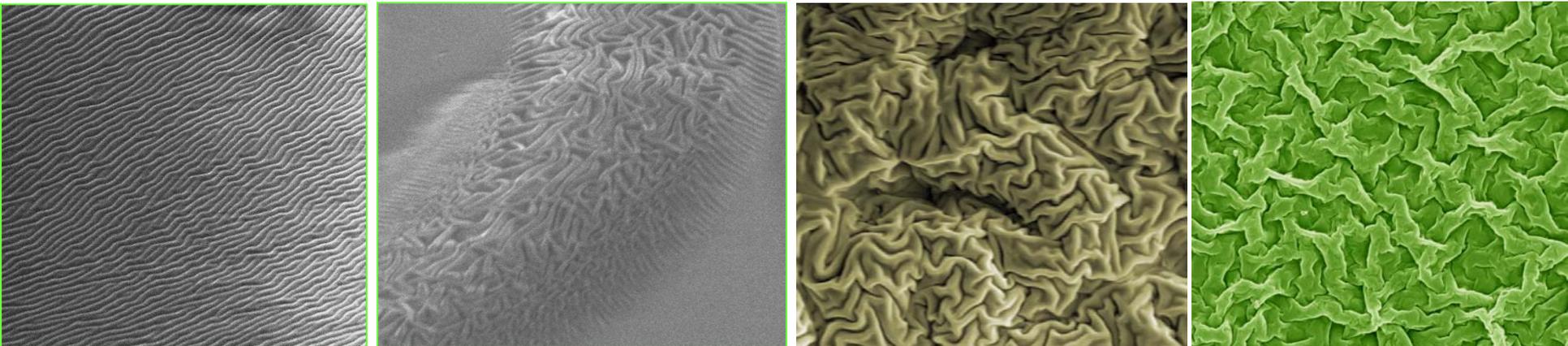


Wrinkled Hard Skin on Polymers Created by Ion Beam and Biological Application

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➤ **Introduction to wrinkle**

Wrinkle of stiff skin on soft substrate in Nature

Wrinkle patterns induced by focused ion beam(FIB)

