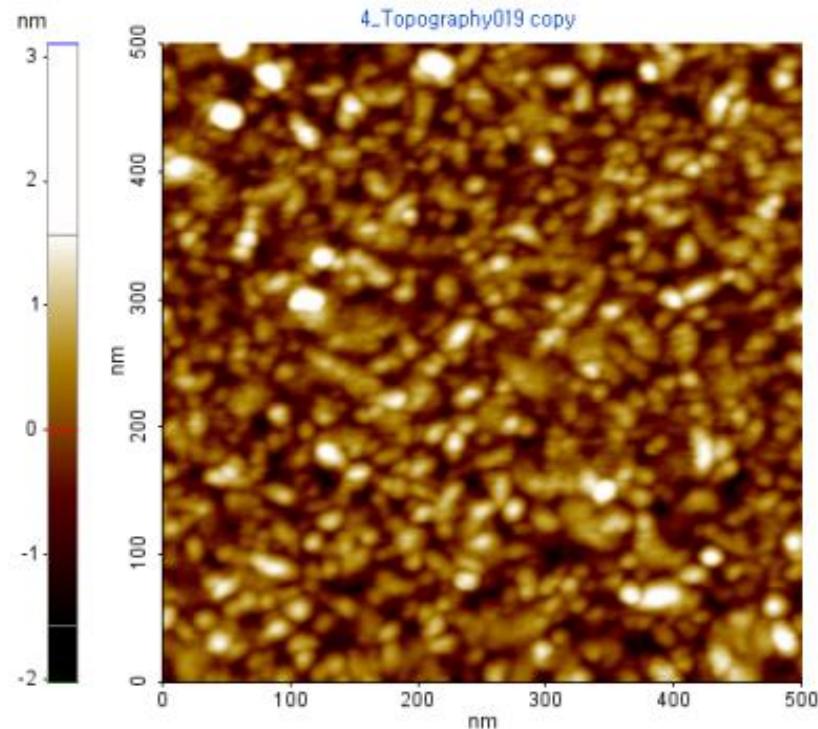


## XE Image Gallery (2009)

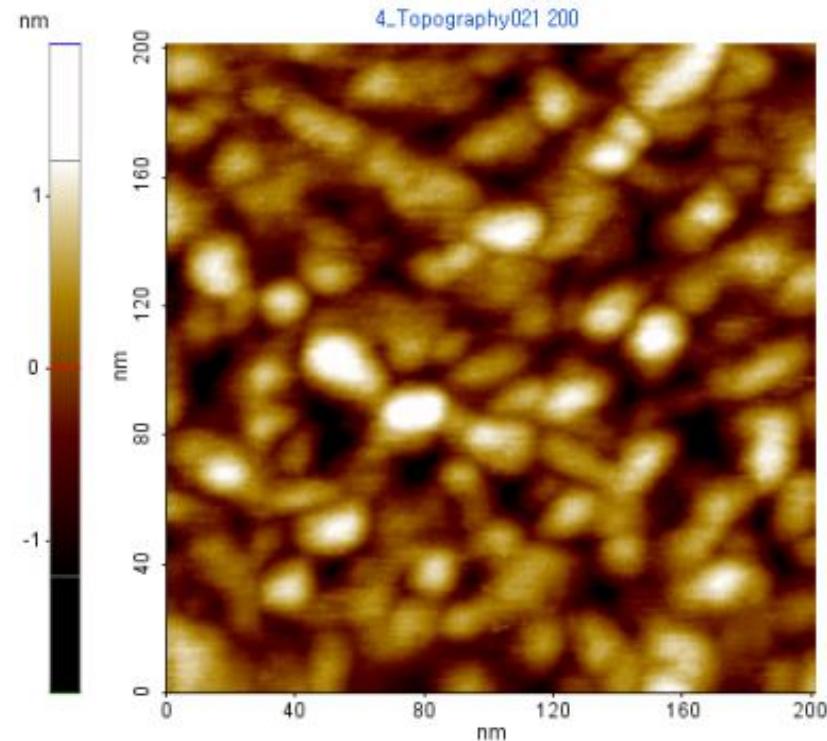
Technical Support Team (henry)



# Ru on TiN / Silicon oxide

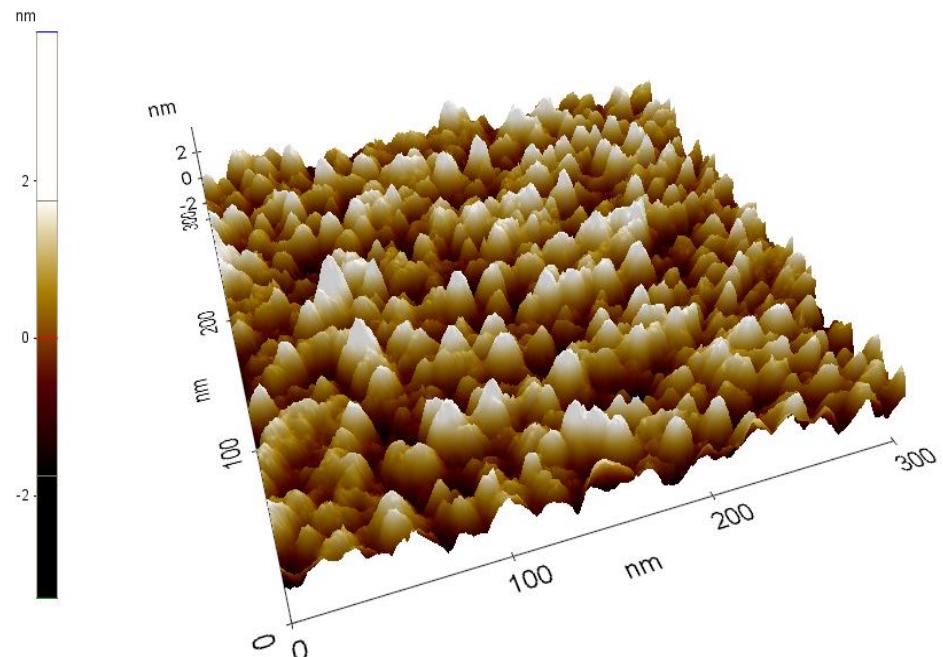
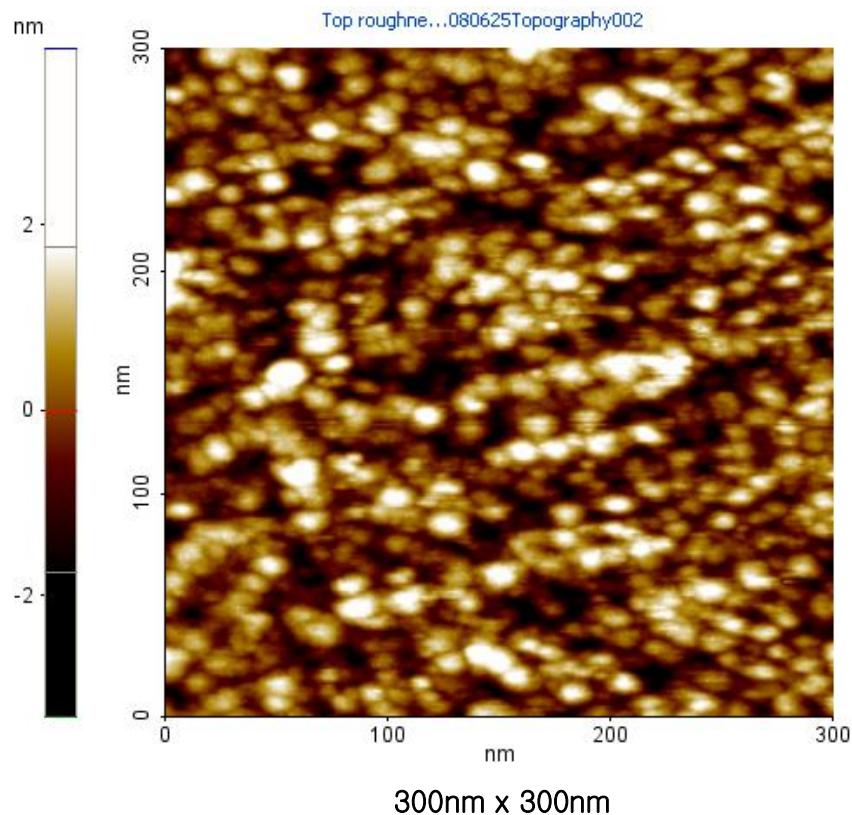


500nm x 500nm



200nm x 200nm

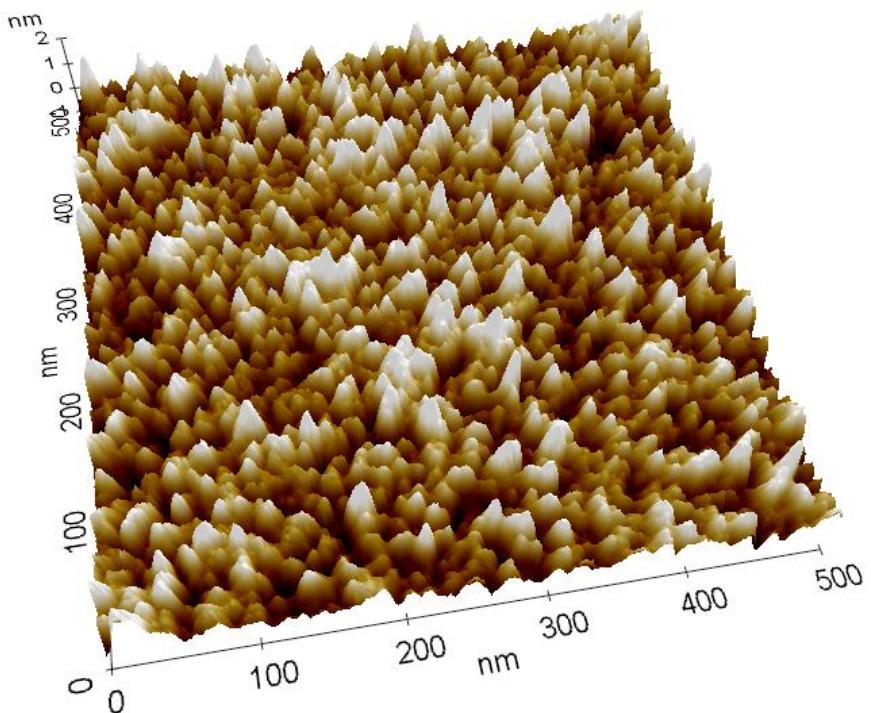
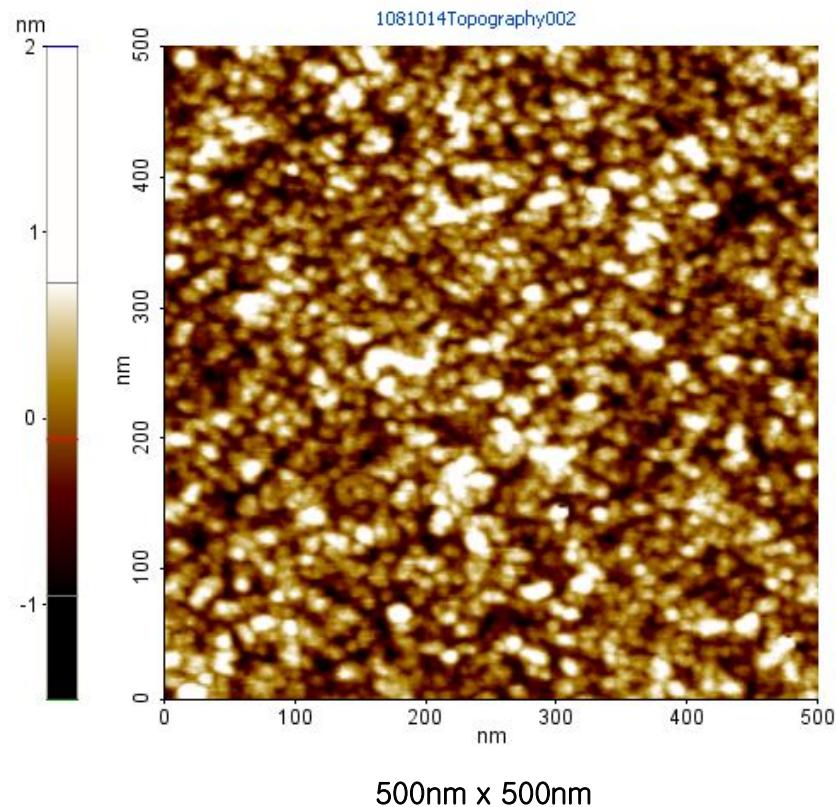
# Polymer Film



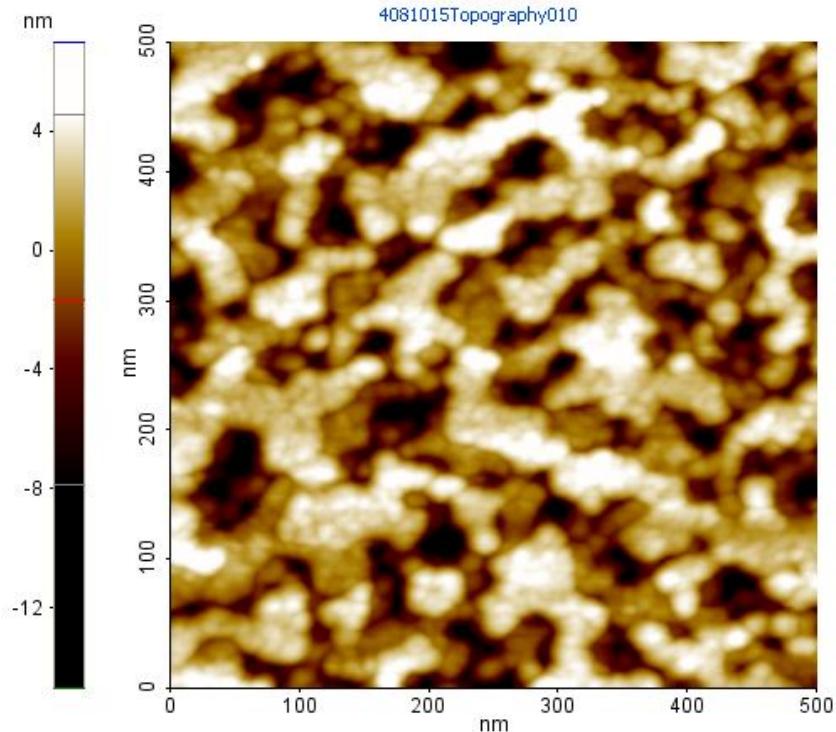
# *Amorphous Si surface*



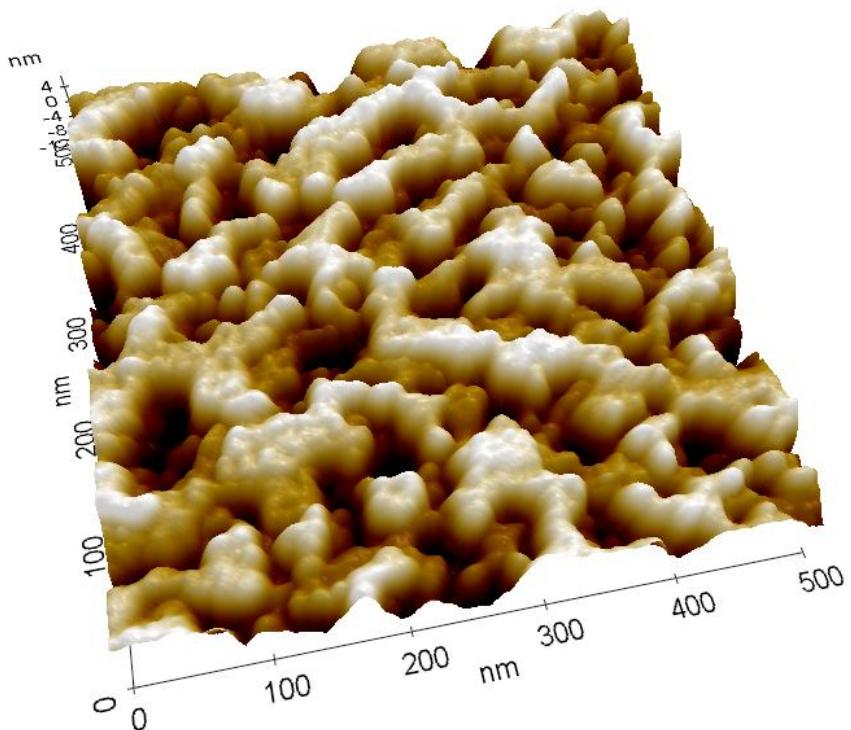
Nanotechnology Solutions Partner



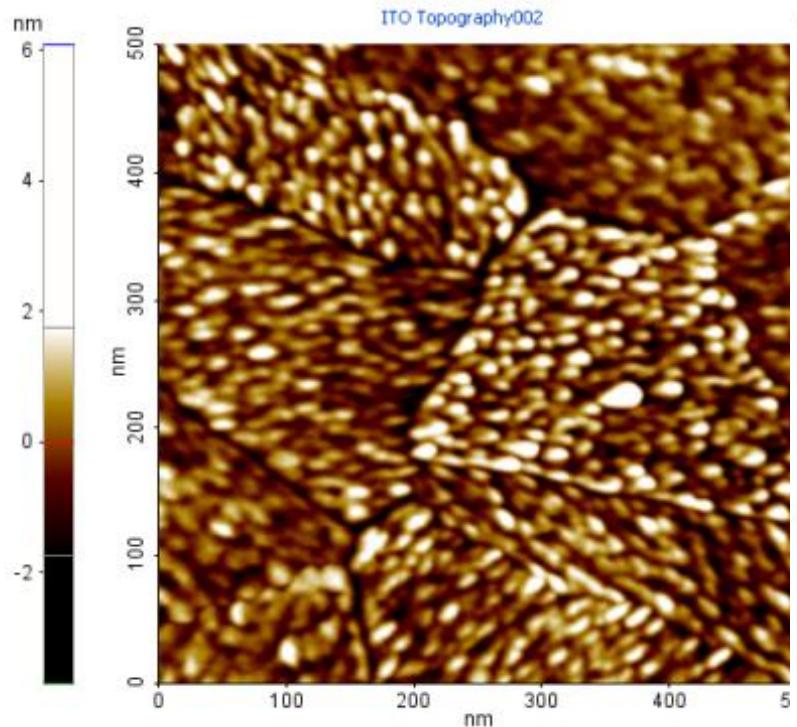
# *Amorphous Si surface*



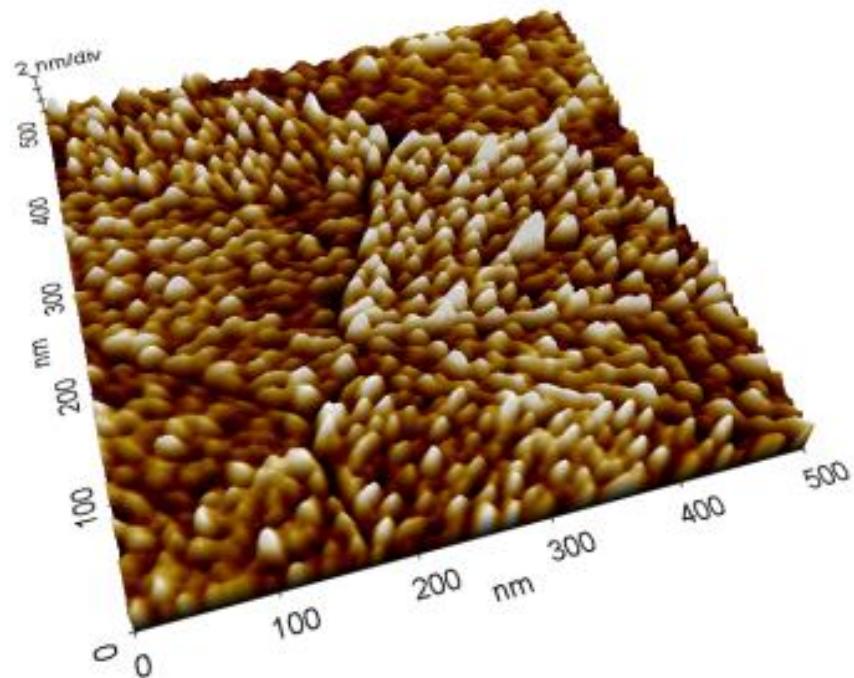
500nm x 500nm



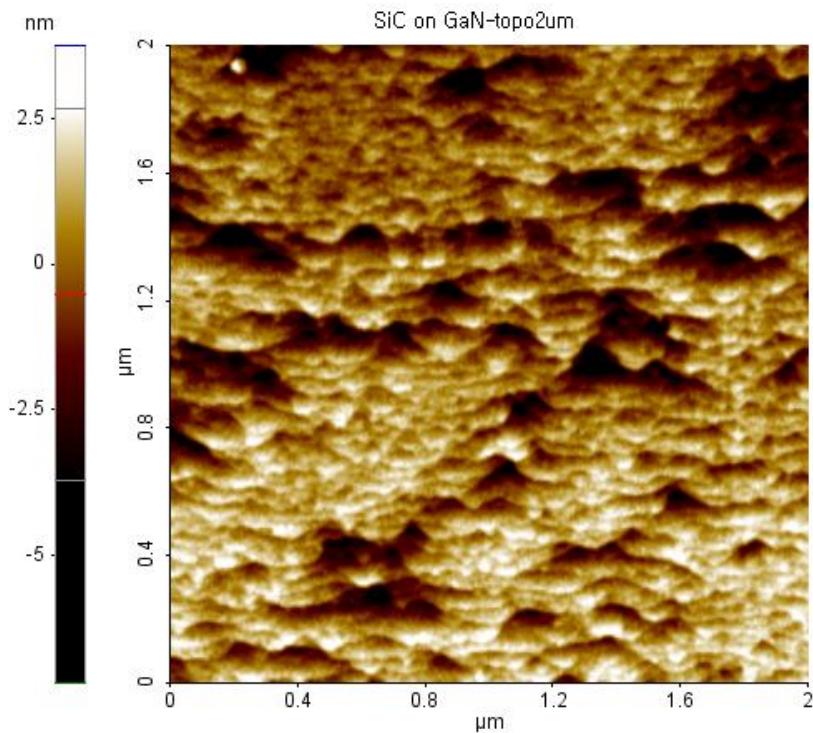
# ITO Sample



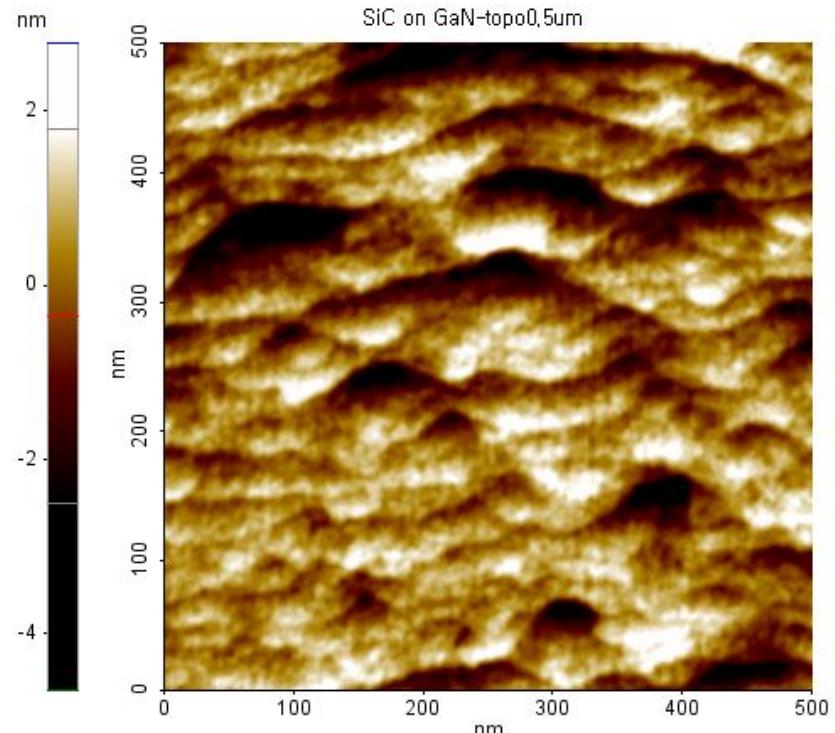
500nm x 500nm



# *SiC on GaN*

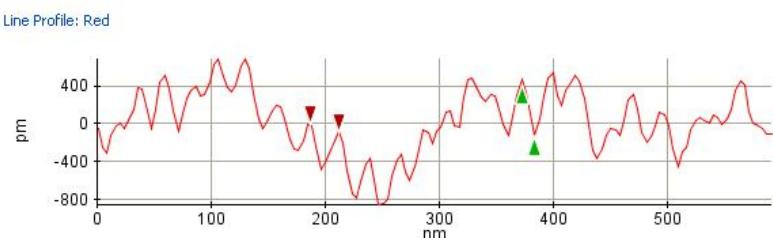
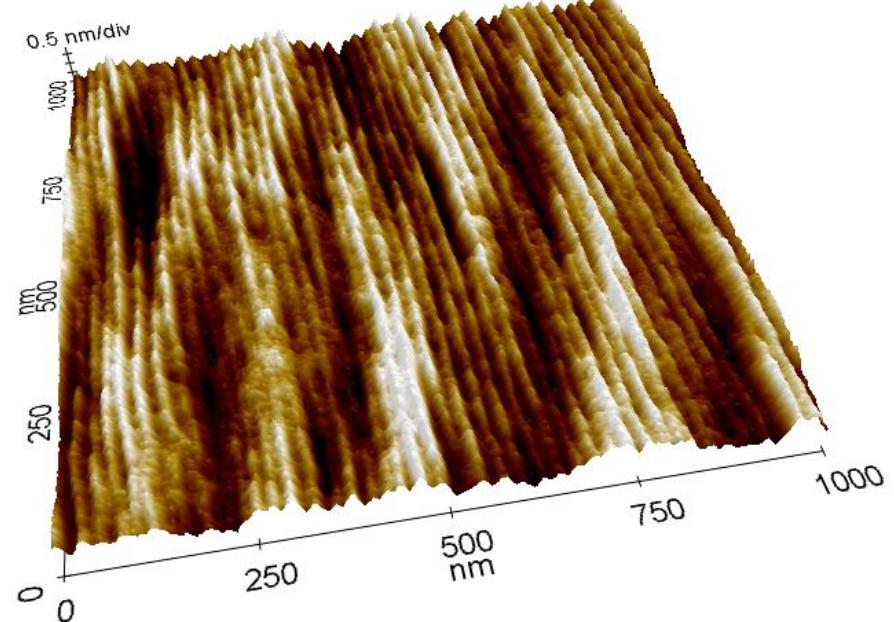
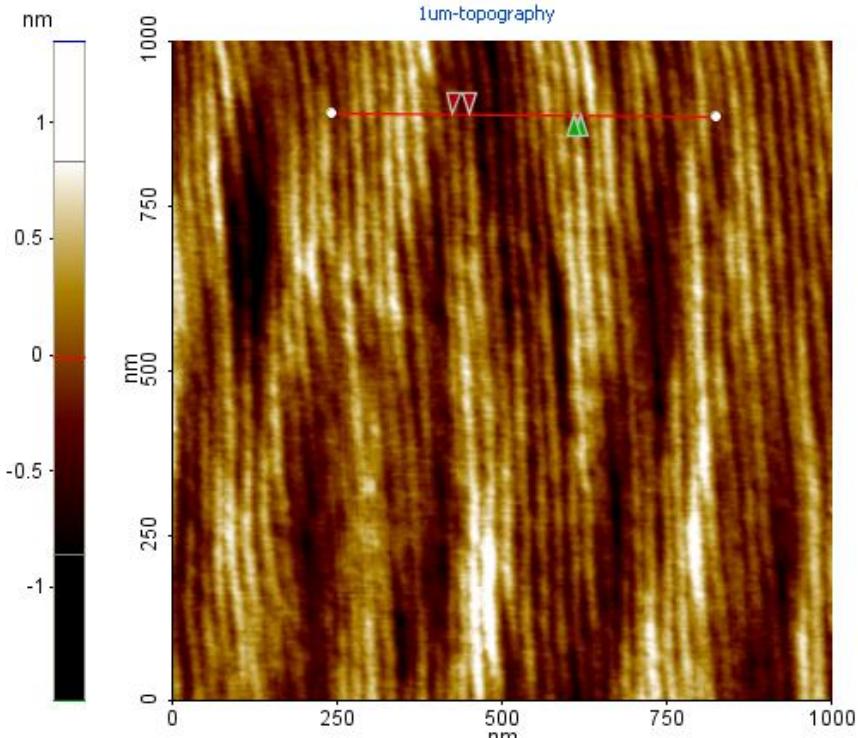


2um x 2um



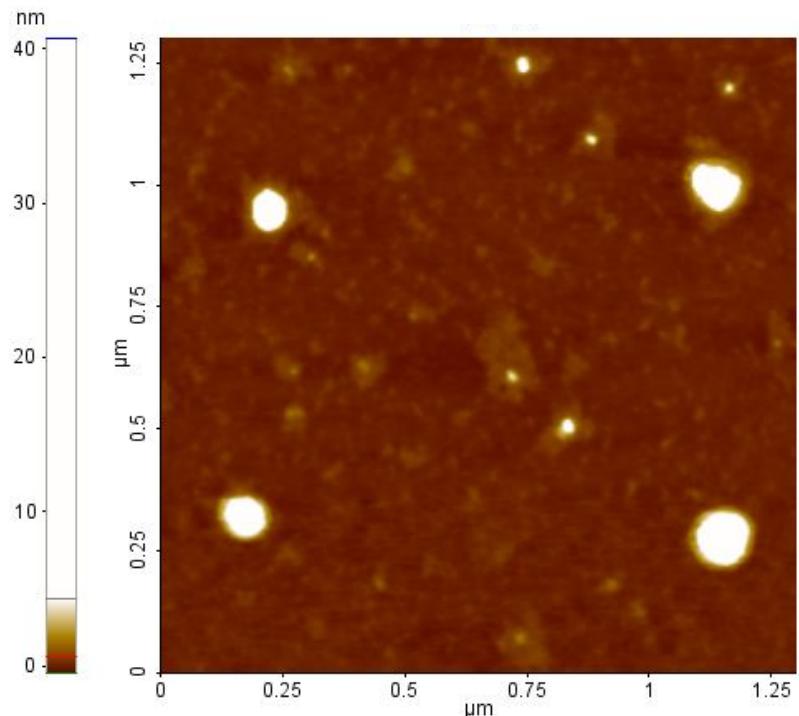
500nm x 500nm

# GaN

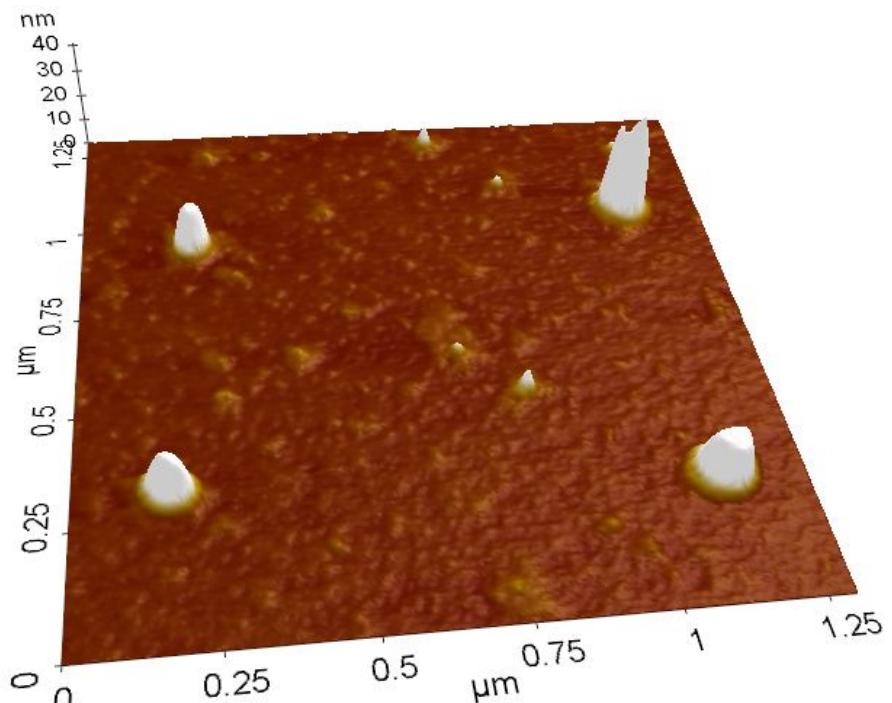


Cursor	$\Delta X$ (nm)	$\Delta Y$ (nm)	Angle(deg)
Red	24.973	-0.092	-0.212
Green	10.703	-0.545	-2.915

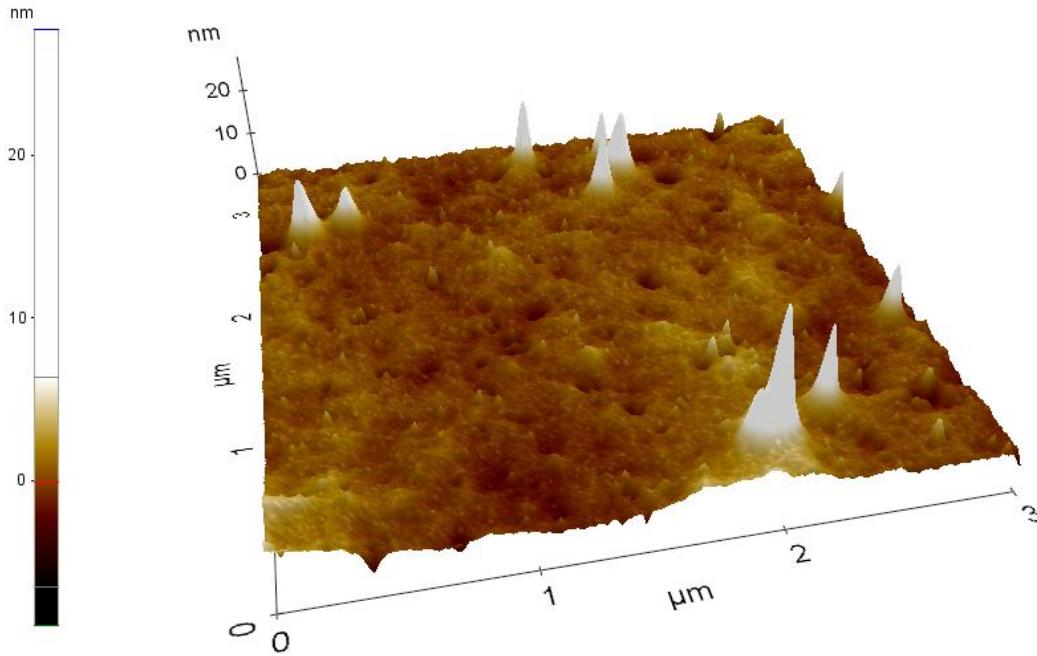
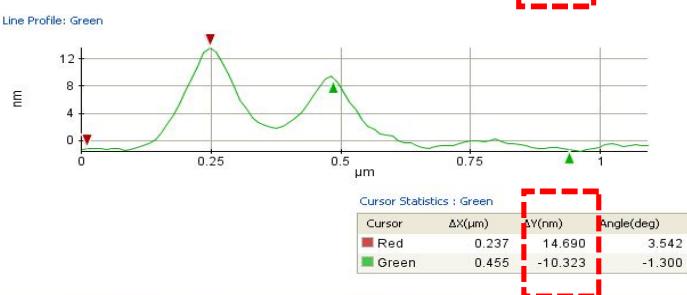
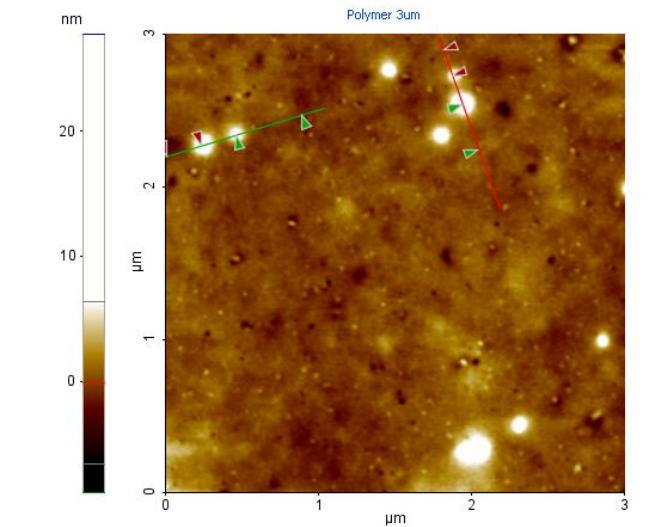
# *Al nano dot*



