Edge Contacts to Atomically-Thin Superconductors

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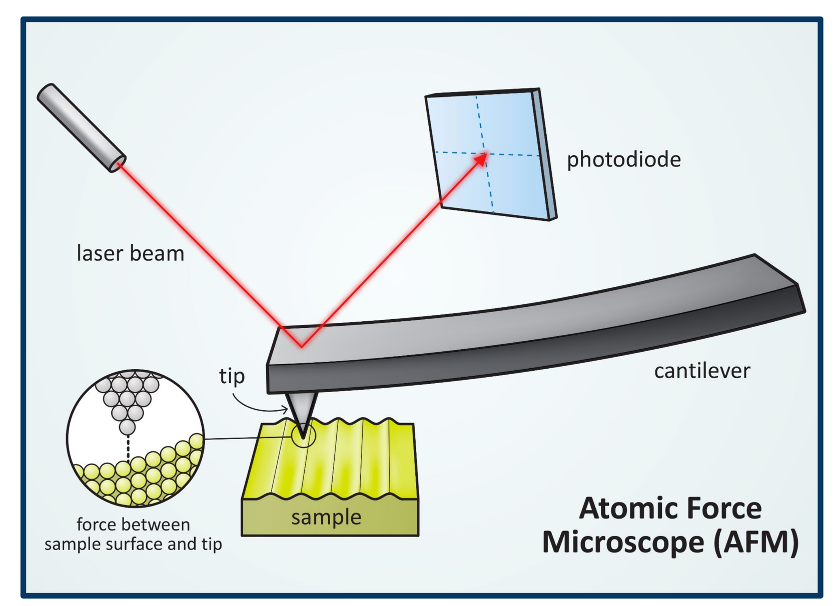
Introduction

- A qubit's quantum properties enable them to possess exponentially greater computing power
- Scaling quantum computers is limited, with a single qubit typically occupying > 1 mm^2 area
- *Van der Waals (vdW) layered materials* show promise to host next-generation qubits with both long-coherence-time data storage and small areas for better scalability
- High-quality electrical contact is crucial to study the electronic properties of these materials

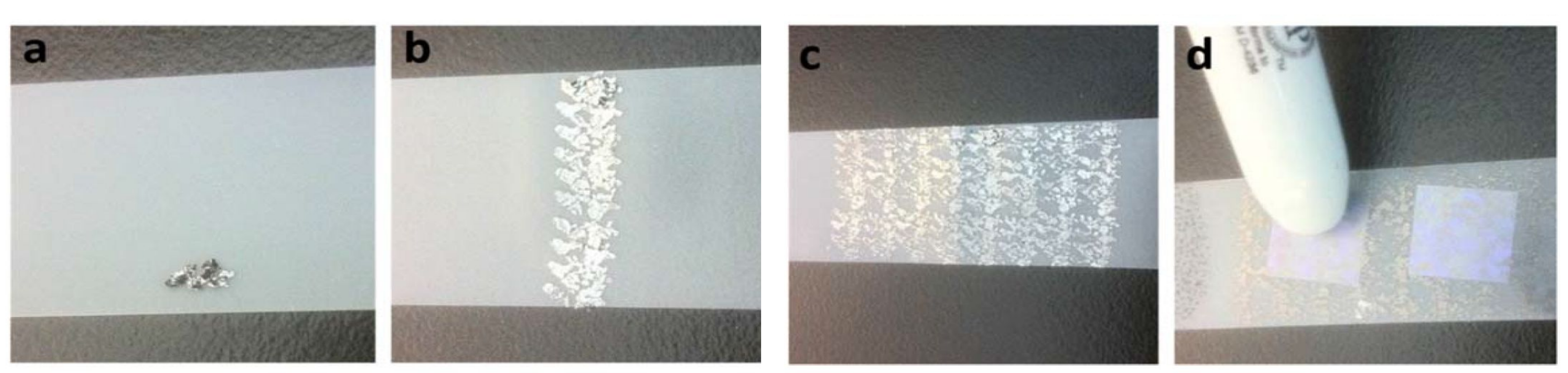
In this poster we will study *edge contact* to single atomic layers of the vdWs hBN and $MoTe_2$