➤ **Characteristics of nano wrinkle by FIB**

Wrinkle modes: straight, herringbone, hierarchical

Geometry characterization: AFM, TEM, Auger

→ denser and compressed than original polymer

➤ **Patterning the wrinkle and application**

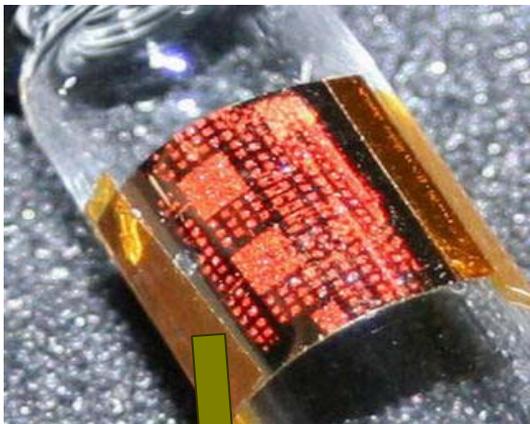
Maskless method for wrinkle patterning

Constructing the nano channel for protein pre-condensation

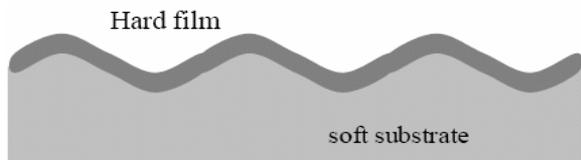
Hard skin (film) on Soft substrate



Popsi.com epaper



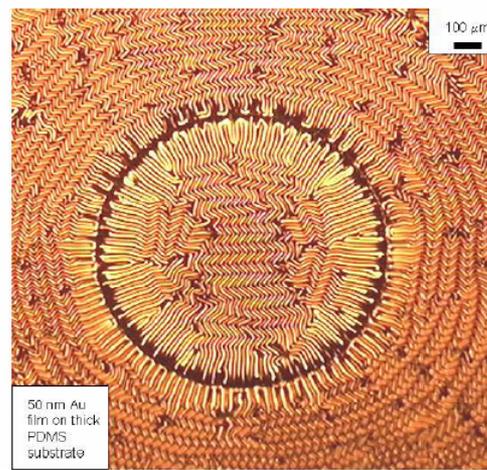
Nature, 2006 flexib electronics



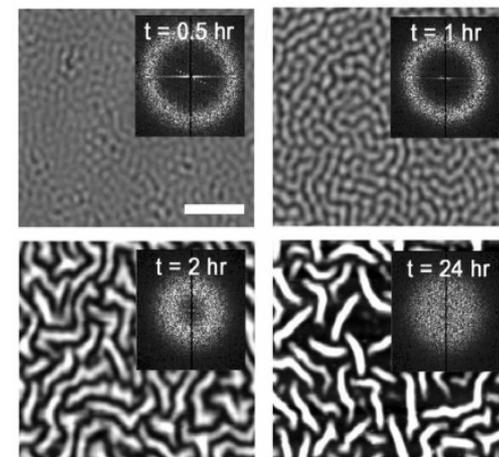
Cedar and Mahadevan, PRL 2003



Bowden, Brittain, Evans, Hutchinson, Whitesides, Nature **393**, 146 (1998).



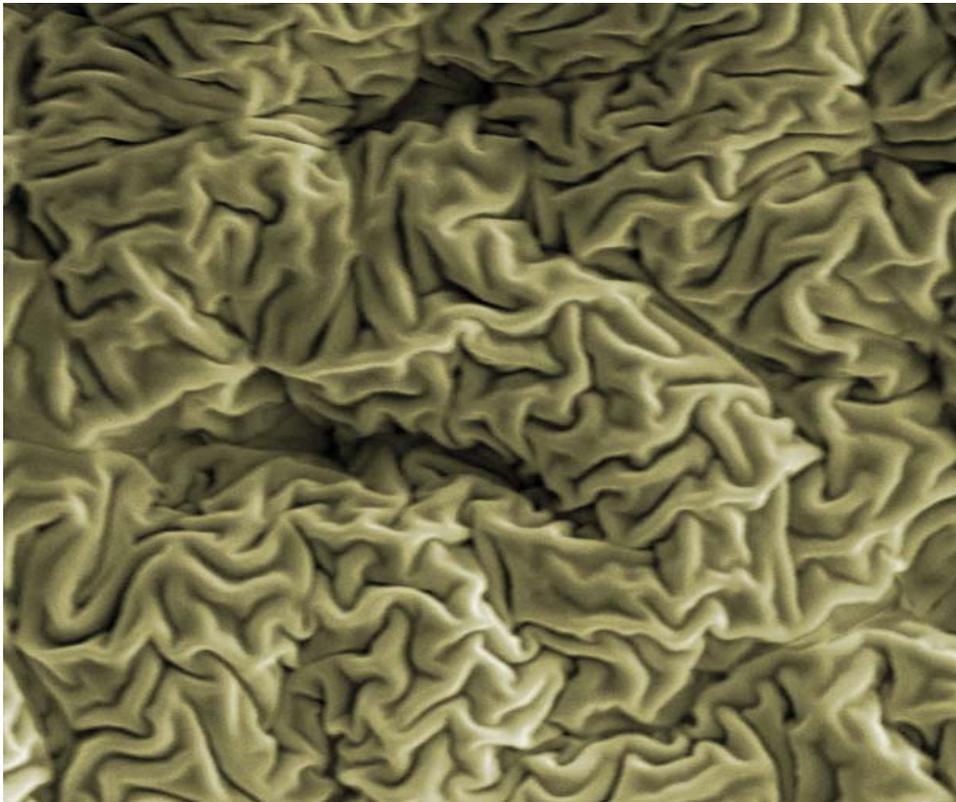
Yoo, Suh, Kang, Lee, PRL 2004



A Novel Method for Wrinkle Patterns

Limitation for wide application with previous method:

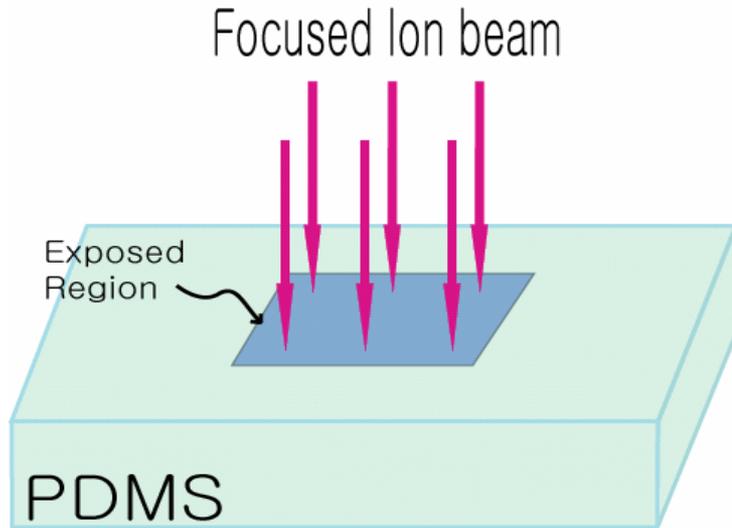
- Complicated steps to make wrinkle (deposition and external force)
- Not easy to fabricate local region and desired direction!!!
- Size of wrinkle wavelength is not controllable.



Wrinkle with FIB

: One step fabrication method of wrinkle pattern in desired region over various sizes

