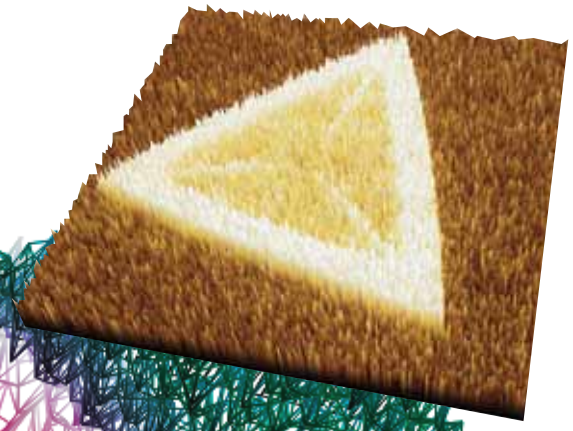
Volume 03

Park Systems Atomic Force Microscopy

IMAGE GALLERY

Here, at Park Systems, we offer a full range of advanced imaging solutions for a wide variety of research applications. Enjoy the images in the gallery which highlight examples from a wide variety of sample types and imaging modes.



CVD grown WS_2 p.21

Standard Modes

True Non-Contact™ Mode

Advanced Modes

Kelvin Probe Force Microscopy

Conductive AFM

Megnetic Force Microscopy

Piezoelectric Force Microscopy

Nanolithography

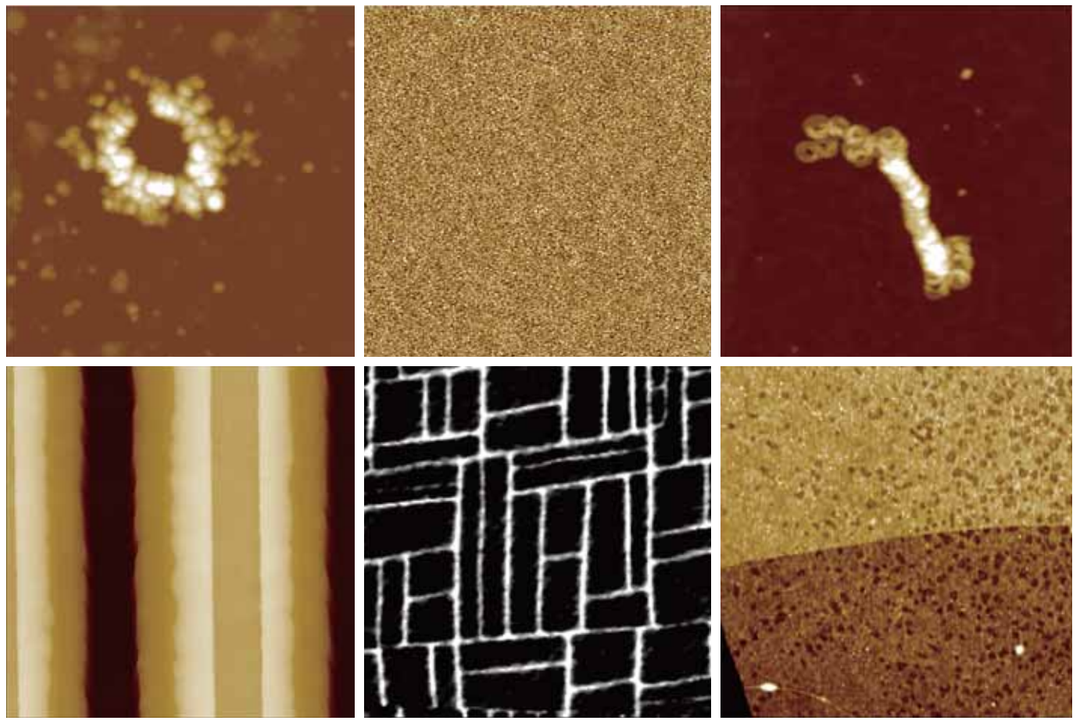
Tapping Mode

Lateral Force Microscopy

PinPoint™ Nanomechanical Mode

Scanning Thermal Microscopy

Park SYSTEMS

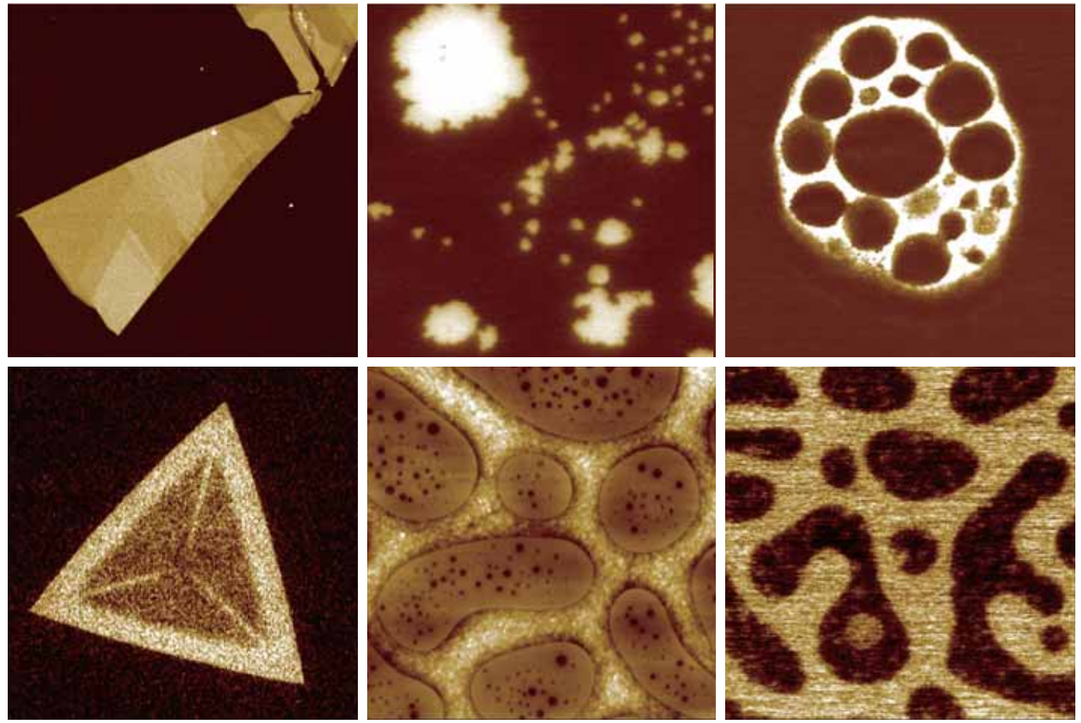


Standard Modes

True Non-Contact™ Mode

Advanced Modes

Kelvin Probe Force Microscopy



Advanced Modes

Conductive AFM

Megnetic Force Microscopy

Piezoelectric Force Microscopy

Nanolithography

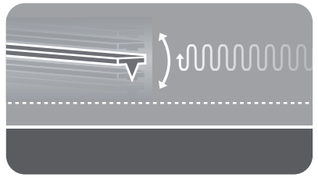
Tapping Mode

Lateral Force Microscopy

PinPoint™ Nanomechanical Mode

Scanning Thermal Microscopy

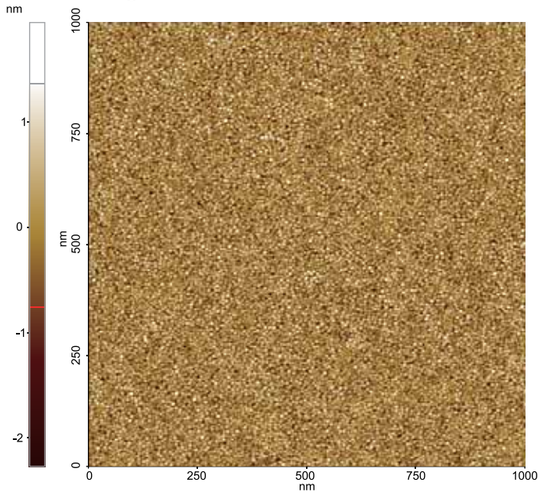
Hard Disk Media



True Non-Contact™ Mode

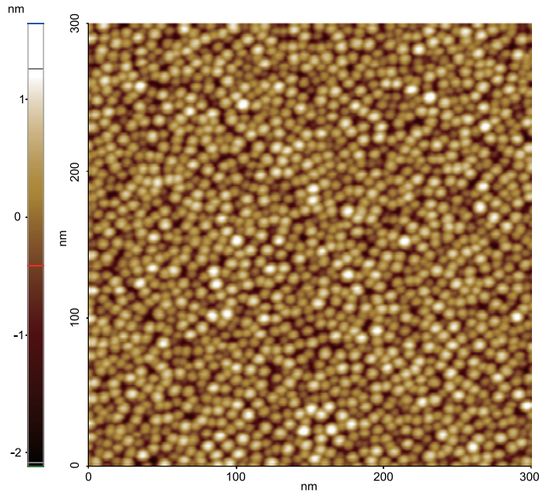
In this technique, the cantilever oscillates just above the surface as it scans. A precise, high-speed feedback loop prevents the cantilever tip from crashing into the surface, keeping the tip sharp and leaving the surface untouched. As the tip approaches the sample surface, the oscillation amplitude of the cantilever decreases. By using the feedback loop to correct for these amplitude deviations, one can generate an image of the surface topography.

Height



Peak to Valley: 3.656 nm
RMS Roughness: 0.361 nm

300 nm scan Height



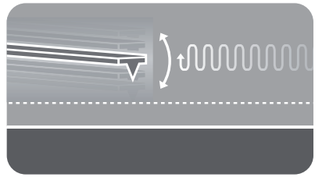
Peak to Valley: 2.451 nm
RMS Roughness: 0.344 nm

Scanning conditions

System: NX10
Scan Size: 1 μm × 1 μm, 0.3 μm × 0.3 μm
Scan Mode: Non-contact

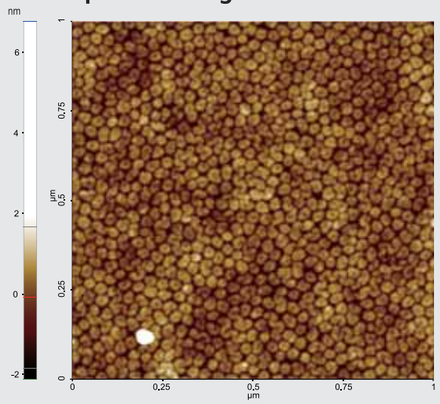
Scan Rate: 0.5 Hz, 1 Hz
Cantilever: SSS-NCHR (k = 42 N/m, f = 300 kHz)
Pixel Size: 512 × 512, 256 × 256

Self-Assembly of Semi-Fluorinated Alkanes



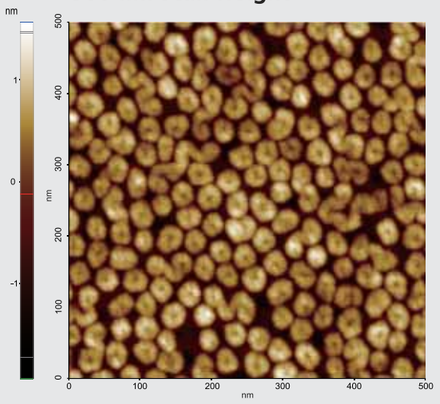
True Non-Contact™ Mode

1 μm scan Height



Peak to Valley: 8.8 nm

500 nm scan Height

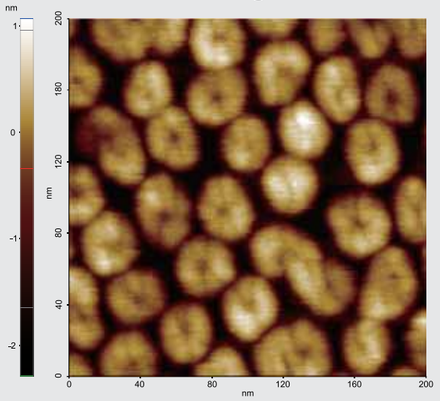


Peak to Valley: 3.5 nm

Domains formed by the self-assembly of semi-fluorinated alkanes deposited as a monolayer on the surface of the water. The monolayer was compressed before being transferred onto a silicon substrate. Each domain includes about 4000 molecules.

The domains were easily detached from the substrate with tapping mode because the molecules were very loosely attached to the substrate. Only non-contact mode could achieve this result.

200 nm scan Height



Peak to Valley: 3.3 nm

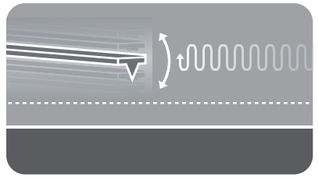
Sample courtesy: INSP Paris Jussieu

Scanning conditions

System: NX10
Scan Size: 1 μm × 1 μm / 0.5 μm × 0.5 μm / 0.2 μm × 0.2 μm
Scan Mode: Non-contact

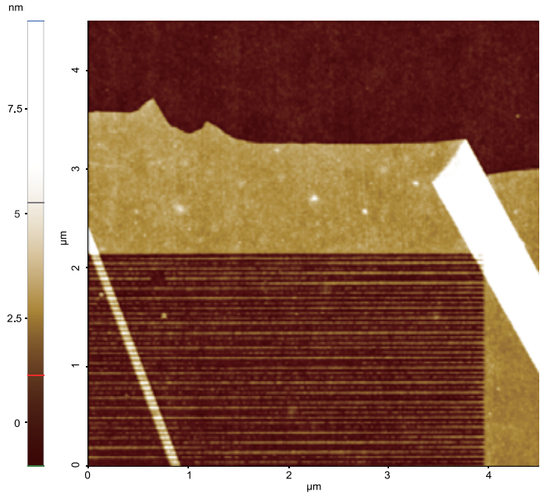
Scan Rate: 2 Hz
Cantilever: PPP-FMR (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 500 × 500

Nanopatterned Graphene on Boron Nitride



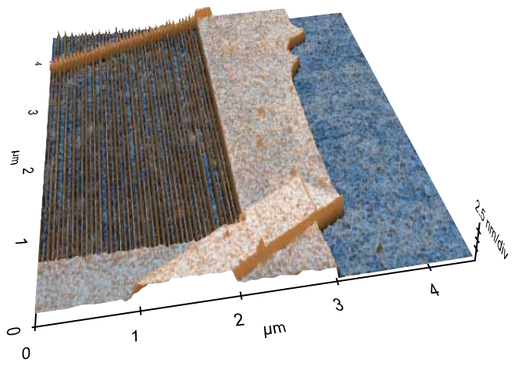
True Non-Contact™ Mode

Height



Peak to Valley: 10.6 nm

3D



X:Y:Z Scale = 1:1:30

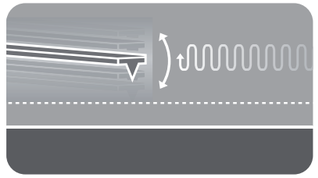
Sample courtesy: Dr. Jonathan Eroms, University of Regensburg, Germany

