

UNT Nanofabrication Cleanroom (NFCR)

April, 2019

- Capacity update



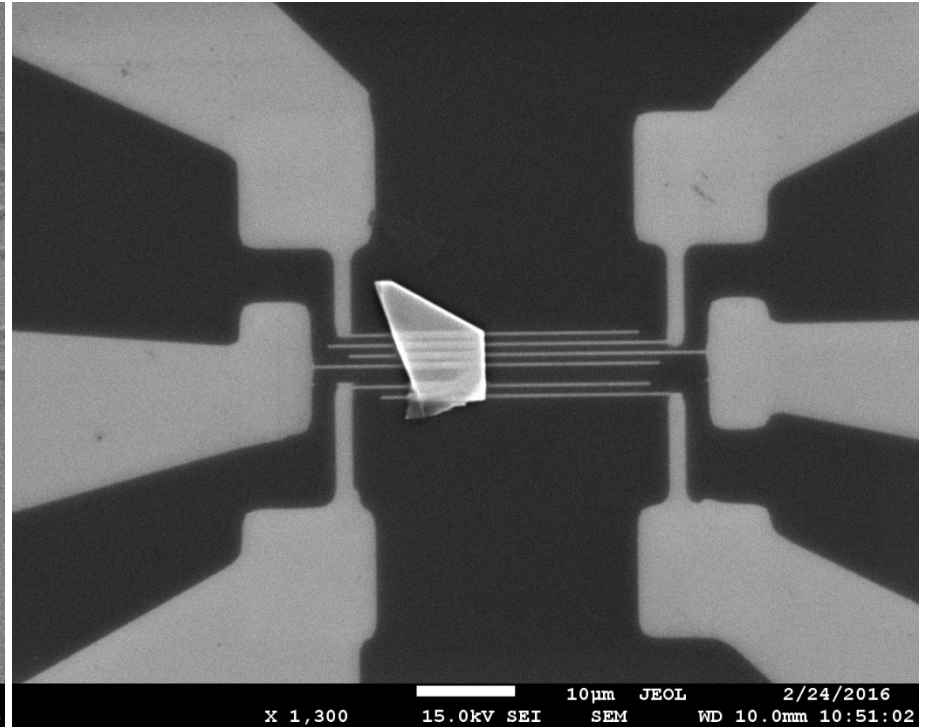
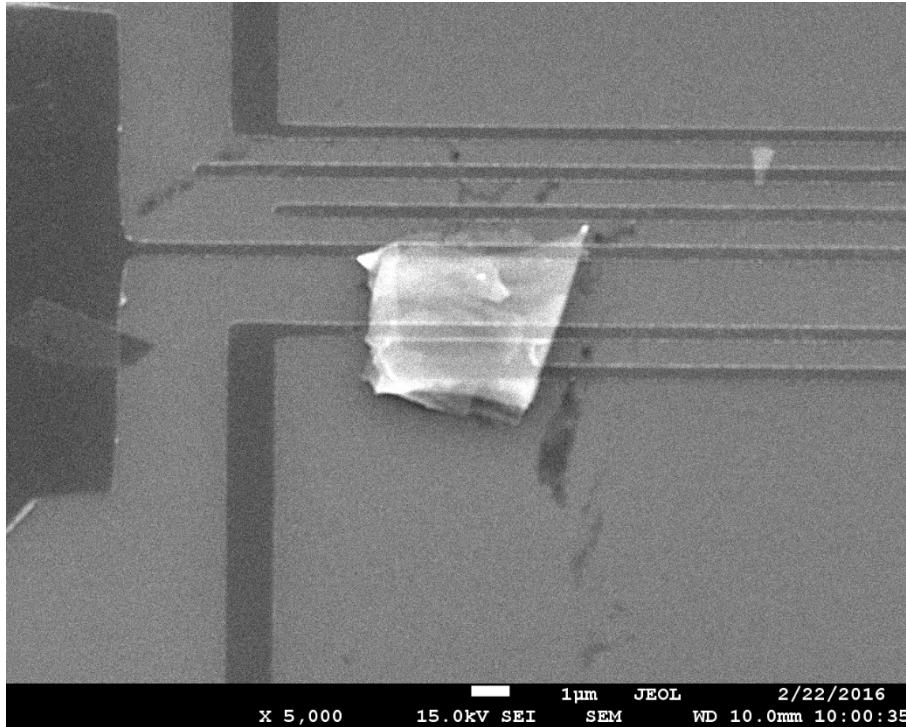
Cleanroom Capacity Update

- Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator
- Maskless photolithography: Heidelberg Laser writer
- Trovato OLED system
- RIE etching capacity
- User EBL sample from Ben
- 1st external user application