1.3um x 1.3um



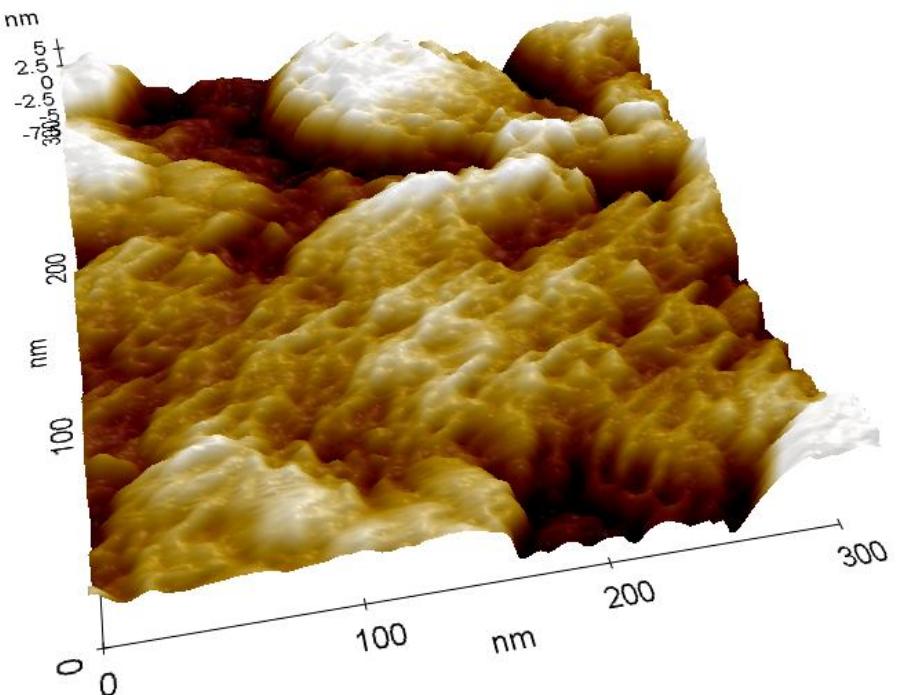
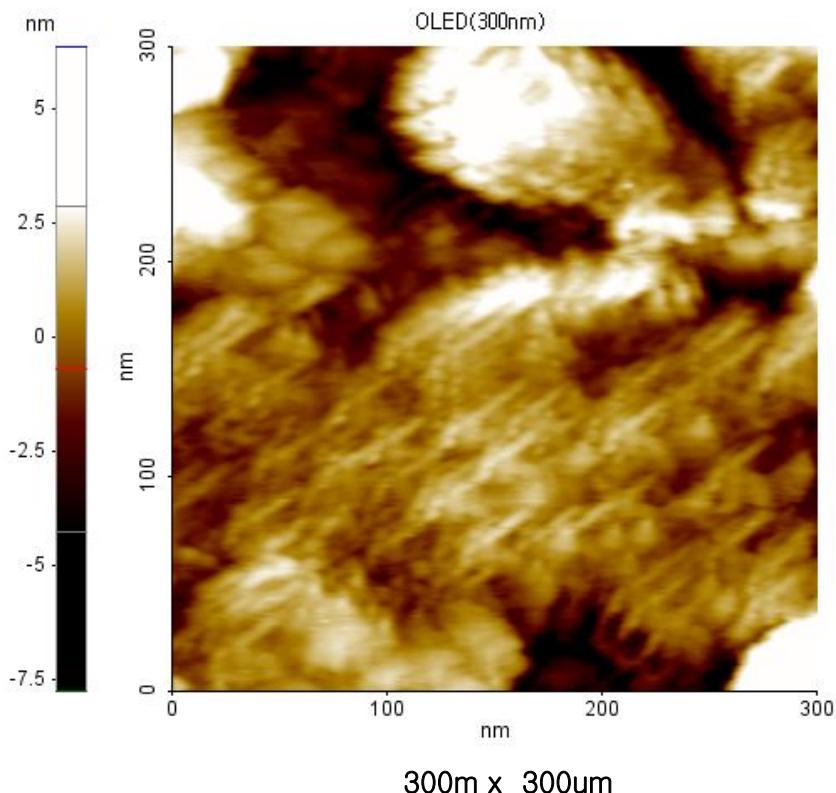
# Polymer powder



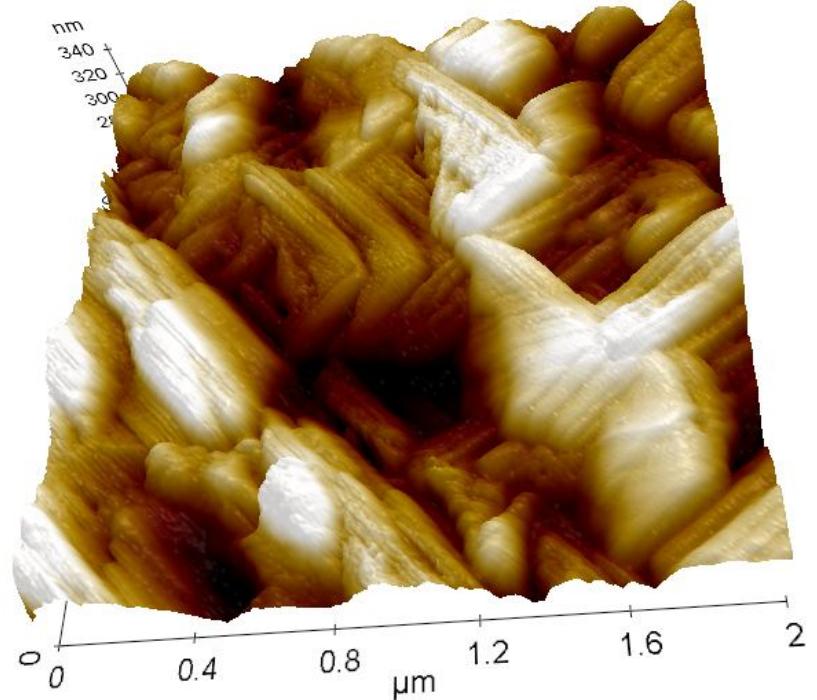
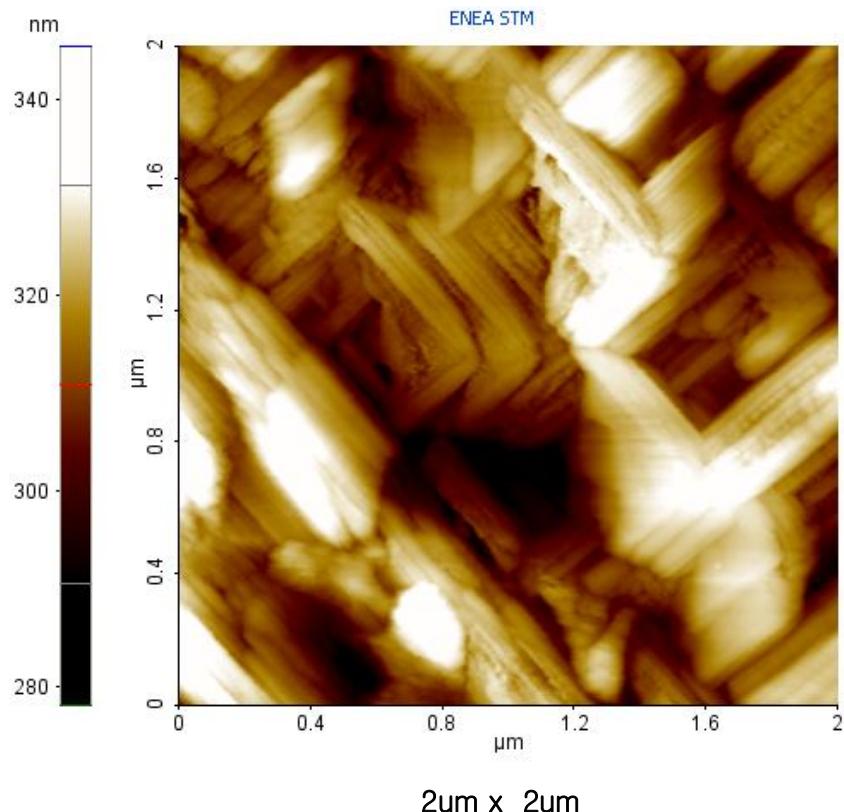
## Sample preparation

- 1) Put polymer powder( $\sim 0.001\text{g}$ ) into DI water ( $500\text{uL}$ )
- 2) Mix it at the Ultrasonic
- 3) Drop  $10\text{uL}$  polymer powder solution onto mica.
- 4) Dry the mica in the air.

# (STM) OLED



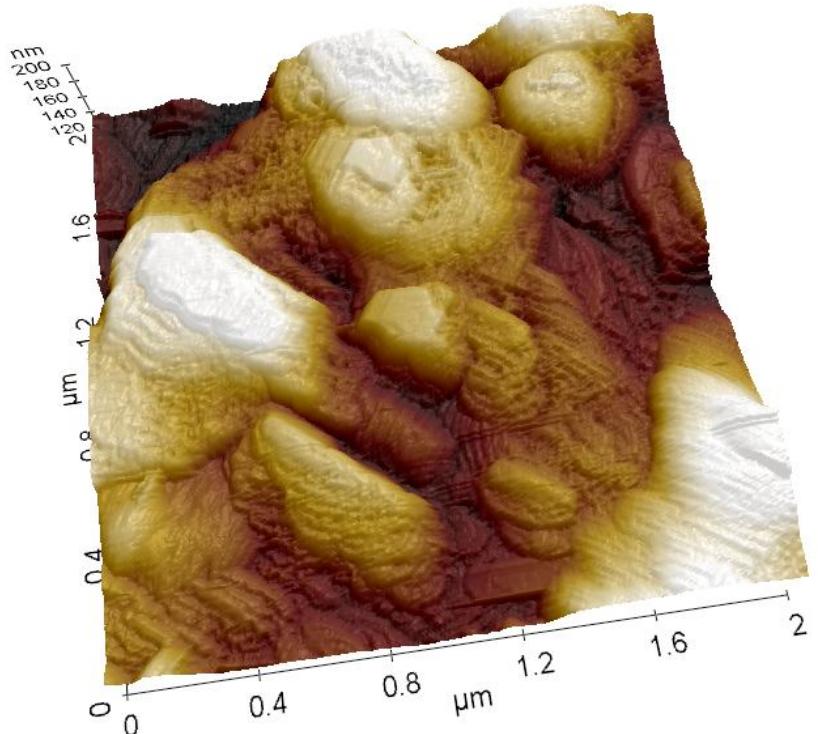
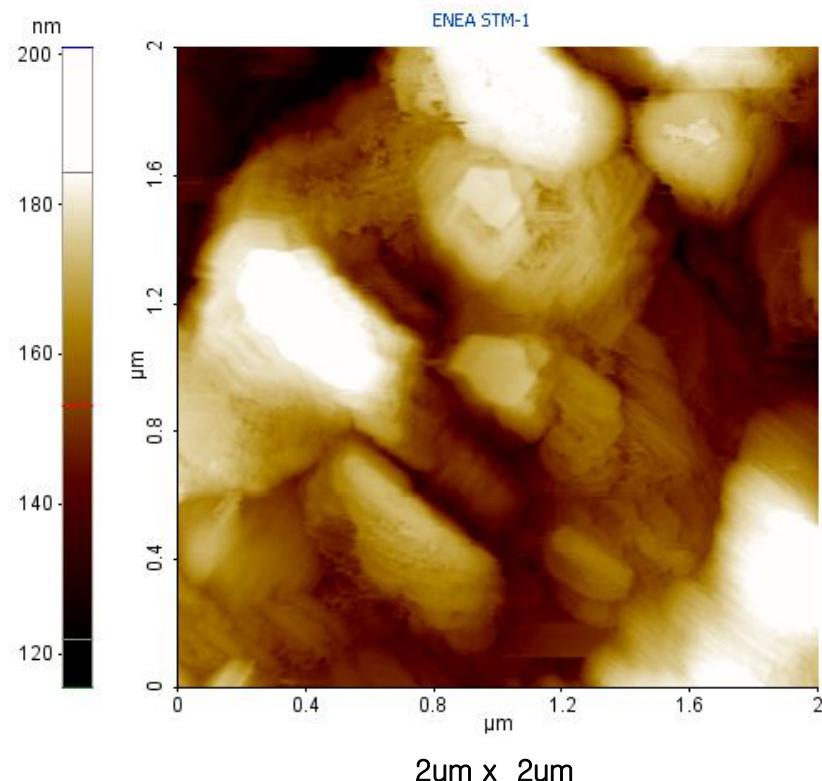
# (STM) $YBa_2Cu_3O_{7-x}$ (YBCO) film



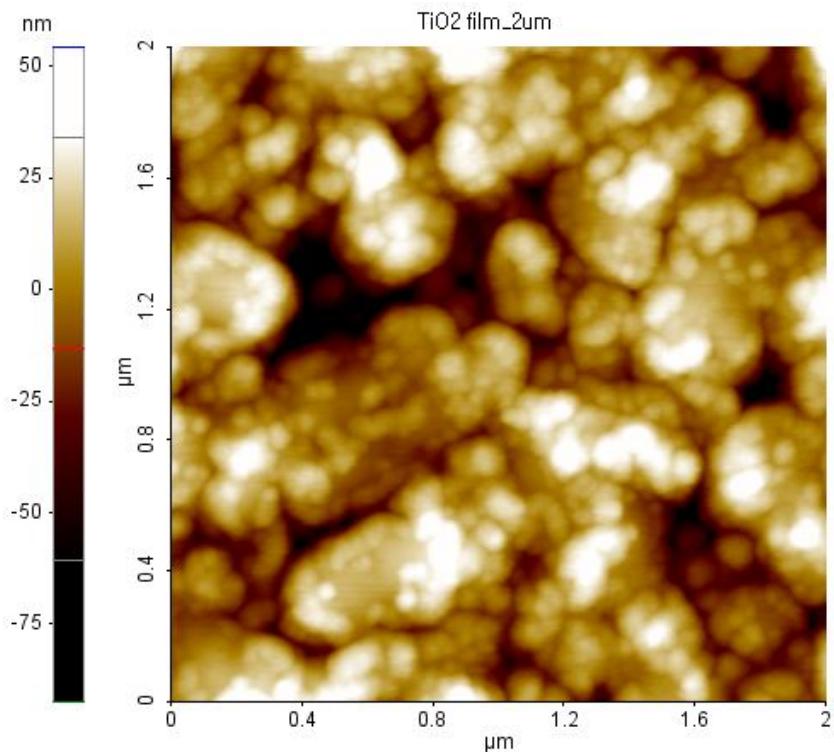
# (STM) $YBa_2Cu_3O_{7-x}$ (YBCO) film



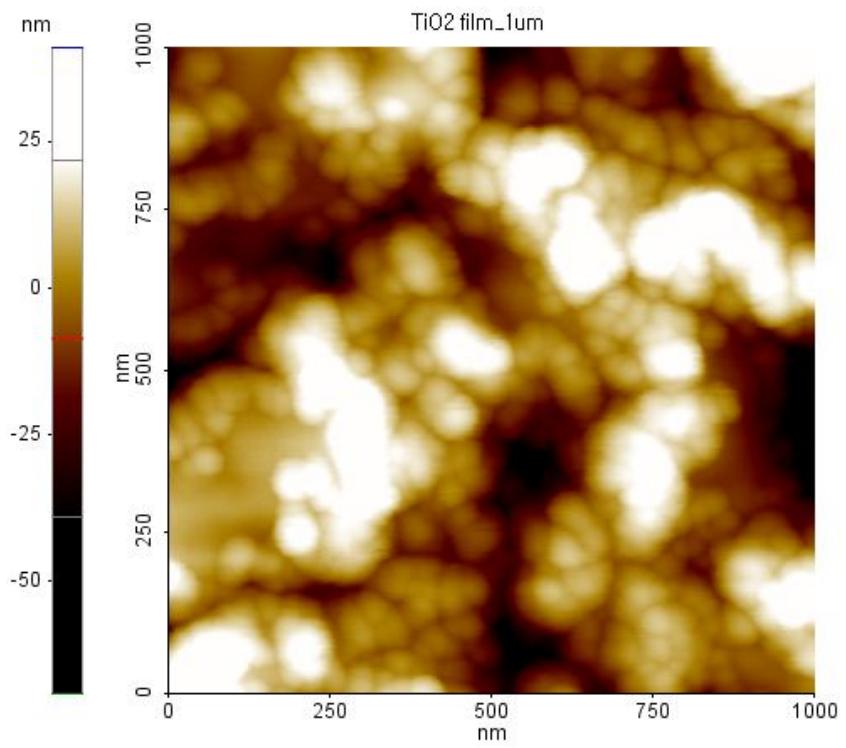
Nanotechnology Solutions Partner



# *TiO<sub>2</sub>* Film



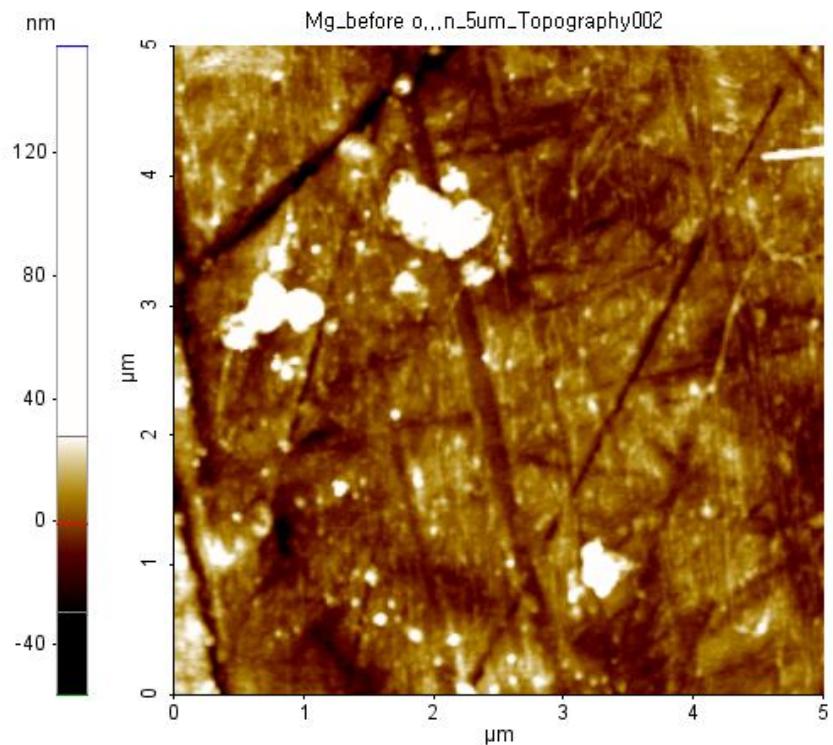
2μm x 2μm



1μm x 1μm

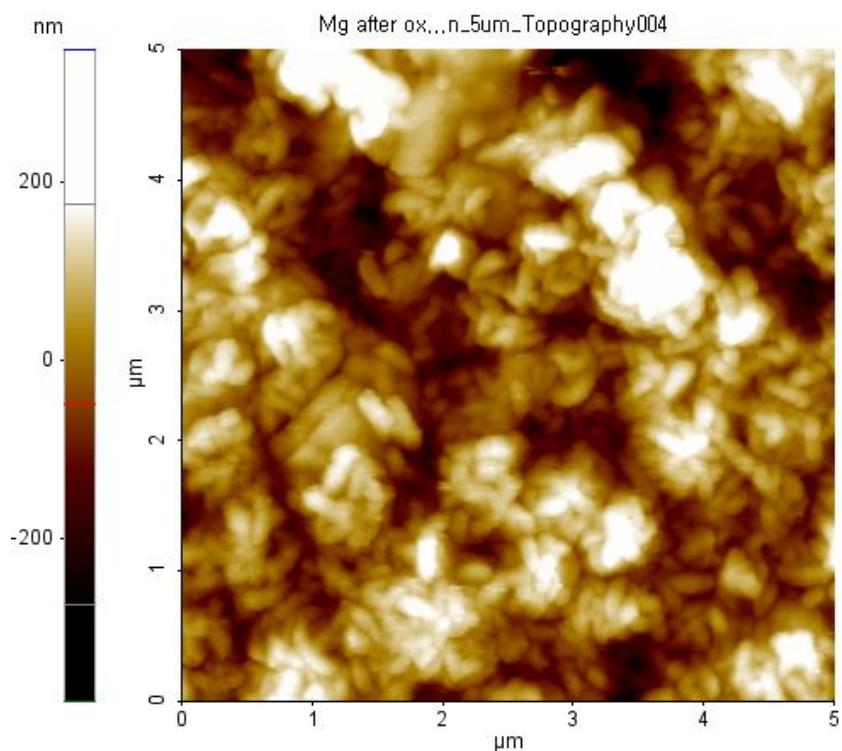
# Mg surface as oxidation

Before oxidation



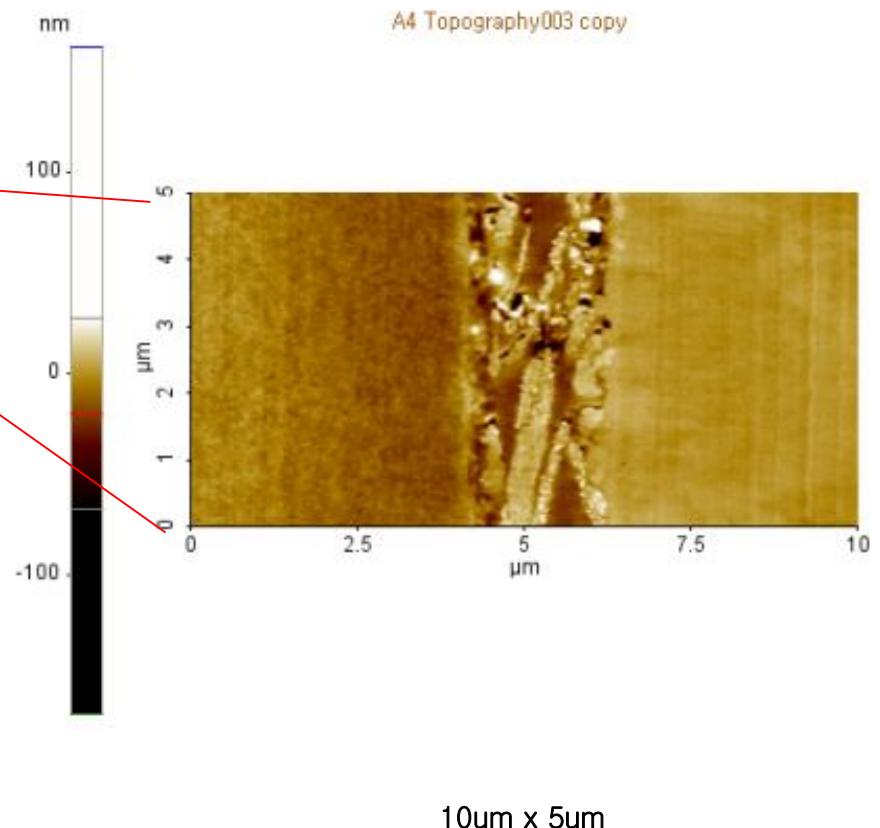
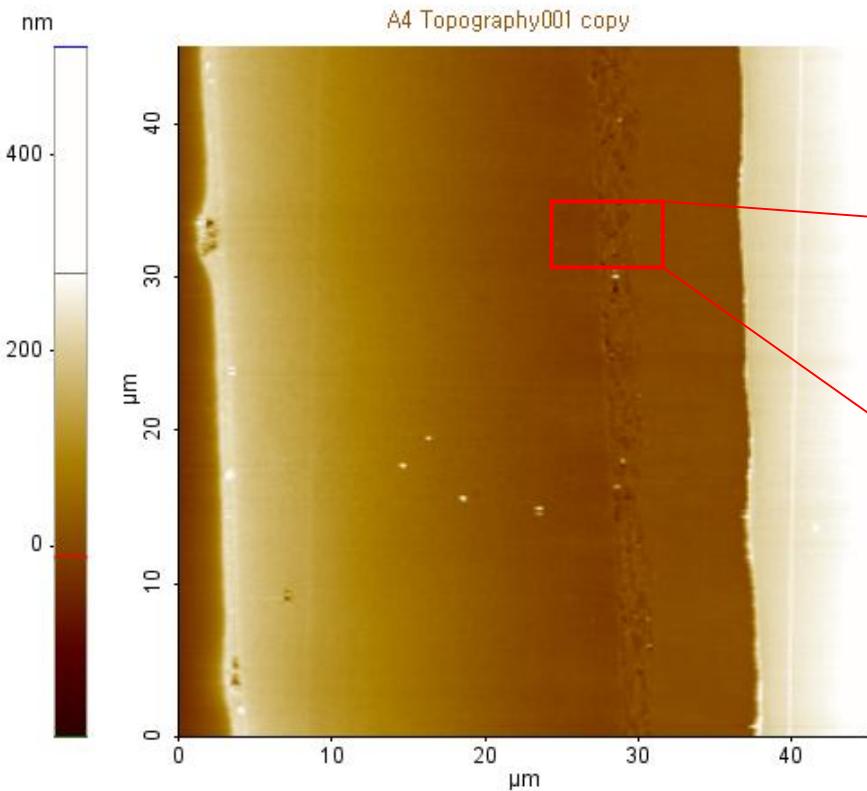
5um x 5um

After oxidation



5um x 5um

# Cross section Cu-silver boundary

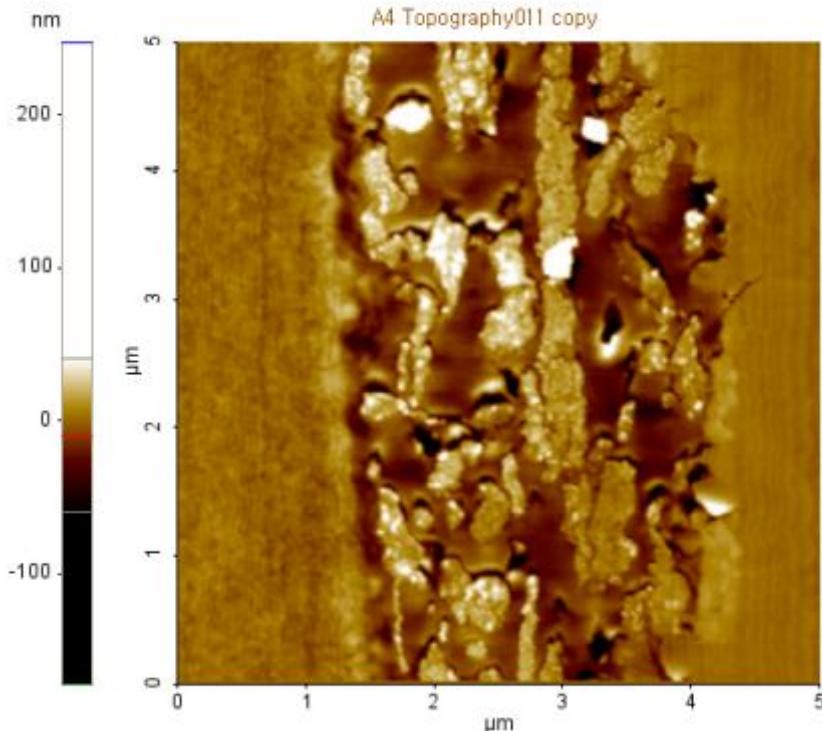


# Cross section Cu-silver boundary (Zoom in)



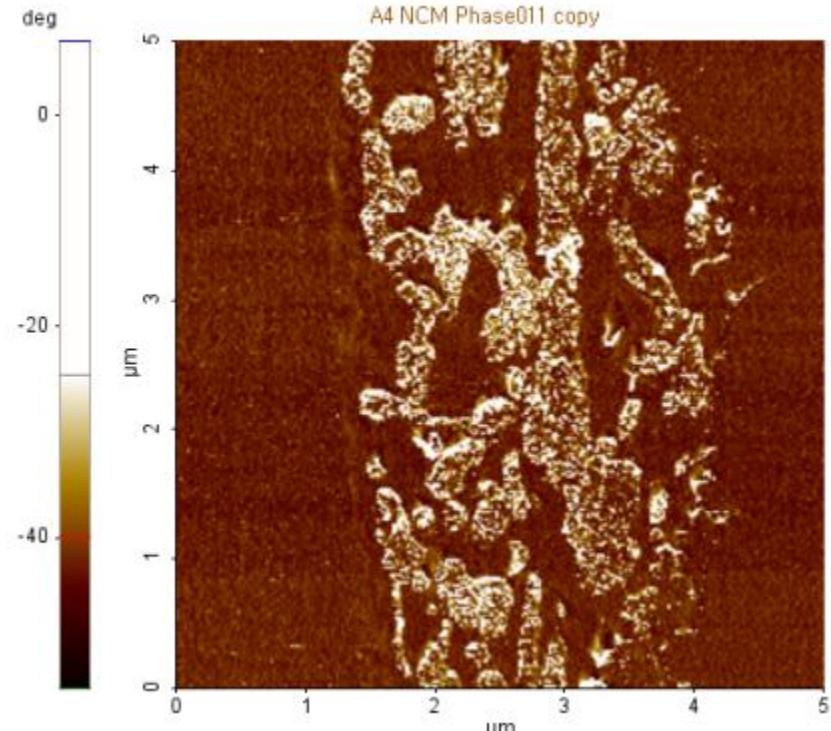
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Topography



5um x 5um

NCM Phase

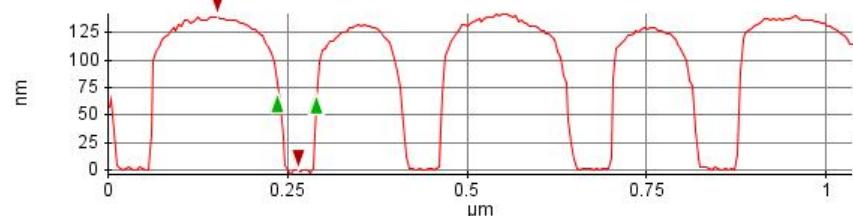
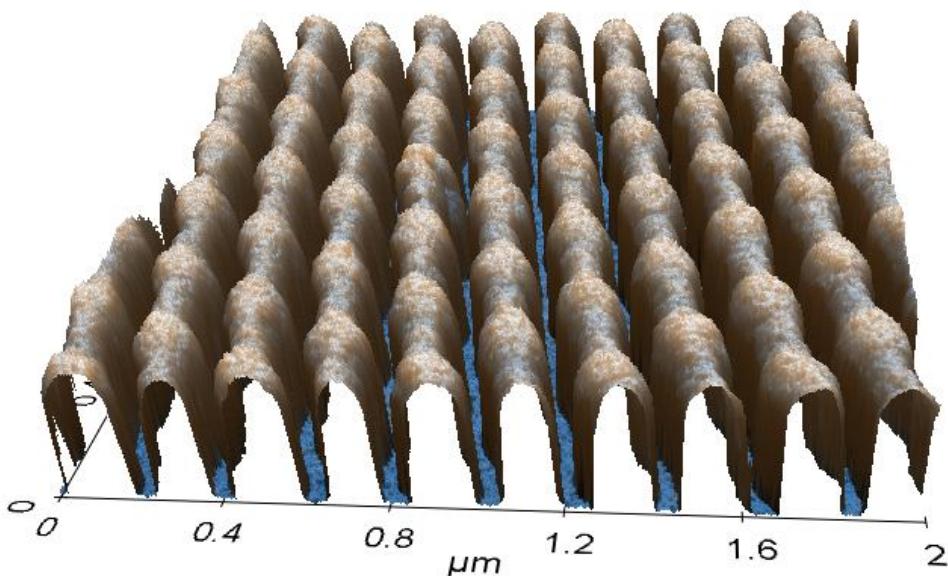
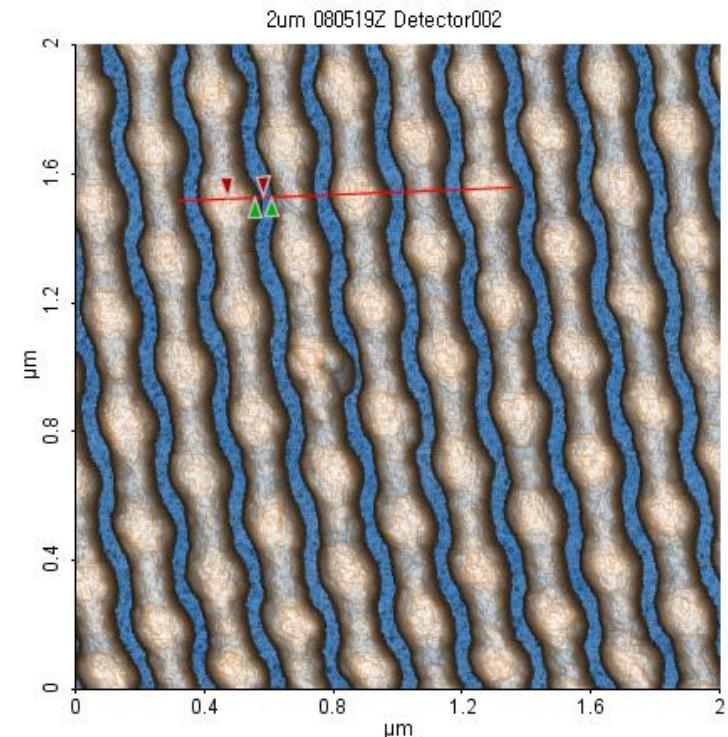


5um x 5um

# Trench sample (Width : 60nm , Depth : 140nm)



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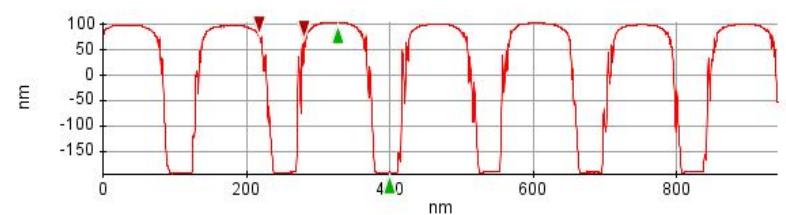
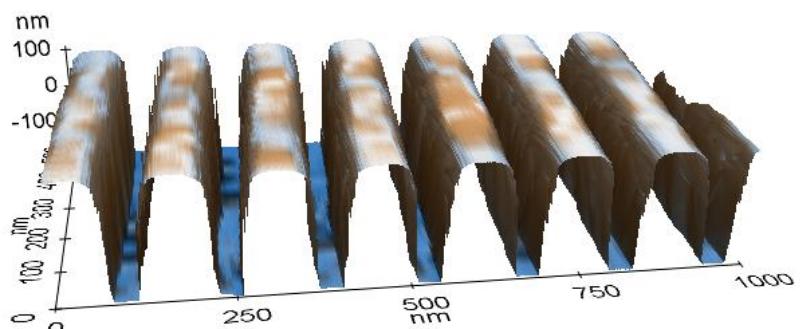
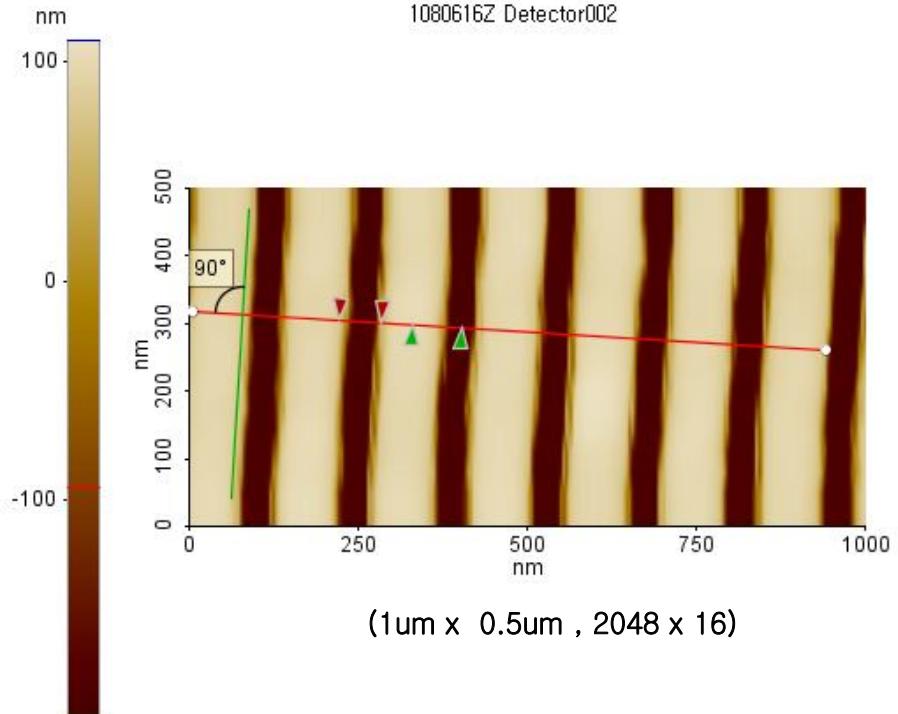
Cursor Statistics : Red