Scanning conditions

System: NX10
Scan Size: 4.5 µm × 4.5 µm
Scan Mode: Non-contact

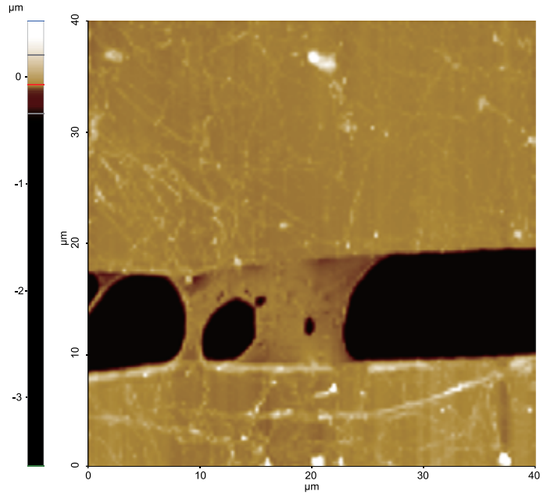
Scan Rate: 0.75 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 512

Suspended Single-Layer Graphene



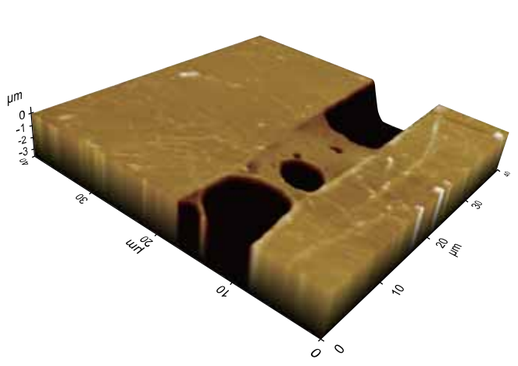
True Non-Contact™ Mode

Height



Peak to Valley: 4200 nm

3D



X:Y:Z Scale = 1:1:1.5

Single-layer graphene is suspended on microchannels fabricated on Si/SiO_2 substrate

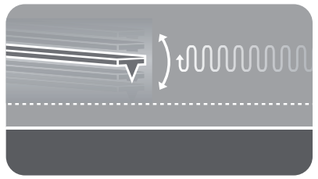
Sample courtesy: Prabhat Vashisth, Dr. Prosenjit Sen, CeNSE, IISc, India
Image courtesy: Sanket Jugade, Dr. Akshay Naik, CeNSE, IISc, India

Scanning conditions

System: NX20
Scan Size: 40 µm × 40 µm
Scan Mode: Non-contact

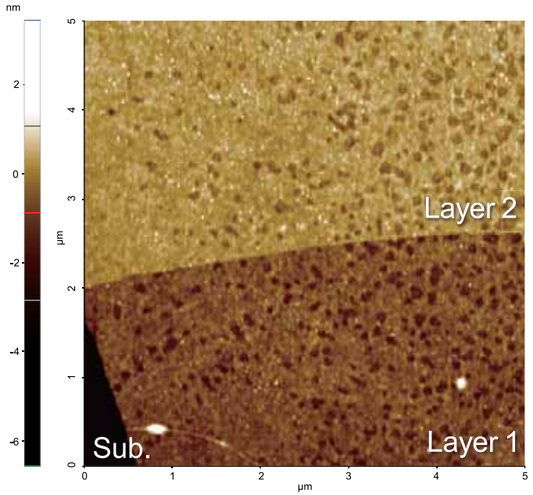
Scan Rate: 0.4 Hz
Cantilever: Access-NC (k = 113 N/m, f=330kHz)
Pixel Size: 256 × 256

MoS_2 Layers on SiO_2



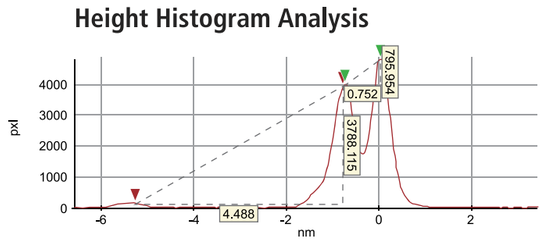
True Non-Contact™ Mode

Height



Peak to Valley: 9.9 nm

Height Histogram Analysis



▲ Height between substrate and layer1 = ~ 4.5 nm
▲ Height between layer1 and layer2 = ~ 0.7 nm

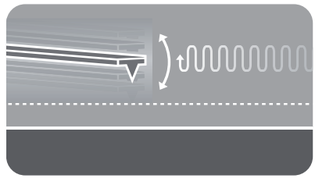
Image courtesy: Wang Junyong, NUS Physics, Singapore

Scanning conditions

System: NX10
Scan Size: 5 μm × 5 μm
Scan Mode: Non-contact

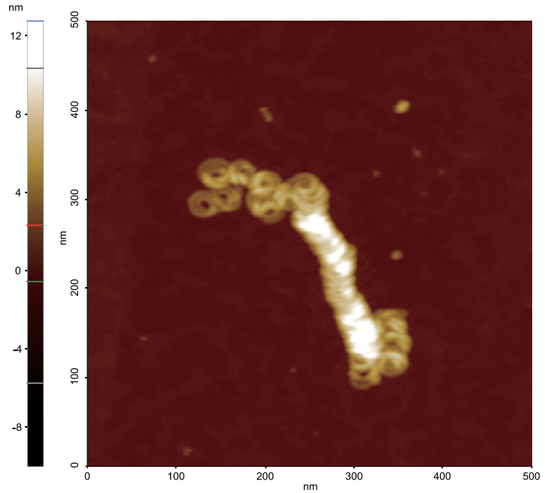
Scan Rate: 1 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 256 × 256

Supramolecular Polymer



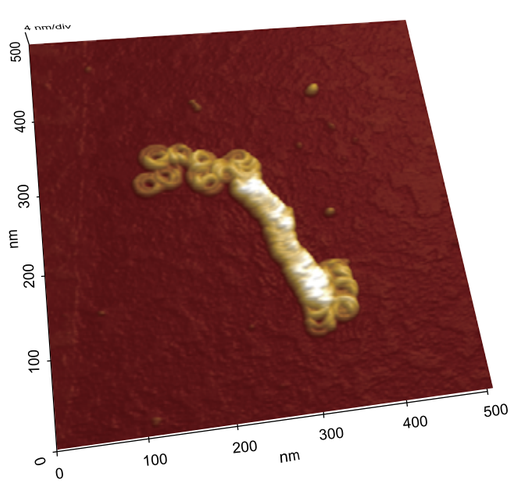
True Non-Contact™ Mode

Height



Peak to Valley: 13.3 nm

3D



X:Y:Z Scale = 1:1:2

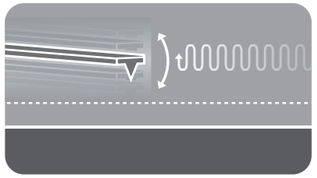
Self-folding of supramolecular polymers

Scanning conditions

System: NX10
Scan Size: 0.5 μm × 0.5 μm
Scan Mode: Non-contact

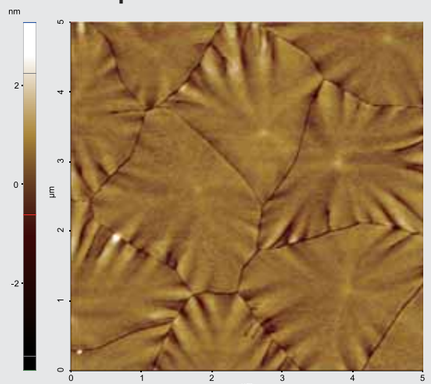
Scan Rate: 0.5 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 512

ITO IIndioum Tin Oxide) Film Sputter Deposited onto Silicon



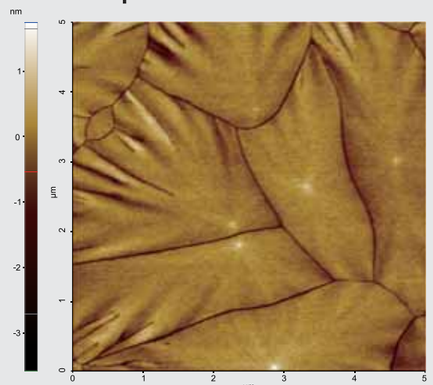
True Non-Contact™ Mode

Sample #1



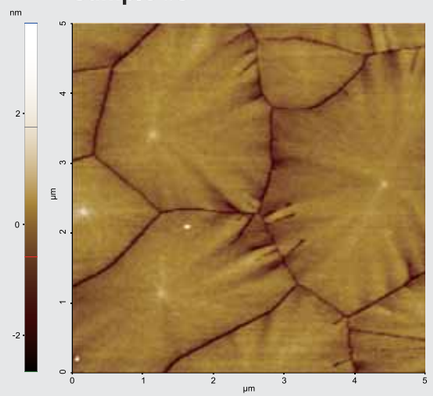
Peak to Valley: 7.0 nm

Sample #2



Peak to Valley: 5.3 nm

Sample #3



Peak to Valley: 6.3 nm

ITO-film, which was sputter deposited onto silicon. The grain size of those samples was influenced by changing the process settings in the Cluterline RAD sputter deposition system, one of the deposition tool platforms manufactured by Evatec.

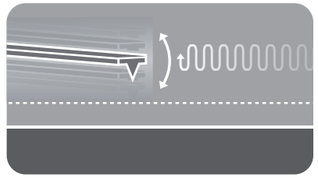
Sample courtesy: Evatec AG - The Thin Film Powerhouse

Scanning conditions

System: NX10
Scan Size: 5 µm × 5 µm
Scan Mode: Non-contact

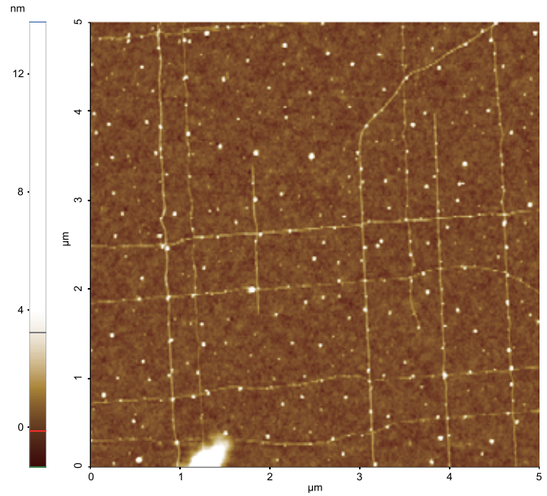
Scan Rate: 0.1 Hz
Cantilever: PPP-EFM (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 256 × 256

Aligned Fibers



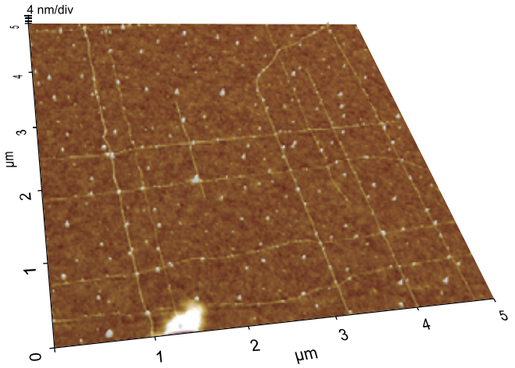
True Non-Contact™ Mode

Height



Peak to Valley: 15 nm

3D



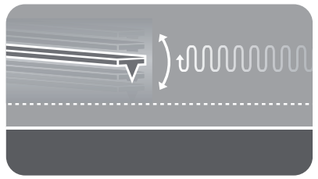
X:Y:Z Scale = 1:1:10

Scanning conditions

System: NX10
Scan Size: 5 µm × 5 µm
Scan Mode: Non-contact

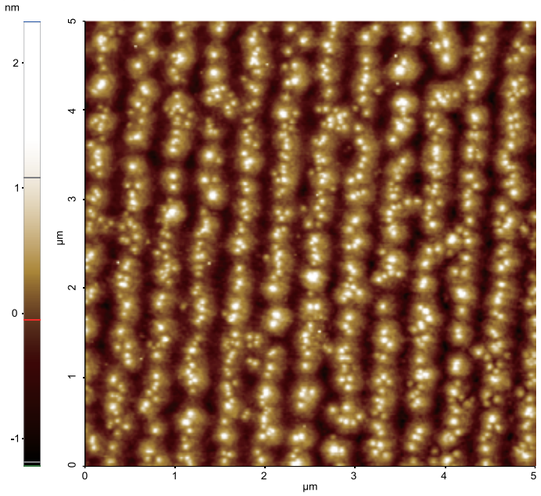
Scan Rate: 1 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 256

AlN/GaN/AlN Hetero Structure



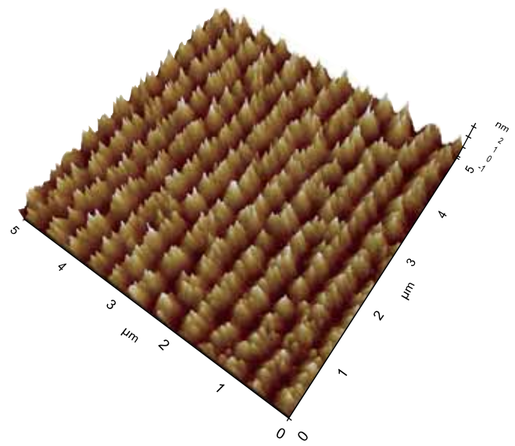
True Non-Contact™ Mode

Height



Peak to Valley: 3.6 nm

3D



X:Y:Z Scale = 1:1:250

AlN/GaN/AlN hetero structure grown on SiC substrate by Molecular Beam Epitaxy (MBE) system

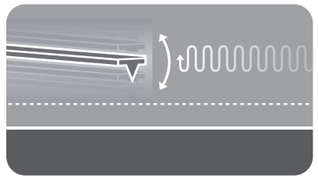
Image courtesy: Temasek Laboratories, NTU, Singapore