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator

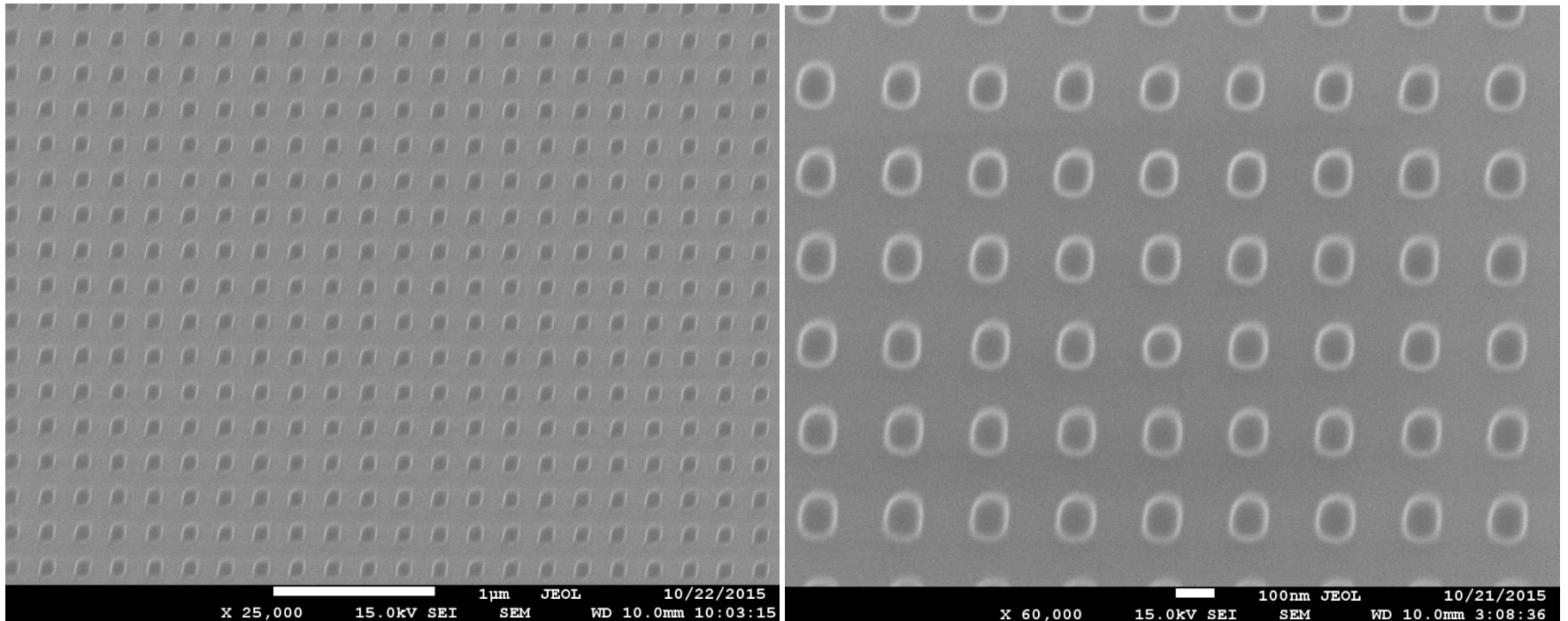


Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



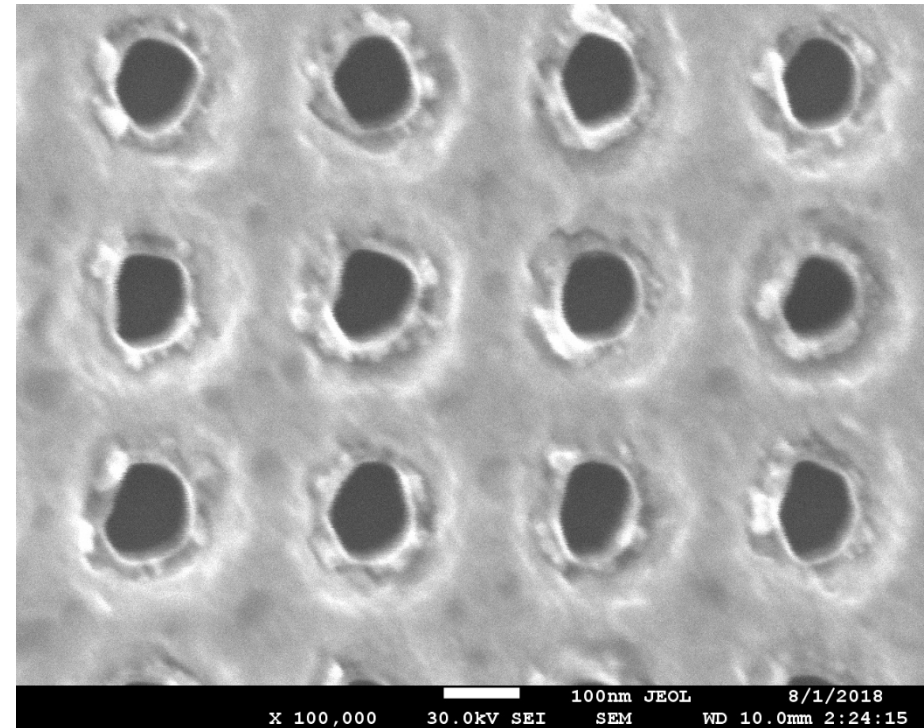
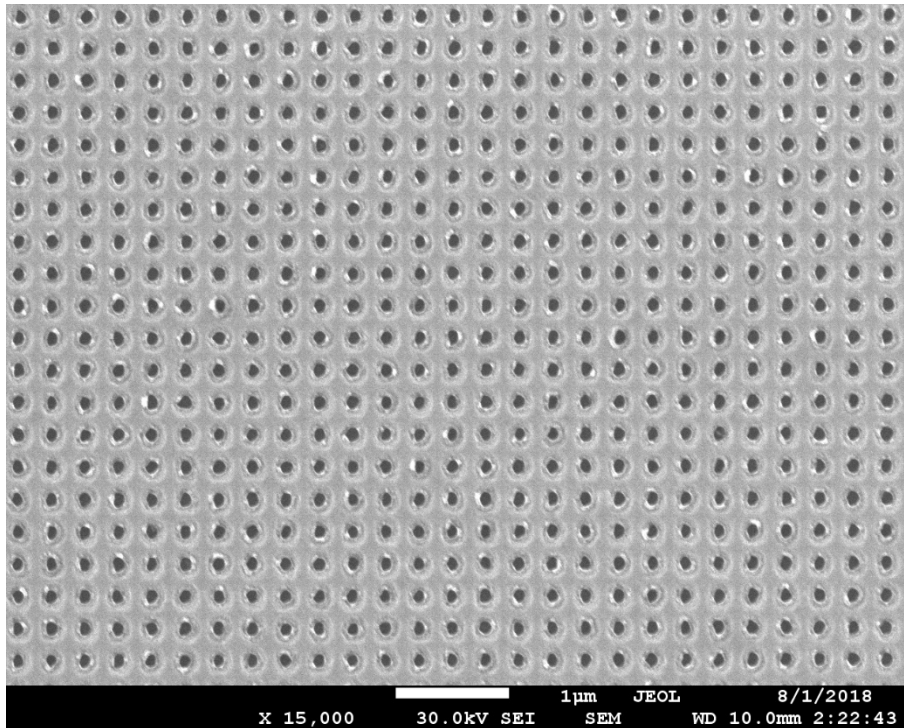
Contact patterns on <math><10\text{ }\mu\text{m}</math> MoTe₂ flakes.
After liftoff (left) and after development (right)

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



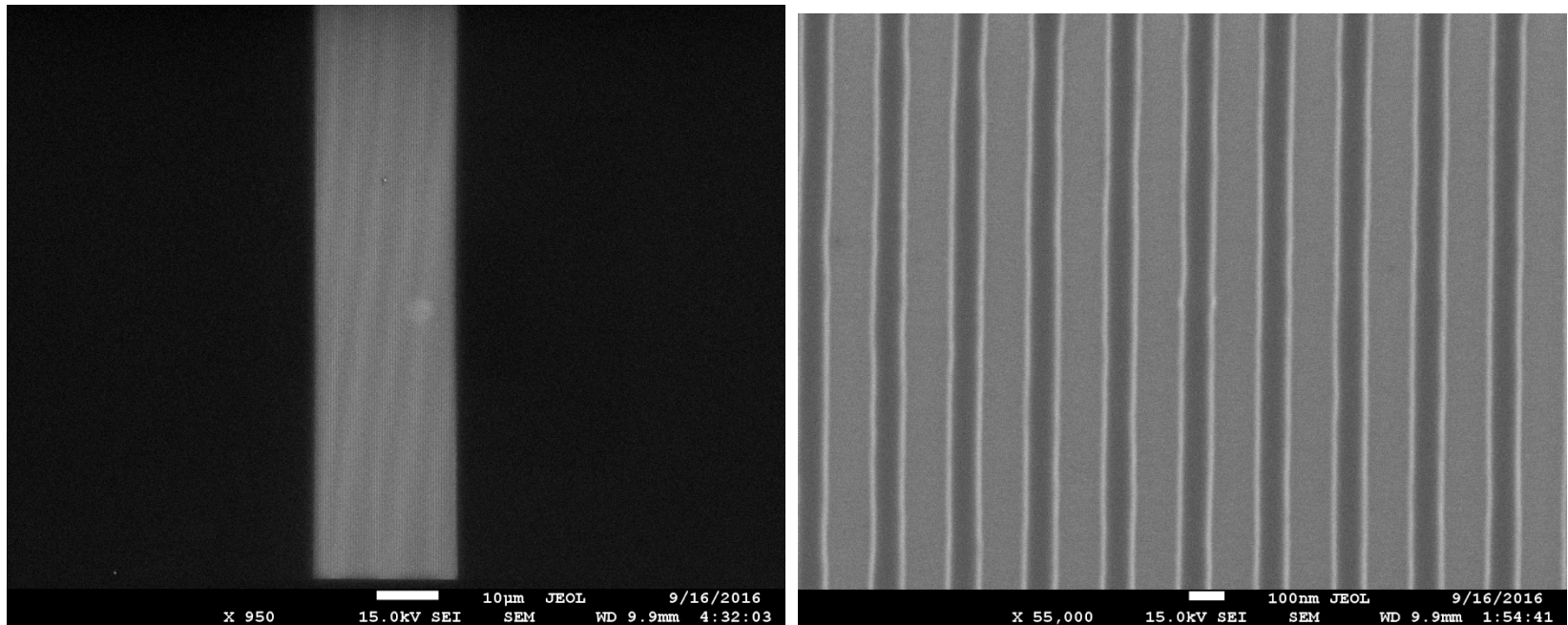
Fishnet pattern after development.
Field size 100 um and 120x120 nm grids

