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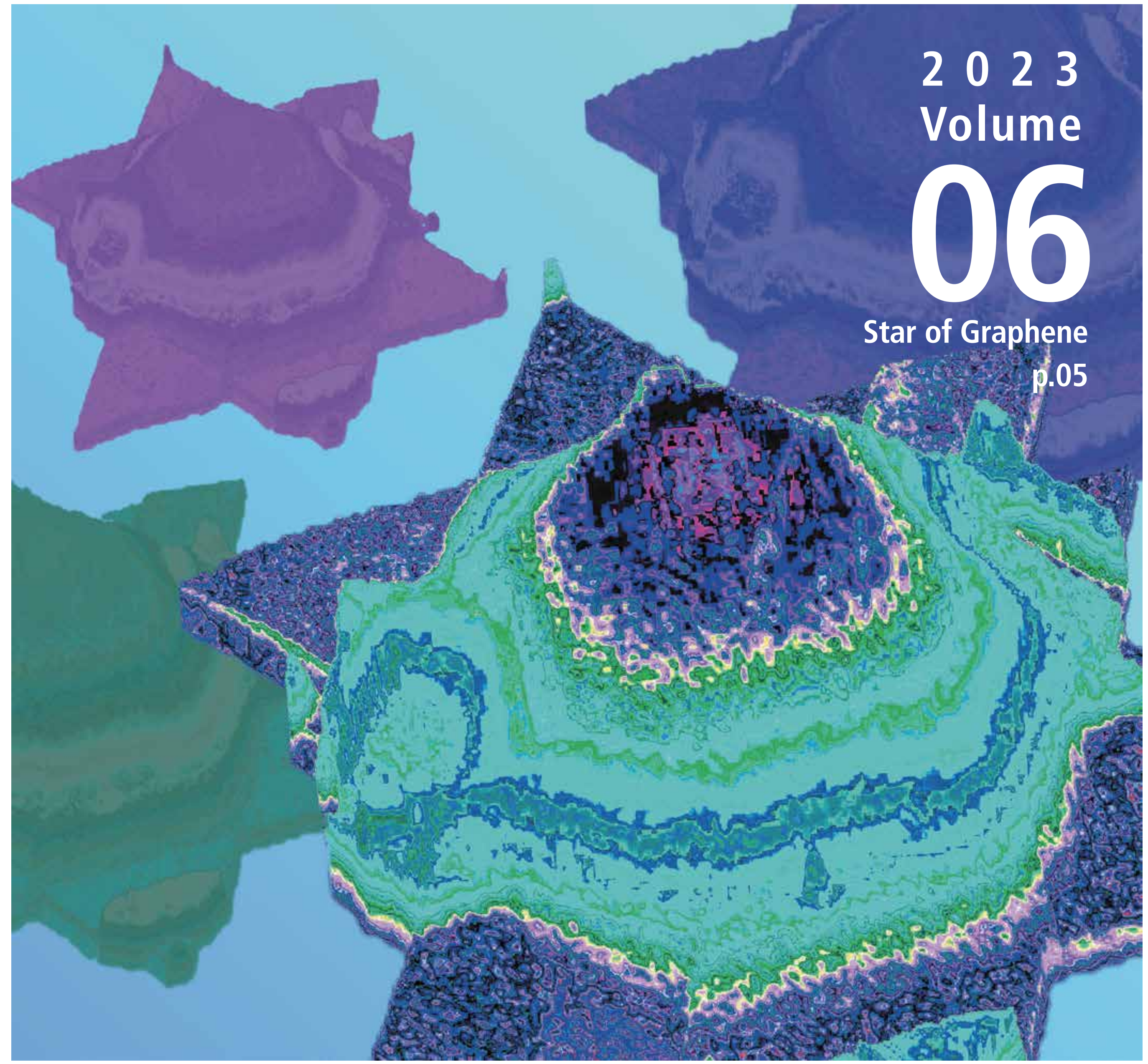
Park Systems Atomic Force Microscopy

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.



01.

Topography

02.

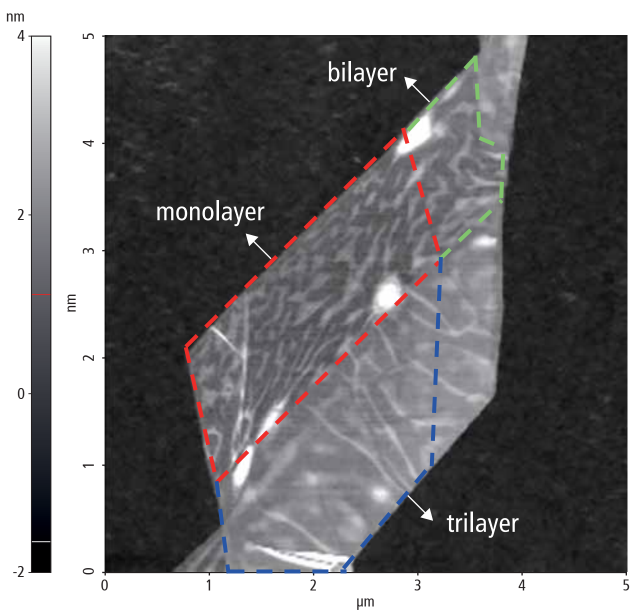
Advanced mode

Trapped water between Graphene & hydrophilic substrate

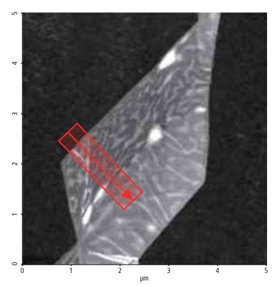
Contact

Contact mode is a standard measurement mode of atomic force microscopy (AFM) that can obtain topographic information on a wide range of sample types. In this mode, as the scanner traces the tip across the sample surface while tip and sample in contact, the repulsive forces between tip and sample cause the cantilever to bend as accommodate for changes in topography. The 3D topographical information of the sample surface can be obtained while feedback the scanner to keep this cantilever deflection constant.

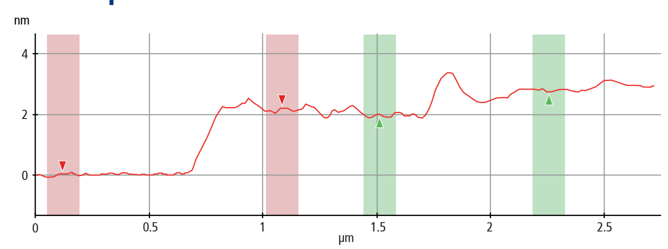
■ Height



Peak to valley: 15 nm



■ Line profile



Cursor	ΔY(nm)	
Red	2.126	→ Thickness between graphene & substrate
Green	0.844	→ Thickness of bilayered step (~0.8 nm)

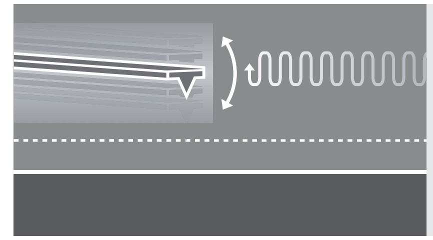
Graphene on SiO_2 substrate. Exfoliation of graphene under 70 % relative humidity condition leading to trapping of moisture between graphene and substrate.
Trapped water shows solid like response to the AFM probe and is often called as nanoscale ice.
The measured height between graphene monolayer and substrate is thicker than graphene monolayer, which proves that water is trapped between the two layers.

• Image courtesy: Sanket Jugade, Abhinav Agrawal, Prof. Akshay Naik, Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science Bengaluru, India

Scanning conditions

- System: NX20
- Scan Size: 5 μm × 5 μm
- Scan Mode: Contact
- Scan Rate: 0.5 Hz
- Cantilever: Cont DLC (k=0.2 N/m, f=13 kHz)
- Pixel Size: 256 × 256

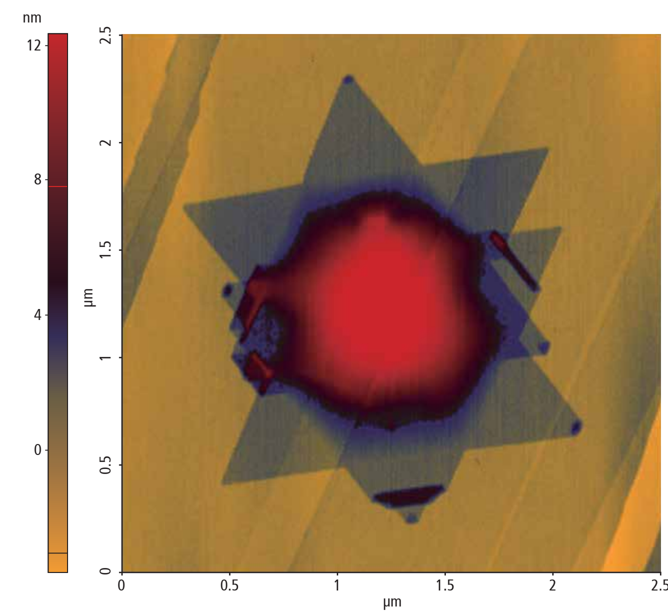
Star of Graphene



Non-contact

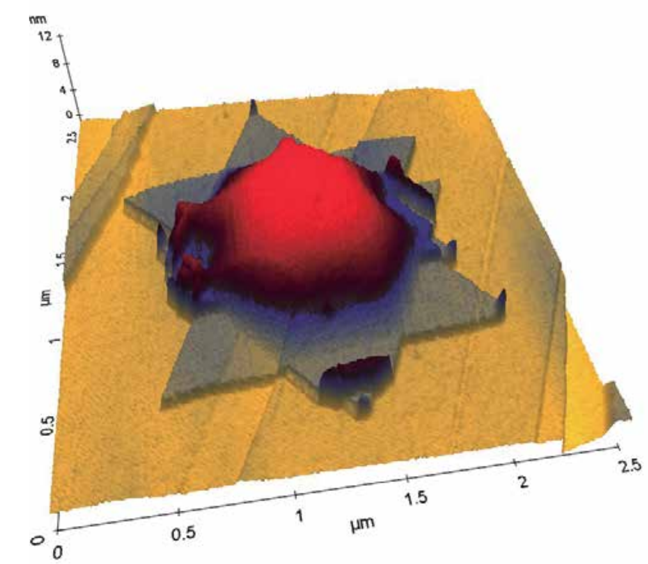
Non-contact mode is a dynamic AFM technique to obtain topographic information of the sample, where the cantilever oscillates at its resonance frequency in close proximity of the surface of a sample. As the tip approaches the sample surface, the oscillation amplitude of the cantilever decreases. By using the feedback loop to correct for these amplitude deviations, one can generate an image of the surface topography.

■ Height



Peak to valley: 16 nm

■ 3D



X : Y : Z scale = 1 : 1 : 50

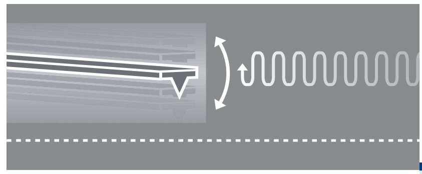
An interesting star-shaped structure formed as the layers of graphene twisted over each other during exfoliation of HOPG surface.
The bright red central region of the star shows the trapped air between the layers.

• Image courtesy: Sanket Jugade, Prof. Akshay Naik, Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science Bengaluru, India

Scanning conditions

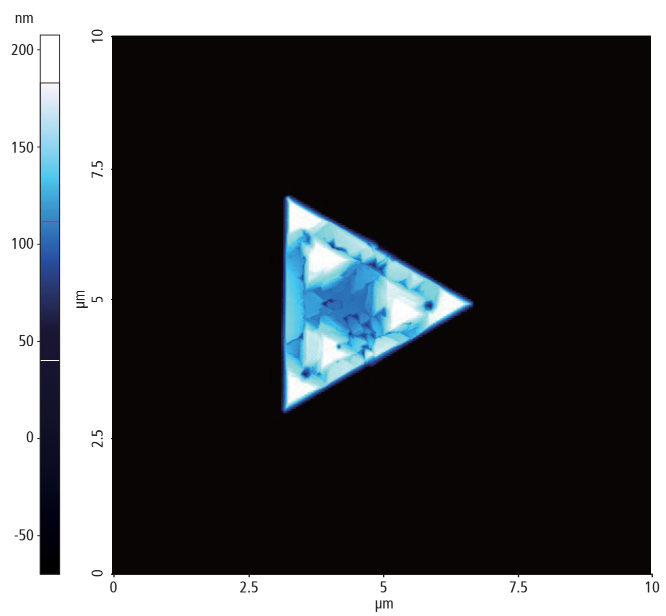
- System: NX20
- Scan Size: 2.5 μm × 2.5 μm
- Scan Mode: Non-contact
- Scan Rate: 0.6 Hz
- Cantilever: Multi75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 256 × 256

Defect of $LiNbO_3$



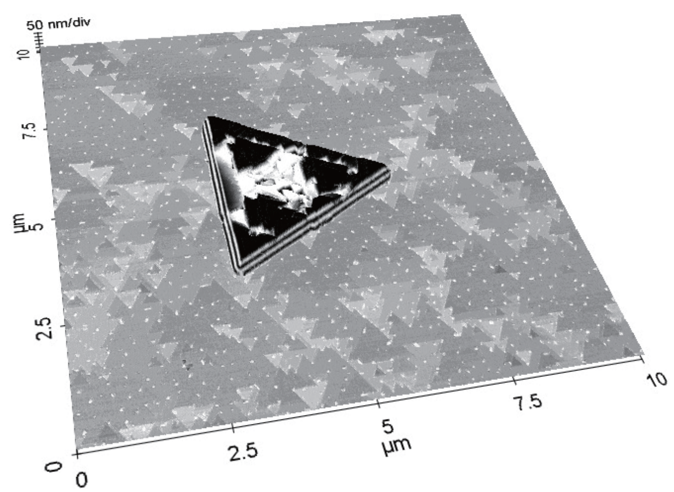
Non-contact

■ Height



Peak to valley: 277 nm

■ 3D



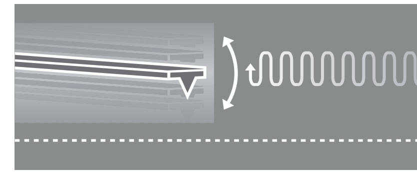
X : Y : Z scale = 1 : 1 : 2

Defective micro-structure due to accumulation of triangular domains against a background of uneven mosaic structures in $LiNbO_3$.

Scanning conditions

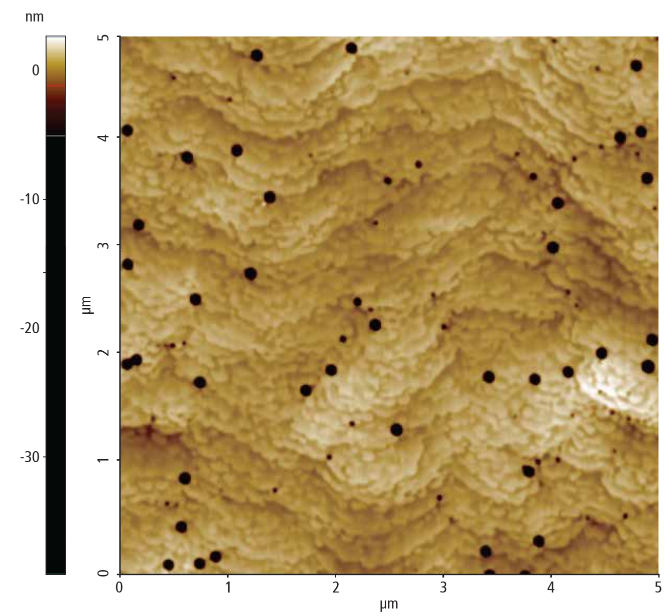
- System: FX40
- Scan Size: 10 μm × 10 μm
- Scan Mode: Non-contact
- Scan Rate: 0.3 Hz
- Cantilever: SCOUT 350 (k=42 N/m, f=350 kHz)
- Pixel Size: 1024×512

GaN epi wafer



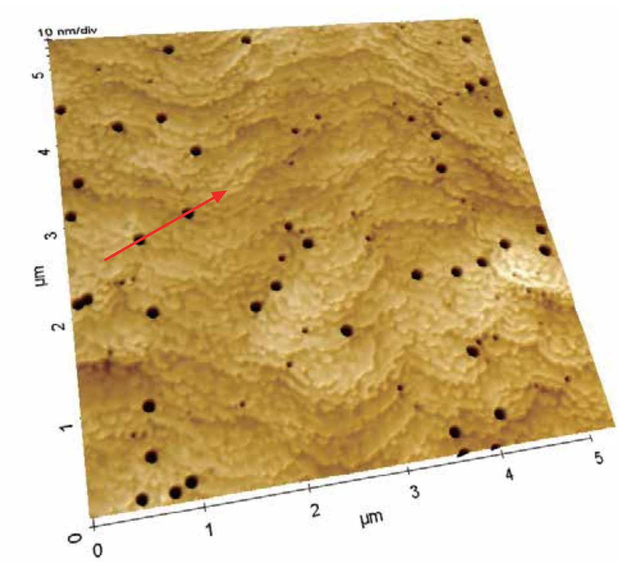
Non-contact

■ Height



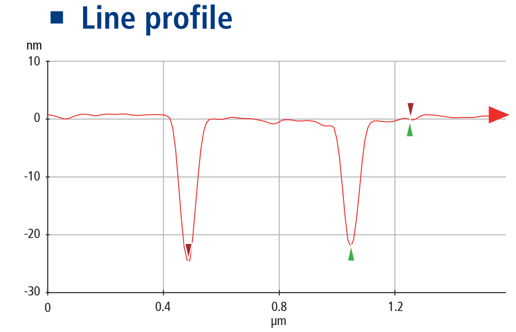
Peak to valley: 41 nm

■ 3D



X : Y : Z scale = 1 : 1 : 15

■ Line profile

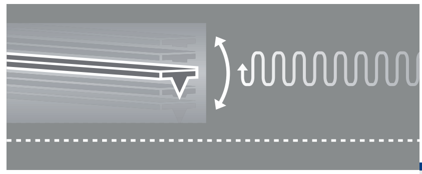


Cursor	ΔY(nm)
Red	24.358
Green	21.476

Scanning conditions

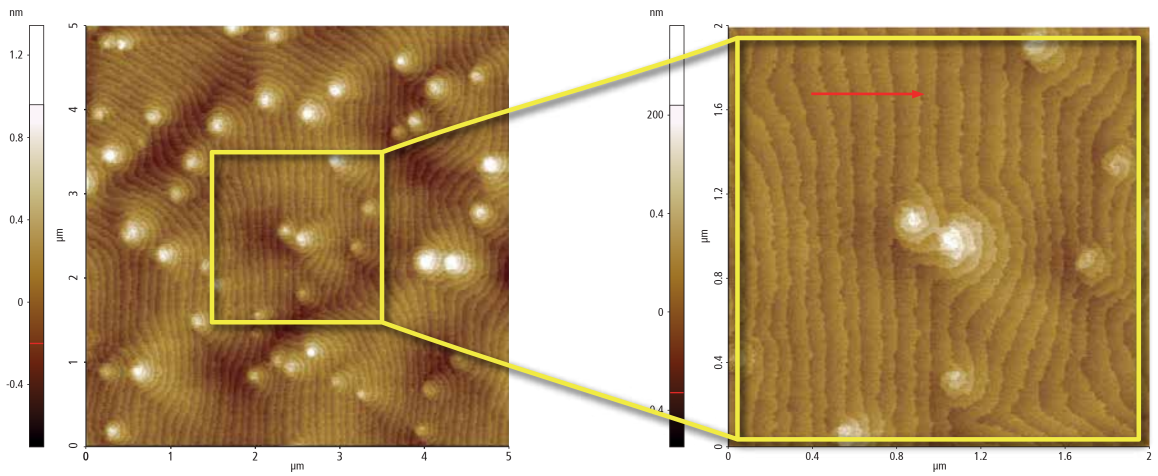
- System: NX-Wafer
- Scan Size: 5 μm × 5 μm
- Scan Mode: Non-contact
- Scan Rate: 0.7 Hz
- Cantilever: PPP-NCHR (k=42 N/m, f=330 kHz)
- Pixel Size: 512 × 512

GaN on Si epi film



Non-contact

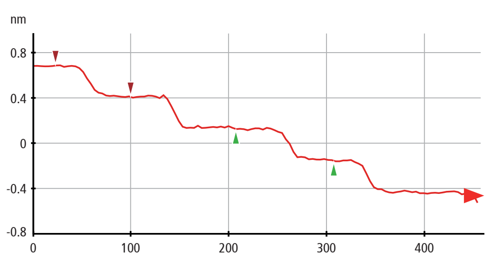
■ Height ■ Zoom-in Height



Peak to valley: 2.5 nm

Peak to valley: 1.7 nm

■ Line profile



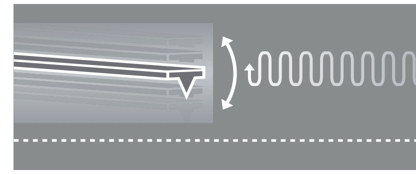
Cursor	ΔY(nm)
Red	-0.280
Green	-0.282

Step height ~2.8 A

Scanning conditions

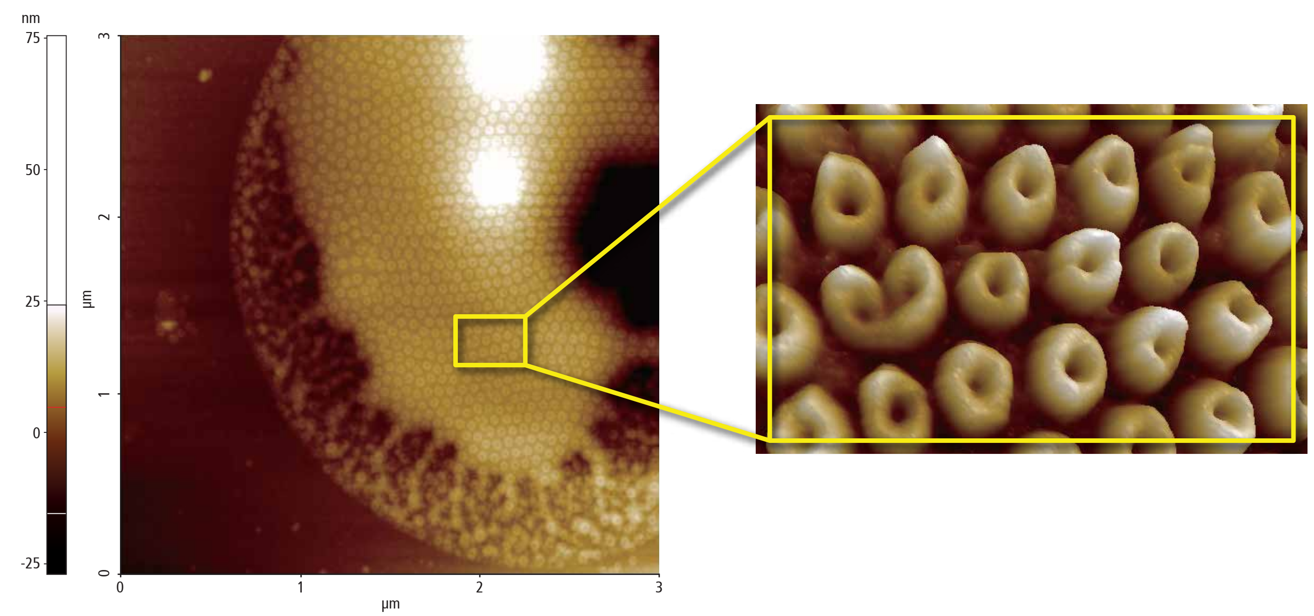
- System: NX20
- Scan Size: 5 μm², 2 μm²
- Scan Mode: Non-contact
- Scan Rate: All 2 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: All 512×512

Semi-fluorinated alkanes



Non-contact

■ Height ■ 3D

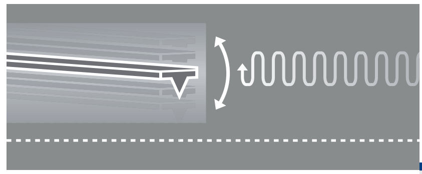


Peak to valley: 102 nm

Scanning conditions

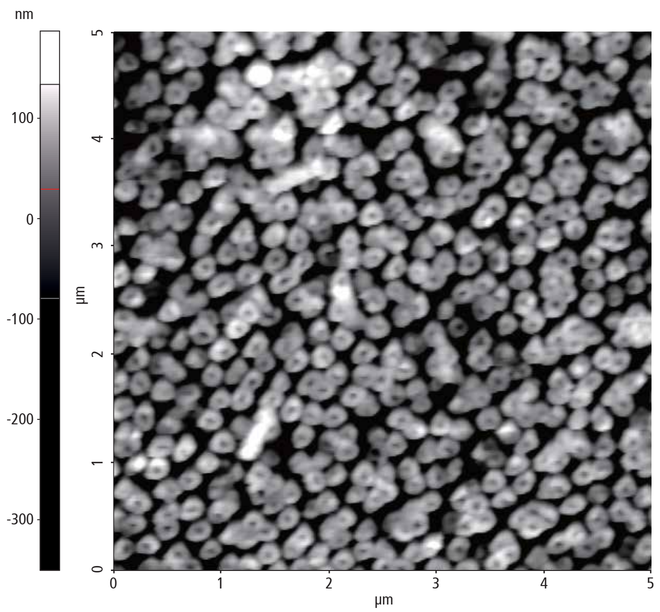
- System: NX10
- Scan Size: 3 μm × 3 μm
- Scan Mode: Non-contact
- Scan Rate: 0.4 Hz
- Cantilever: HQ: NSC14/CR-AU (k=5 N/m, f=160 kHz)
- Pixel Size: 1024 × 1024

Nanostructures on polymer

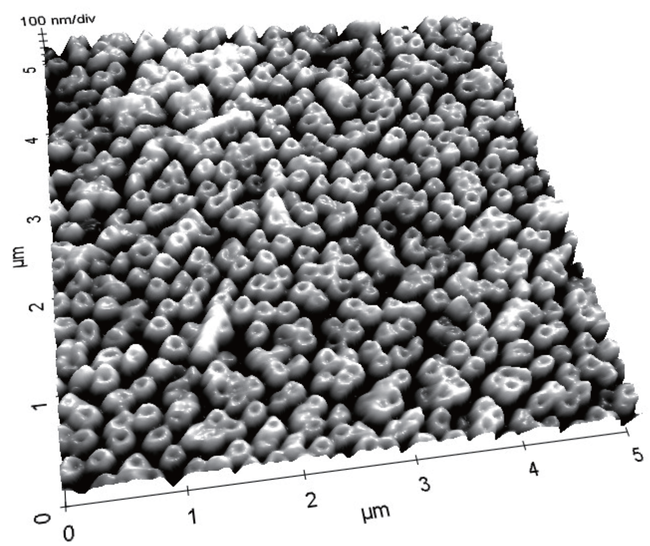


Non-contact

■ Height



■ 3D



Peak to valley: 539 nm

X : Y : Z scale = 1 : 1 : 1

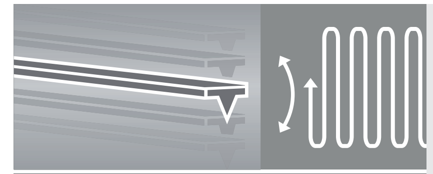
Nanostructures with ~100 nm diameter and ~400 nm height are formed on polymer.