Cursor	$\Delta X(\mu m)$	$\Delta Y(nm)$	Angle(deg)
Red	0.113	-140.220	-51.210
Green	0.054	-0.678	-0.716

# Trench sample (Width : 60nm , Depth : 300nm)

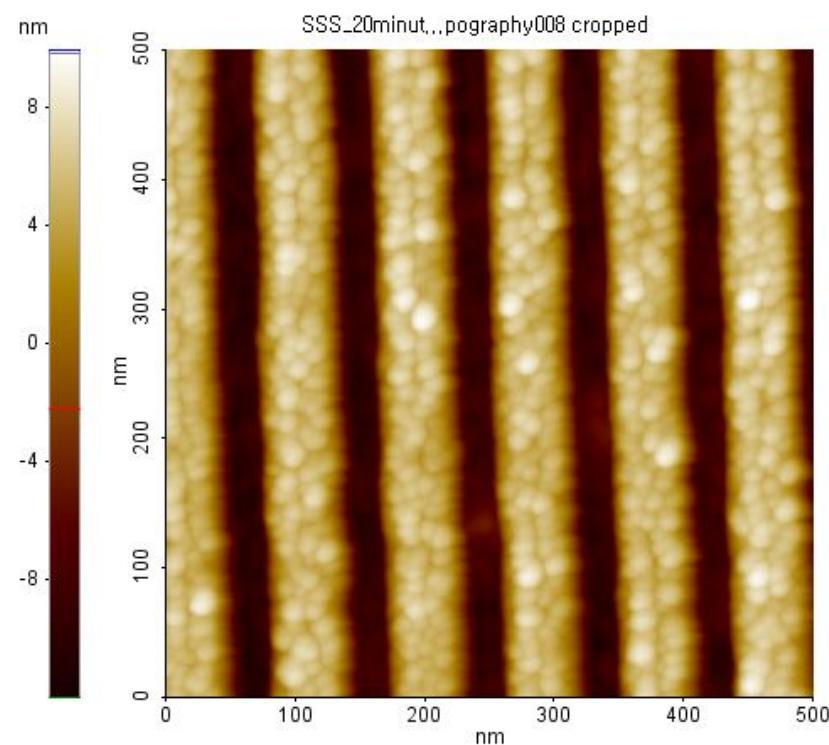


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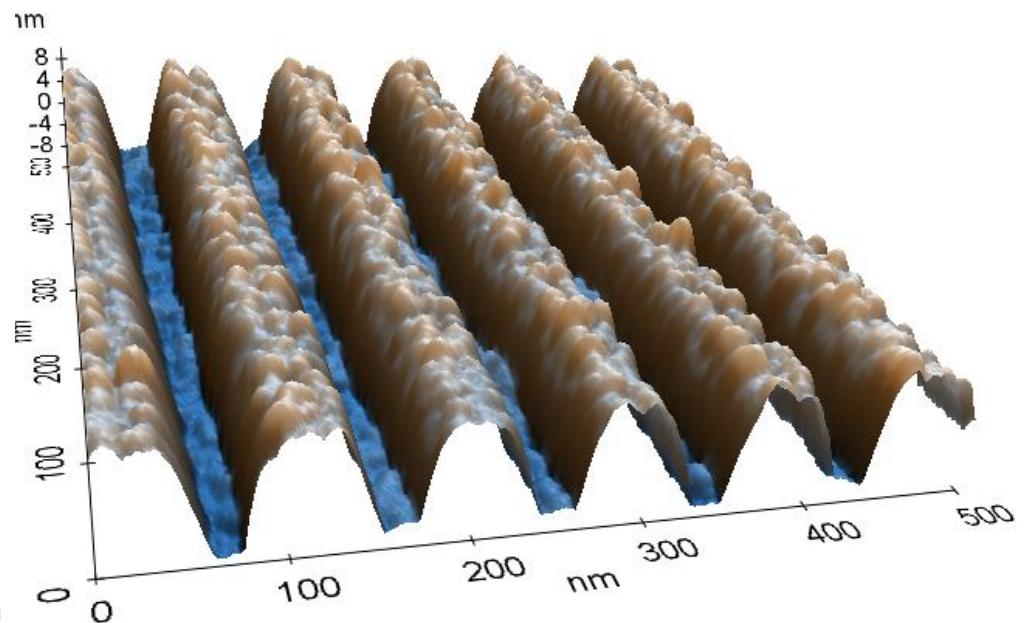


Cursor	$\Delta X$ (nm)	$\Delta Y$ (nm)	Angle(deg)
Red	62.545	-8.694	-7.905
Green	72.021	-295.590	-76.307

# Metal Trench



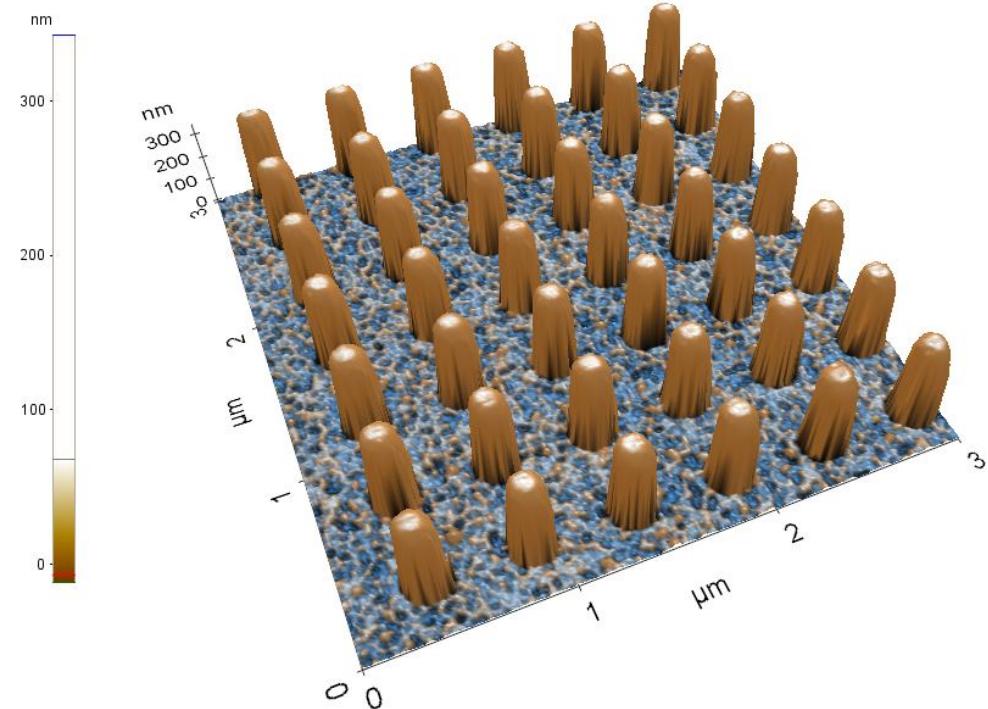
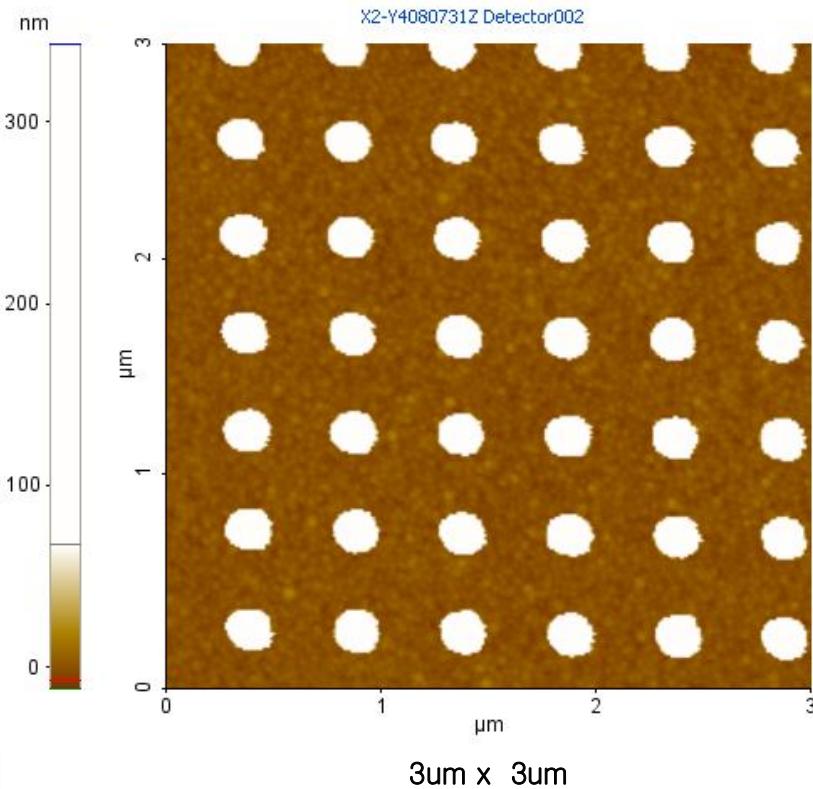
500nm x 500nm



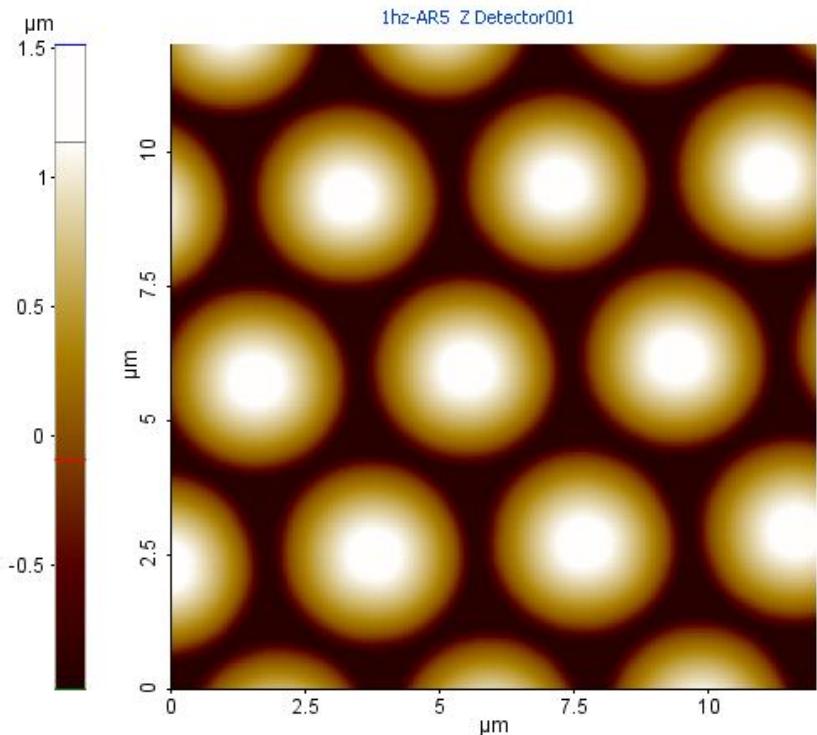
# *The PhotoResist Pillar sample*



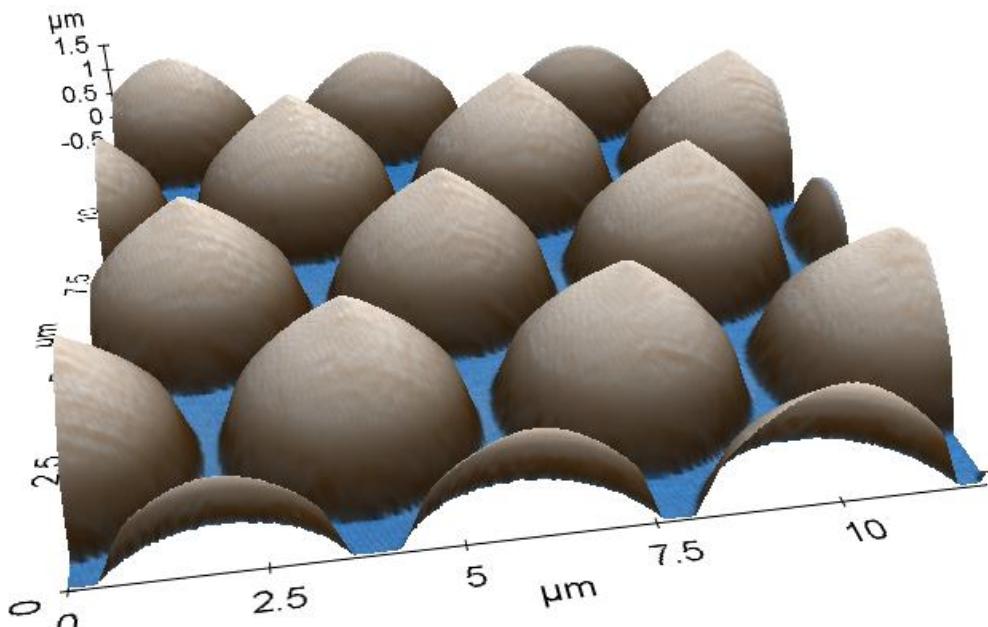
Nanotechnology Solutions Partner



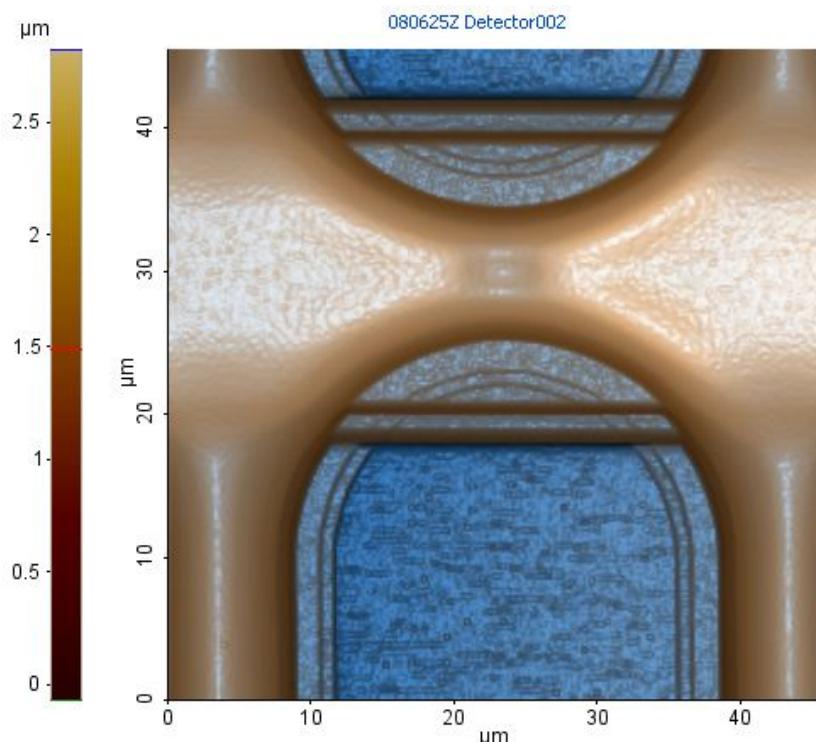
# Micro lens



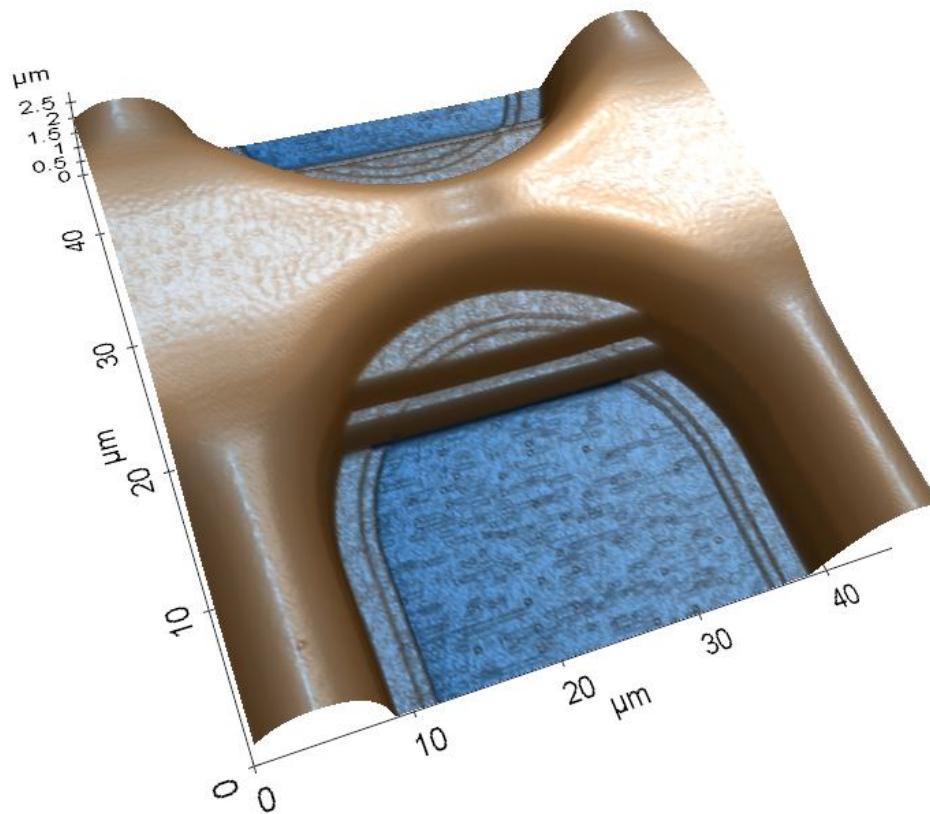
12 $\mu\text{m} \times$  12 $\mu\text{m}$



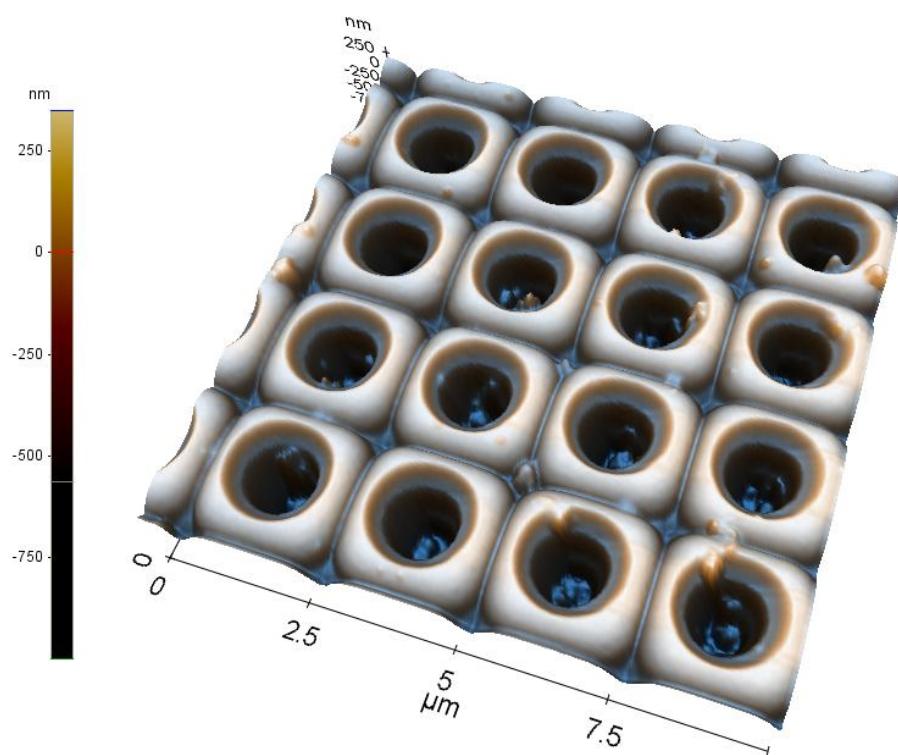
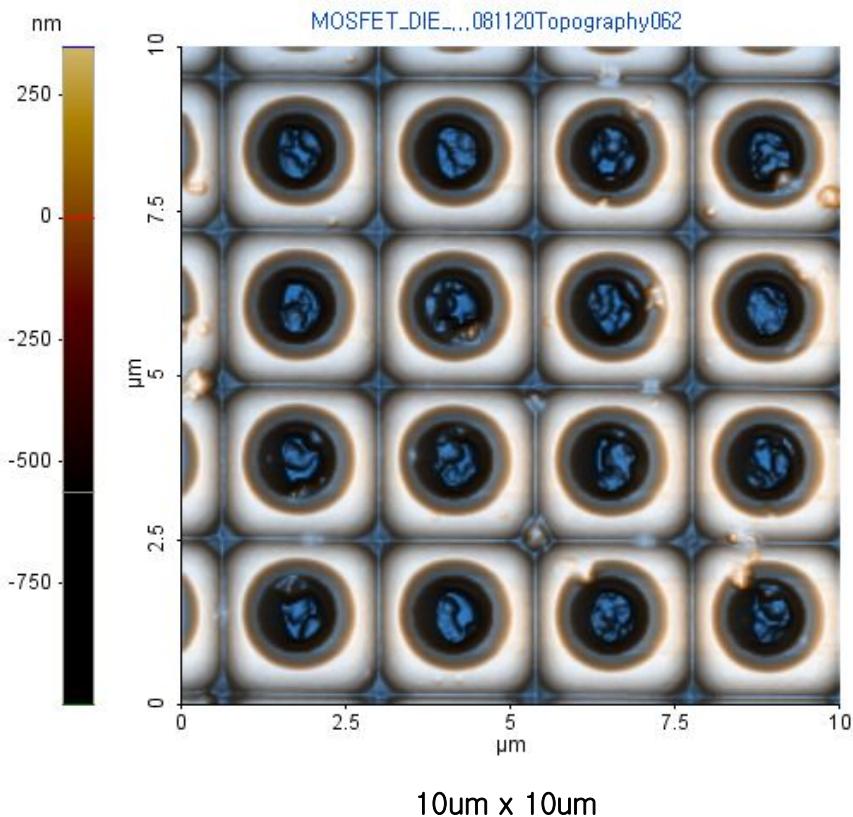
# Channel (?)



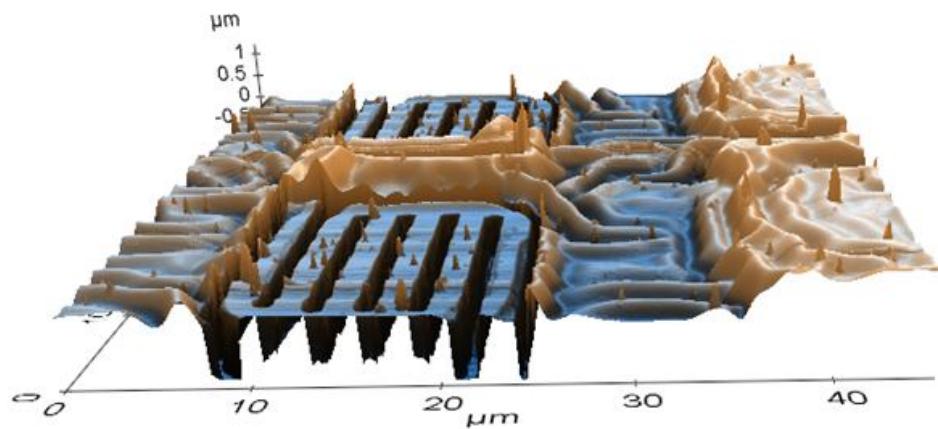
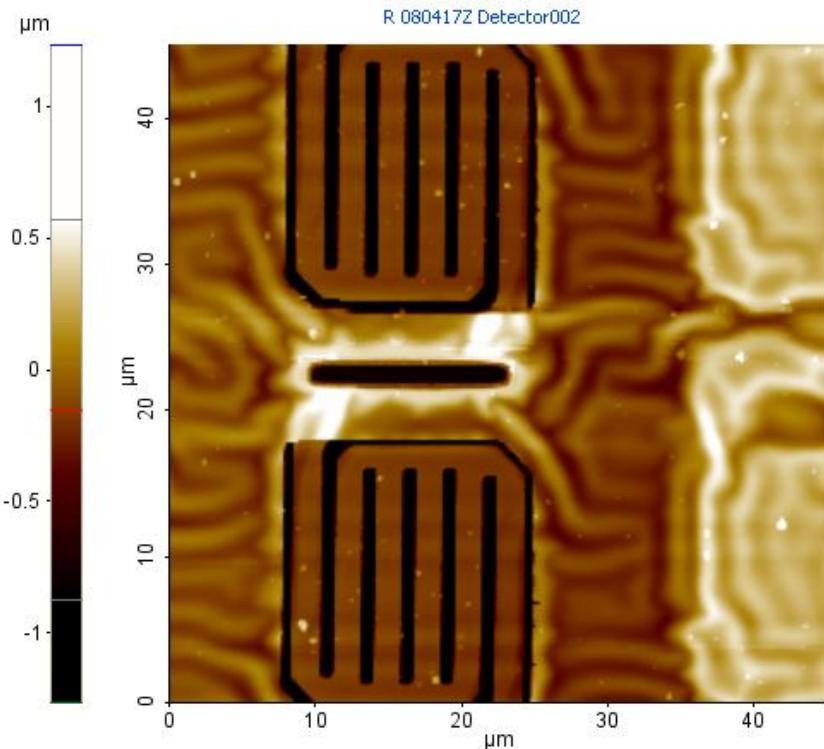
45um x 45um



# MOSFET DIE after Al etch



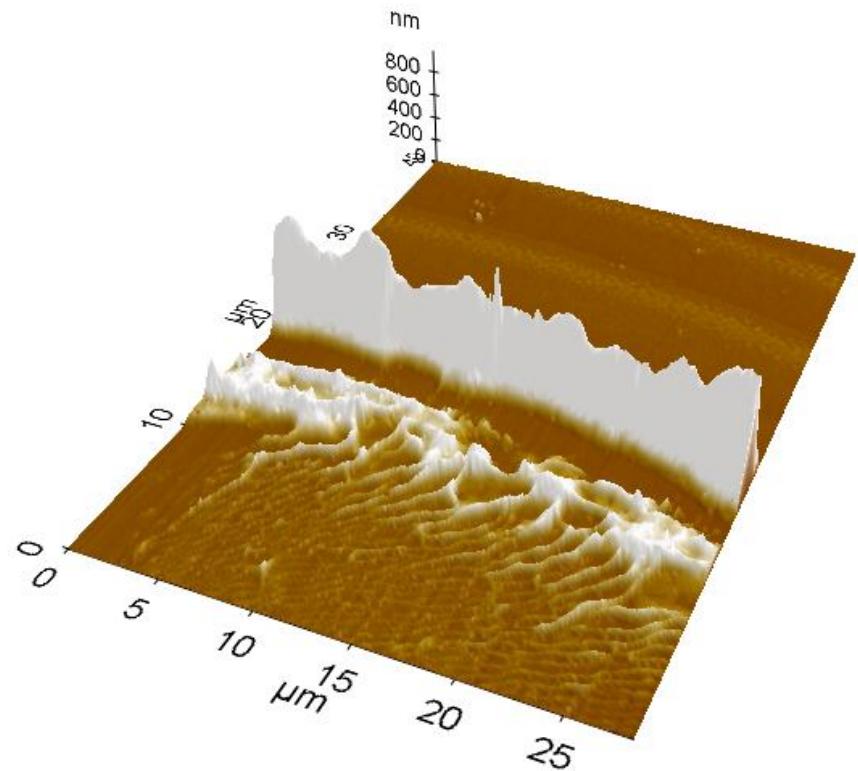
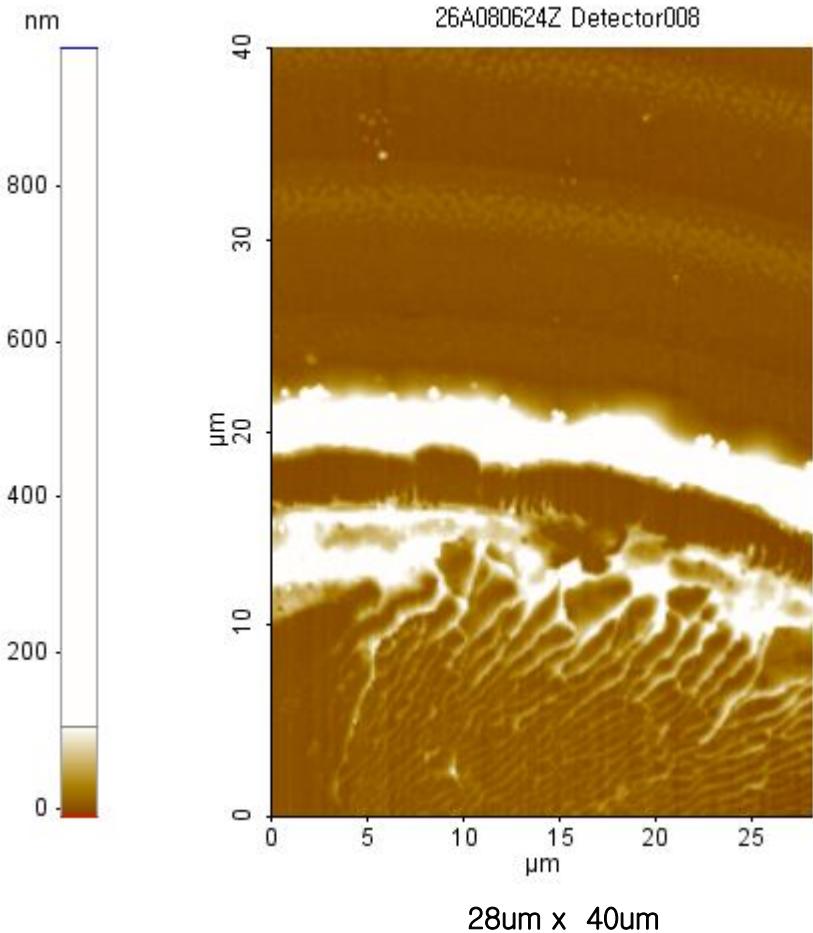
# MEMS sample



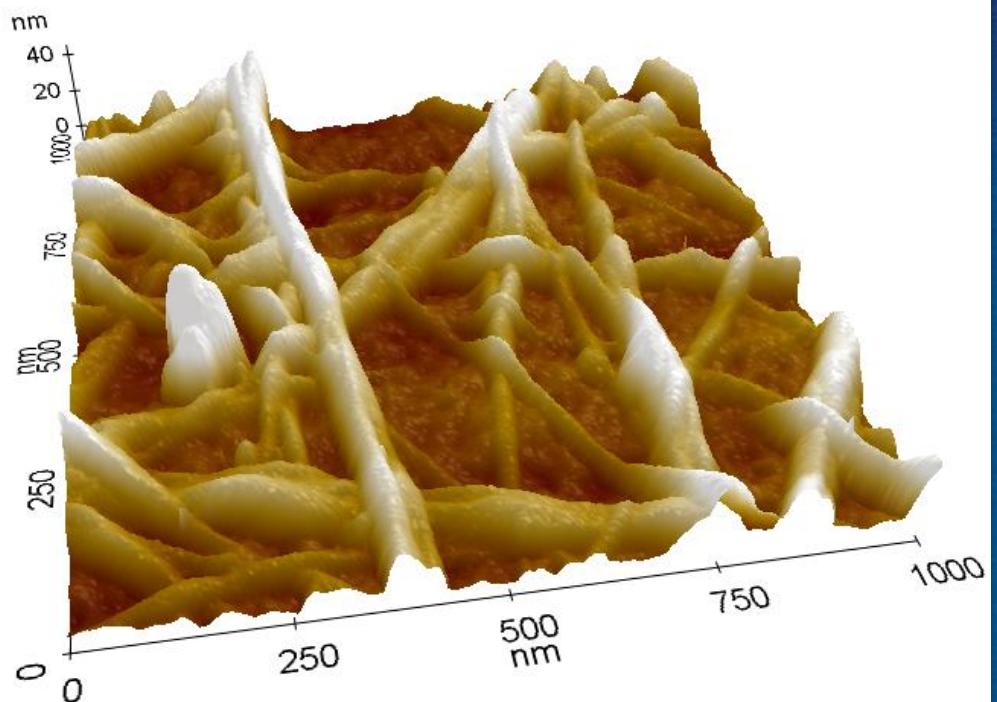
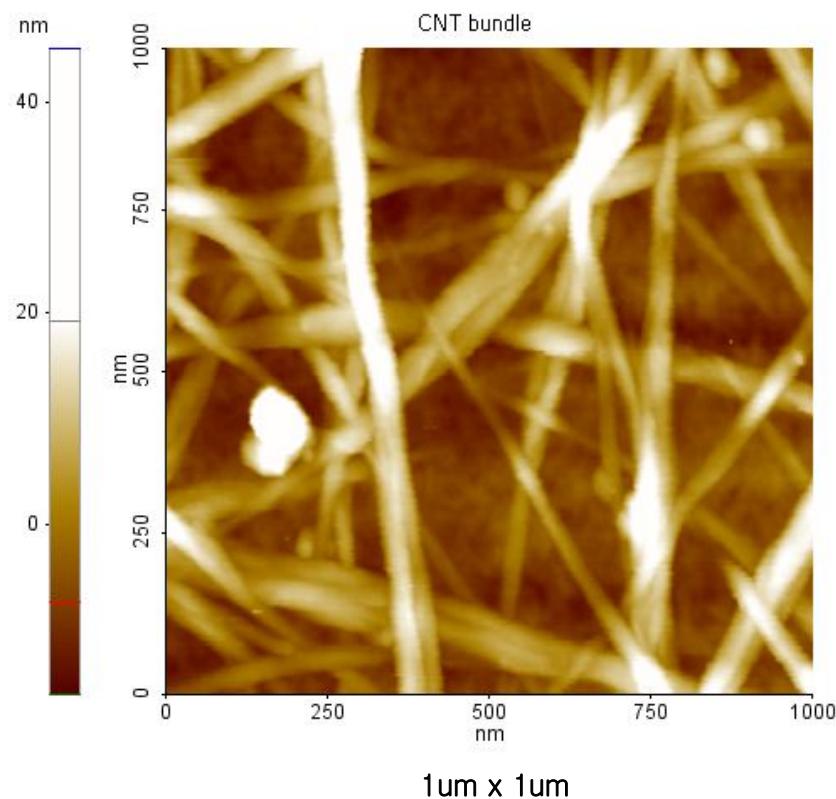
# *Delamination occurred from the Photoresist*