Scanning conditions

System: NX20
Scan Size: 5 µm × 5 µm
Scan Mode: Non-contact

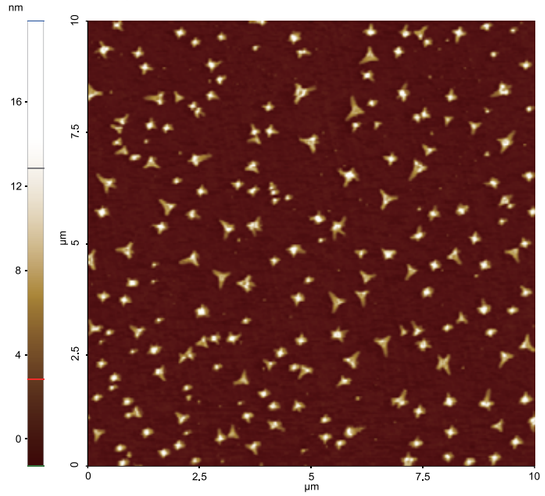
Scan Rate: 0.5 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 512

HfO_2 into ITO (Indium Tin Oxide) Film



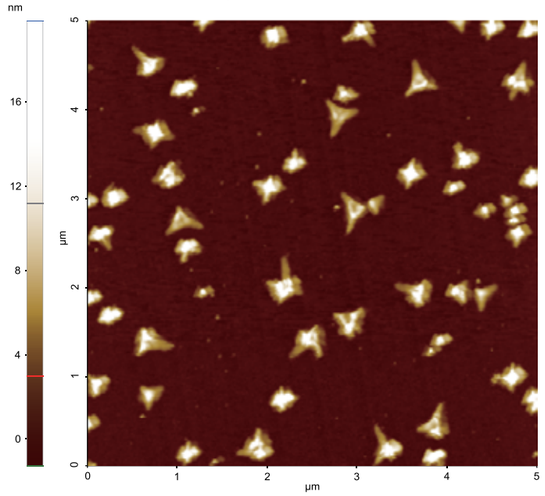
True Non-Contact™ Mode

Height



Peak to Valley: 21 nm

Zoom in Height



Peak to Valley: 21 nm

ITO film on 1% HfO_2-doped yttria-stabilized zirconia (001) orientation grown by pulsed laser deposition-surface segregation of HfO_2 into ITO film

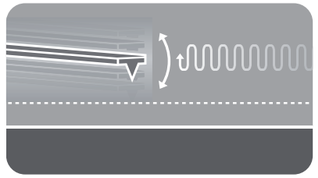
Image courtesy: Saurav Prakash, NUS NNI Nanocore, Singapore

Scanning conditions

System: NX10
Scan Size: 10 µm × 10 µm, 5 µm × 5 µm
Scan Mode: Non-contact

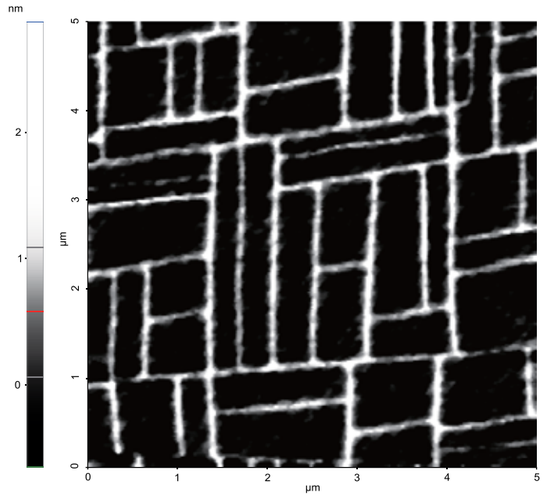
Scan Rate: 0.6 Hz, 1 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 256 × 256, 256 × 256

Al_2O_3-Doped $CaMnO_3$



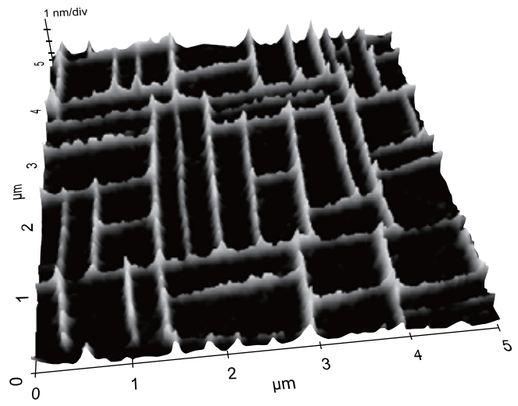
True Non-Contact™ Mode

Height



Peak to Valley: 4.5 nm

3D



X:Y:Z Scale = 1:1:200

1% Al_2O_3-doped $CaMnO_3$ on $LaAlO_3$ (001) orientation substrate by pulsed laser deposition

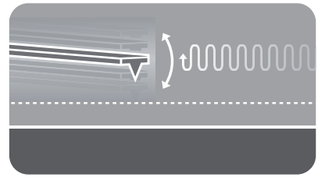
Image courtesy: Lim Zhi Shiuh, NUS NNI Nanocore, Singapore

Scanning conditions

System: NX10
Scan Size: 5 µm × 5 µm
Scan Mode: Non-contact

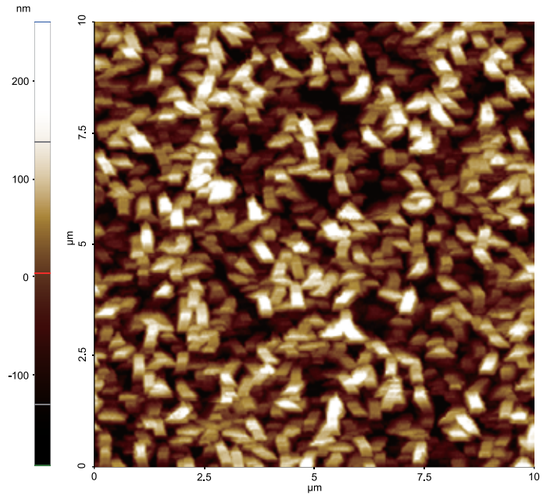
Scan Rate: 1 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 256 × 256

SnS_2 Flakes



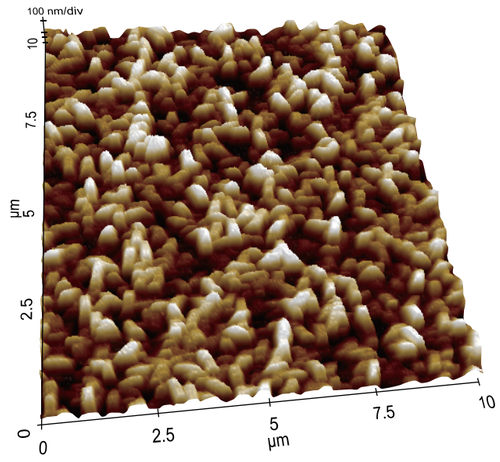
True Non-Contact™ Mode

Height



Peak to Valley: 453 nm

3D



X:Y:Z Scale = 1:1:2

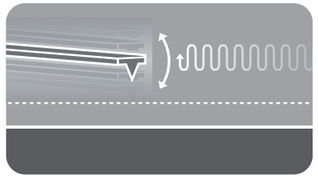
Sample courtesy: Dr. James Eakin, Worcester Polytechnic Institute, US

Scanning conditions

System: NX10
Scan Size: 10 µm × 10 µm
Scan Mode: Non-contact

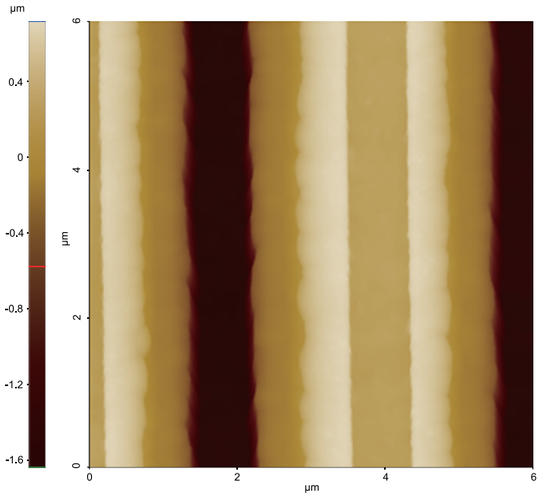
Scan Rate: 0.4 Hz
Cantilever: AC240TS (k = 2 N/m, f = 70 kHz)
Pixel Size: 256 × 256

Trench Etch Profile on MESA

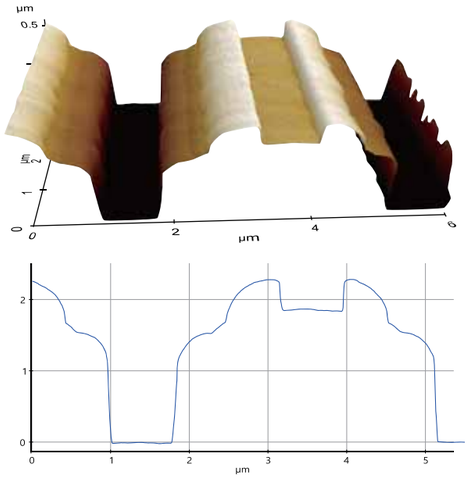


True Non-Contact™ Mode

Height



3D & Line Profile



X:Y:Z Scale = 1:1:1

Top dielectric trench etch profile on MESA on Si wafer

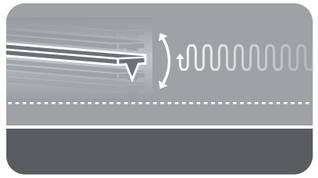
Sample courtesy: Sang-Soo Je, Global Comm. Semiconductors, US

Scanning conditions

System: NX20
Scan Size: 6 µm × 6 µm
Scan Mode: Non-contact

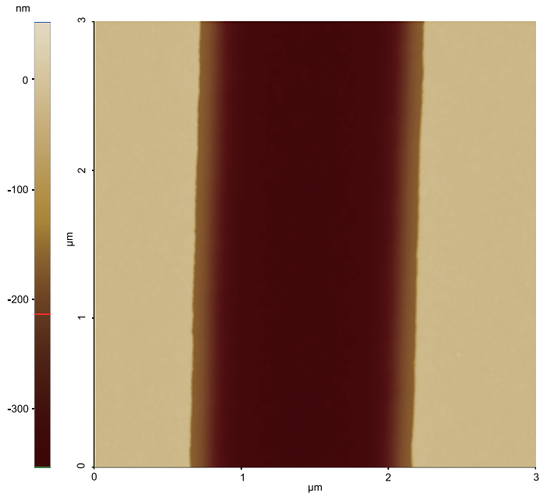
Scan Rate: 0.12 Hz
Cantilever: AR5T-NCHR (k = 42 N/m, f = 300 kHz)
Pixel Size: 1024 × 256

Trench Etch Profile on Si Wafer

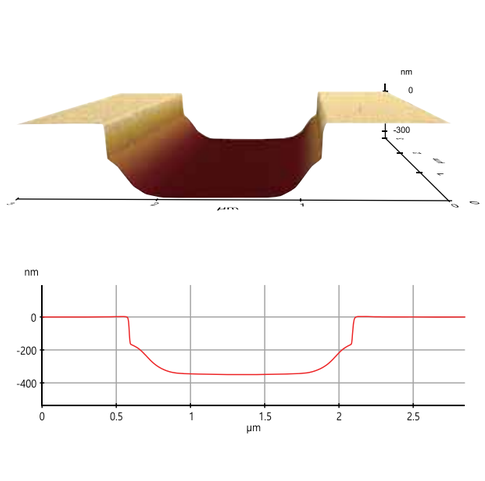


True Non-Contact™ Mode

Height



3D & Line Profile



X:Y:Z Scale = 1:1:1

Top dielectric trench etch profile on Si wafer having tapered slope at the trench sidewall

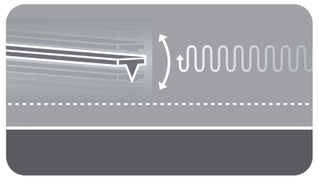
Sample courtesy: Sang-Soo Je, Global Comm. Semiconductors, US

Scanning conditions

System: NX20
Scan Size: 3 µm × 3 µm
Scan Mode: Non-contact

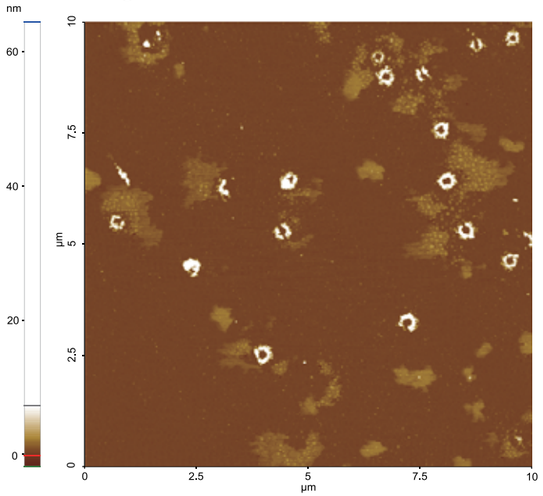
Scan Rate: 0.21 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 1024 × 256

Cannabidiol (CBD) Molecules

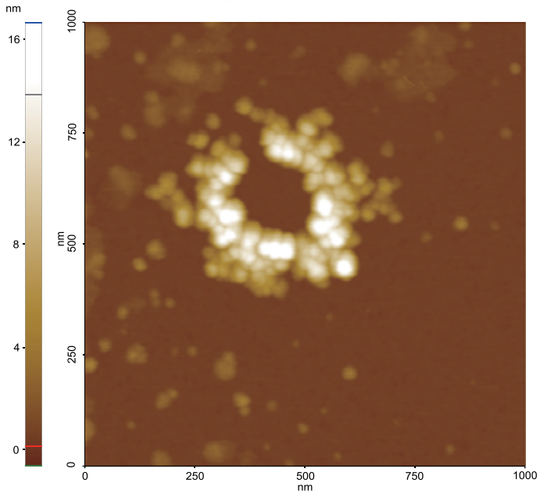


True Non-Contact™ Mode

Height



Zoom in Height



Peak to Valley: 66 nm

Peak to Valley: 17 nm

CBD (concentration: 20 mg/mL) molecules assembled on mica surface after solution rinsing aggregated CBD molecules as a ring shape

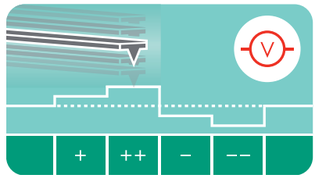
Sample courtesy: Henry Herman, CHRYSALIS INC., US

Scanning conditions

System: NX10
Scan Size: 10 µm × 10 µm, 1 µm × 1 µm
Scan Mode: Non-contact

Scan Rate: 0.4 Hz, 0.3 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 512, 256 × 256