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



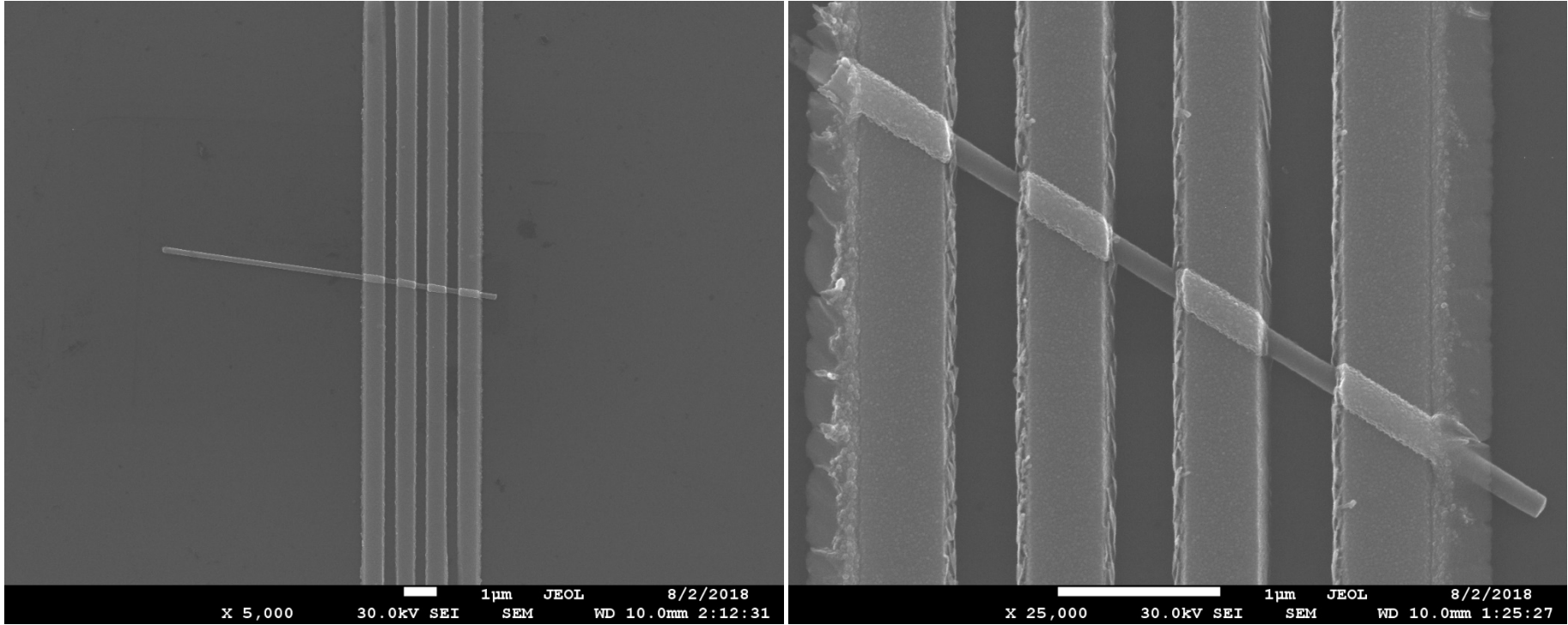
Fishnet pattern after deposition of Ag/Al₂O₃ multilayers and lift off.
Field size 100 µm and 120x120 nm grids

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



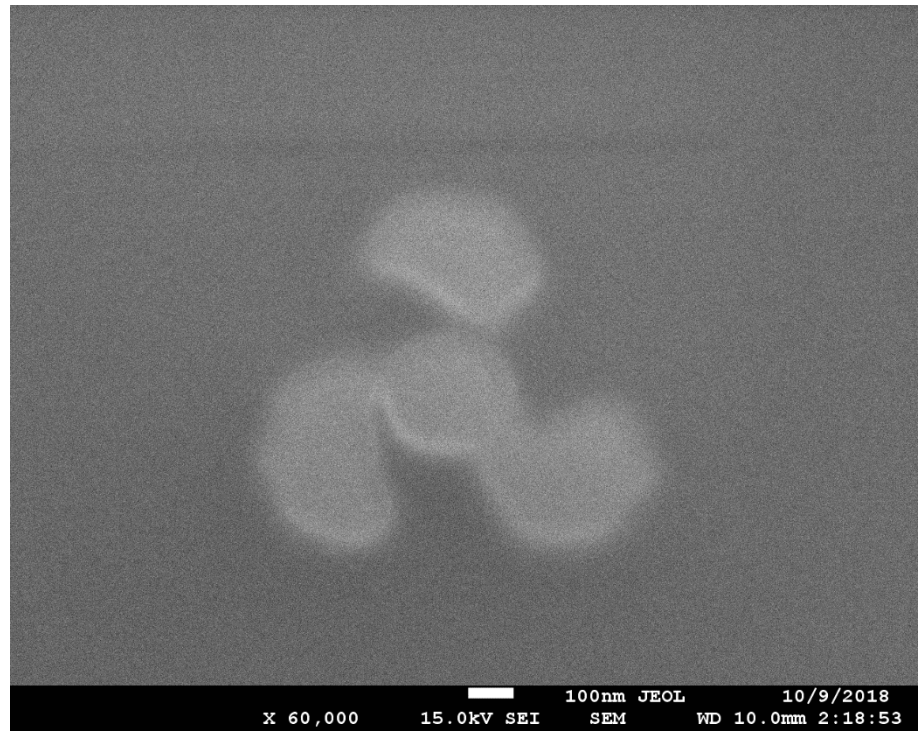
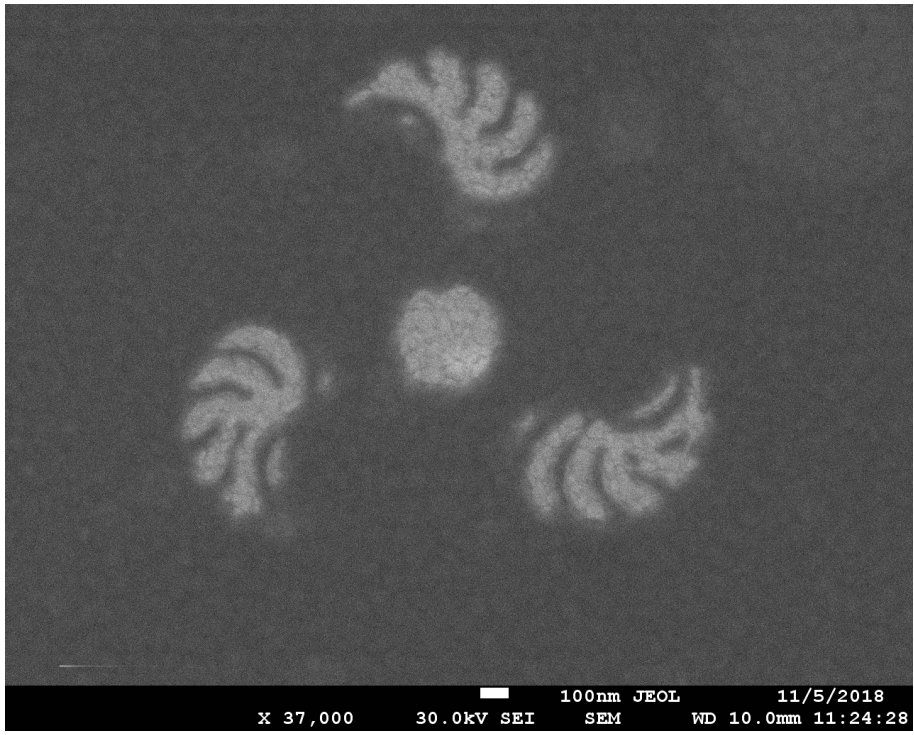
Line patterns for graphene etching.
Field size 100 μm and 100 nm lines and 100 nm gaps.