Methods

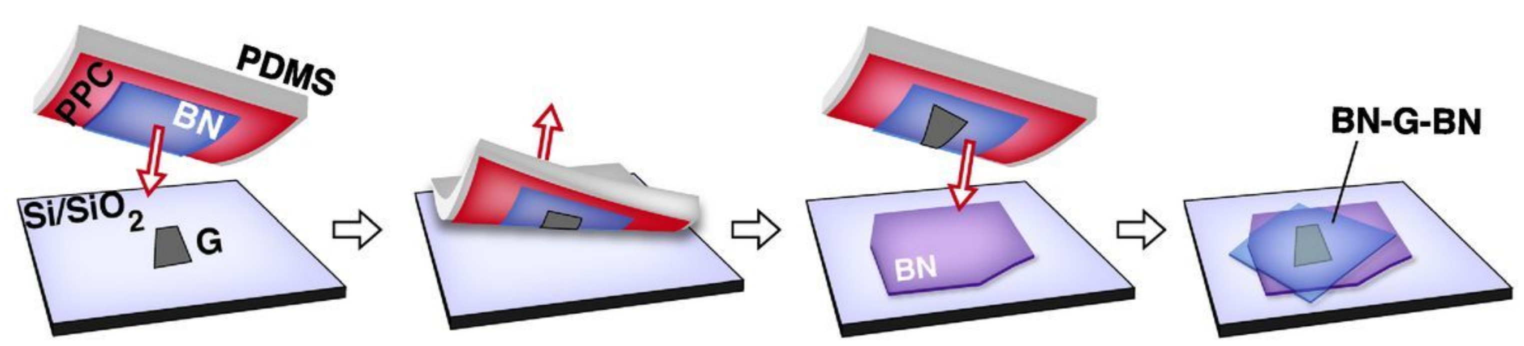
- We began with ***exfoliation*** of hBN and $MoTe_2$ to extract thin sheets from its bulk crystal
  - Due to its air sensitivity, $MoTe_2$ is exfoliated in the glovebox
  - After exfoliation, we search for sufficient flakes under the microscope
  - To check the surface we use the AFM



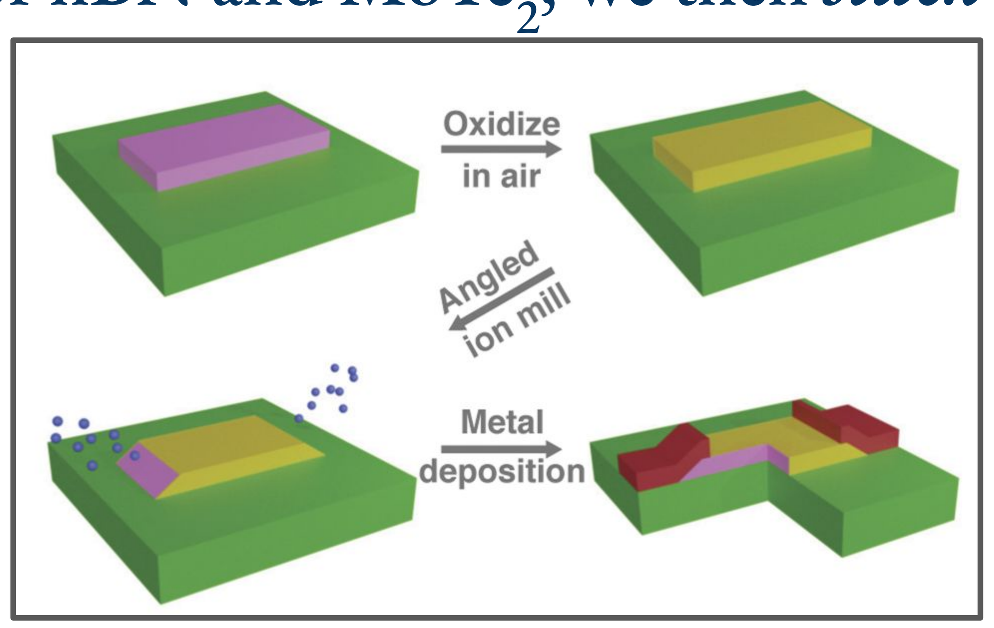
NISE, (2016).