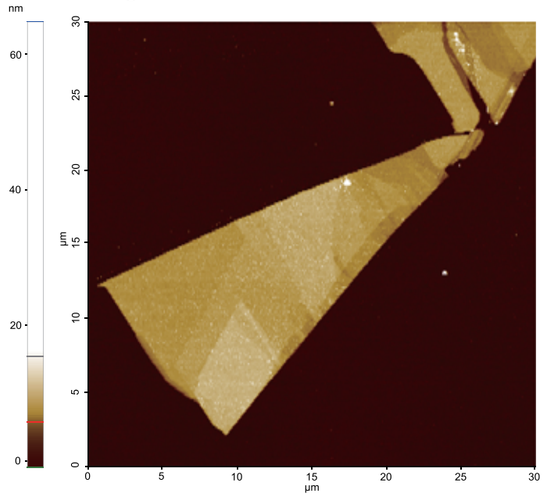
MoS_2 Layers on SiO_2



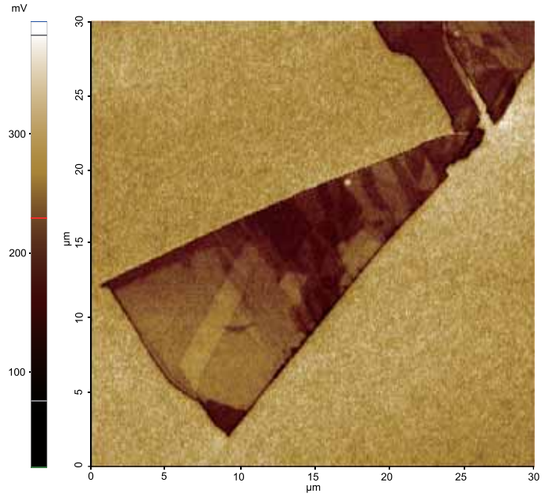
Kelvin Probe Force Microscopy

In Kelvin Probe Force Microscopy (KPFM), the AFM operates in non-contact mode while a conductive cantilever, oscillated at its fundamental resonant frequency, laterally scans over the sample surface. The resulting electrostatic signal provides information related to surface potential and the capacitance gradient. The topographic data is taken by controlling the force between the tip and the sample.

Height



Surface Potential



Peak to Valley: 16.7nm

A few layers of MoS_2 on SiO_2

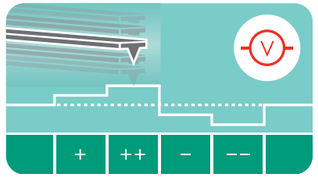
Image courtesy: Wang Junyong, NUS Physics, Singapore

Scanning conditions

System: NX10
Scan Size: 30 µm × 30 µm
Scan Mode: AM-KPFM

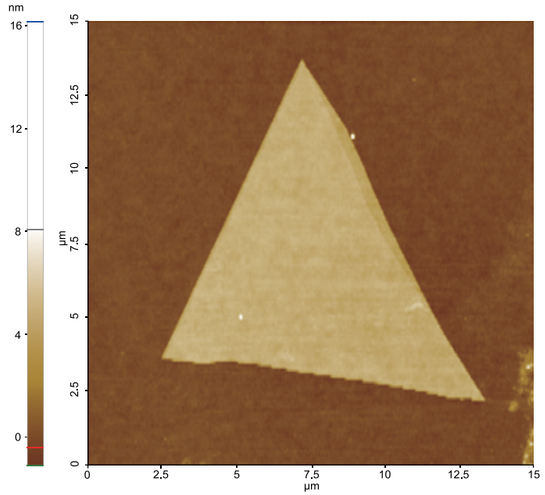
Scan Rate: 0.3 Hz
Cantilever: NSC36Cr-Au B (k = 2 N/m, f = 130 kHz)
Pixel Size: 512 × 256

Mechanical Exfoliated WS_2

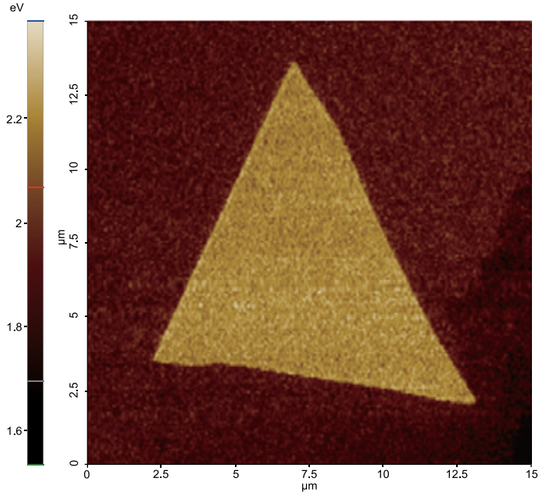


Kelvin Probe Force Microscopy

Height



Work Function



Peak to Valley: 17.2 nm

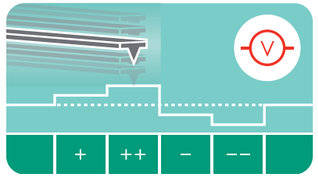
Sample courtesy: Prof. Young-Jun Yu, Dr. Seok-Ju Kang, Department of Physics, Chungnam National University, Korea

Scanning conditions

System: NX10
Scan Size: 15 µm × 15 µm
Scan Mode: AM-KPFM

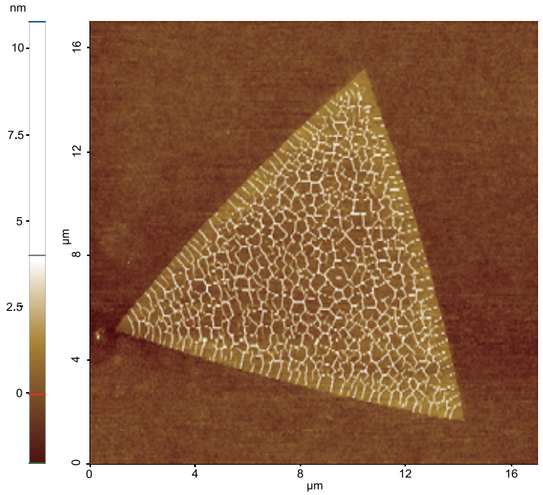
Scan Rate: 0.4 Hz
Cantilever: NSC36Cr-Au A (k = 1 N/m, f = 90 kHz)
Pixel Size: 512 × 256

CVD Grown WS_2

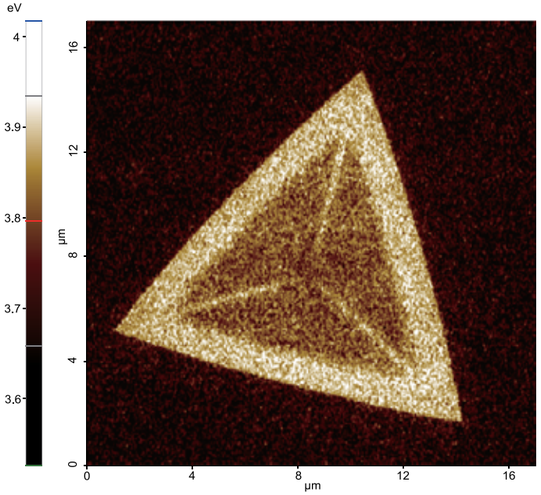


Kelvin Probe Force Microscopy

Height



Work Function



Peak to Valley: 12.8 nm

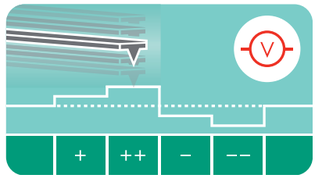
Sample courtesy: Prof. Hyun Seok Lee, Department of Physics, Chungbuk National University, Korea

Scanning conditions

System: NX10
Scan Size: 17 µm × 17 µm
Scan Mode: AM-KPFM

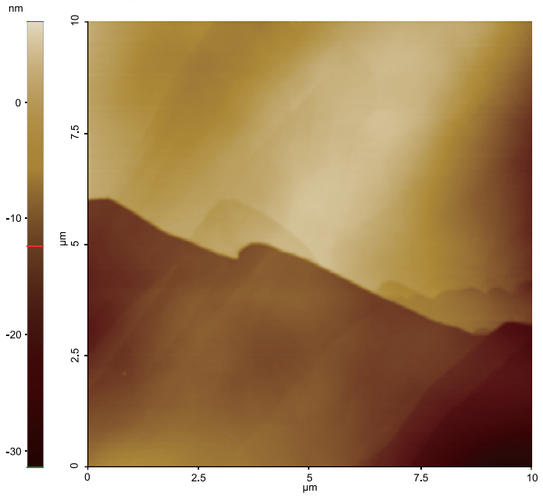
Scan Rate: 0.3 Hz
Cantilever: NSC36Cr-Au A (k = 1 N/m, f = 90 kHz)
Pixel Size: 512 × 256

HOPG

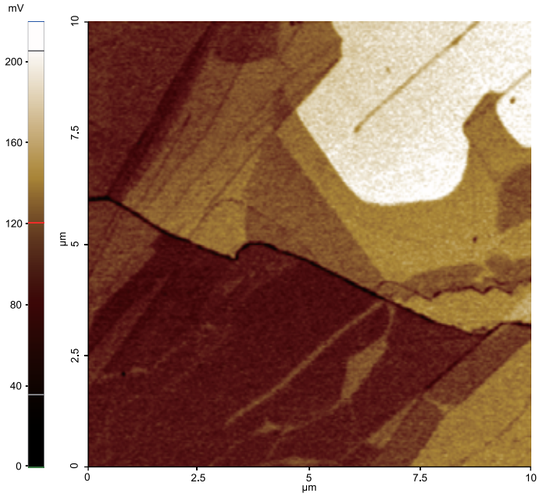


Kelvin Probe Force Microscopy

Height



Surface Potential



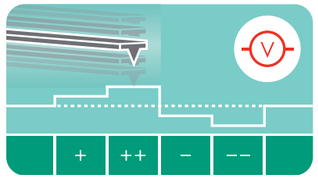
Peak to Valley: 38.3 nm

Scanning conditions

System: NX20
Scan Size: 10 μm × 10 μm
Scan Mode: FM-KPFM

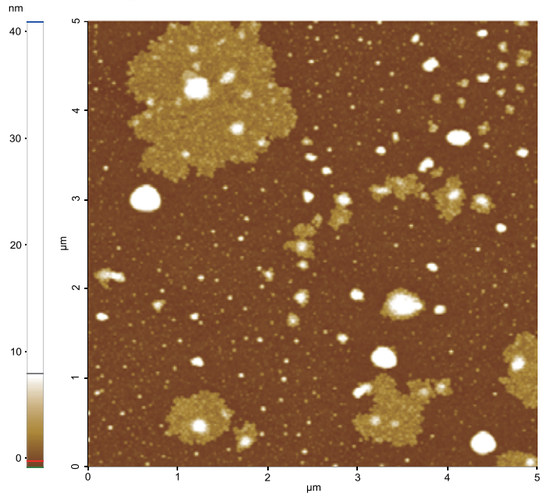
Scan Rate: 0.5 Hz
Cantilever: qpBioAC AuCB1 (k = 0.3 N/m, f = 90 kHz)
Pixel Size: 512 × 256

$F_{14}H_{20}$ on Si

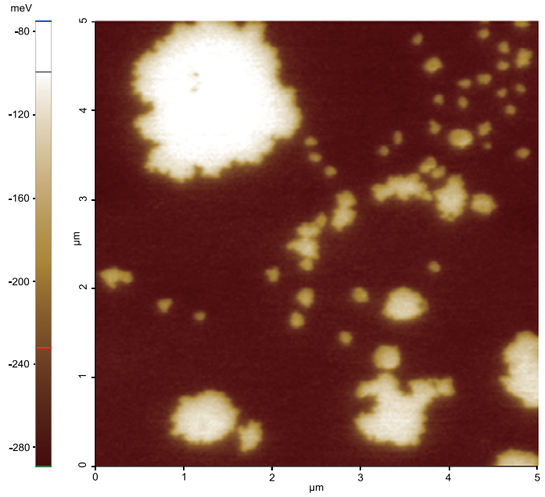


Kelvin Probe Force Microscopy

Height



Work Function



Peak to Valley: 41.6 nm

Semifluorinated alkanes on Si

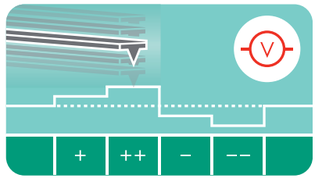
Sample courtesy: SPMLabs, US

Scanning conditions

System: NX10
Scan Size: 5 μm × 5 μm
Scan Mode: AM-KPFM

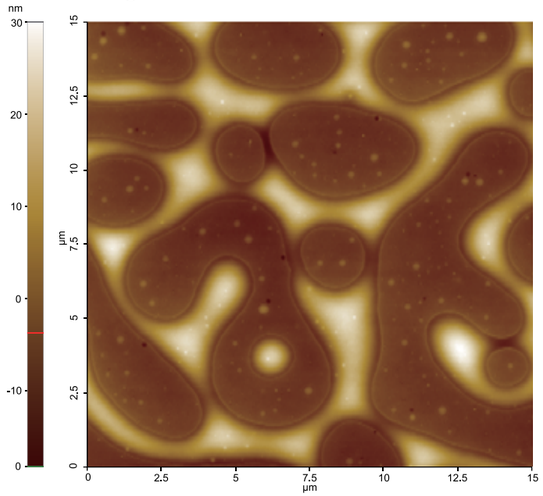
Scan Rate: 0.3 Hz
Cantilever: qpBioAC AuCB1 (k = 0.3 N/m, f = 90 kHz)
Pixel Size: 512 × 256

PS/PVAc Film

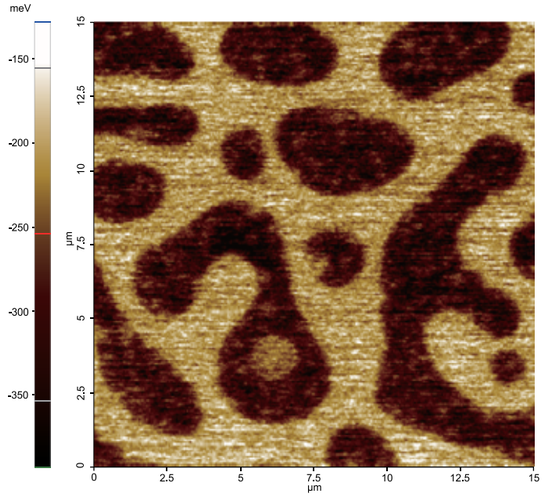


Kelvin Probe Force Microscopy

Height



Work Function



Peak to Valley: 48.3 nm

Film of polystyrene/poly (vinyl acetate) blend on Si

Sample courtesy: SPMLabs, US

Scanning conditions

System: NX20
Scan Size: 15 µm × 15 µm
Scan Mode: AM-KPFM

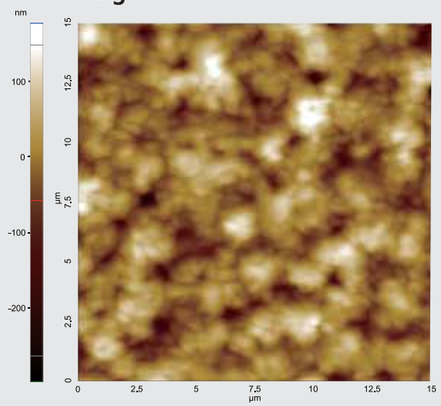
Scan Rate: 0.3 Hz
Cantilever: NSC36Cr-Au C (k = 0.6 N/m, f = 65 kHz)
Pixel Size: 1024 × 256

Formamidinium Lead Iodide ($FAPbI_3$) Perovskite Film

Conductive AFM

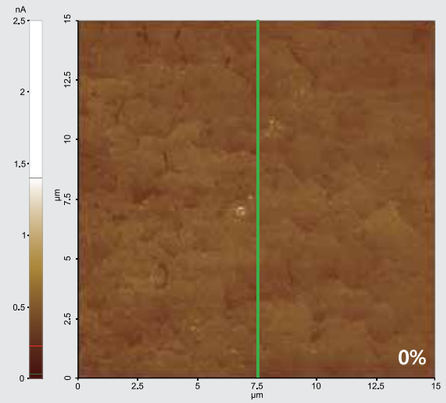
The conductivity of the sample can be measured by performing a contact AFM scan with a conducting, biased tip. Regions of high conductivity on the sample surface allow current to pass through easily, while regions of low conductivity will have a higher resistance. C-AFM yields both the topography and the electrical properties of a sample surface.

