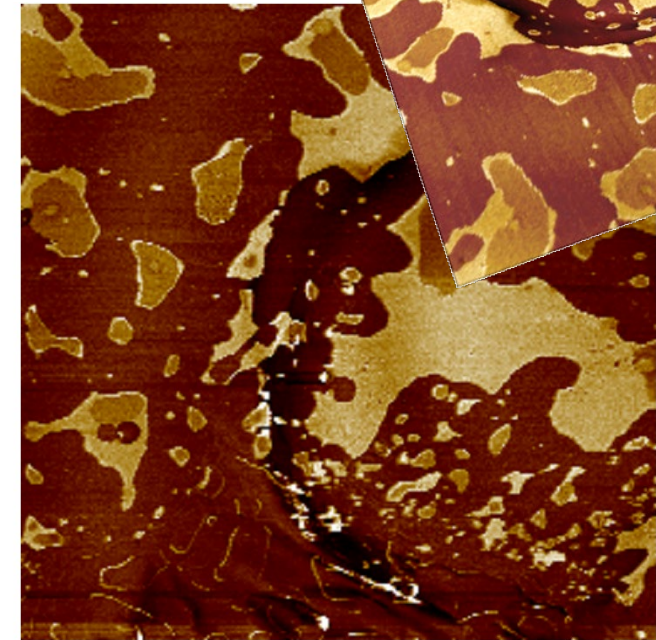
- Accurate mechanical property measurements at standard imaging speeds
- Adhesion, Modulus, Deformation, Indentation
- Sample courtesy: Ph. Leclere, Uni Mons, Belgium



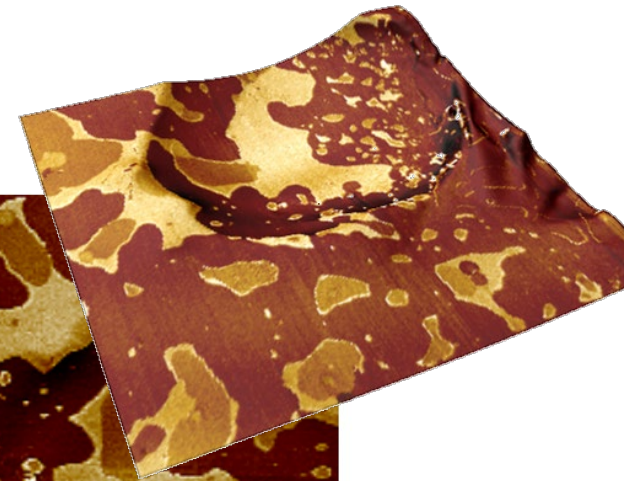
Height Sensor

1.0 μm 

LogDMTModulus

1.0 μm 

Adhesion

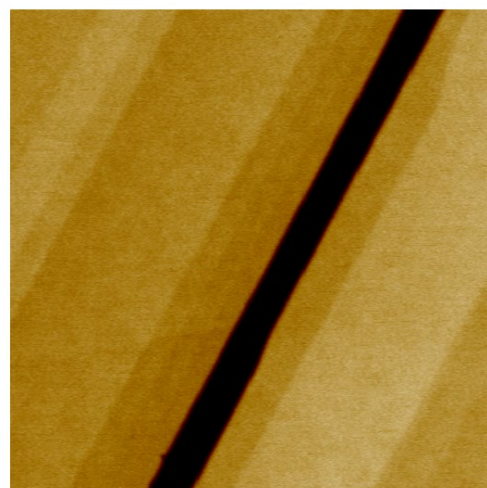
1.0 μm 

Kelvin Probe Force Microscopy: a suite of implementations

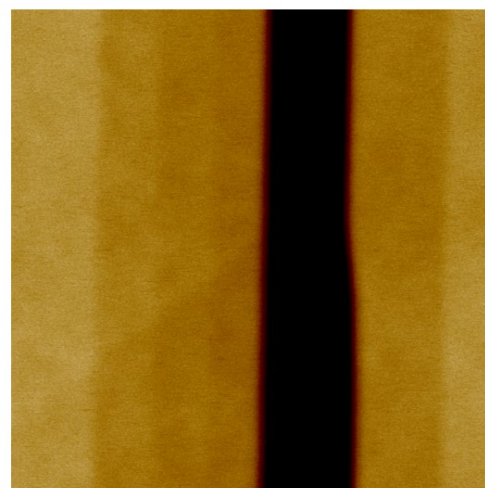
- Five different implementations for surface potential measurements