- Once we accumulate sufficient flakes of hBN and $MoTe_2$, we then ***stack***



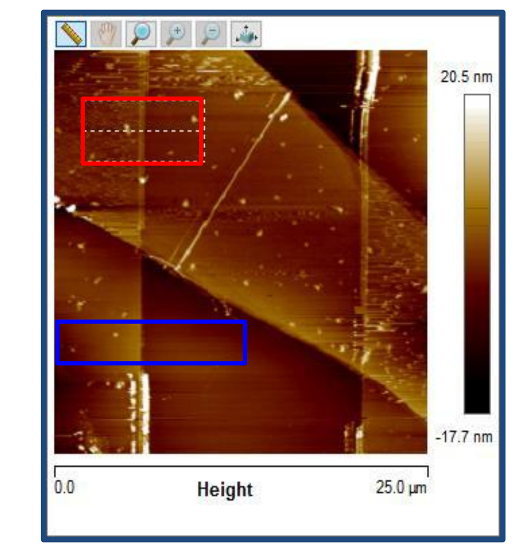
Science 342, 614-617 (2013)



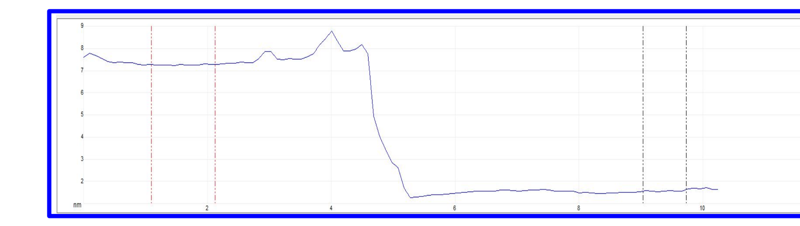
J. Phys.: Condens. Matter 34, (2022).

- Following stacking, we use ***Argon (Ar) Milling*** to etch and deposit onto $MoTe_2$ ***in situ*** at ultra-high-vacuum (UHV)
  - This ensures high-quality electrical contact without significant surface oxidation