Height

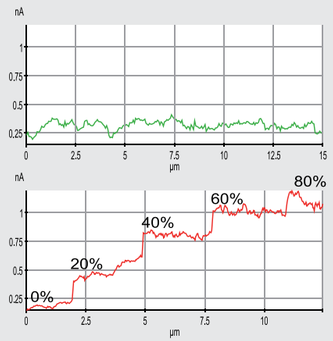


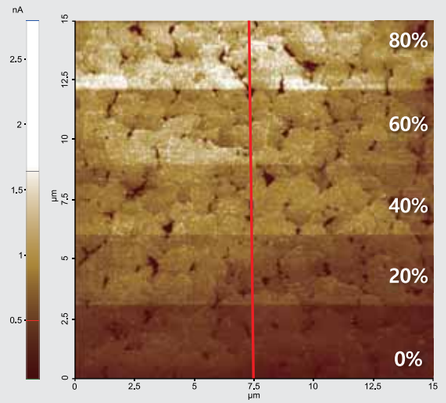
Peak to Valley: 474 nm

Current w/o LED



Current w/ 0~80% LED





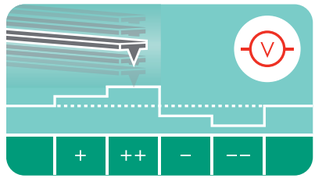
$FAPbI_3$ is an organic-inorganic hybrid perovskite material currently used for high efficiency perovskite solar cells.

Sample courtesy: Zhang Yong, Next Generation Photo-electronics Lab, Chemical Engineering, SKKU., Korea

Scanning conditions

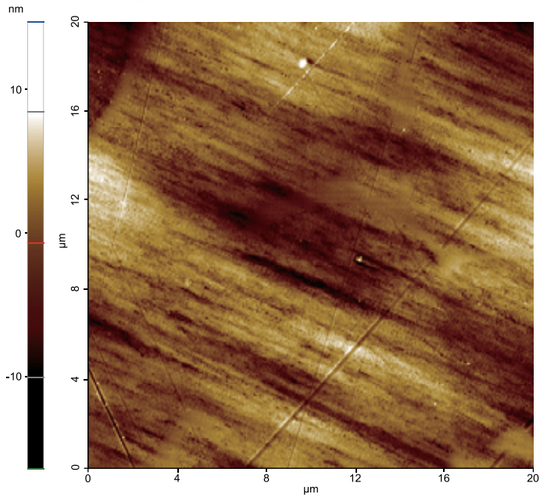
System: NX10
Scan Size: 15 µm × 15 µm
Scan Mode: Conductive AFM

Scan Rate: 0.5 Hz
Cantilever: CDT-NCHR (k = 80 N/m, f = 400 kHz)
Pixel Size: 512 × 256



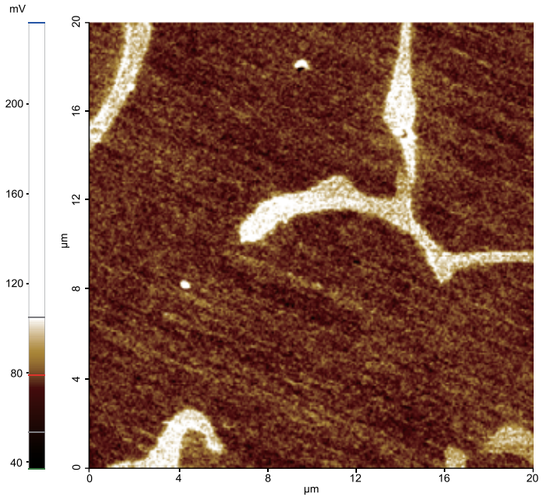
Kelvin Probe Force Microscopy

Height



Peak to Valley: 31.2 nm

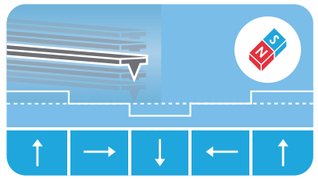
Surface Potential



Sample courtesy: Hyun-Bae Lee, Nuclear&Quantum Engineering, KAIST, Korea

Scanning conditions

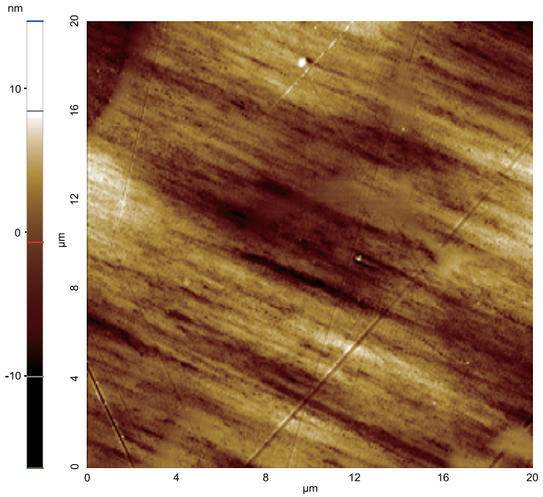
System: NX20
Scan Size: 20 µm × 20 µm
Scan Mode: AM-KPFM
Scan Rate: 0.3Hz
Cantilever: PPP-MFMR (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 512 × 512



Magnetic Force Microscopy

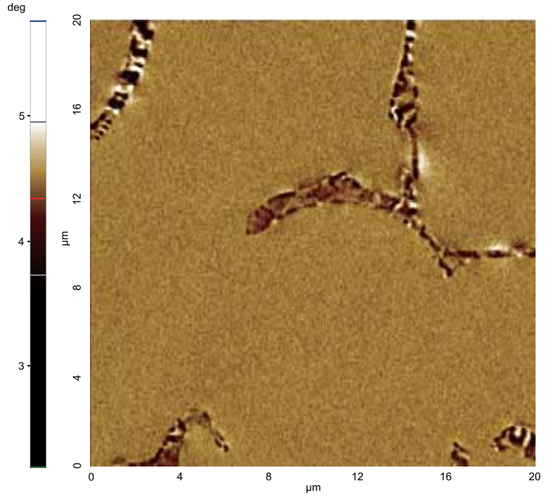
As much as EFM couples a topography scan with a separate scan for electrical properties, Magnetic Force Microscopy (MFM) combines a topography scan with a separate scan for magnetic properties. MFM features a contact AFM scan to obtain the topography, and a scan farther from the surface to probe long-range magnetic force. In this magnetic force domain, deflections of the magnetized cantilever correspond.

Height



Peak to Valley: 31.2 nm

MFM Phase



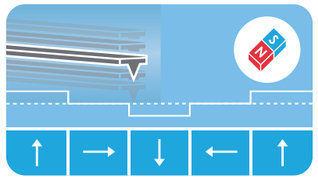
The ferrite MFM phase has a striped appearance due to its ferromagnetic behavior, while the paramagnetic austenite phase shows a uniform appearance.

Sample courtesy: Hyun-Bae Lee, Nuclear&Quantum Engineering, KAIST, Korea

Scanning conditions

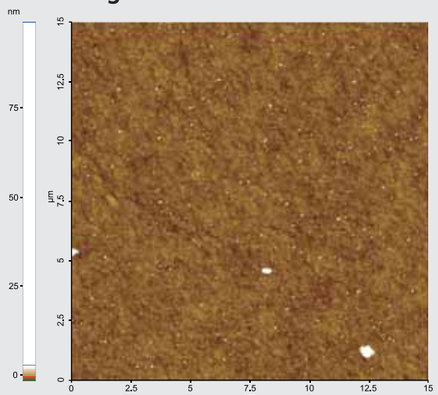
System: NX20
Scan Size: 20 µm × 20 µm
Lift Height: 30 nm
Scan Mode: MFM
Scan Rate: 0.3Hz
Cantilever: PPP-MFMR (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 512 × 512

Fe Thin Films



Magnetic Force Microscopy

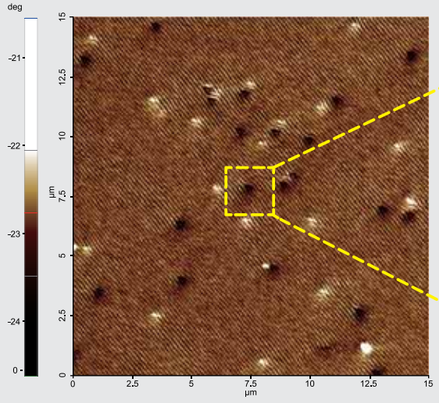
Height



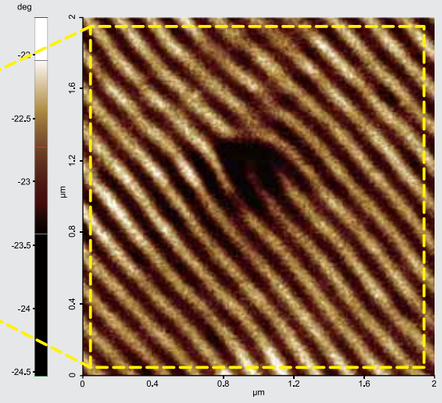
Peak to Valley: 100.5 nm

MFM images of Fe thin films (80 nm) epitaxied on GaAs (001) and then implanted with N-atoms. Images reveal weak stripe domains at magnetic remanence.

MFM Phase



Zoom in MFM Phase



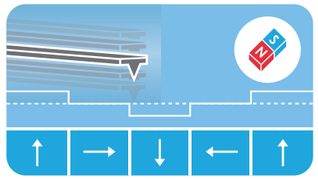
Sample courtesy: INSP - Paris Institute of Nanosciences

Scanning conditions

System: NX10
Scan Size: 15 µm × 15 µm, 2 µm × 2 µm
Lift height: 50 nm
Scan Mode: MFM

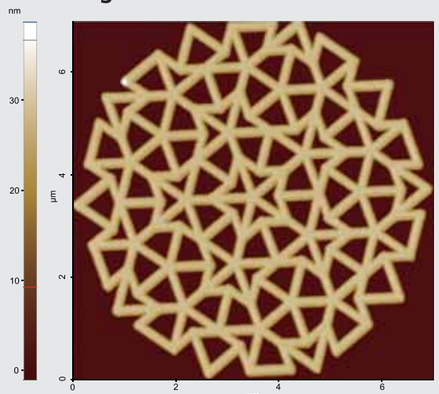
Scan Rate: 0.5 Hz, 1 Hz
Cantilever: PPP-MFMR (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 512 × 512, 256 × 256

Ferromagnetic Nanobars Array

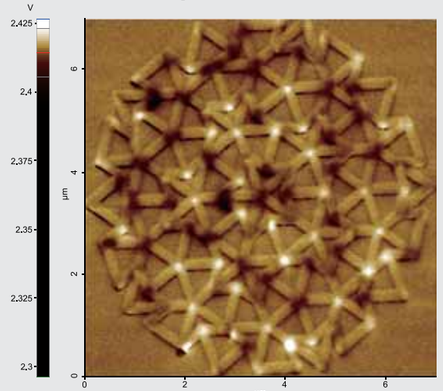


Magnetic Force Microscopy

Height



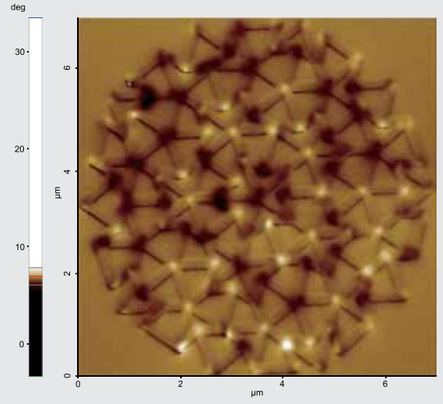
MFM Amplitude



Peak to Valley: 40 nm

Ferromagnetic nanobars are arranged on a penrose P2 tiling. The permalloy ($Ni_{81}Fe_{19}$) nanobars are 810 nm and 500 nm long. The width and thickness of a nanobar amount to about 120 nm and 25 nm, respectively.