Name in Software	Type	Topography	Surface Potential
PeakForce KPFM	Two-scans	PeakForce Tapping (with QNM)	FM-KPFM (in lift mode)
PeakForce KPFM-AM	Two-scans	PeakForce Tapping (with QNM)	AM-KPFM (in lift mode)
PeakForce KPFM-HV	Two-scans	PeakForce Tapping (with QNM)	Open loop FM-KPFM (in lift mode)
Surface Potential (AM-KPFM)	Two-scans	Tapping	AM-KPFM (in lift mode)
Surface Potential (FM-KPFM)	Single scan	Tapping	FM-KPFM

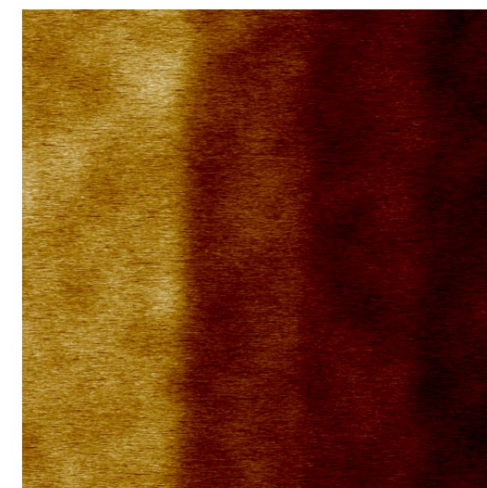
FM-KPFM on hBN: high spatial resolution and sensitivity



