SOLID STATE PROTEIN SENSOR

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Why is it important?

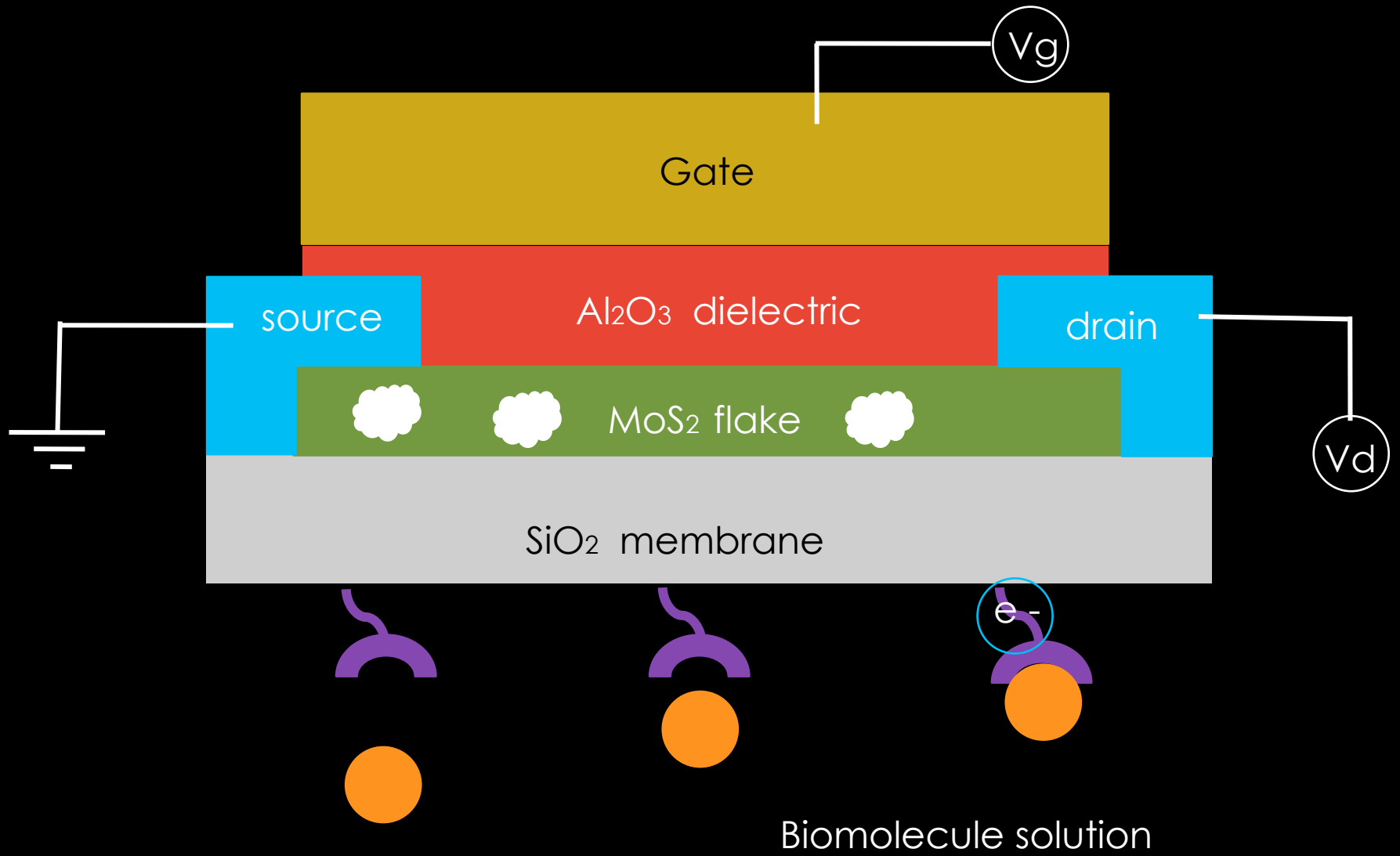
Personalized medicine

- Disease Identification
- Treatment (effects of pharmaceuticals)
- Identification of Neurotransmitter

What is a solid state protein sensor ?

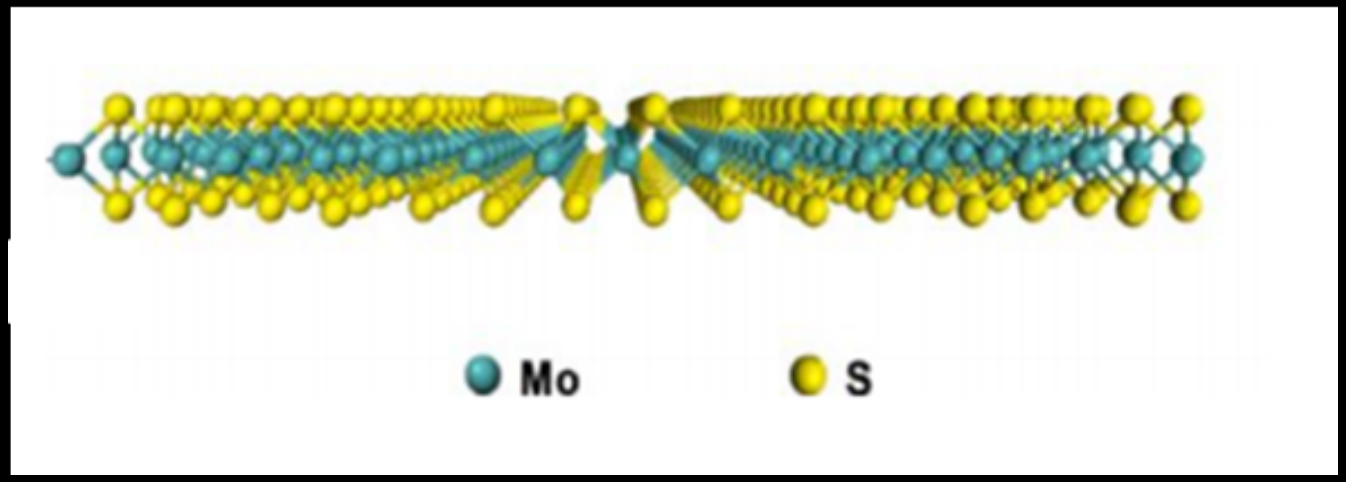
- A device that is used to detect the presence of specific atoms, molecules and ions in liquids by changing the amount of current.

How does it work?



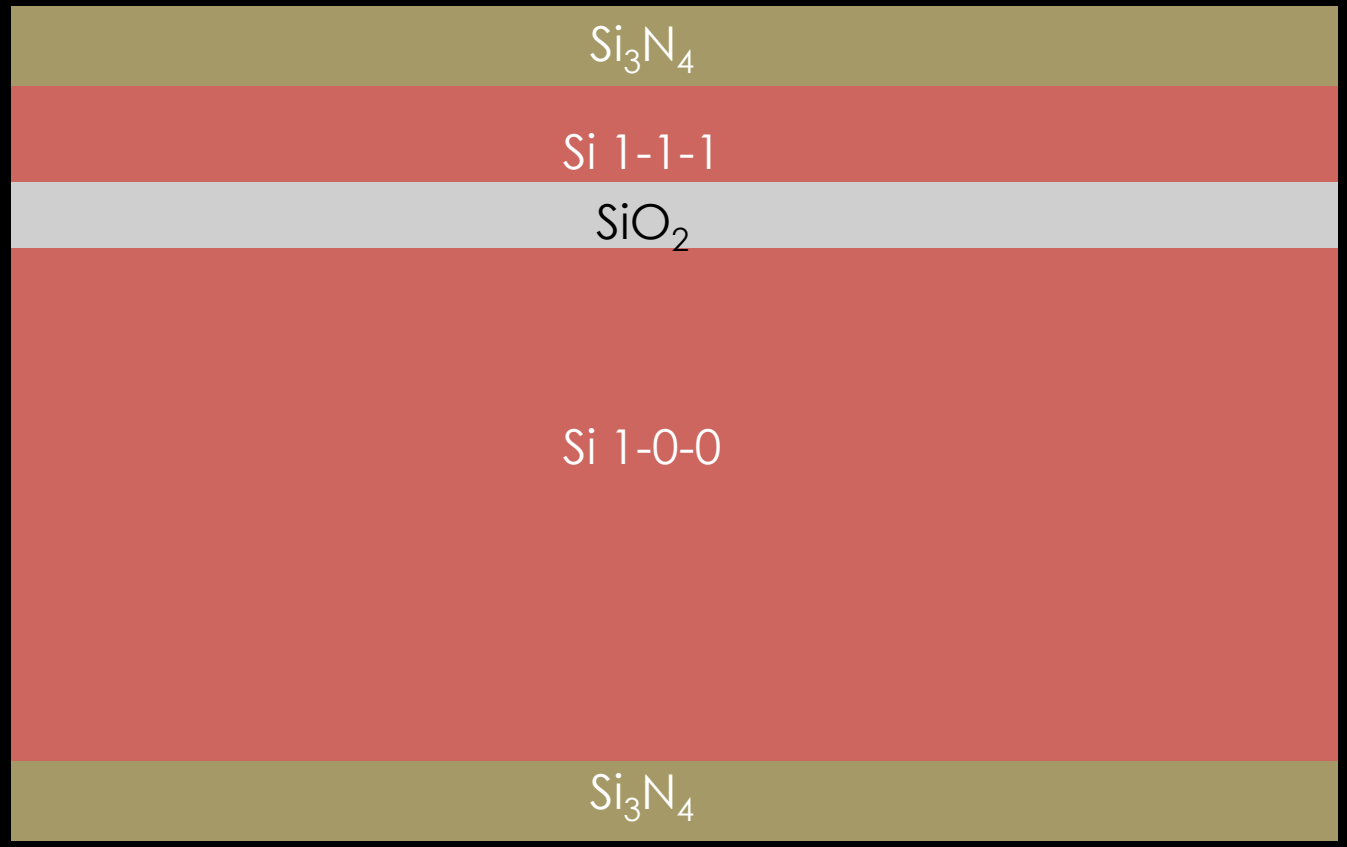
Why use MoS_2?

