Monolayer Semiconductors

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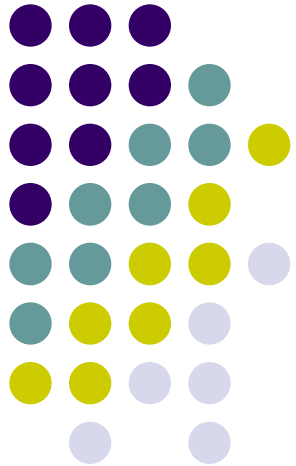
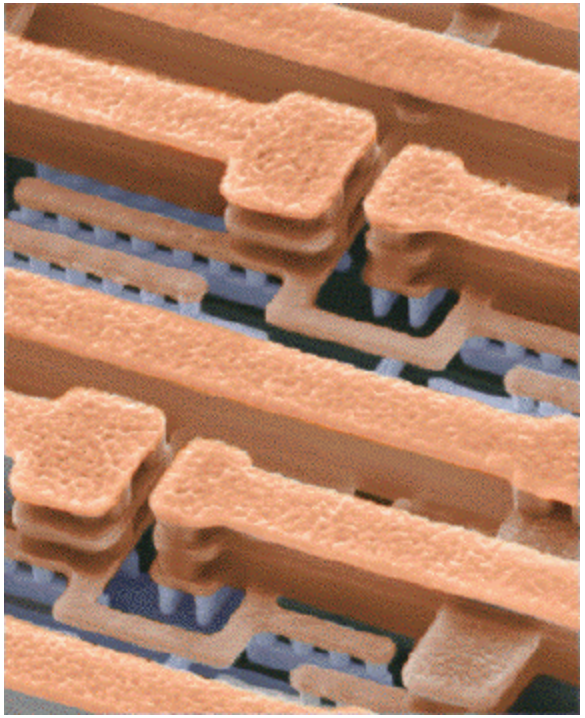
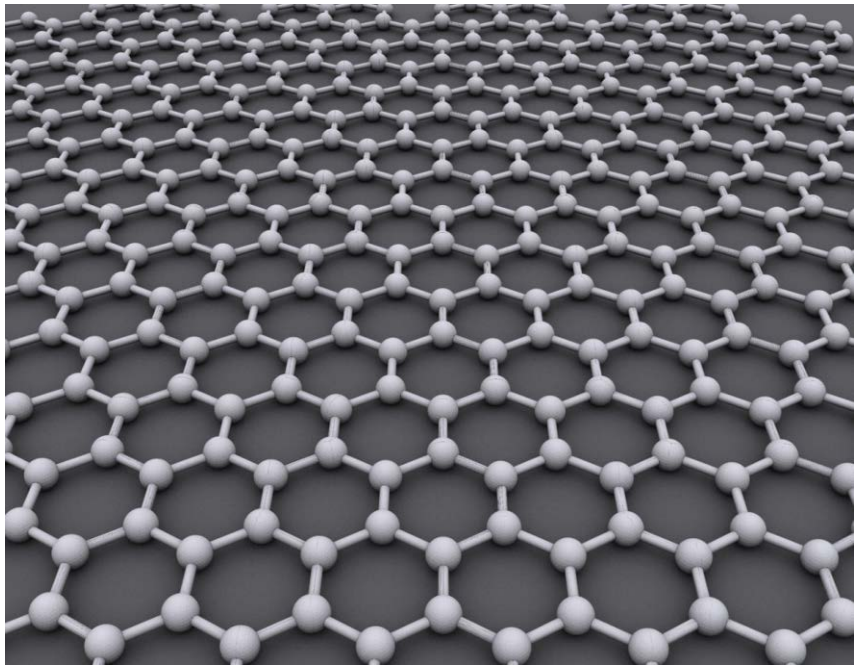


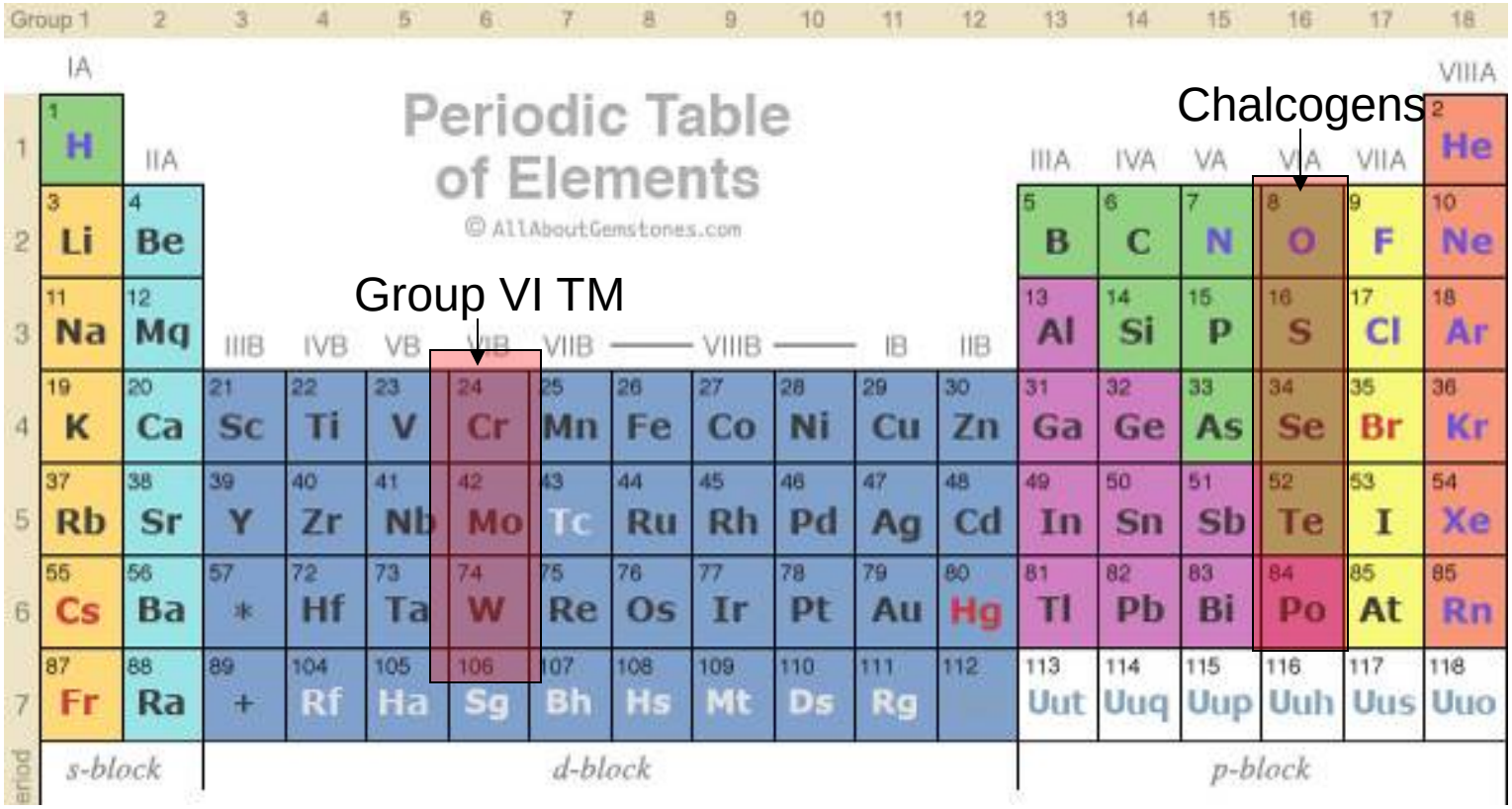
Search for new materials

- What can replace silicon?
- 2-D materials?