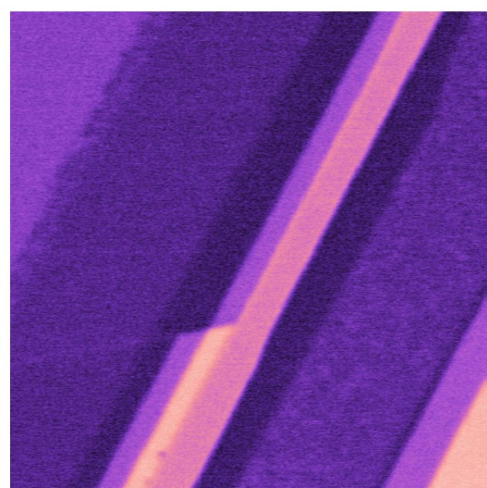
1.0 μm



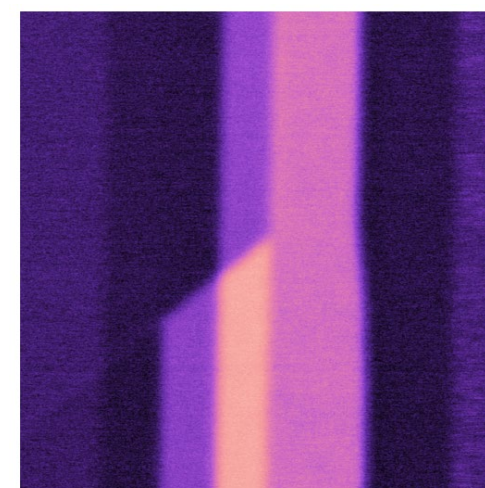
500.0 nm



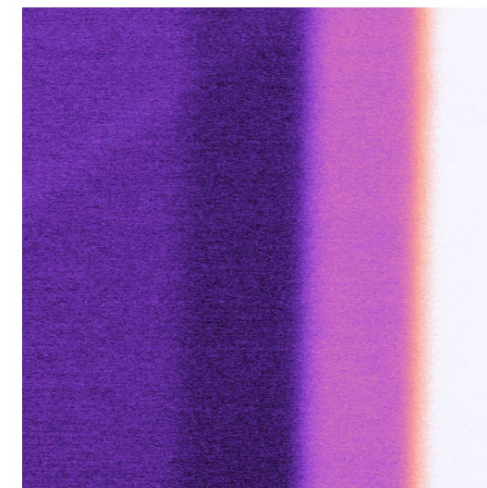
240.0 nm



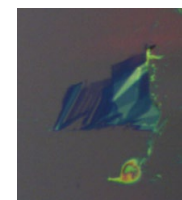
1.0 μm



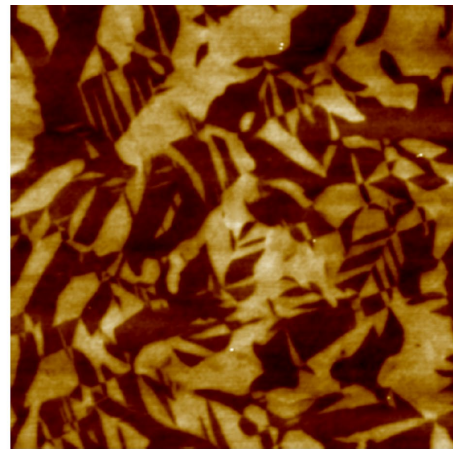
500.0 nm



240.0 nm



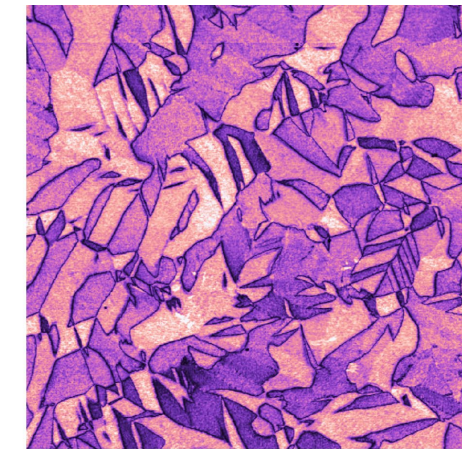
Piezo Force Microscopy (PFM): single crystal lead PMN-PT