▪ Sample courtesy: Monisha M, Biological sciences, Indian Institute of Science (IISc), India

Scanning conditions

- System: NX10
- Scan Size: 5 µm × 5 µm
- Scan Mode: Non-contact
- Scan Rate: 0.5 Hz
- Cantilever: PPP-NCHR (k=42 N/m, f=330 kHz)
- Pixel Size: 256 × 256

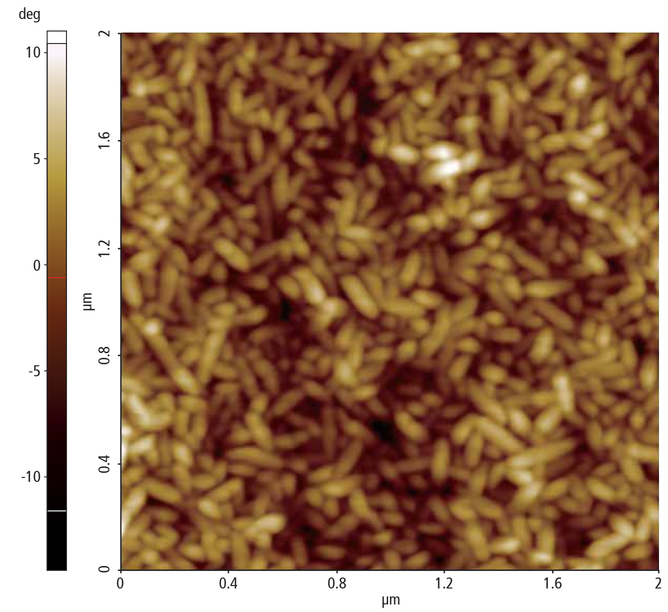
P (VDF-TrFE-CFE)



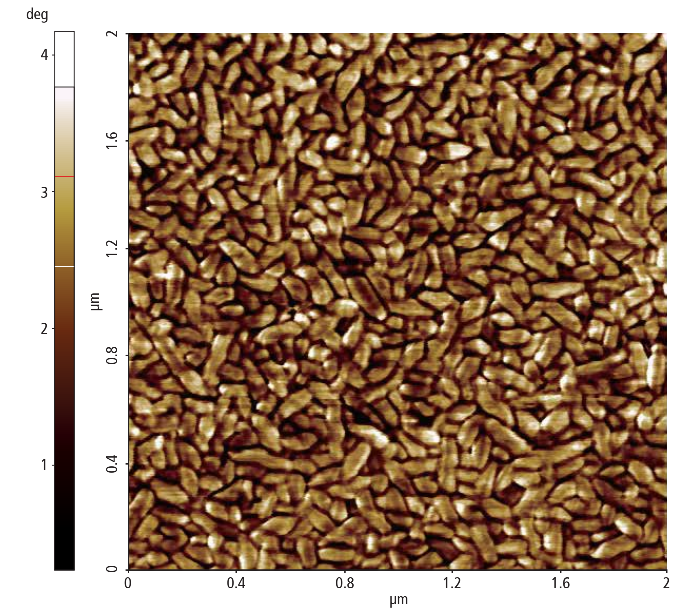
Tapping

Tapping mode is a dynamic AFM technique that images the sample topography by scanning the surface with an oscillating cantilever, similar to Non-contact mode. In tapping mode, the cantilever oscillates with a larger amplitude compared to Non-contact mode and the tip makes intermittent contact with the sample surface during the measurement. Here, the amplitude is used as topography feedback, while the phase delay between the drive and detect signal contains information about the material-specific mechanical properties.

■ Height



■ NCM Phase



Peak to valley: 25 nm

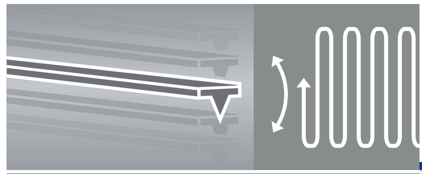
P(VDF-TrFE-CFE): Poly (vinylidene fluoride-trifluoroethylene-chlorofluoroethylene)

Blended terpolymer

Scanning conditions

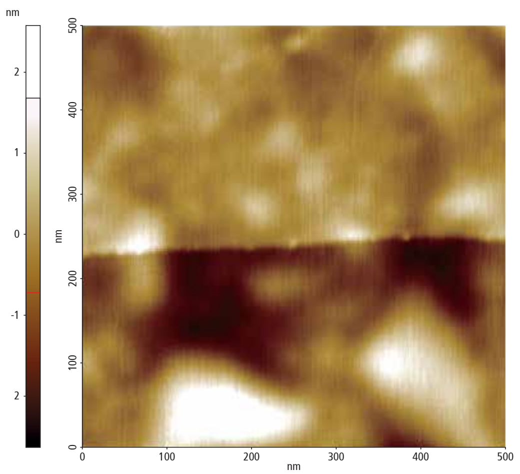
- System: FX40
- Scan Size: 2 µm × 2 µm
- Scan Mode: Tapping
- Scan Rate: 0.5 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: 512 × 512

MoS_2-WSe_2



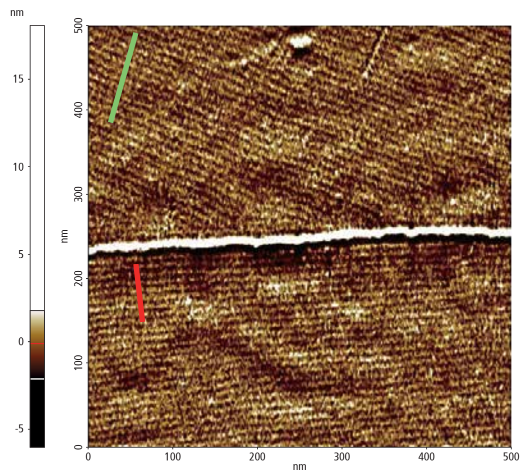
Tapping

■ Height

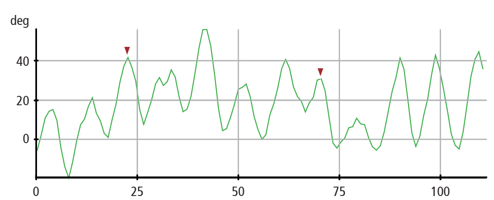


Peak to valley: 5.2 nm

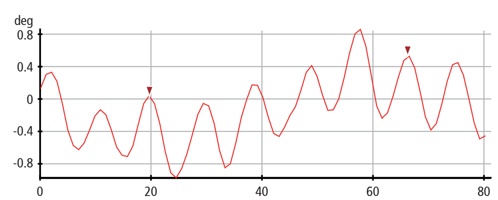
■ NCM Phase



■ Line profile



Period: 9.5 nm



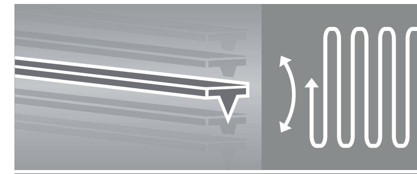
Period: 9.3 nm

▪ Sample courtesy: Nanyang Technological University (NTU), Singapore

Scanning conditions

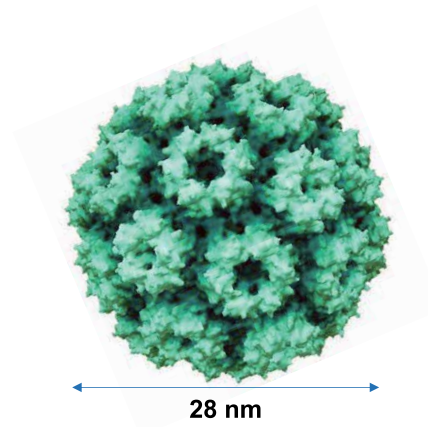
- System: FX40
- Scan Size: 500 nm × 500 nm
- Scan Mode: Tapping
- Scan Rate: 3 Hz
- Cantilever: PPP-FMR (k=2.8 N/m, f=75 kHz)
- Pixel Size: 512 × 512

Cowpea chlorotic mottle viruses (CCMV)

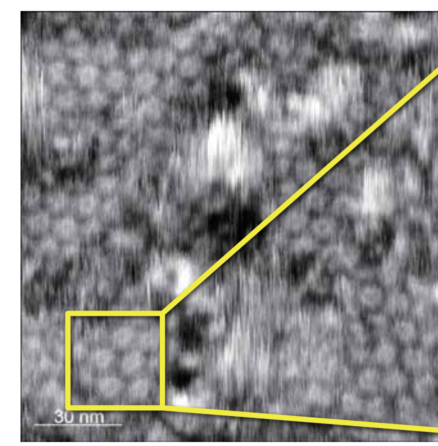


Tapping

■ CCMV model

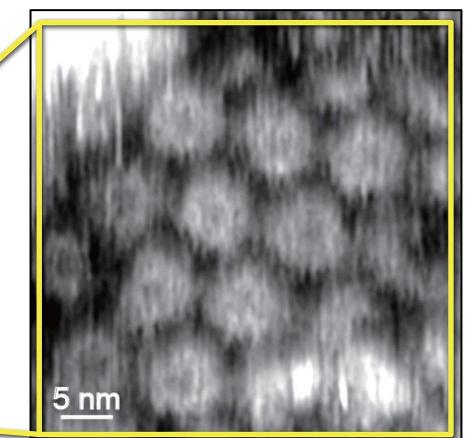


■ Height in buffer



Peak to valley: 6.1 nm

■ Zoom-in Height



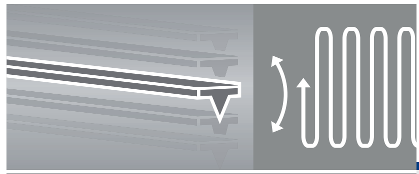
Peak to valley: 2.5 nm

▪ Sample courtesy: LPS, France

Scanning conditions

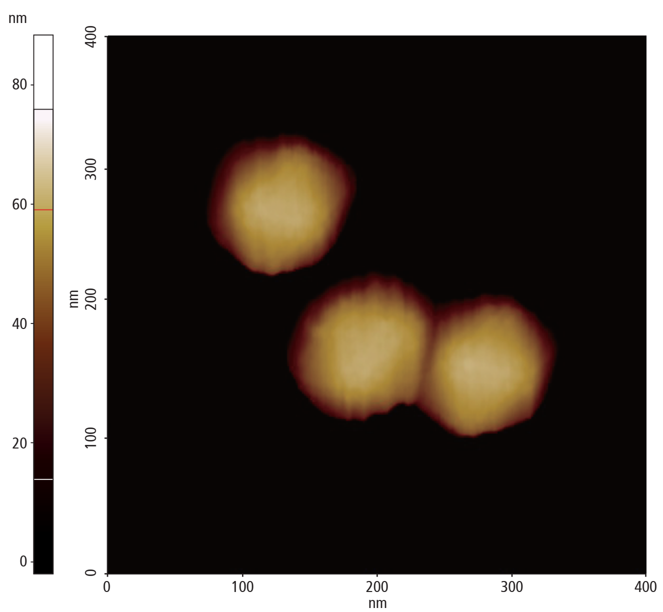
- System: FX40
- Scan Size: 150 nm × 150 nm
- Scan Mode: Tapping in Liquid
- Scan Rate: 3 Hz
- Cantilever: SCOUT 350 (k=42 N/m, f=350 kHz)
- Pixel Size: 512 × 512

Adenovirus



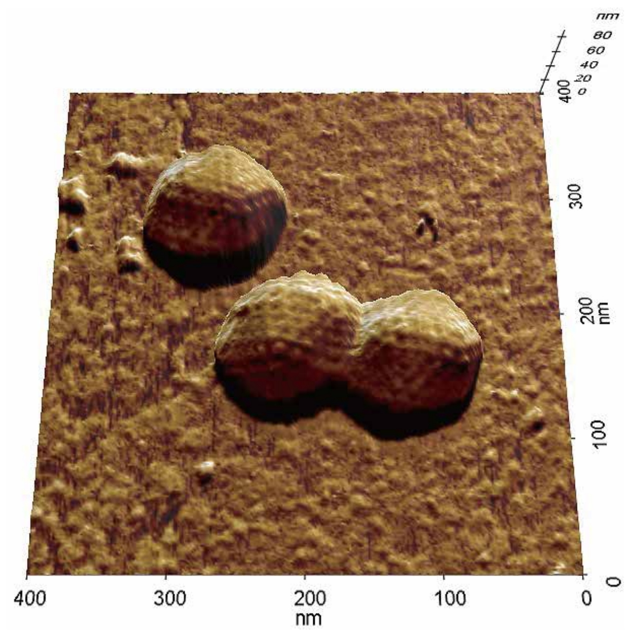
Tapping

■ Height



Peak to valley: 729 nm

■ 3D (Amplitude overlaid on height)



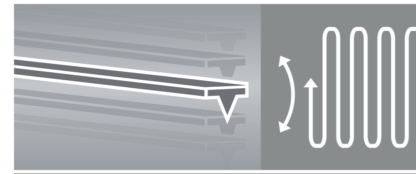
X : Y : Z scale = 1 : 1 : 1

Adenovirus is a type of virus that can cause various respiratory illnesses such as colds, sore throat, pneumonia, diarrhea, etc.
AFM allows studies of virus structure and biomechanics under specific physiological condition.

Scanning conditions

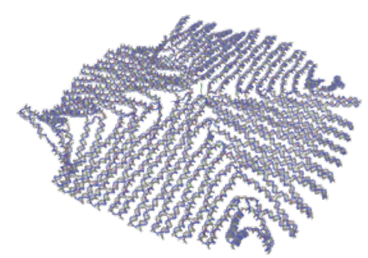
- System: FX40
- Scan Size: 400 nm × 400 nm
- Scan Mode: Tapping in Liquid
- Scan Rate: 0.82 Hz
- Cantilever: USC-F0.3-k0.3 (k=0.3 N/m, f=300 kHz)
- Pixel Size: 1024 × 512

Plate-shaped DNA origami



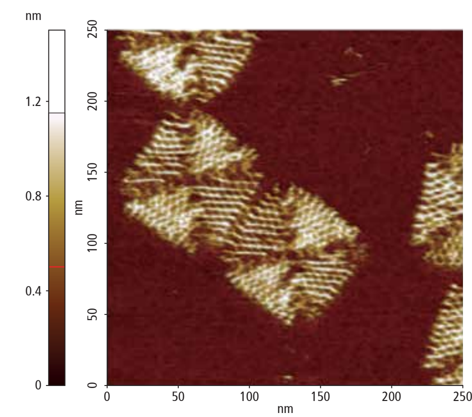
Tapping

■ Schematic



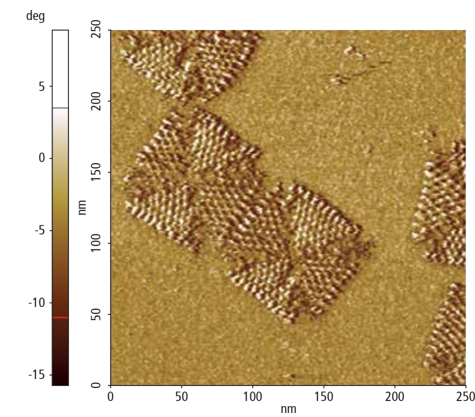
Truchet tile

■ Height



Peak to valley: 1.5 nm

■ NCM Phase

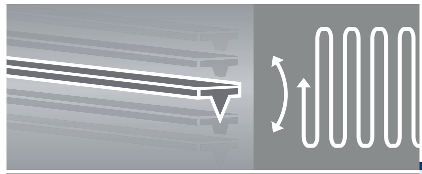


▪ Sample courtesy: Prof. Seungwoo Lee, KU-KIST Graduate School of Converging Science and Technology, Korea University, Korea

Scanning conditions

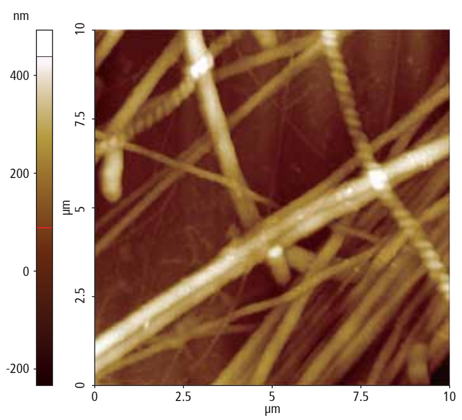
- System: FX40
- Scan Size: 250 nm × 250 nm
- Scan Mode: Tapping in Liquid
- Scan Rate: 1 Hz
- Cantilever: USC-F0.3-k0.3 (k=0.3 N/m, f=300 kHz)
- Pixel Size: 512 × 256

Collagen fibrils



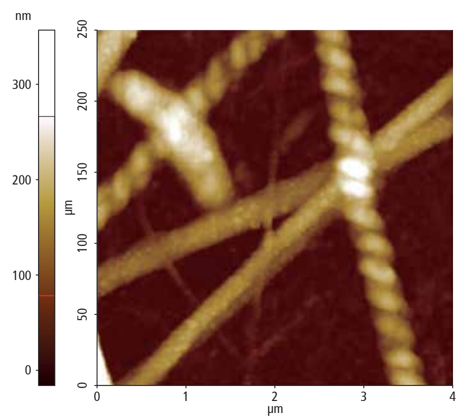
Tapping

■ Height of 10 µm2



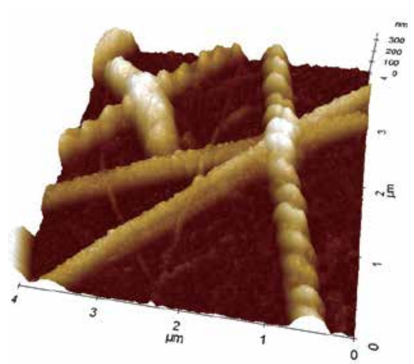
Peak to valley: 732 nm

■ Height of 4 µm2



Peak to valley: 374 nm

■ 3D

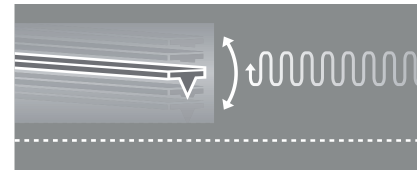


X : Y : Z scale = 1 : 1 : 1

Scanning conditions

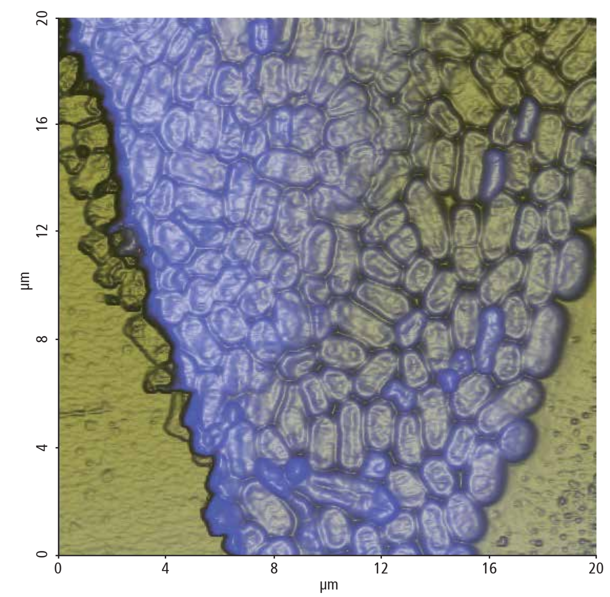
- System: NX10
- Scan Size: 10 µm², 4 µm²
- Scan Mode: Tapping in Liquid
- Scan Rate: All 0.3 Hz
- Cantilever: PPP-FMR (k=2.8 N/m, f=75 kHz)
- Pixel Size: All 256 × 256

Bacteria Klebsiella pneumoniae (KP)



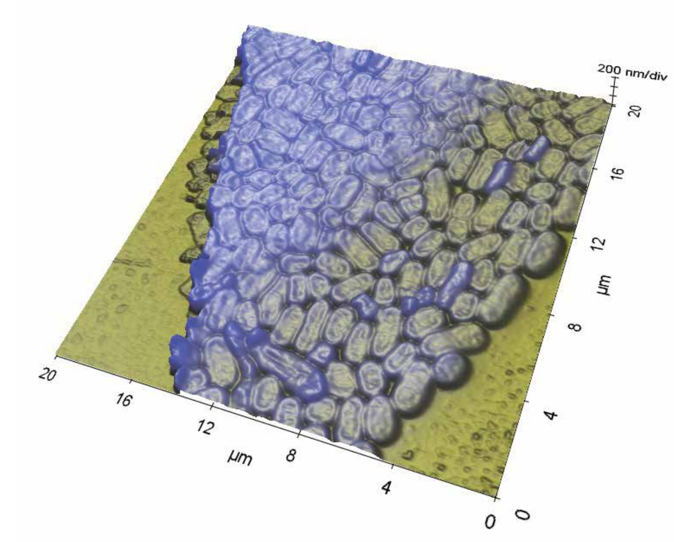
Non-contact

■ Height



Peak to valley: 655 nm

■ 3D



X : Y : Z scale = 1 : 1 : 3

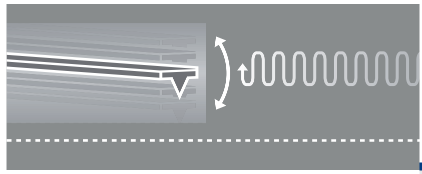
Klebsiella pneumoniae (KP) is after Escherichia coli the most common gram-negative species causing invasive infections. KP is normally found in the human intestines.

- Sample courtesy: Monisha M, Biological sciences, Indian Institute of Science (IISc), India

Scanning conditions

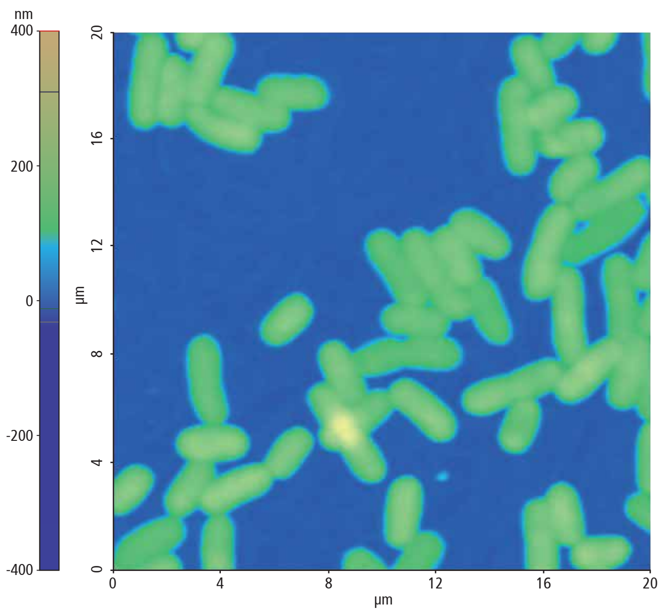
- System: NX10
- Scan Size: 20 µm × 20 µm
- Scan Mode: Non-contact
- Scan Rate: 0.5 Hz
- Cantilever: PPP-ContSCR (k=0.2 N/m, f=25 kHz)
- Pixel Size: 256 × 256

Escherichia coli (E. coli)



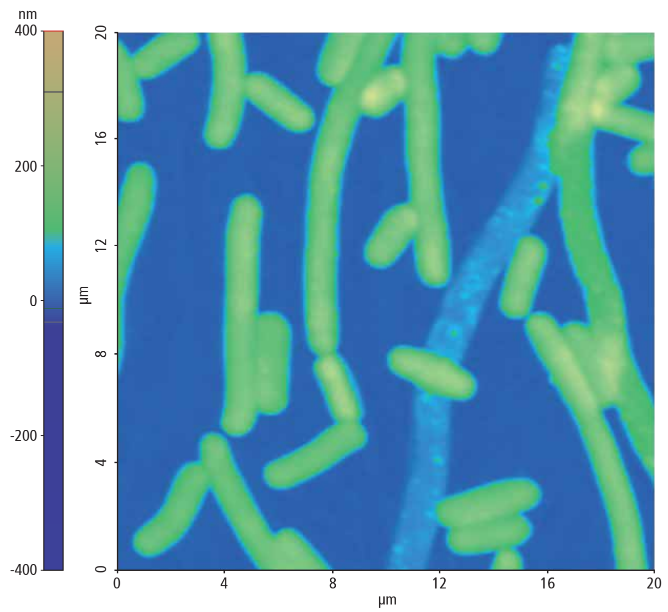
Non-contact

▪ Wild Type E. coli



Peak to valley: 319 nm

▪ Delta Lon treated E. coli



Peak to valley: 295 nm

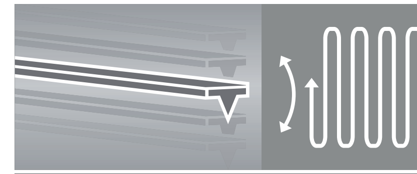
Escherichia coli (E. coli) is normally found in the environment, foods, and intestines of people and animals. Most strains of E. coli are harmless, but some strains of E. coli can cause diarrhea and some can cause urinary tract infections, respiratory illness and pneumonia.