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



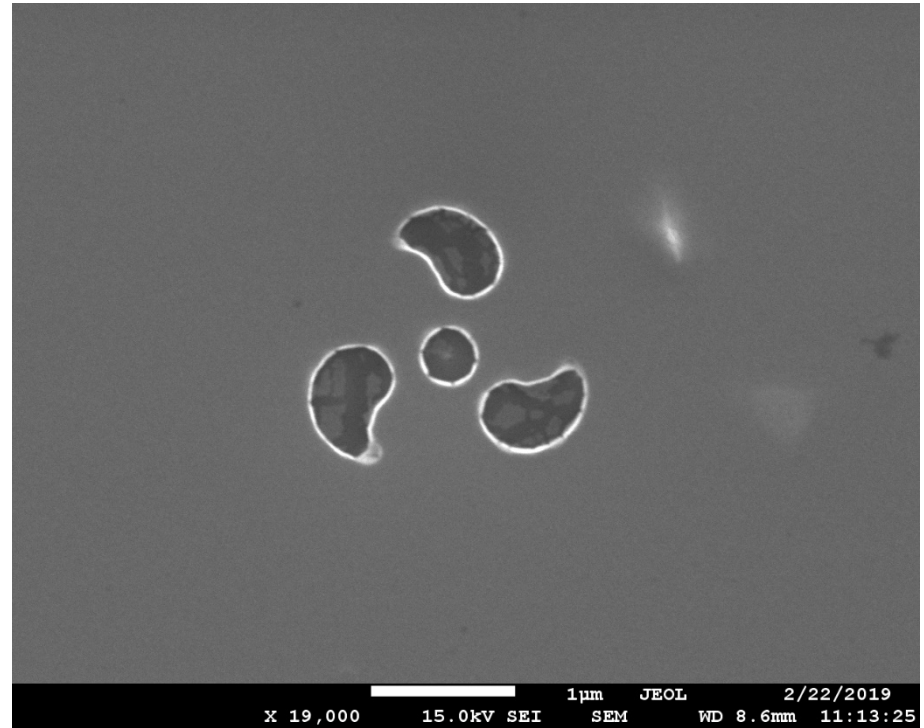
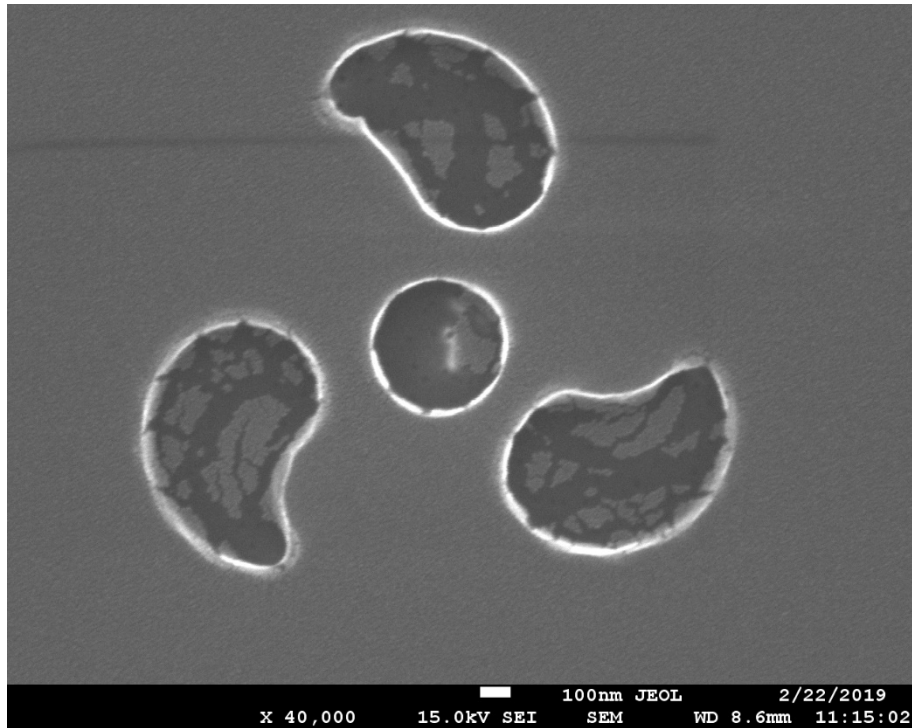
nanowire contact patterning.

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



Yin-yang pattern

Ebeam Lithography: JEOL 7001 SEM & XPG pattern generator



Yin-yang pattern on glass after development

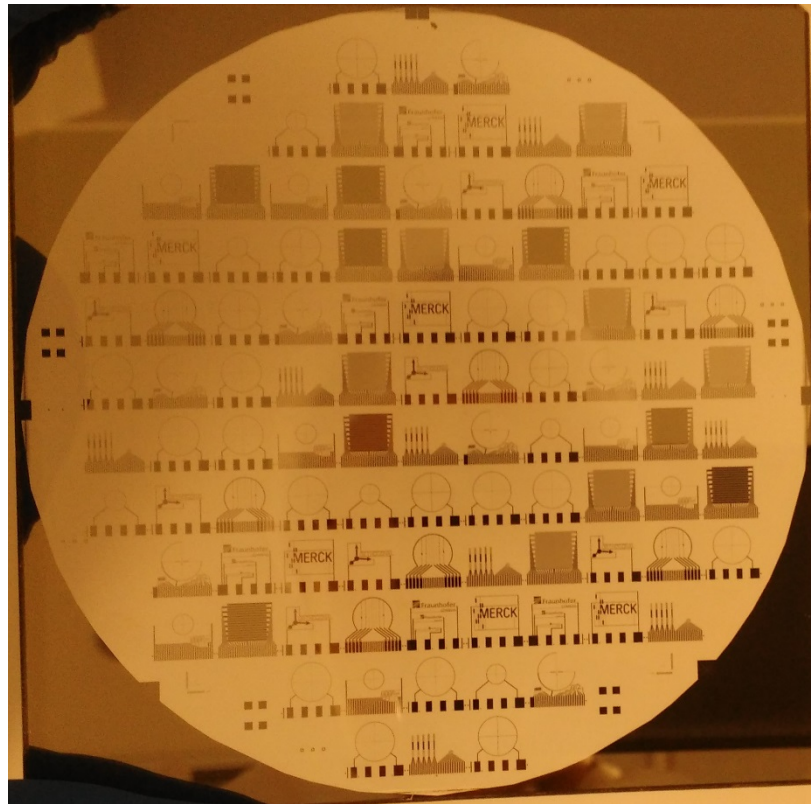
Maskless photolithography: Heidelberg Laser writer Chemical processing stations



Maskless photolithography: Heidelberg Laser writer

Photomask writing service

- Resolution $\geq 1\mu\text{m}$
and $\geq 10\mu\text{m}$ features
- 4 mm writer head for high resolution and
40 mm write head for fast writing



4"x4" Photomasks writing service

Maskless photolithography: Heidelberg Laser writer

Direct write pattern service

- Resolution $\geq 1\mu\text{m}$ and $\geq 10\mu\text{m}$ features
- 4 mm writer head for high resolution and 40 mm write head for fast writing