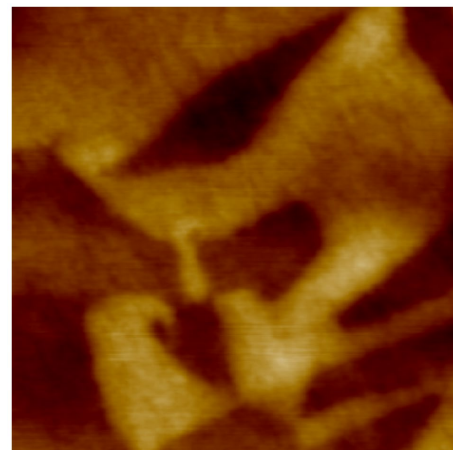
Height Sensor 2.0 μm



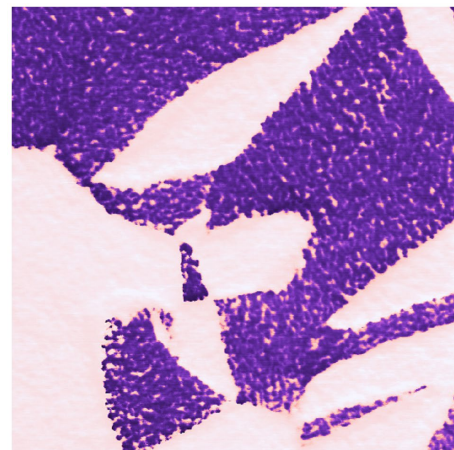
HS PR Phase 2.0 μm



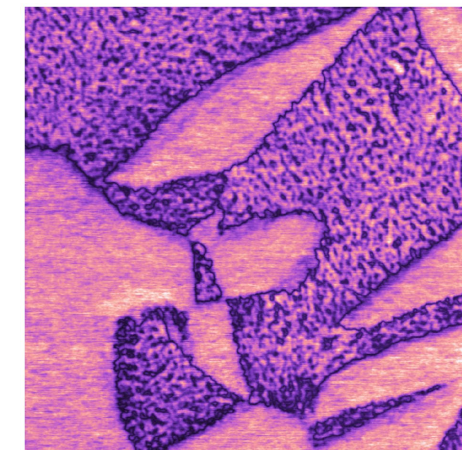
HS PR Amplitude 2.0 μm



Height Sensor 400.0 nm



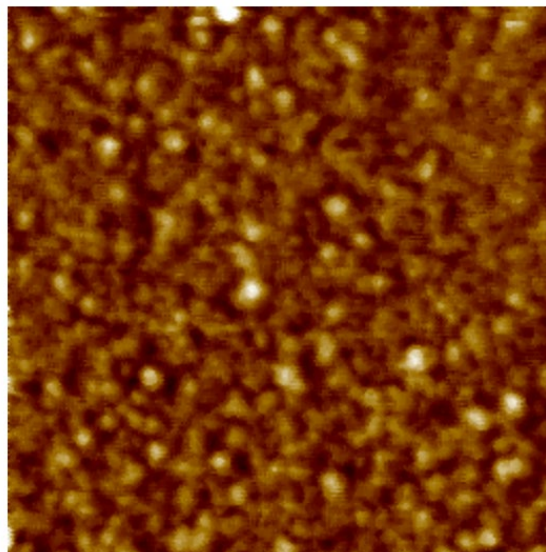
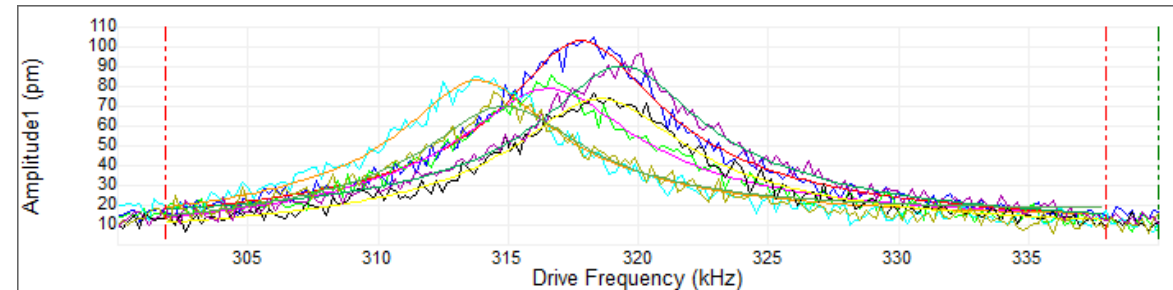
HS PR Phase 400.0 nm



HS PR Amplitude 400.0 nm

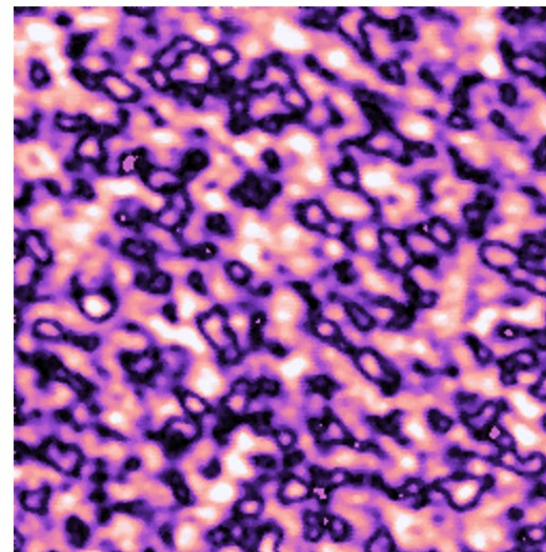
DataCube Contact Resonance PFM: stay tuned

- BFO sample test.
- Sweeping the AC frequency during hold.
- Following the contact resonance at every pixel.