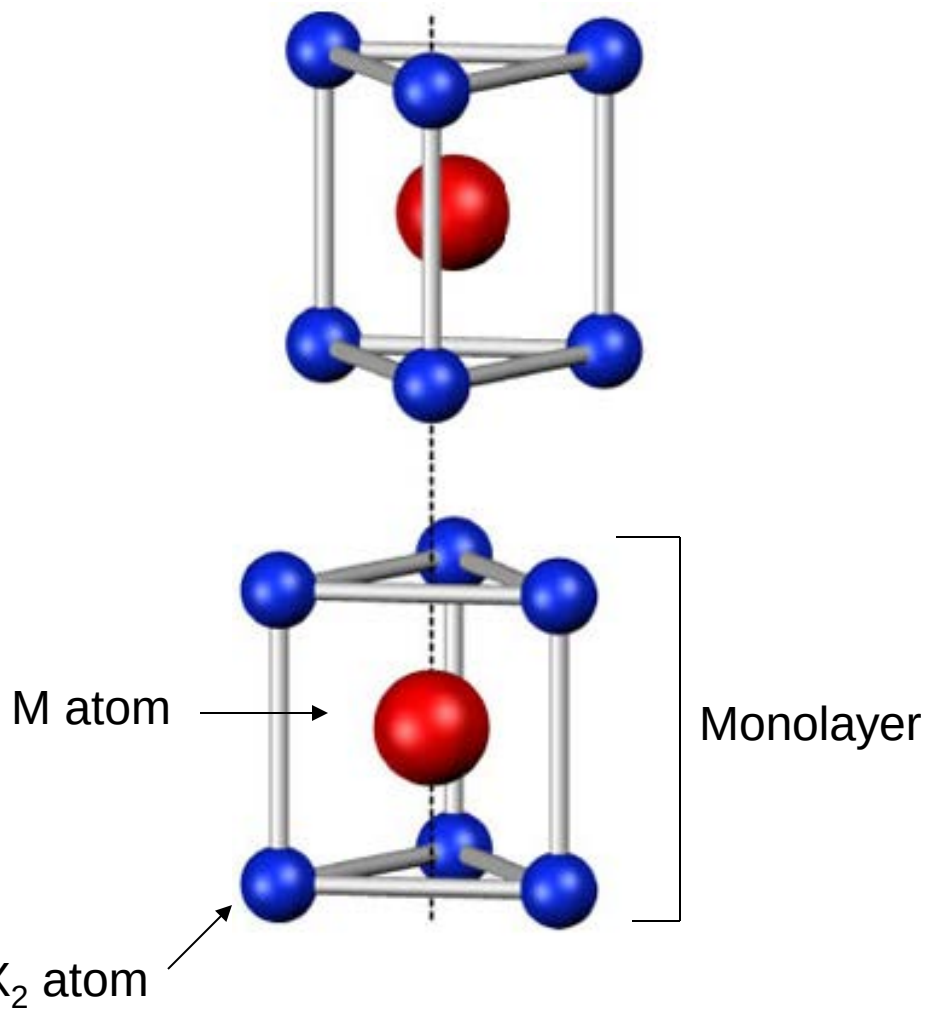


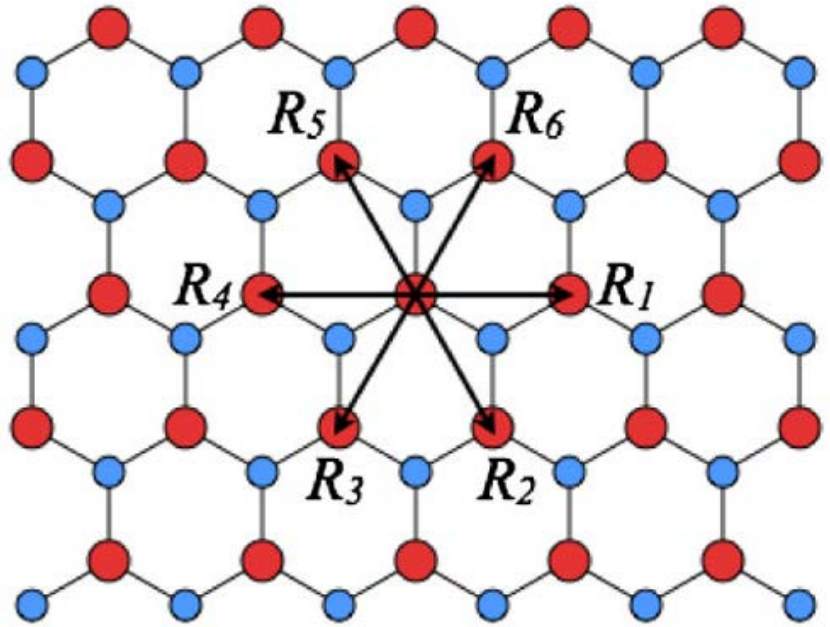
Transition Metal Dichalcogenides (MX_2)



- Group VI transition metal (M = W, Mo)
- Chalcogen (X_2 = S_2, Se_2)
- Monolayers are direct bandgap semiconductors
- Bandgap is in the visible light spectrum

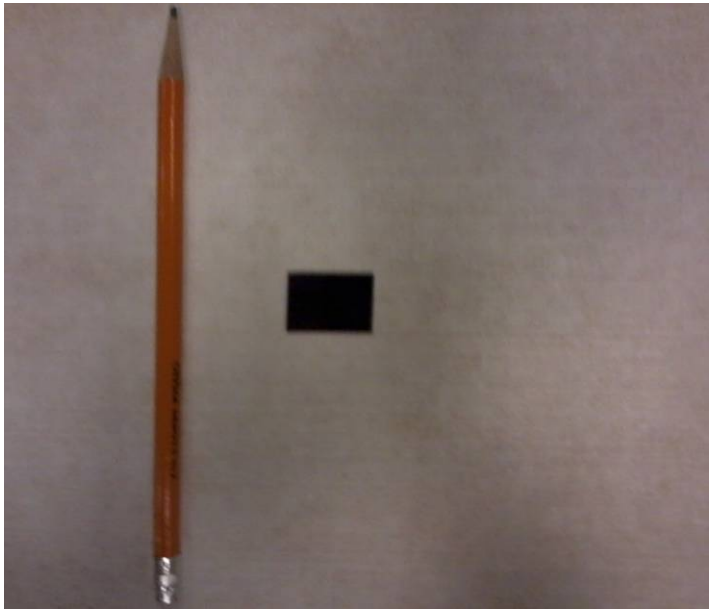
MX_2 Structure

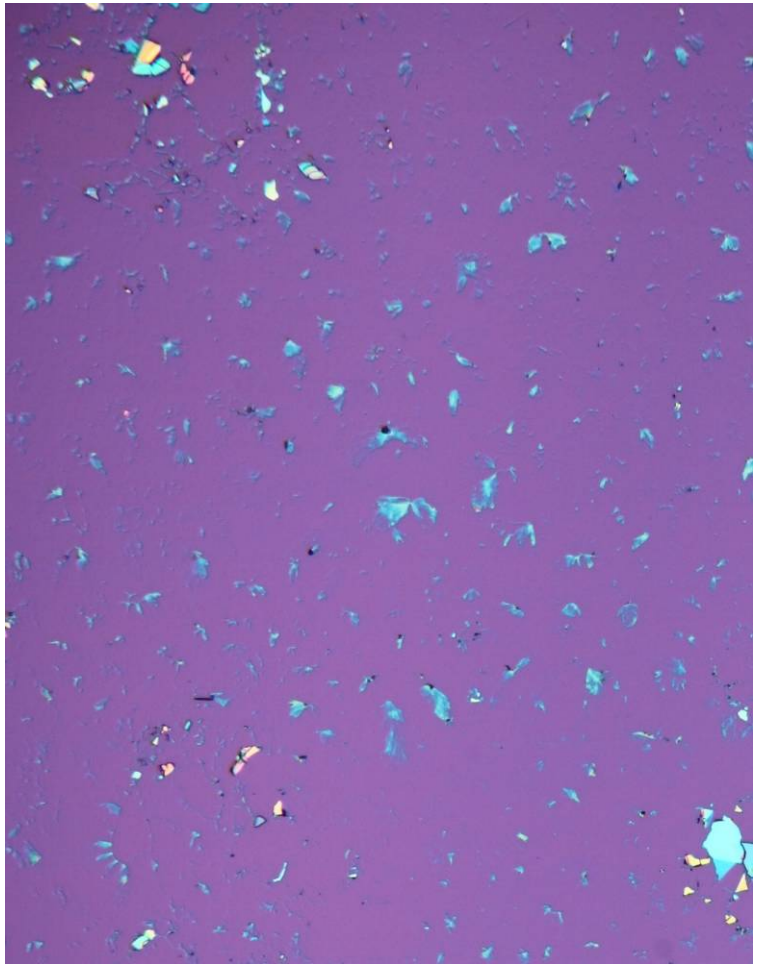




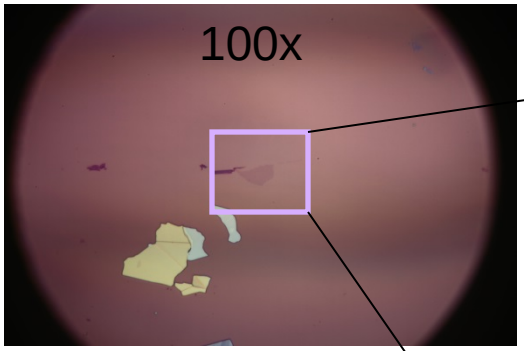
"Coupled Spin and Valley Physics in Monolayers of MoS2 and Other Group-VI Dichalcogenides," D. Xiao, G. Liu, W. Feng, X. Xu, W. Yao, ***Phys. Rev. Lett.*** *108, 196802 (2012).*