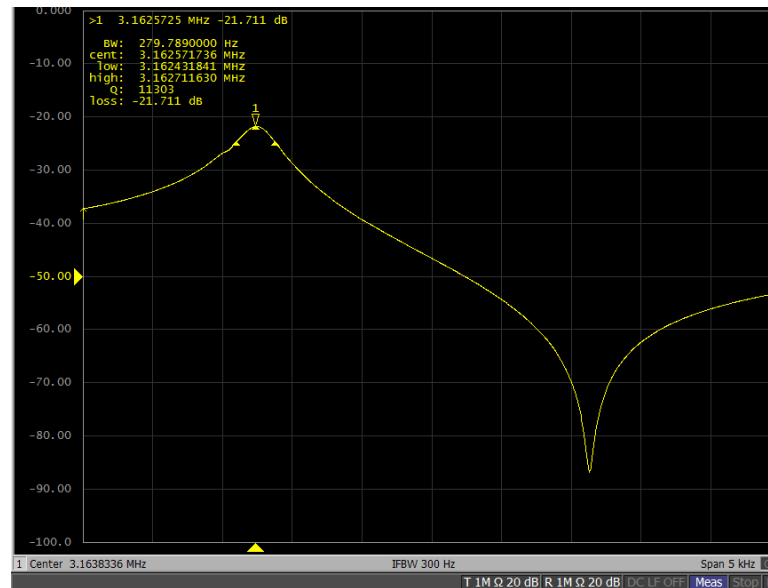
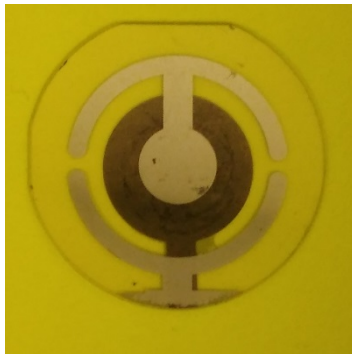


Ag Contact pattern on 1 inch Si wafer

Maskless photolithography: Heidelberg Laser writer

Example

- frequency response curve of LGS (Langasite) crystal material for viscosity measurement using BAW (bulk acoustic wave) resonator technique



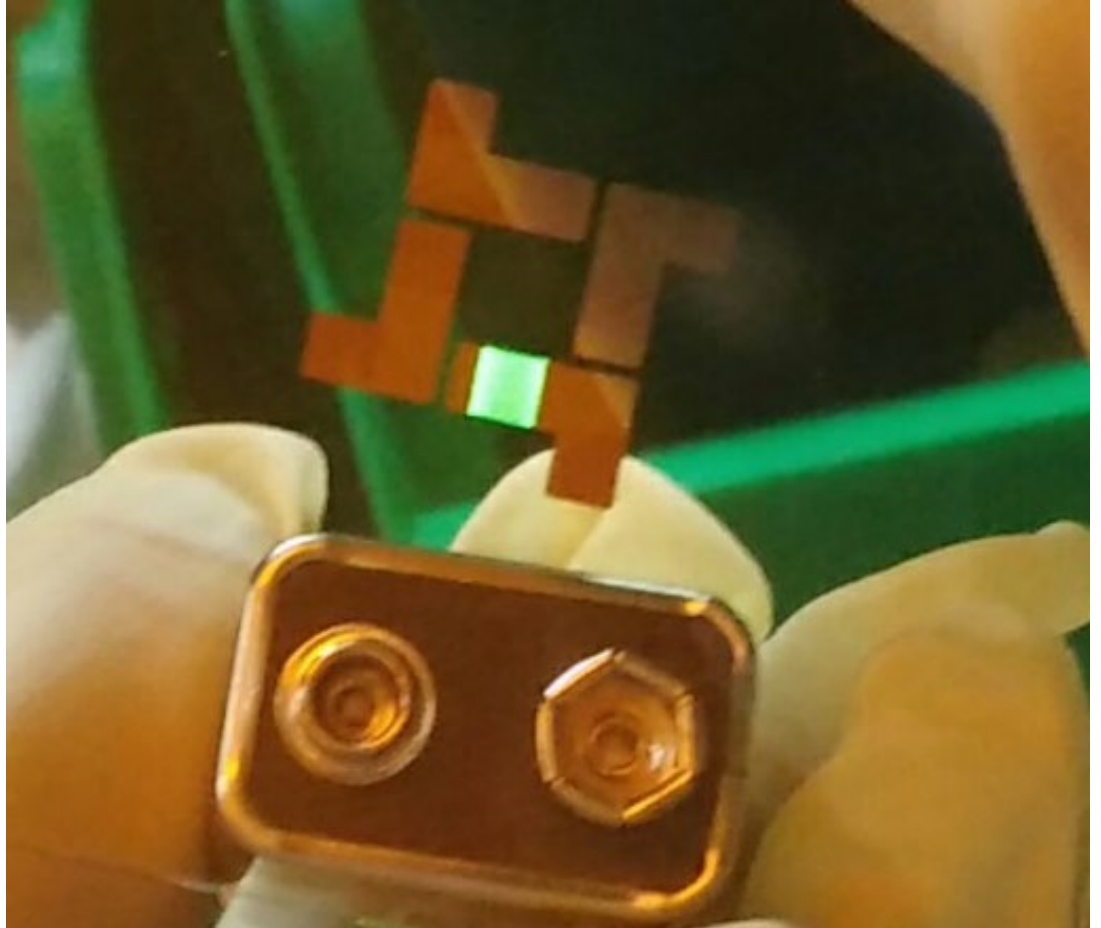
Trovato OLED deposition system



Trovato OLED deposition system

Al/LiF/AIQ/MBT/ITO

OLED fabrication



Reactive Ion Etching



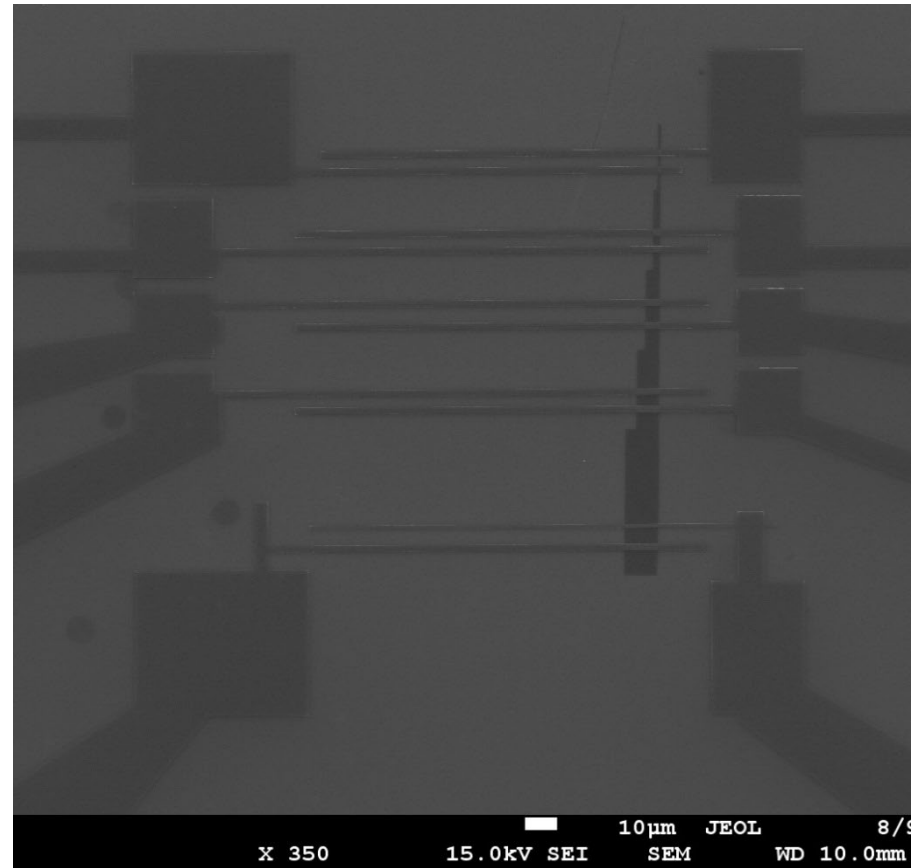
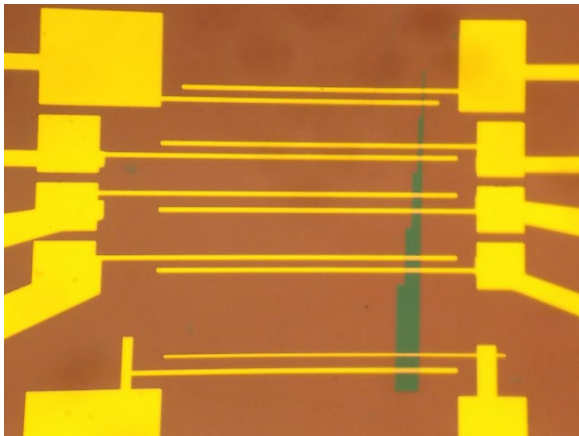
Reactive Ion Etching