MFM Phase



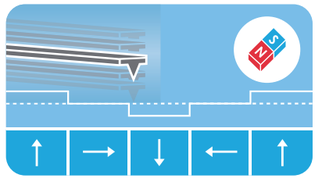
Sample courtesy: Dr. Vinayak Bhat, CMi nanofabrication facility of EPFL for research on artificial ferromagnetic quasicrystals performed in the Laboratory of Nanoscale Magnetic Materials and Magnonics headed by Prof. Dirk Grundler; research funded by SNF 163016, Switzerland

Scanning conditions

System: NX10
Scan Size: 7 µm × 7 µm
Lift height: 85 nm
Scan Mode: MFM

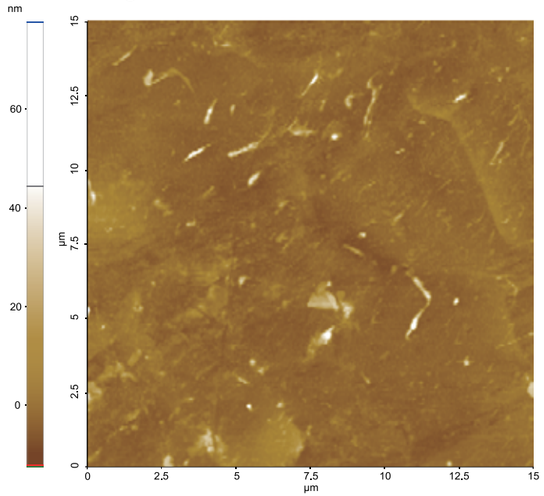
Scan Rate: 1 Hz
Cantilever: MFMR (k = 2.8 N/m, f = 70 kHz)
Pixel Size: 512 × 512

Fe-Nd-B Alloy

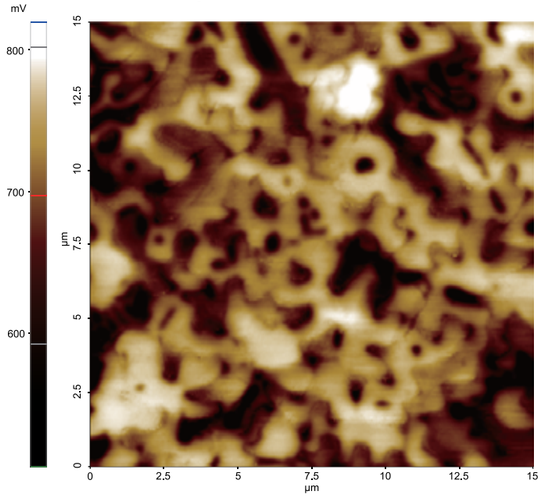


Magnetic Force Microscopy

Height



MFM Amplitude



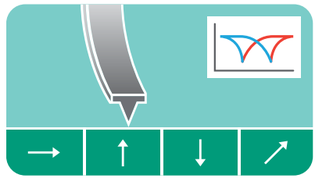
Peak to Valley: 90.0 nm

Scanning conditions

System: NX10
Scan Size: 15 µm × 15 µm
Lift height: 100 nm
Scan Mode: MFM

Scan Rate: 0.5 Hz
Cantilever: PPP-MFMR (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 512 × 256

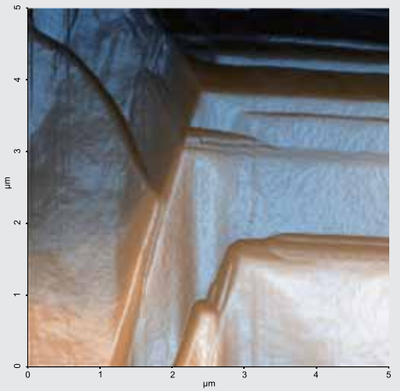
Composite Barium Titanate



Piezoelectric Force Microscopy

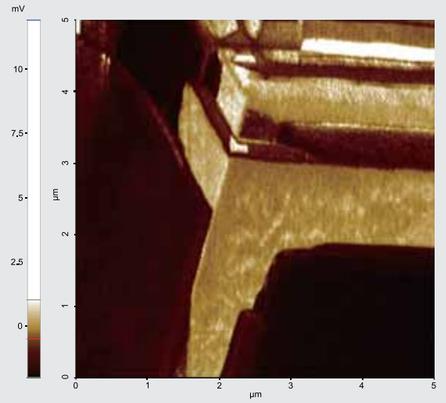
PFM utilizes a lock-on amplifier to study the electrical properties and topography of a piezo sample surface in a single scan. Here, the cantilever is biased with an AC current different than the resonance of the cantilever. The oscillation component of the PSPD signal is extracted by the lock-in amplifier, resulting in the PFM signal.

Height



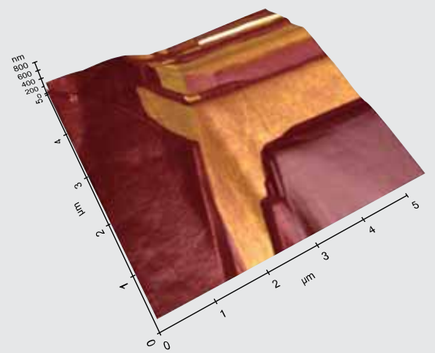
Peak to Valley: 832 nm

PFM Quad



3D Overlay

PFM Quad color is overlaid on 3D surface morphology



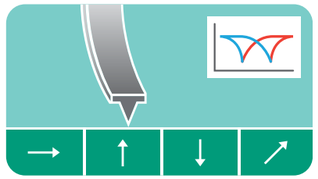
Sample courtesy: Biomedical Engineering Department at Yeditepe University, Turkey

Scanning conditions

System: NX10
Scan Size: 5 µm × 5 µm
Scan Mode: PFM

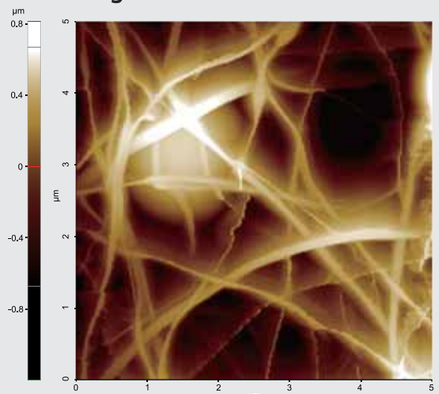
Scan Rate: 0.3 Hz
Cantilever: PPP-ContScPt (k = 0.2 N/m, f = 25 kHz)
Pixel Size: 256 × 256

PVDF Fibrous Membrane



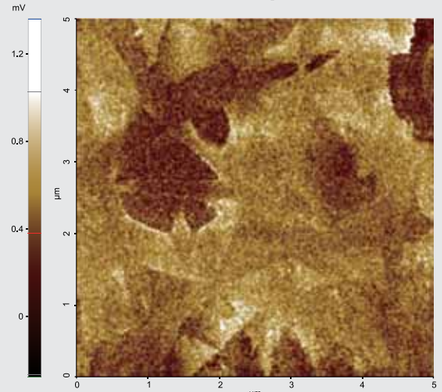
Piezoelectric Force Microscopy

Height

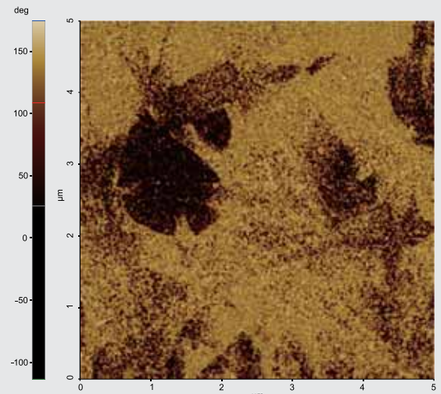


Peak to Valley: 2000 nm

PinPoint PFM Amplitude



PinPoint PFM Phase



PVDF fibrous membrane made by electrospinning

Sample courtesy: M. Suchea, IMT Bucharest, Romania P Pascariu, Petru Poni Institute, Romania

Scanning conditions

System: NX10
Scan Size: 5 µm × 5 µm
Scan Mode: Pinpoint PFM
Scan Rate: 0.05 Hz
Cantilever: PPP-EFM (k = 2.8 N/m, f = 75 kHz)
Pixel Size: 256 × 256

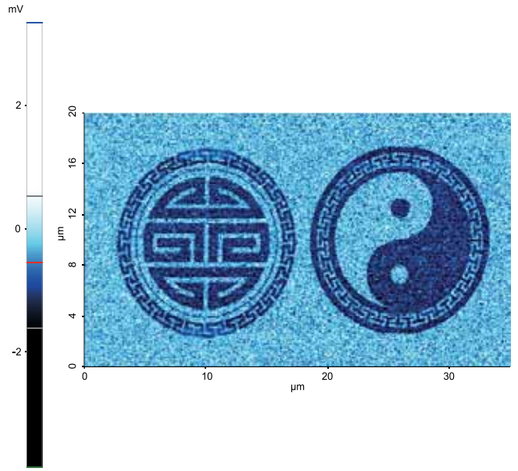
Taegeuk Mark Lithography on PZT

Nanolithography

Here, the cantilever is used to intentionally modify the sample surface via mechanical and/or electrical means. To mechanically alter a surface, a specialized, robust cantilever gouges the surface with excessive force. To electrically alter a surface, a cantilever with a high bias is used to oxidize local surface regions

Design

PFM Quad



Re-arranged domain pole direction on PZT surface using lithography bias mode

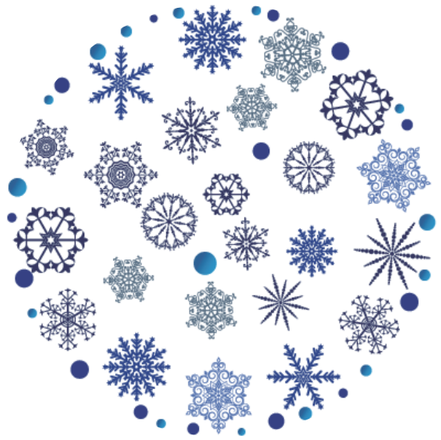
Scanning conditions

System: NX10
Scan Size: 35 µm × 20 µm
Tip Bias: -10V for patterned area
Scan Mode: Lithography
Scan Rate: 0.5 Hz
Cantilever: PPP-ContScPt (k = 0.2 N/m, f = 25 kHz)
Pixel Size: 1024 × 1024

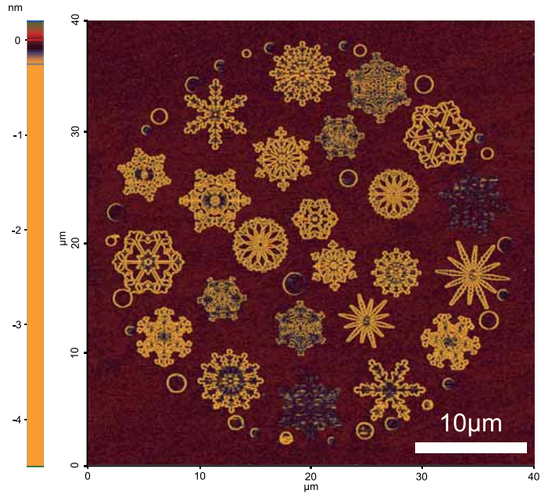
Christmas Ball Lithography on Si

Nanolithography

Design



Height



Peak to Valley: 2.9 nm

Create Oxidation layers created on bare Si surface using lithography bias mode

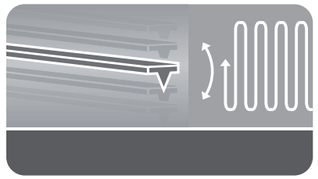
Image courtesy: Sanket Jugade, Dr. Akshay Naik, CeNSE, IISc, India

Scanning conditions

System: NX10
Scan Size: 40 µm × 40 µm
Tip Bias: -10V for patterned area
Scan Mode: Lithography

Scan Rate: 0.5 Hz
Cantilever: AD-40-SS (k = 40 N/m, f = 200 kHz)
Pixel Size: 1024 × 1024

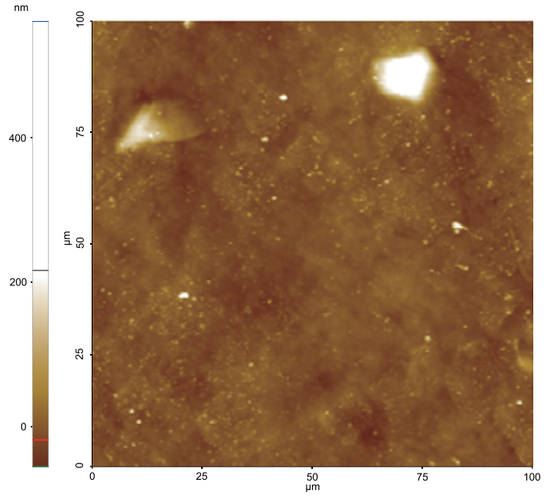
Monolayer graphene on PDMS surface



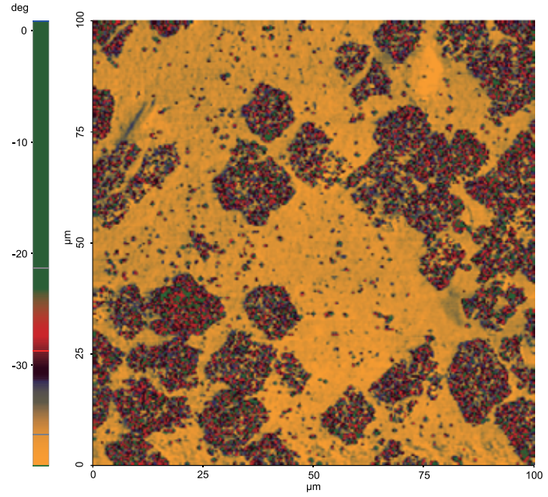
Tapping Mode

In this alternative technique to non-contact mode, the cantilever again oscillates just above the surface, but at a much higher amplitude of oscillation. The bigger oscillation makes the deflection signal large enough for the control circuit, and hence an easier control for topography feedback. It produces modest AFM results but blunts the tip's sharpness at a higher rate, ultimately speeding up the loss of its imaging resolution.