MoS_2

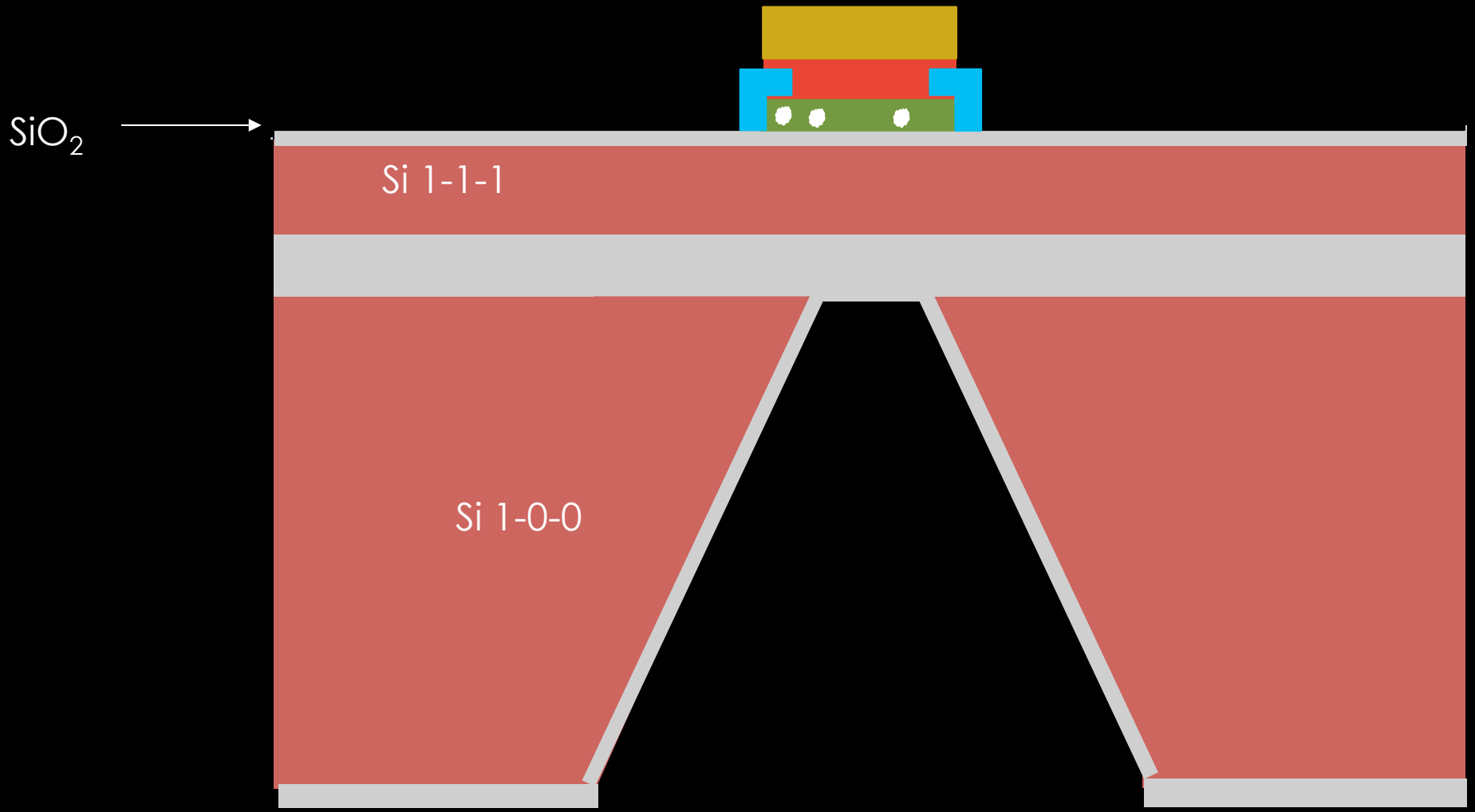


Energy Band Gap: 1.2-1.8 eV

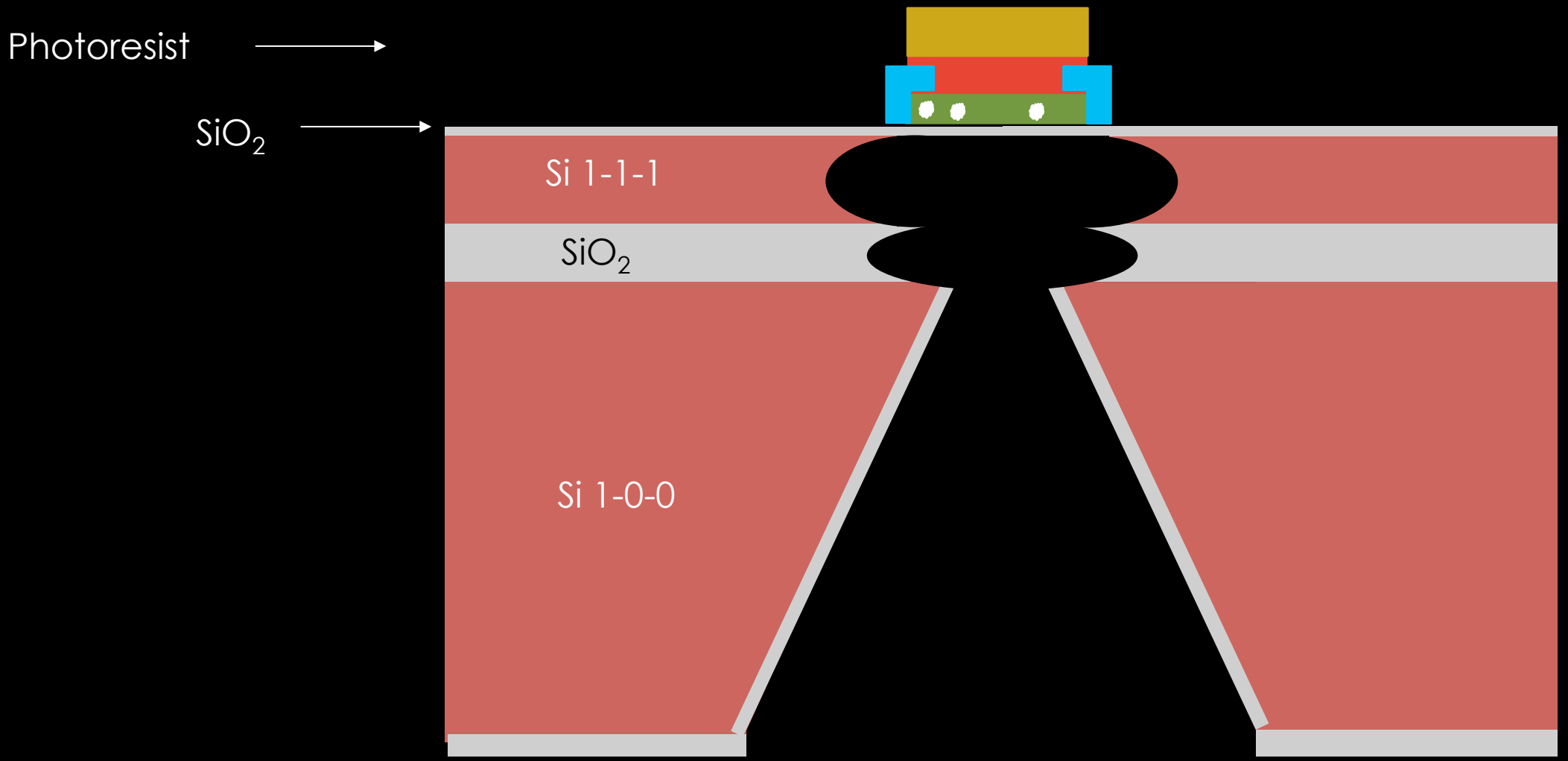
Construction of target substrate out of a silicon-on-insulator (SOI) wafer