▪ Sample courtesy: Monisha M, Biological sciences, Indian Institute of Science (IISc), India

Scanning conditions

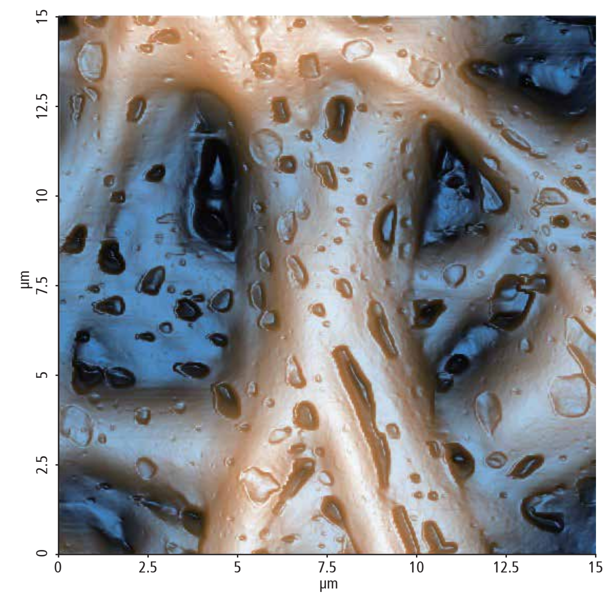
- System: NX10
- Scan Mode: Non-contact
- Cantilever: PPP-NCHR (k=42 N/m, f=330 kHz)
- Scan Size: 20 µm × 20 µm
- Scan Rate: 0.5 Hz
- Pixel Size: 256 × 256

Crosslinked starch & pectin fibers



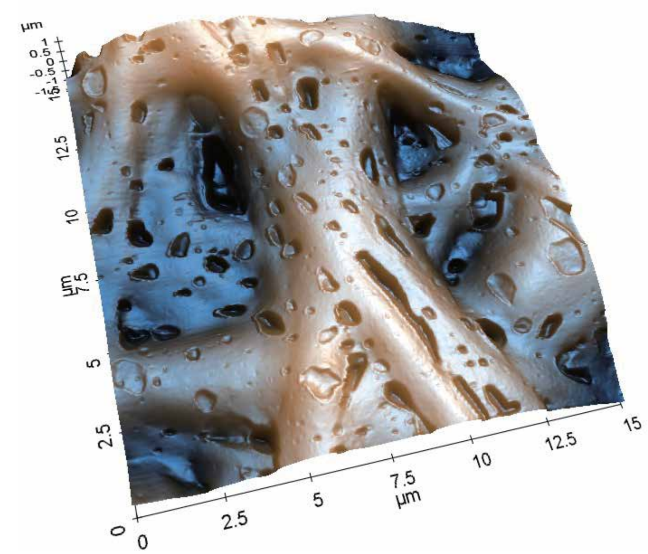
Tapping

▪ Height



Peak to valley: 729 nm

▪ 3D



X : Y : Z scale = 1 : 1 : 1

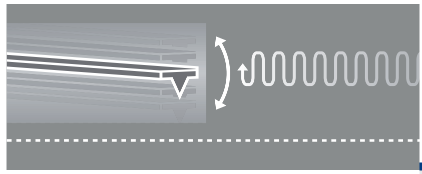
Starch-Pectin fibers crosslinked with Transglutaminase.

▪ Sample courtesy: Dr. Jorge Chanona, Nanotechnology Department, Instituto Politecnico Nacional [IPN], Mexico City, Mexico

Scanning conditions

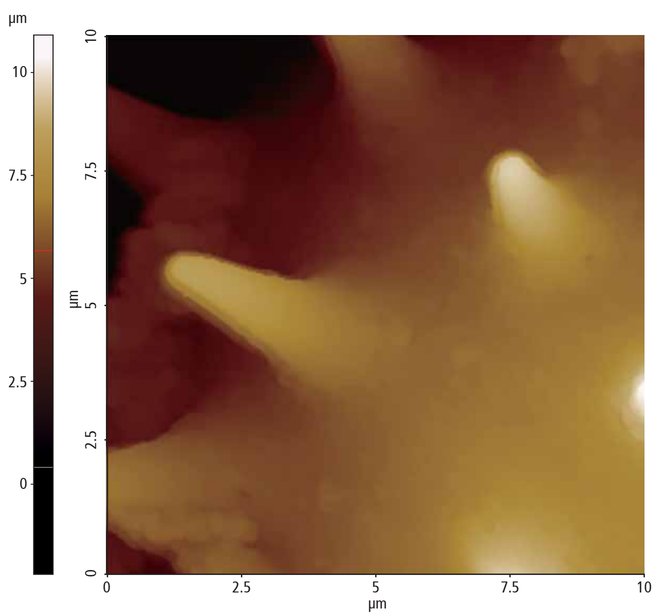
- System: NX10
- Scan Mode: Tapping
- Cantilever: ContSCR (k=0.2 N/m, f=25 kHz)
- Scan Size: 15 µm × 15 µm
- Scan Rate: 0.31 Hz
- Pixel Size: 256 × 256

Sunflower pollen



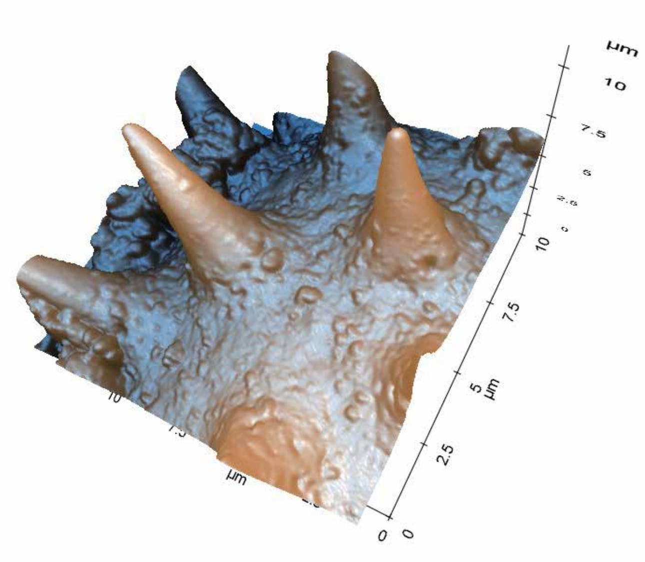
Non-contact

■ Height



Peak to valley: 13 µm

■ 3D



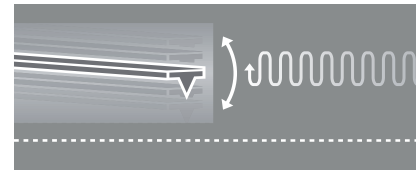
X : Y : Z scale = 1 : 1 : 1

There are numerous pollens, but especially sunflower pollen has special shape.
Sunflower pollen of Sunflower has medicinal effect on itself.
The bees from farms with more sunflower area had lower infection rates.
NCM can even take images of the complicated structure of pollen.

Scanning conditions

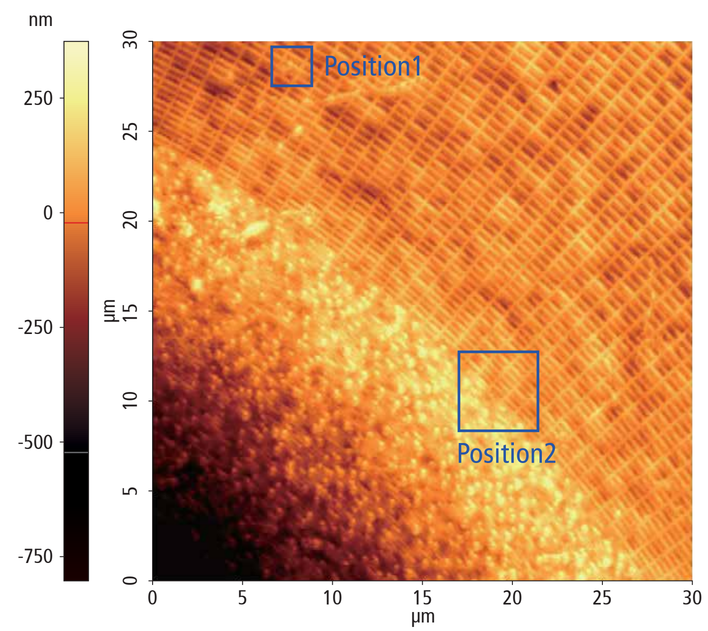
- System: NX12
- Scan Size: 10 µm × 10 µm
- Scan Mode: Non-contact with long travel head
- Scan Rate: 0.1 Hz
- Cantilever: AR5T-NCHR (k=42 N/m, f=330 kHz)
- Pixel Size: 256 × 256

Diamond with plated / gold nickel



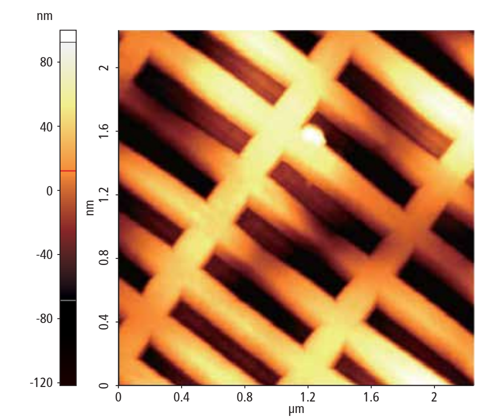
Non-contact

■ Height



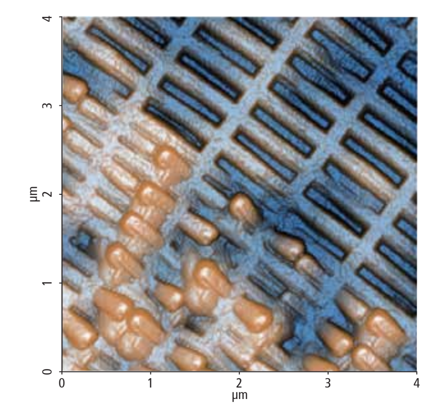
Peak to valley: 684 nm

■ Zoom-in height of position 1



Peak to valley: 222 nm

■ Zoom-in height of position 2



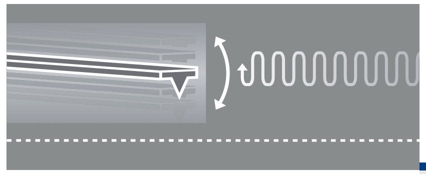
Peak to valley: 427 nm

- Sample courtesy: SLAC National Accelerator Center, United States

Scanning conditions

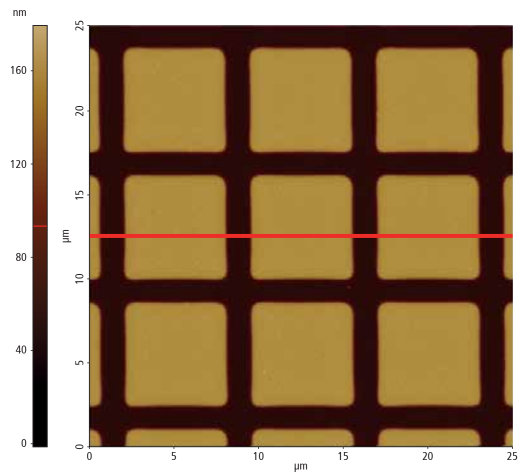
- System: NX20
- Scan Size: 30 µm², 2.25 µm², 4 µm²
- Scan Mode: Non-contact
- Scan Rate: 0.49 Hz for 30 µm², 4 µm²
  0.6 Hz for 2.25 µm²
- Cantilever: AD-2.8-AS (k=2.8 N/m, f=75 kHz)
- Pixel Size: All 256 × 256

CMP test key

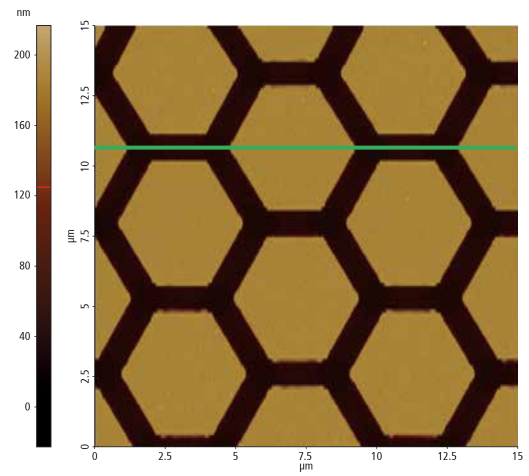


Non-contact

■ Height of pattern 1

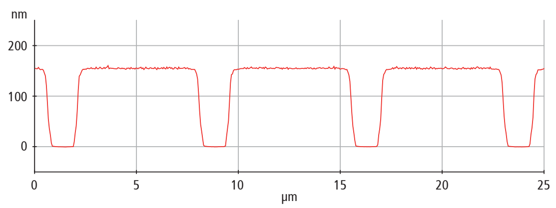


■ Height of pattern 2

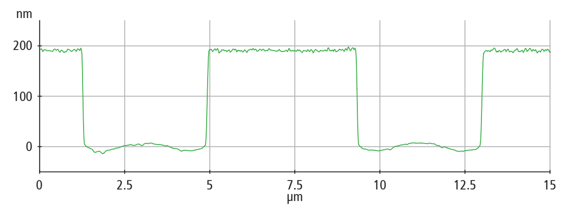


■ Line profiles

Pattern 1



Pattern 2

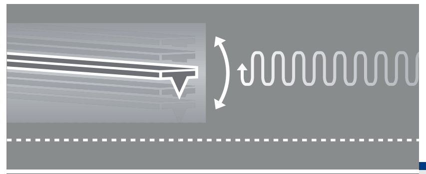


Test key is a set of periodic pattern to simulate real complicate pattern within die/chip.
The purpose of test key is to provide measurement site for some metrological tool that can't measure at real pattern.

Scanning conditions

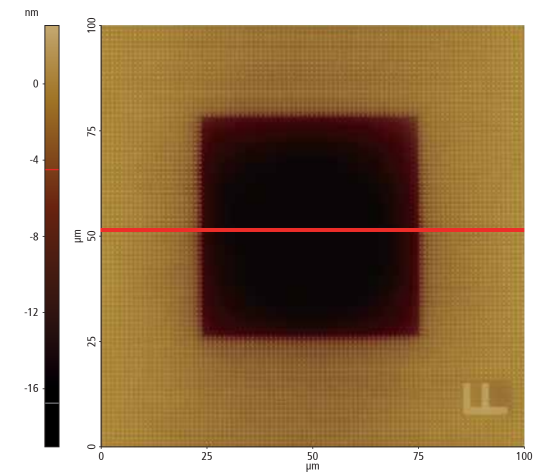
- System: NX20
- Scan Size: 25 μm², 15 μm²
- Scan Mode: Non-contact
- Scan Rate: 1 Hz for 25 μm², 0.6 Hz for 15 μm²
- Cantilever: PPP-NCHR (k=42 N/m, f=330 kHz)
- Pixel Size: 512 × 256 for 25 μm², 1024 × 128 for 15 μm²

CMP test key

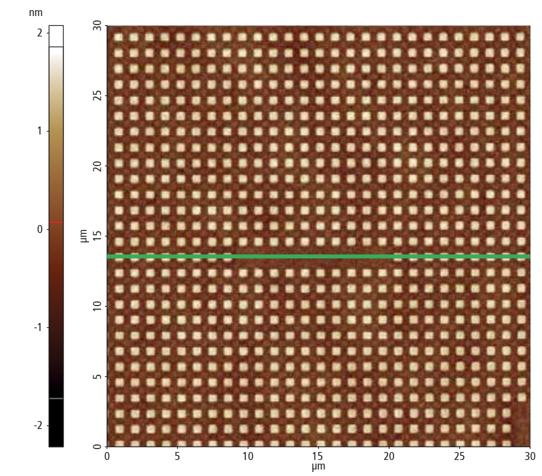


Non-contact

■ Height of pattern 1

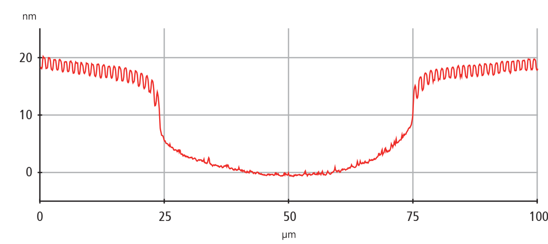


■ Height of pattern 2

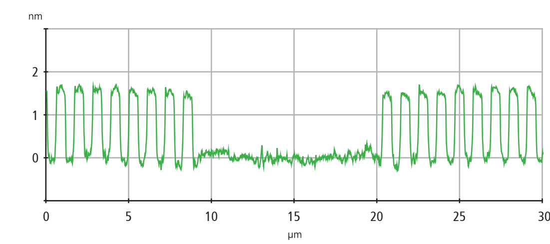


■ Line profiles

Pattern 1



Pattern 2



Test key is a set of periodic pattern to simulate real complicate pattern within die/chip.
The purpose of test key is to provide measurement site for some metrological tool that can't measure at real pattern.

Scanning conditions

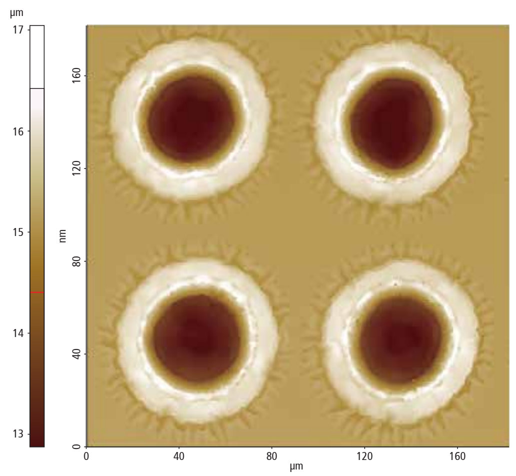
- System: NX-Wafer
- Scan Size: 100 μm², 30 μm²
- Scan Mode: Non-contact
- Scan Rate: 1 Hz for 100 μm², 1.5 Hz for 30 μm²
- Cantilever: OMCL-AC240TS (k=2 N/m, f=70 kHz)
- Pixel Size: All 1024 × 512

WLI image of wafer ID mark

White Light Interferometer (WLI)

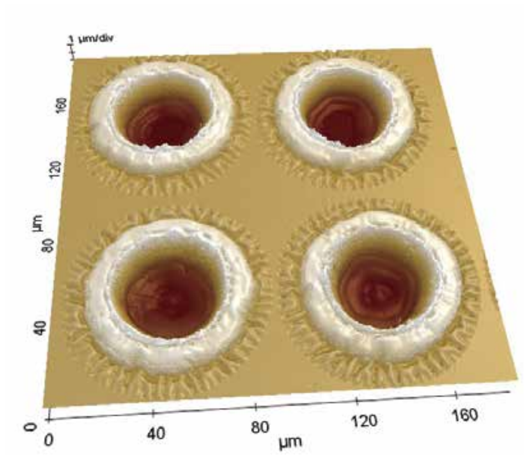
White light interferometry (WLI) is a non-destructive optical method capable of imaging topographical information, enabling high-throughput measurements by measuring a wide sample area with fast speed. Hybrid of AFM and WLI makes it suitable for cases requiring high throughput measurements over a large area that can zoom down to nanometer-scale regions with sub-nano resolution and ultra-high accuracy.

■ WLI Height



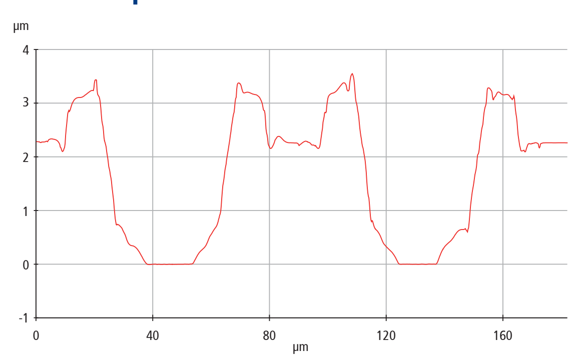
Peak to valley: 4 µm

■ 3D



X : Y : Z scale = 1 : 1 : 5

■ Line profile

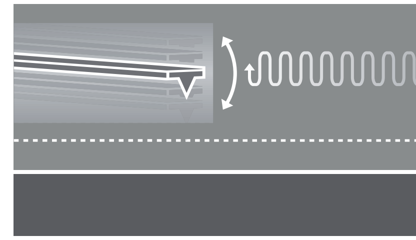


WLI image of wafer ID mark.

Scanning conditions

- System: NX-Hybrid WLI
- Scan Mode: WLI
- Field of view: 182 µm × 182 µm

TSV Cu pad oxidation

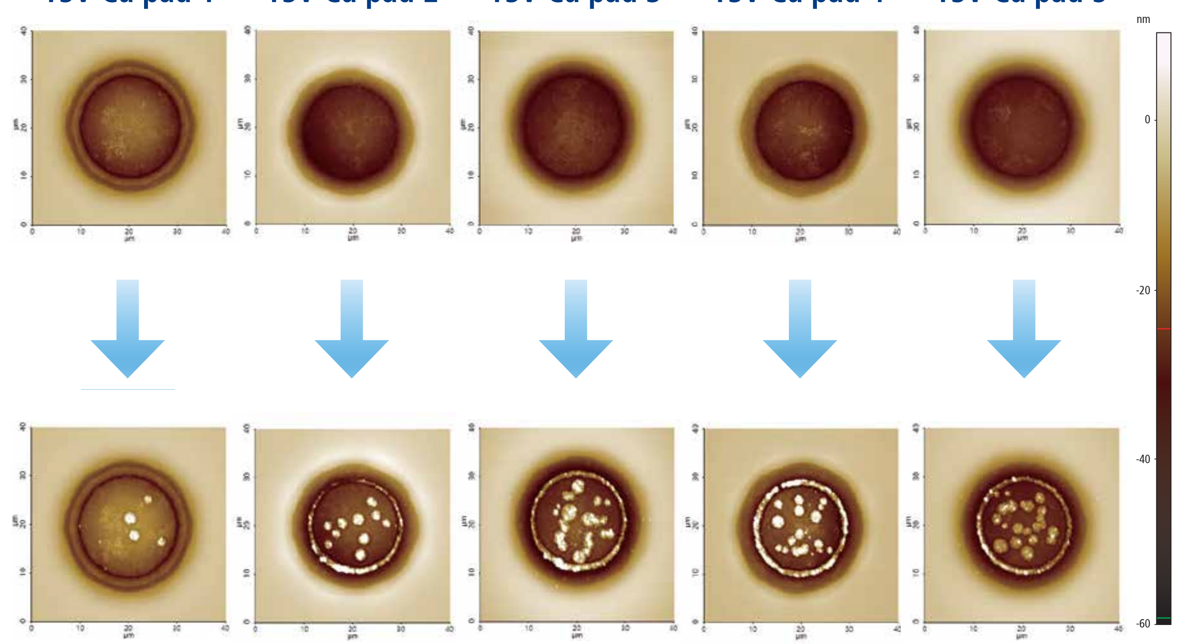


Non-contact

TSV Cu pad 1 | TSV Cu pad 2 | TSV Cu pad 3 | TSV Cu pad 4 | TSV Cu pad 5

Height of Through Silicon Via (TSV)-Cu pad

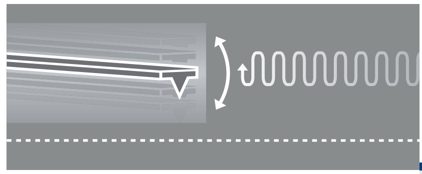
Height of TSV-Cu pad after oxidation



Scanning conditions

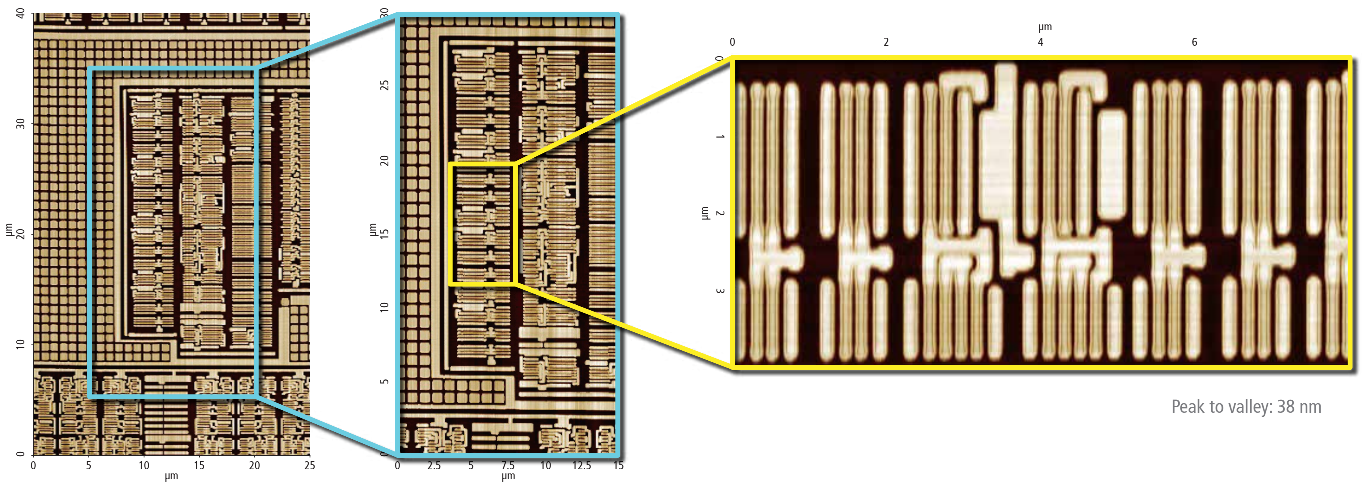
- System: NX-Wafer
- Scan Mode: Non-contact
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Scan Size: 40 µm × 40 µm
- Scan Rate: All 1 Hz
- Pixel Size: All 512 × 512

Chip



Non-contact

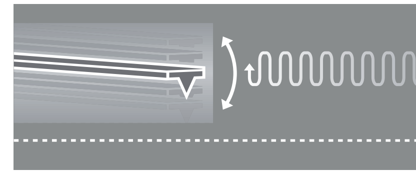
■ Height ■ Zoom-in Height ■ Zoom-in Height



Scanning conditions

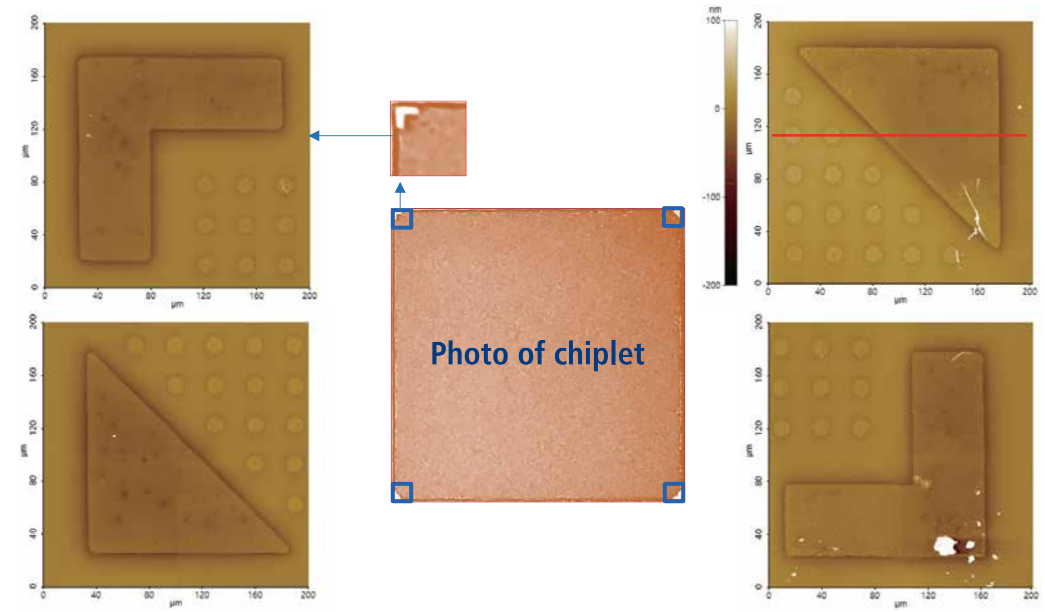
- System: NX-Wafer
- Scan Size: 25 µm × 40 µm, 15 µm × 30 µm, 8 µm × 4 µm
- Scan Mode: Non-contact
- Scan Rate: All 1 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: 2048 × 256, 2048 × 256, 1024 × 256

Stitched image of Chiplet

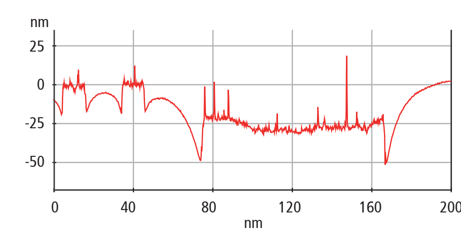


Non-contact

■ Height of chiplet corner



■ Line profile of stitched image

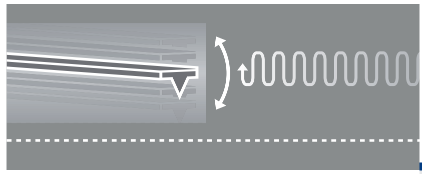


Four corners of chiplet with 200 µm × 200 µm scan size. Four AFM single images (2×2) of 100 µm × 100 µm scans were stitched together.