- Etching MoS₂/SiO₂ thin film to Stair shape pattern.
- Blue area is MoS₂. pink area is SiO₂ without MoS₂
- The widths for each stair are: 0.5 μ m, 1.2 μ m, 3 μ m, 6 μ m, 11 μ m



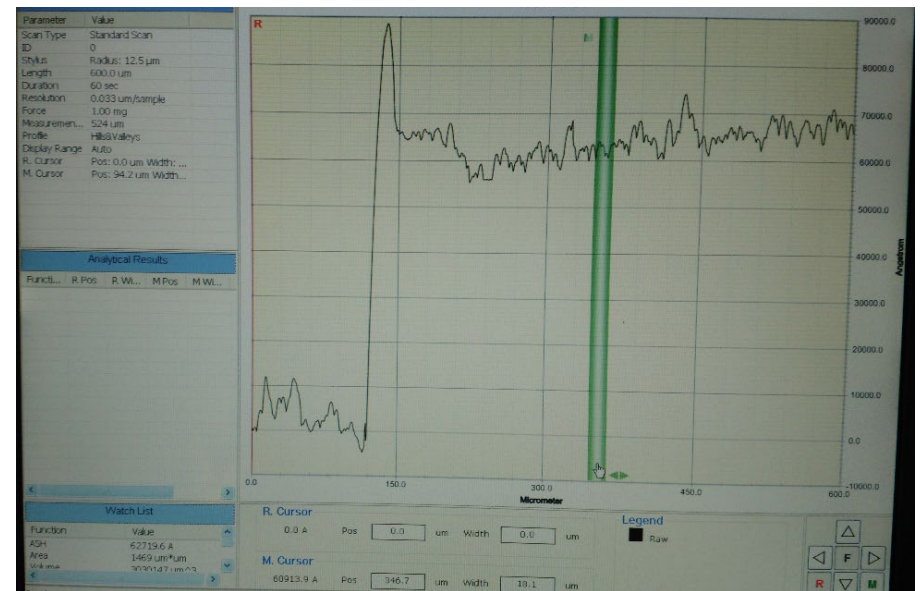
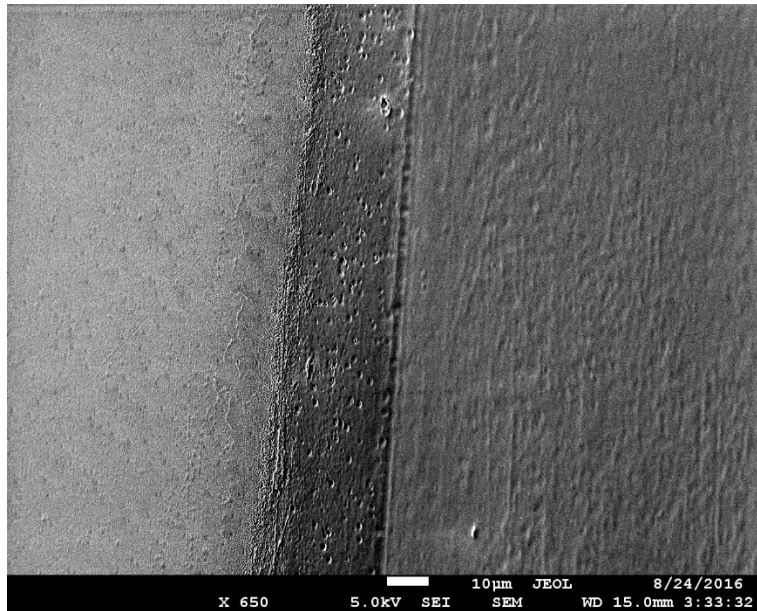
Reactive Ion Etching & Contact patterning

- Patterning the Ag contact on top of the etched MoS₂ stairs
- Ebeam evaporator for the Ag contacts



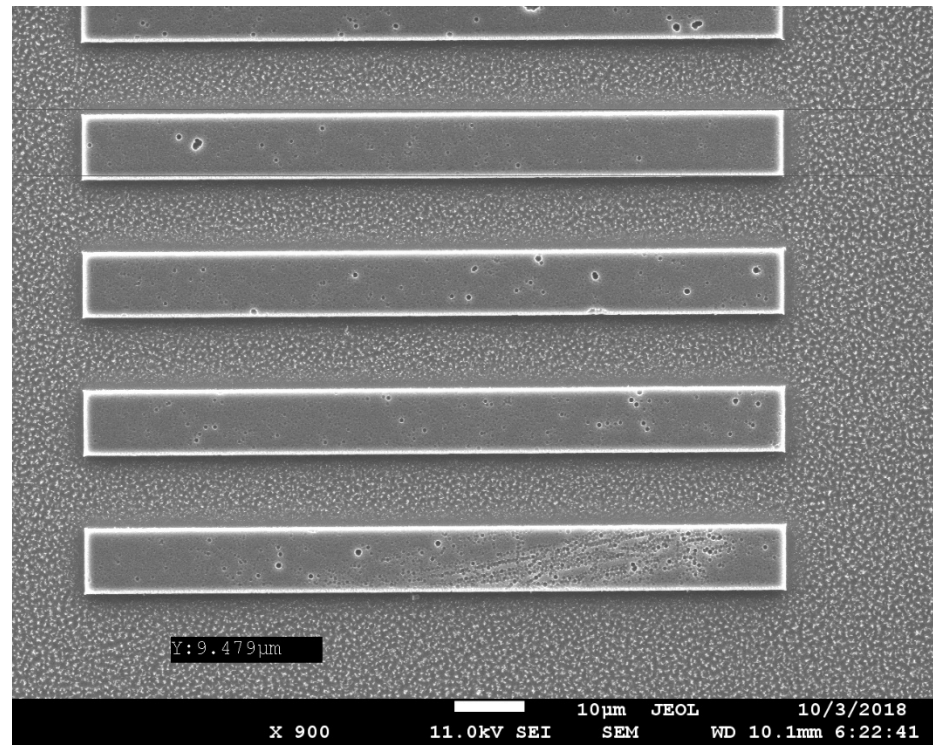
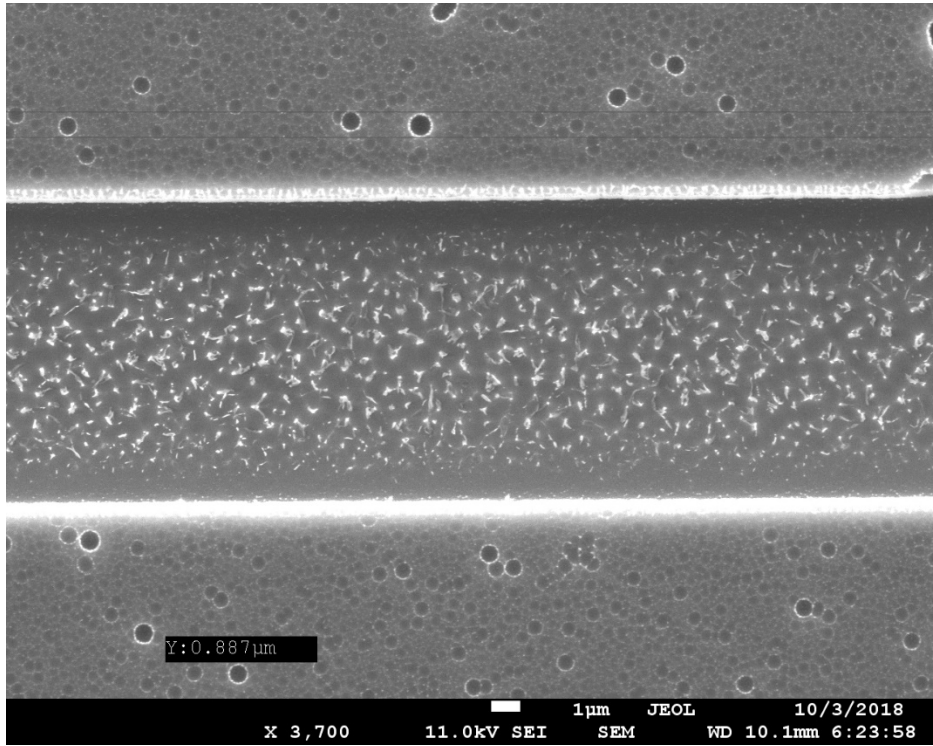
Reactive Ion Etching