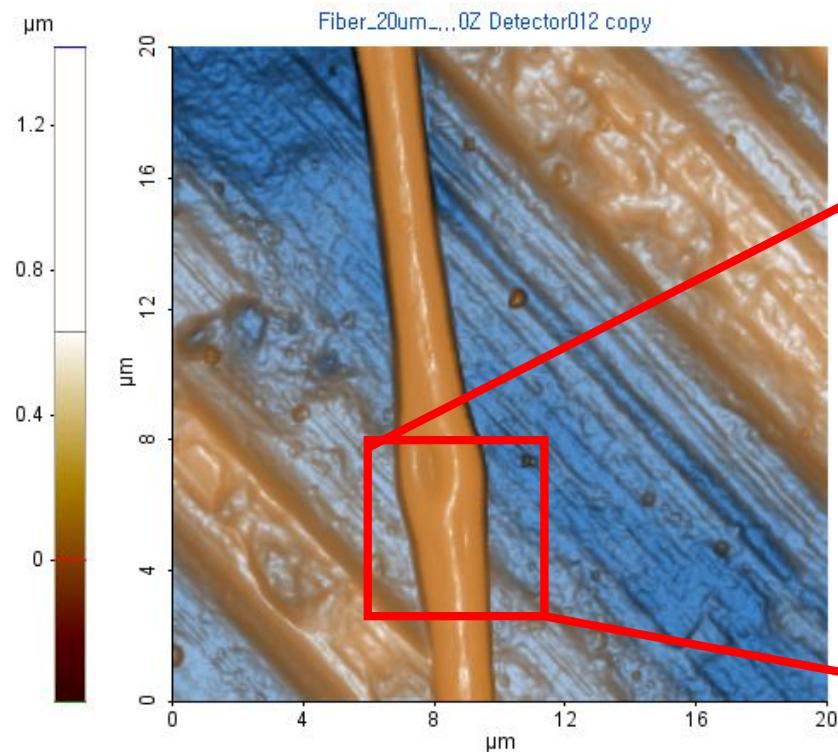
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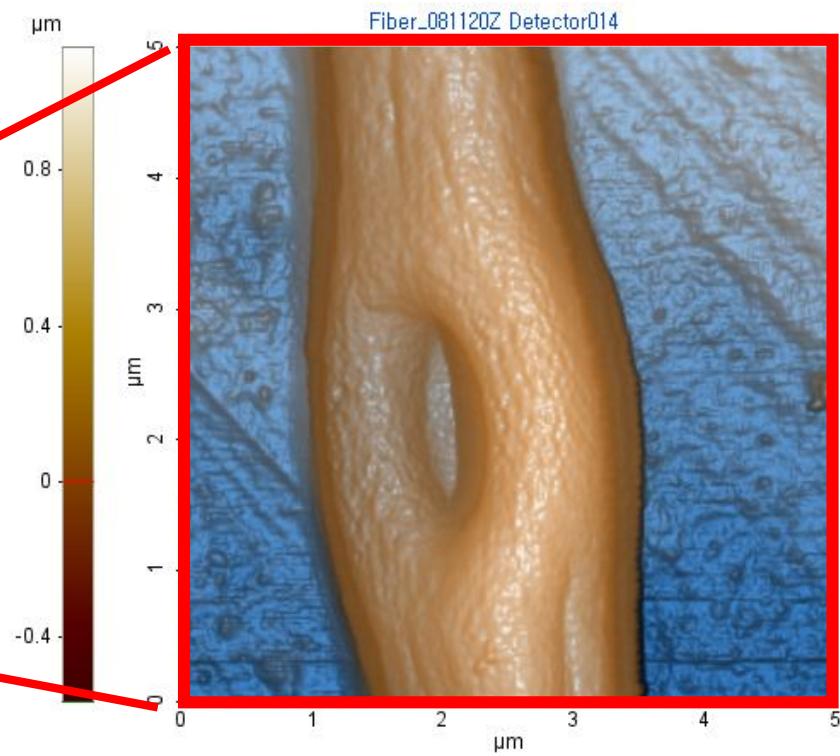
# CNT bundle



# Fiber

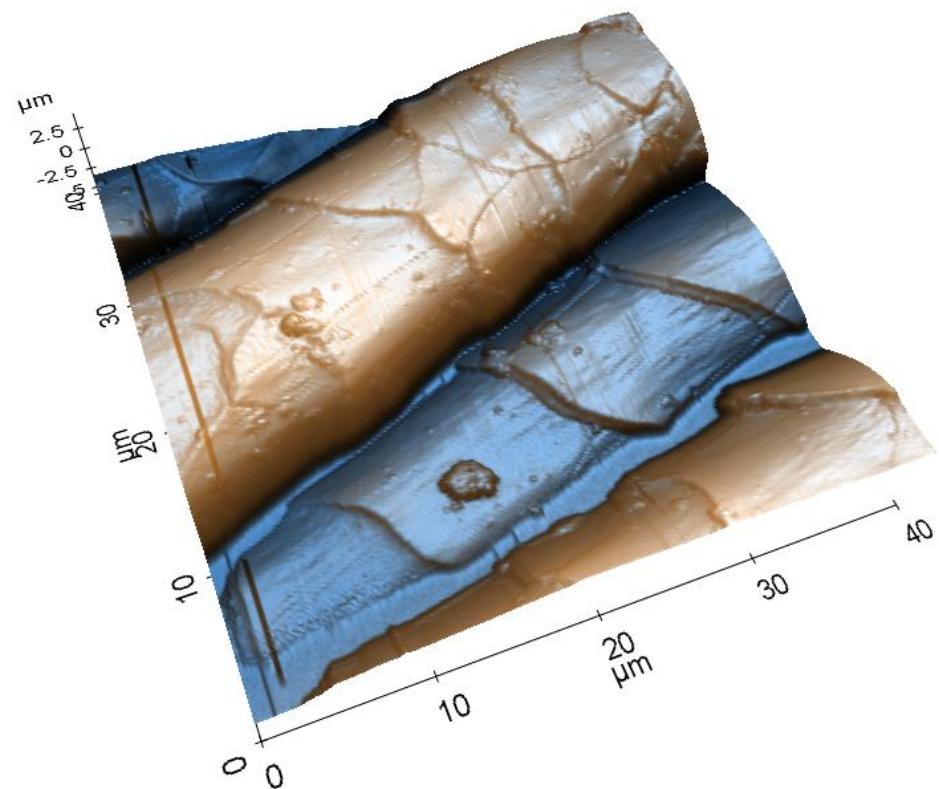
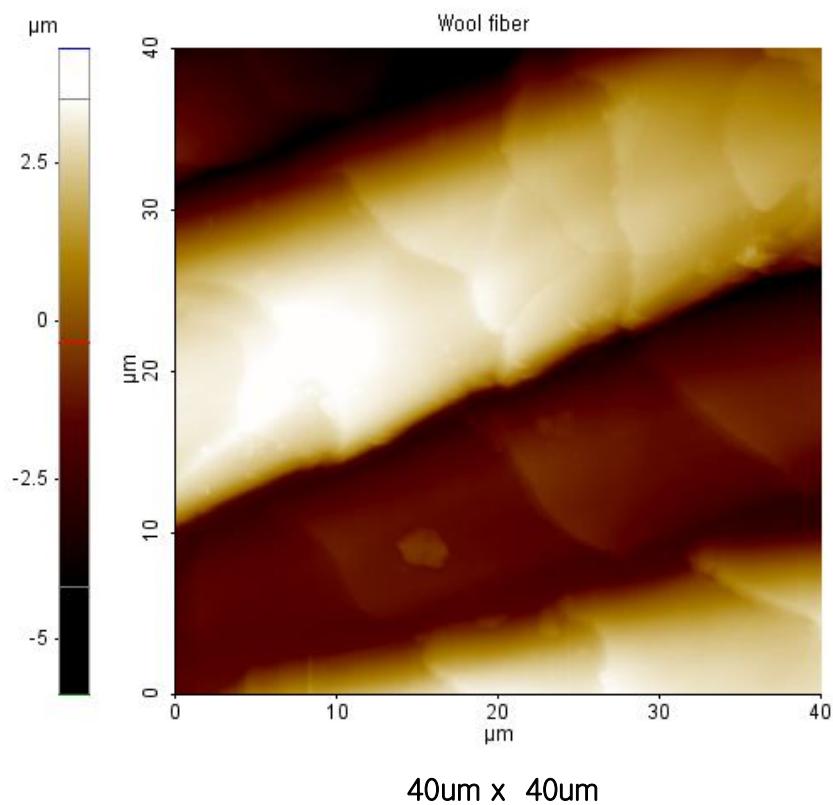


20um x 20um



5um x 5um

# Wool fiber



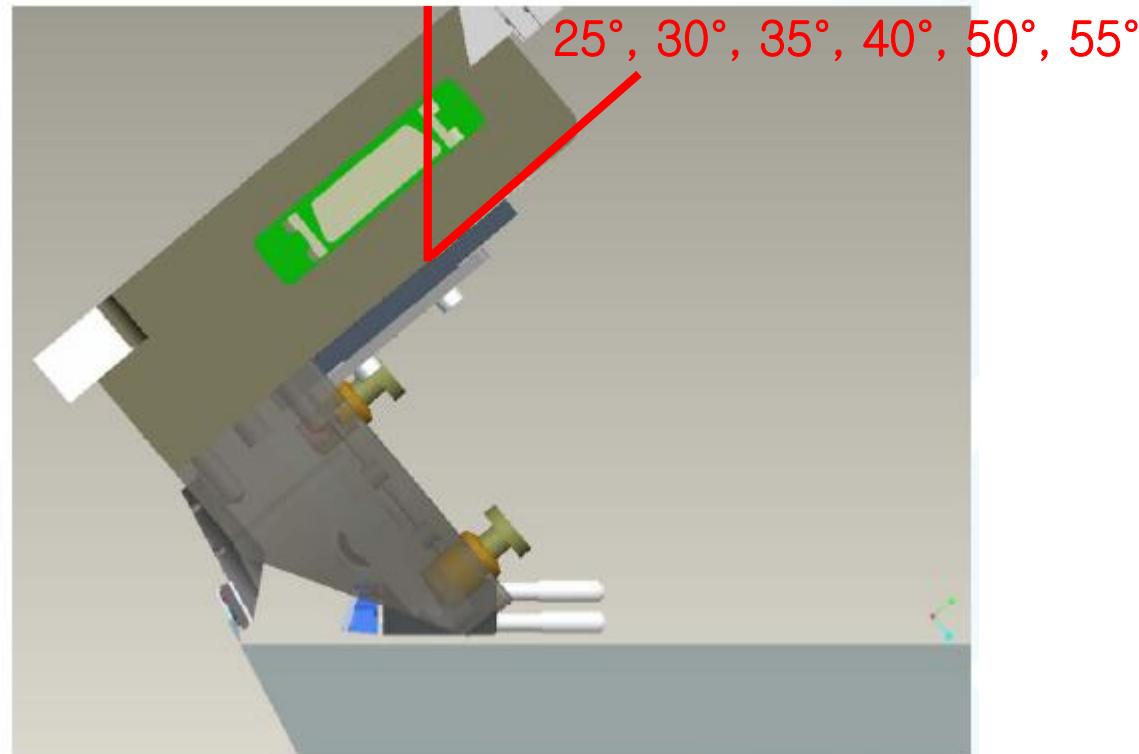


# **Undercut Angle & Roughness measurement (XE-FT & XE-3DM)**



# ***XE-FT (Front tilting head)***

Conceptual design of Front tilting head

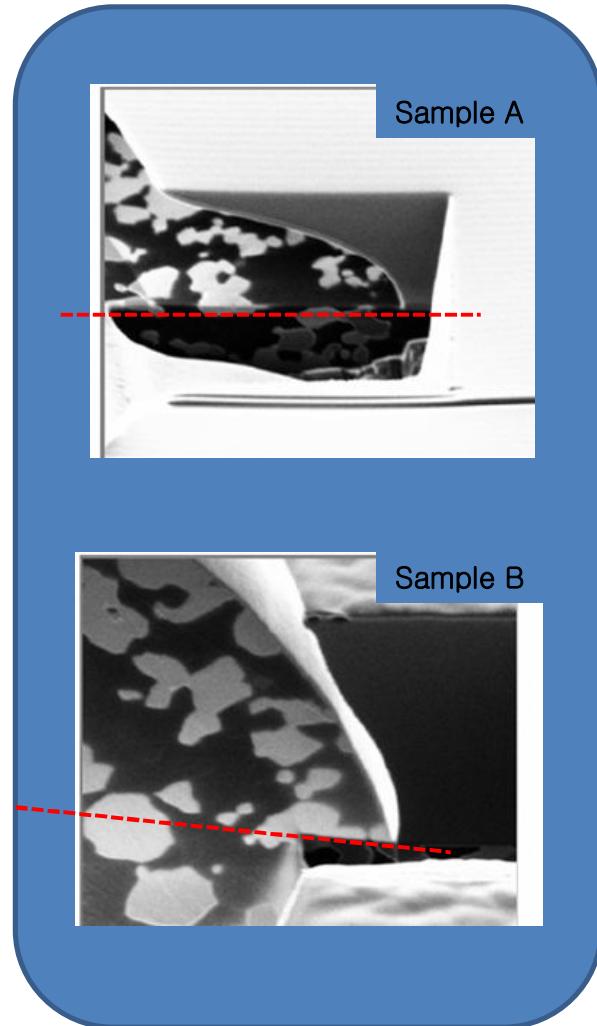


# XE-FT (Front tilting head)

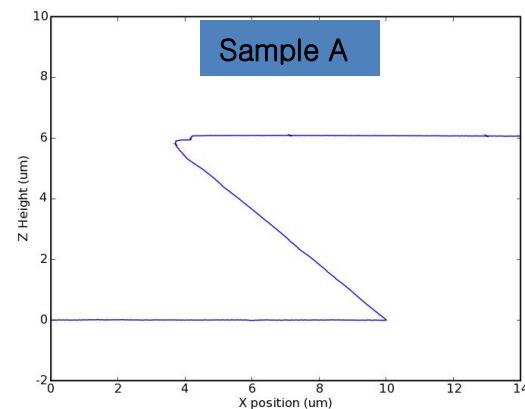


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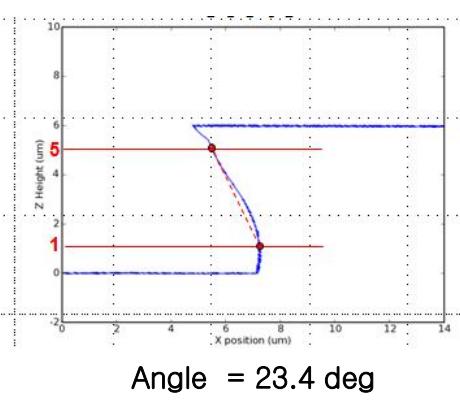
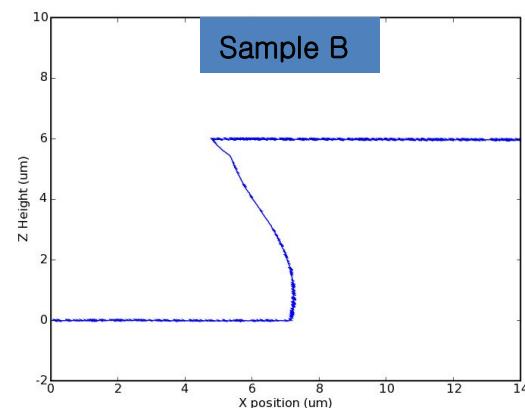
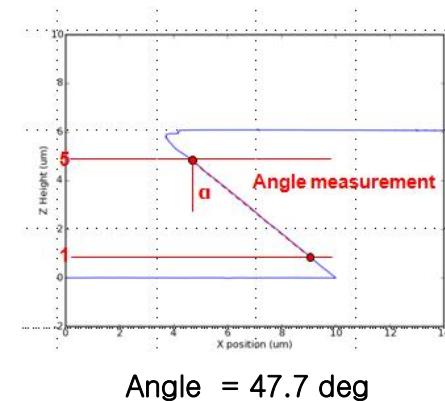
FIB SAM image



Line profiles



Angle measurement

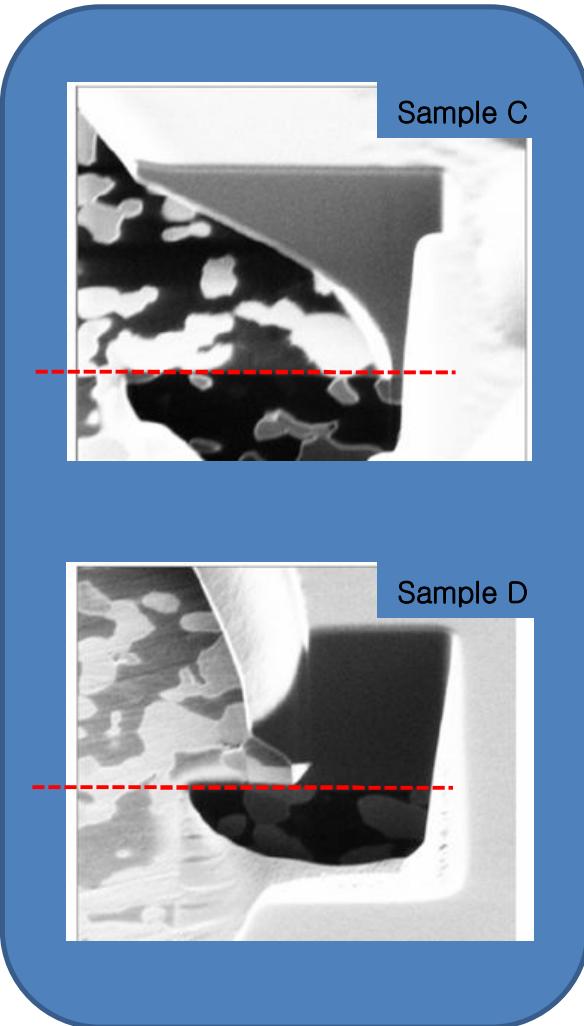


# XE-FT (Front tilting head)

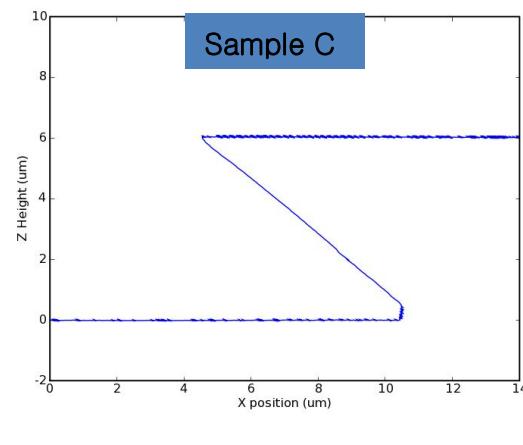


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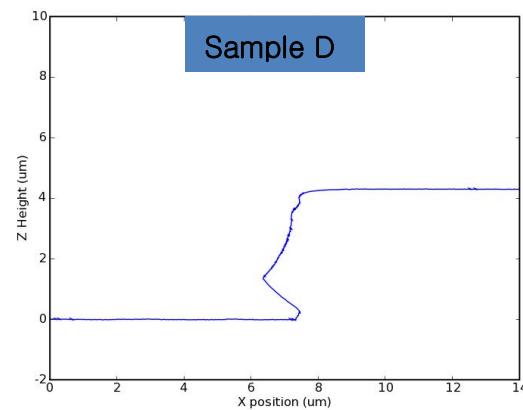
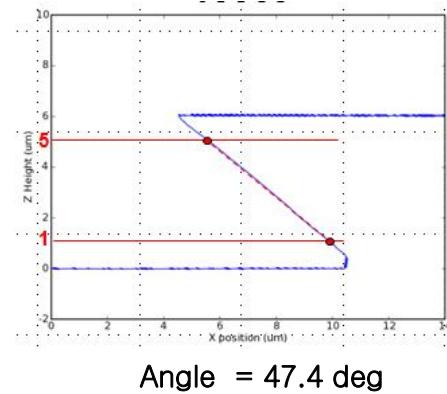
FIB SAM image



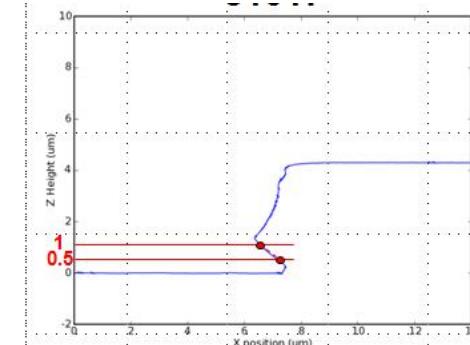
Line profiles



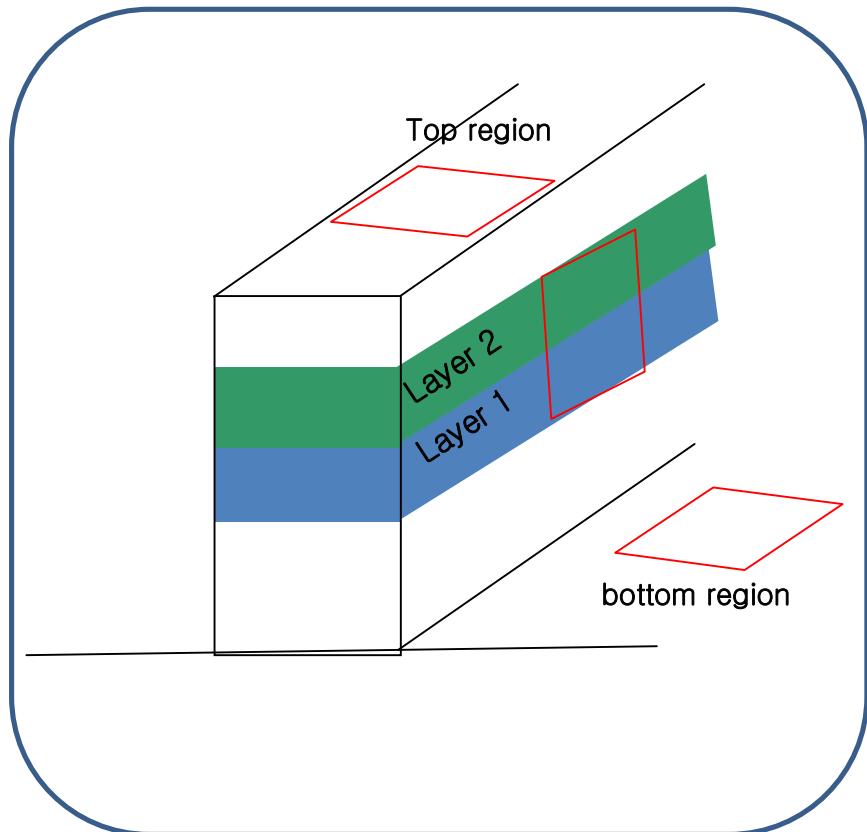
Angle measurement



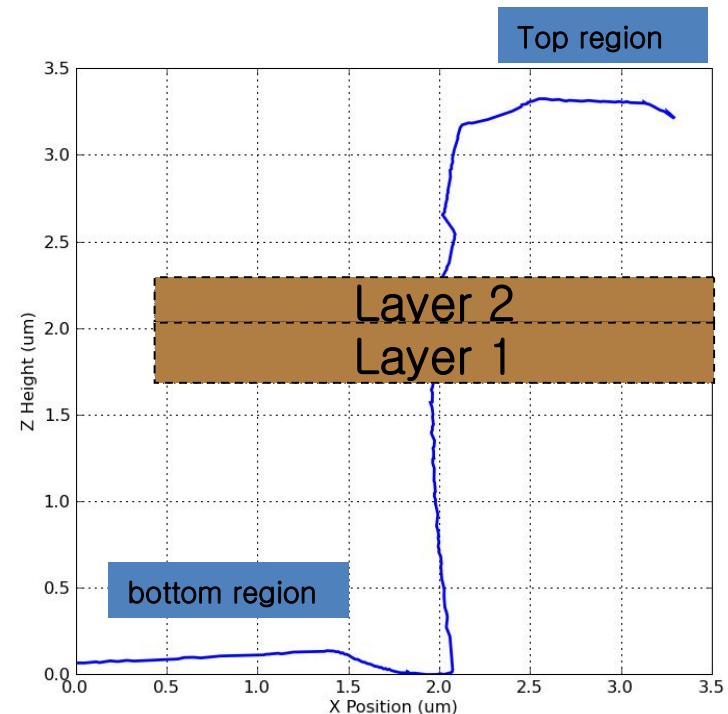
Angle = 48.0 deg



# *XE-FT & XE-3DM\_ Sidewall Roughness*



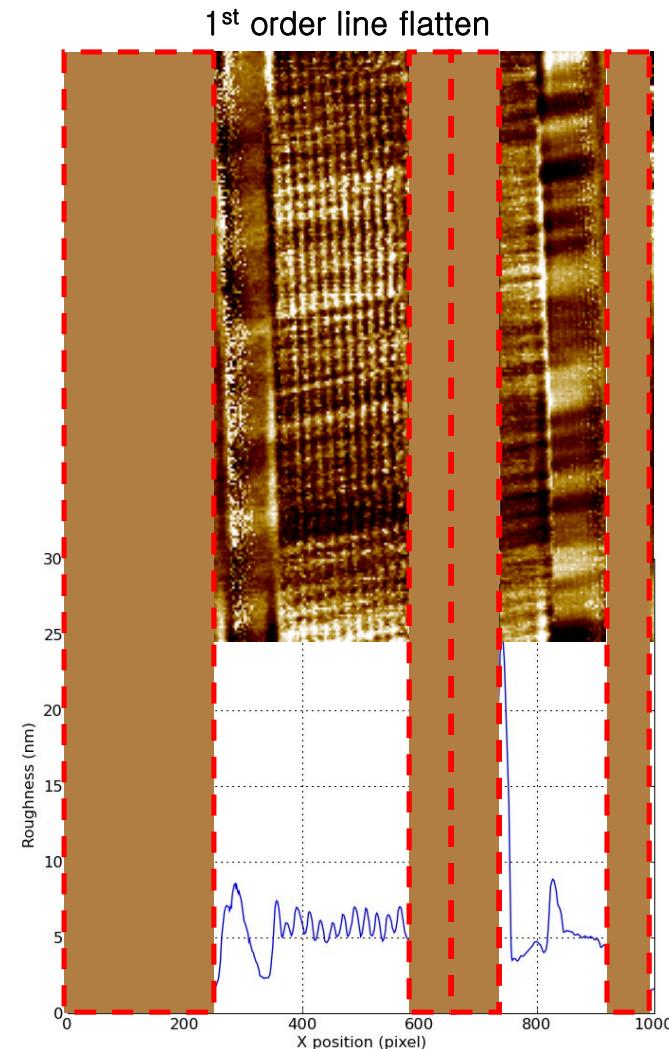
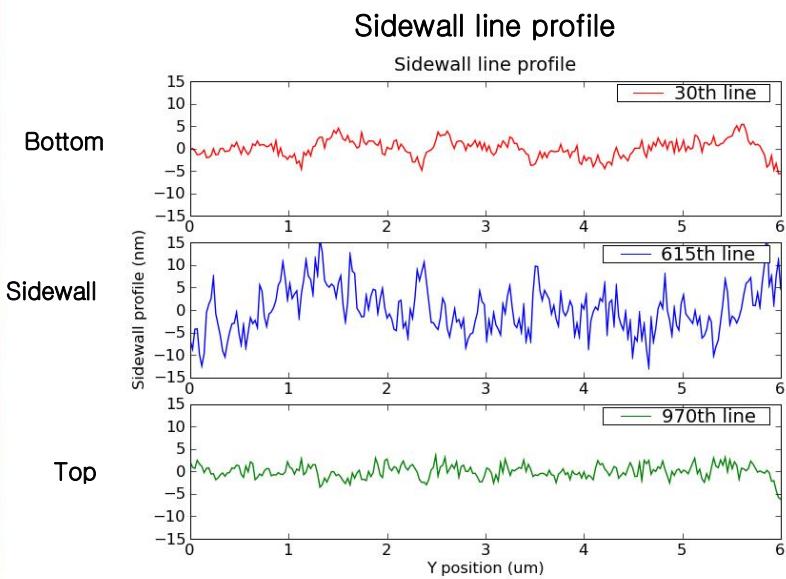
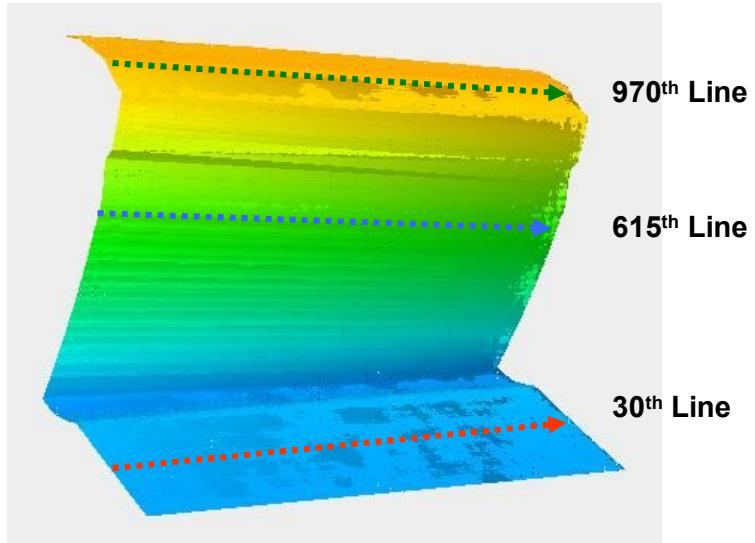
Line profile

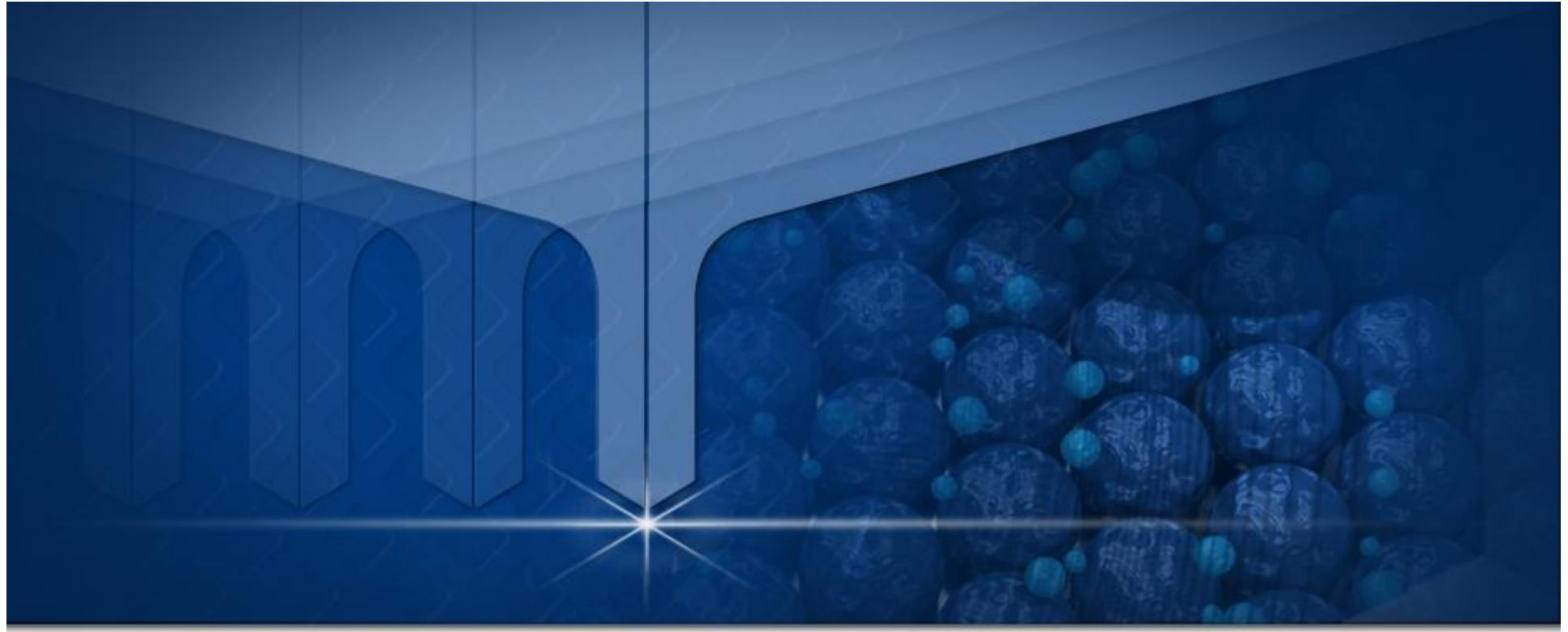


# XE-FT & XE-3DM\_ Sidewall Roughness



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# Biologic and Optical measurement (XE-Bio, NSOM)



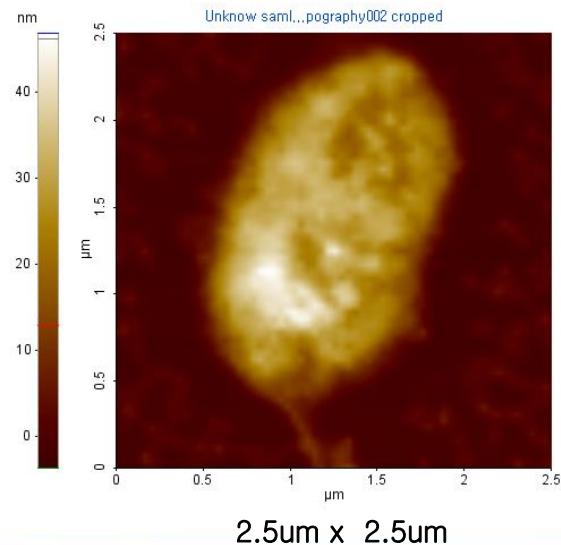
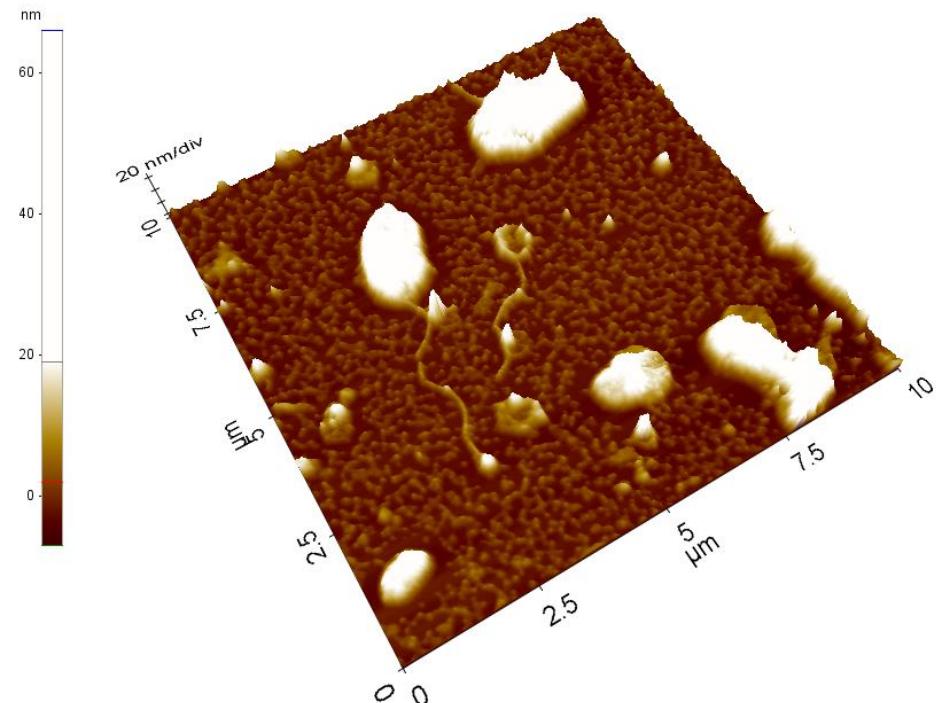
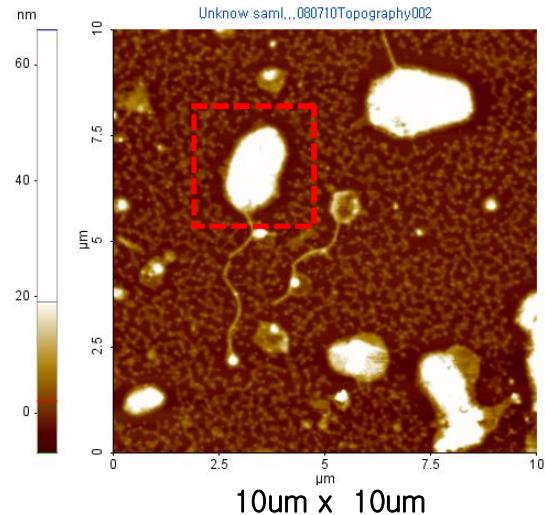
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# Polymerase (in Air)



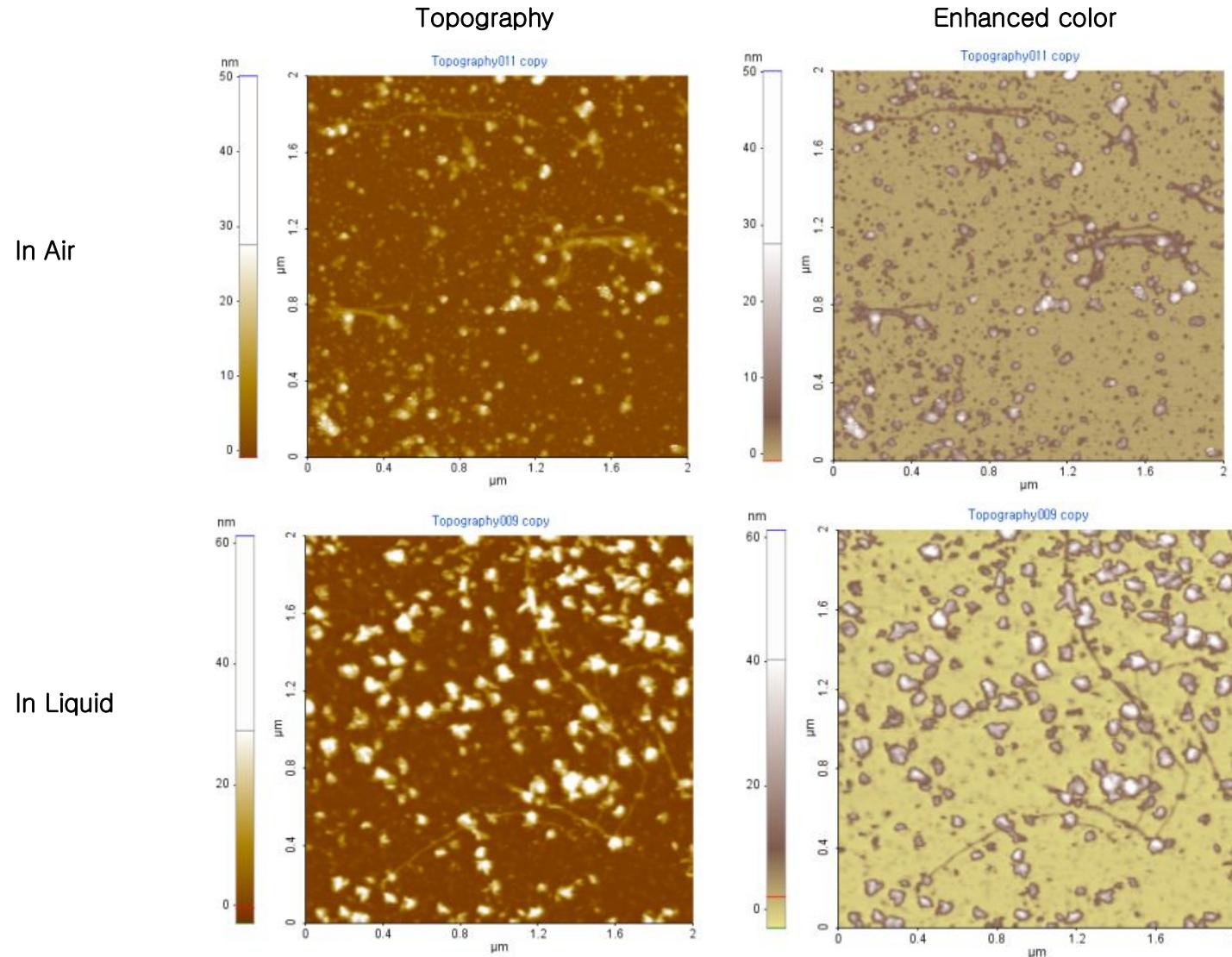
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Topography



1. Samples diluted with distilled water .
2. This was mixed about 10 to 20 seconds by Ultrasonics.
3. Sample was put on the mica and dried 1~2 hours.