Scanning conditions

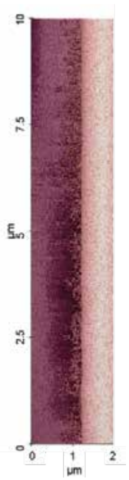
- System: NX-Wafer
- Scan Size: 100 µm × 100 µm for single image (200 µm × 200 µm stitched image)
- Scan Mode: Non-contact
- Scan Rate: 0.5 Hz
- Cantilever: OMCL-AC240TS (k=2 N/m, f=70 kHz)
- Pixel Size: 512 × 128 for single image

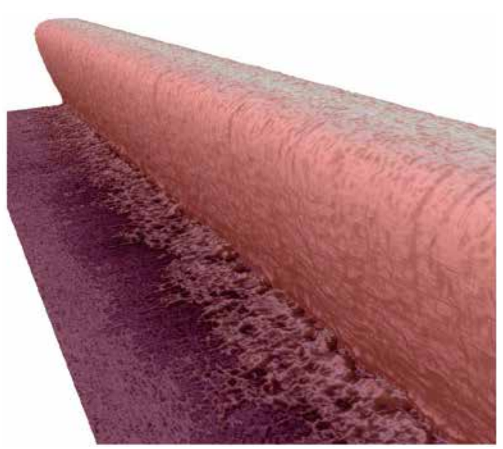
Photoresist pattern (post-development process)



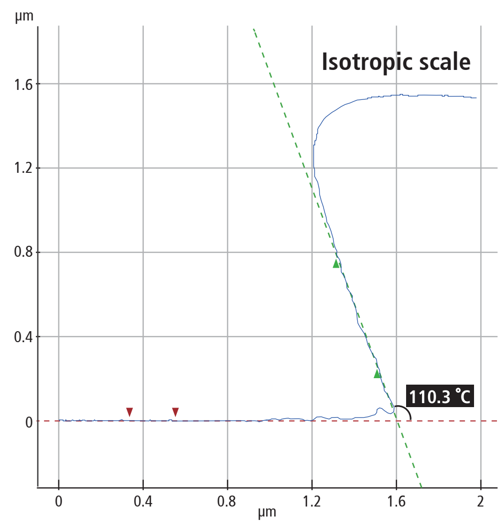
Non-contact

- Height
- 3D
- Line profile





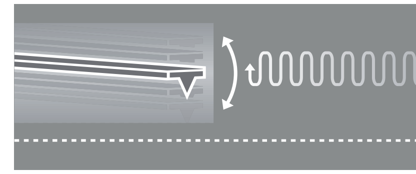
X : Y : Z scale = 1 : 1 : 1



Scanning conditions

- System: NX-3DM
- Scan Size: 2 μm × 10 μm
- Scan Mode: Non-contact
- Scan Rate: 0.1 Hz
- Cantilever: EBD-R2-NCLR (k= 45 N/m, f=190 kHz)
- Pixel Size: 512 × 2048

$MoSi_2$ hard defect repair

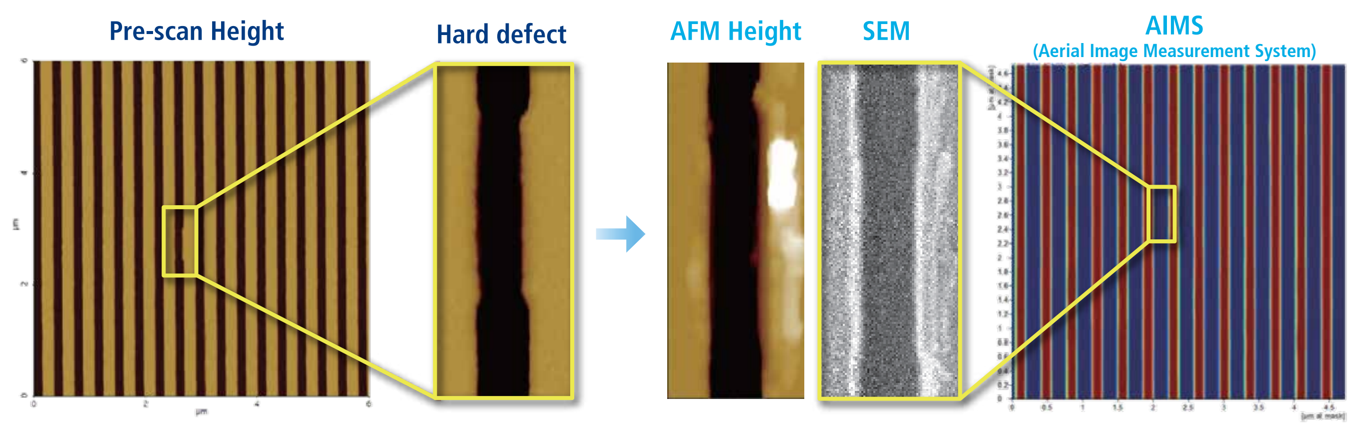


Non-contact

- Before repairing

Mask repair process

- After repairing



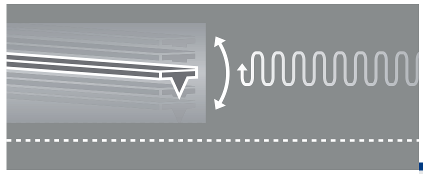
Peak to valley: 100 nm

AIMS result: 94.5 % Diff.
User spec: 100±6 % Diff.

Scanning conditions

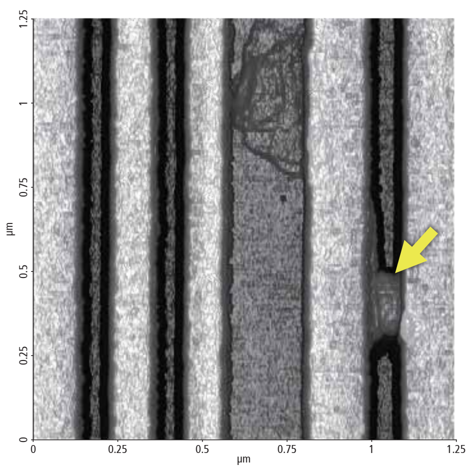
- System: NX-Mask
- Scan Size: 6 μm², 0.5 μm × 1 μm
- Scan Mode: Non-contact for imaging, sweep for repairing
- Scan Rate: 0.3 Hz
- Pixel Size: 512 × 64 for 6 μm², 512 × 32 for 0.5 μm × 1 μm

Hard defect repair of photomask



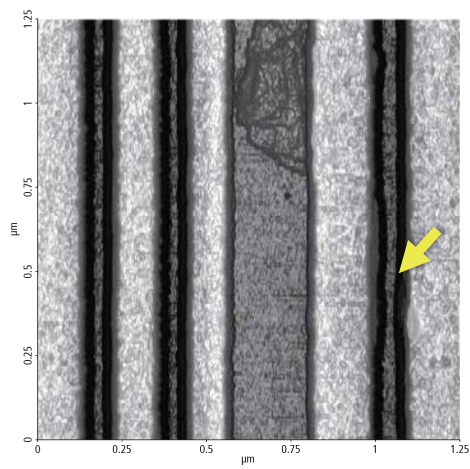
Non-contact

■ Height before mask repairing



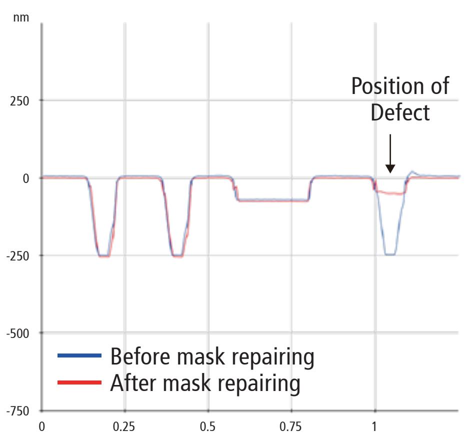
Peak to valley: 265 nm

■ Height after mask repairing



Peak to valley: 265 nm

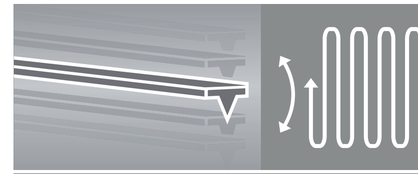
■ Line profile



Scanning conditions

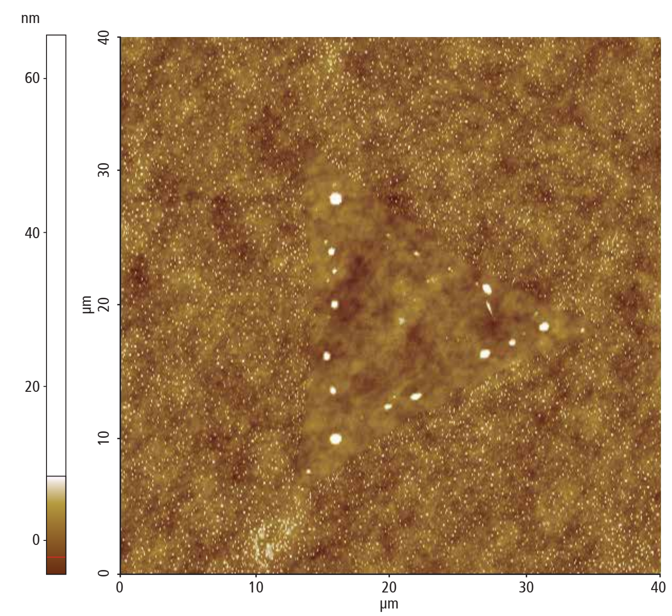
- System: NX-Mask
- Scan Size: 1.25 µm × 1.25 µm
- Scan Mode: Non-contact for imaging, sweep for repairing
- Scan Rate: 0.3 Hz
- Cantilever: OMCL-AC160TS for imaging AD-40-AS for repairing
- Pixel Size: 256 × 256

MoS_2 film

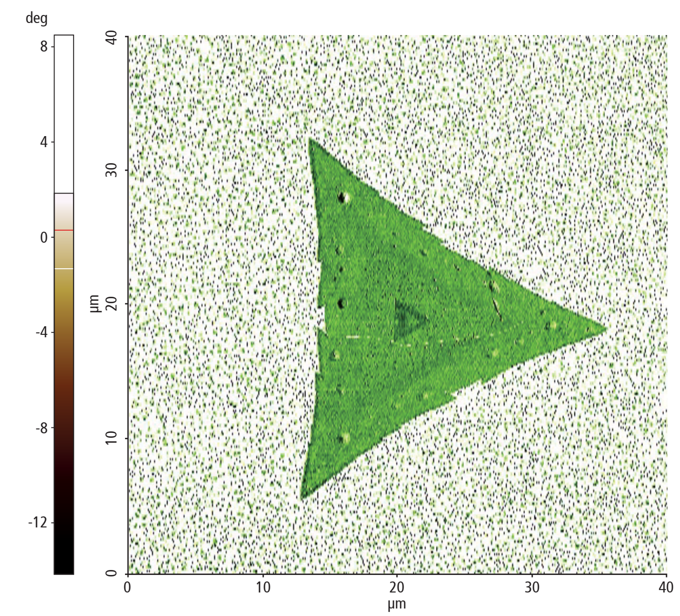


Tapping

■ Height



■ NCM Phase



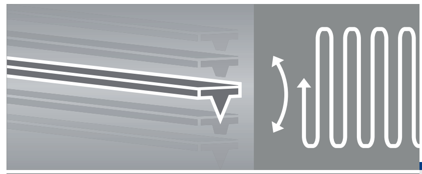
Peak to valley: 70 nm

Triangular shape of MoS_2 film on Si substrate was well observed in phase image.

Scanning conditions

- System: FX40
- Scan Size: 40 µm × 40 µm
- Scan Mode: Tapping
- Scan Rate: 1 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: 512 × 256

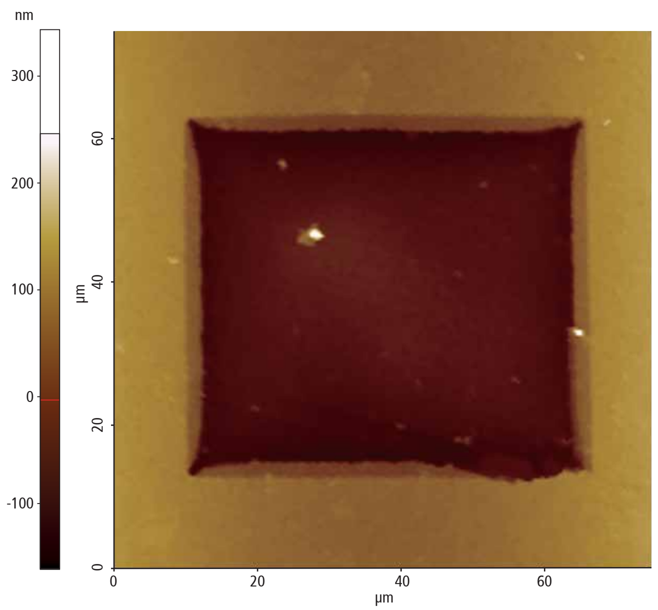
Suspended silicon nitride membrane

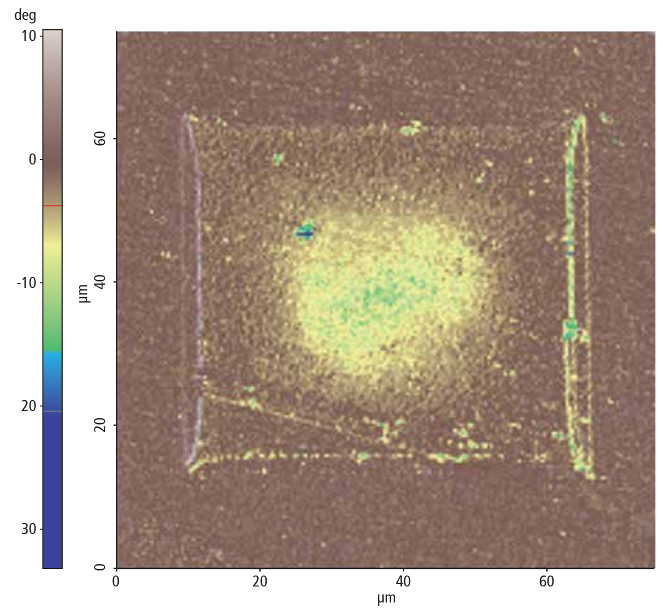


Tapping

■ Height

■ NCM Phase





Peak to valley: 500 nm

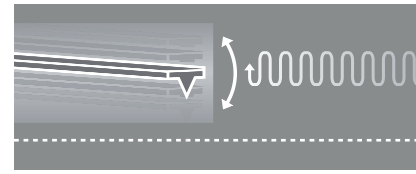
Suspended square-shaped silicon nitride membrane to be used in nanopore-based sensing applications.
Topography clearly shows that the membrane is buckled due to a high biaxial compressive strain.
Phase shows a radially increasing from the edge towards the center of the membrane
due to the gradual reduction in the stiffness of membrane along this direction.

- Iample courtesy: Sanket Jugade, Prof. Akshay Naik, Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science Bengaluru, India
- Sample courtesy: Dr. Sohini Pal, Prof. Manoj Verma

Scanning conditions

- System: NX20
- Scan Size: 75 µm × 75 µm
- Scan Mode: Tapping
- Scan Rate: 0.2 Hz
- Cantilever: TESPA-V2 (k=37 N/m, f=320 kHz)
- Pixel Size: 256 × 256

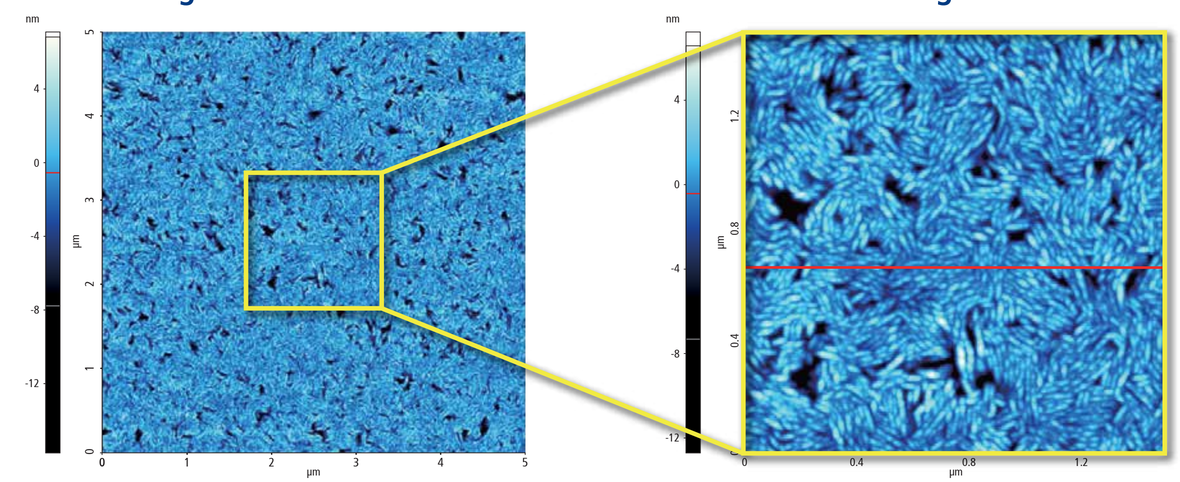
Mo film



Non-contact

■ Height

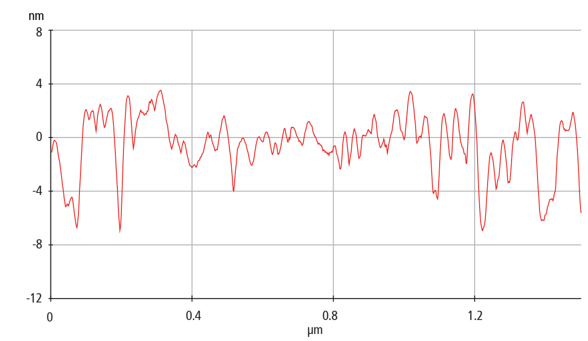
■ Zoom-in Height



Peak to valley: 23 nm

Peak to valley: 20 nm

■ Line profile

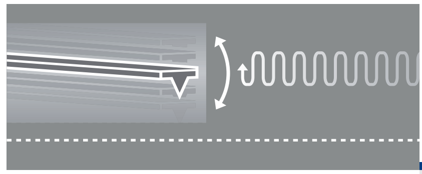


Mo layer on 8 inch Si wafer.