Height



Phase



Peak to Valley: 617.2 nm

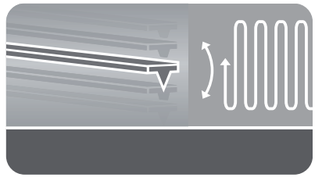
Monolayer graphene grown on Cu foil using CVD process is transferred on to PDMS substrate

Scanning conditions

System: NX20
Scan Size: 100 µm × 100 µm
Scan Mode: Tapping

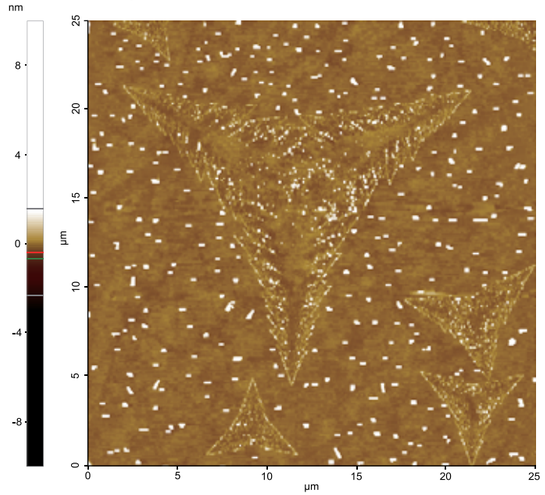
Scan Rate: 0.6 Hz
Cantilever: Access-NC (k = 113 N/m, f = 330 kHz)
Pixel Size: 256 × 256

MoS_2

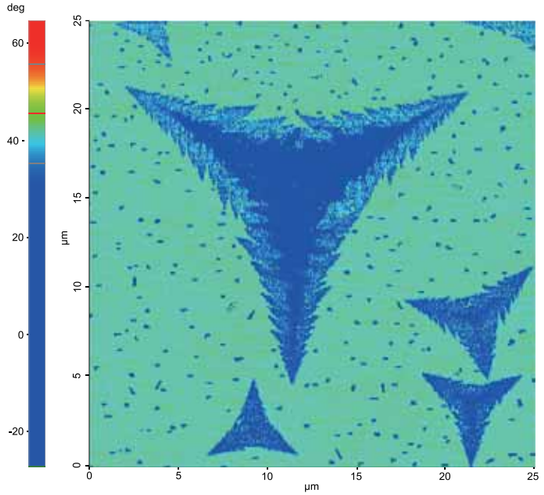


Tapping Mode

Height



Phase



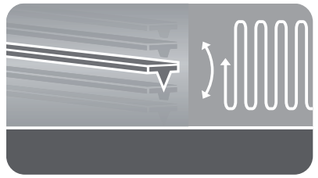
Peak to Valley: 103 nm

Scanning conditions

System: NX10
Scan Size: 25 μm × 25 μm
Scan Mode: Tapping mode

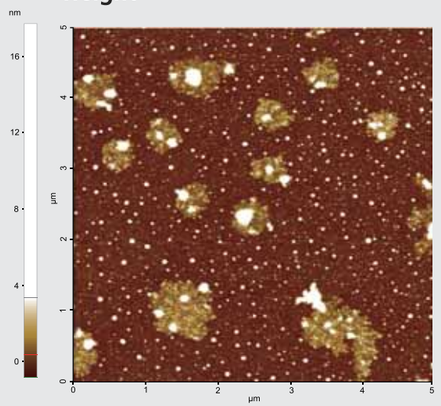
Scan Rate: 0.8 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 256

$F_{14}H_{20}$



Tapping Mode

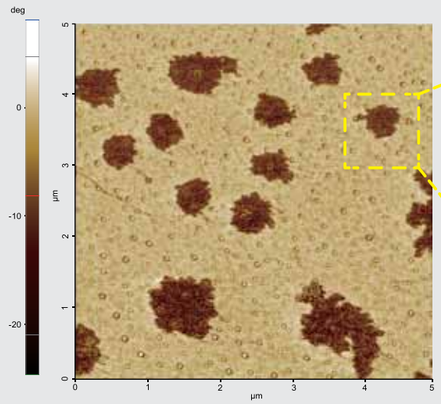
Height



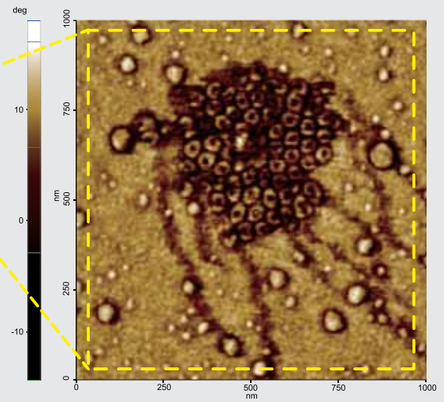
Semifluorinated alkanes on Si

Peak to Valley: 18,5 nm

Phase



Zoom in Phase



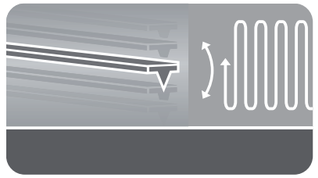
Sample courtesy: SPMLabs, US

Scanning conditions

System: NX20
Scan Size: 5 μm × 5 μm, 1 μm × 1μm
Scan Mode: Tapping

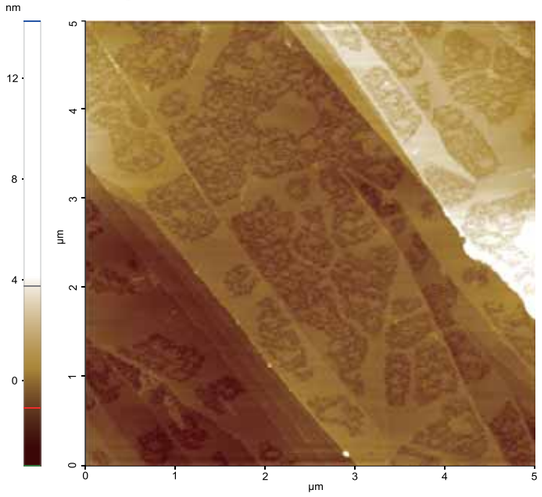
Scan Rate: 0.5 Hz, 1 Hz
Cantilever: AD40AS (k = 20 N/m, f = 100 kHz)
Pixel Size: 1024 × 512, 512 × 256

$C_{36}H_{74}$

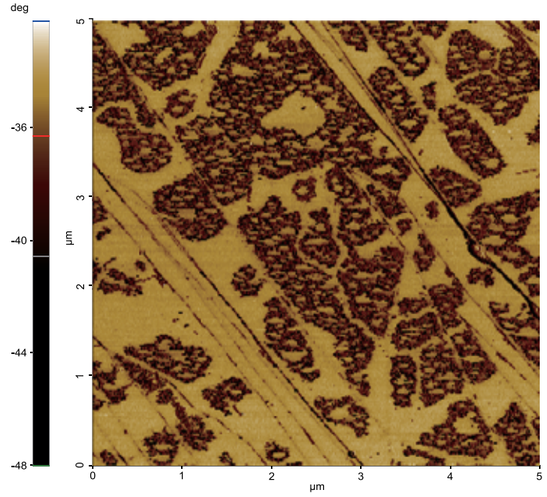


Tapping Mode

Height



Phase



Peak to Valley: 17.6 nm

Layer of $C_{36}H_{74}$ alkane on HOPG

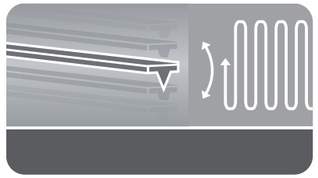
Sample courtesy: SPMLabs, US

Scanning conditions

System: NX20
Scan Size: 5 µm × 5µm
Scan Mode: Tapping

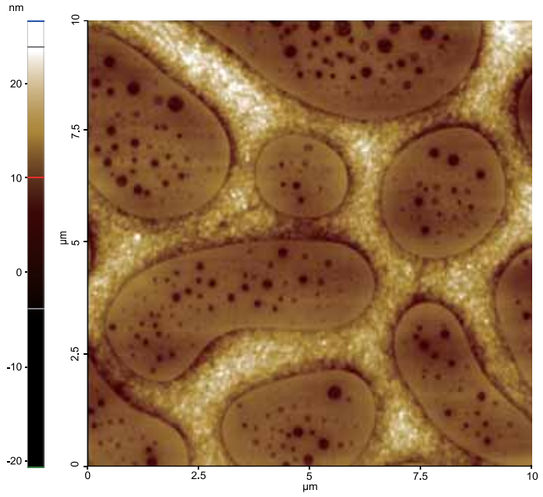
Scan Rate: 0.5 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 512 × 256

PS/LDPE

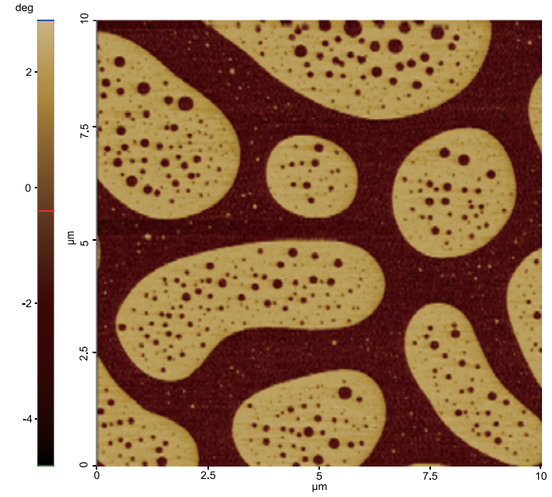


Tapping Mode

Height



Phase



Peak to Valley: 47.1 nm

Spincast layer of PS/LDPE blend on Si

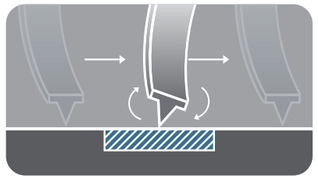
Sample courtesy: SPMLabs, US

Scanning conditions

System: NX20
Scan Size: 10 µm × 10 µm
Scan Mode: Tapping

Scan Rate: 0.5 Hz
Cantilever: AD40AS (k = 20 N/m, f = 100 kHz)
Pixel Size: 512 × 256

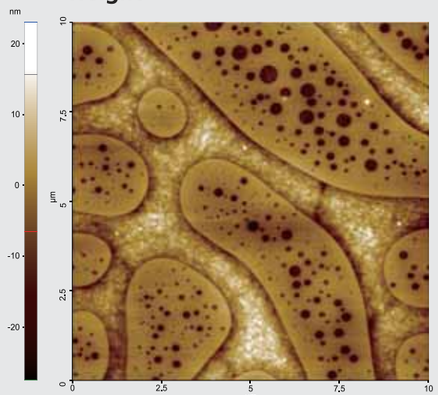
PS/LDPE



Lateral Force Microscopy

While more traditional AFM techniques focus on vertical deflections of the cantilever to image the surface topography, lateral force microscopy (LFM) instead focuses on torsional deflections as the cantilever scans across the surface. The amount the cantilever twists as the tip is dragged across a sample surface provides useful insight into the frictional force and adhesion properties of the sample.

Height

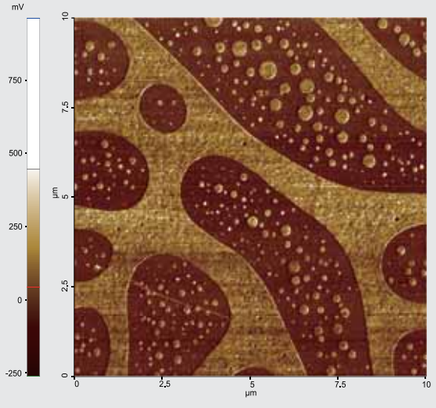


Spincast layer of PS/LDPE blend on Si

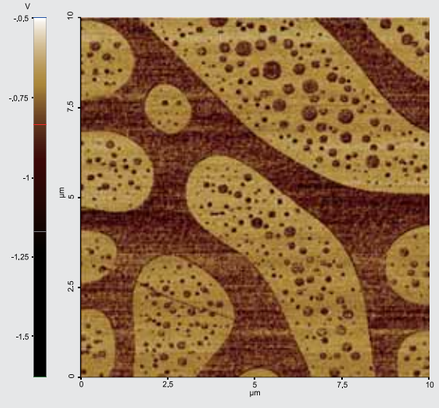
*FFM forward: LFM forward – LFM backward
*FFM backward : LFM backward – LFM forward

Peak to Valley: 50.5 nm

FFM Forward



FFM Backward



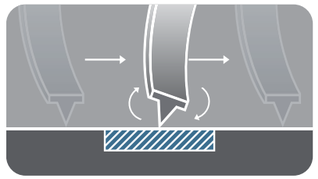
Sample courtesy: SPMLabs, US

Scanning conditions

System: NX10
Scan Size: 10 μm × 10 μm
Scan Mode: LFM

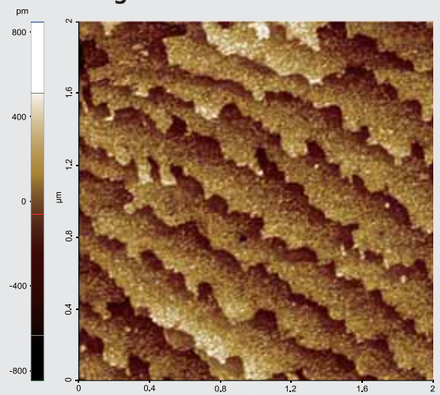
Scan Rate: 1 Hz
Cantilever: BL-AC40TS (k = 0.09 N/m, f = 110 kHz)
Pixel Size: 512 × 512

Single-Crystal $SrTiO_3$ (001) After Annealing



Lateral Force Microscopy

Height

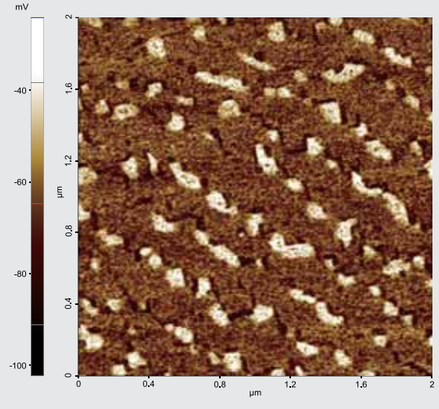


Single-crystal $SrTiO_3$ (001) after 1h annealing at 1000°C in air. Formation of steps and terraces, and assembly at the nanoscale of SrO and TiO_2 chemical terminations

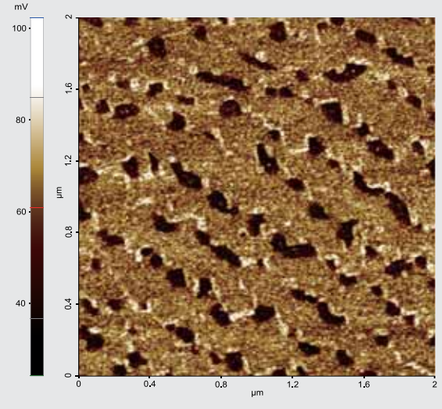
*FFM forward: LFM forward – LFM backward
*FFM backward : LFM backward – LFM forward