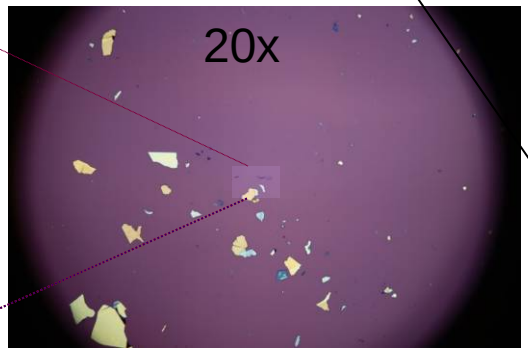
Exfoliation

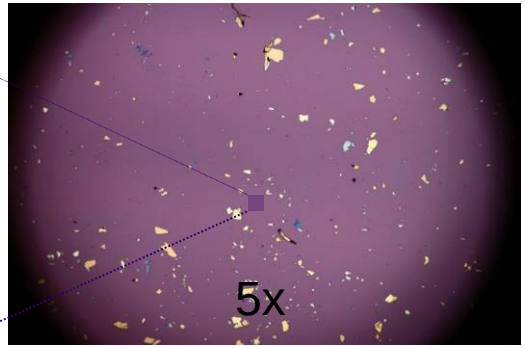




Searching

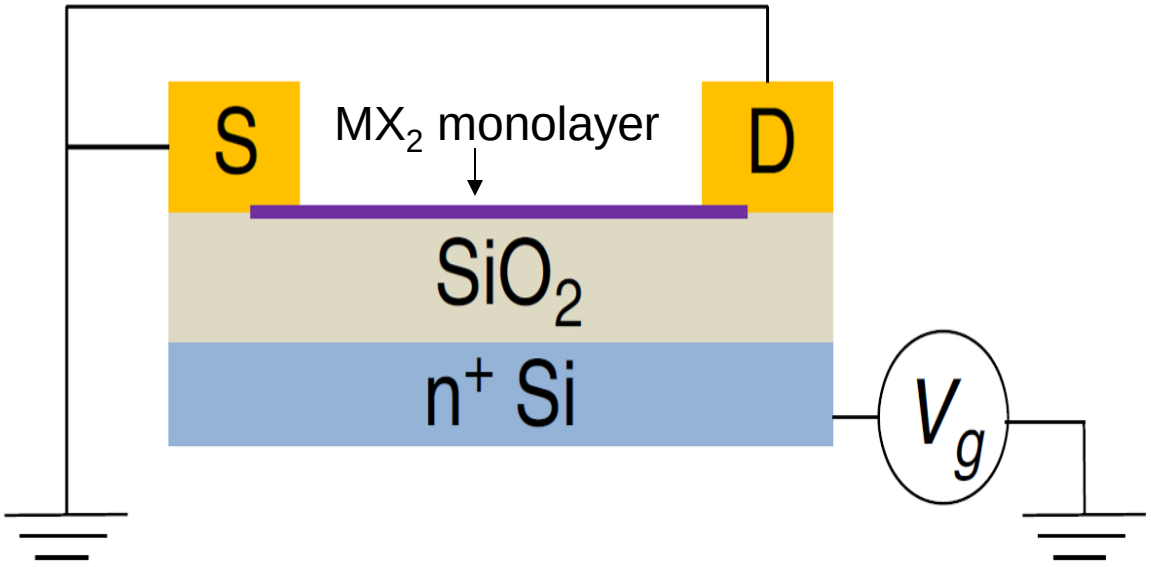






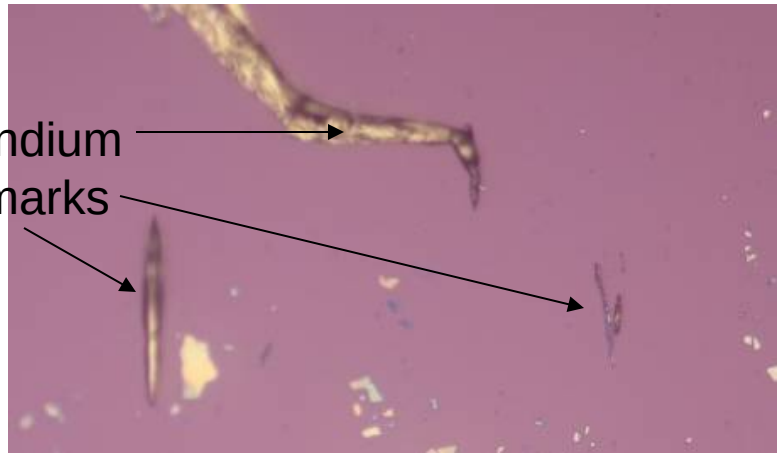
Monolayer FETs

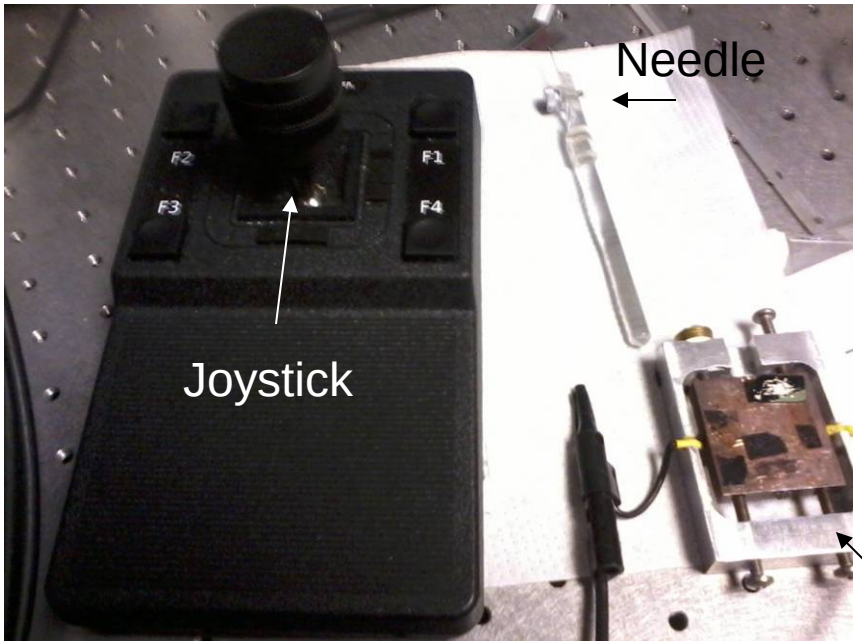
- Field Effect Transistors

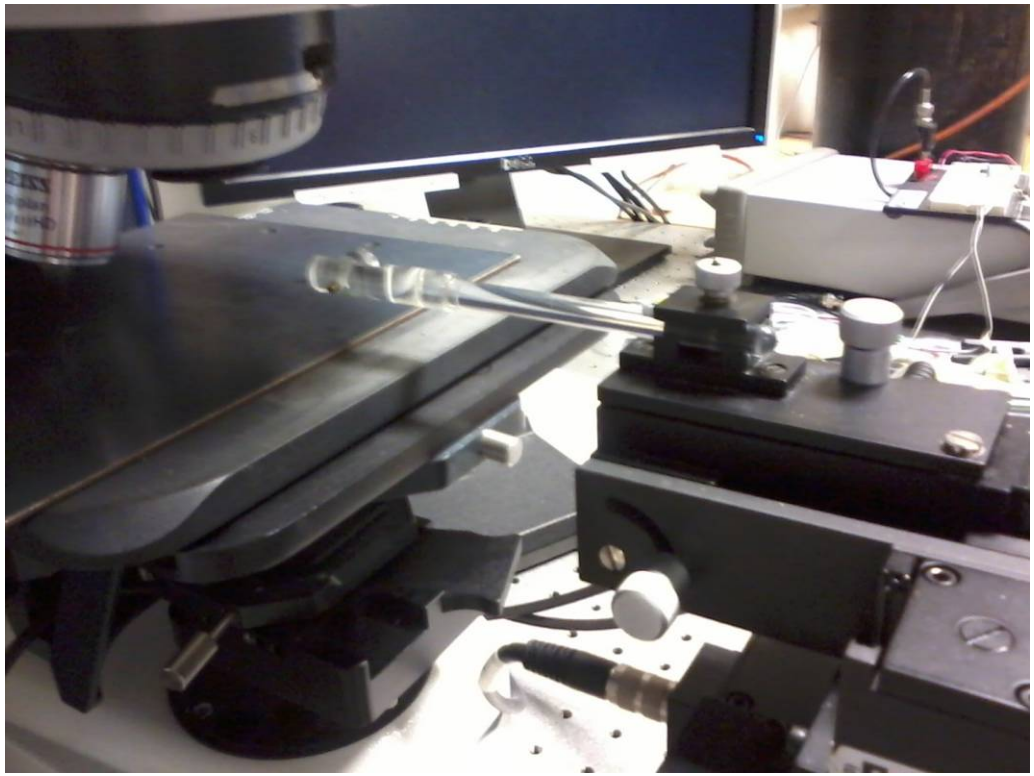


"Electrical Control of Neutral and Charged Excitons in a Monolayer Semiconductor ,"Jason S. Ross, Sanfeng Wu*, Hongyi Yu, Nirmal J. Ghimire, Aaron M. Jones, Grant