Scanning conditions

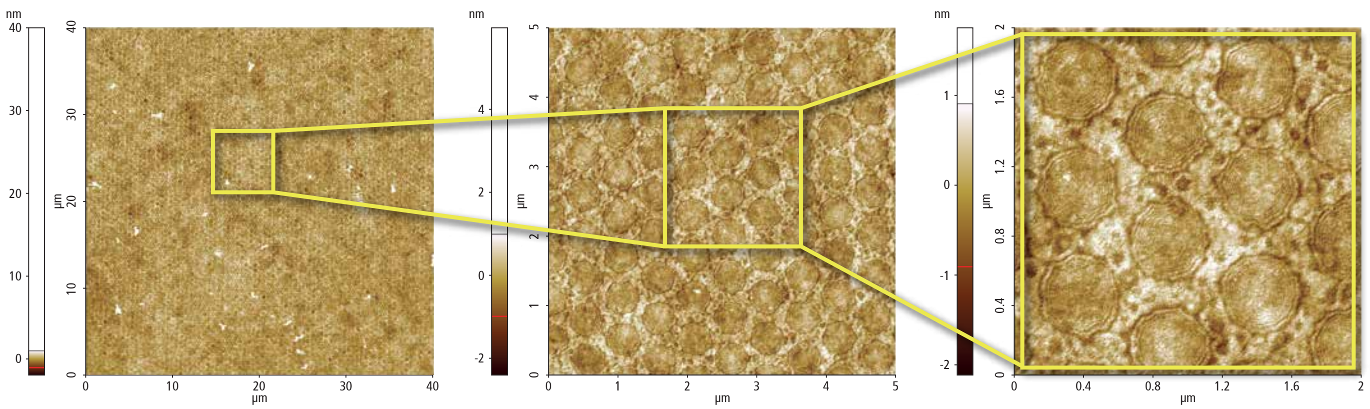
- System: NX-Wafer
- Scan Size: 5 µm², 1.5 µm²
- Scan Mode: Non-contact
- Scan Rate: 0.5 Hz, 0.8 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: All 1024 × 512

AR Lens



Non-contact

- Height
- Zoom-in Height
- Zoom-in Height



Peak to valley: 42 nm

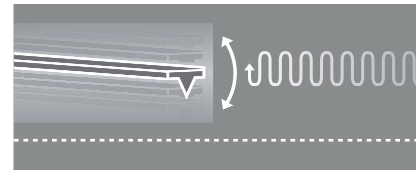
Peak to valley: 8 nm

Peak to valley: 4 nm

Scanning conditions

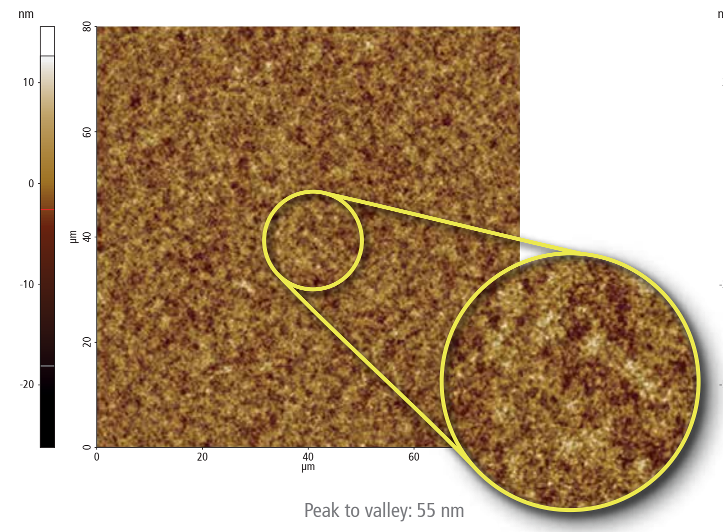
- System: FX40
- Scan Size: 40 μm^2, 5 μm^2, 2 μm^2
- Scan Mode: Non-contact
- Scan Rate: 0.5 Hz for 40 μm^2, 1.5 Hz for 5 μm^2, 2 μm^2
- Cantilever: OMCL-AC55TS (k=85 N/m, f=1.6 MHz)
- Pixel Size: 2048 × 512 for 40 μm^2, 5 μm^2, 1024 × 256 for 2 μm^2

Copper film



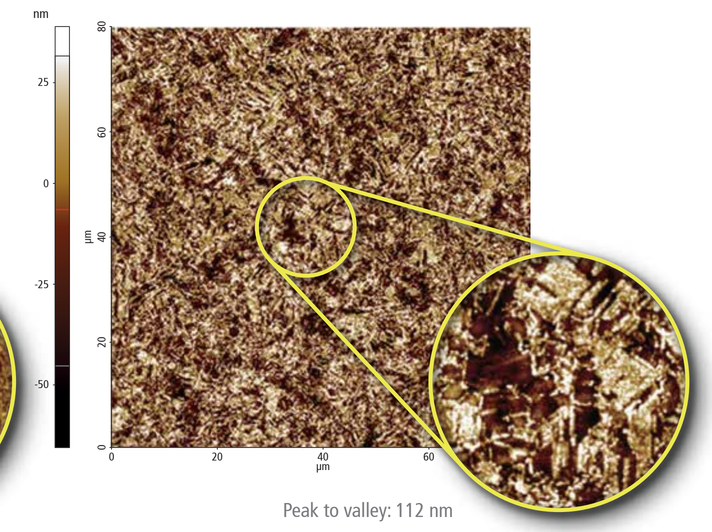
Non-contact

- Cu deposition surface by sputtering (as growth)



Peak to valley: 55 nm

- Cu surface after furnace annealing

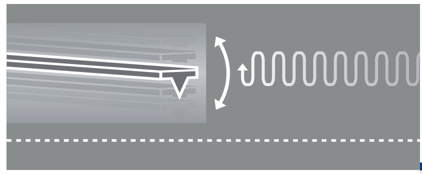


Peak to valley: 112 nm

Scanning conditions

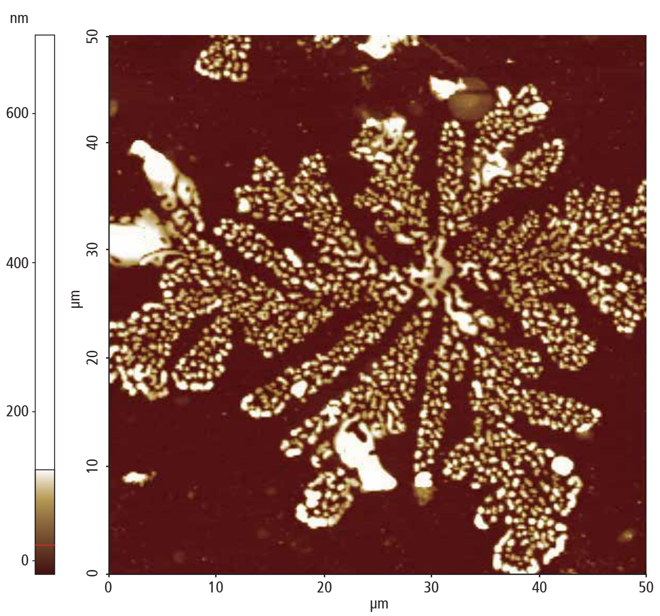
- System: NX-Wafer
- Scan Size: 80 µm × 80 µm
- Scan Mode: Non-contact
- Scan Rate: All 1 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: All 512 × 256

Fractals of silver nanoparticles



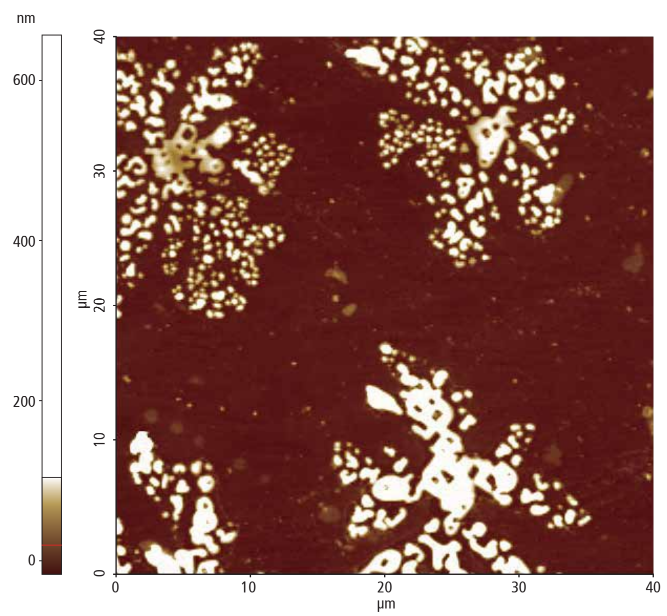
Non-contact

■ Height of position 1



Peak to valley: 729 nm

■ Height of position 2



Peak to valley: 672 nm

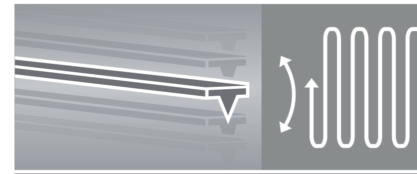
Silver nanoparticles on a glass slide forming fractals structures.

▪ Sample courtesy: Dr. Monserrat Escamilla, Chemistry department, Universidad Autonoma de Queretaro [UAQ], Queretaro, Mexico

Scanning conditions

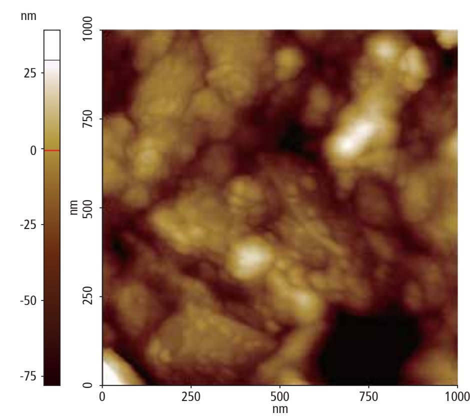
- System: NX10
- Scan Size: 50 μm², 40 μm²
- Scan Mode: Non-contact
- Scan Rate: 0.31 Hz, 0.27 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: All 256 × 256

Ceramic-Portland cement



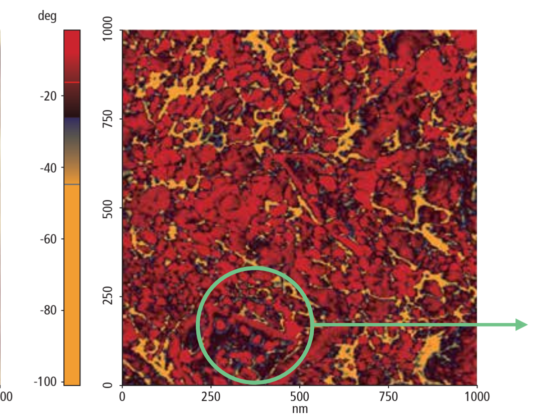
Tapping

■ Height

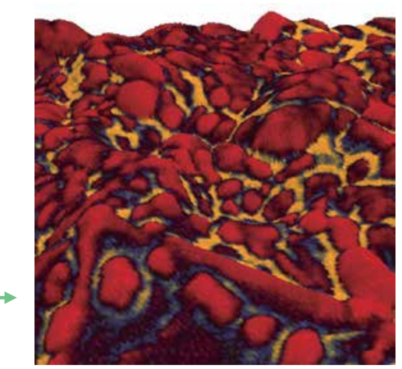


Peak to valley: 117 nm

■ NCM Phase



■ 3D (Phase overlaid on height)



X : Y : Z scale = 1 : 1 : 2

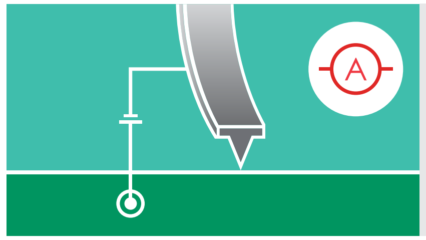
Compound of ceramic and hydrated Portland cement

▪ Image courtesy: Dr. Frank León, CIIDIR Unidad Oaxaca, Instituto Politecnico Nacional [IPN], Oaxaca Mexico

Scanning conditions

- System: NX10
- Scan Size: 1 μm × 1 μm
- Scan Mode: Tapping
- Scan Rate: 1 Hz
- Cantilever: PPP-NCHR (k=42 N/m, f=330 kHz)
- Pixel Size: 256 × 256

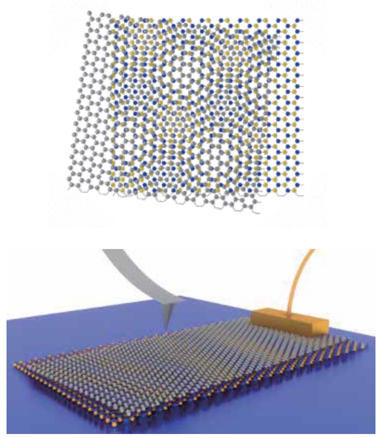
Graphene on hBN



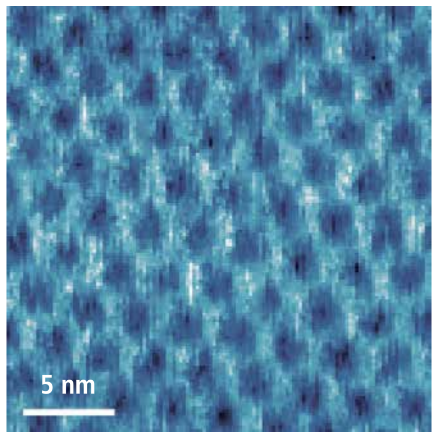
Conductive AFM (C-AFM)

Conductive AFM (C-AFM) simultaneously measures the topography and conductivity of a sample by scanning the surface with a conductive material coated tip as a nanoscale electrical probe at an applied DC bias. The current distribution at the given bias is detected via a current amplifier and visualizes heterogeneities in the local conductivity. C-AFM is a common technique to study electrical properties of a wide range of materials, including nanoparticles, nanowires, carbon nanotubes, 2D materials, thin-film coatings, and bulk materials.

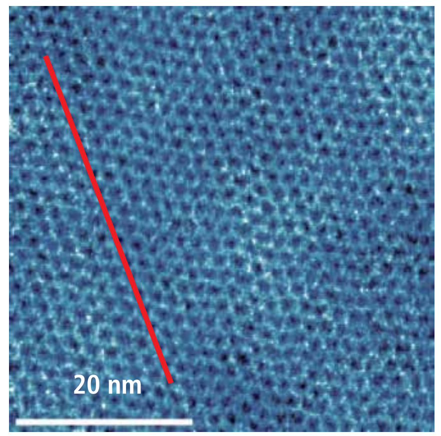
- **Moiré pattern**



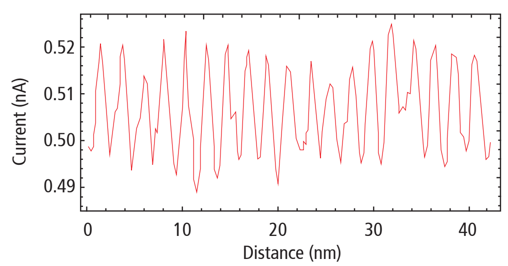
- **Current of 25 nm² scan**



- **Current of 50 nm² scan**



- **Line profile**



Moiré period: 2.20 nm

Single layer graphene (SLG) and hexagonal boron nitride (hBN) flakes sequentially picked up and transferred onto Cr/Au contacts on SiO_2/Si.
SLG on top of hBN such that the SLG surface is exposed.

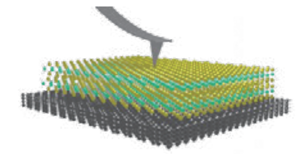
Scanning conditions

- System: FX40
- Scan Size: 25 nm², 50 nm²
- Sample bias: 1 V
- Scan Mode: C-AFM
- Scan Rate: 25 Hz for 25 nm², 10 Hz for 50 nm²
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 128 × 128 for 25 nm², 256 × 256 for 50 nm²

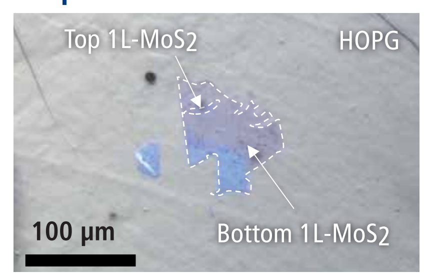
2L-MoS_2 (1/3)

C-AFM, LFM

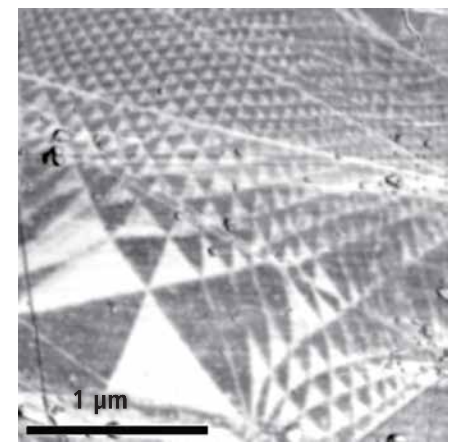
- **Schematic of AFM measurements and optical vision of 2L-MoS_2 (0°)**



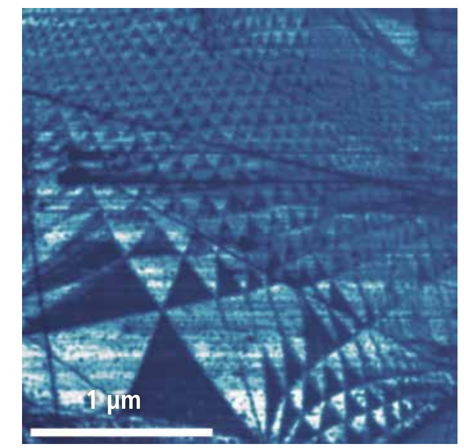
- **Optical view**



- **LFM**



- **Current**



~0° stacked 2L-MoS_2 prepared by exfoliation onto PDMS, deterministically breaking the flake during transfer and mechanically re-stacking.
Contrast observed in both LFM deflection and current image.

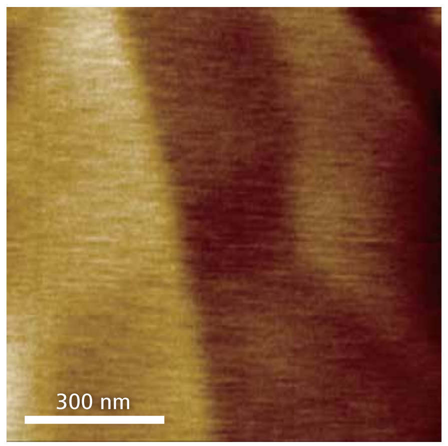
Scanning conditions

- System: FX40
- Scan Size: 2.5 µm × 2.5 µm
- Sample bias: 0.25 V
- Scan Mode: C-AFM, LFM
- Scan Rate: 4 Hz
- Cantilever: ContSCPt (k=0.2 N/m, f=25 kHz)
- Pixel Size: 512 × 512

2L-MoS_2 (2/3)

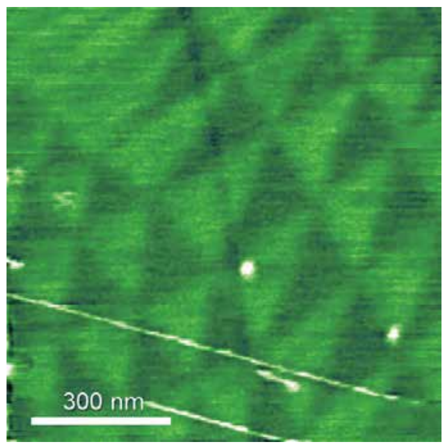
C-AFM, LFM

■ Height



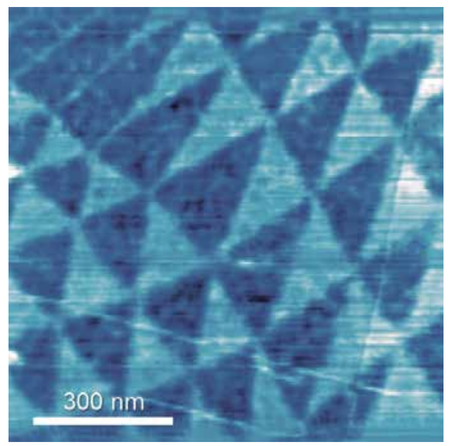
Peak to valley: 0.8 nm

■ LFM



Peak to valley: 4.7 mV

■ Current



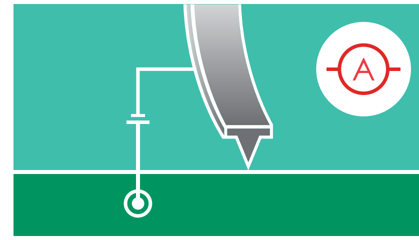
Peak to valley: 4.9 nA

~0° stacked 2L-MoS_2 prepared by exfoliation onto PDMS, deterministically breaking the flake during transfer and mechanically re-stacking.
Contrast observed in both LFM deflection and current image.

Scanning conditions

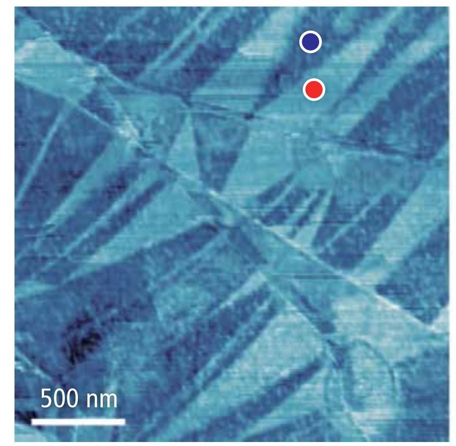
- System: FX40
- Scan Size: 1 µm × 1 µm
- Sample bias: 0.5 V
- Scan Mode: C-AFM, LFM
- Scan Rate: 12 Hz
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 512 × 512

2L-MoS_2 (3/3)



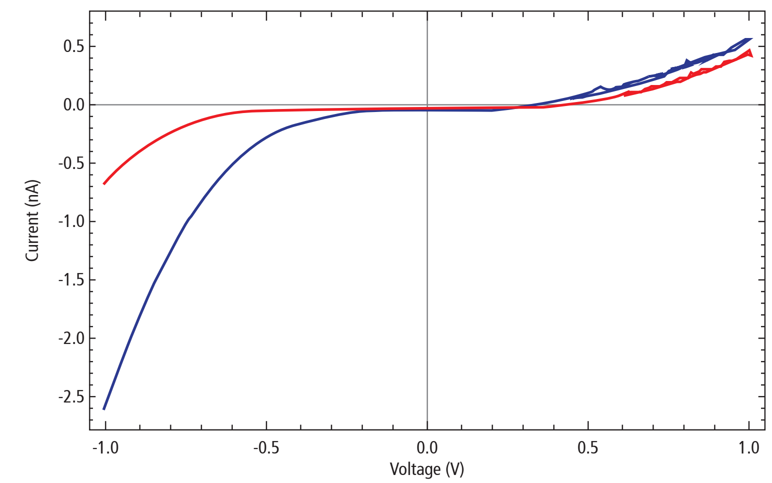
Conductive AFM (C-AFM)

■ Current



Peak to valley: 624 pA

■ I-V spectroscopy

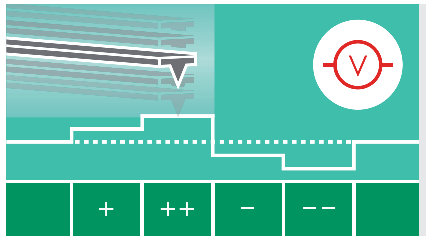


~0° stacked 2L-MoS_2 prepared by exfoliation onto PDMS, deterministically breaking the flake during transfer and mechanically re-stacking.
C-AFM reveals reconstructed domains in addition to different point current-voltage behaviour of the tunnelling current to the tip from domains of each type.

Scanning conditions

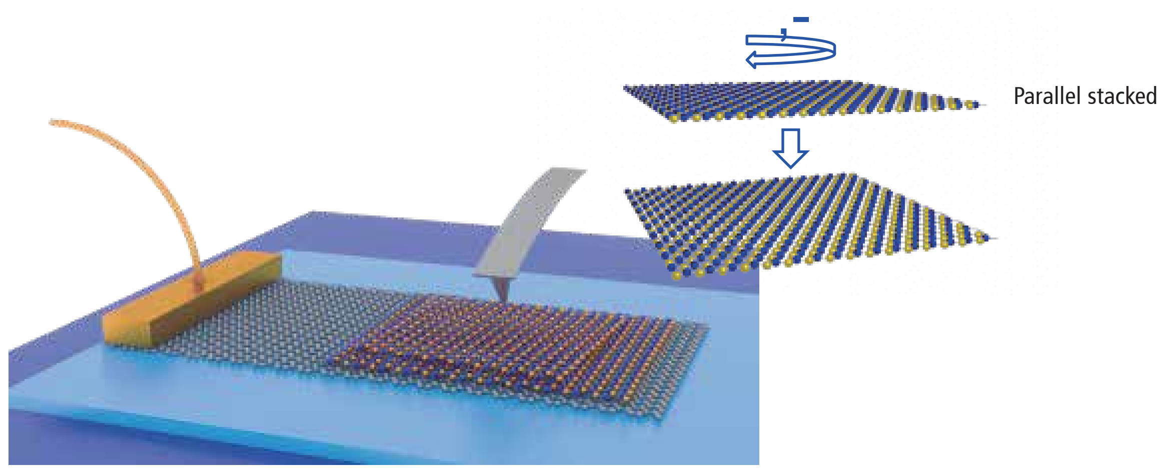
- System: FX40
- Scan Size: 2.5 µm × 2.5 µm
- Sample bias: 0.8 V
- Scan Mode: C-AFM
- Scan Rate: 4 Hz
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 512 × 512

Ferroelectric superlattices in 2L-hBN (0°)



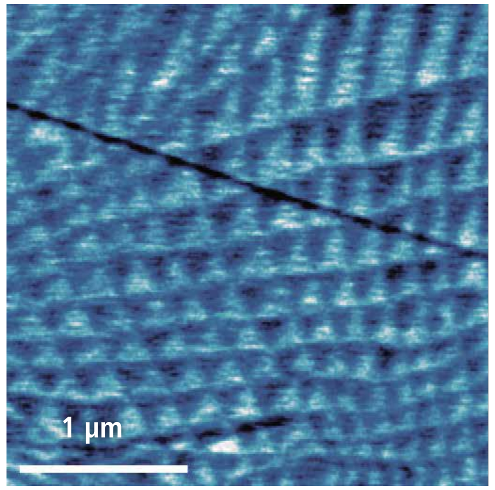
Kelvin Probe Force Microscopy (KPFM)

In kelvin probe force microscopy (KPFM), the AFM operates in non-contact mode while a conductive material coated cantilever, oscillated at its fundamental resonant frequency, laterally scans over the sample surface. KPFM provides quantitative results of the local surface potential distribution or, if calibrated, the work function of the sample.
Sideband KPFM, one of the KPFM techniques, measures the surface potential of the sample using the signal that appears in the sideband of the resonant frequency. It has good spatial resolution compared to conventional KPFM by using a force gradient, which measures the local interaction at the tip apex, not the average value acting on the entire lever.

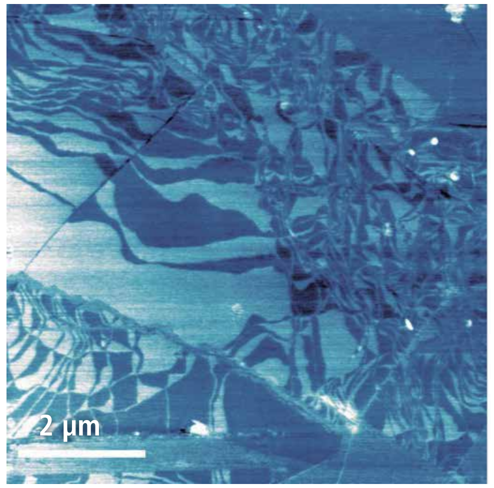


Above is a schematic of AFM measurements performed on parallel stacked hBN on graphene.
All the images below correspond to parallel stacked material and
show different levels of strain/layer thickness and the effect of poling.