Etch, oxidize & place device on membrane

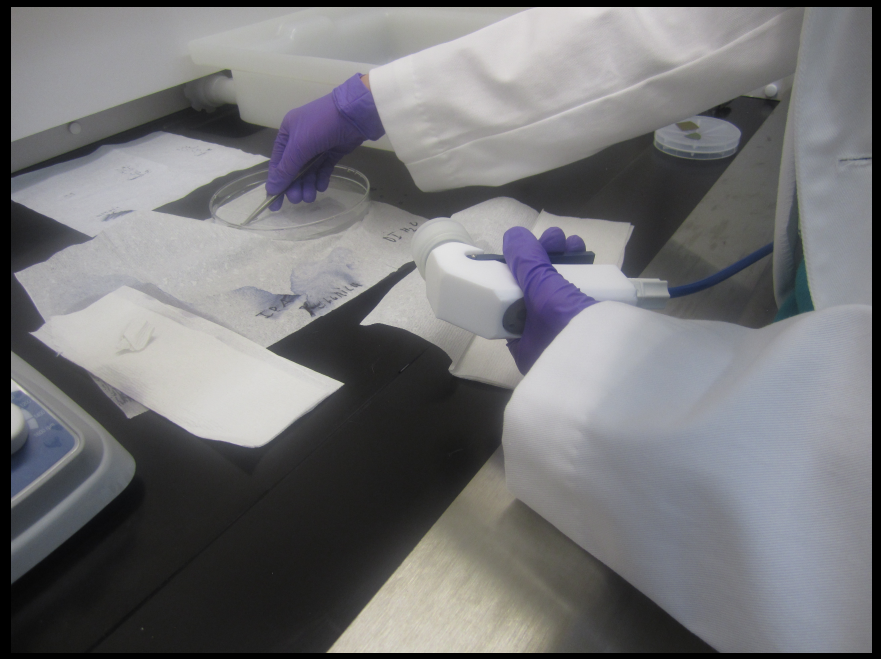


Etched and oxidized



Exfoliate MoS_2 flakes

Cleaning the dummy and target substrates



Acetone
70 C
30 mins.

→

Isopropyl Alcohol
Room temp
5 mins.

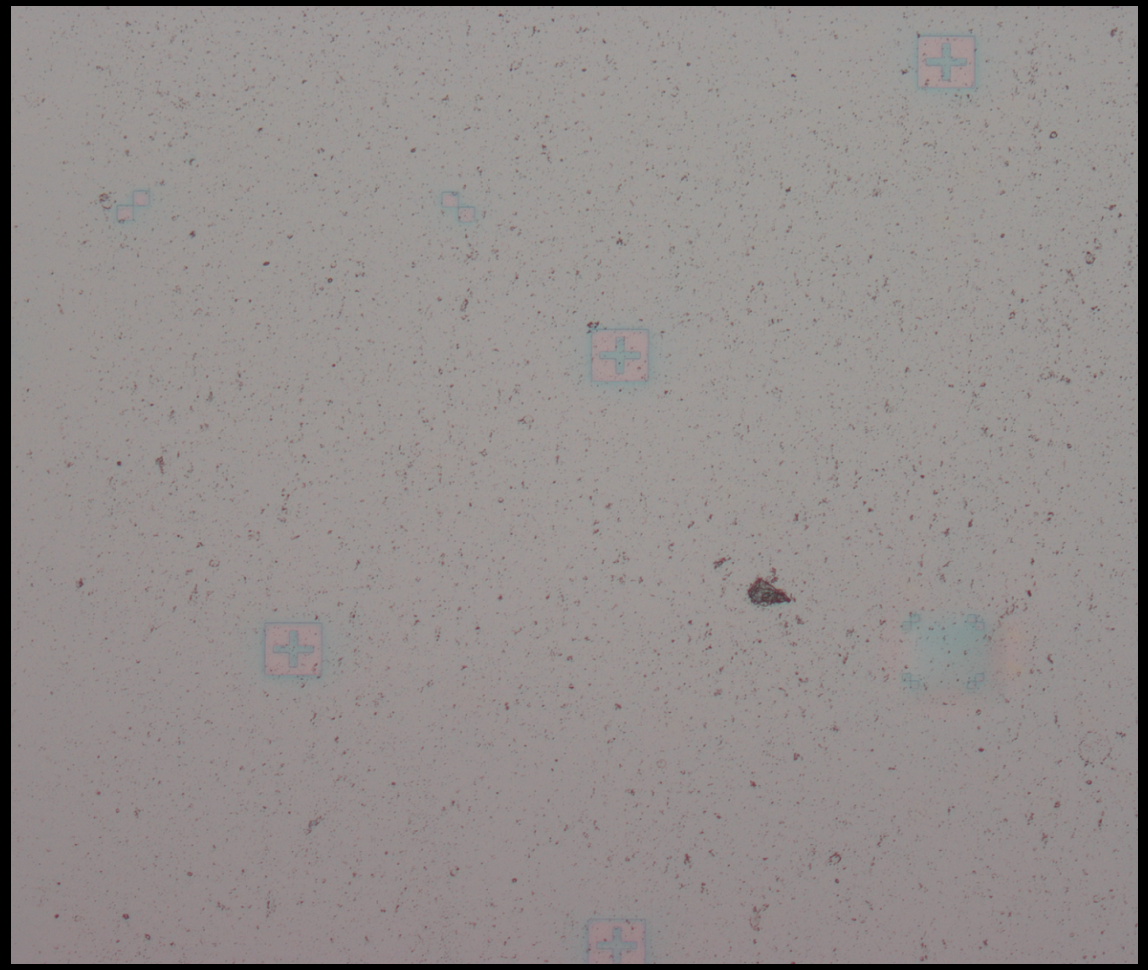
→

De-ionized Water
Room temp
1 min.