- Etching quartz slide to depth of 6 μm or more



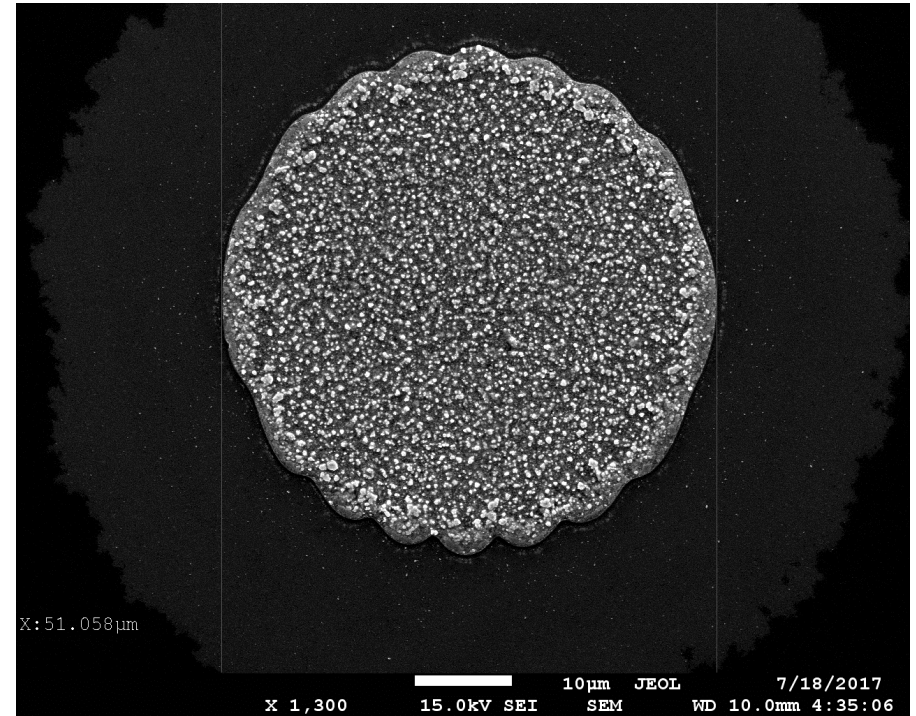
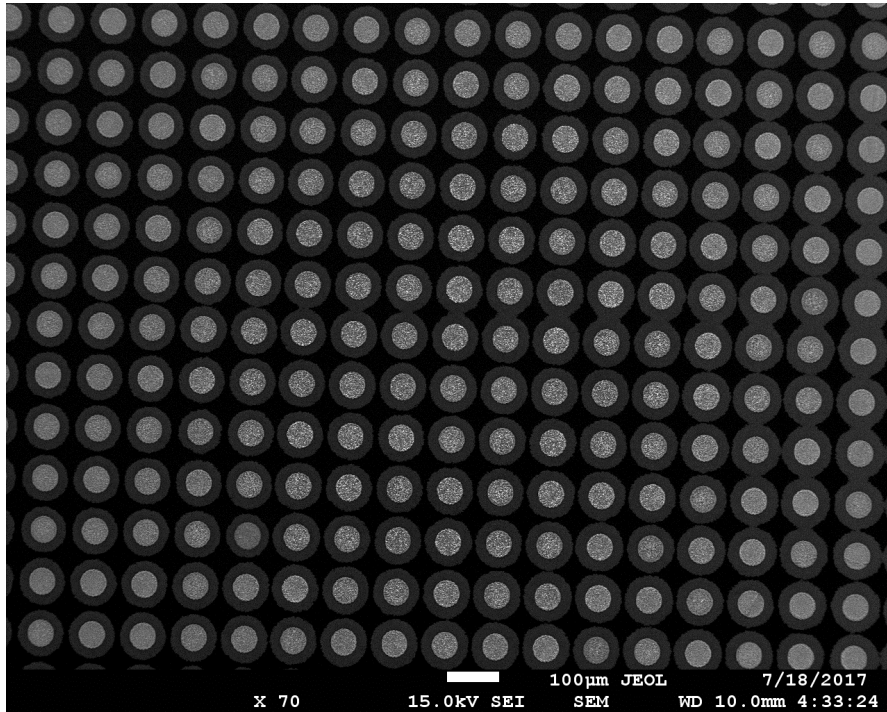
Titled cross section

Reactive Ion Etching



Silicon etch

Reactive Ion Etching



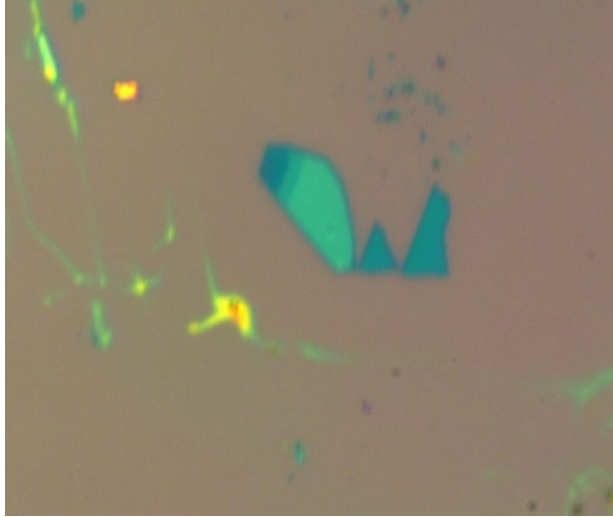
Silicon etch

Back-gated FETs from MoTe₂ flakes

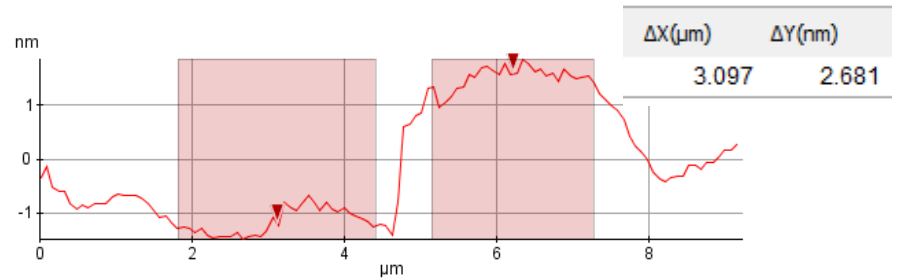
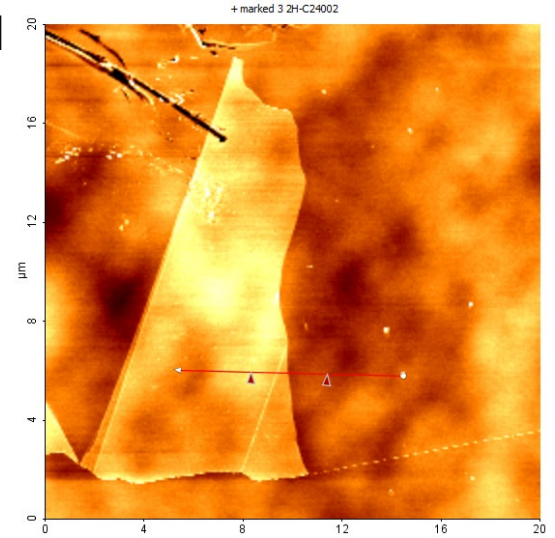
Ben Sirota