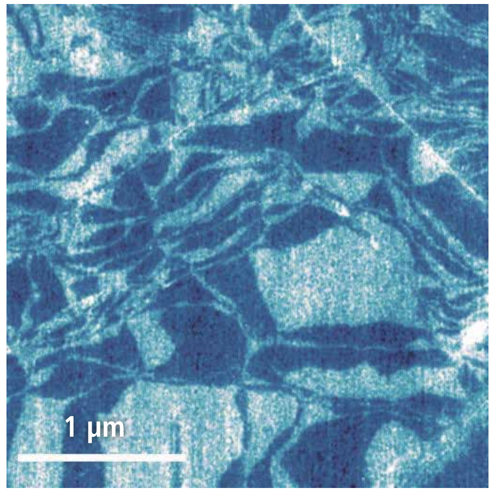
- Potential on position 1



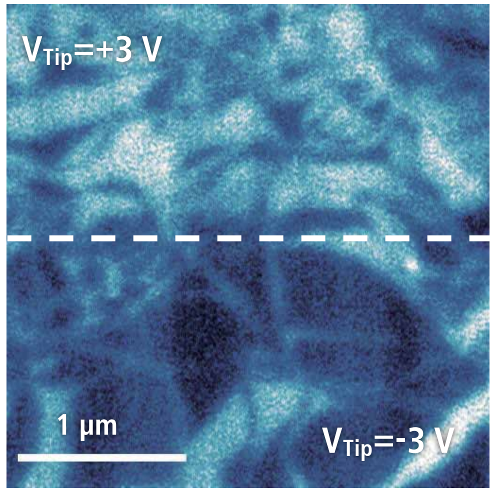
- Potential on position 2



- Potential: Domain before poling



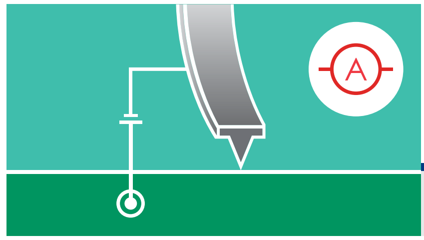
- Potential: Domain after poling



Scanning conditions

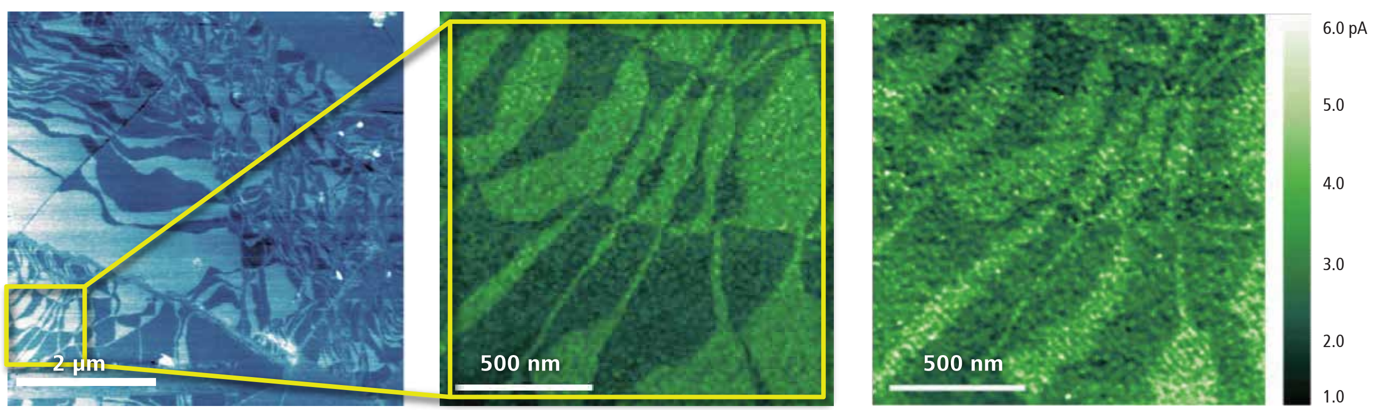
- System: FX40
- Scan Size: 3 µm × 3 µm, 4 µm × 4 µm
- Scan Mode: Sideband KPFM
- Scan Rate: All 0.3 Hz
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: All 512 × 512

Ferroelectric 2L-hBN



Conductive AFM (C-AFM)

■ Potential ■ Current @ 0.25 V_{Sample} ■ Current @ 0.8 V_{Sample}



Peak to valley: 500 mV

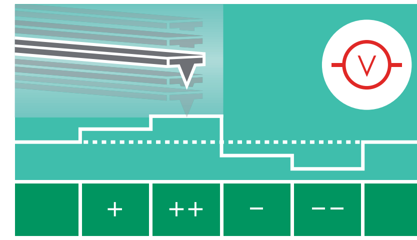
Peak to valley: 2 pA

Mapping tunnelling current across ferroelectric hBN.
C-AFM can be used to measure the tunnelling current across 2L-hBN,
where contrast is observed between ferroelectric domains of different orientation in the current map.

Scanning conditions

- System: FX40
- Scan Size: 1.5 µm × 1.5 µm
- Sample bias: 0.25 V, 0.8 V
- Scan Mode: C-AFM
- Scan Rate: 8 Hz
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 256 × 256

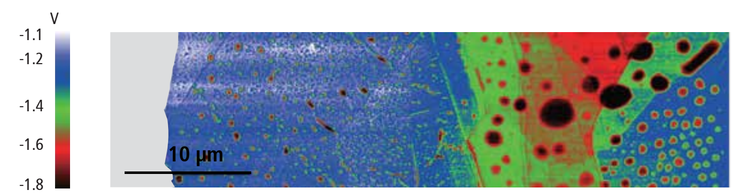
Strained MoS_2 on Si



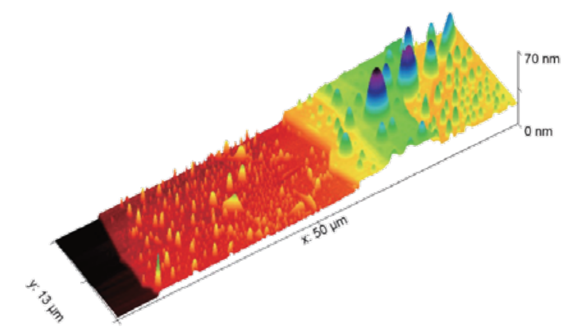
Kelvin Probe Force Microscopy (KPFM)

■ Height

■ Potential



■ 3D

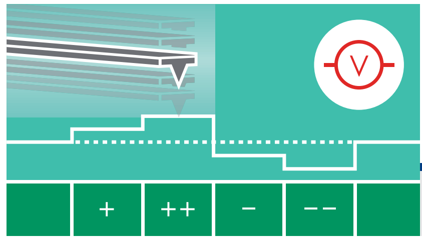


X : Y : Z scale = 1 : 1 : 150

Scanning conditions

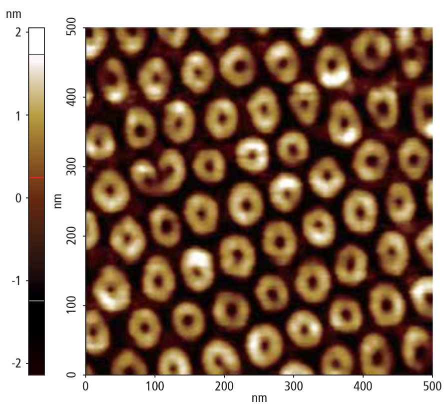
- System: FX40
- Scan Size: 50 µm × 13 µm
- Scan Mode: Sideband KPFM
- Scan Rate: 0.15 Hz
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 2048 × 1024

Semi-fluorinated alkanes



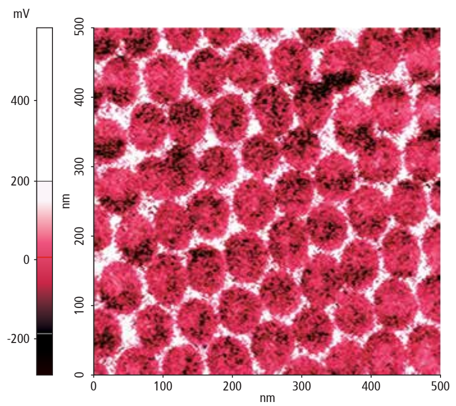
Kelvin Probe Force Microscopy (KPFM)

■ Height



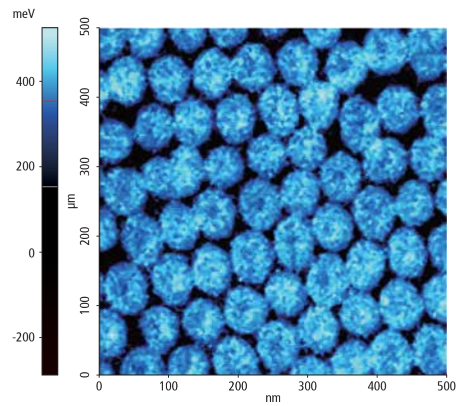
Peak to valley: 4.2 nm

■ Potential



Peak to valley: 875 mV

■ Work function

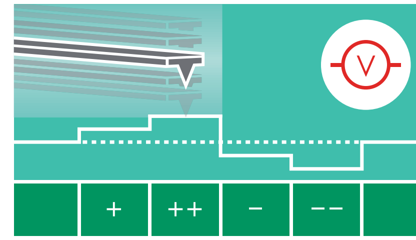


Peak to valley: 334 meV

Scanning conditions

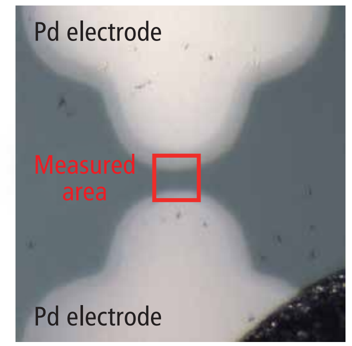
- System: NX10
- Scan Size: 500 nm × 500 nm
- Scan Mode: Sideband KPFM
- Scan Rate: 0.4 Hz
- Cantilever: HQ: NSC14/CR-AU (k=5 N/m, f=160 kHz)
- Pixel Size: 256 × 256

Perovskite coated on glass with Palladium electrodes



Kelvin Probe Force Microscopy (KPFM)

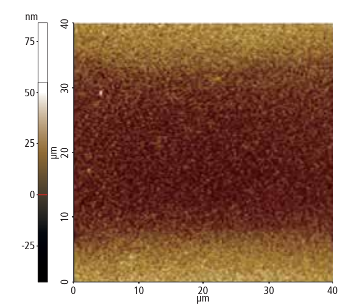
■ Optical view

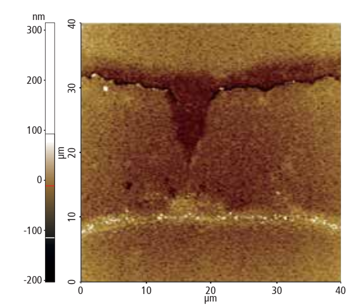


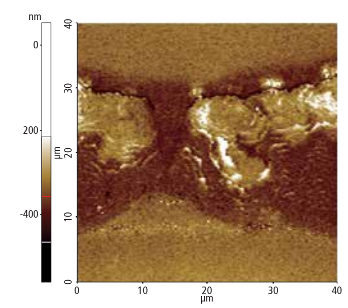
Height and surface potential were measured after applying +50 V for 5 min and -50 V for 5 min between two Pd electrodes.

■ Initial status ■ After applying +50 V ■ After applying -50 V

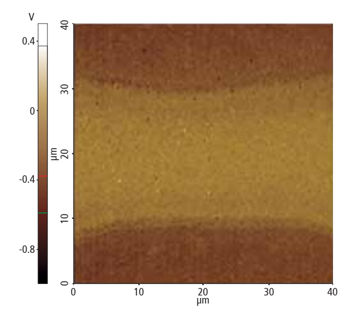
■ Height

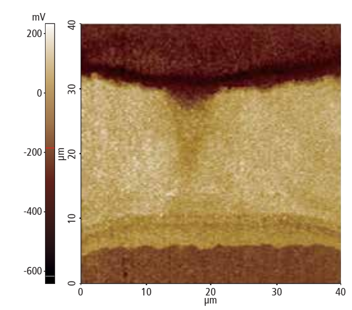


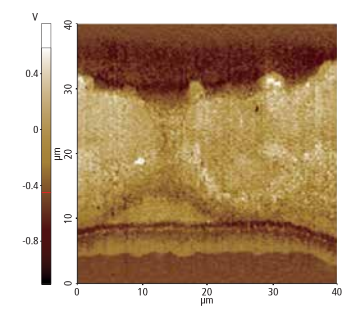




■ Potential



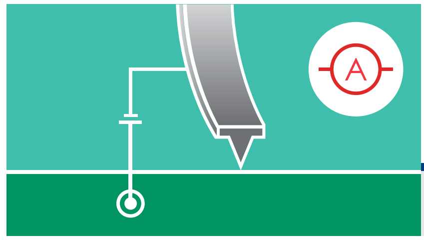




Scanning conditions

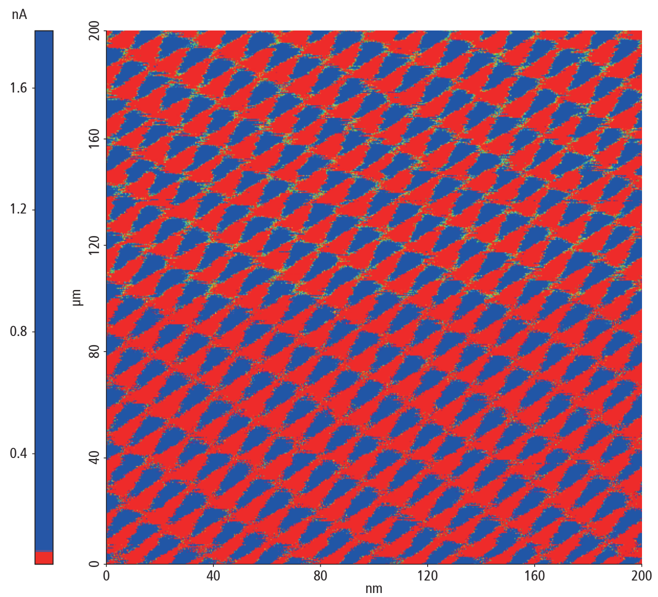
- System: FX40
- Scan Size: 40 µm × 40 µm
- Scan Mode: Sideband KPFM with HV toolkit
- Scan Rate: All 0.4 Hz
- Cantilever: NSC36 Pt C (k=0.6 N/m, f=65 kHz)
- Pixel Size: All 512 × 256

hBN-few layer graphene

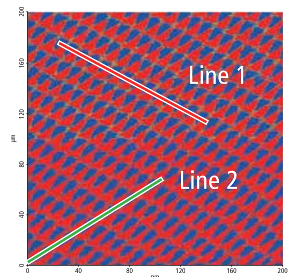


Conductive AFM (C-AFM)

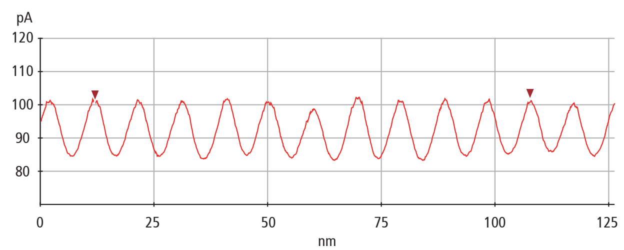
■ Current



Peak to valley: 1.7 nA

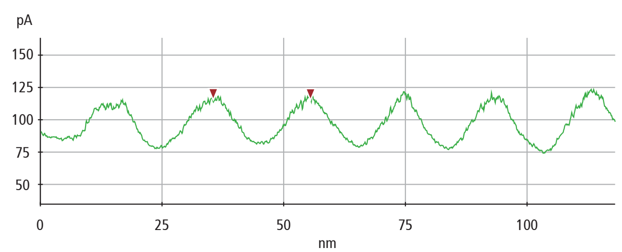


■ Line profile 1



Moiré period: 9.5 nm

■ Line profile 2



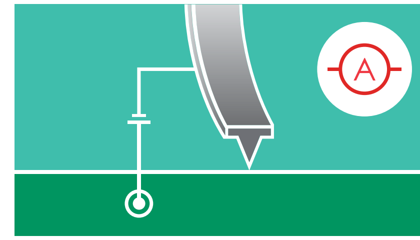
Moiré period: 20 nm

▪ Image courtesy: National University of Singapore (NUS) Physics, Singapore

Scanning conditions

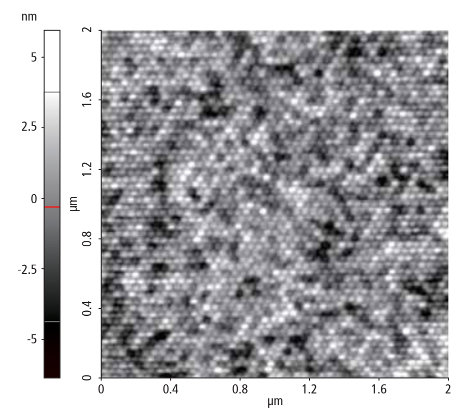
- System: NX10
- Scan Size: 200 nm × 200 nm
- Sample bias: 1.75 V
- Scan Mode: C-AFM
- Scan Rate: 0.5 Hz
- Cantilever: AD-2.8-AS (k=2.8 N/m, f=75 kHz)
- Pixel Size: 2048 × 2048

Multi-layer necking device defect



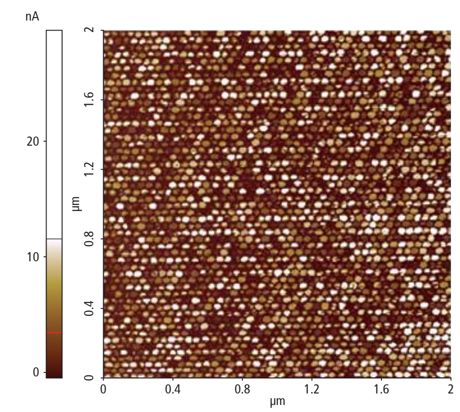
Conductive AFM (C-AFM)

■ Height



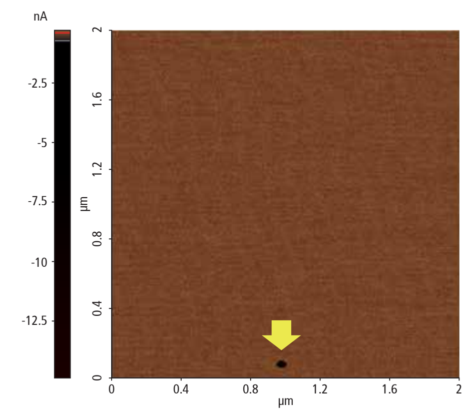
Peak to valley: 12 nm

■ Current with positive bias



Peak to valley: 15 nA

■ Current with negative bias



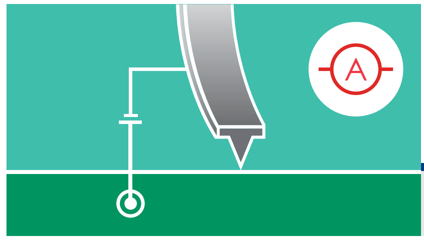
Peak to valley: 15 nA

Multi-layer necking on 300 mm wafer.

Scanning conditions

- System: NX-Wafer
- Scan Size: 2 µm × 2 µm
- Scan Mode: C-AFM
- Scan Rate: 2 Hz
- Cantilever: AD-2.8-AS (k=2.8 N/m, f=75 kHz)
- Pixel Size: 512 × 256

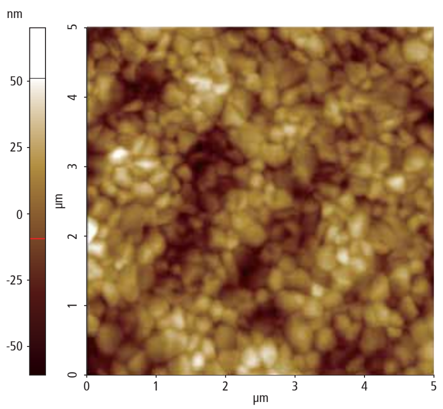
Triple-cation perovskite



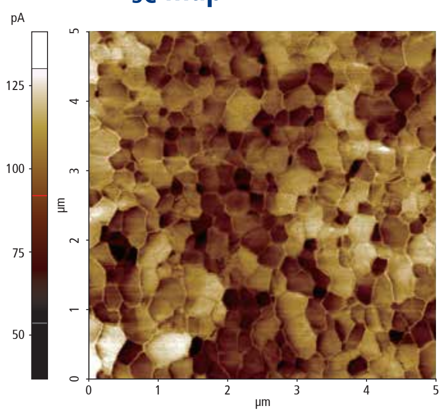
Conductive AFM (C-AFM)

* I_{SC}: short-circuit current, I_{OC} :open-circuit current

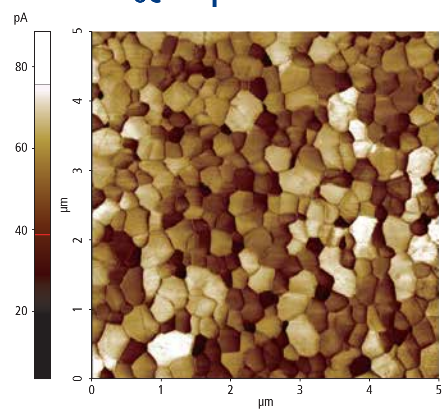
■ Height



■ Current without bias; I_{SC} map



■ Current @ 0.5 V; I_{OC} map



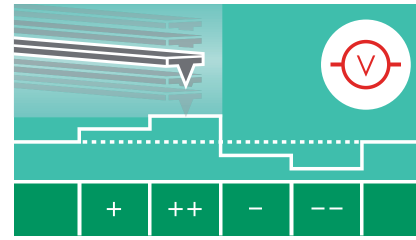
Conductive AFM under red light excitation was measured on the triple-cation perovskite film for solar cell application. The second image (I_{SC}) indicates photocurrents from different areas and the last one (I_{OC}) links to electronic traps.

▪ Image courtesy: Kanjanaboos Lab, Mahidol University, Thailand

Scanning conditions

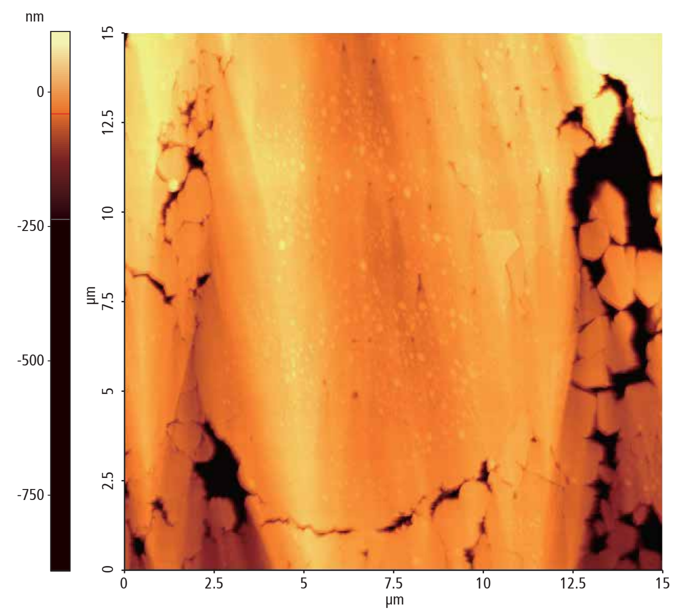
- System: NX10
- Scan Size: 5 µm × 5 µm
- Sample bias: 0 V, 0.5 V
- Scan Mode: C-AFM with PCM toolkit
- Scan Rate: 0.25 Hz
- Cantilever: ANSCM-PC (k=0.2 N/m, f=12 kHz)
- Pixel Size: 512 × 512

NCA of Li-ion battery (1/2)



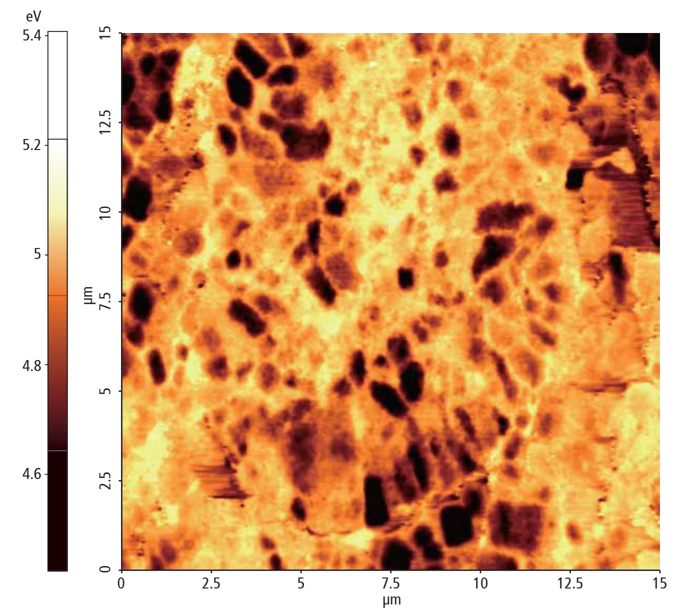
Kelvin Probe Force Microscopy (KPFM)

■ Height



Peak to valley: 1 µm

■ Work function



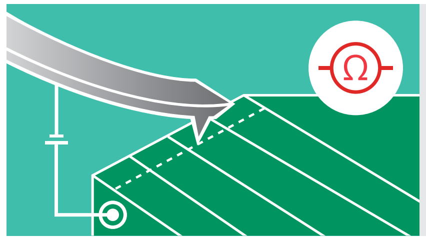
Peak to valley: 0.9 eV
Mean: 4.9 eV

Lithium Nickel-Cobalt-Aluminum oxide (NCA) is used as a cathode material for small lithium-ion batteries because of its high energy density and output power characteristics. KPFM is used to verify the material's electrochemical degradation process, and when the NCA is oxidized or degraded, the work function value decreases from the ref. value (ref. value 4.8 eV to 5.0 eV).