# Amyloid fibril ( Air & liquid condition)



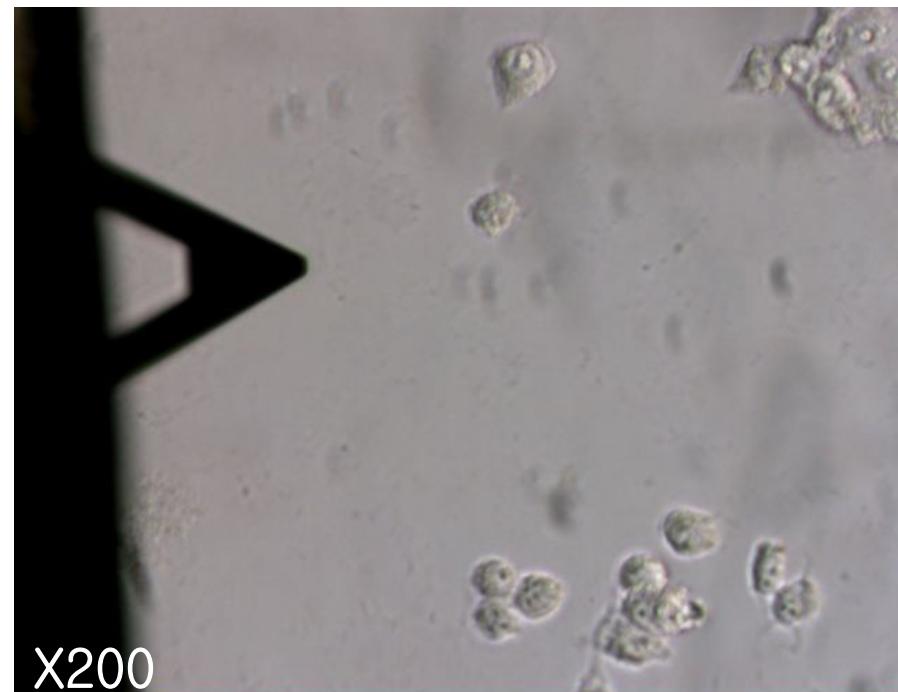
# *Cytoplasm Surface (in Liquid)*



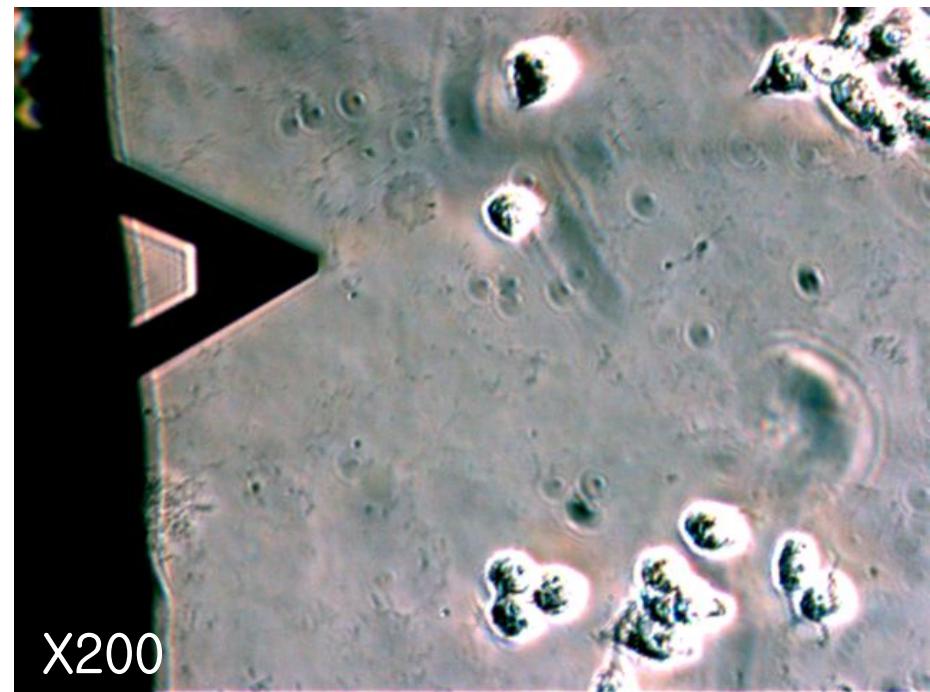
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XE-Bio System

IOM Image (Bright Field Image)



IOM Image (Phase contrast Image)

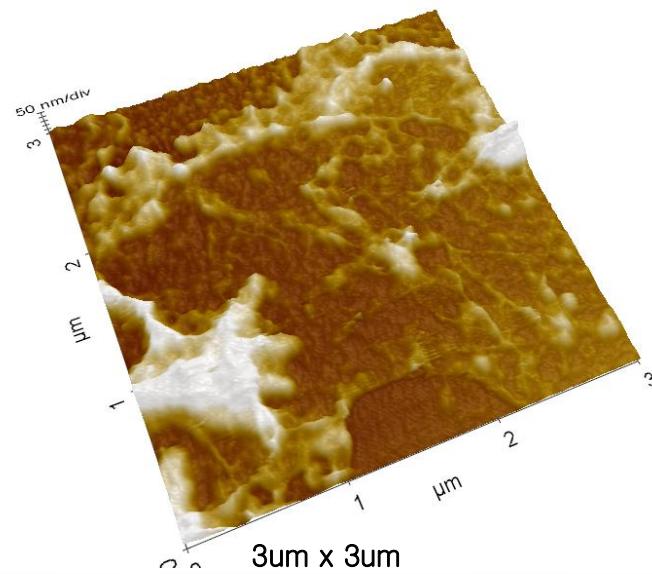
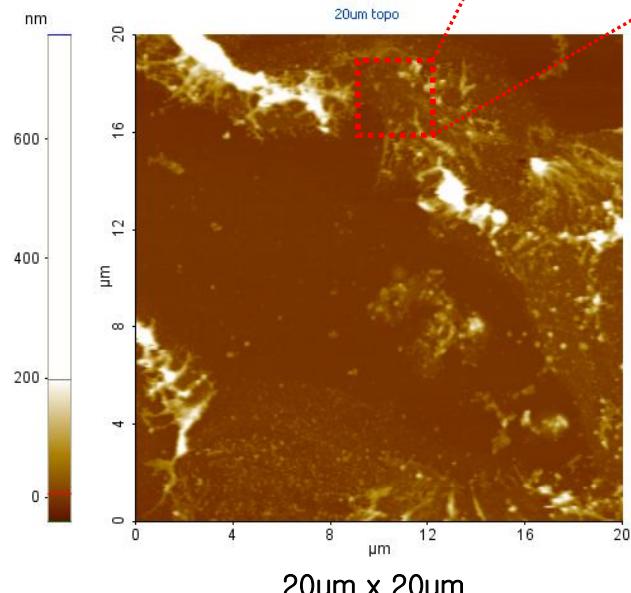
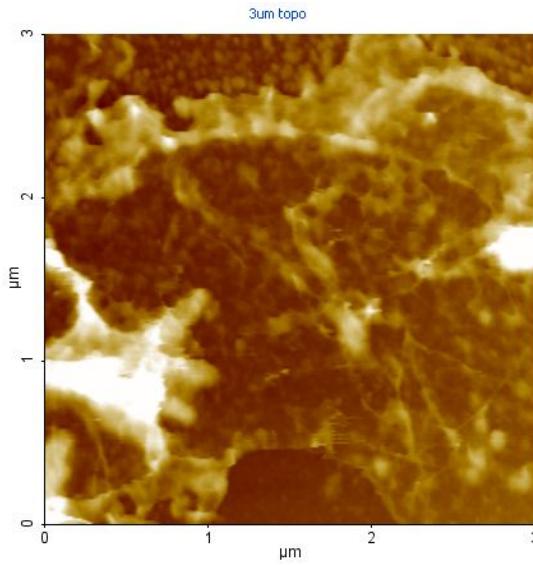
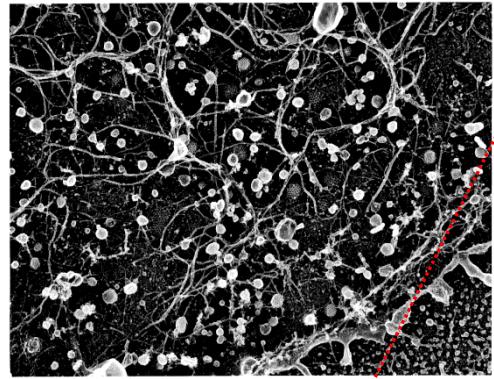


# Cytoplasm Surface (in Liquid, Q controller option)



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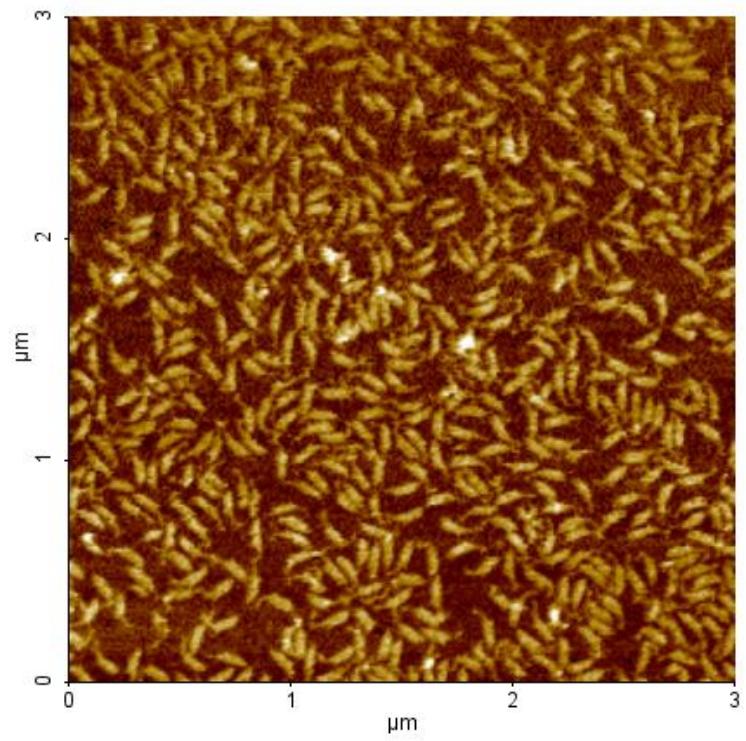
TEM image



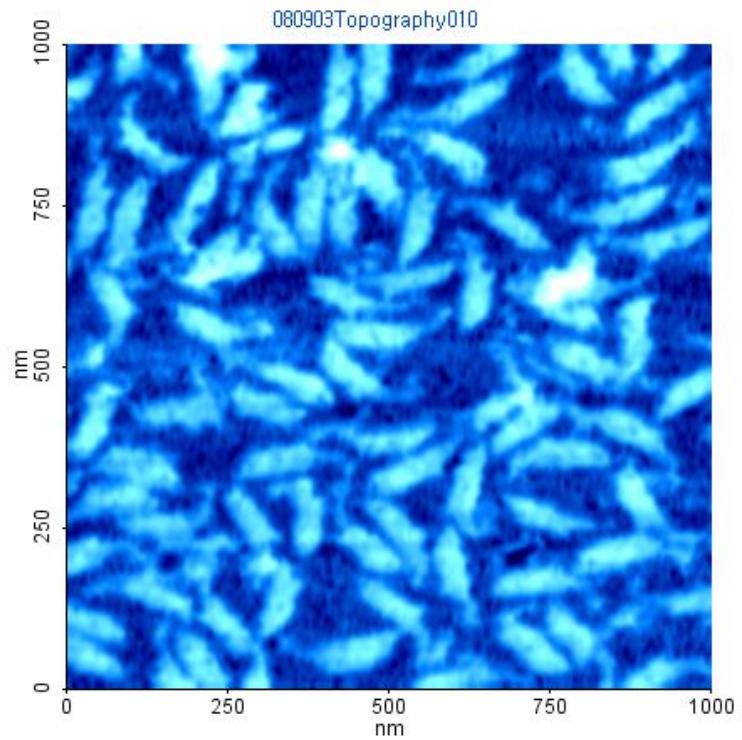
# *Dolphin DNA (in Liquid)*



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3 $\mu\text{m} \times$  3 $\mu\text{m}$



1 $\mu\text{m} \times$  1 $\mu\text{m}$

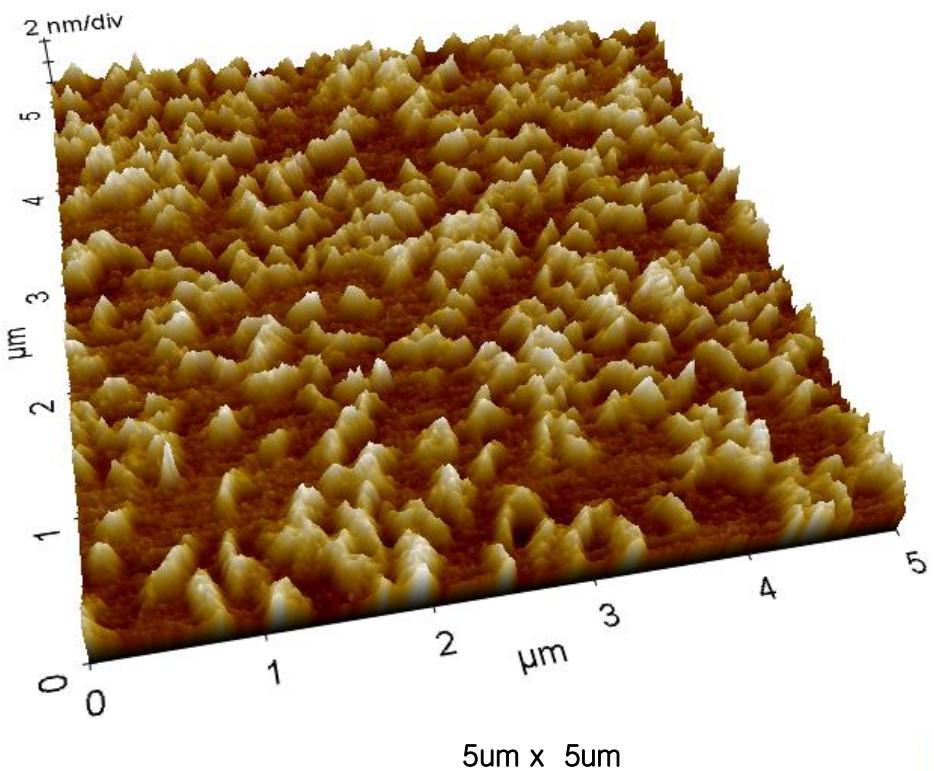
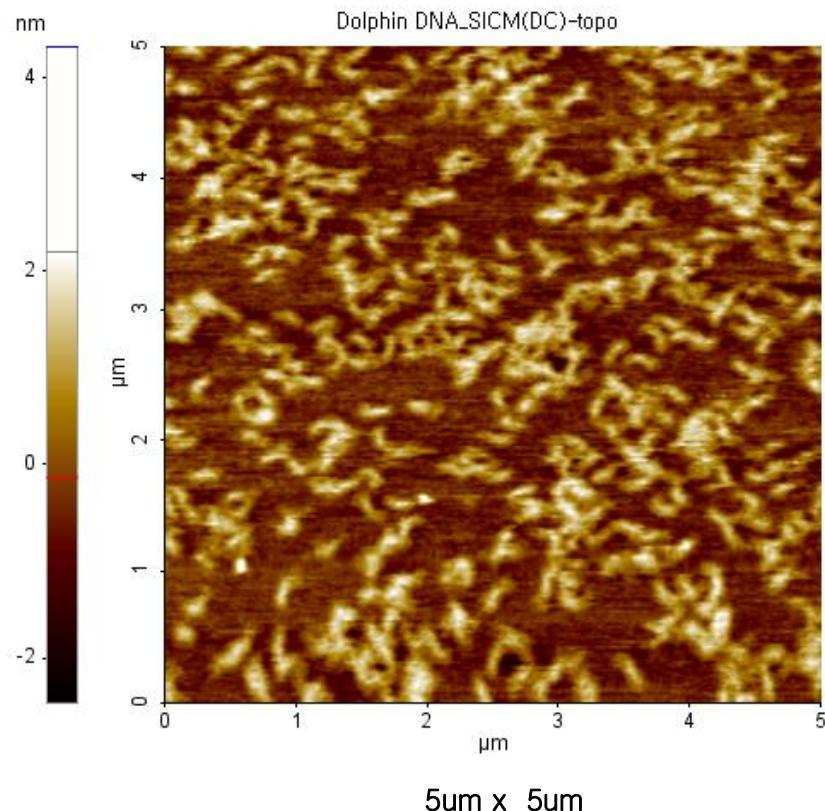
# (SICM\_DC mode) Dolphin DNA

SICM : Scanning Ion conductive Microscopy



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Topography



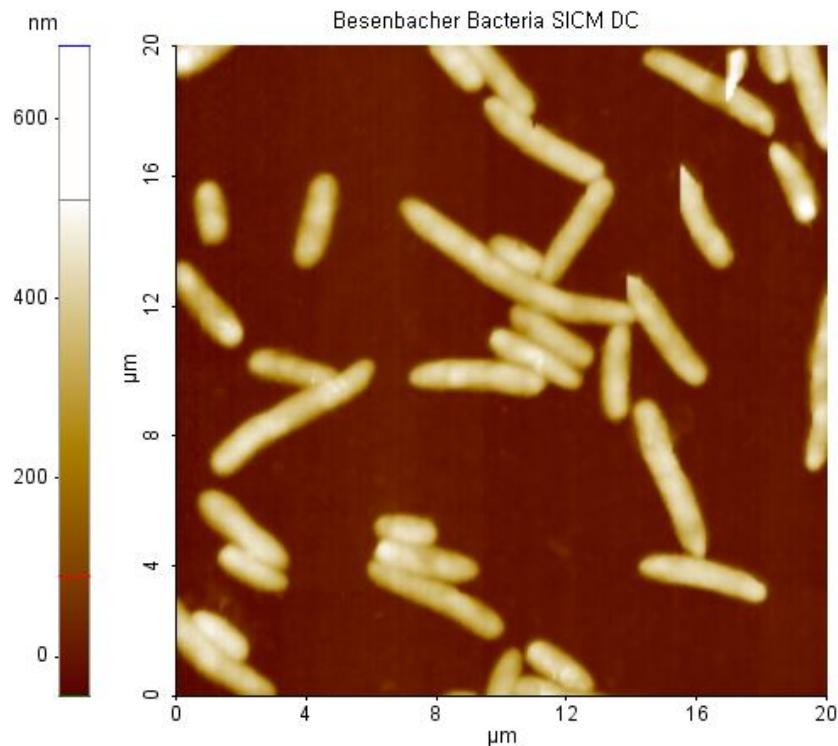
# (SICM\_DC mode) Besenbacher Bacteria

SICM : Scanning Ion conductive Microscopy



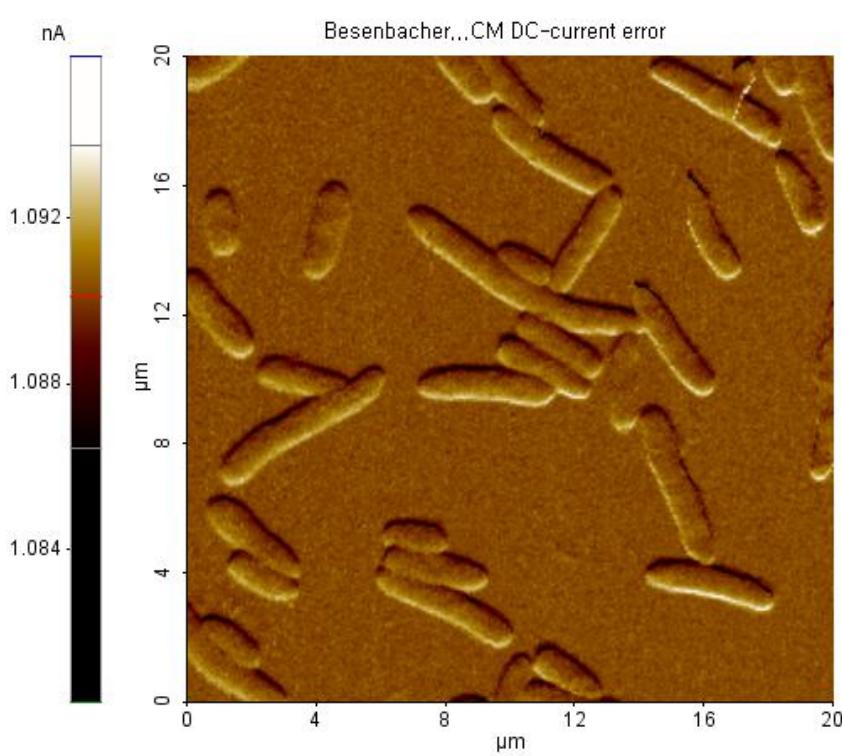
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Topography



20um x 20um

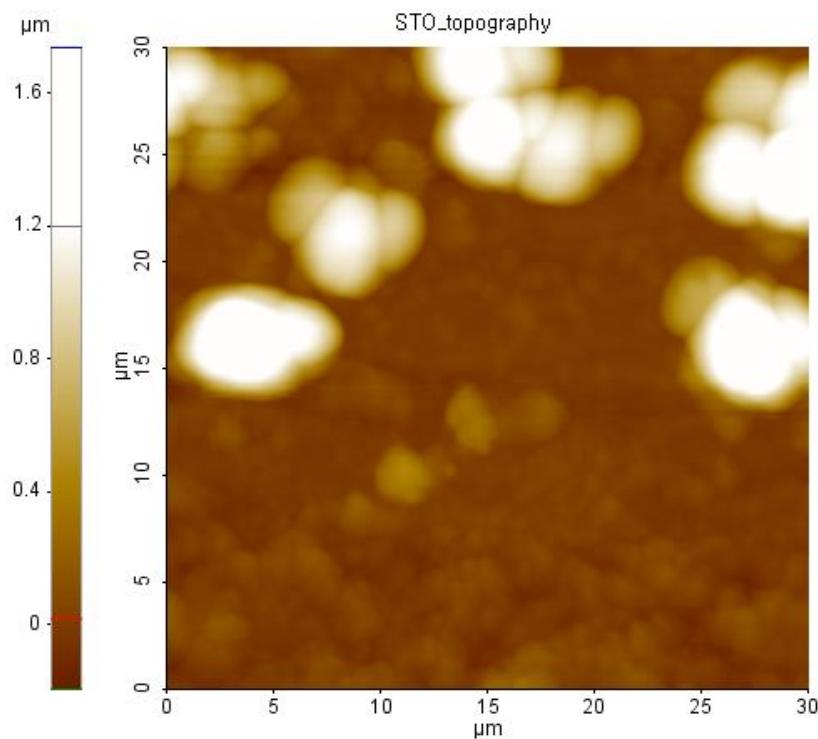
Current error



20um x 20um

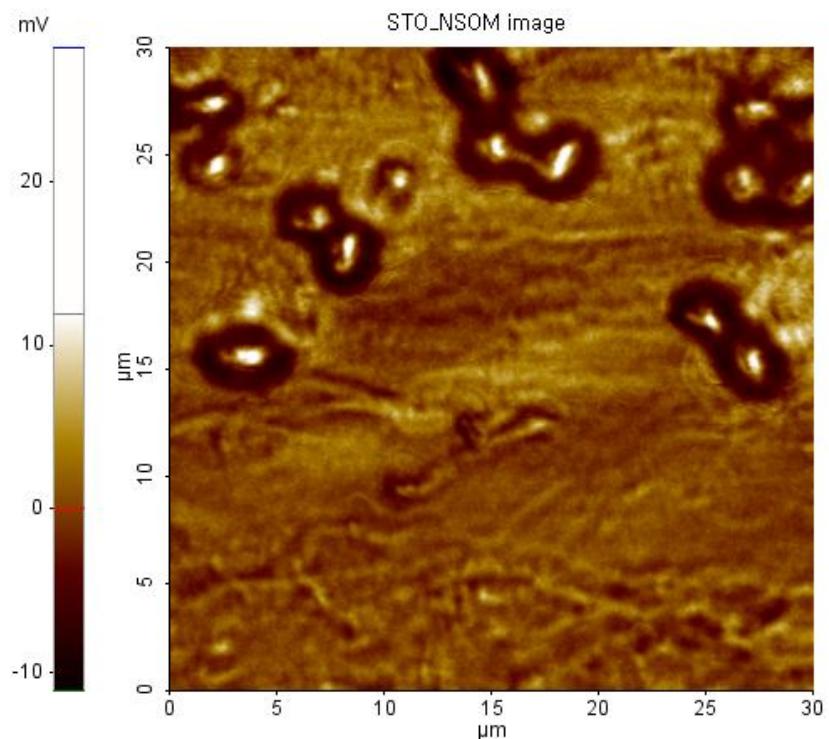
# (NSOM) STO

Topography



30um x 30um

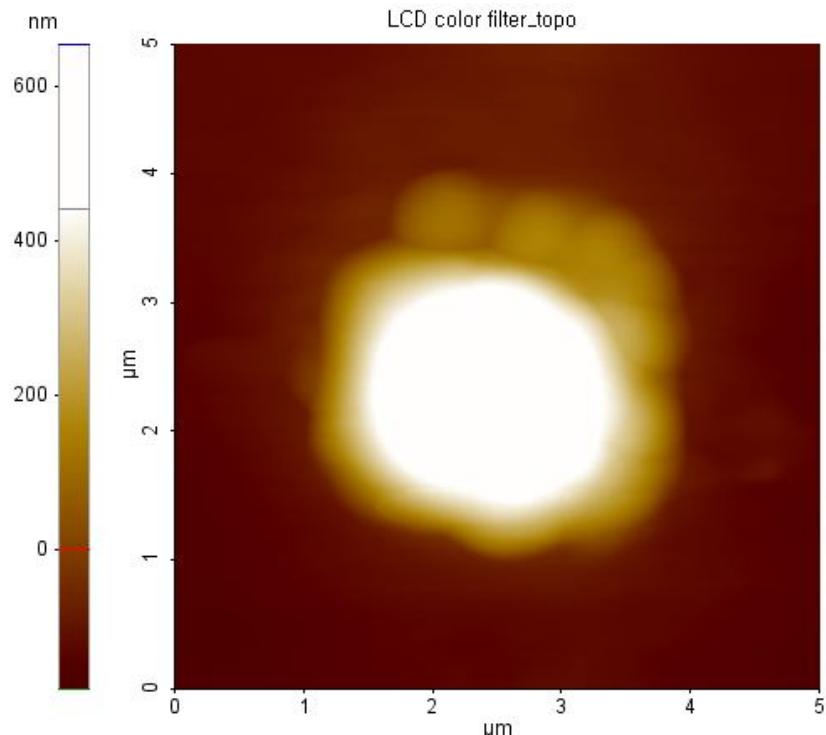
NSOM image



30um x 30um

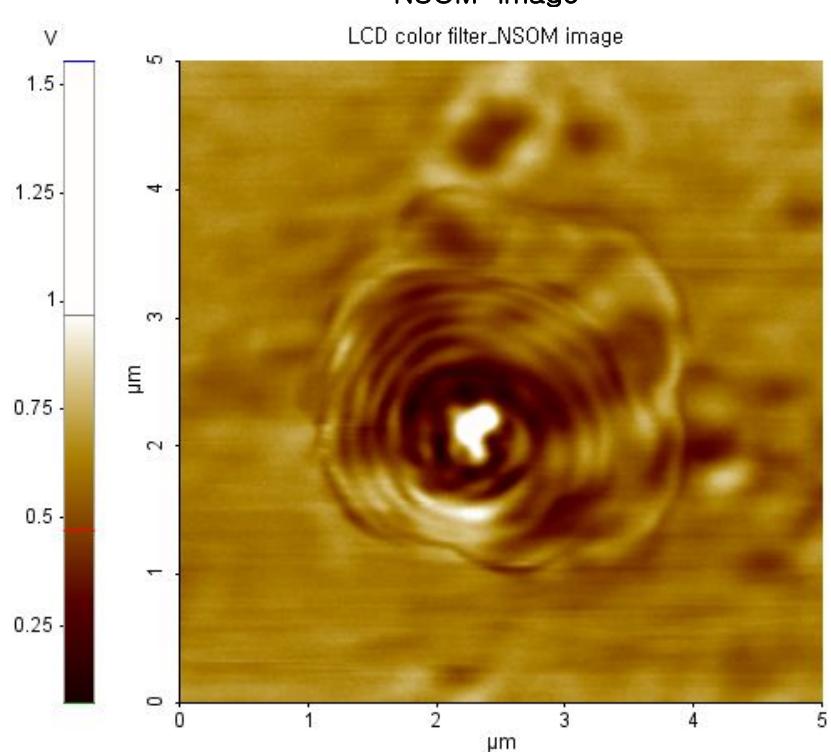
# (NSOM) LCD color filter

Topography



5um x 5um

NSOM image



5um x 5um



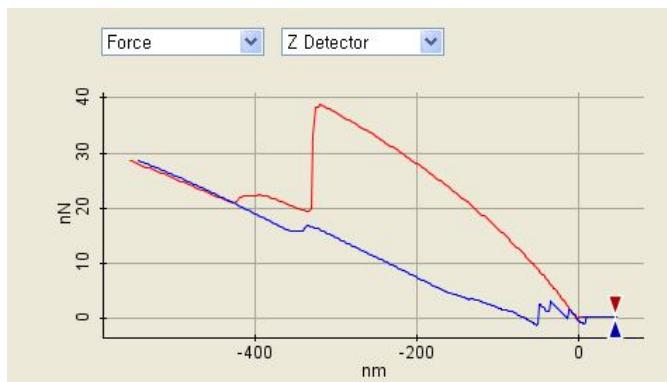
# Option Image (Mechanical Property)



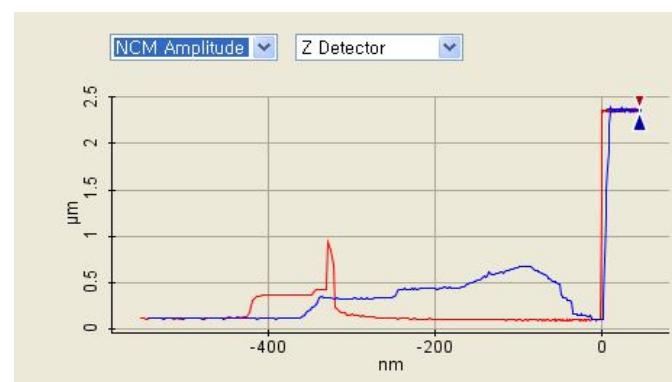
# F/D curve \_CNT cantilever

## Elastic measurement of CNT cantilever

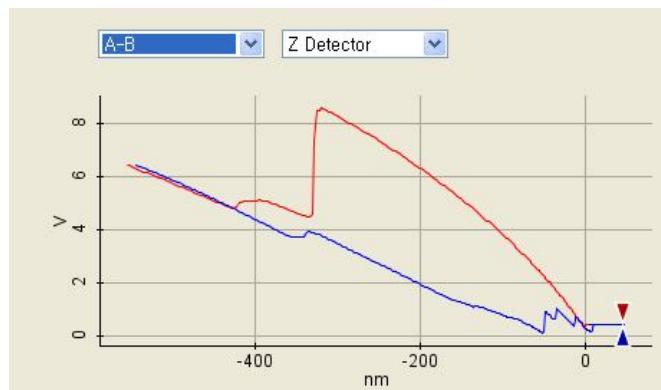
1) Force vs Z detector (Z scanner)



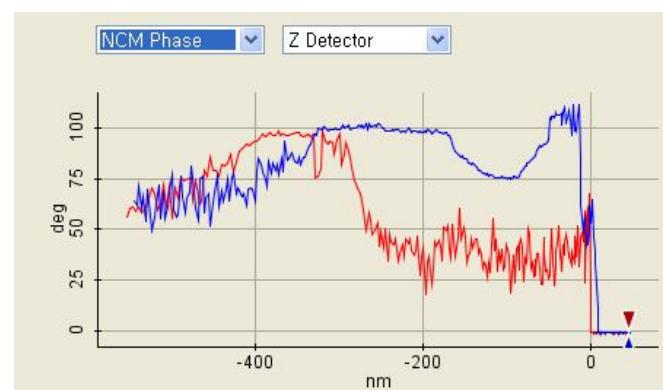
3) NCM Amplitude vs Z detector



2) A-B vs Z detector (Z scanner)