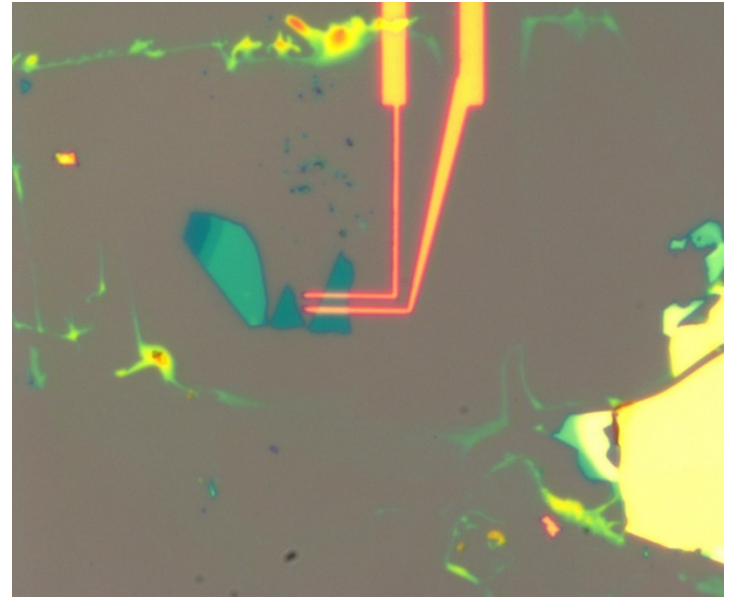
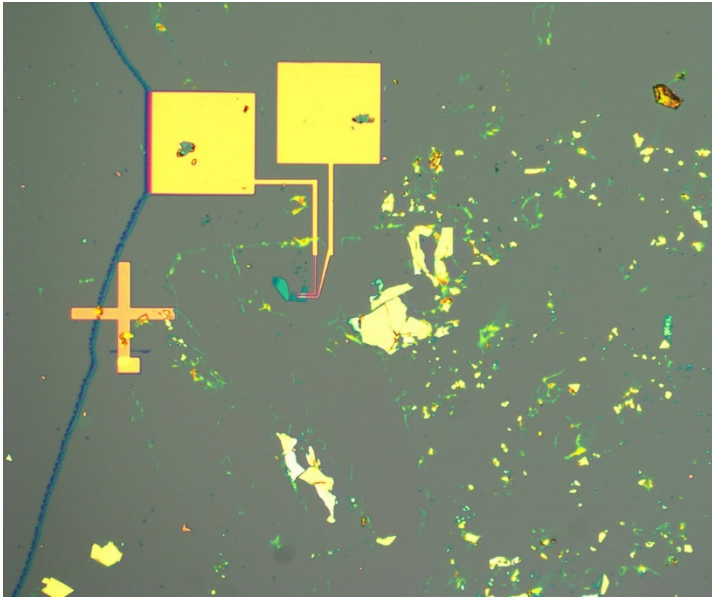
Materials Science and Engineering

MoTe₂ flakes were exfoliated from bulk crystals on silicon substrates with a 300 nm SiO₂ layer. Flakes were identified using optical microscope.

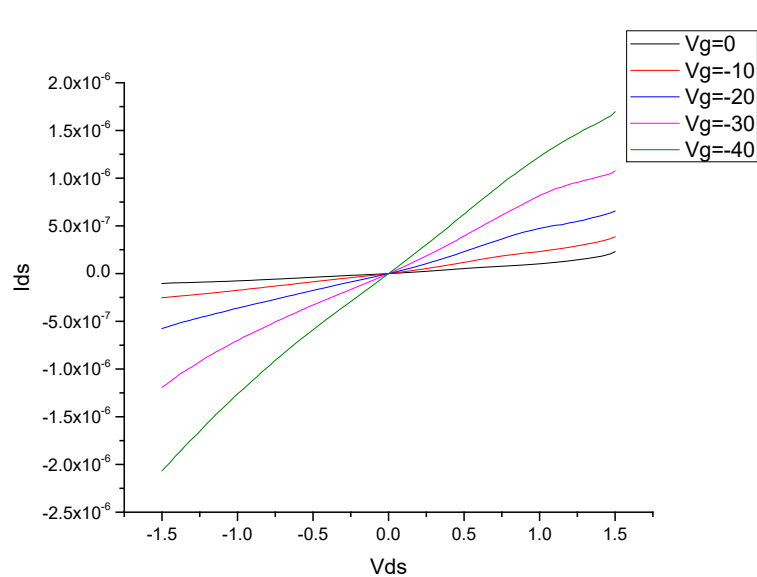


Flake size and thickness was confirmed using AFM. In this case, the thickness was measured as 2.681 nm which is about 3 atomic layers.

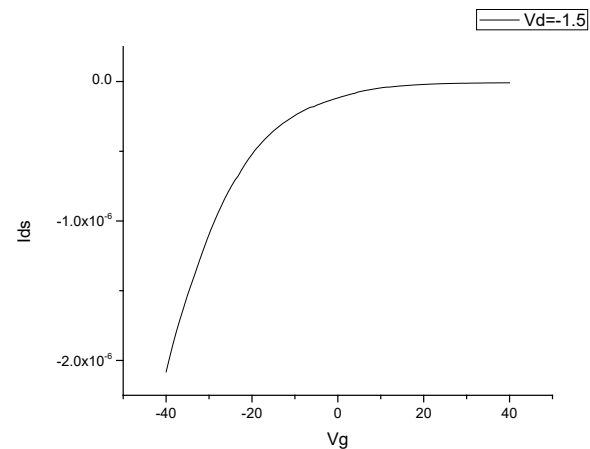




Electrical contacts were designed and written using electron beam lithography. Ti/Au (5/20 nm) metal contacts were deposited by electron-beam evaporation and lift-off. The two deposited contacts form the source and drain while the silicon substrate is used as the gate electrode. Finally, the SiO₂ insulative layer acts as a dielectric layer. Therefore these devices are known as back-gated field effect transistors.

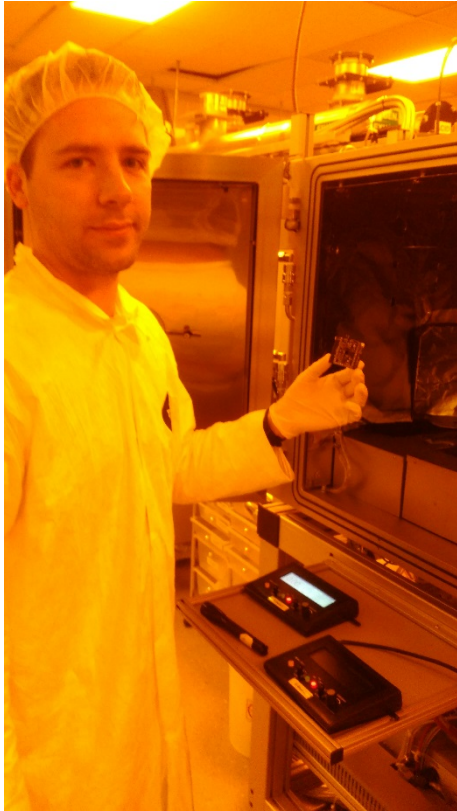


2H-C24
3-2
+M4



Electrical properties were measured using a voltmeter and probe station. The exfoliated flakes demonstrate very responsive FET properties with a high on/off ratio. The MoTe₂ flake exhibits p-type semiconductor behavior.

1st External user application



KubOS, inc. testing their mini Satellite module with Oerlikon High vacuum chamber.