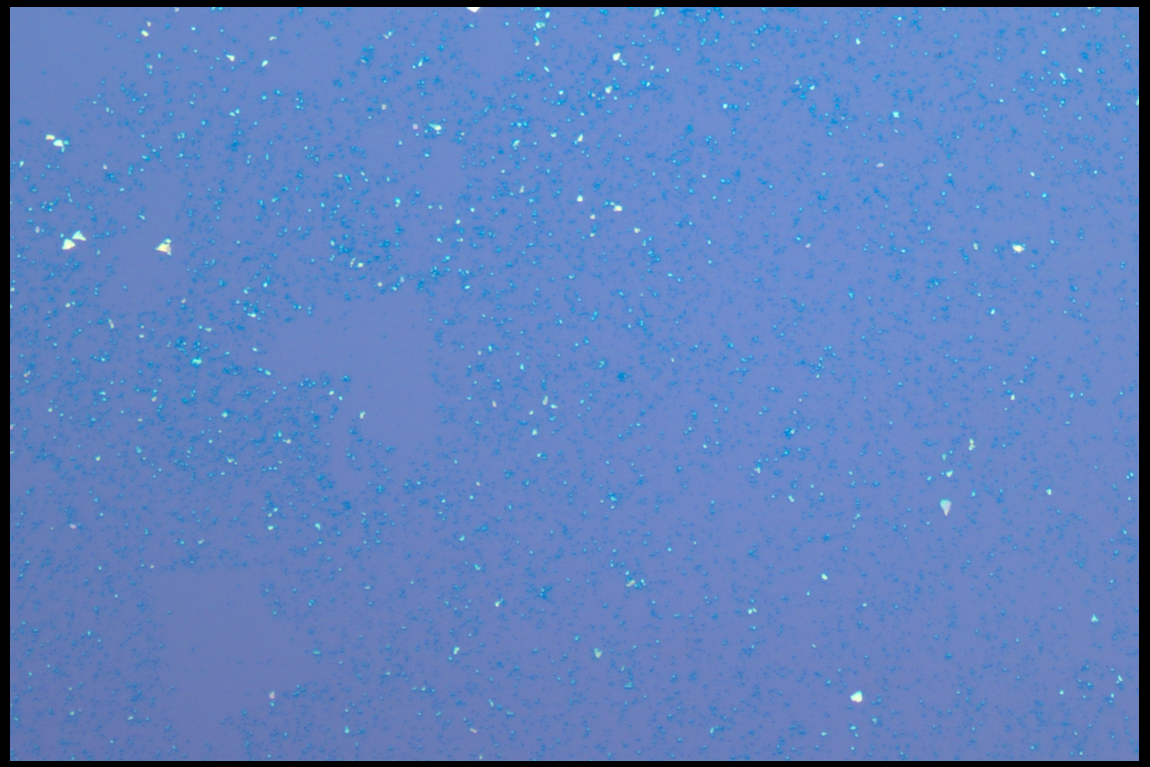
→

Blow dry with nitrogen gas gun

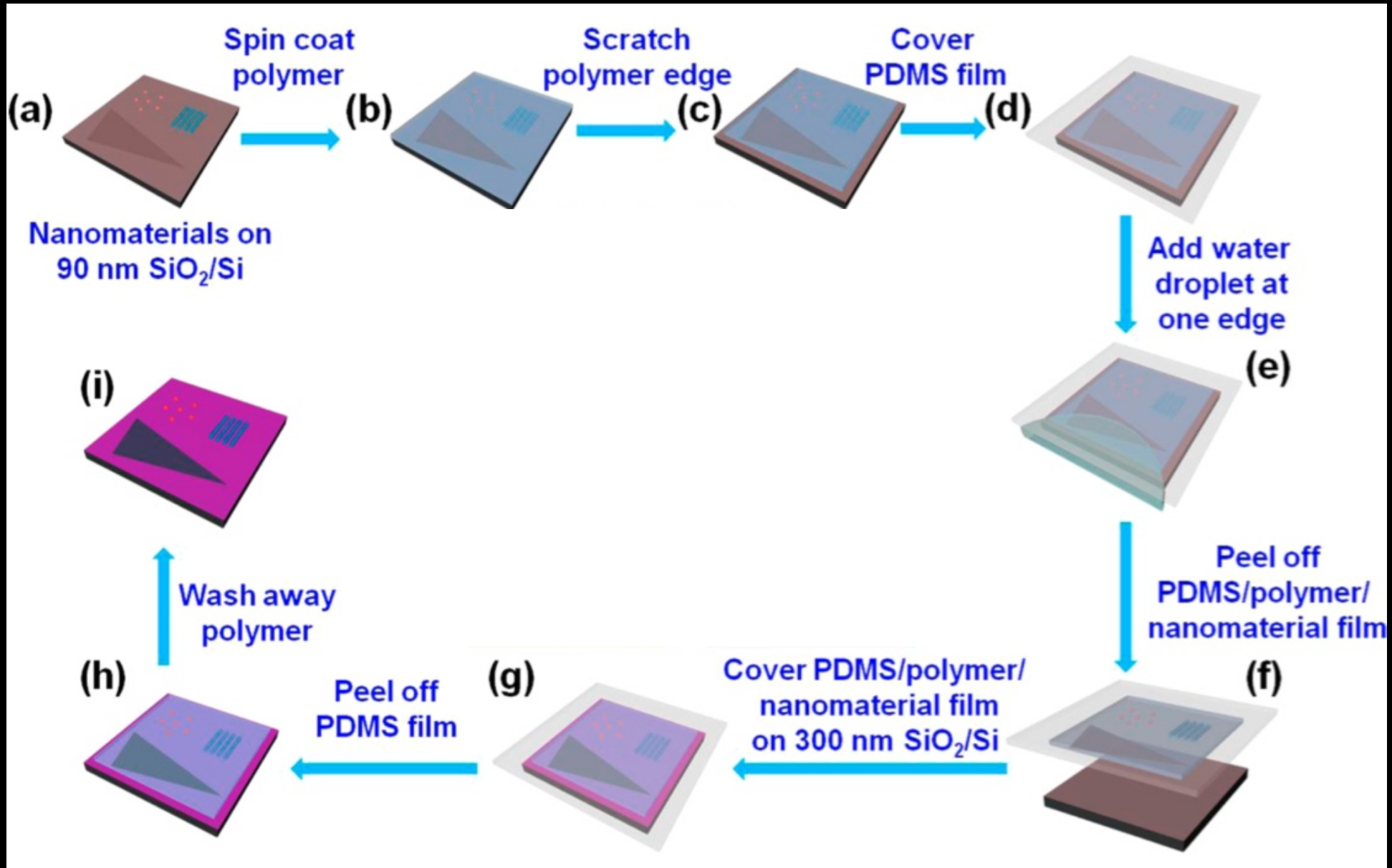
Before and after cleaning



Deposit MoS_2 flakes onto dummy substrate

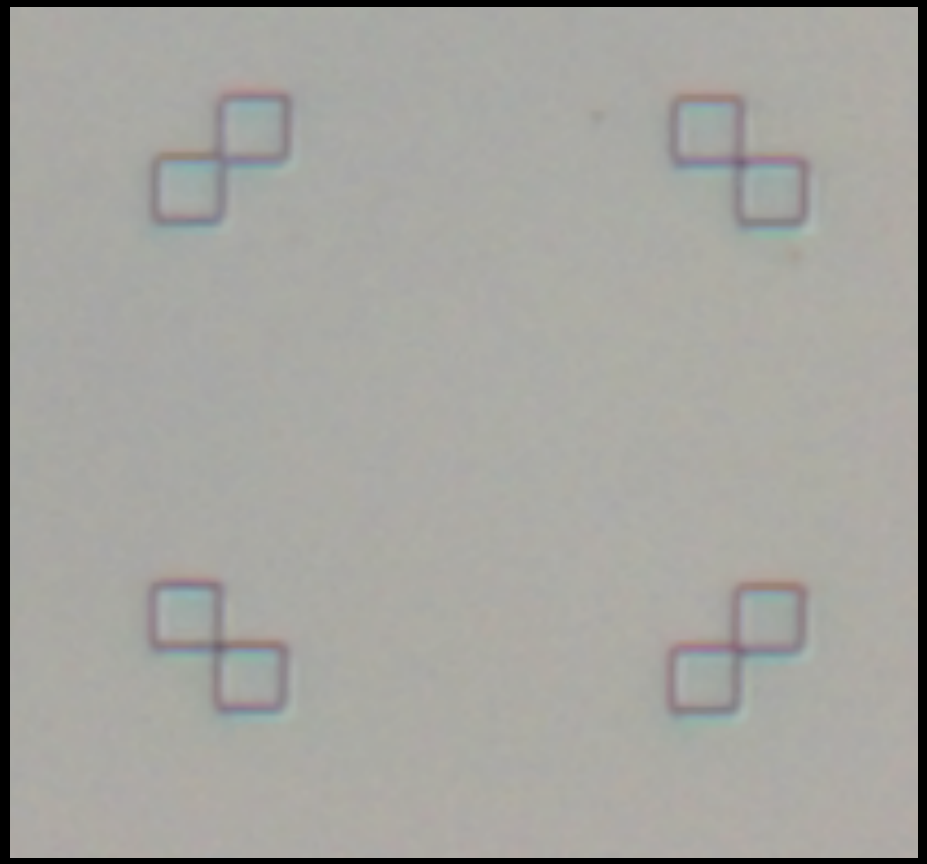


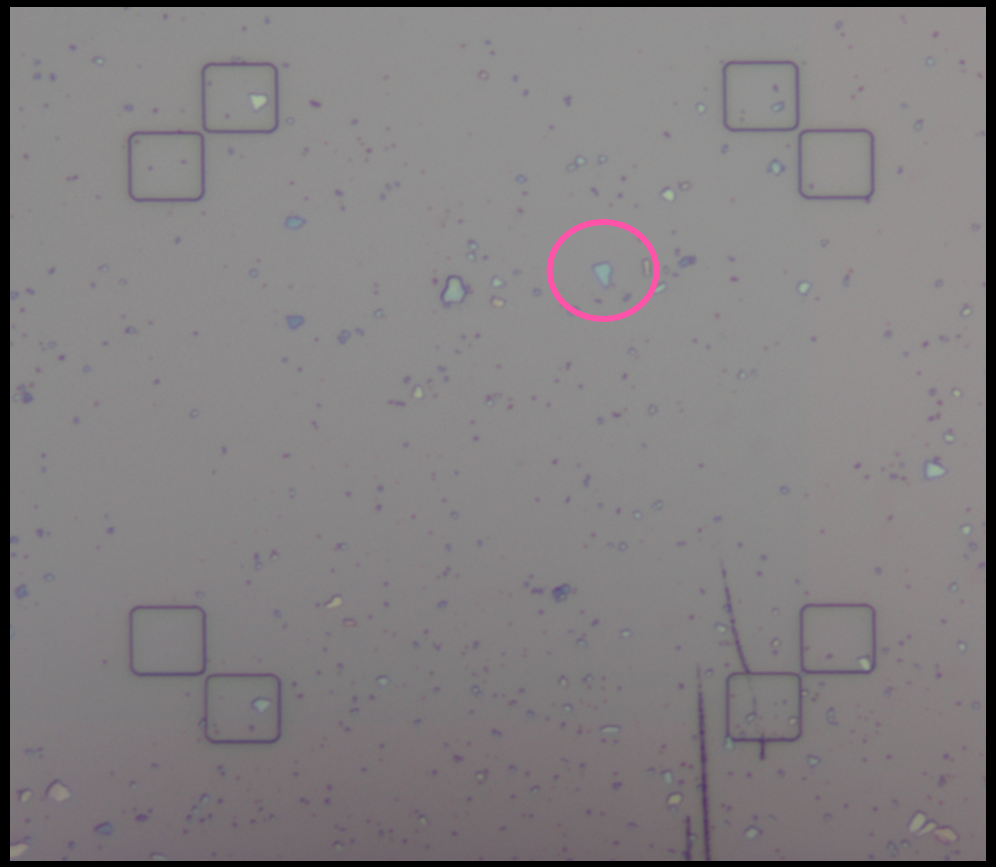
Transfer process



Hai Li, Jumiati Wu, Xiao Huang, Zongyou Yin, Juqing Liu, and Hua Zhang, 2014. ACS Nano, J. 8, 6564.