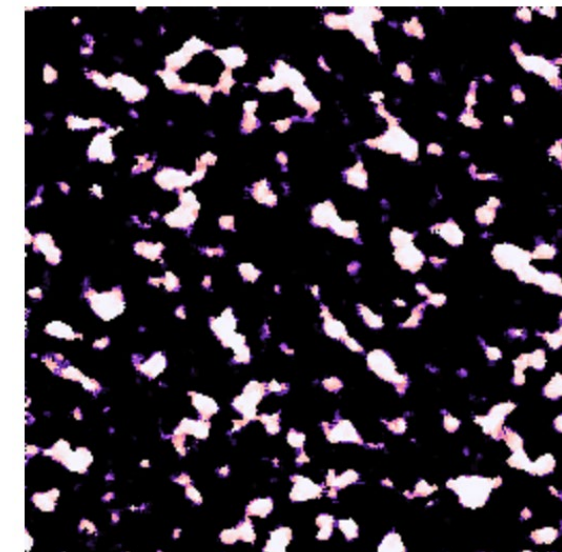
Height Sensor

600.0 nm



CR Amplitude

600.0 nm

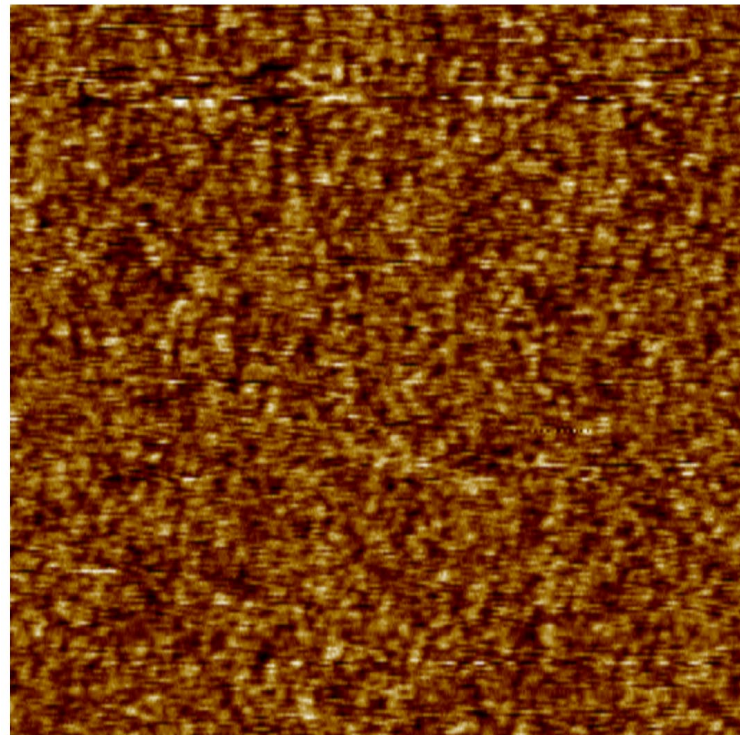
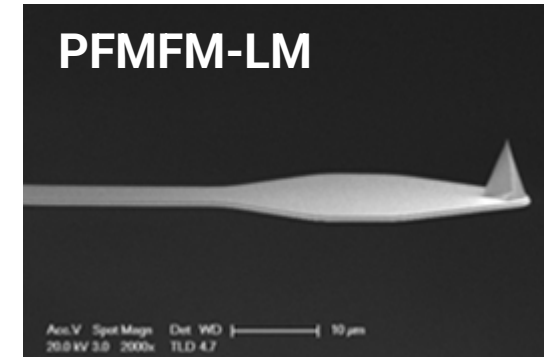


CR Phase

600.0 nm

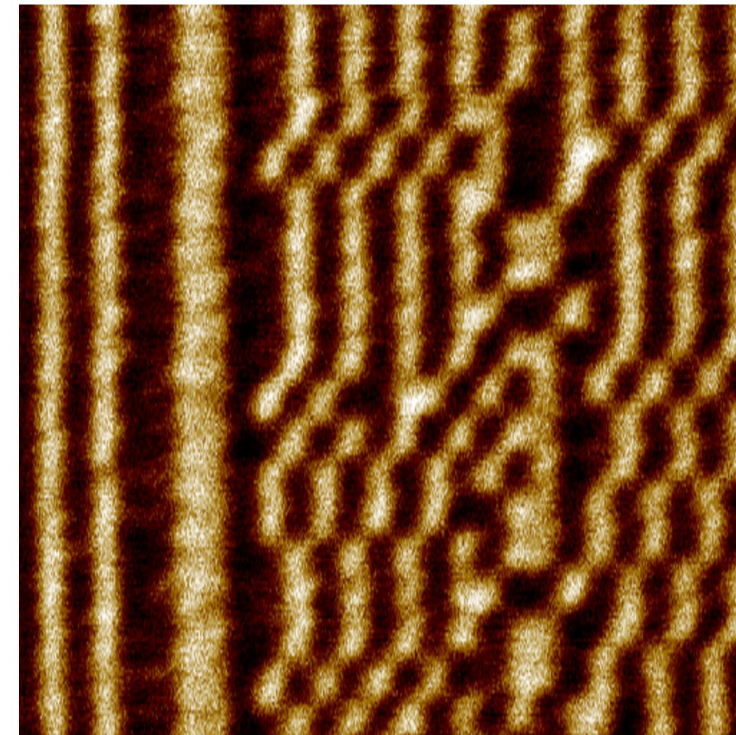
PeakForce Magnetic Force Microscopy (PF MFM): 20 TB HDD

- Improved sensitivity and resolution owing to special probes.
- $k \sim 0,5 \text{ N/m}$, $f_{\text{res}} \sim 110 \text{ kHz}$, $Q \sim 60$.
- Higher sensitivity (Q/k) and higher speed (f/Q).