Wrinkles on polymer by FIB

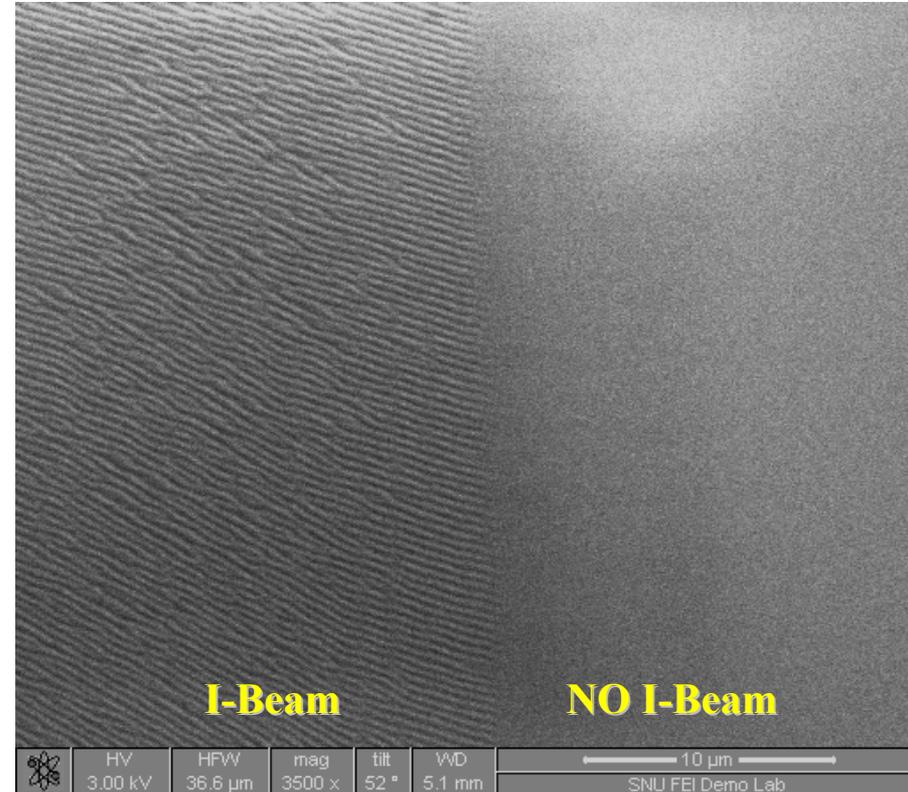


PDMS

- Elastomer vs cross linker = 15:1, cured at 80°C 1hour

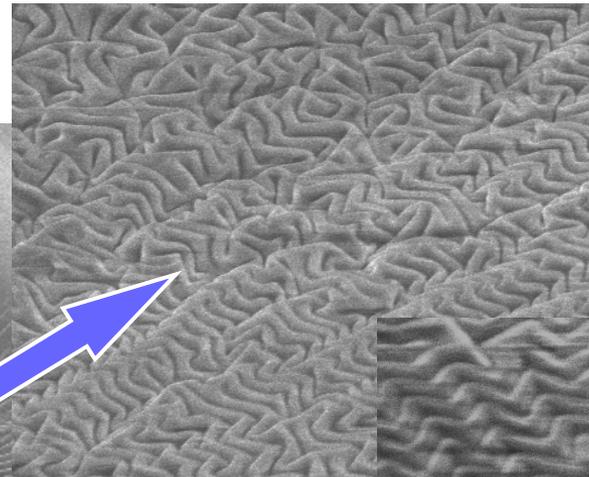
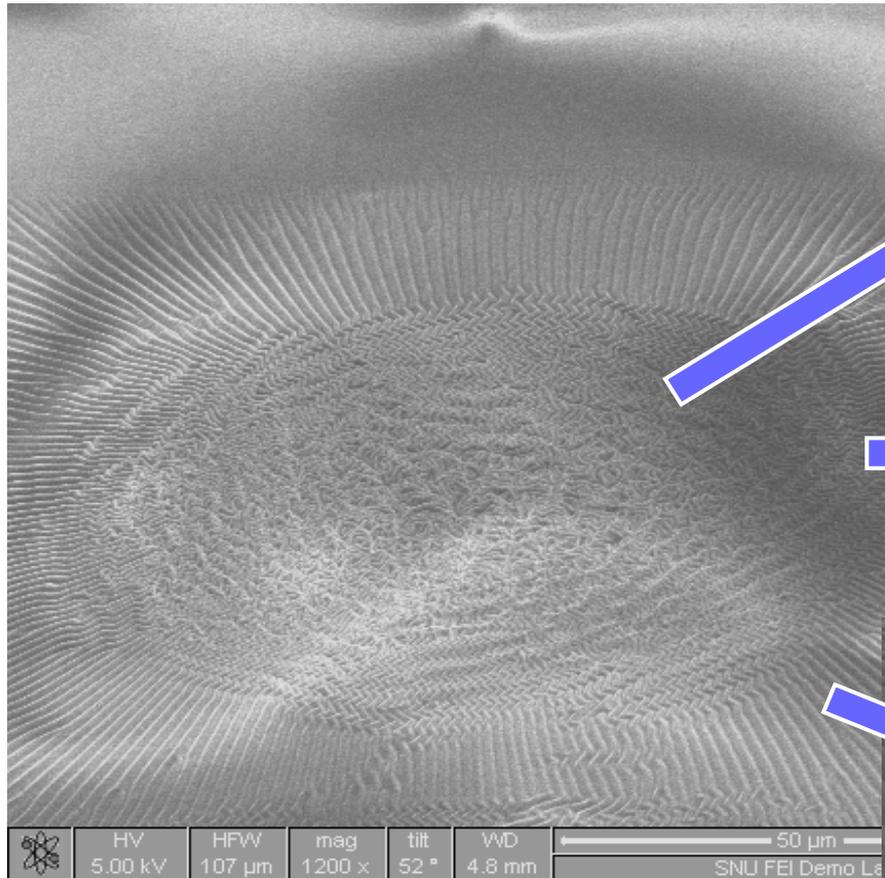
FIB (HRFIB/SEM, nova200, FEI)
30KeV, 1pA~20nA.