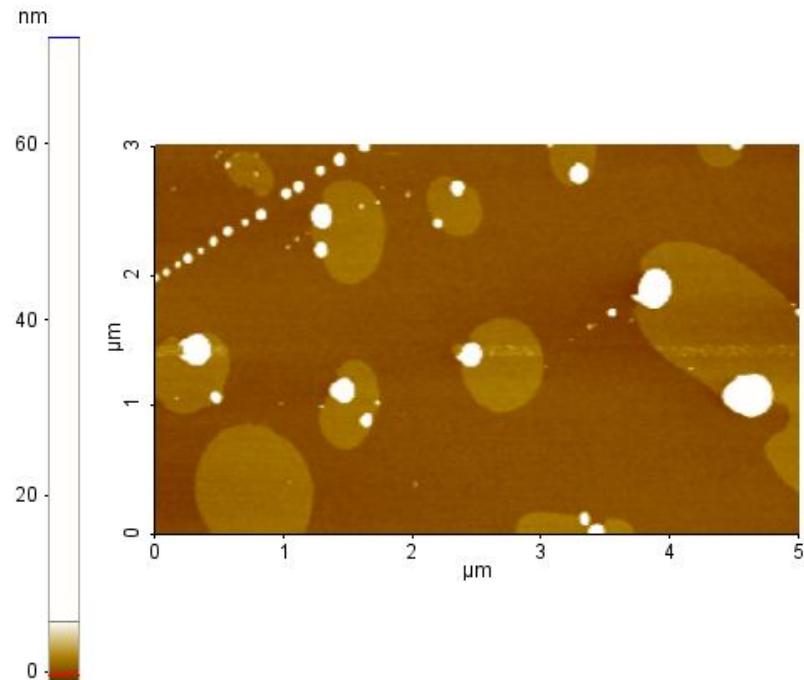


4) NCM Phase vs Z detector

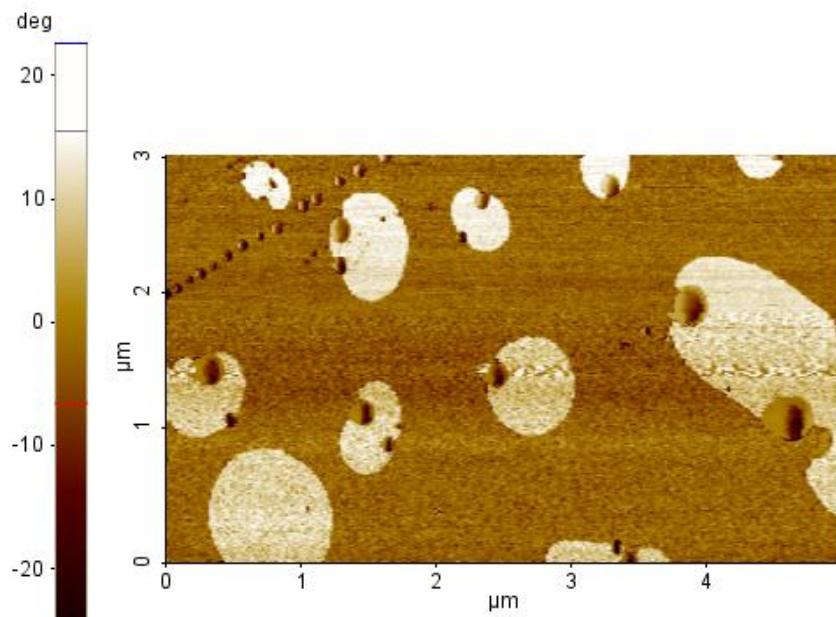


# Embedded Polymer

Topography



Phase image

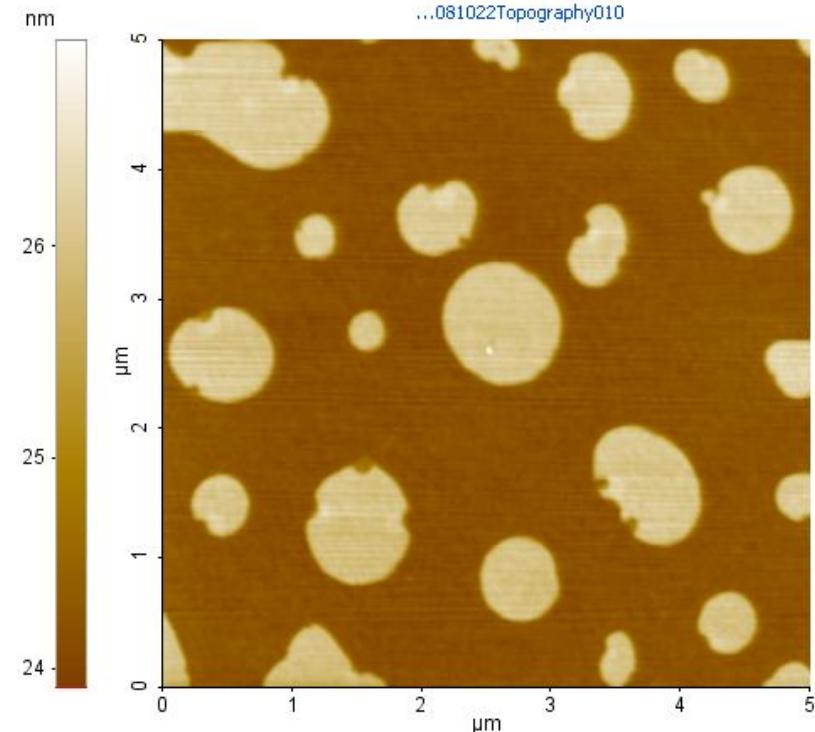


# (FMM)\_ Embedded Polymer

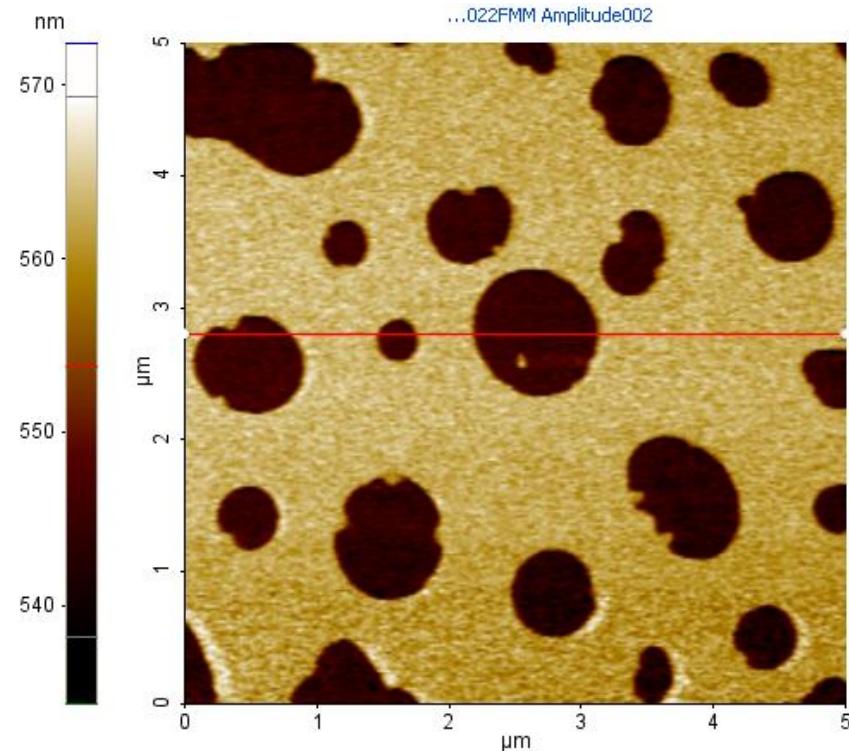


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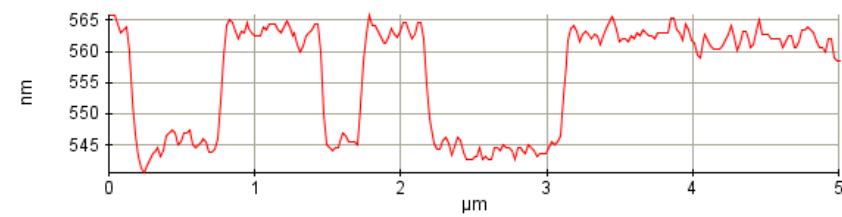
Topography



FMM Amplitude

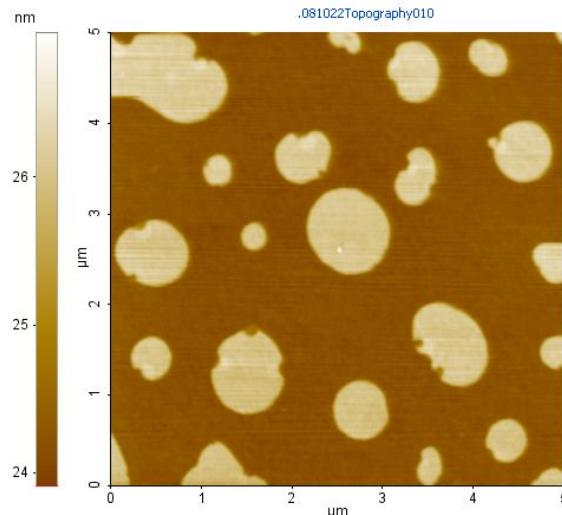


Line Profile: Red - 144

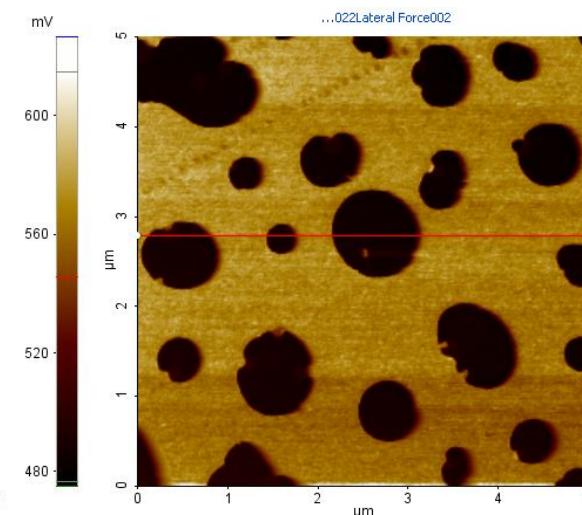


# *(LFM )\_ Embedded Polymer*

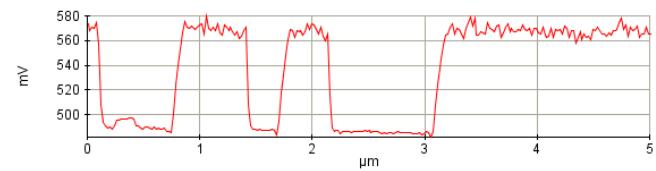
Topography



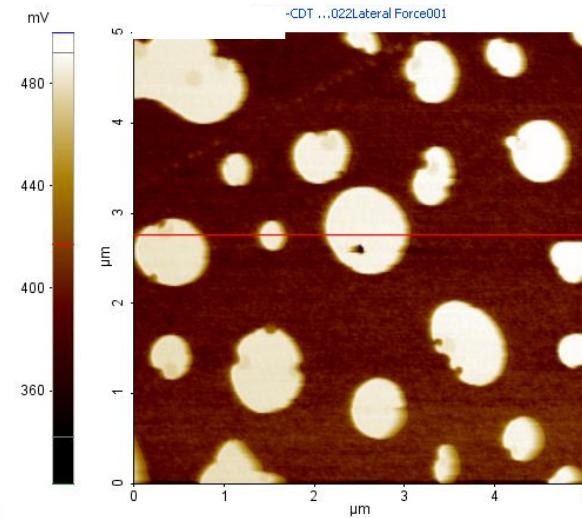
LFM Forward



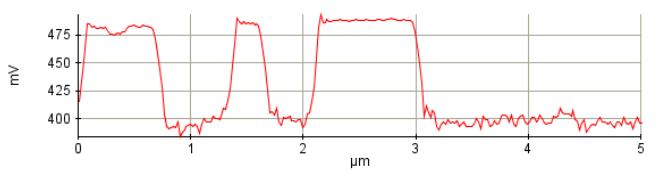
Line Profile: Red - 143



LFM Backward



Line Profile: Red - 142

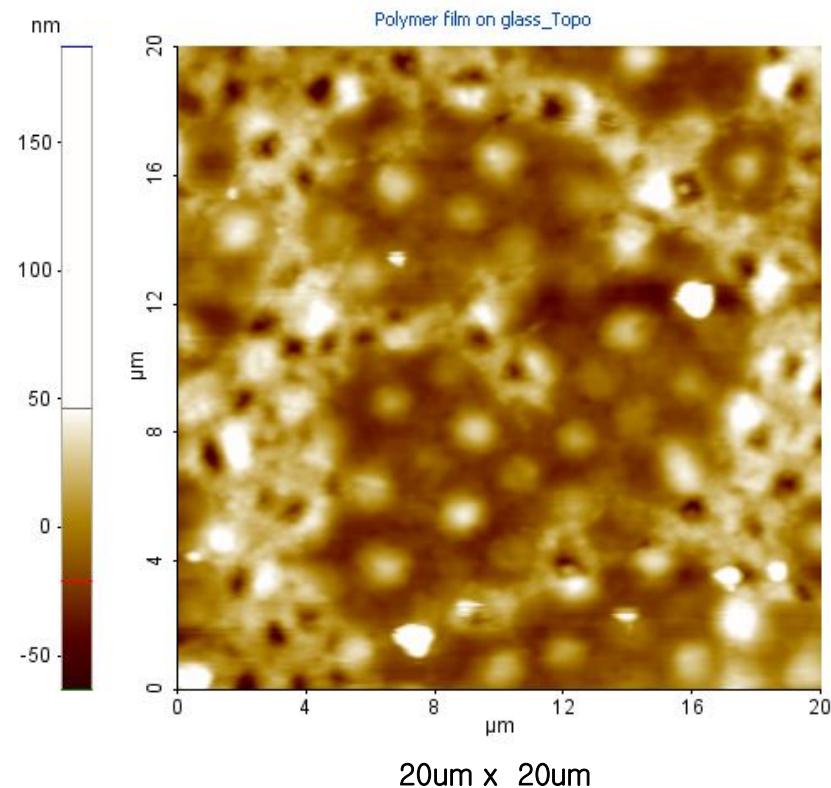


# (FMM )\_Polymer on Glass

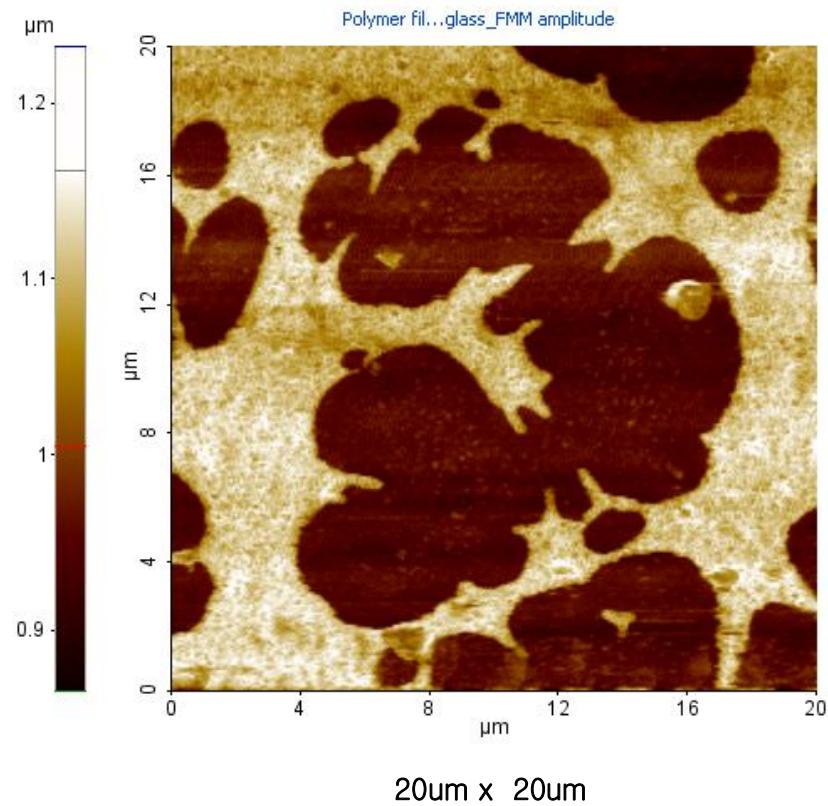


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Topography



FMM Amplitude

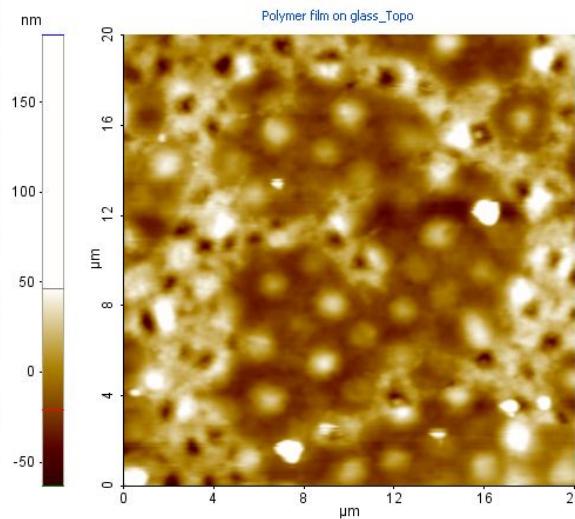


# (LFM )\_Polymer on Glass

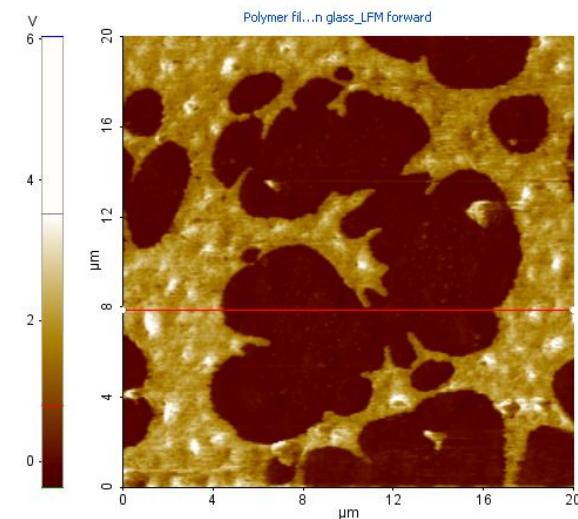


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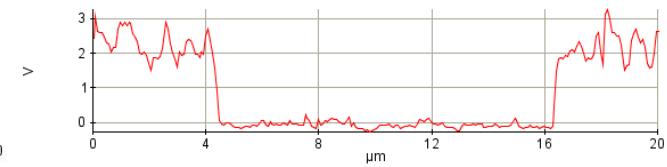
Topography



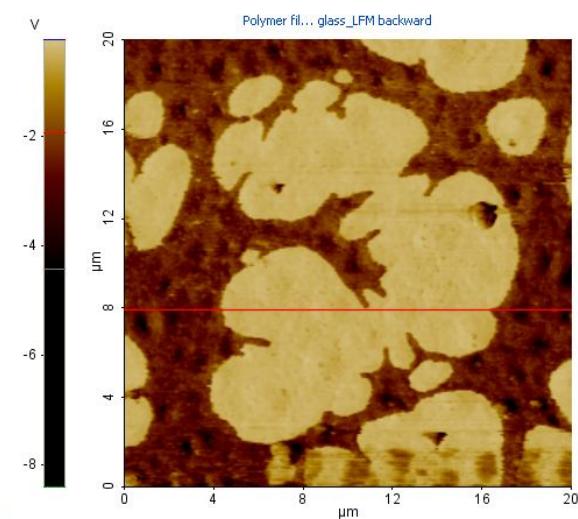
LFM Forward



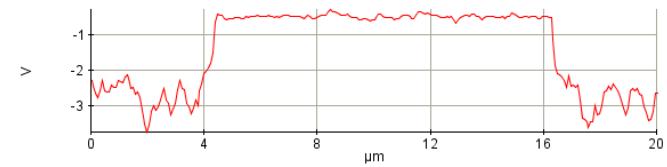
Line Profile: Red - 101



LFM Backward



Line Profile: Red - 102



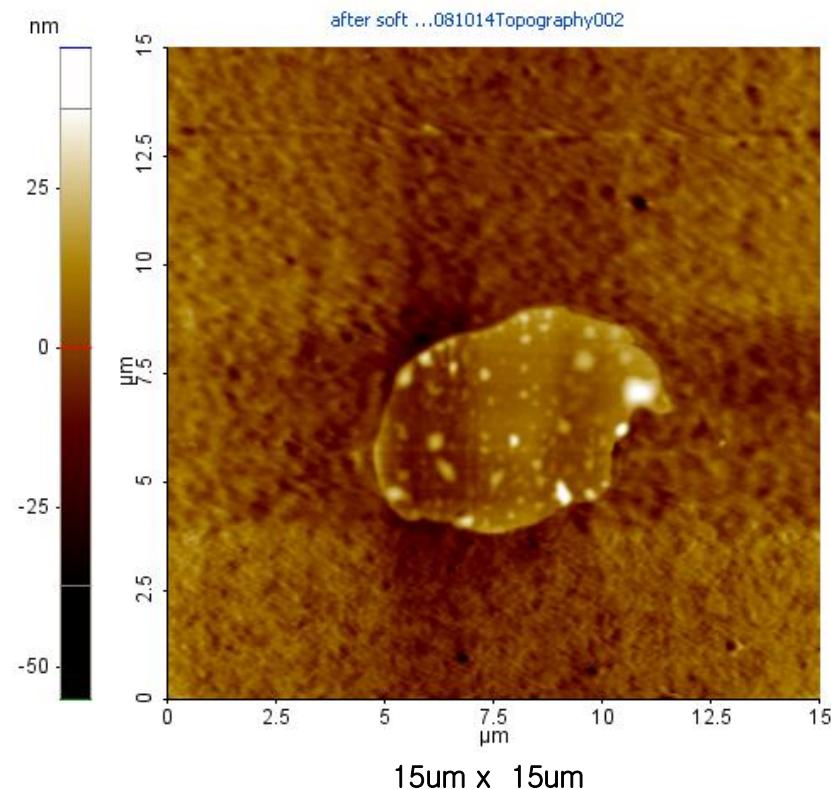
# (FMM)\_ Embedded Polymer ball in Plastic.



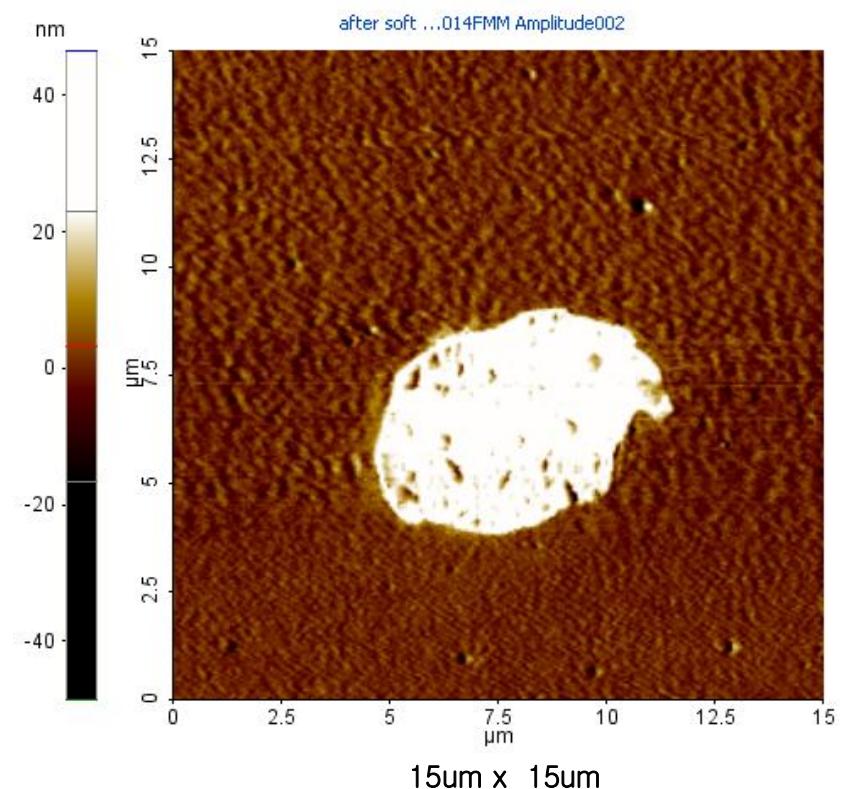
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Micro-ball is more hard than reference region from the FMM data.

Topography



FMM Amplitude

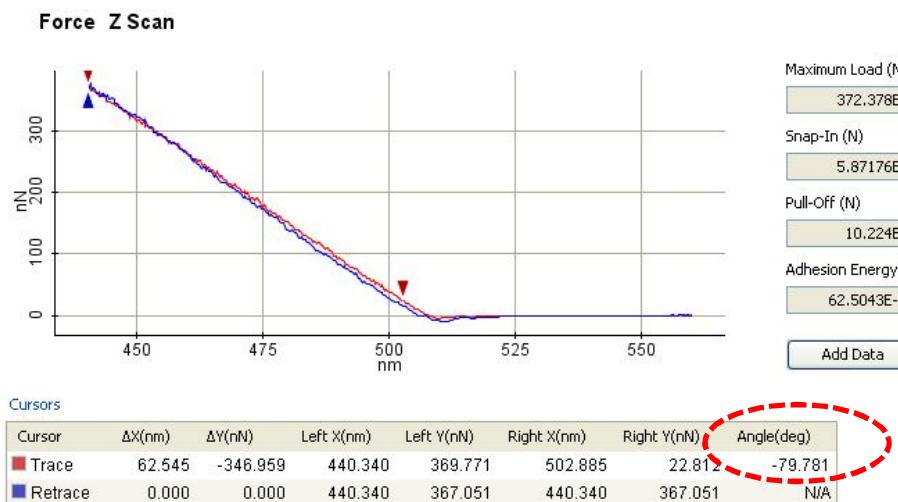
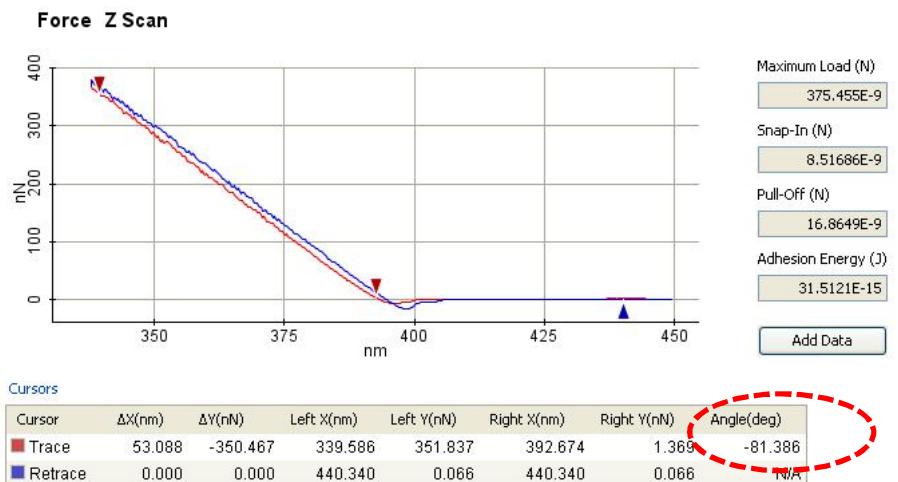
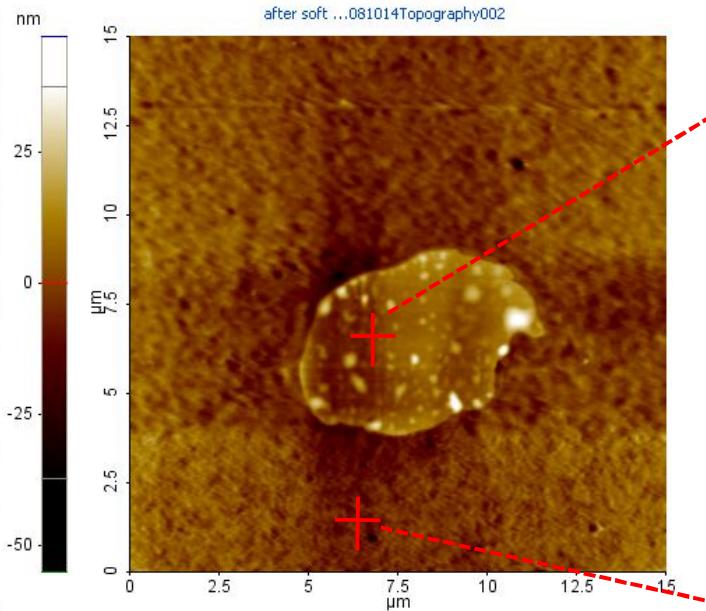


# (F/D curve) \_ Embedded Polymer ball in Plastic.



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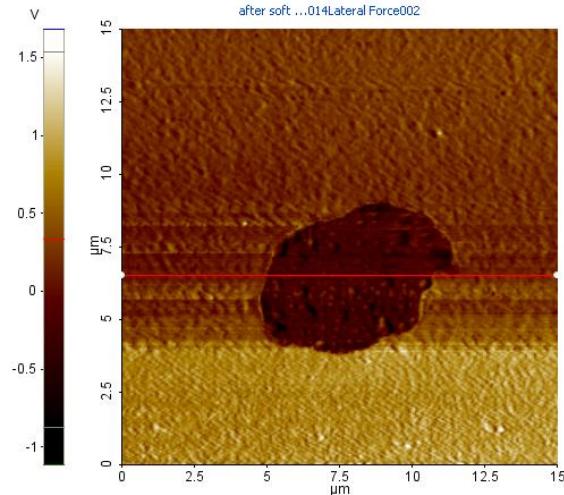
Micro-ball is more hard than reference region from the F/D result.



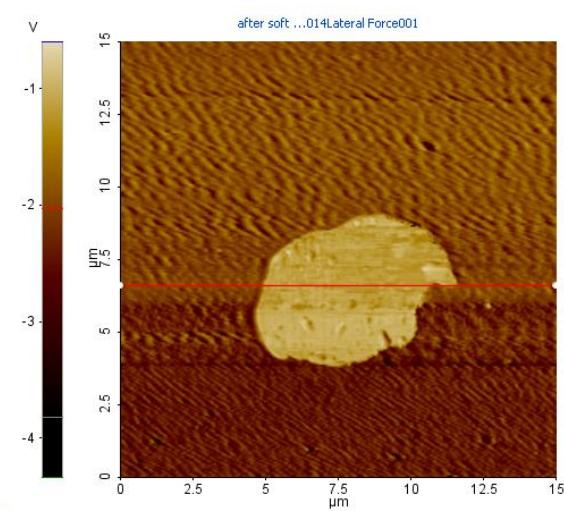
# *(LFM) – Embedded Polymer ball in Plastic.*

- Friction force of the micro-ball is more small than reference region

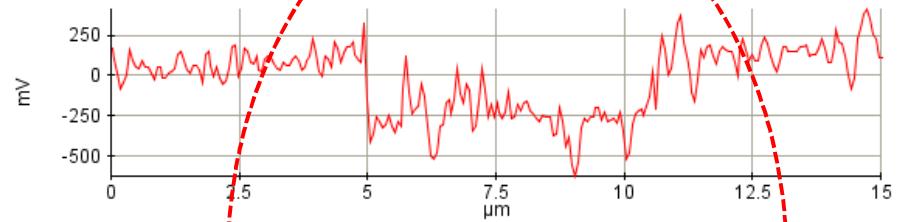
LFM Forward data



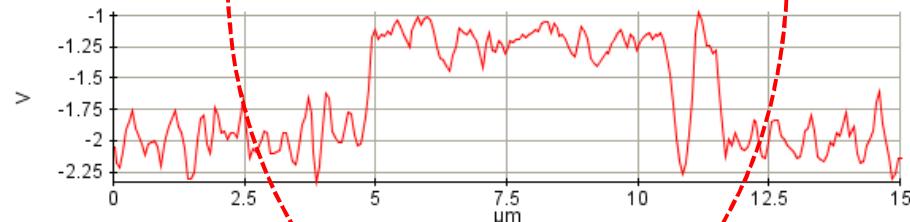
LFM Forward data



Line Profile: Red - 112



Line Profile: Red - 113

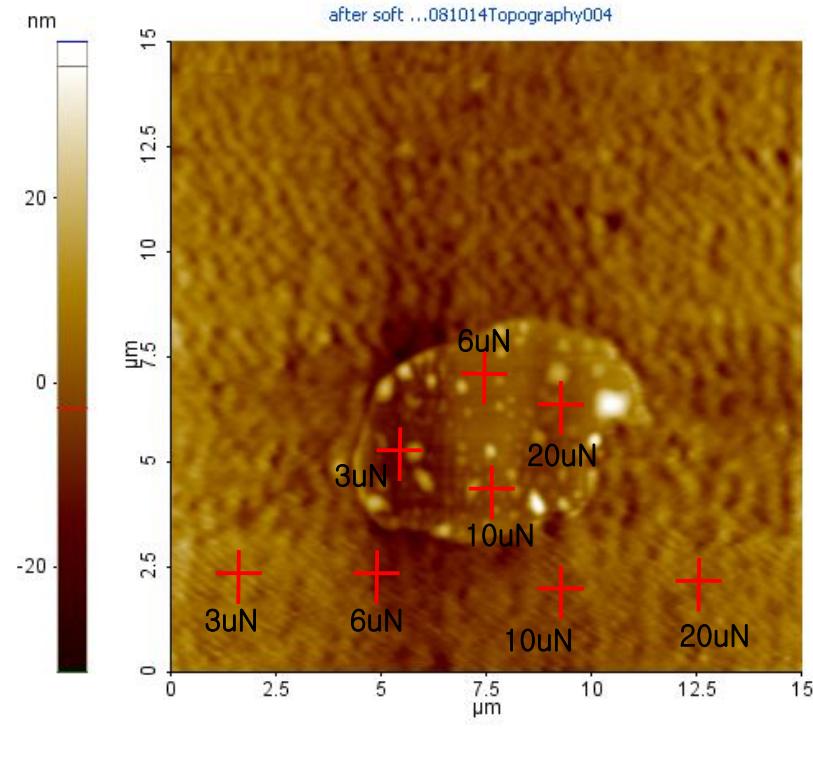


# (Indentation)\_ Embedded Polymer ball in Plastic.

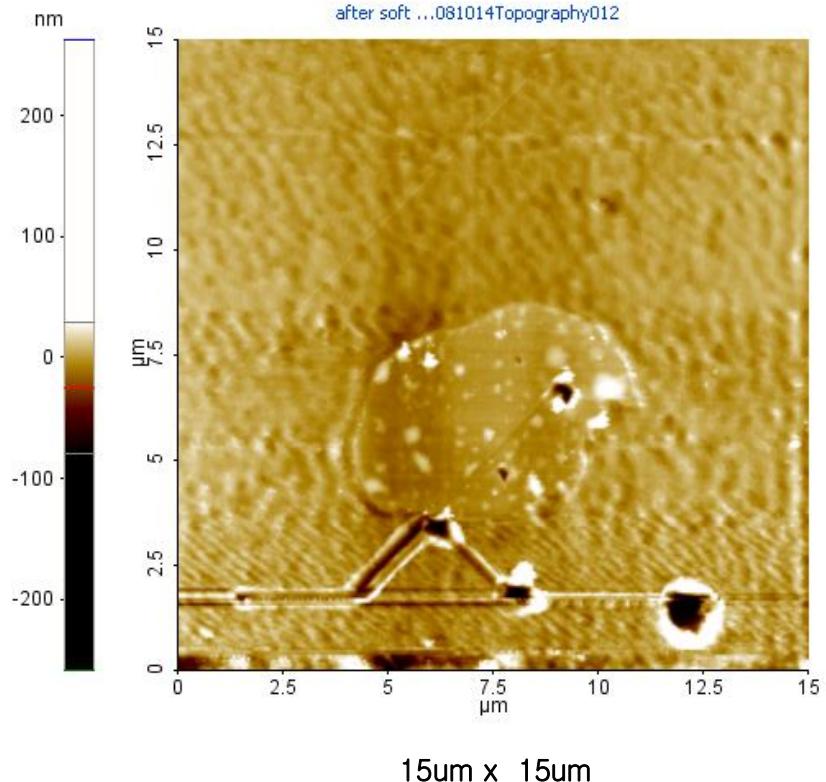


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Before nano Indentation



After nano Indentation

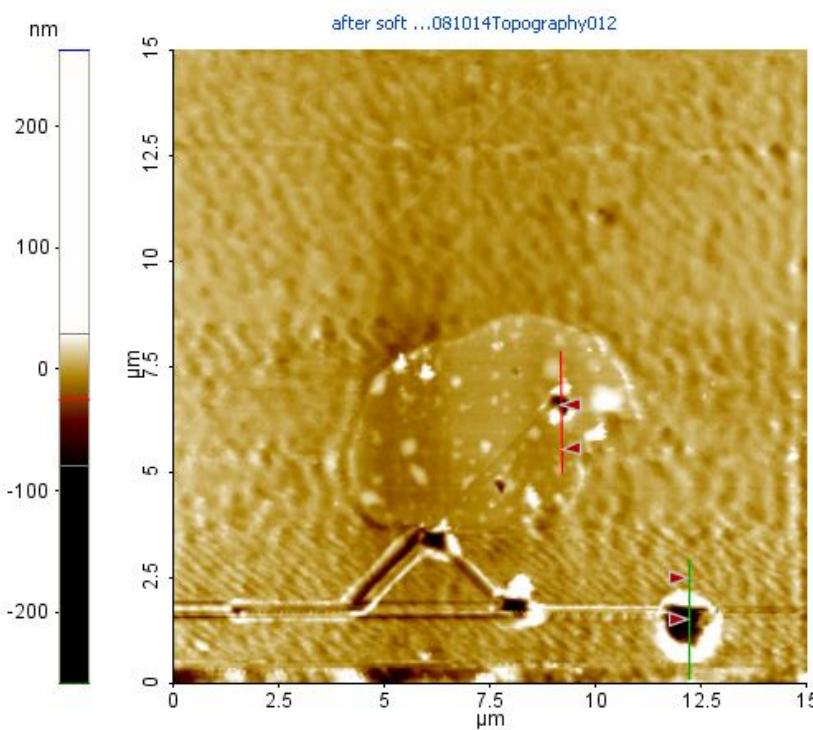


# (Indentation)\_ Embedded Polymer ball in Plastic.

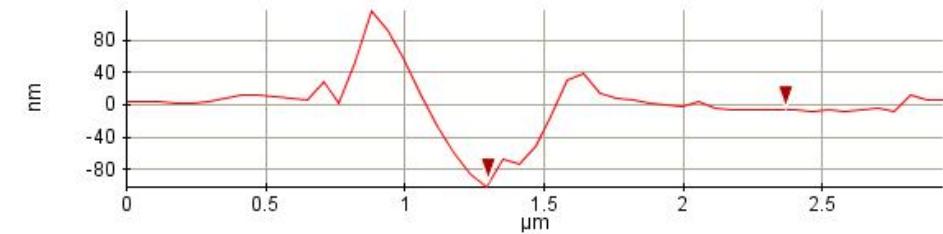


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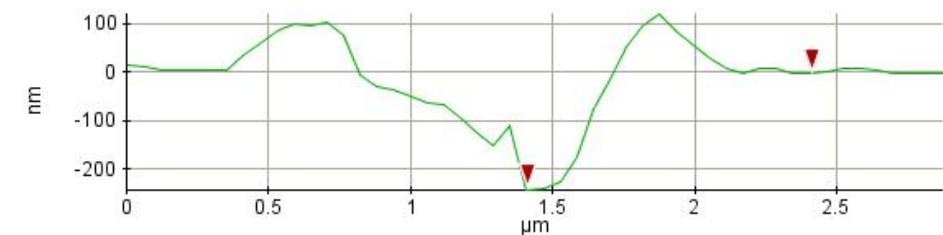
Micro-ball is more hard than reference region from the Indentation result.