Aivazian, Jiaqiang Yan, David G. Mandrus, Di Xiao, Wang Yao, Xiaodong Xu,* ***Nature Communication*** *4, Article number: 1474 doi:10.1038/ncomms2498 (2013)*

Alignment

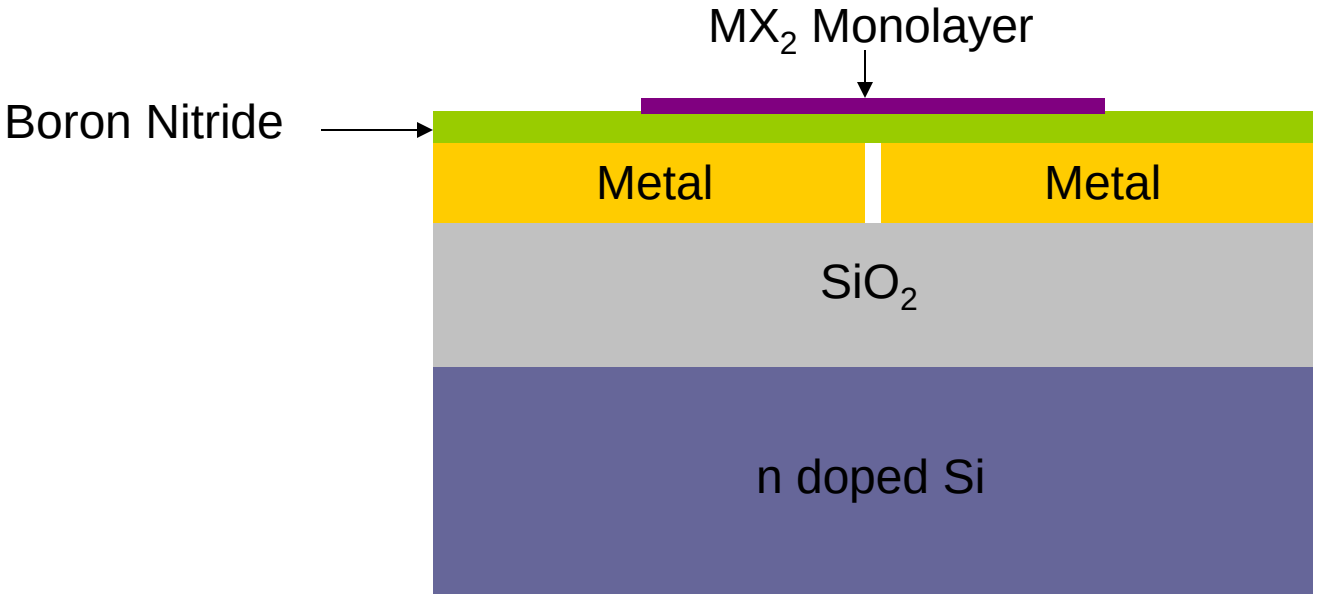


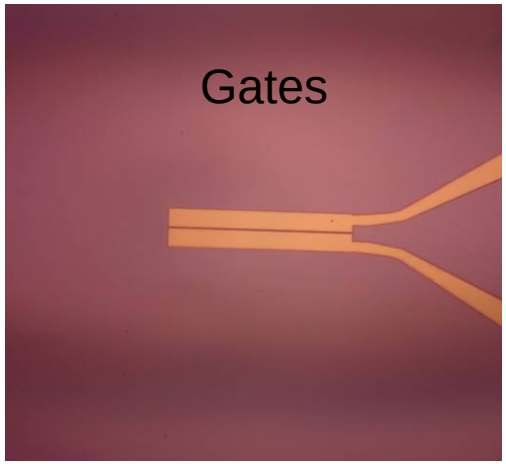


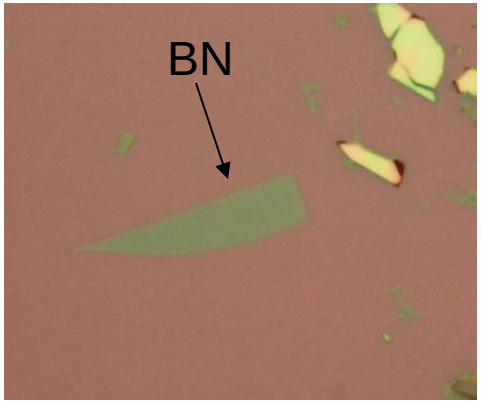


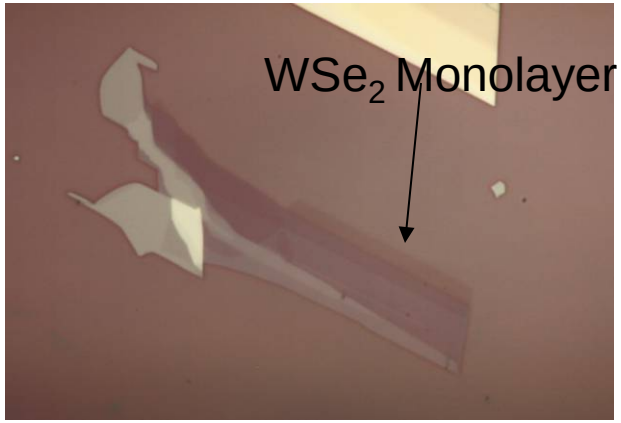
Heating Stage

Another Device







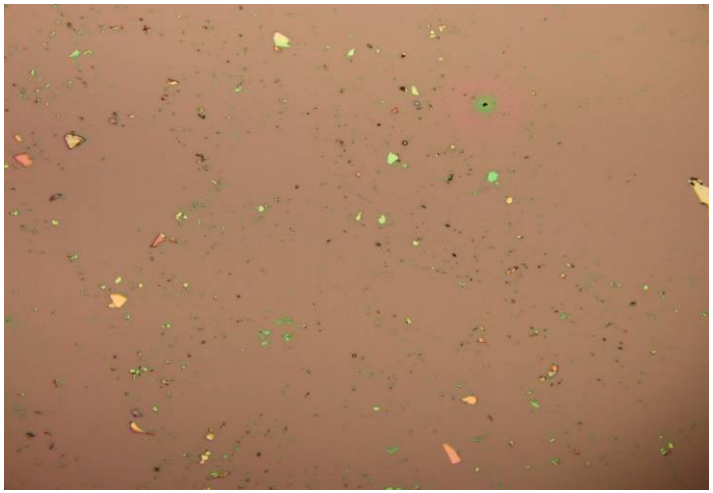


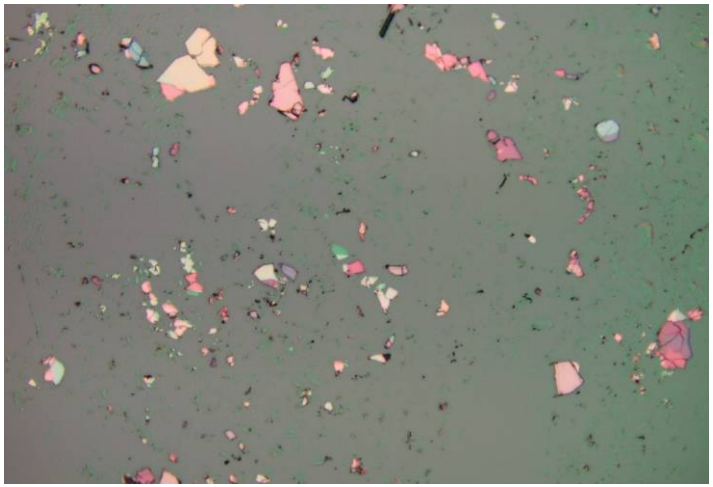
Chemical Spinning

Poly(methyl methacrylate)