Transfer of MoS_2 flakes from dummy onto target





Criteria for desired flakes

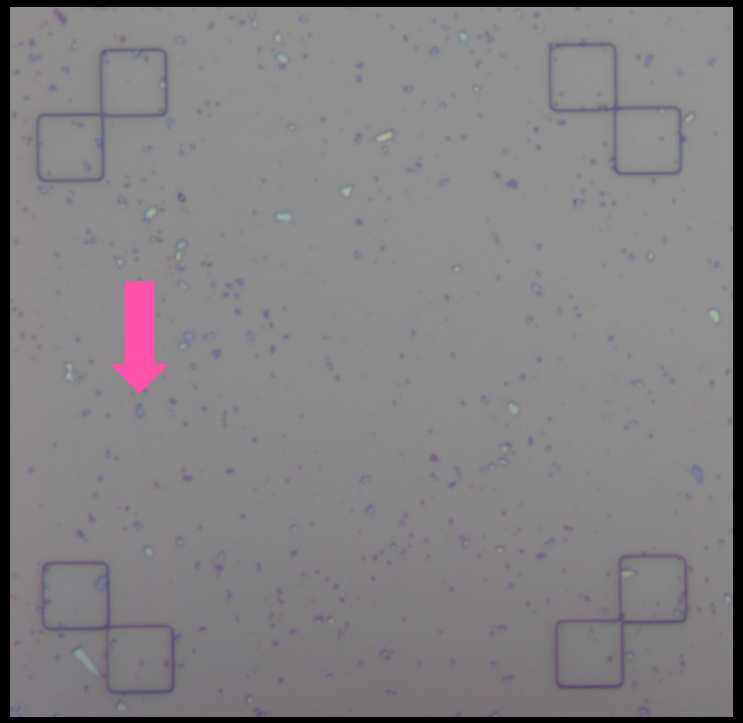
- 2 – 10 μm in length and width
- Roughly rectangular shape

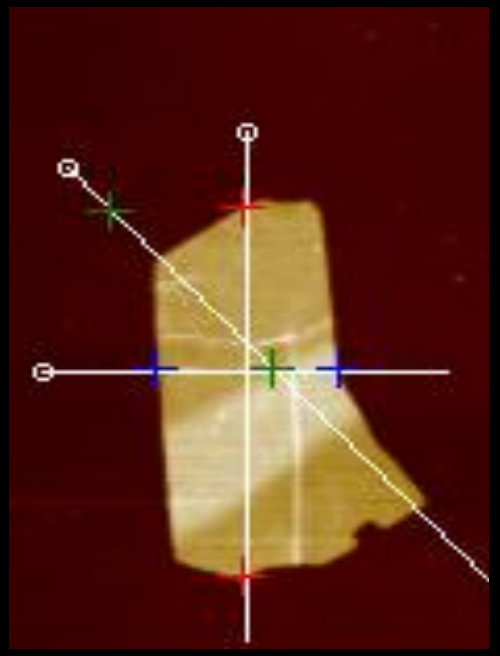
} Optical microscopy (OM)

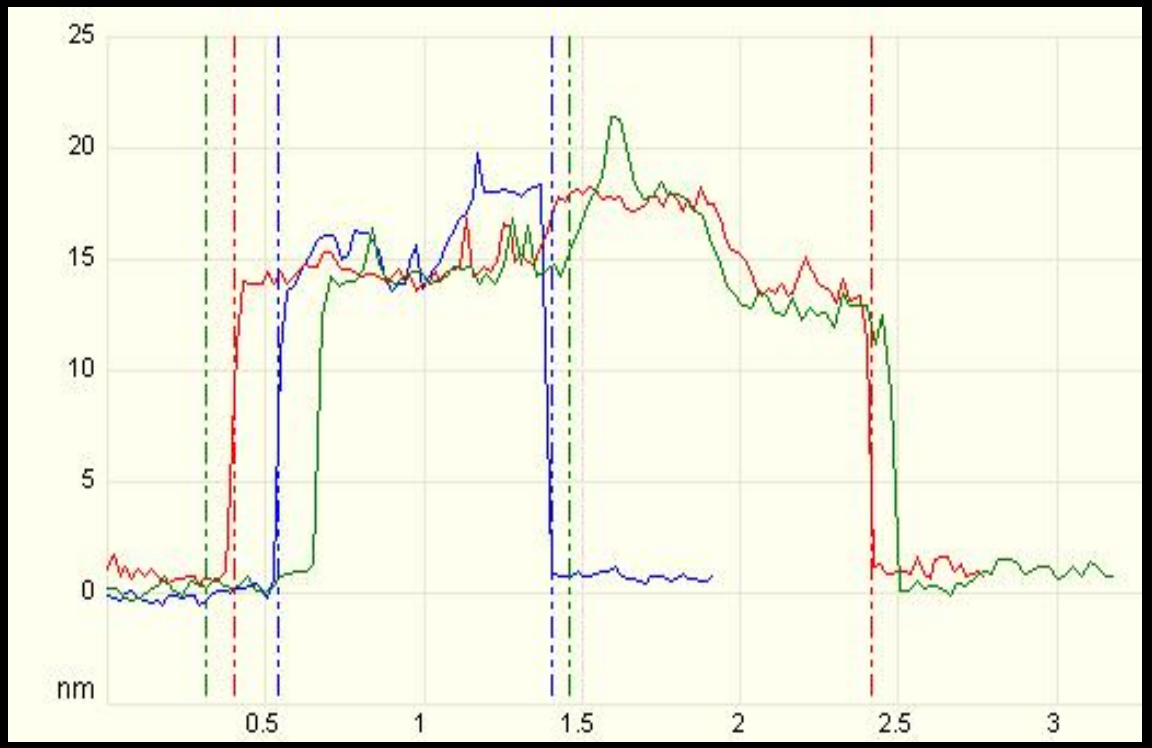
- 10 – 20 nm thick
- Relatively flat surface

} Atomic force microscopy (AFM)