Scanning conditions

- System: FX40
- Scan Size: 15 µm × 15 µm
- Scan Mode: Sideband KPFM
- Scan Rate: 0.25 Hz
- Cantilever: PPP-EFM (k=2.8 N/m, f=75 kHz)
- Pixel Size: 512 × 512

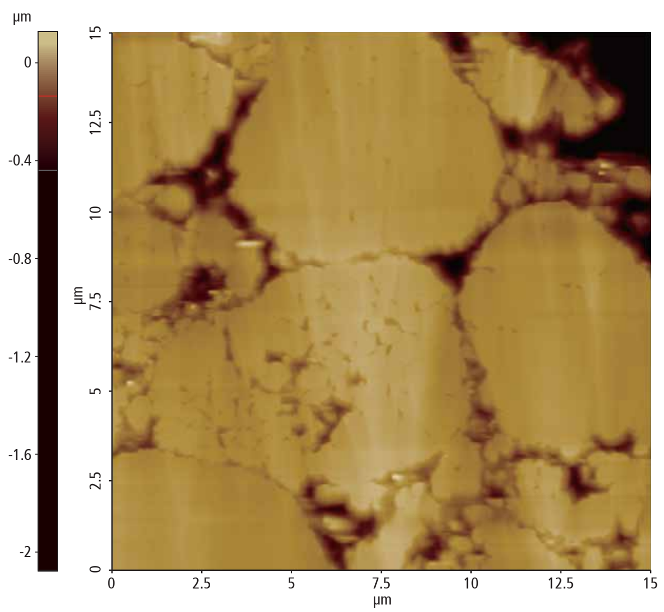
NCA of Li-ion battery (2/2)



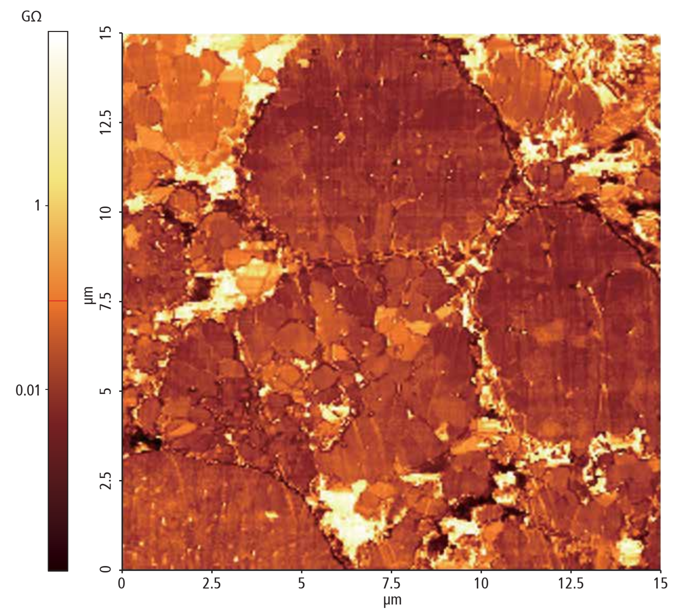
Scanning Spreading Resistance Microscopy (SSRM)

Scanning spreading resistance microscopy (SSRM) is a technique based on scanning probe microscopy (SPM), in which a conductive material-coated tip scans a biased sample surface and measures electrical properties such as current, conductance, and resistance of the samples. Using a logarithmic amplifier, it can simultaneously measure a wide range of conductive materials from insulators and semiconductors to metals. SSRM is a highly efficient technique for 2D carrier profiling of semiconductors since it allows directly contacting the sample surface by stripping the oxide layer while imaging with a durable diamond AFM tip.

■ Height



■ Resistance



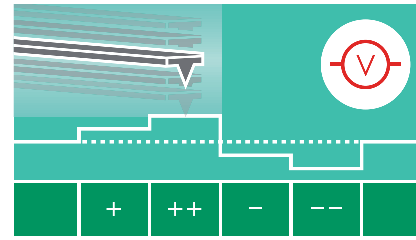
Peak to valley: 2.2 µm

Lithium Nickel-Cobalt-Aluminum oxide (NCA) is used as a cathode material for small lithium-ion batteries because of its high energy density and output power characteristics.
It is possible to confirm the changes in various chemical and physical characteristics that occur when Li-ions are intercalated and deintercalated by observing the change in electrode resistance after charging/ discharging in research on electrode material of LIB.

Scanning conditions

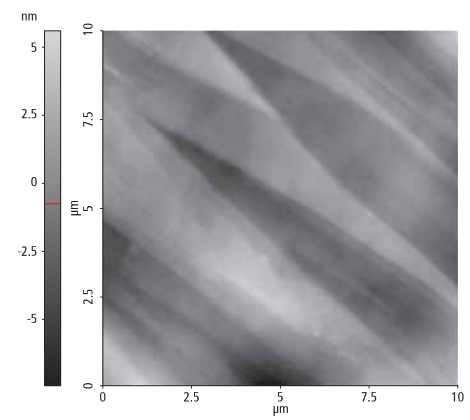
- System: NX-Hivac
- Scan Size: 15 µm × 15 µm
- Sample bias: 1 V
- Scan Mode: SSRM
- Scan Rate: 0.25 Hz
- Cantilever: AD-40-AS (k=40 N/m, f=200 kHz)
- Pixel Size: 256 × 256

HOPG



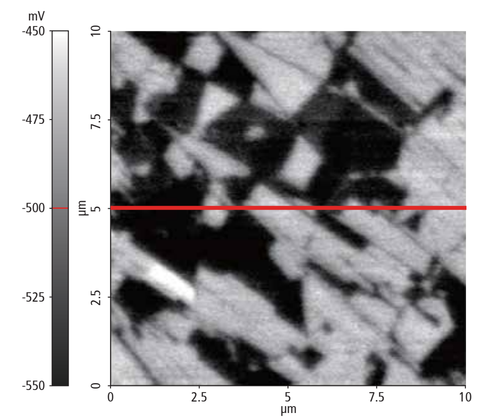
Kelvin Probe Force Microscopy (KPFM)

■ Height



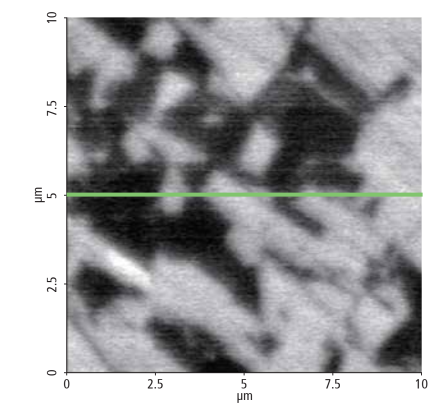
Peak to valley: 13 nm

■ Potential of Sideband KPFM



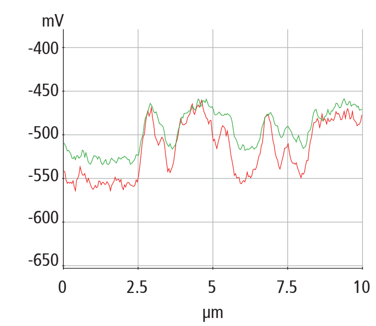
Peak to valley: 148 mV

■ Potential of AM KPFM



Peak to valley: 114 mV

■ Line profile

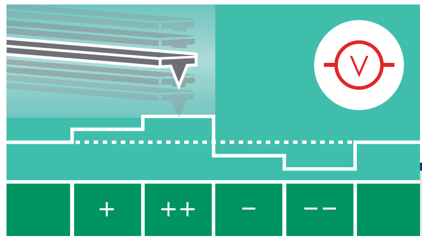


Surface potential comparison between sideband KPFM and AM KPFM after cleaving the HOPG surface.
Sideband KPFM exhibits improved sensitivity of surface potential signal compared to AM KPFM.

Scanning conditions

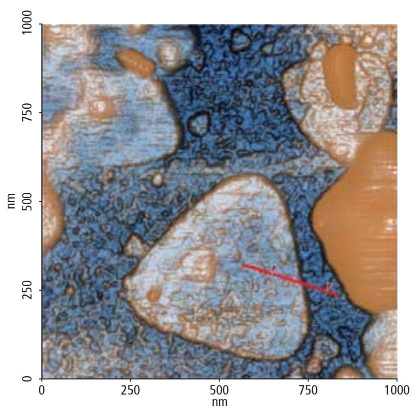
- System: FX40
- Scan Size: 10 µm × 10 µm
- Scan Mode: Sideband, AM KPFM
- Scan Rate: 0.55 Hz
- Cantilever: NSC36 Cr-Au C (k=0.6 N/m, f=65 kHz)
- Pixel Size: 256 × 256

MoS_2



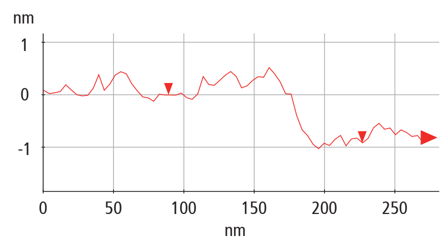
Kelvin Probe Force Microscopy (KPFM)

■ Height



* Edge enhanced color

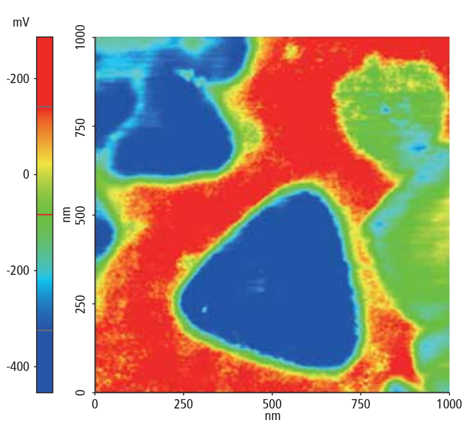
■ Line profile



ΔY(nm)
-0.662

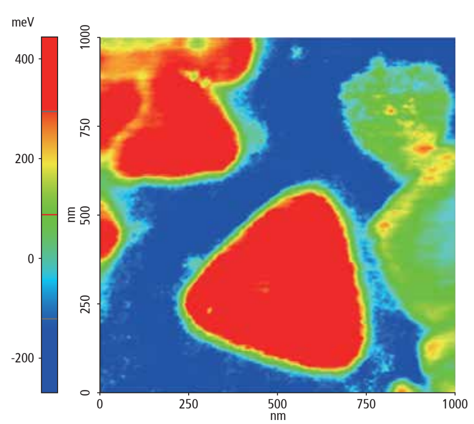
Thickness of MoS_2 ~0.65 nm

■ Potential



Peak to valley: 799 mV

■ Work function



Peak to valley: 748 meV

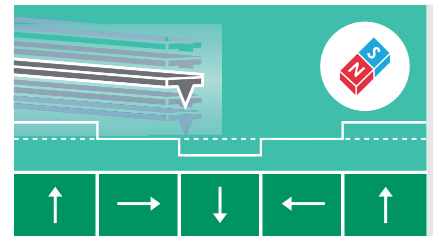
Topography and surface potential of monolayer MoS_2 grown on SiO_2.
Surface potential and work function were measured by AM KPFM.

- Image courtesy: Yasumitsu Miyata associate professor, Tokyo Metropolitan University, Japan

Scanning conditions

- System: NX10
- Scan Size: 1 μm × 1 μm
- Scan Mode: AM KPFM
- Scan Rate: 0.4 Hz
- Cantilever: NSC36 Cr-Au C (k=0.6 N/m, f=65 kHz)
- Pixel Size: 256 × 256

Magnetic device



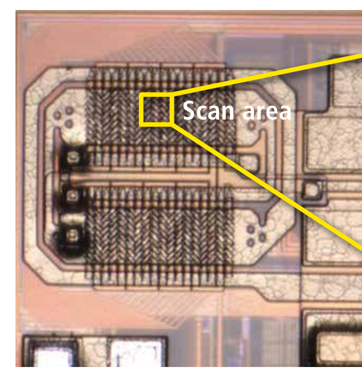
Magnetic Force Microscopy (MFM)

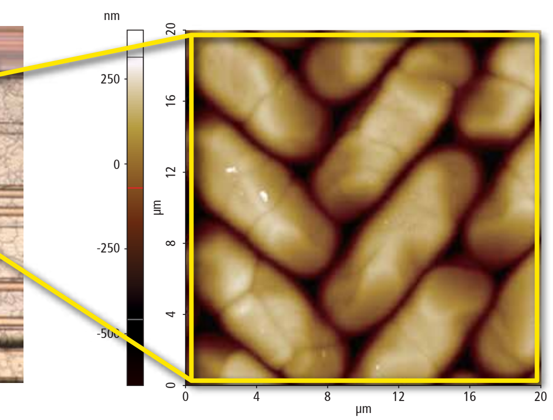
Magnetic force microscopy (MFM) is an atomic force microscopy (AFM) application that is widely used to characterize magnetic properties of various materials at the nanoscale. In this technique, a sharp tip coated with ferromagnetic material scans the surface and maps the distribution and strength of magnetic domains on the sample.

■ Optical view

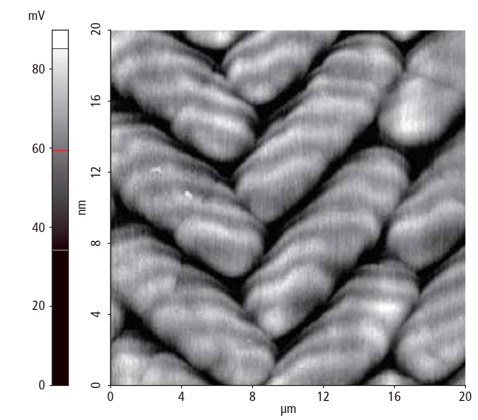
■ Height

■ MFM Amplitude





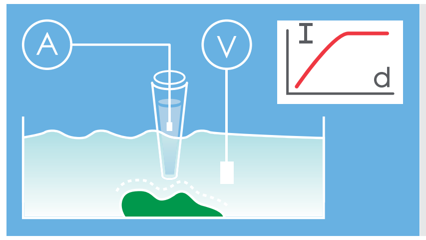
Peak to valley: 1 μm



Scanning conditions

- System: NX20
- Scan Size: 20 μm × 20 μm
- Lift Height: 50 nm
- Scan Mode: MFM
- Scan Rate: 0.3 Hz
- Cantilever: PPP-MFMR (k=2.8 N/m, f=75 kHz)
- Pixel Size: 512 × 256

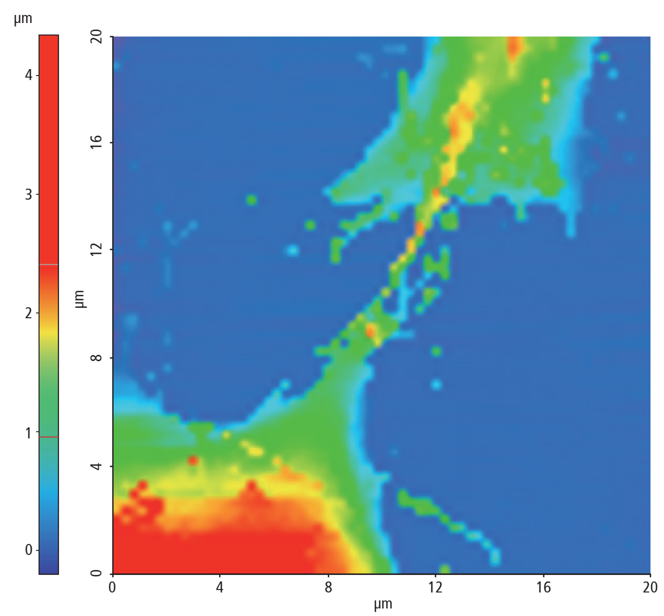
Live fibroblast cell



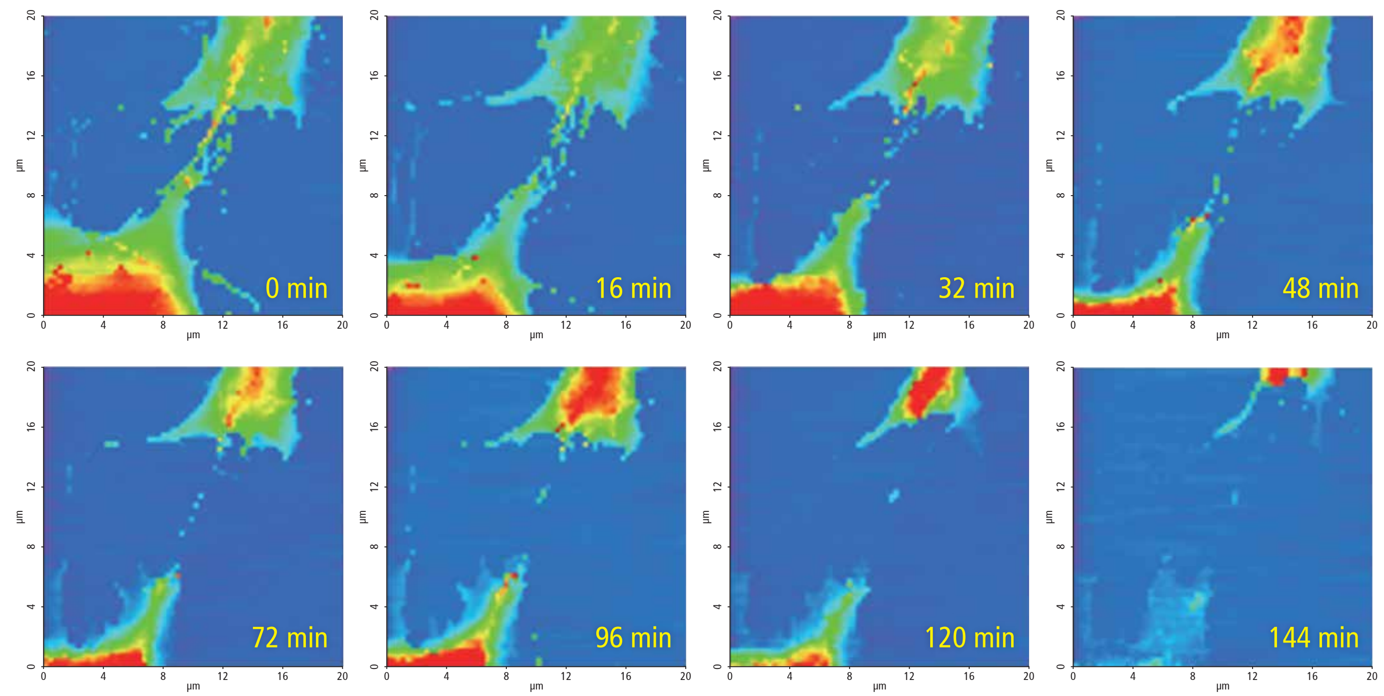
Scanning Ion Conductance Microscopy (SICM)

Scanning ion conductance microscopy (SICM) is a resourceful SPM method for molecular biology and material science research, as SICM ensures non-contact imaging and works well in liquid medium with high ionic concentration. The fundamental operation of SICM relies on an ion current that flows between a nano-pipette electrode and a bath electrode. This ion current is used as feedback signal to maintain a constant distance between the pipette and the sample, allowing the nano-pipette to scan the surface for topography imaging. Most importantly, the sensitivity to changes of the ion current achieves measurements without any physical contact between pipette and sample.
This aspect is essential to image soft biological samples, especially living cells.

■ Time-lapse video



■ Height images by time

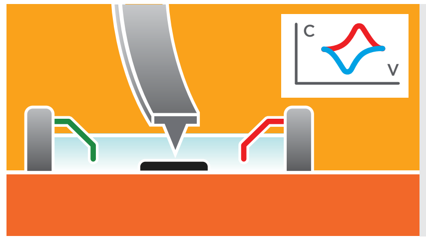


Time-lapse topography imaging reveals the mobility of living fibroblast cells.

Scanning conditions

- System: NX12
- Scan Size: 20 μm × 20 μm
- Scan Mode: SICM
- Scan Rate: 0.1 Hz
- Cantilever: Nano pipette
- Pixel Size: 64 × 64

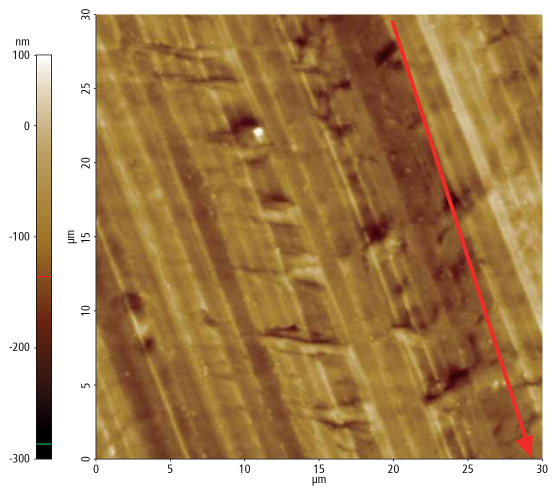
Li electroplating (deposition) on Cu foil



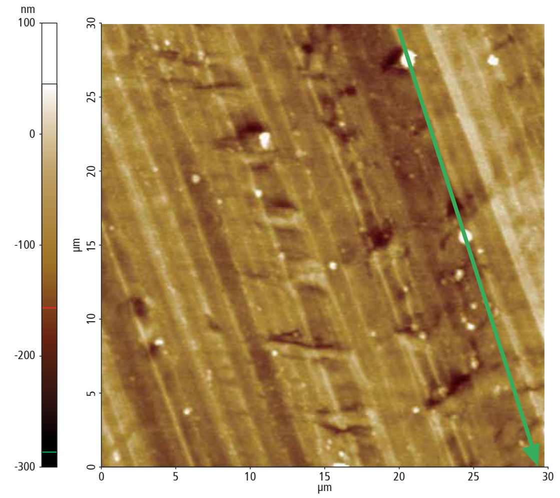
Electrochemical AFM (EC-AFM)

Electrochemical atomic force microscopy (EC-AFM) combines high-resolution imaging of surfaces with electrochemical characterization. EC-AFM is operated in a liquid electrolyte environment containing electrochemical reactive species with a working electrode, a counter electrode and a reference electrode. A CV voltammetry curve experiment is performed using a potentiostat, and at this time, changes in the sample surface due to redox (oxidation-reduction) reaction are monitored through AFM measurement. EC-AFM can provide information into many electrochemical processes like deposition, corrosion and electron transfer mechanism as well as provide insight into material design for sensors, catalysts and battery/energy cell application.

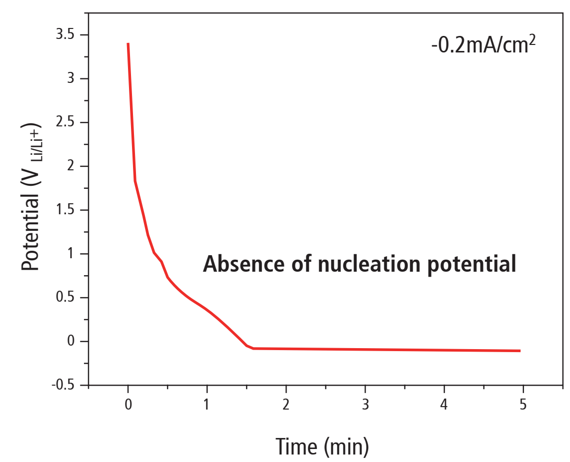
■ Height of fresh surface



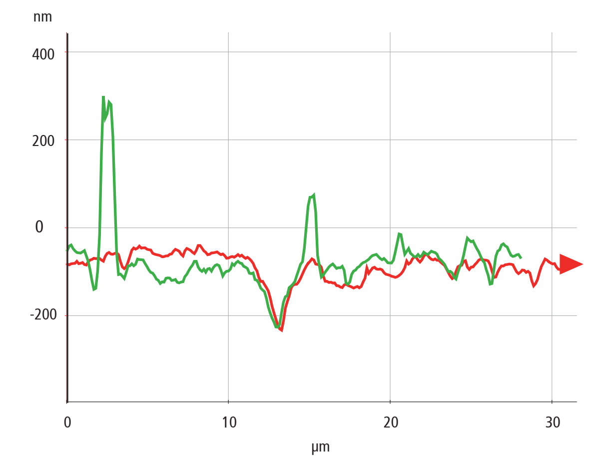
■ Height after 5 min plating



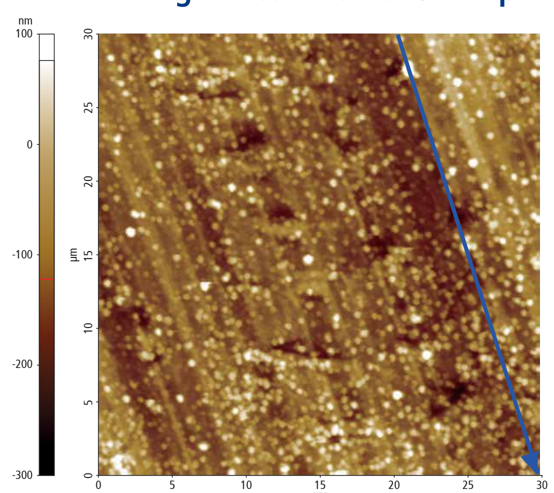
■ Potential vs. time



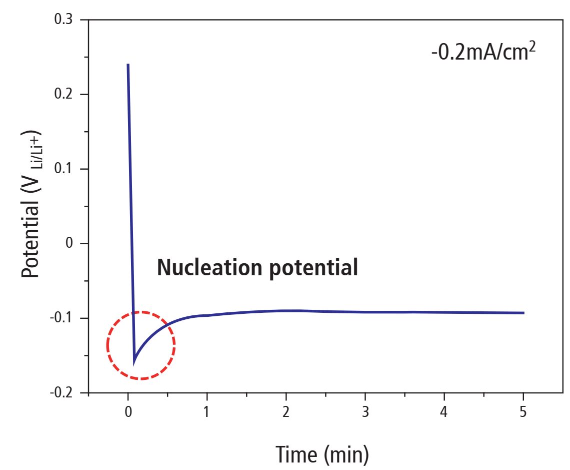
■ Line profiles



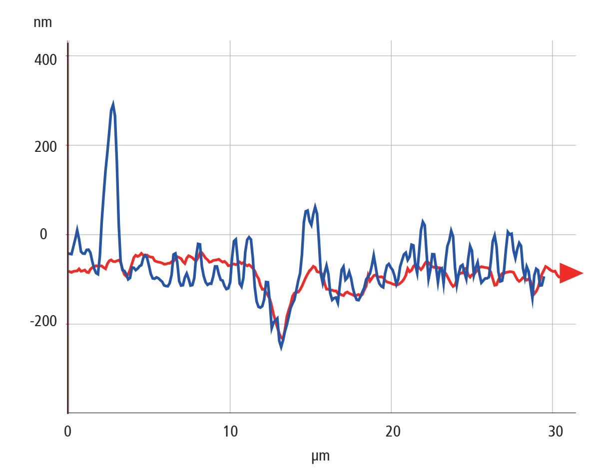
■ Height after another 5 min plating



■ Potential vs. time



■ Line profiles



▪ Image courtesy: Weerawat Toaran, SKKU Advanced Institute of Nanotechnology (SAINT), Korea