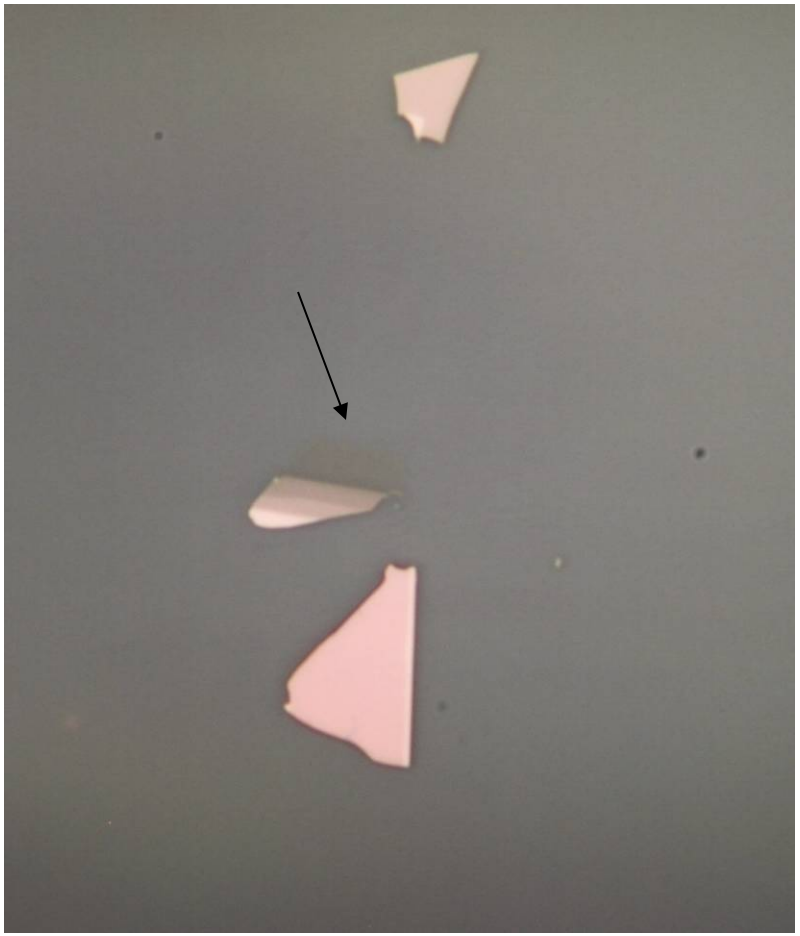
Polyvinyl Alcohol (PVA)