A rejected MoS_2 flake

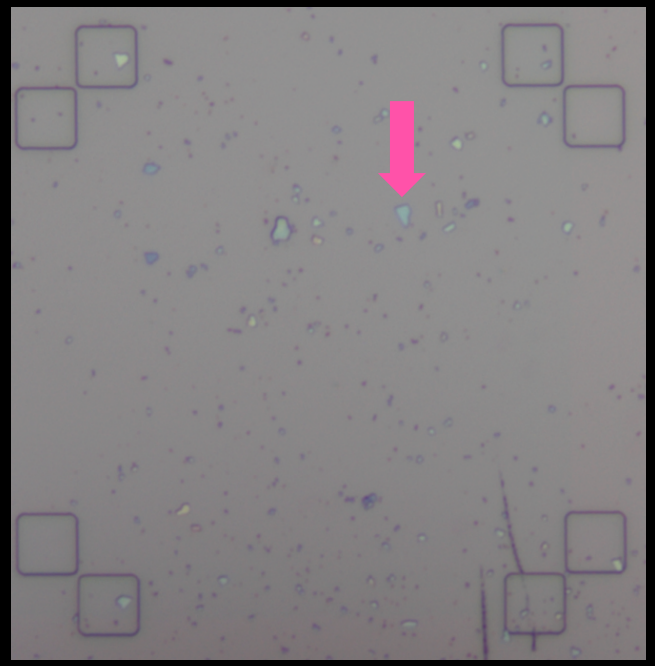


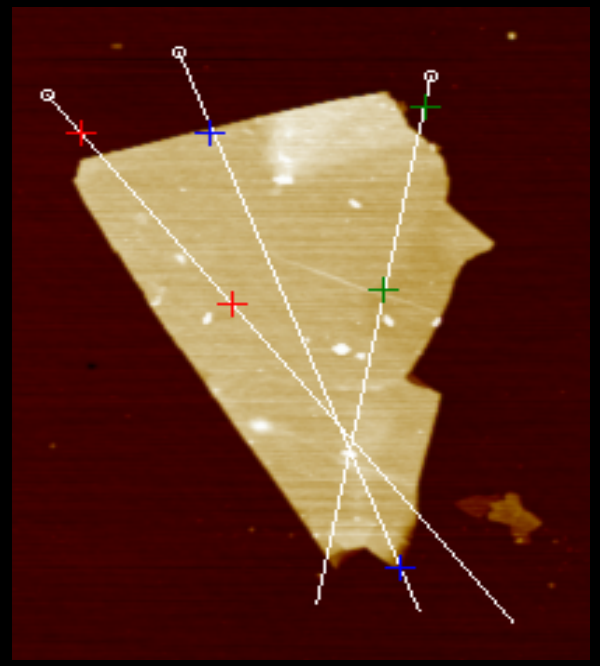


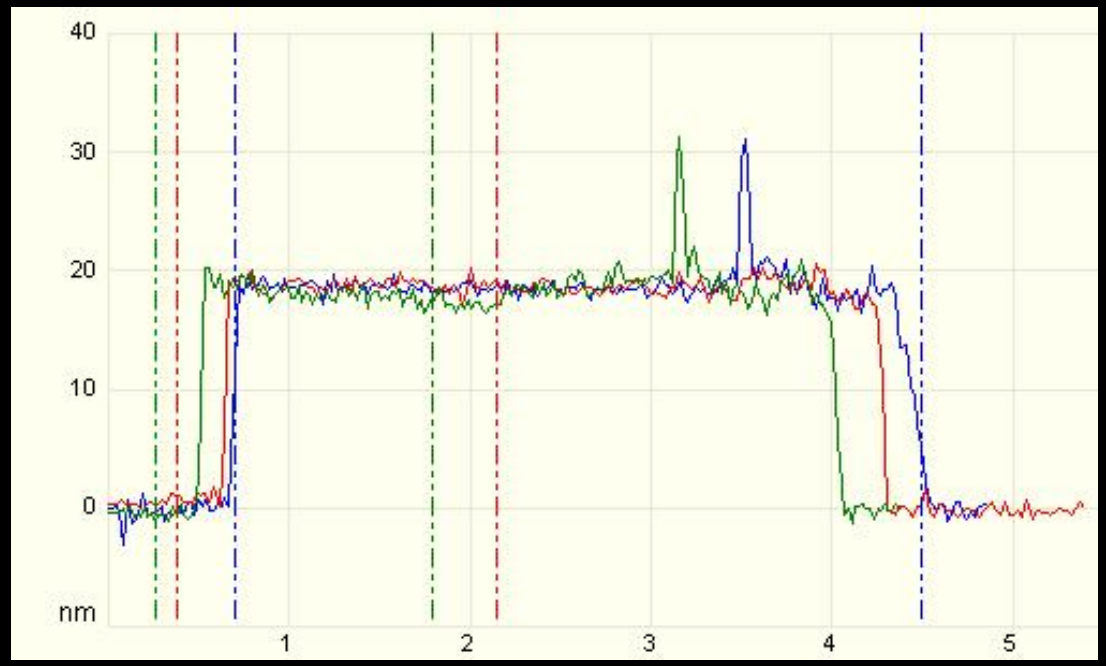


Length: ~0.861 μm
Width: ~2.016 μm
Average Thickness: 15.020 nm

A candidate MoS_2 flake

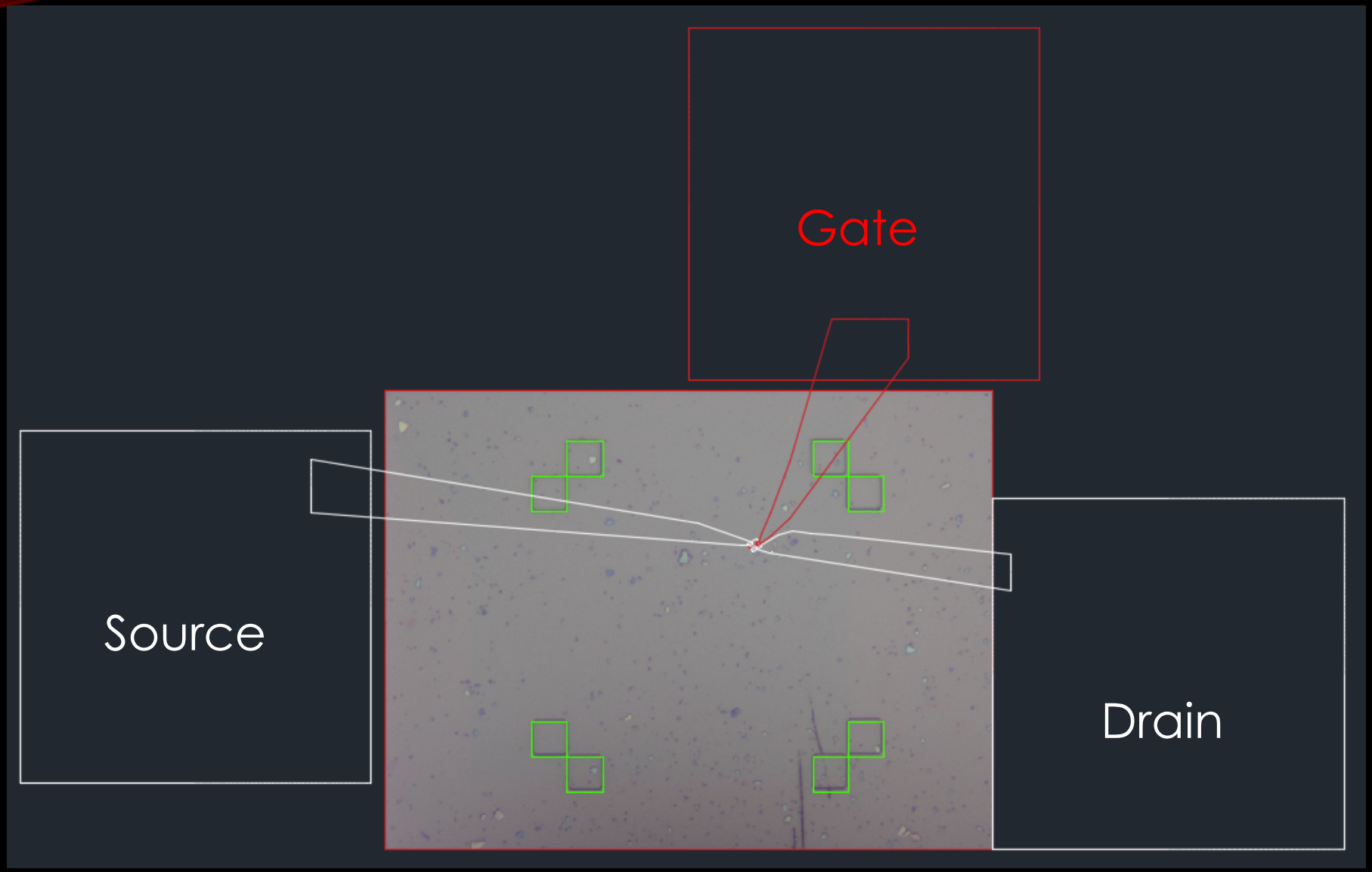




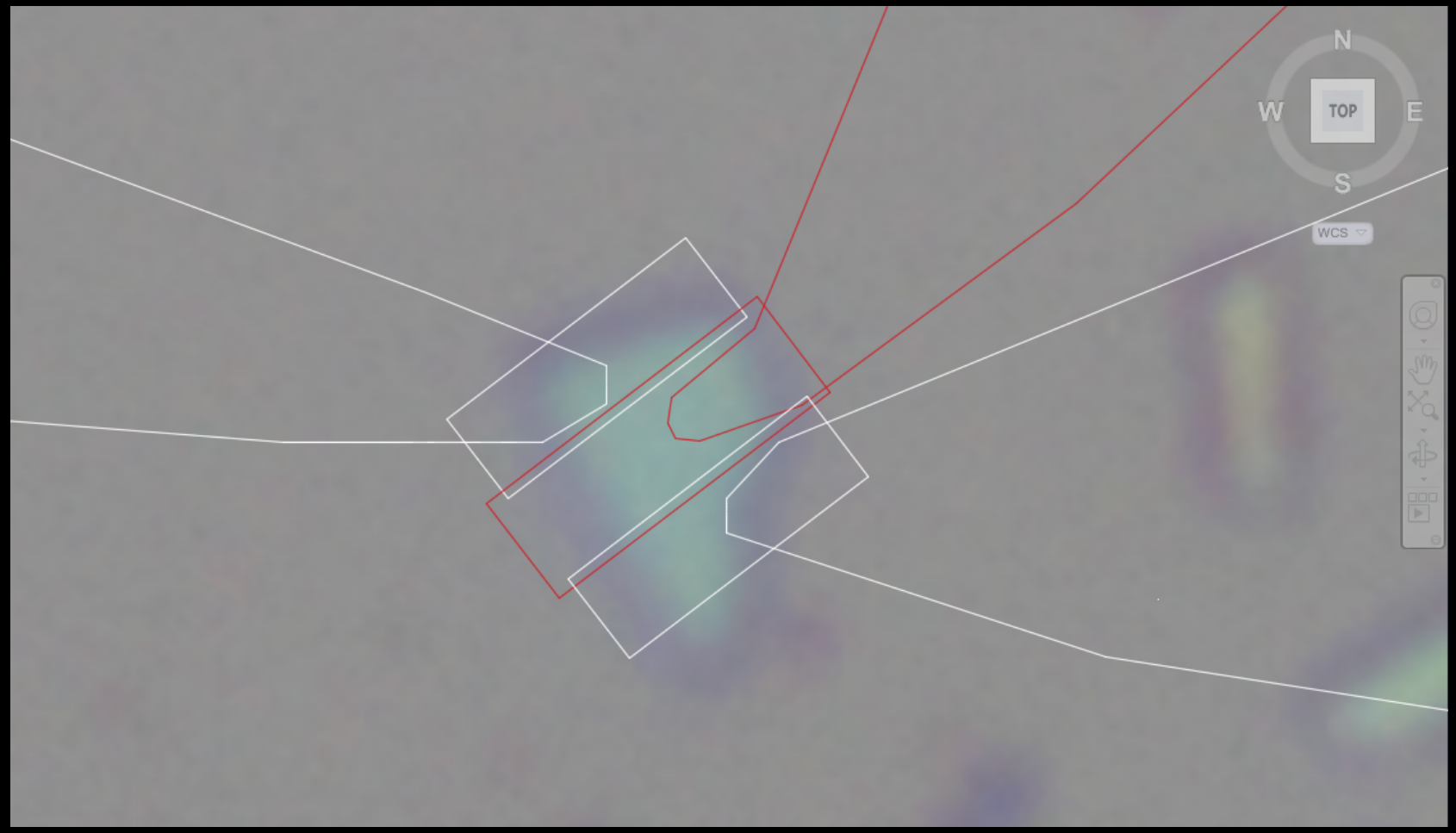


Length: ~2.365 μm
Width:~3.751 μm