Fluence range, $10^{13} \sim 10^{16}$ ions/cm², controlled by the current, exposing time and exposing area

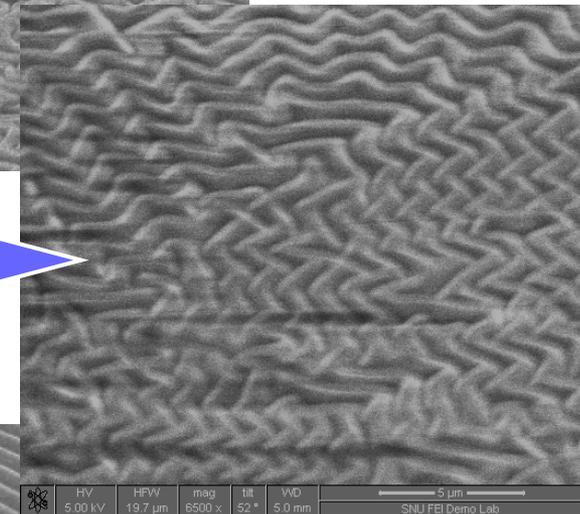
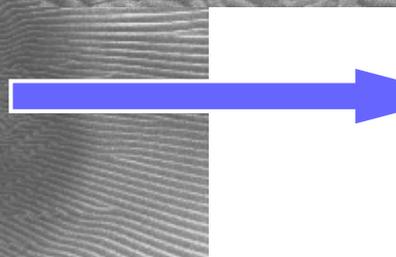


Wrinkled surface: modes

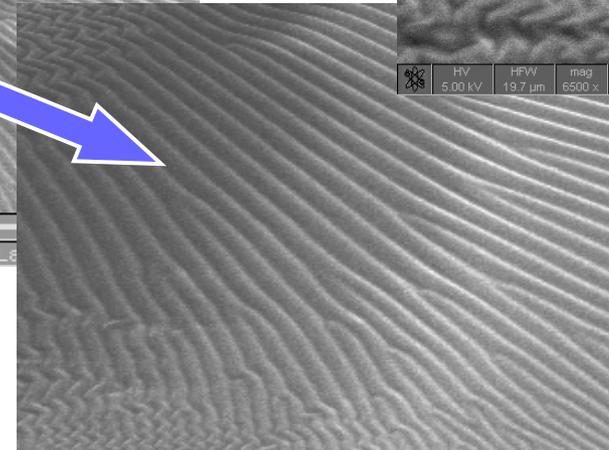
- Single scan of Ion mode



Hierarchical

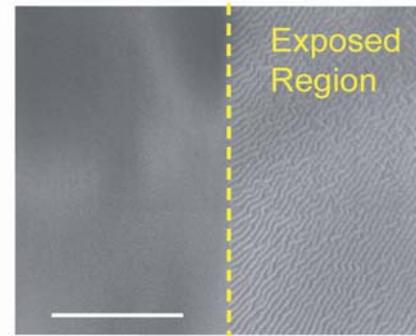
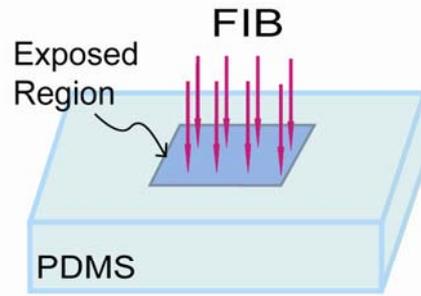