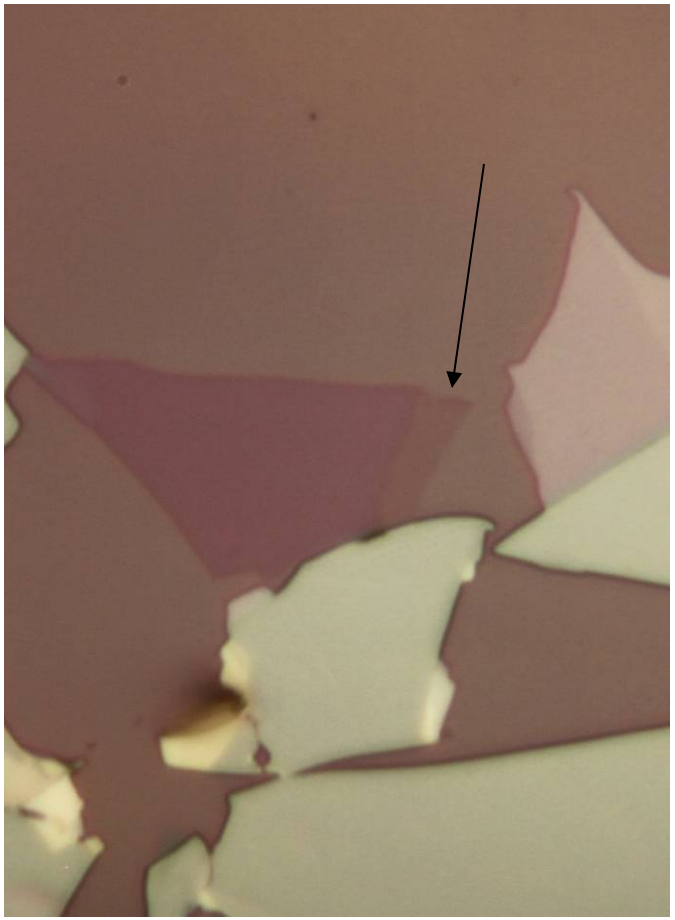
Silicon



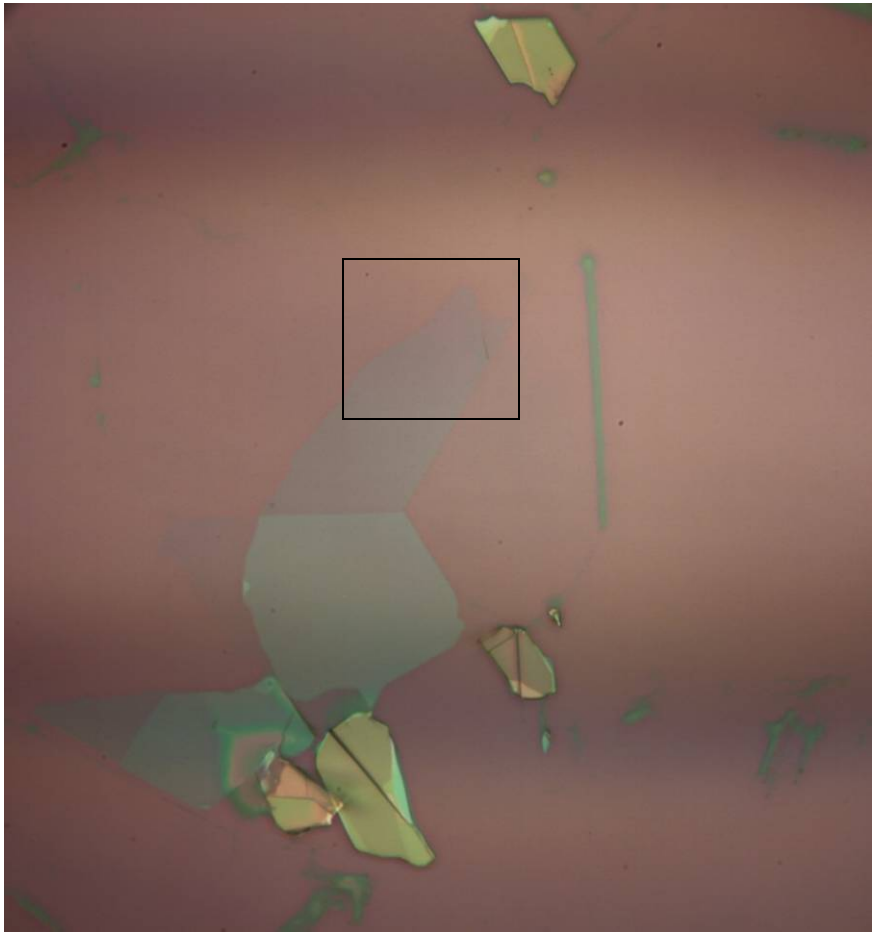


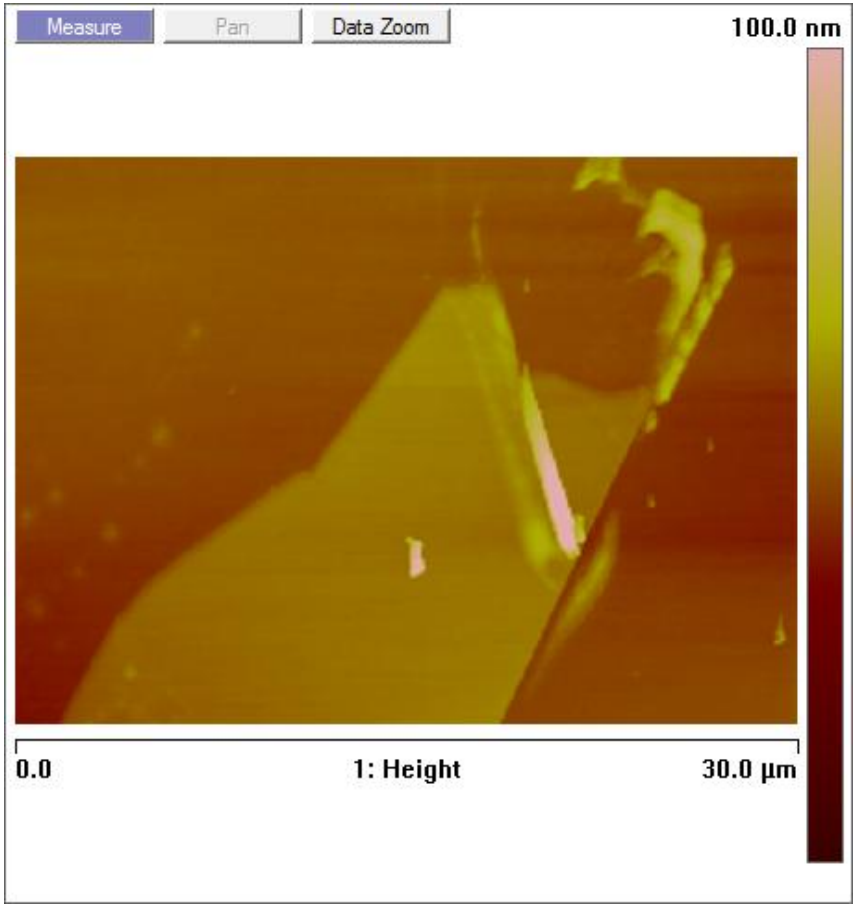
Green vs. Purple



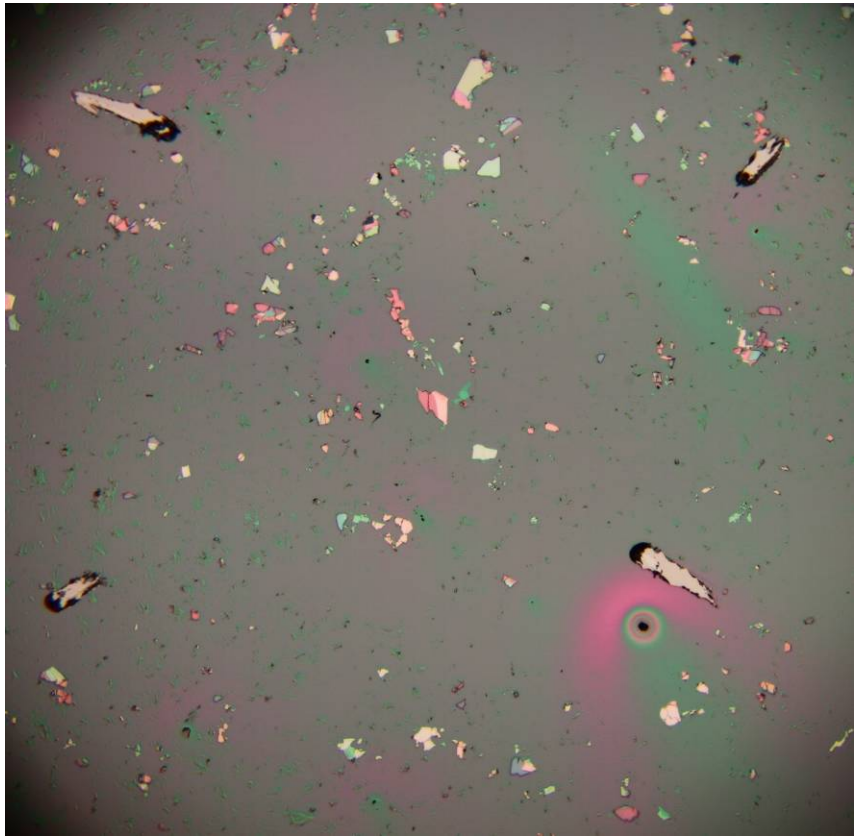


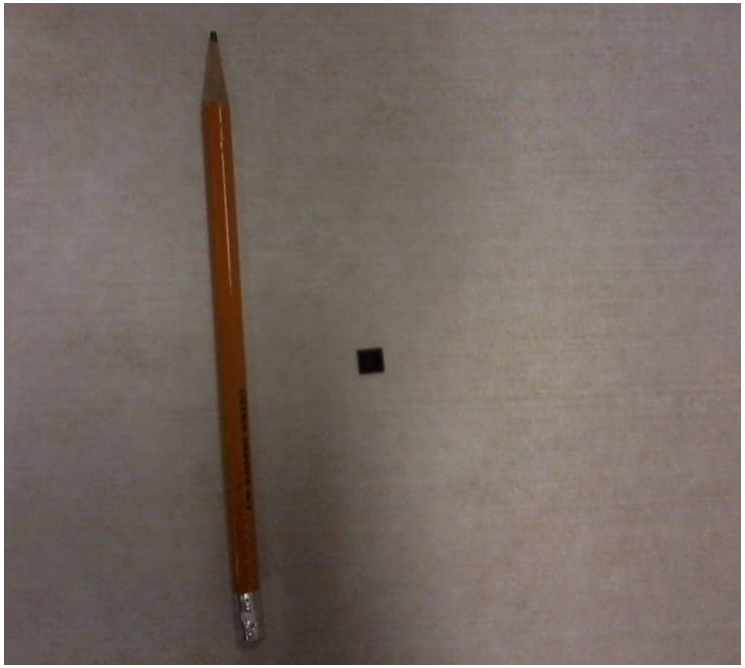
AFM



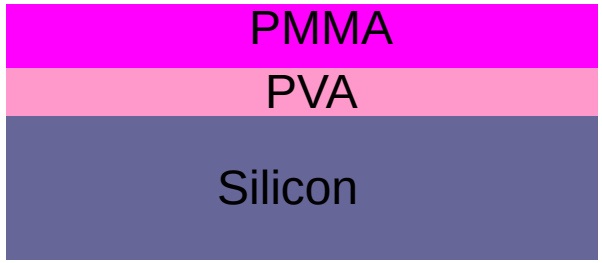


Marking



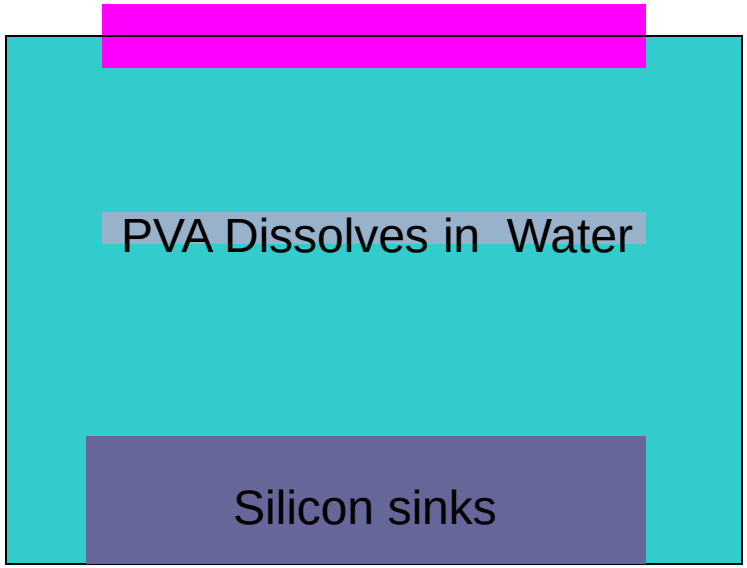


PMMA Liftoff