Line Profile: Red



Line Profile: Green

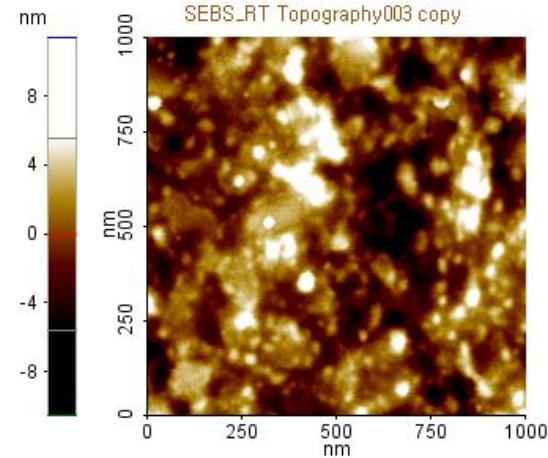


# (Heating stage)\_SEBS image depending on Temp

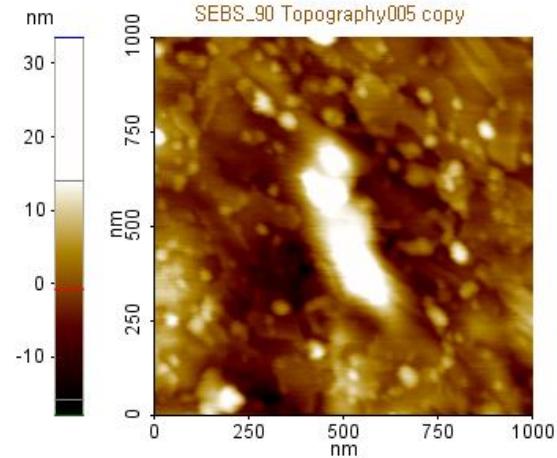


Nanotechnology Solutions Partner

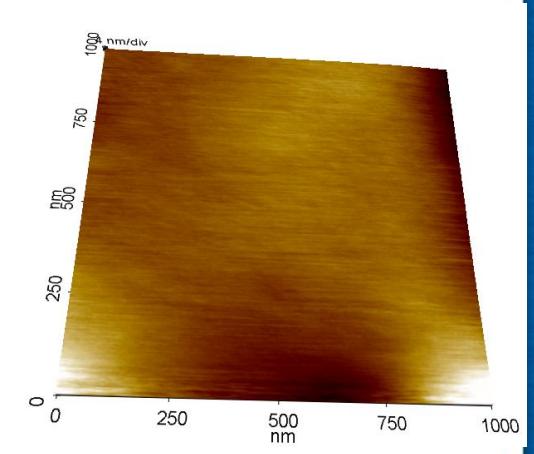
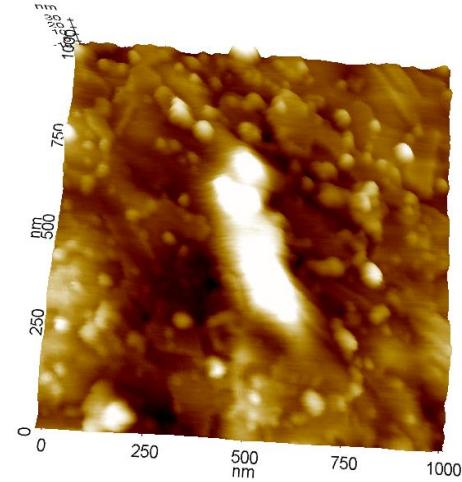
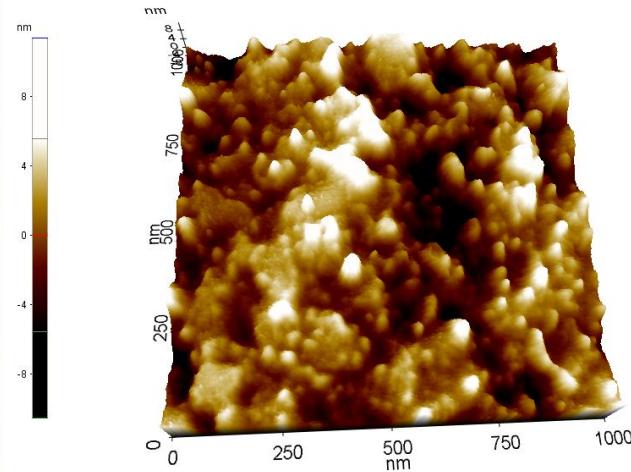
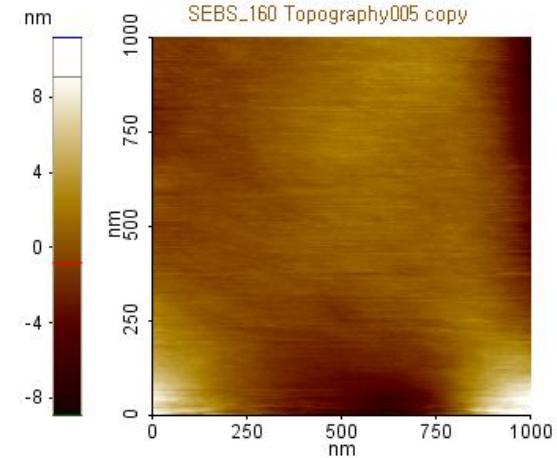
Room temp.

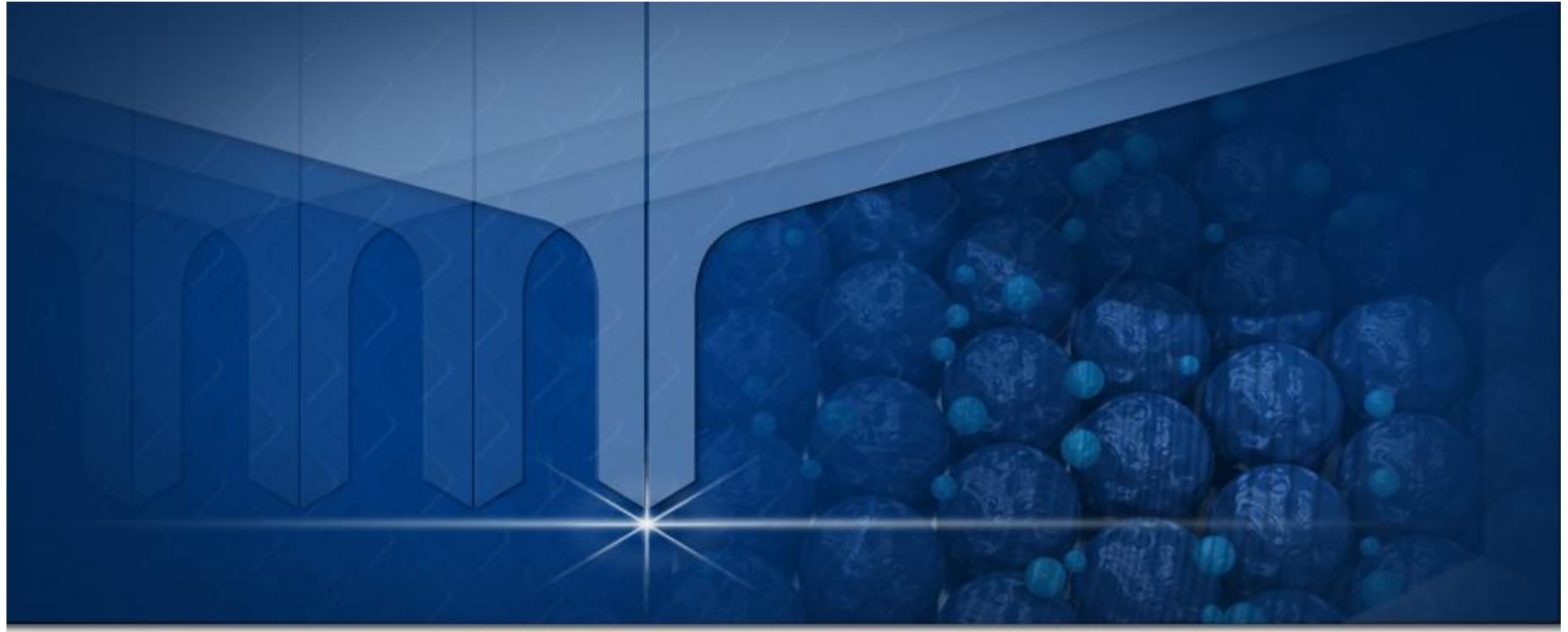


90°C



160°C (melting temp.)





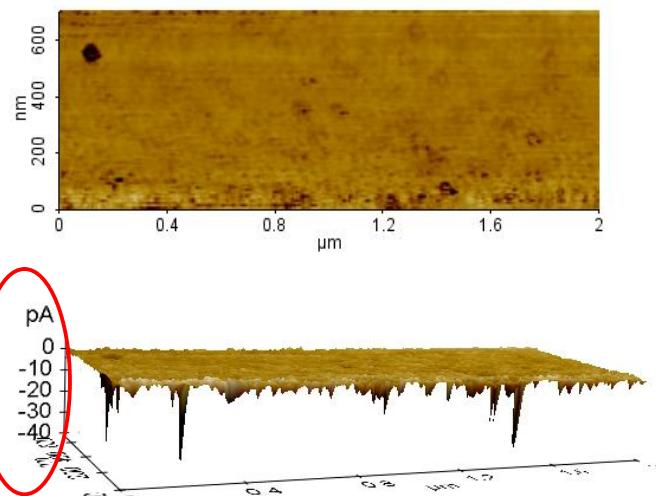
# Option image (Electrical Property)



# Dark Current mode (Photo-sensitive sample)

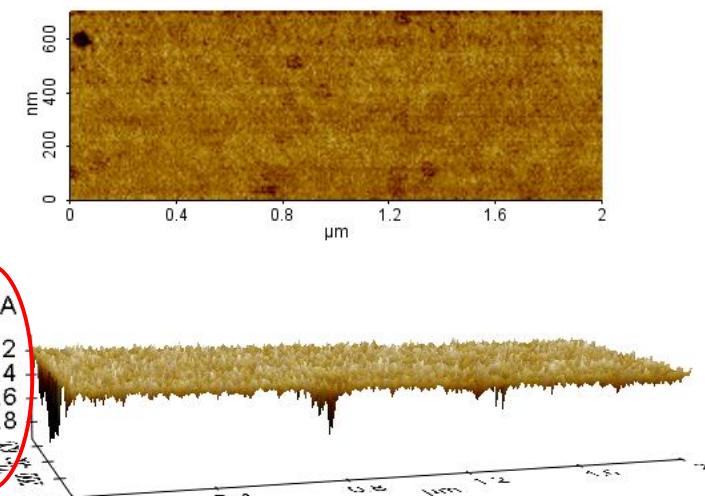
- Normal Current mode
  - One scan : Topography & Current image
- Dark Current mode
  - First scan : Topography
  - Second scan : Current image with laser\_off

Normal current mode



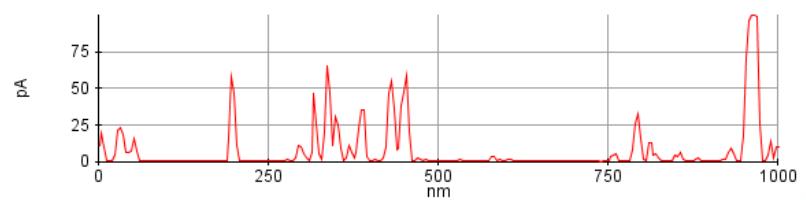
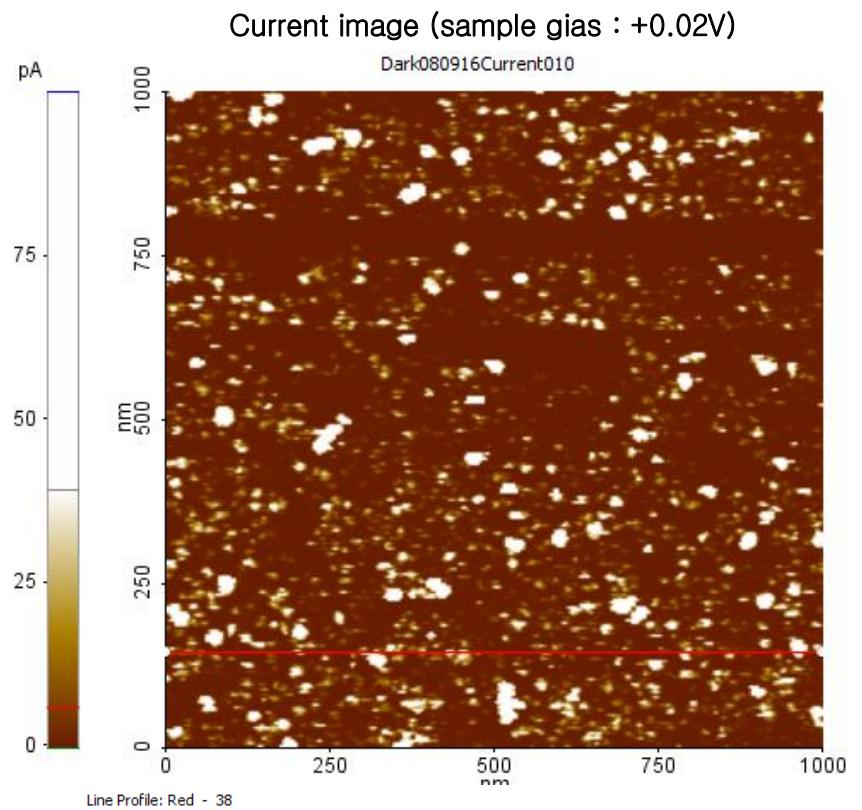
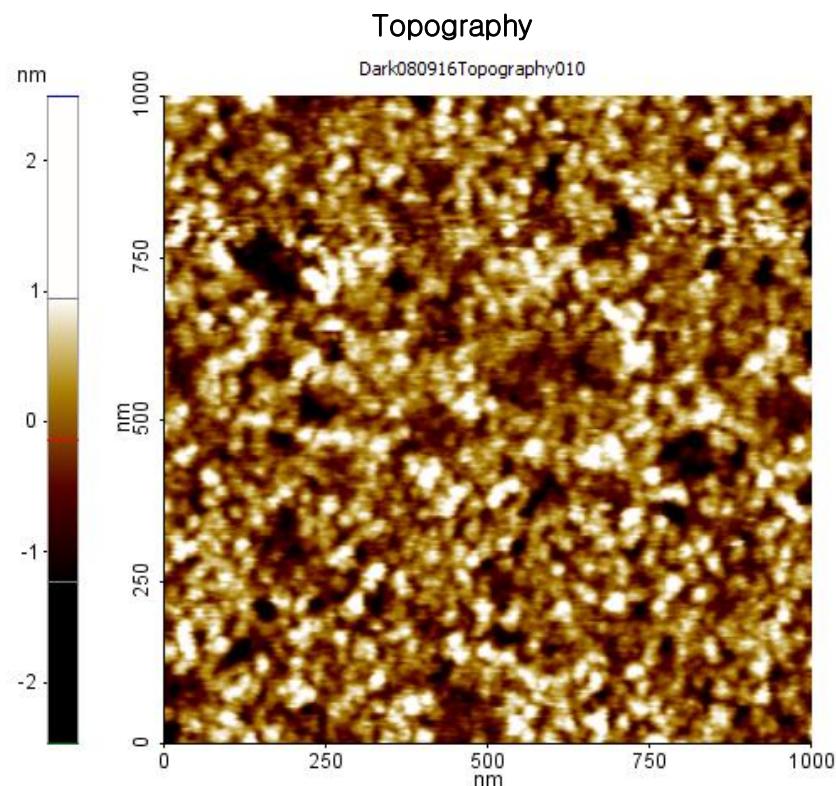
Sample bias : -7V  
ULCA current amplifier

Dark current mode



Sample bias : -7V  
ULCA current amplifier

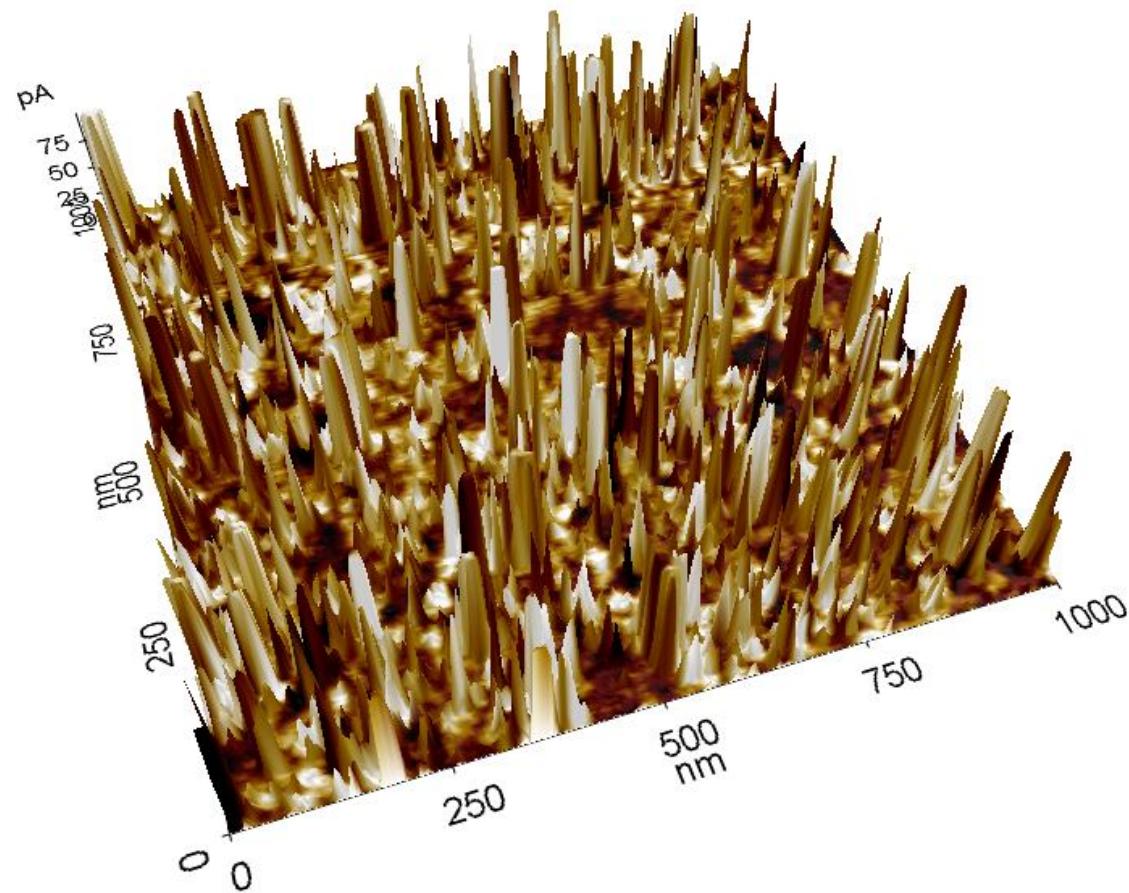
# *Dark Current mode \_GST*



# Dark Current mode \_GST

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Overlay(Topography & Current)



# Dark I/V curve \_ GST(phase transition)



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Current measurement as voltage sweep (0V → -1V → 0V)

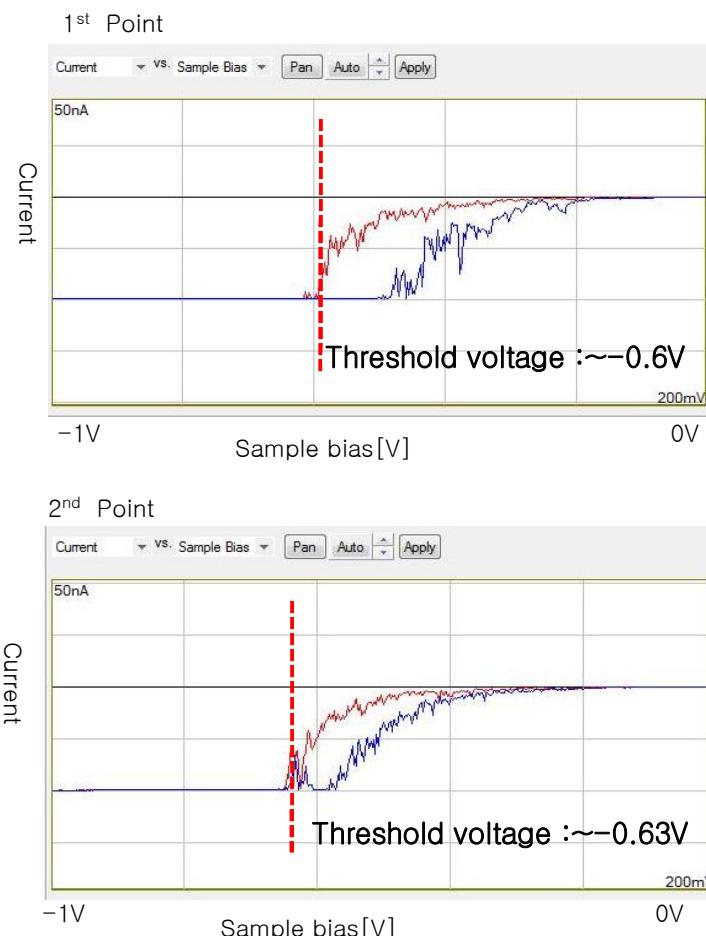
0V → -1V : red line

-1V → 0V : blue line

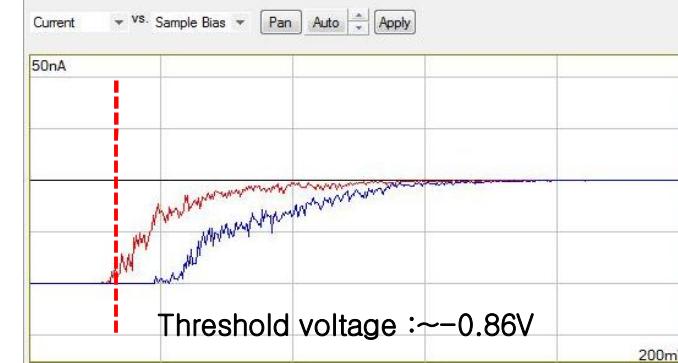
Voltage sweep condition

IV Spectroscopy Control

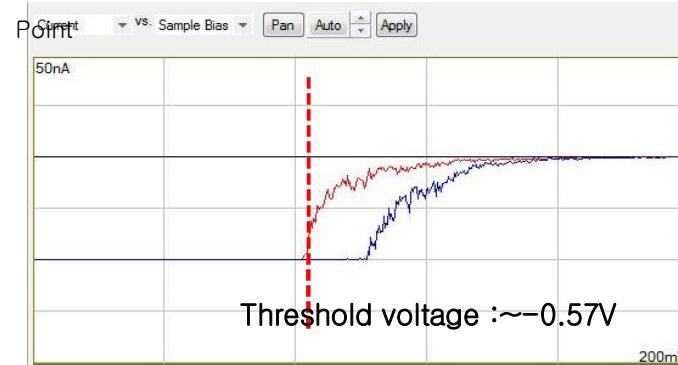
Min	Max
-1.000 V	0.000 V
Period	Points
2.00 sec	512
Current Limit	
100.000 nA	<input type="checkbox"/> Reverse
Start Voltage	End Voltage
0.000 V	0.000 V
Set Point	
50.00 nA	<input checked="" type="checkbox"/> Z Servo
HoldTime	
0.000 sec	
<input type="button"/> Start	
<input type="button"/> Clipboard	
<input type="button"/> Acquire	
<input type="checkbox"/> Map	<input type="checkbox"/> Repeat



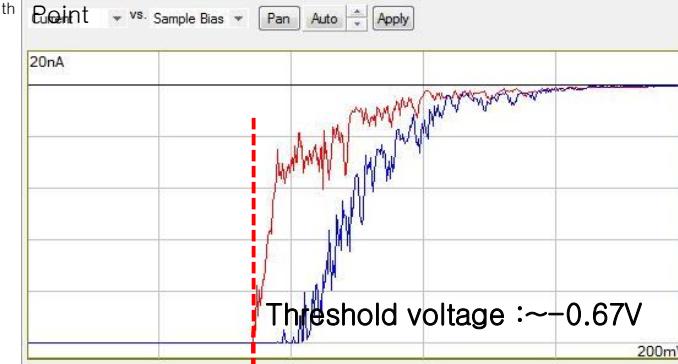
3<sup>rd</sup> Point



4<sup>th</sup> Point



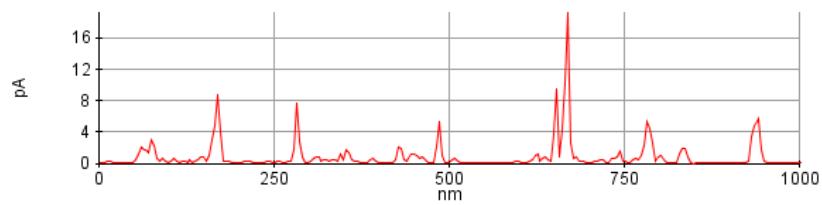
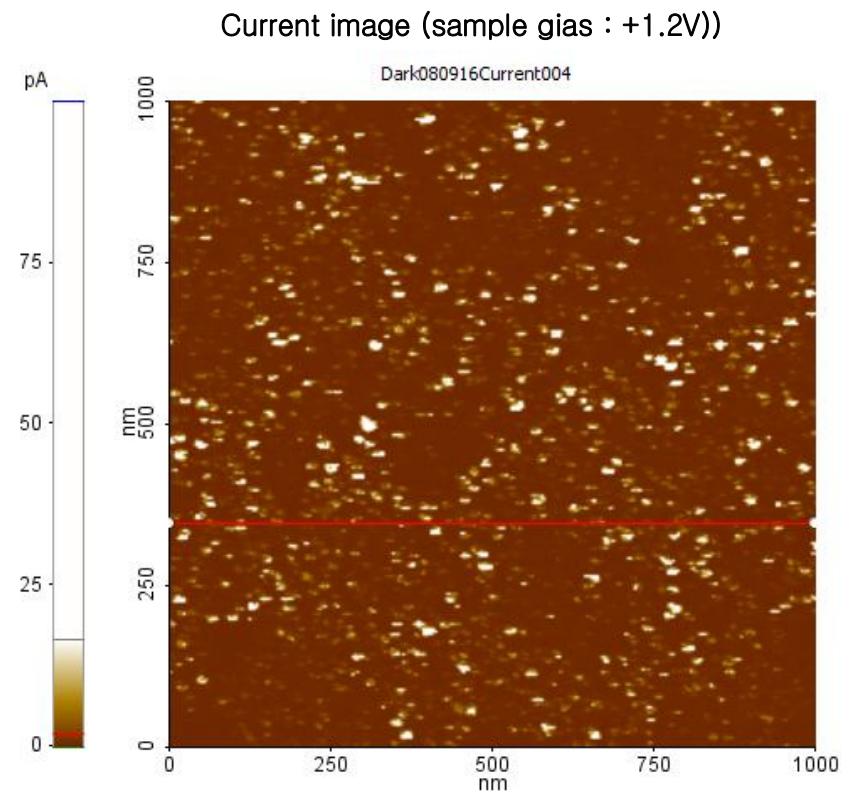
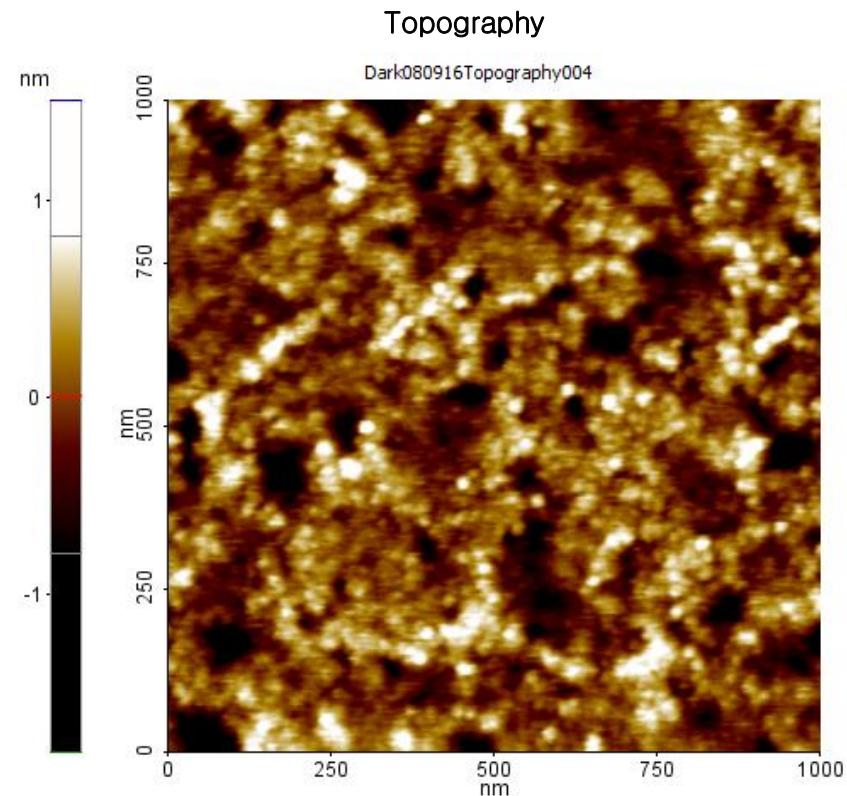
5<sup>th</sup> Point



# *Dark Current mode \_InGST*



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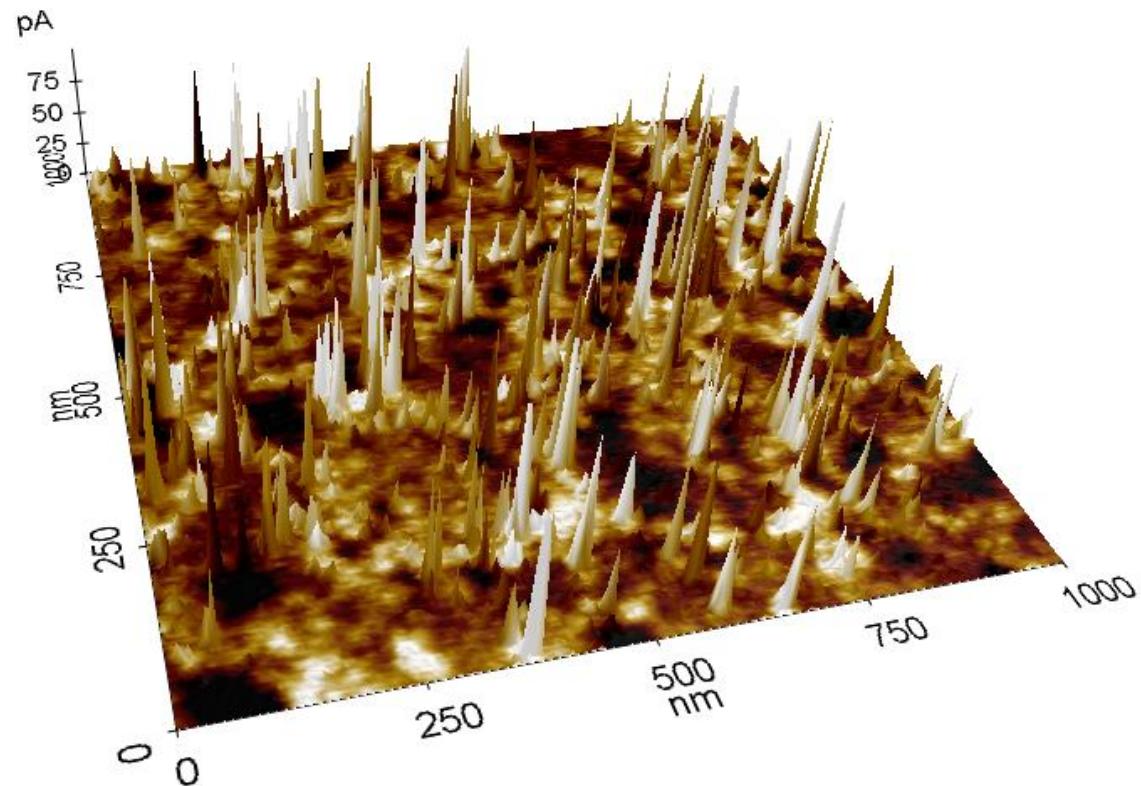


# *Dark Current mode \_InGST*



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Overlay(Topography & Current)



# Dark I/V curve \_ InGST(phase transition)

Nanotechnology Solutions Partner

Current measurement as voltage sweep (0V → -3V → 0V)

0V → -3V : red line

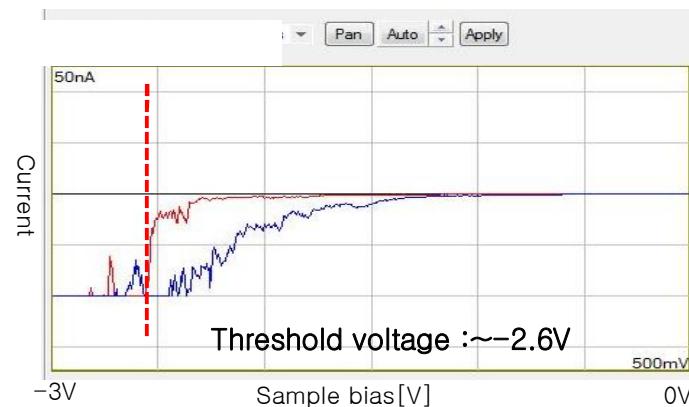
-3V → 0V : blue line

Voltage sweep condition

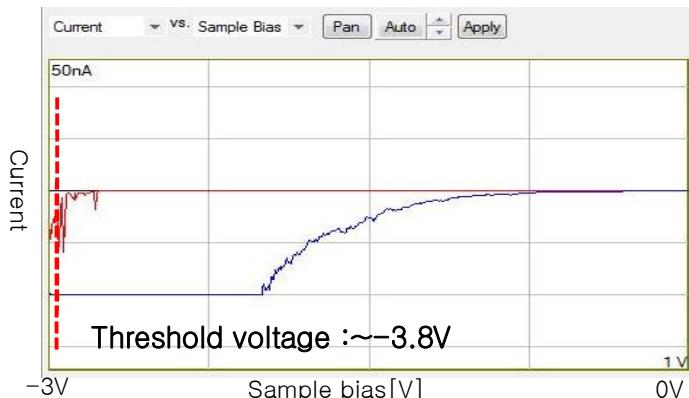
IV Spectroscopy Control

Min	Max
-3.000 V	0.000 V
Period	Points
1.00 sec	512
Current Limit	
100.000 nA	<input type="checkbox"/> Reverse
Start Voltage	End Voltage
0.000 V	0.000 V
Set Point	<input checked="" type="checkbox"/> Z Servo
50.00 nN	
HoldTime	
0.000 sec	
<b>Start</b>	
<b>Acquire</b>	
<input type="checkbox"/> Map	<input type="checkbox"/> Repeat