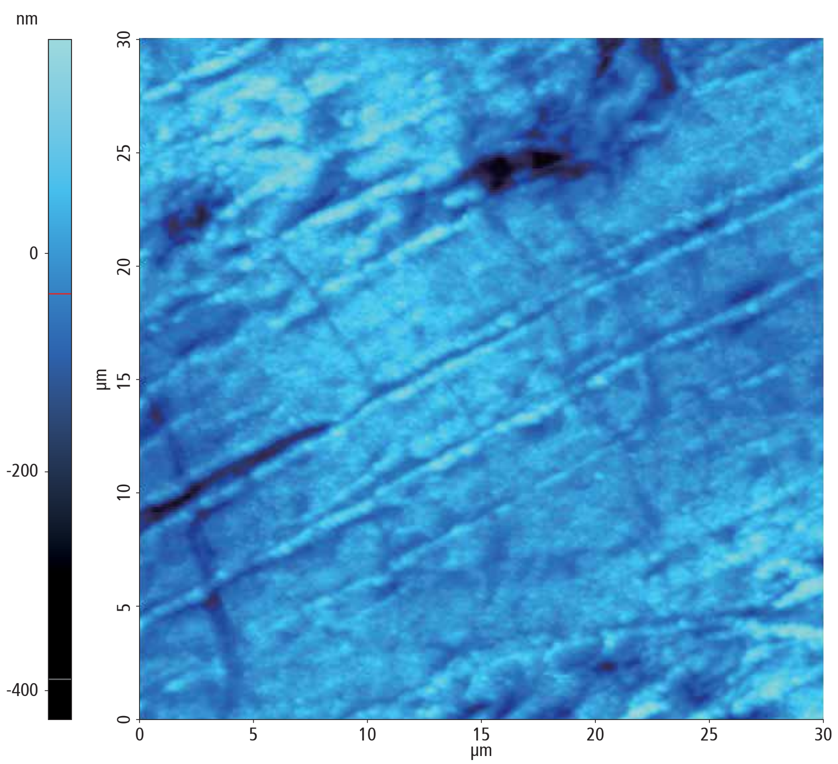
Scanning conditions

- System: NX10 in dry room
- Scan Size: 30 μm × 30 μm
- Scan Mode: Contac, EC-AFM
- Scan Rate: 0.13 Hz
- Cantilever: Multi75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 256 × 256
- EC: Cu foil (Working electrode), Li metal (Reference electrode), Li (Counter electrode), 1M LiTFSI in TEGDME (Electrolyte)
- Open circuit voltage: 3.34 $V_{Li/Li+}$

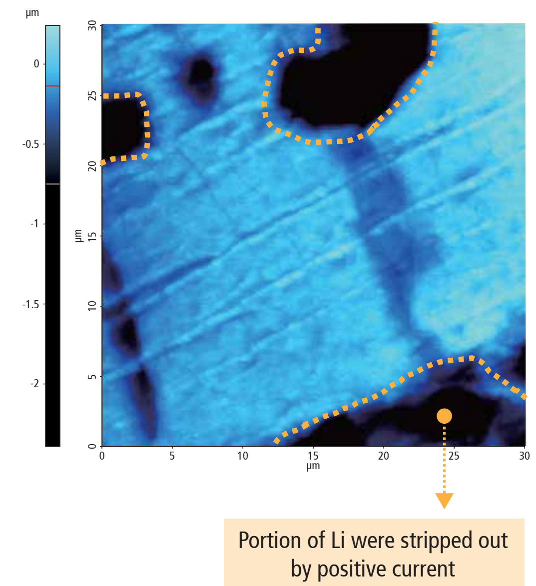
Li stripping-plating on Li surface

Contact, EC-AFM

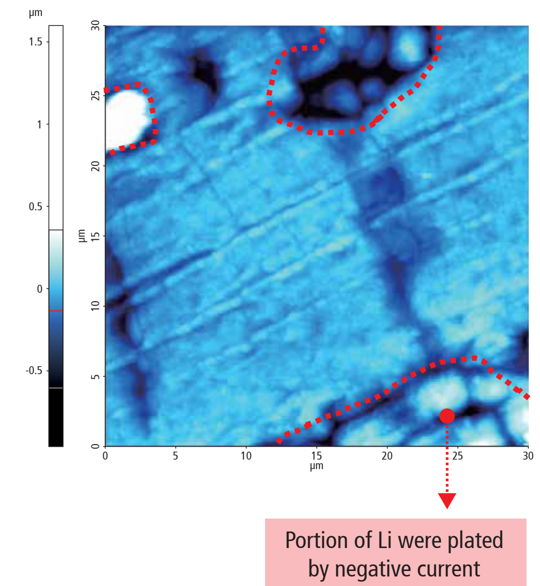
■ Height of fresh surface



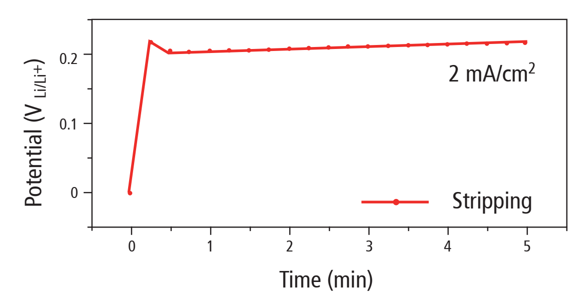
■ Height after 5 min stripping



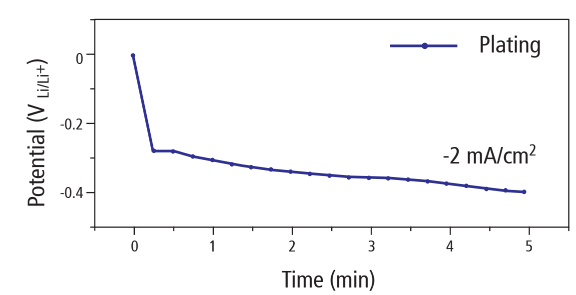
■ Height after 5 min plating



■ Potential vs. time



■ Potential vs. time



▪ Image courtesy: Weerawat Toaran, SKKU Advanced Institute of Nanotechnology (SAINT), Korea

Scanning conditions

- System: NX10 in dry room
- Scan Size: 30 µm × 30 µm
- Scan Mode: Contact, EC-AFM
- Scan Rate: 0.15 Hz
- Cantilever: Multi75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 256 × 256
- EC: Li metal (Working electrode), Li metal (Reference electrode), Li (Counter electrode), 1M LiTFSI in TEGDME (Electrolyte)
- Open circuit voltage: 1 $mV_{Li/Li+}$

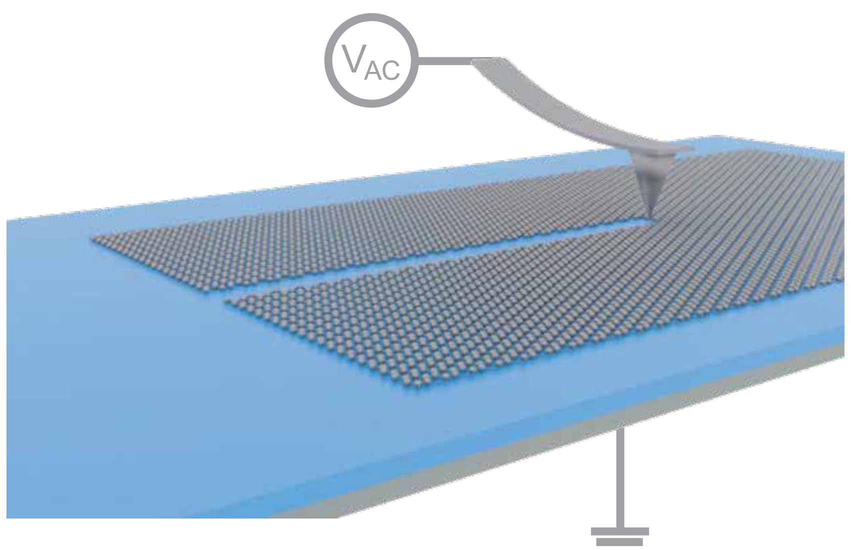
Cutting Graphene

Nanolithography

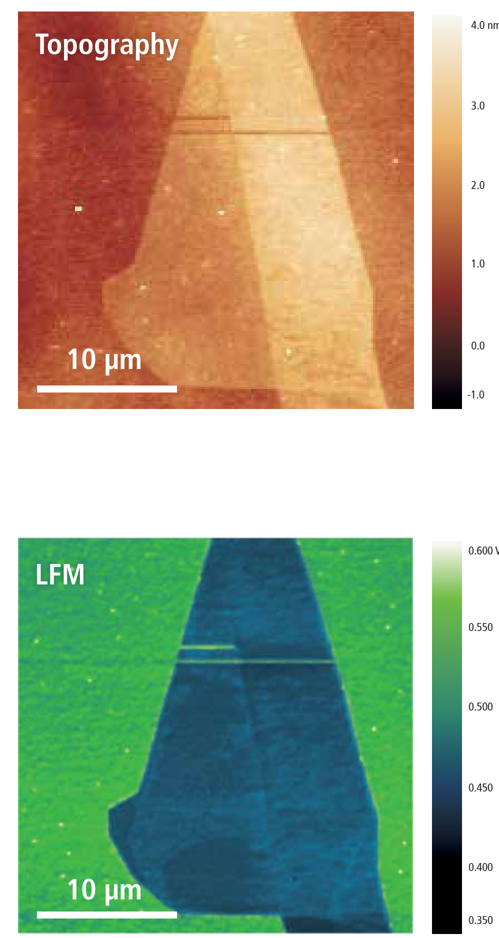
In nanolithography, the AFM probe becomes a tool to modify the sample surface at nanometer resolution.
Here, the cantilever is used to intentionally modify the sample surface via mechanical and/or electrical means.
To mechanically alter a surface, a specialized, robust cantilever gouges the surface with excessive force and creates scratches on a sample surface. To electrically alter a surface, a conductive material coated cantilever with a high bias is used to oxidize local surface regions and generates oxide patterns. Tip position for lithography can be easily controlled by importing your own vector drawings or raster (bitmap) images.

Contact, Nanolithography

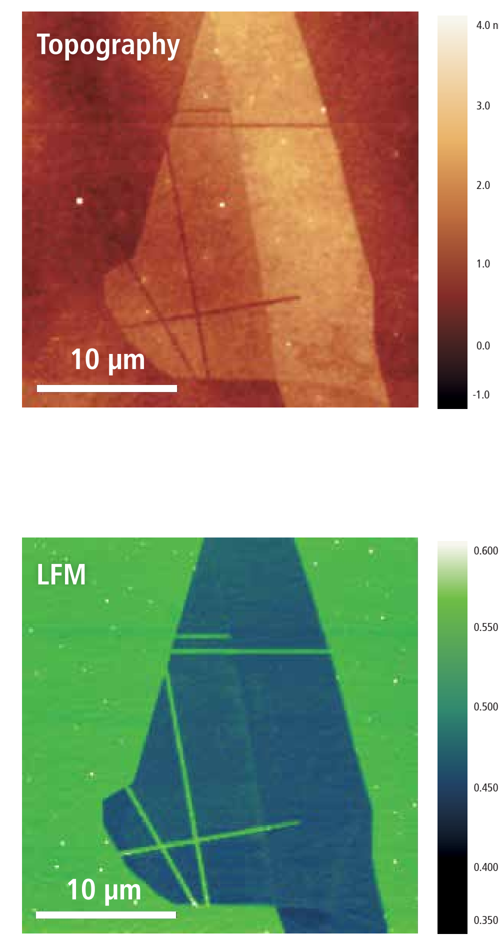
■ Schematic of bias lithography



■ Before lithography



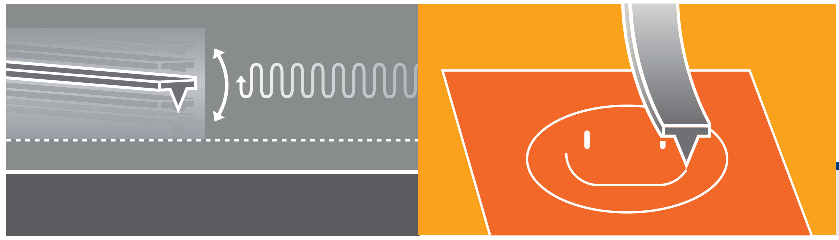
■ After lithography



Scanning conditions

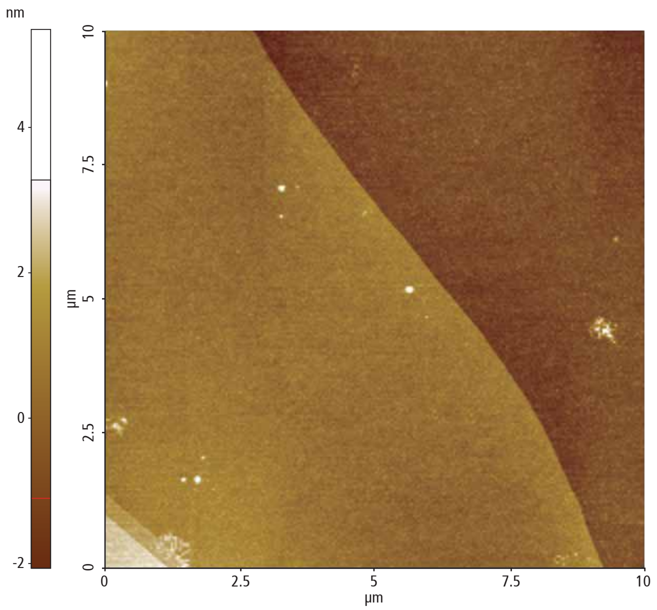
- System: FX40
- Scan Size: 30 µm × 30 µm
- Scan Mode: Contact, Nanolithography
- Scan Rate: 0.7 Hz
- Cantilever: ElectricMulti75-G (k=3 N/m, f=75 kHz)
- Pixel Size: 256 × 256
- Lithography Condition: Force 500 nN, writing speed 0.1 µm/s, AC bias 10 V @ 40 kHz

Exfoliated graphene on SiO_2/Si wafer



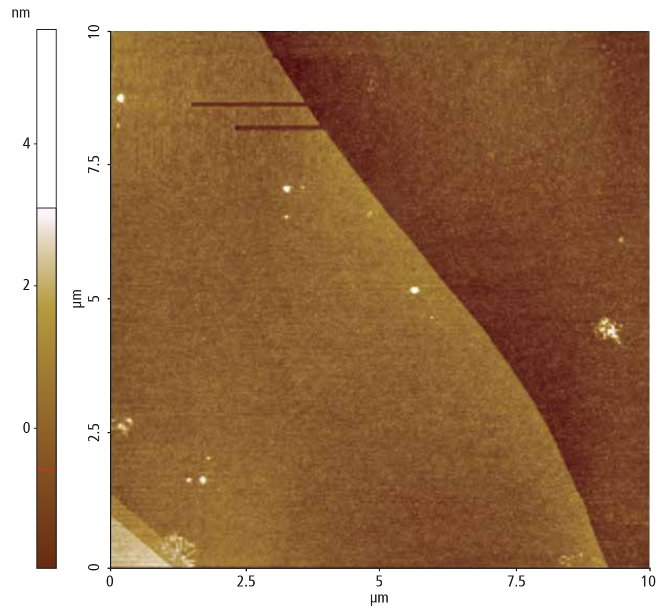
Non-contact, Nanolithography

▪ Height before graphene cutting



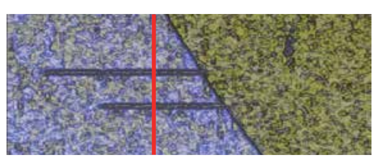
Peak to valley: 7.4 nm

▪ Height after graphene cutting

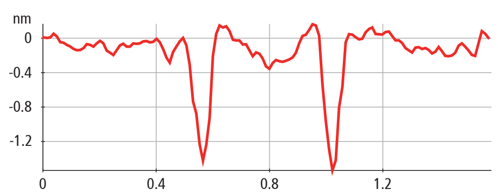


Peak to valley: 7.6 nm

▪ Enhanced color



▪ Line profile



Litho. Condition
- Force 200 nN
- Writing speed 0.2 µm/s
- AC bias 10 V @ 40 kHz
- Humidity ~90% RH

Scanning conditions

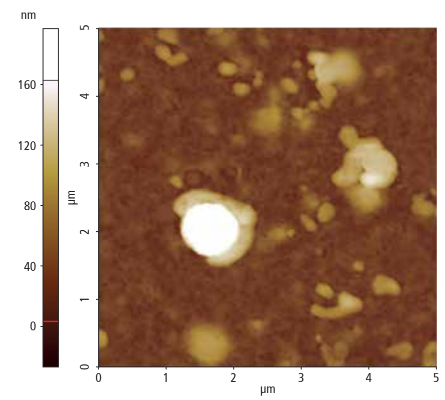
- System: FX40
- Scan Size: 10 µm × 10 µm
- Scan Mode: Non-contact, Nanolithography
- Scan Rate: 1 Hz
- Cantilever: PPP-EFM (k=2.8 N/m, f=75 kHz)
- Pixel Size: 256 × 256

Protein vesicles

PinPoint Nanomechanical

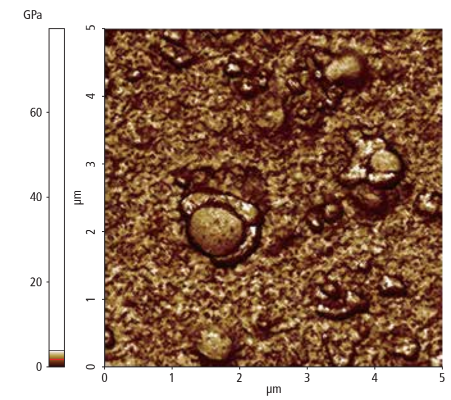
PinPoint™ Nanomechanical mode obtains the best of resolution and accuracy for nanomechanical characterization. Stiffness, elastic modulus, adhesion forces are acquired simultaneously in real-time. While the XY scanner stops, the high speed force-distance curves are taken with well-defined control of 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.

▪ Height

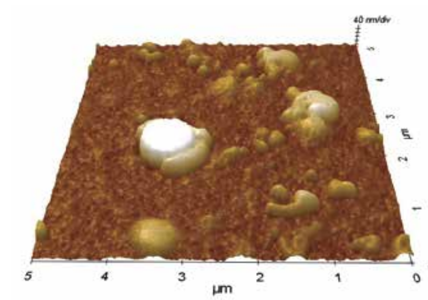


Peak to valley: 224 nm

▪ Modulus



▪ 3D



X:Y:Z scale = 1:1:2

- Sample courtesy: Dr. Yeongseon Jang, Department of Chemical Engineering, University of Florida, United States

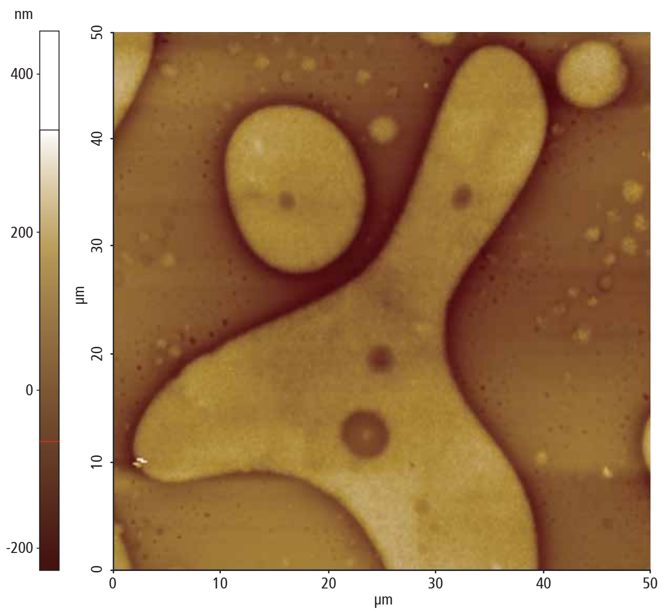
Scanning conditions

- System: FX40
- Scan Size: 5 µm × 5 µm
- Scan Mode: PinPoint Nanomechanical
- Scan Rate: 0. 1 Hz
- Cantilever: PPP-FMR (k=2.8 N/m, f=75 kHz)
- Pixel Size: 256 × 256

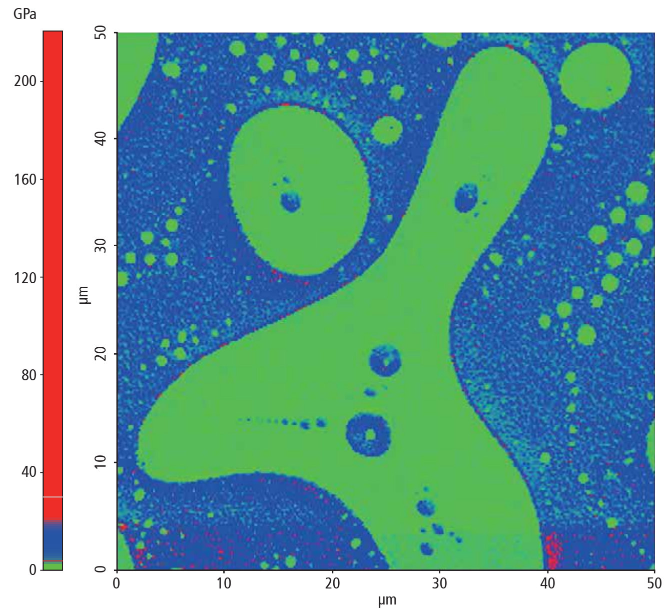
PS/LDPE

PinPoint Nanomechanical

■ Height



■ Modulus



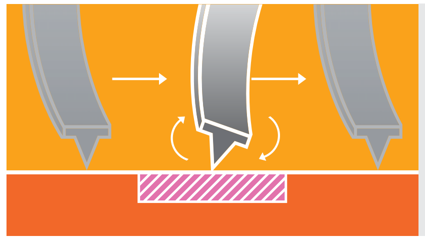
Peak to valley: 688 nm

Spin-cast thin layer of polystyrene and low-density polyethylene.

Scanning conditions

- System: FX40
- Scan Size: 50 µm × 50 µm
- Scan Mode: PinPoint Nanomechanical
- Scan Rate: 0.15 Hz
- Cantilever: OMCL-AC160TS (k=26 N/m, f=300 kHz)
- Pixel Size: 256 × 256

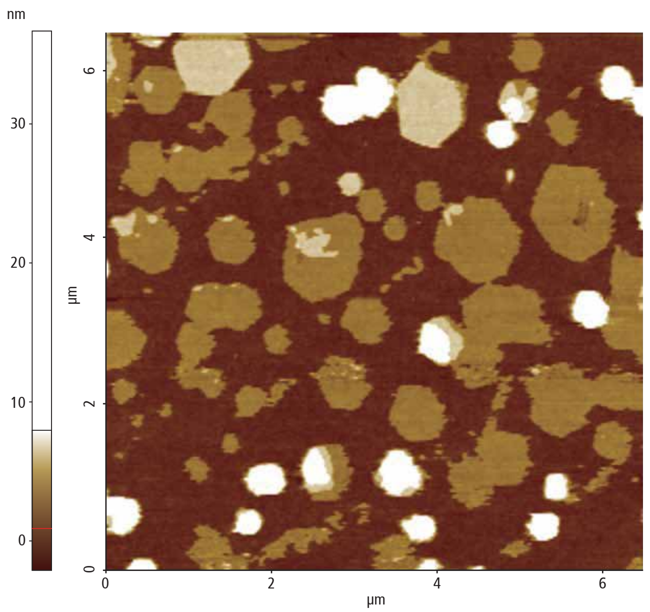
CTA2B12H12 Nanosheet



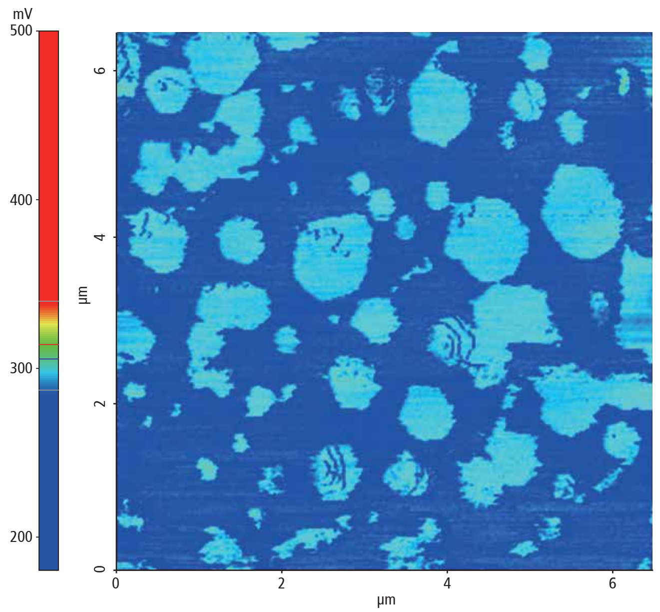
Lateral Force Microscopy (LFM)

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 properties such differences in material compositions on coating layers, lubricant properties, strength of adhesion on patterned structures and so on.

■ Height



■ LFM



Peak to valley: 38 nm

• Sample courtesy: University of Technology Sydney (UTS), Australia

LFM measurement on CTA2B12H12 nanosheet.
* CTA2: Carbocyclic Thromboxane A2
* B12H12: Dodecaborate

Scanning conditions

- System: NX7
- Scan Size: 6.5 µm × 6.5 µm
- Scan Mode: LFM
- Scan Rate: 0.5 Hz
- Cantilever: RTESPA-150 (k=5 N/m, f=150 kHz)
- Pixel Size: 256 × 256

Enabling Nanoscale Advances

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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:

- Material Science
- Failure Analysis
- Semiconductor Analysis
- Hard Disk Media Analysis

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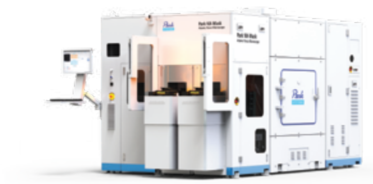
- Semiconductor Analysis
- Hard Disk Media Analysis



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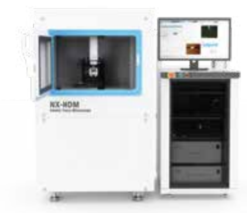
Automated industrial AFM for high-resolution 3D metrology



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