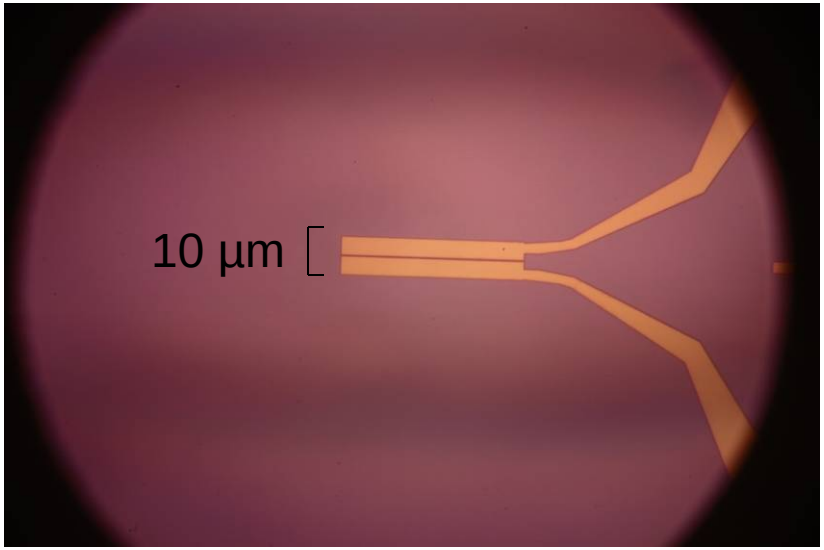


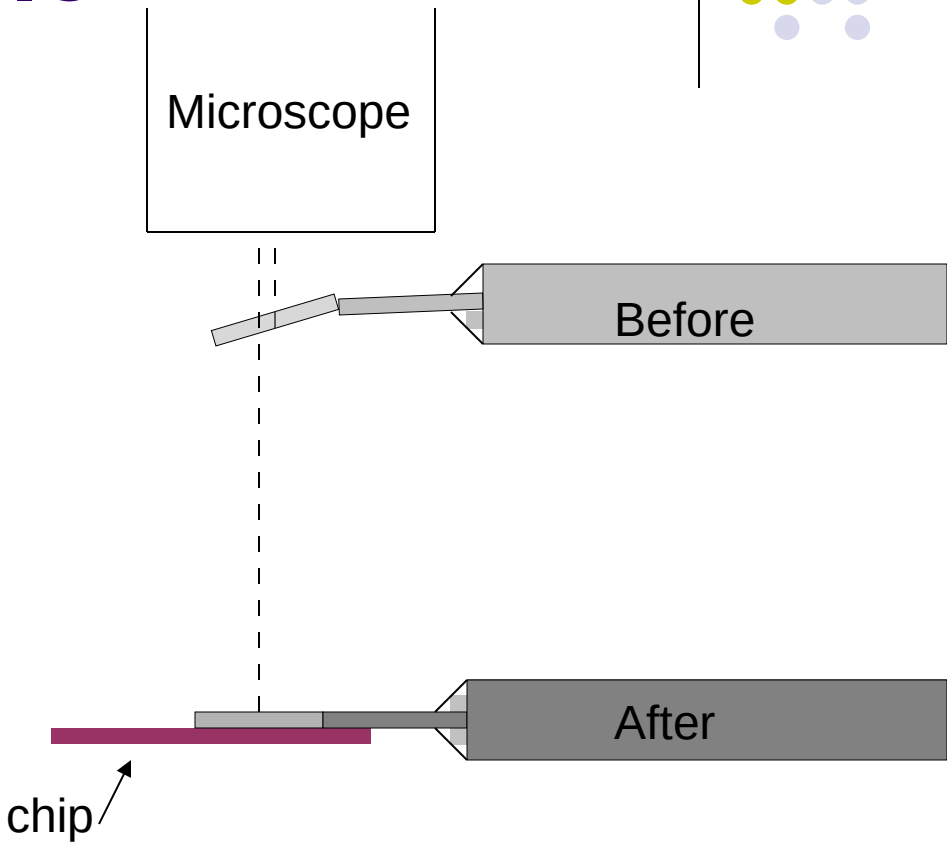
Place chip
in water

PMMA Floats with exfoliated samples on it

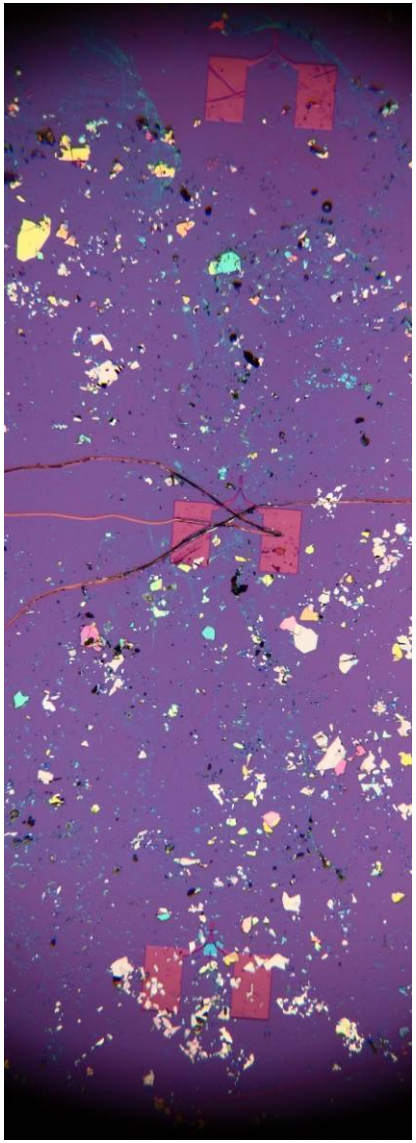


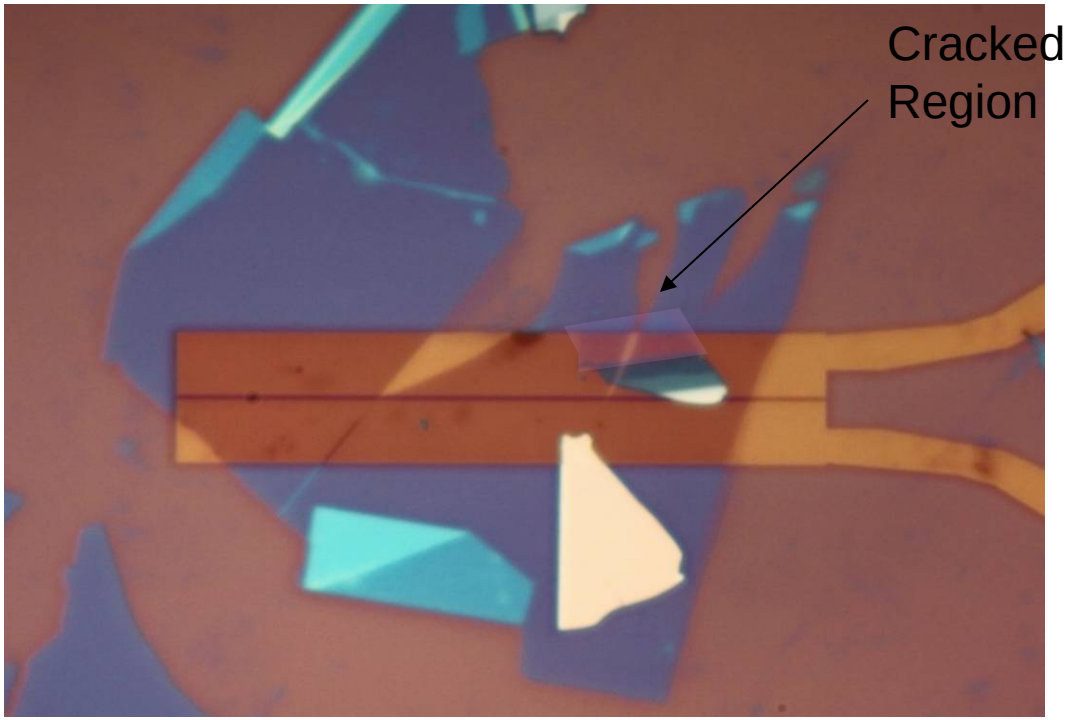
Placing the Sample



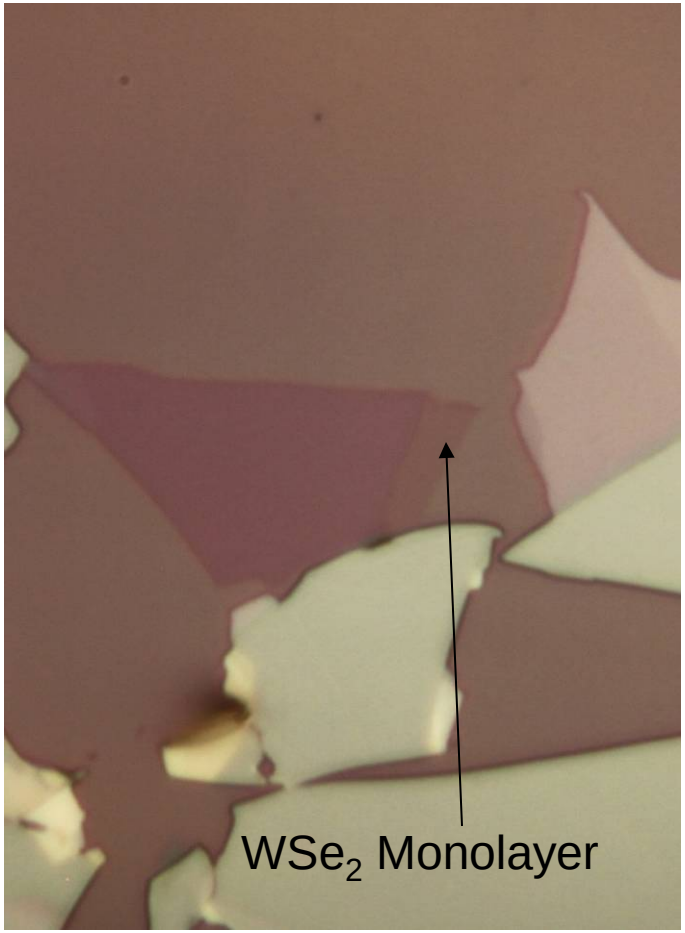


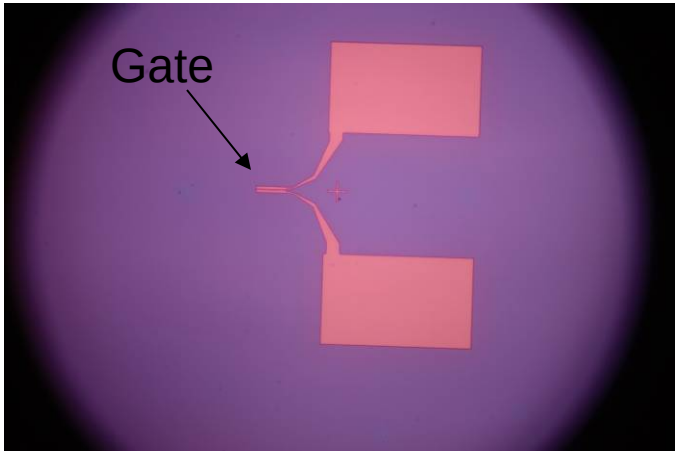
Failures