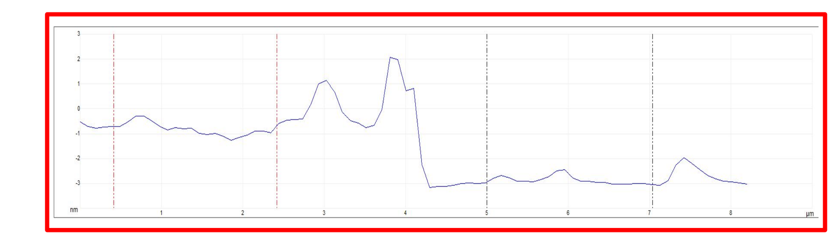
Results



hBN on SiO_2 chip, "soft milled" for 5 minutes

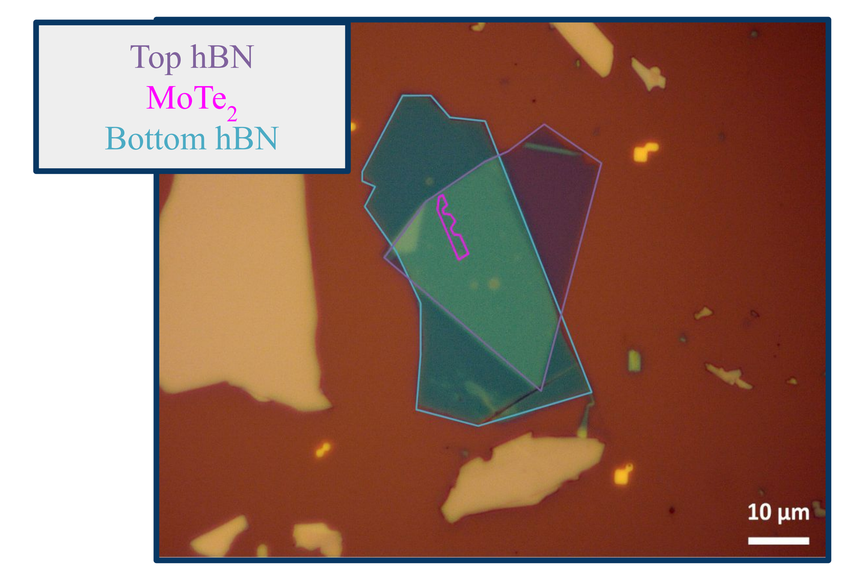


SiO2: 5.0 nm etched

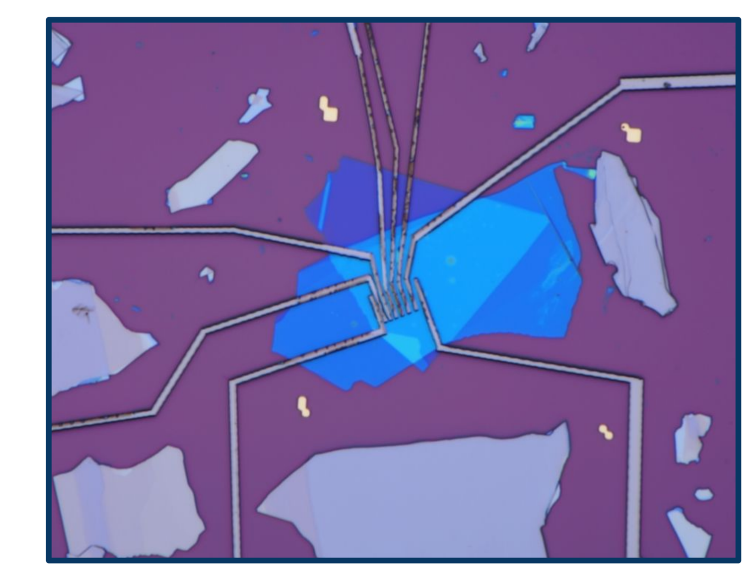


hBN: 2.0~2.1 nm etched

AFM "Z-Height" plots



hBN, $MoTe_2$ stack on SiO_2 chip



Stack following etching and deposition of metal

Reference	Milling rate	Parameters			Material
		Beam V	Accel V	Emission Cur	
Philip Kim Group (Harvard)	~0.6 nm/min (soft milling)	200 V	40 V	8.0 mA	TMDC
Gil-Ho Lee Group (POSTECH)	~1.0 nm/ min	400 V		10 mA	h-BN
Raytheon BBN	15 nm/min	400 V	80 V	23 mA	MoTe2
Photonics Labratory[3]	~14.7 nm/min	250 V	50 V	10 mA	MoOx (for contact)

Conclusions

- Successfully tested Ar milling on hBN
- Unsuccessful translation of Ar milling to the stack
- Ar milling conditions in indicated 5 minutes insufficient to etch through the top hBN layer, preventing edge contact with $MoTe_2$
- **Plan for the future:** Test longer milling with different conditions outlined in the table
- **Potential implications:** Advancements for MoTe2 applications and enhanced future quantum devices

Acknowledgments

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References

1. L. Wang et al. *Science* 342, 614-617 (2013).
2. A. Antony et al. *J. Phys.: Condens. Matter* 34, (2022).
3. A. Jain et al. *Nano Letters* 19 (10), 6914-6923, (2019).