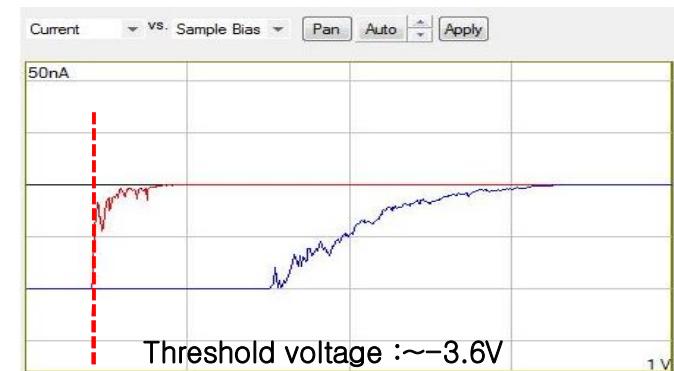
1<sup>st</sup> Point



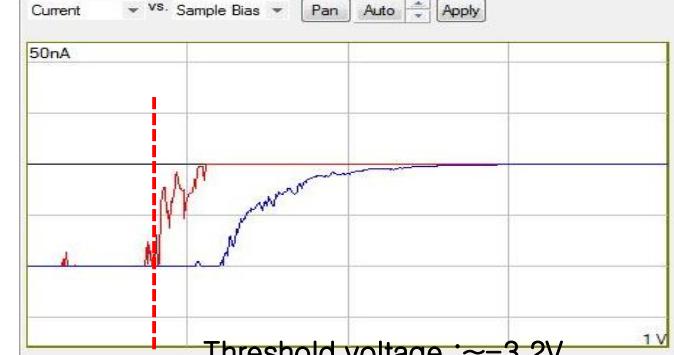
2<sup>nd</sup> Point



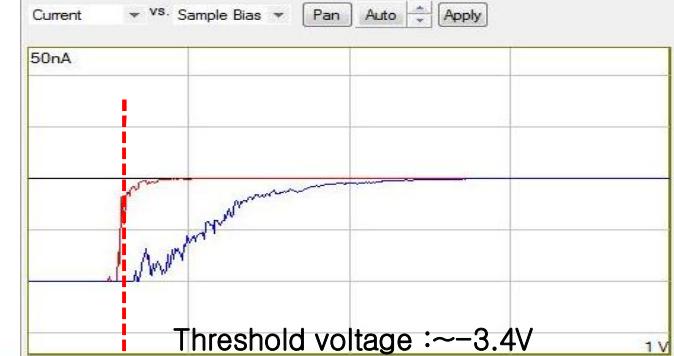
3<sup>rd</sup> Point



4<sup>th</sup> Point



5<sup>th</sup> Point

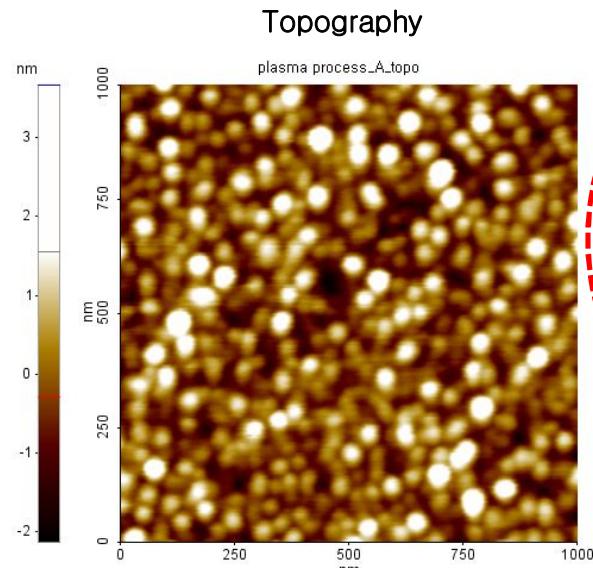


# (SSRM) \_ ITO (Conductance difference as plasma process)

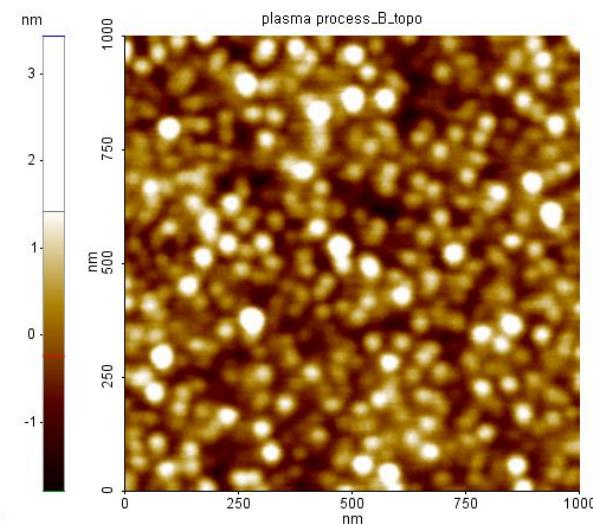


Nanotechnology Solutions Partner

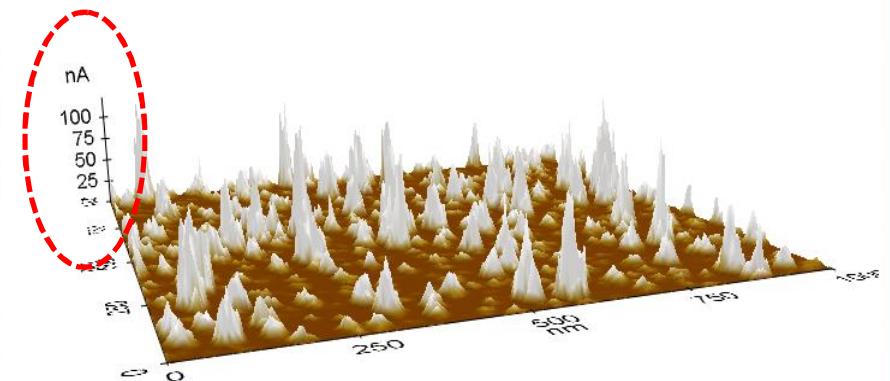
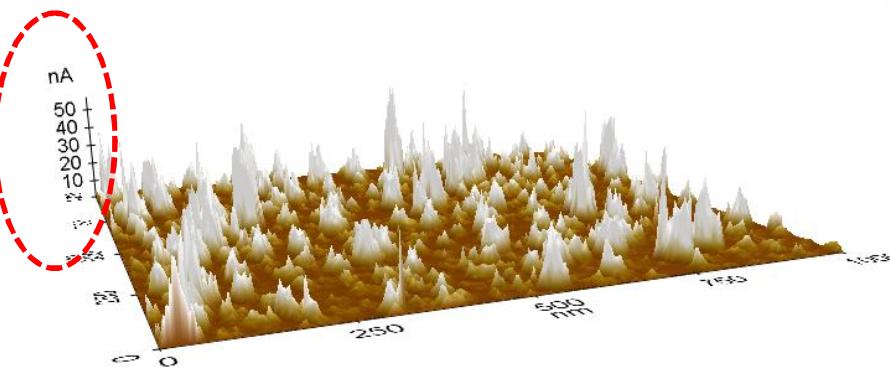
Plasma process A



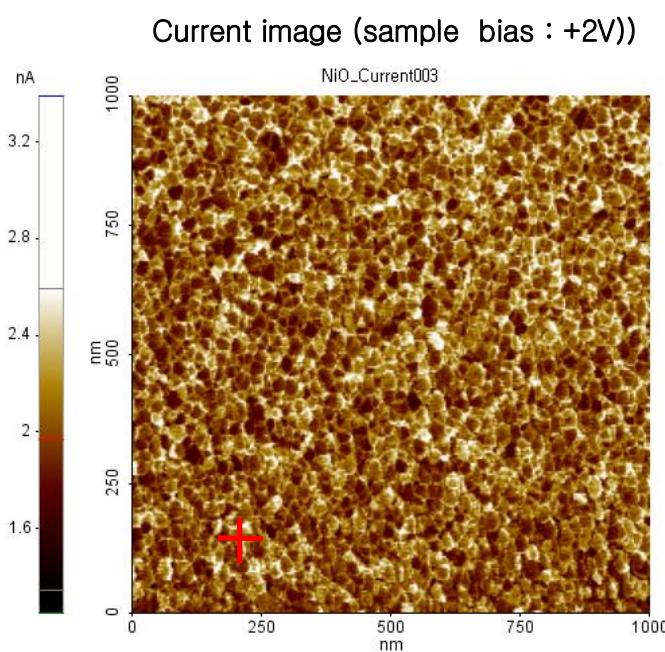
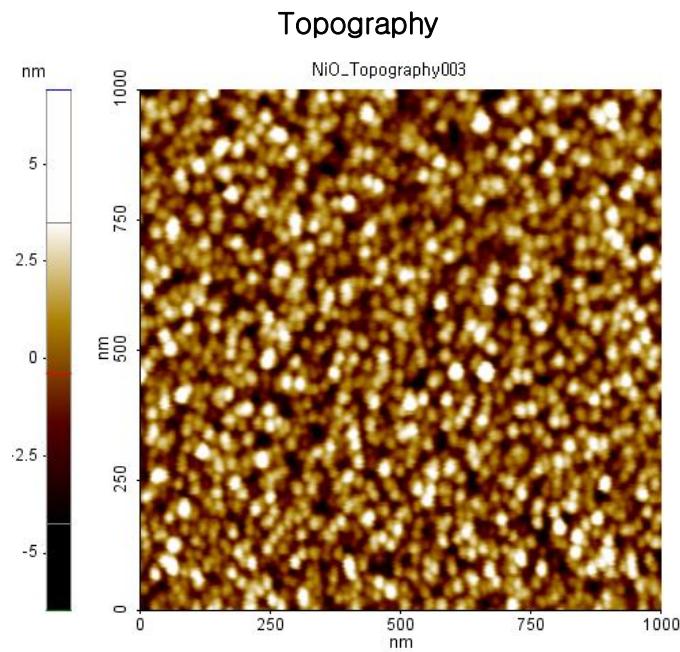
Plasma process B



Current image (sample bias : +0.08V))

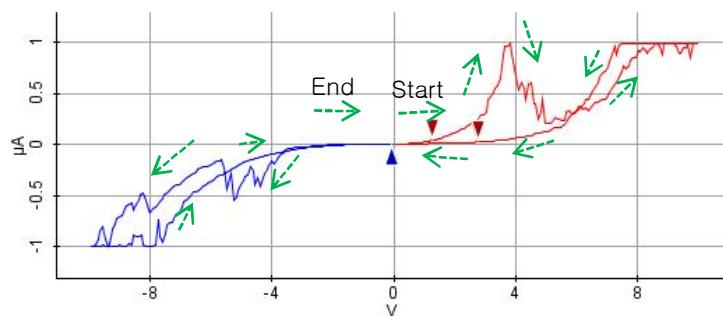


# (I-AFM) \_ NiO



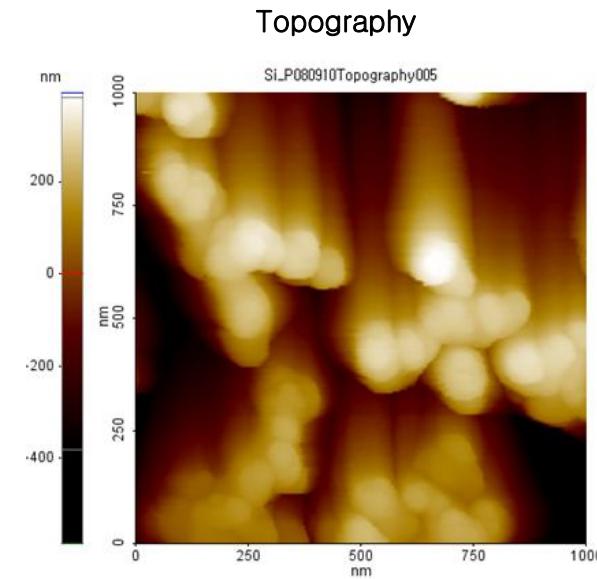
I/V curve ( 0V → +9V → -9V → 0V)

Current Sample Bias

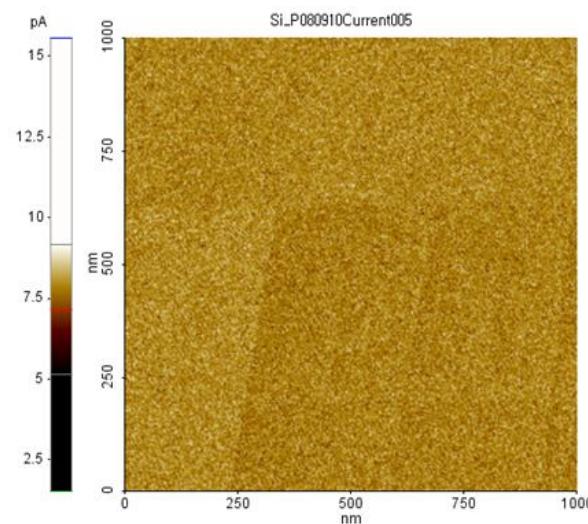


# (I-AFM) Si & Si+CNT pillar

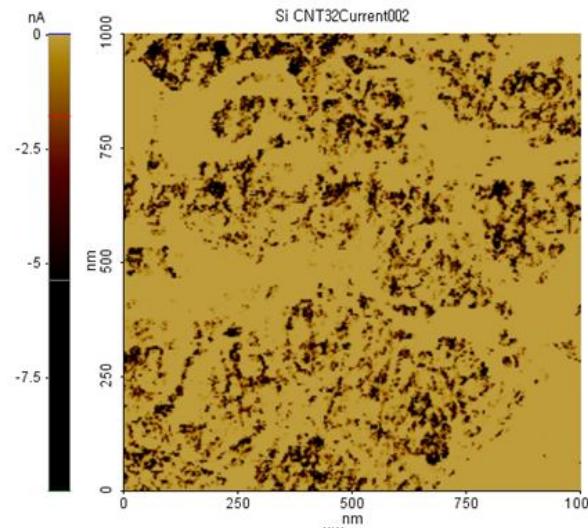
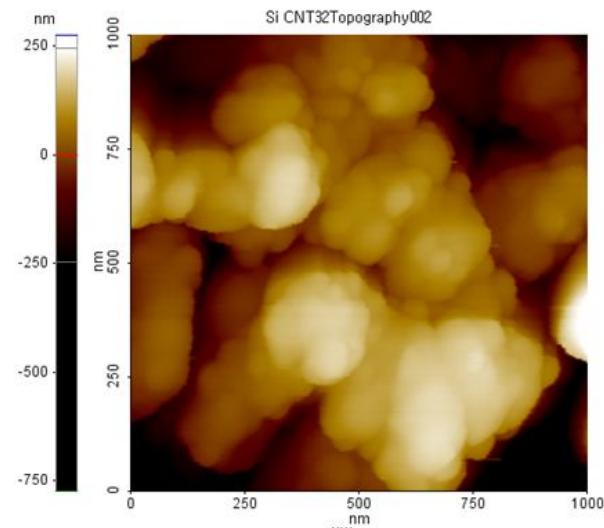
Si pillar



Current image (sample bias : +1V)

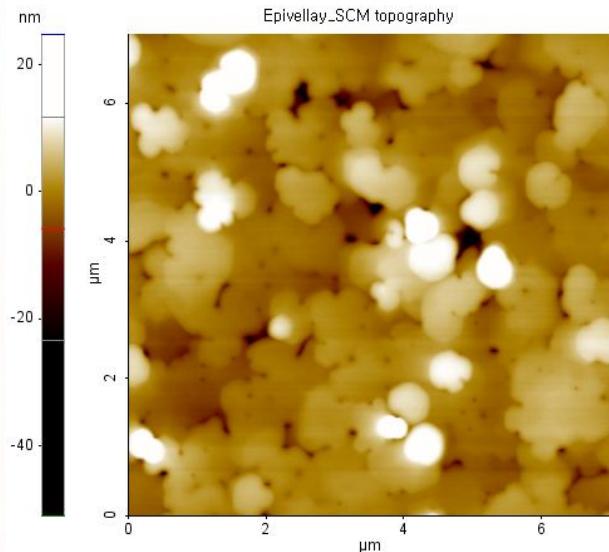


Si + CNT pillar

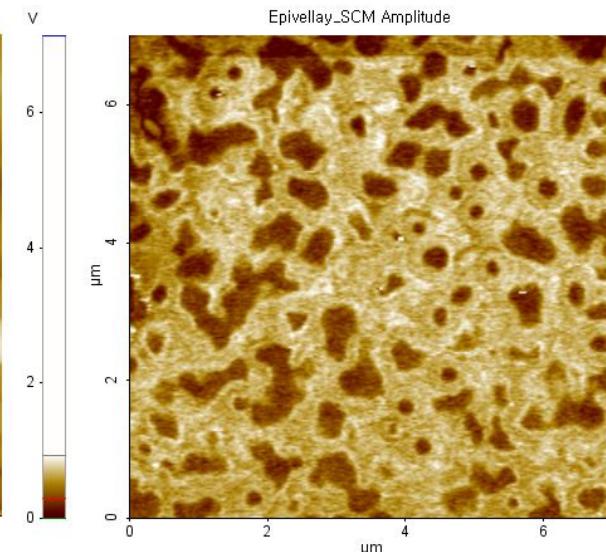


# (SCM) – (?)

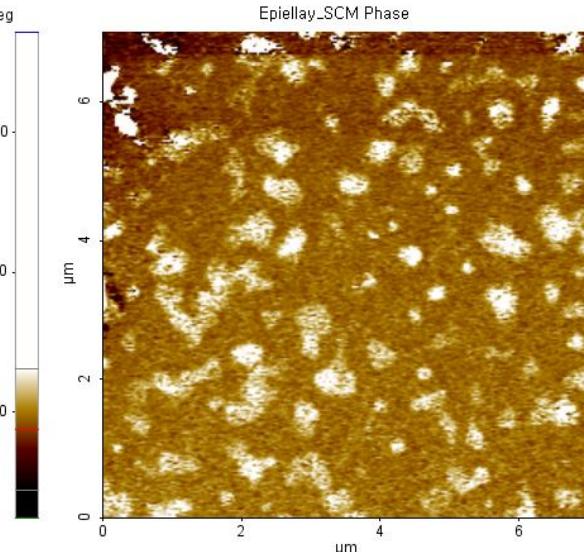
Topography



SCM Amplitude

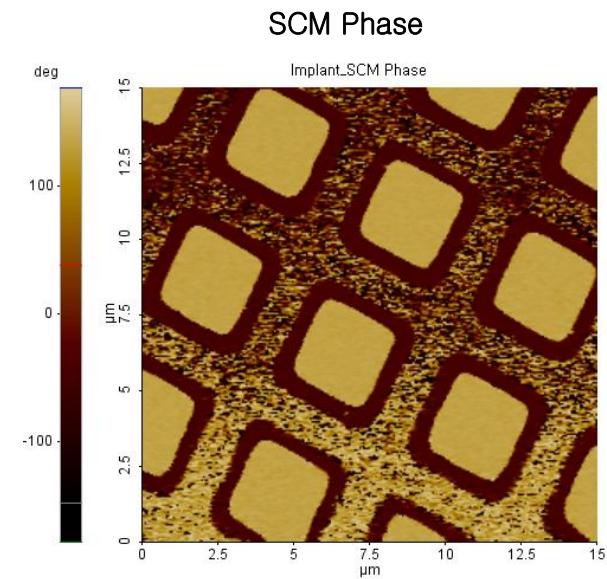
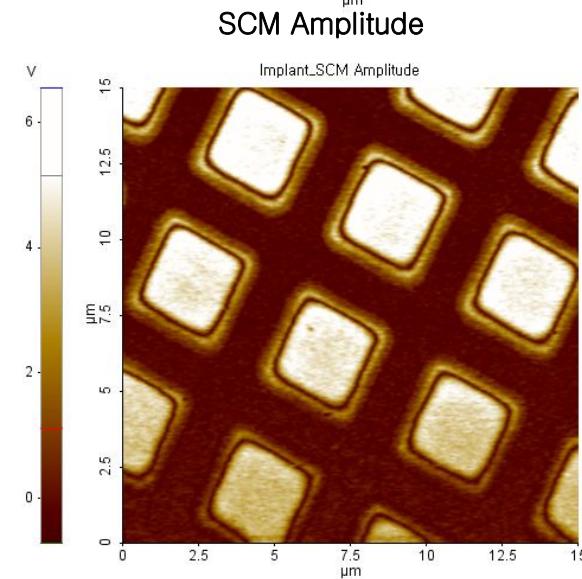
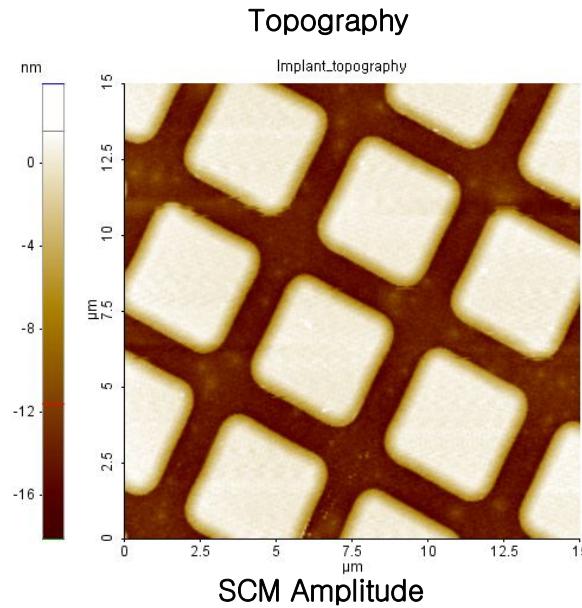
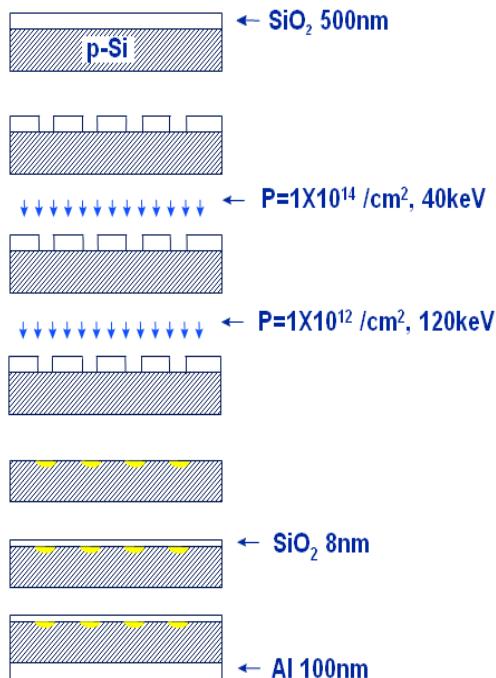


SCM Phase



# (SCM) \_Implant sample

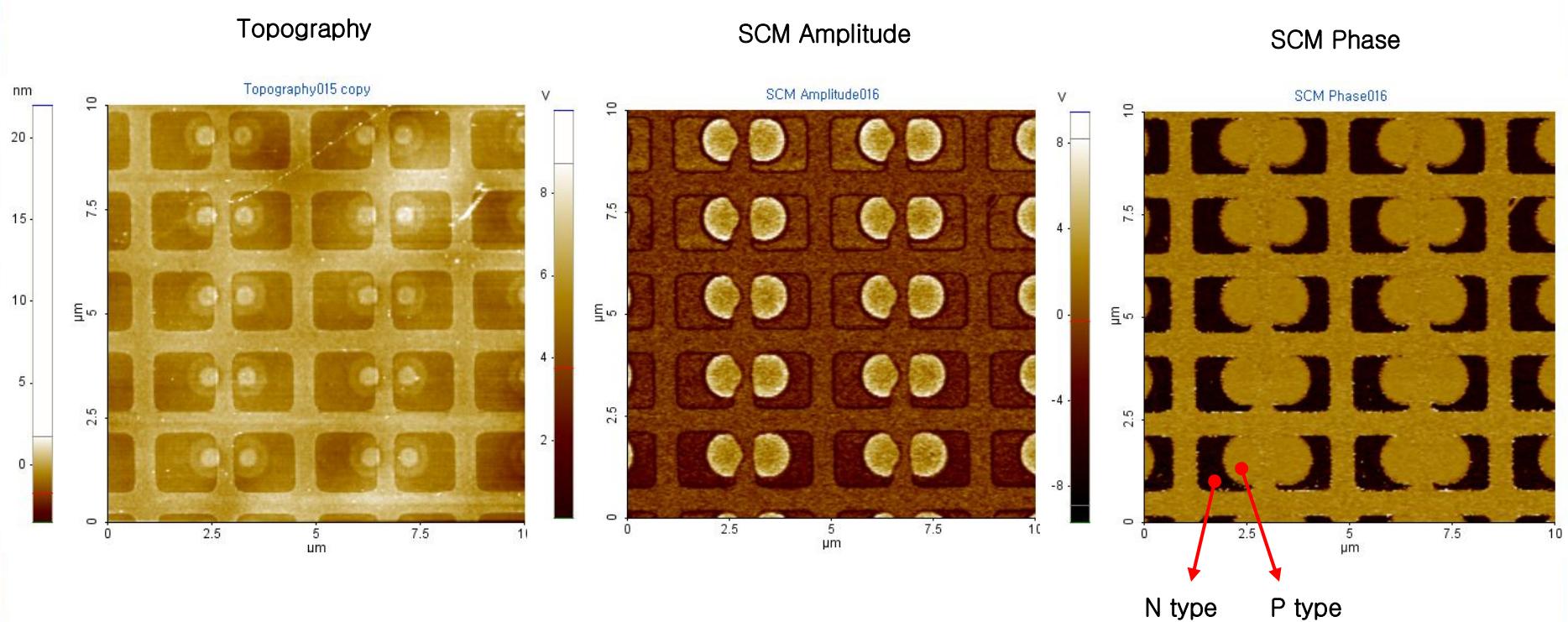
## ❖ Preparation of the implant sample



# **(SCM) \_Implant sample**

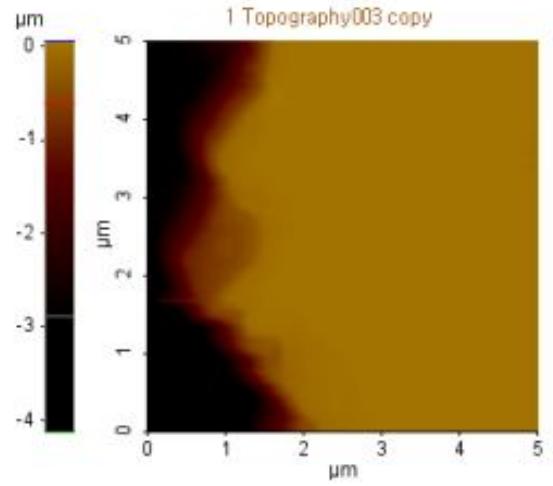


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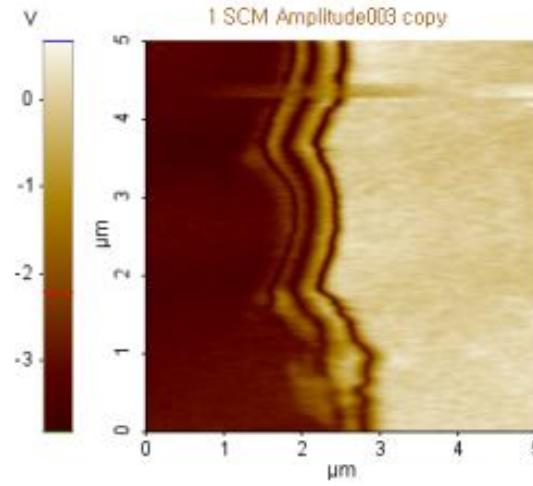


# (SCM) Solar Cell

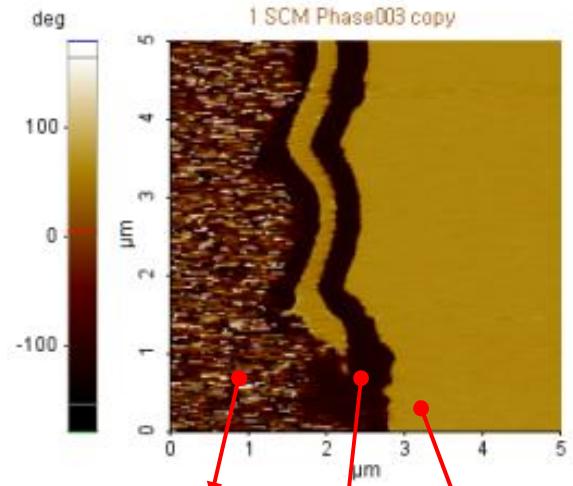
Topography



SCM Amplitude



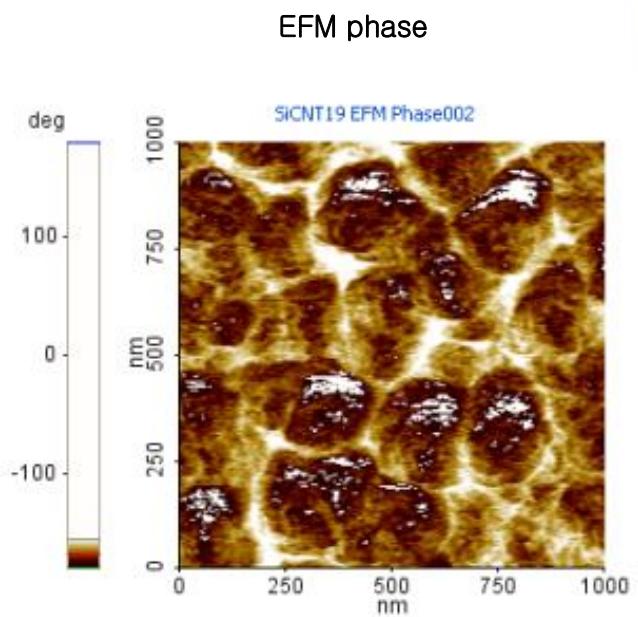
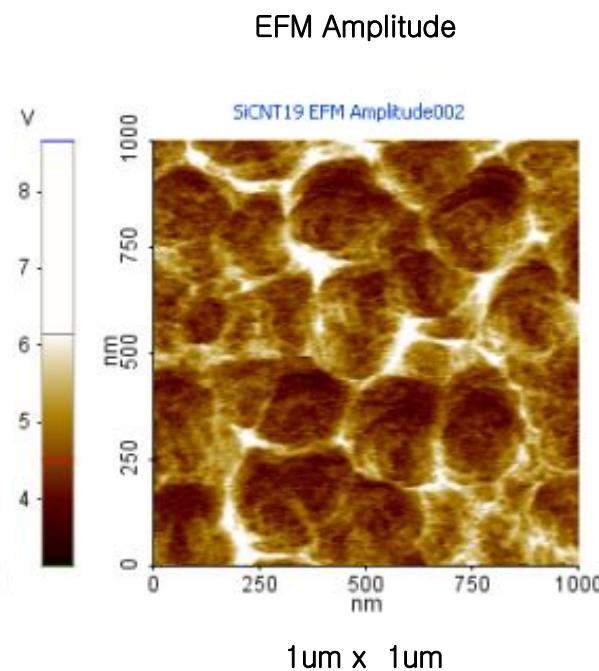
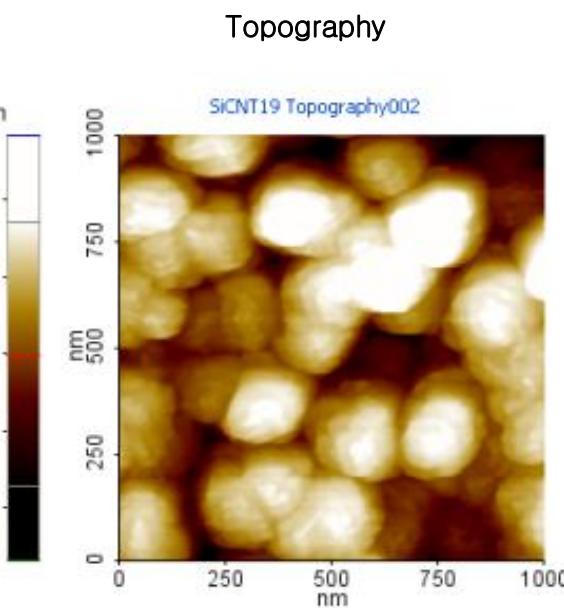
SCM Phase



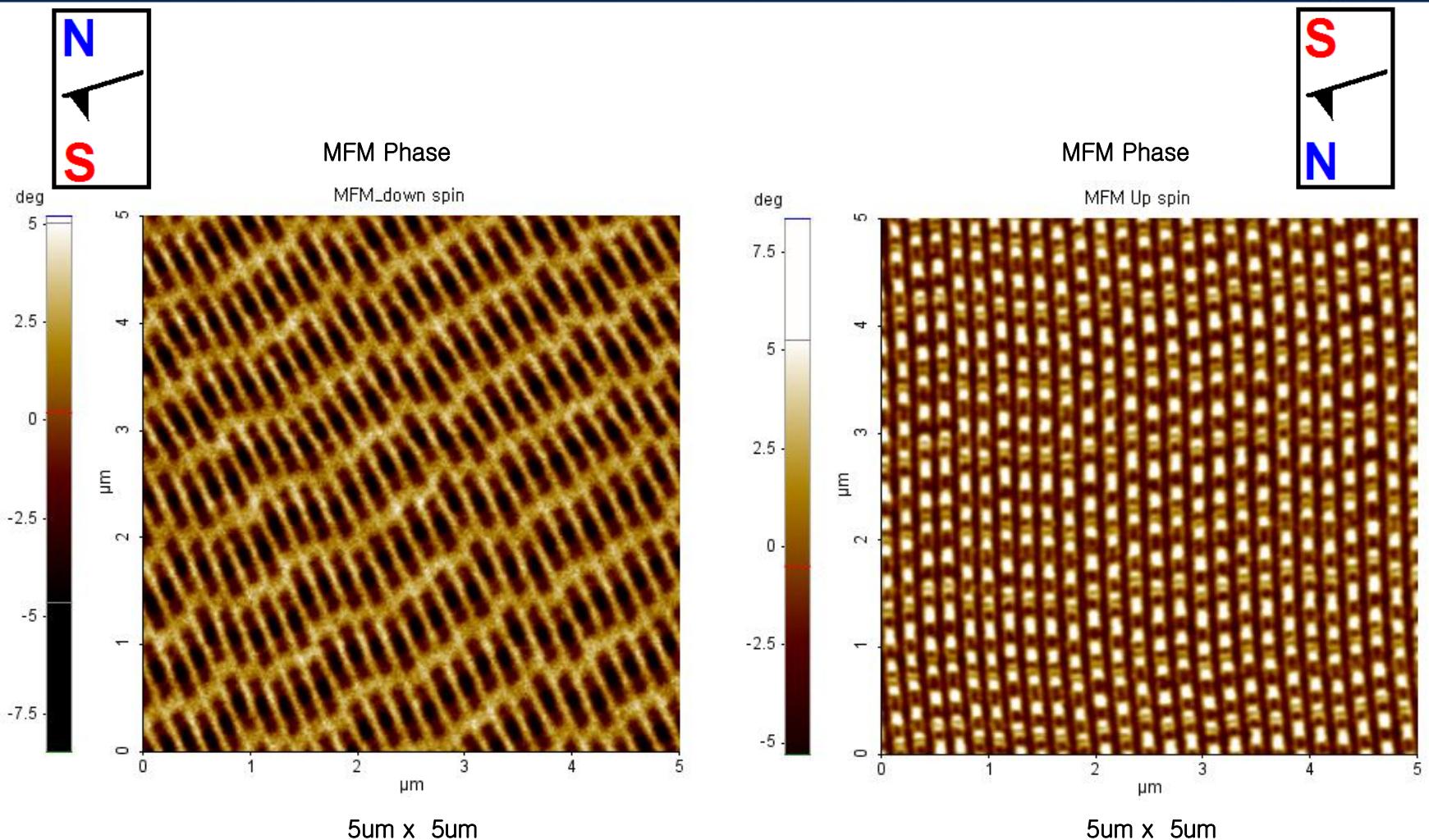
# (EFM) Si+CNT pillar (External bias : 0V)



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# MFM phase image depending on magnetizing direction





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