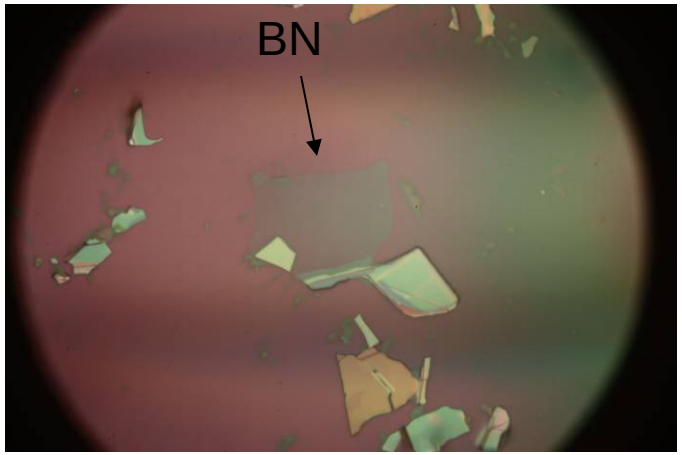




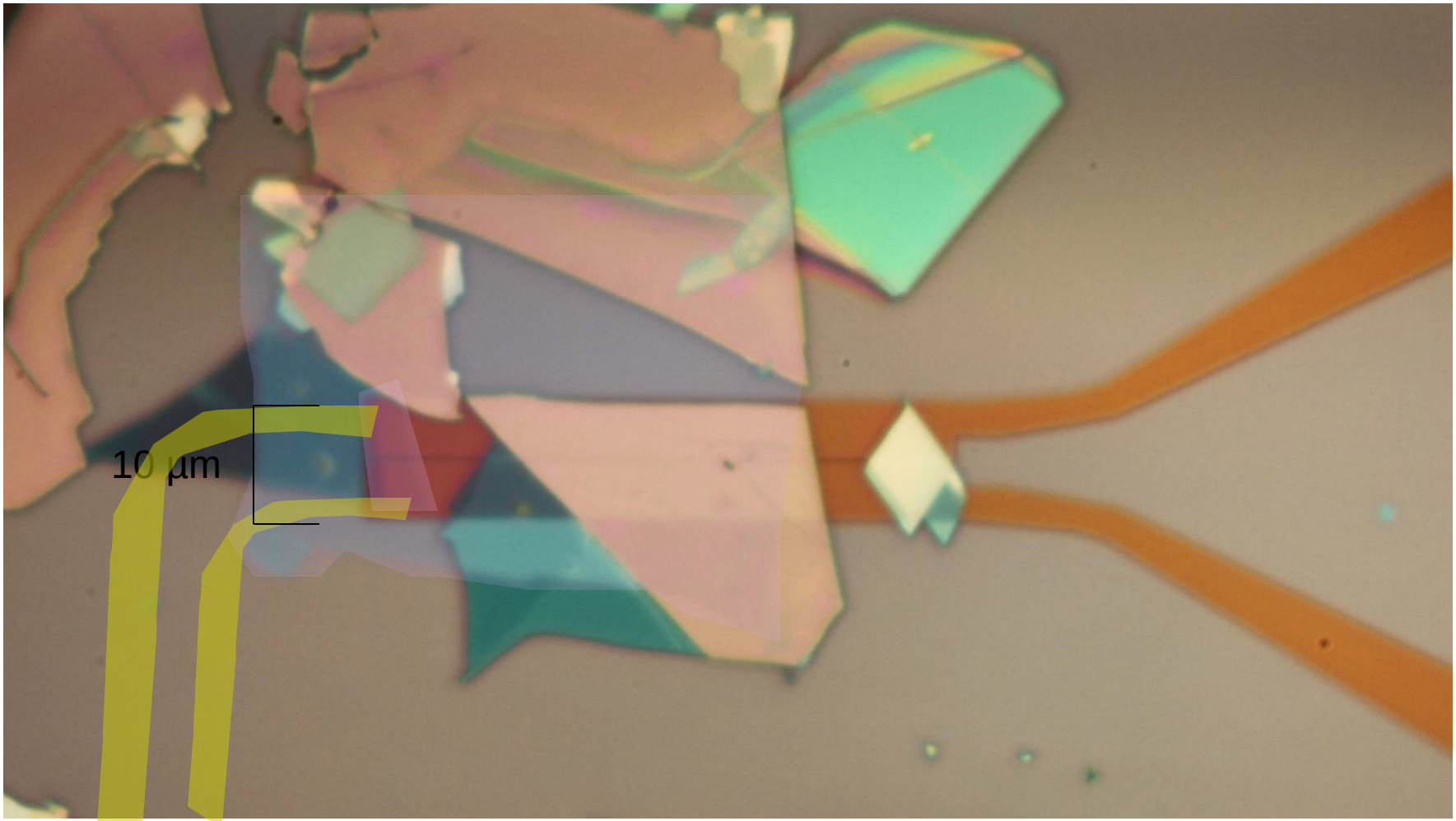
Materials







Device



Future Work

- Stronger field effect
- Better transfer process
- Optoelectronics

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- Mitch, Grant, Jason, Pasqual, Sanfeng, and the rest of the Xu Group and David Cobden's lab
- Deep and Alejandro
- NSF

Questions?