Peak to Valley: 1.69 nm

FFM Forward



FFM Backward



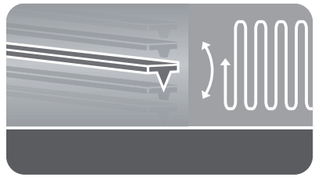
Sample courtesy: Romain BACHELET, Institut des Nanotechnologies de Lyon, INL CNRS UMR 5270, France

Scanning conditions

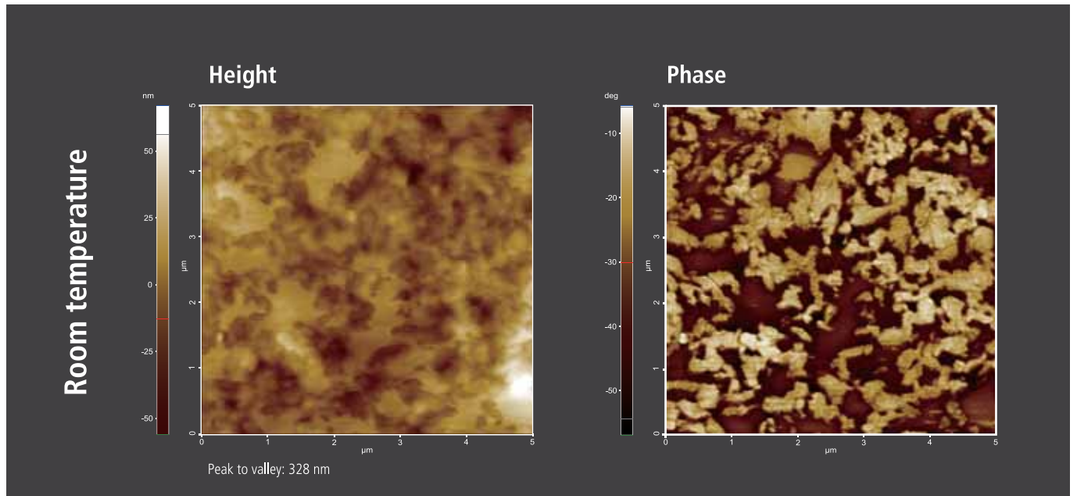
System: NX10
Scan Size: 2 μm × 2 μm
Scan Mode: LFM

Scan Rate: 1 Hz
Cantilever: qpBioAC CB1 (k = 0.02 N/m, f = 110 kHz)
Pixel Size: 256 × 256

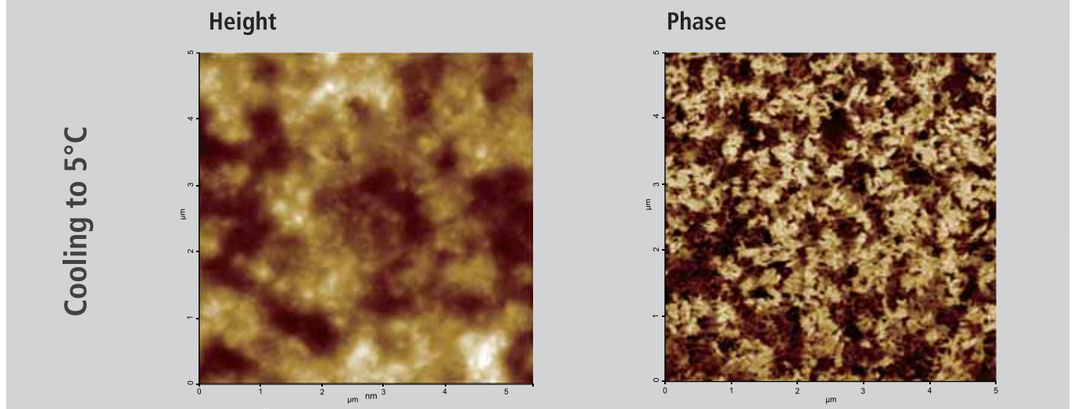
Margarines



Tapping mode



Phase change of Margarine surface by temperature control



Scanning conditions

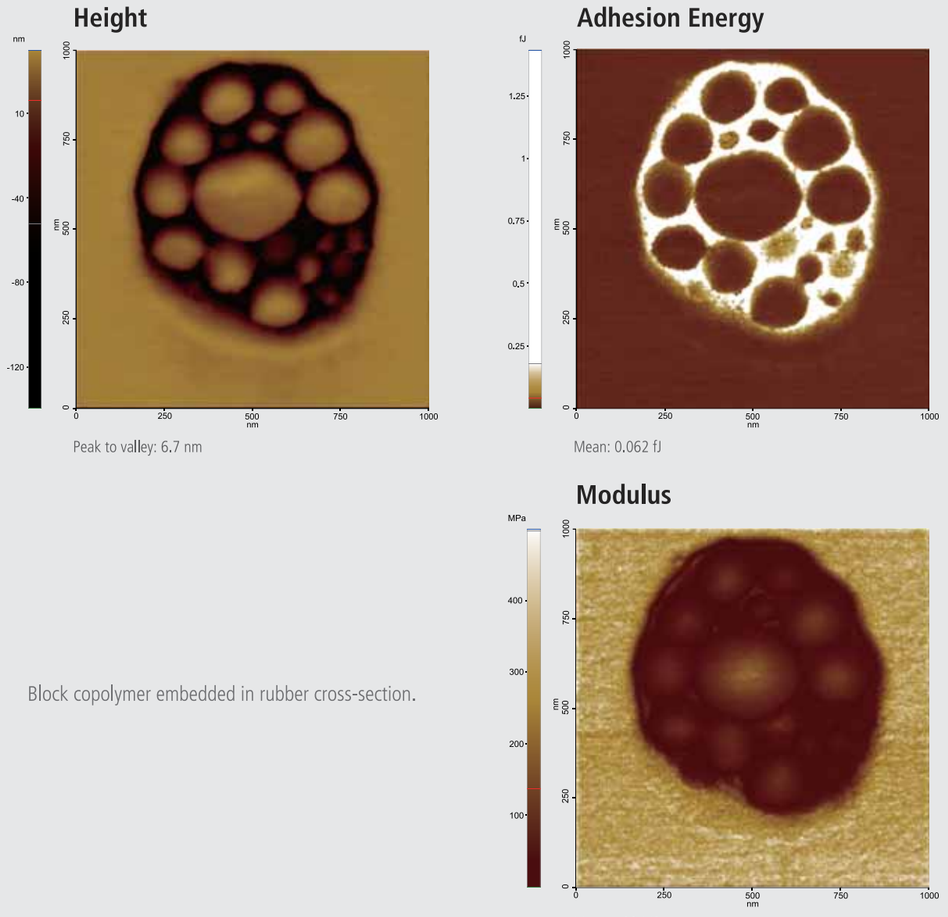
System: NX10
Scan Size: 5 μm × 5 μm
Scan Mode: Tapping, TCS1

Scan Rate: 1.2 Hz
Cantilever: AC160TS (k = 26 N/m, f = 300 kHz)
Pixel Size: 256 × 256

Block Copolymer Embedded in Rubber

PinPoint™ Nanomechanical Mode

PinPoint™ Nanomechanical mode obtains the best of resolution and accuracy for nanomechanical characterization. Stiffness, elastic modulus, and adhesion force are acquired simultaneously, in real-time. While the XY scanner stops, the high speed force-distance curves are taken with well-defined control of contact force and contact time between the tip and the sample. Due to controllable data acquisition time, PinPoint™ Nanomechanical Mode allows optimized nanomechanical measurement with high signal-to-noise ratio over various sample surfaces.



Scanning conditions

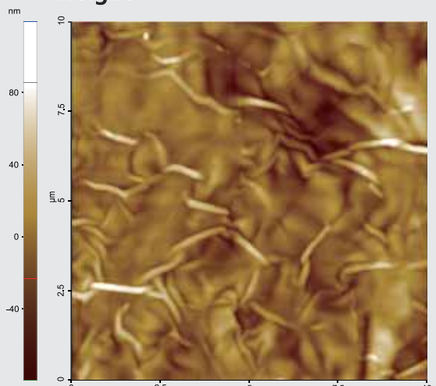
System: NX20
Scan Size: 1 μm × 1 μm
Scan Mode: Pinpoint

Scan Rate: 0.29 Hz
Cantilever: NSC36Cr-Au B (k = 2 N/m, f = 130 kHz)
Pixel Size: 256 × 256

TPU Plastic Thin Film

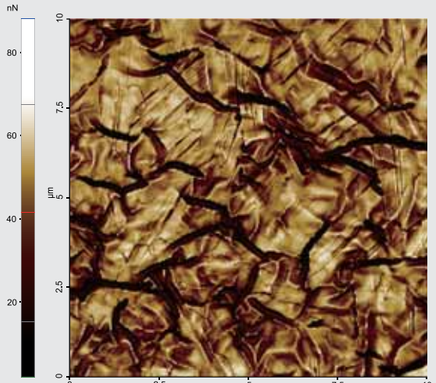
PinPoint™ Nanomechanical Mode

Height



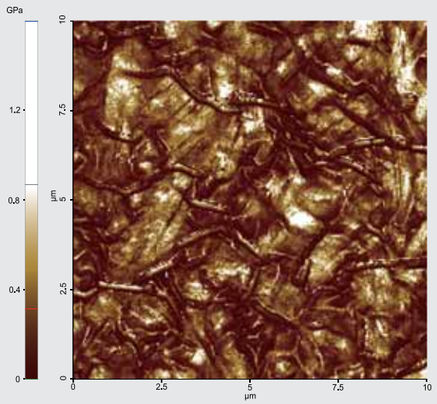
Peak to valley: 199 nm

Adhesion Force



Mean: 41 nN

Modulus



Mean: 327 MPa

Thermoplastic polyurethane (TPU) is polyurethane plasticswith many properties, including elasticity, transpaency, and resistance to oil, grease and abrasion.

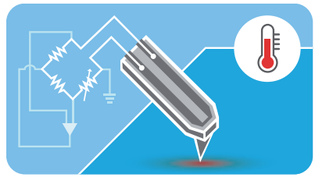
Image courtesy: Dr. Ghazali Omar, UTEM, Singapore

Scanning conditions

System: NX20
Scan Size: 10 µm × 10 µm
Scan Mode: Pinpoint

Scan Rate: 0.28 Hz
Cantilever: PPP-CONTSCR (k = 0.2 N/m, f = 25 kHz)
Pixel Size: 256 × 256

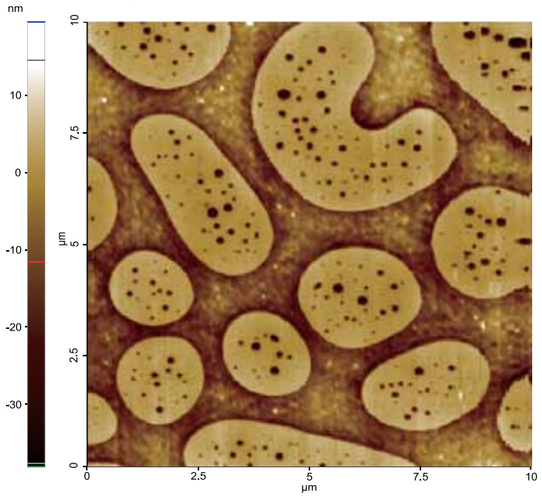
PS/LDPE



Scanning Thermal Microscopy

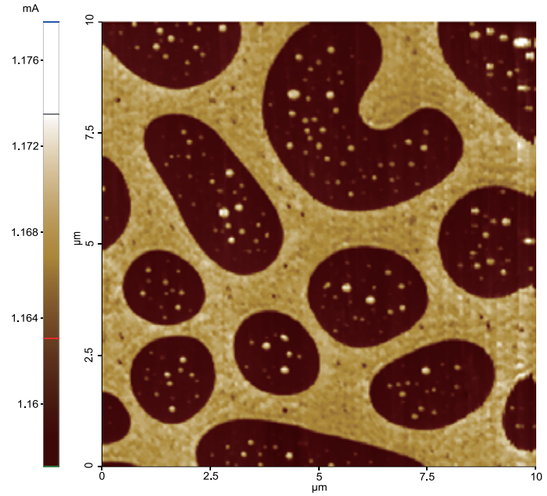
In order to measure the thermal properties of a sample surface, a contact AFM scan is performed using a cantilever with temperature-dependent resistivity. Any changes in the tip resistance during the scan are recorded and correlated into a thermal image of the sample surface.

Height



Peak to valley: 57.5 nm

Probe Current



Signal change by thermal conductivity difference

Spincast layer of PS/LDPE blend on Si

Sample courtesy: SPMLabs, US

Scanning conditions

System: NX10
Scan Size: 10 µm × 10 µm
Scan Mode: SThM

Scan Rate: 0.5 Hz
Cantilever: NanoThermal probe
Pixel Size: 256 × 512

ATOMIC FORCE MICROSCOPE

Park Systems

Dedicated to producing the most accurate and easiest to use AFMs

General AFMs

Park Systems provides a range of popular AFMs for general research and industrial applications. Designed to be extremely versatile while still providing the accuracy and functionality necessary to do high quality work, our line of general AFMs offer researchers and engineers alike the ability to get extremely accurate results quickly and easily.

Applications:

- Biological Science
- Materials Science
- Failure Analysis
- Semiconductor Analysis
- Hard Disk Media Analysis

Park NX10

The world's most accurate easy-to-use research AFM

Park NX20

Power, versatility, ease of use, brilliantly combined for large sample AFM

Park XE15

Capable, adaptable, and affordable -the best value large sample AFM

Park XE7

True research-grade AFM for the practical budget

Park NX-Hivac

The most advanced high vacuum AFM for failure analysis and sensitive materials research

Bio and Chemistry

Allowing users to take highly accurate measurements and complete their work more quickly, these tools can improve efficiency in the workplace and reduce errors, leading to more profitable, more consistent development and productive processes.

Park NX10 SICM

Cutting-edge nanoscale imaging in aqueous environments

Park NX12-Bio

Three compelling nanoscale microscopies in one innovative platform

Park NX12

The most versatile AFM platform for your nanoscale microscopy needs

Industrial AFMs

Park Systems is dedicated not just to advancing research, but industry as well. That's why our designers have worked to build a line of the most effective AFMs for FA engineers and industrial applications.

Applications:

- Failure Analysis
- Semiconductor Analysis
- Hard Disk Media Analysis

Park NX-HDM

The most innovative AFM for automated defect review and surface roughness measurement

Park NX-PTR

Fully automated AFM for accurate inline metrology of hard disk head sliders

Park NX-Wafer

Low noise, high throughput atomic force profiler with automatic defect review

Park NX-3DM

Innovation and efficiency for 3D metrology