Average Thickness: 17.959 nm

AutoCAD: Source, Gate, and Drain



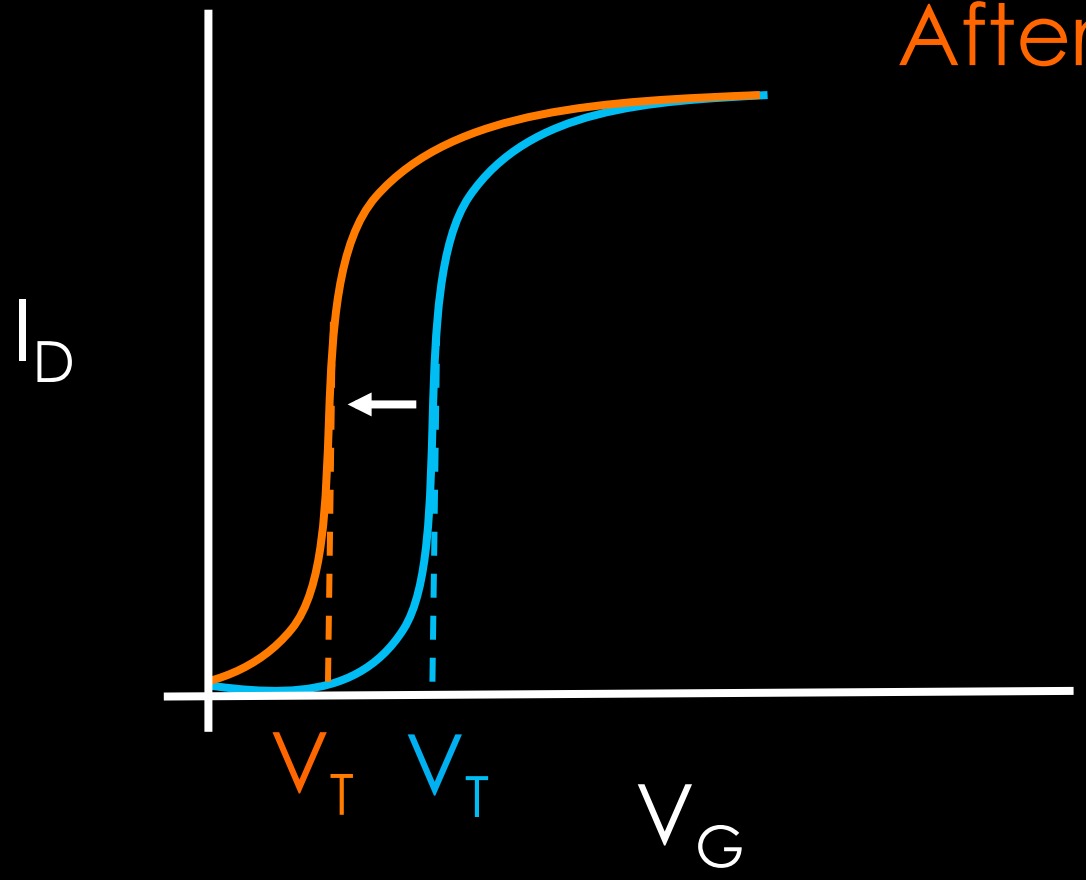
AutoCAD: Source, Gate, and Drain



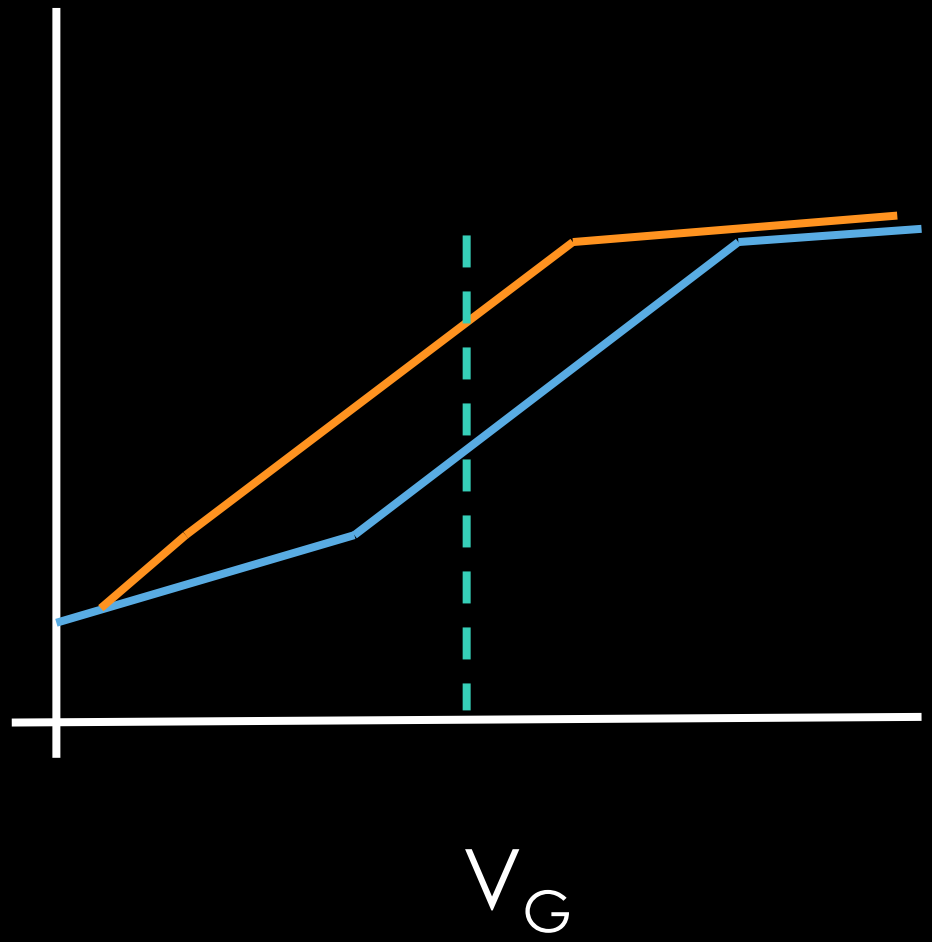
How we predict the sensor to behave

Before protein

After protein



Log $[I_D]$



- Brought this project to a point where a working device is very nearly completed.