Herringbone



Straight 
Korea Institute of
Science and Technology

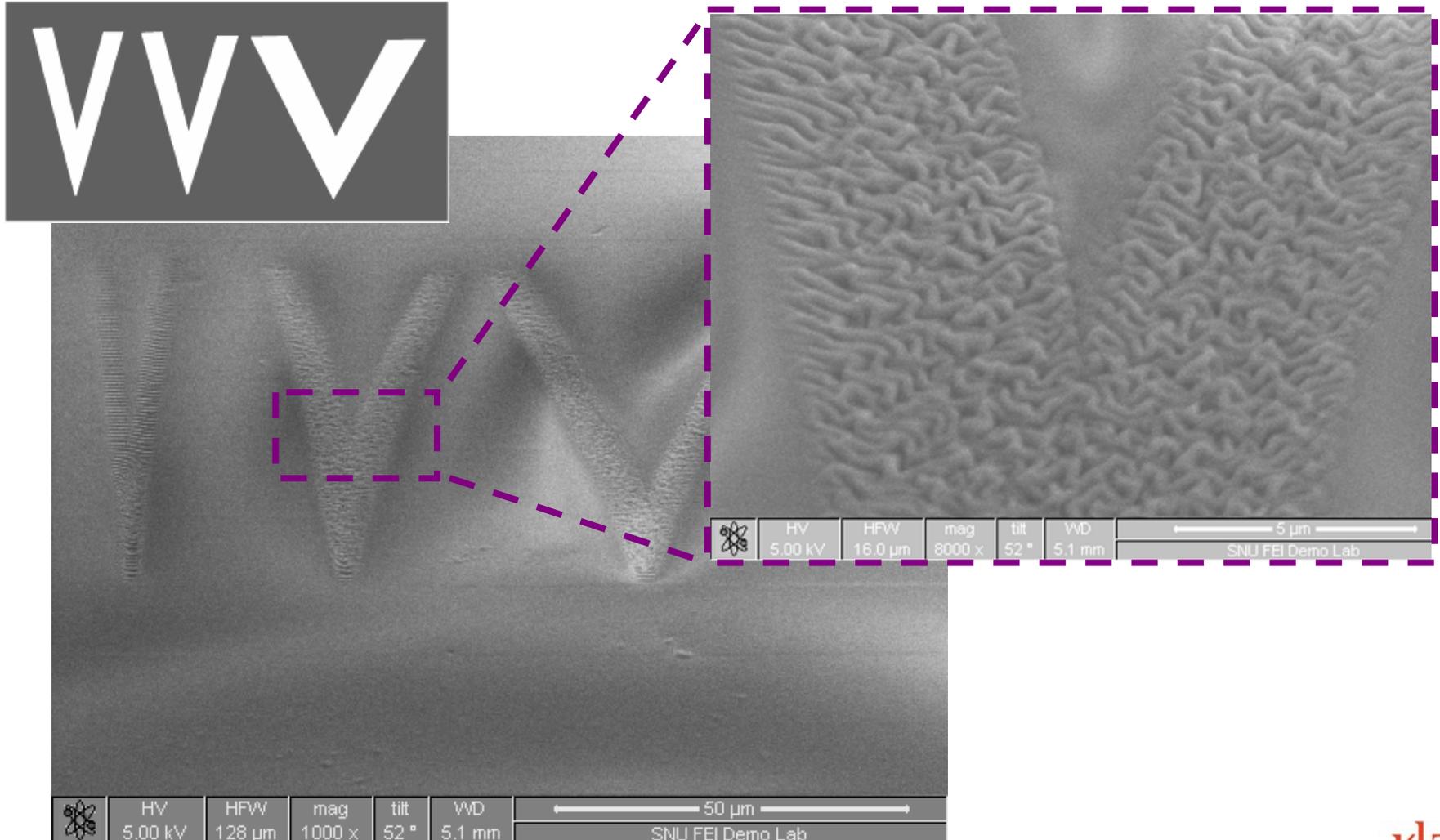
Raster scanning



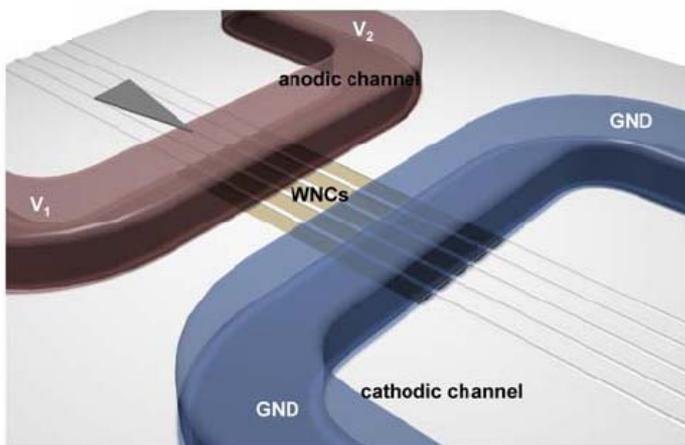
Patterning

Mask-less Patterning Method

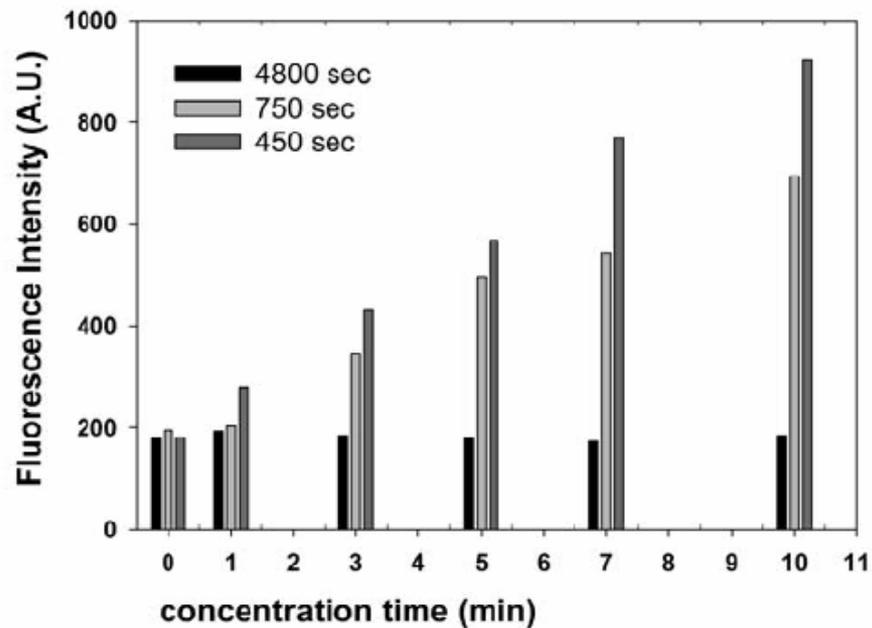
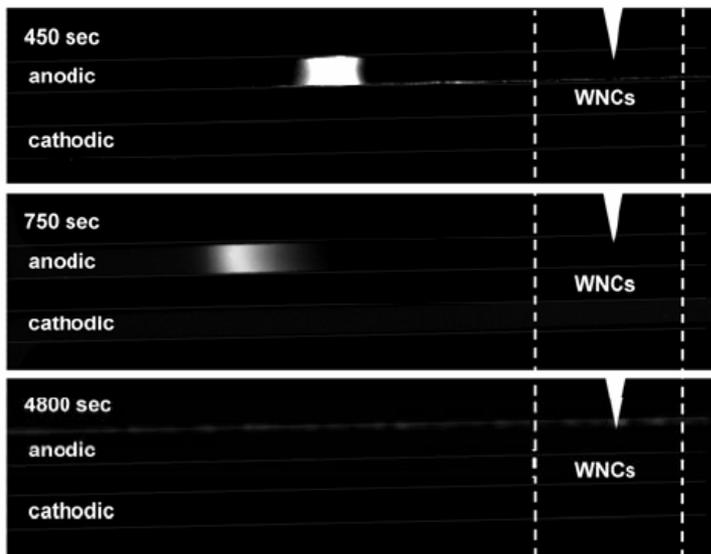
- **Bitmap Image** For FIB mask



Nano-channel for protein precondensation



Time (sec)	Width (nm)	Height (nm)
450	900	233
750	1470	275
4800	8600	989



Summary

➤ **Focused Ion Beam induced wrinkle**

Hard skin with wrinkle by Ga⁺ ion beam bombardment

No deposit of skin!, No applied stress!!

➤ **Wrinkling morphologies with ion fluence**

Straight, herringbone, nested herringbone with over three generations of different scale with 25nm thickness at 30KeV wavelength increased from 40 to 450nm for 5 to 30keV.

➤ **Wrinkle patterning and its application**

- Locally patterned wrinkling by controlling the exposed region by relative motion of substrate – microfluidic channel
- Maskless patterning method-fluidic channel
- Cell culturing templates
and nano-channels for protein-pre-condensation

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Thanks !!!

Please visit my poster
for further details!!!