Height Sensor

200.0 nm



Phase1

200.0 nm

AFM Modes Handbook



ATOMIC FORCE MICROSCOPY

The Definitive AFM Modes Handbook

A Comprehensive Guide to Expanding Your Materials Research Capabilities

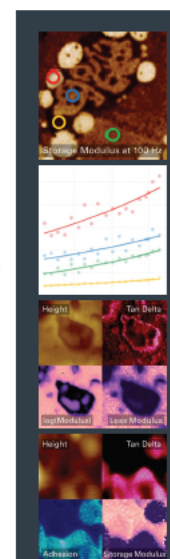
- Download from <https://www.bruker.com/en/products-and-solutions/microscopes/materials-afm/resource-library/e-book-the-definitive-afm-modes-handbook.html>

TappingMode

TappingMode is the most popular AFM imaging mode in both air and liquids, and is also the backbone for many specialized modes, such as PeakForce TUNA and magnetic development of hers to image nd the lateral forces i speeds much in contact mode.

sted technique that pping the surface, at resonance sw nanometers The cantilever's with sample xography image is changes and closing ze them. When s phase signal is jing page).

graphical studies e sciences. n both air and liquid le to virtually any damage to tip or in thousands of high-bandwidth also be a



AFM Nanoscale Dynamic Mechanical Analysis (AFM-nDMA)

AFM-nDMA provides quantitative viscoelastic property measurements of nanoscale domains in heterogeneous polymeric materials. AFM-nDMA directly addresses frequency and temperature dependence of viscoelastic properties in the rheologically relevant range (0.1–20 kHz). In contrast with traditional AFM modes, AFM-nDMA compares well with established mechanical characterization techniques while enabling studies of microstructure and bulk properties.

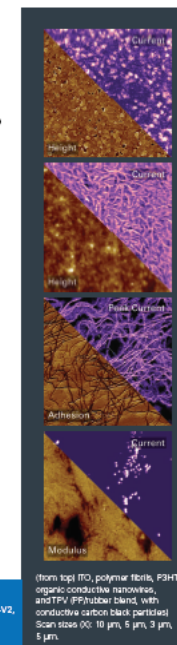
AFM-nDMA includes two main modes of operation. First, viscoelastic moduli images can be collected through single-frequency data collection in force volume mode. Second, frequency sweep measurements are performed in selected positions on the sample. This advanced ramp spectroscopy uses a ramp scripting routine with a series of segments to control preload, relaxation, modulation, and calculation of contact radius. Analysis then leads to the creation of mastercurves, as well as quantitative data for loss tangent, loss modulus, and storage modulus.

AFM-nDMA is the most advanced AFM method for the quantitative characterization of viscoelastic properties at the nanoscale. It is preferred over other AFM-based nanomechanical methods for characterizing a wide variety of polymer and nanomaterial samples.

PeakForce Tunneling AFM (PeakForce TUNA)

PeakForce TUNA was specifically designed for local electrical conductivity mapping on soft and fragile samples. This technique offers high spatial resolution, high current sensitivity, and the ability to map properties, such as the electrical conductivity, over the entire scan area. The current can be measured in a short time since the probe tip is fixed.

PeakForce TUNA offers a variety of electrical properties better than other AFM modes.



PeakForce TUNA, SCM-PIC-V2, and others

(from top) PD, polymer fibrils, P3HT organic conductive nanowires, and P3HT/P3HT nanowires, with conductive carbon black particles. Scan sizes (X): 10 μm, 5 μm, 3 μm, 1 μm.

Summary

- Come by our booth to see the Nexus live



Connect with us:



Bruker Nano Surfaces & Metrology



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@BrukerNanoSurfacesMetrology

John Thornton, john.thornton@bruker.com

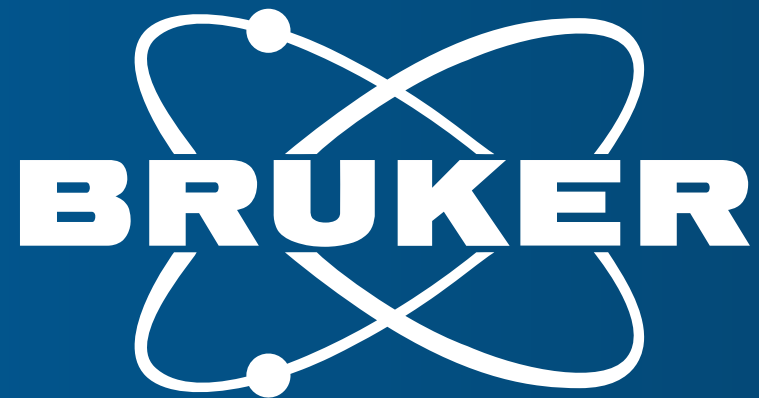
Thank you!



<https://www.bruker.com/en/meta/forms/bns-form-pages/brochures/afmi/dimension-nexus.html>



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