- When completed it will be a breakthrough in biomedical technology and diagnostic capability

Acknowledgements

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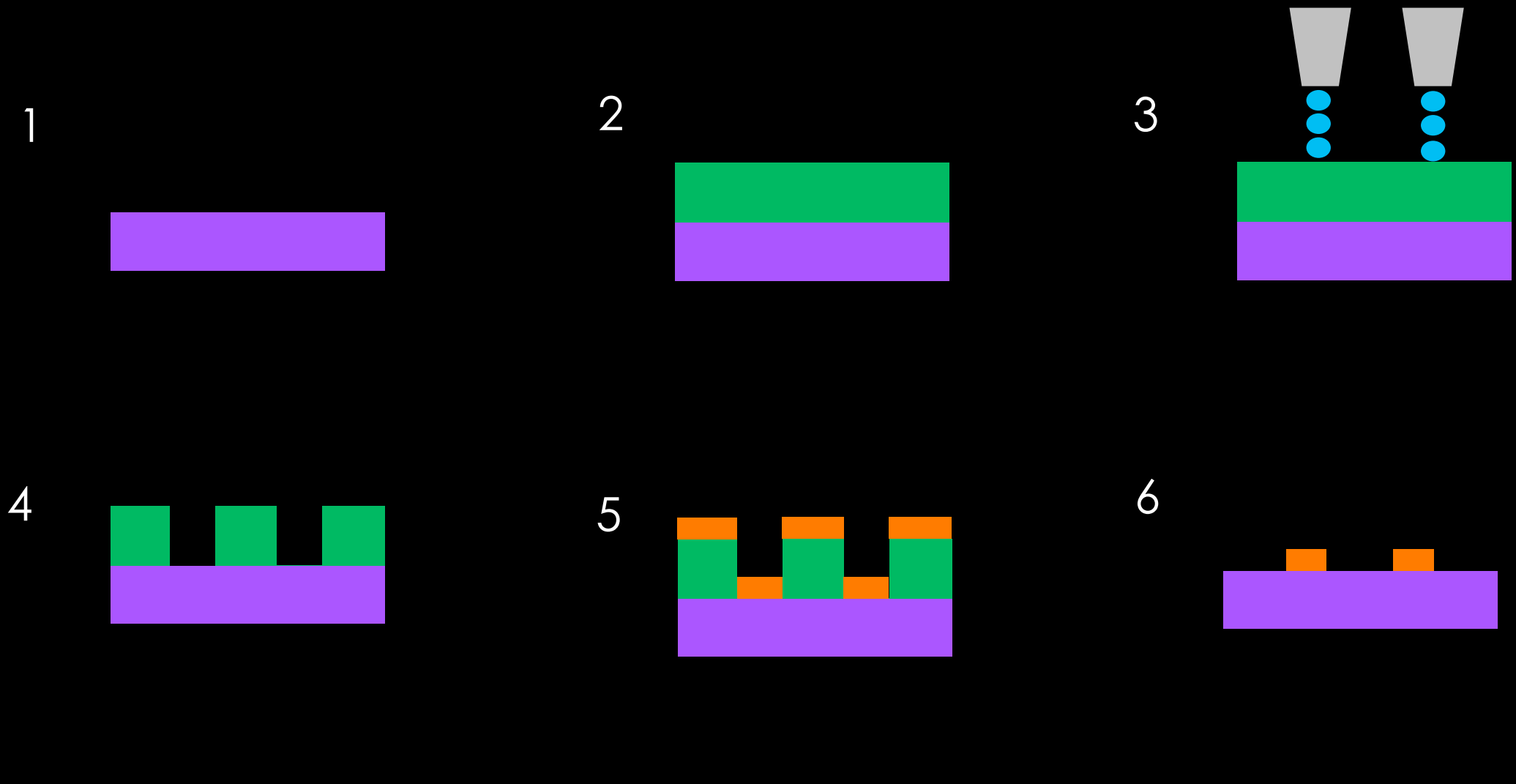
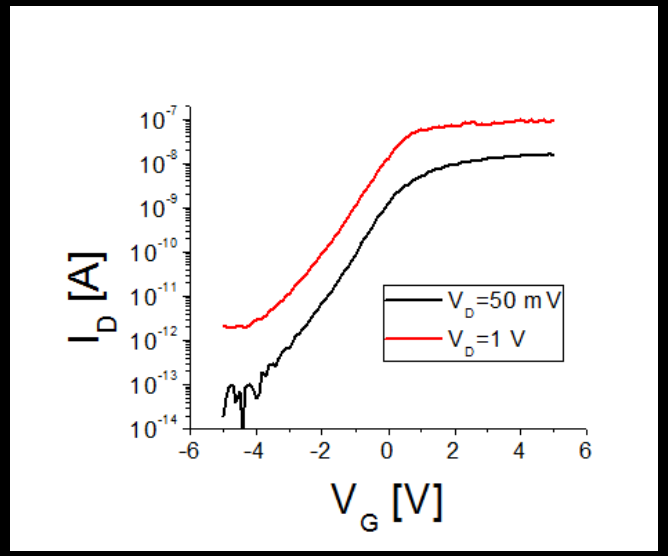
- SPS staff

Future work: e-beam lithography

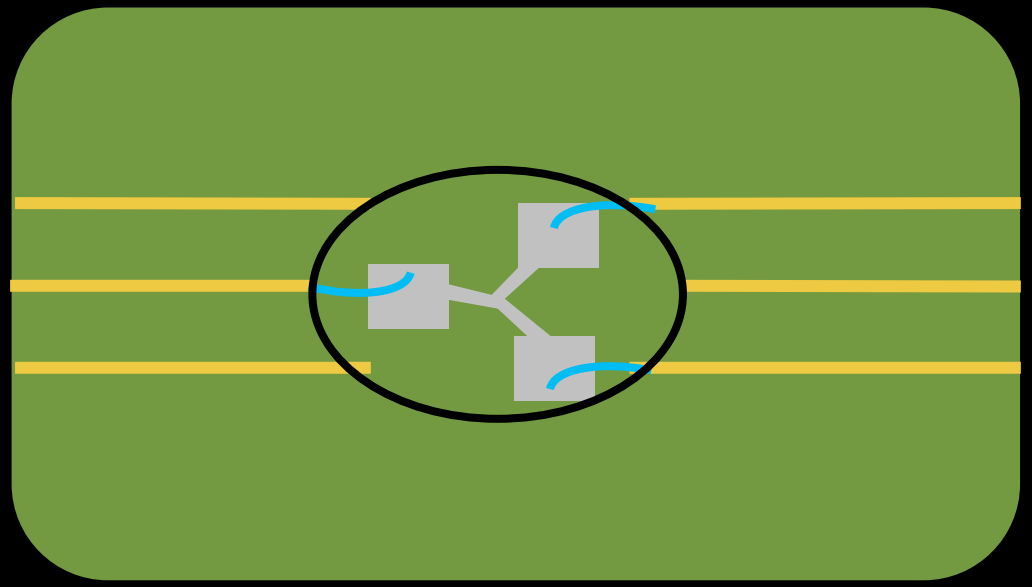


Future work

Probe Station



Wire Bonding to PC Board



Protein Sensing