Improved Performance in hBN encapsulated MoS_2 Field-Effect Transistors Contacted by Highly Doped Graphene Electrodes.

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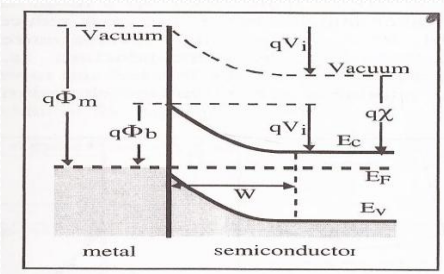
Outline

- Motivation
- Results
    A. Graphene contacted MoS_2 FETs encapsulated by hBN.
    B. Using molecular doping with Benzyl Viologen (BV) to tune the contact barrier.
    C. Four-probe measurement to understand the intrinsic channel properties and scattering mechanisms.
- Conclusions

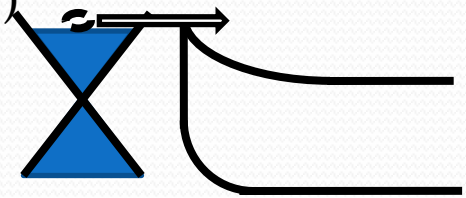
Motivation

For large band gap semiconductors such as MoS_2, a significant Schottky barrier may form at the metal/semiconductor contact, yielding a high contact resistance. To optimize the performance of MoS_2 FETs, it is crucial to use low resistance Ohmic contacts.



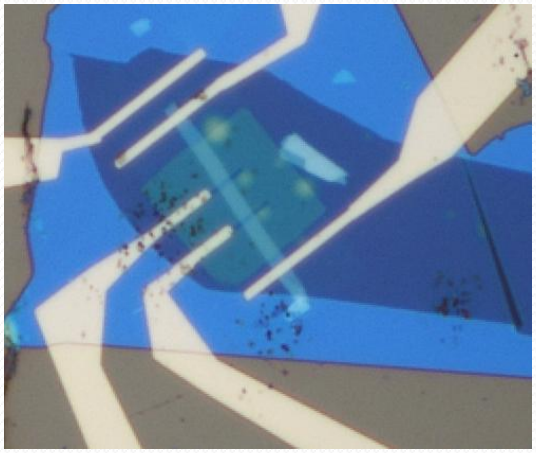
Our Approaches

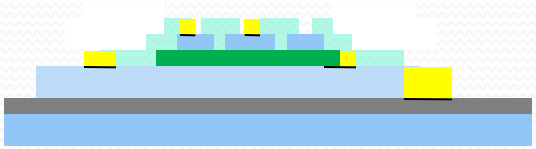
- Reducing Schottky barrier height by heavily n-doping the graphene contacts using strong electron donating Benzyl Vologen (BV)



- Using hBN encapsulation to protect the channel from BV doping and preserve the intrinsic channel properties of MoS2

Animation for fabrication steps

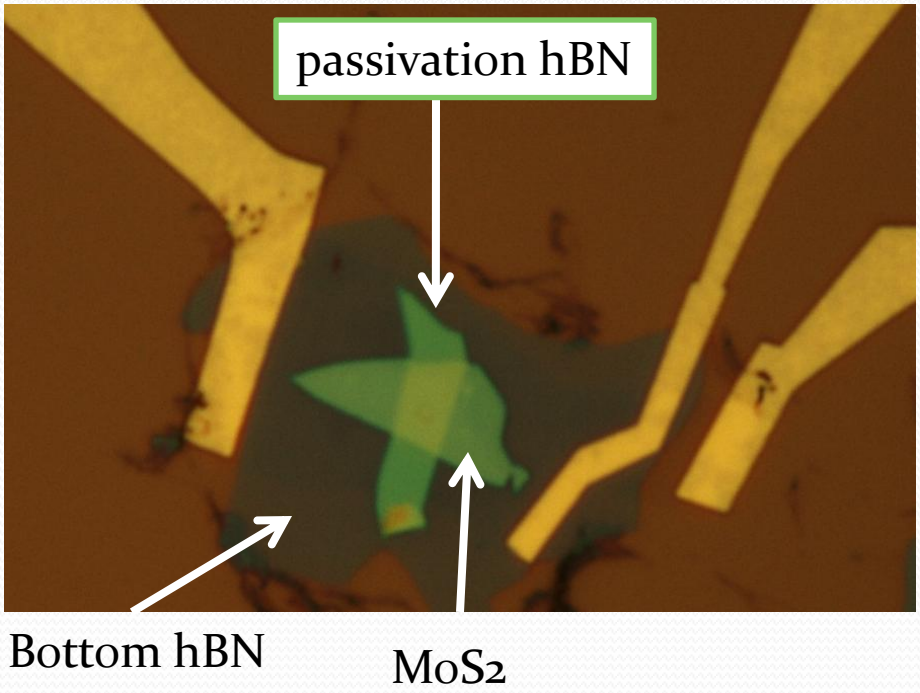




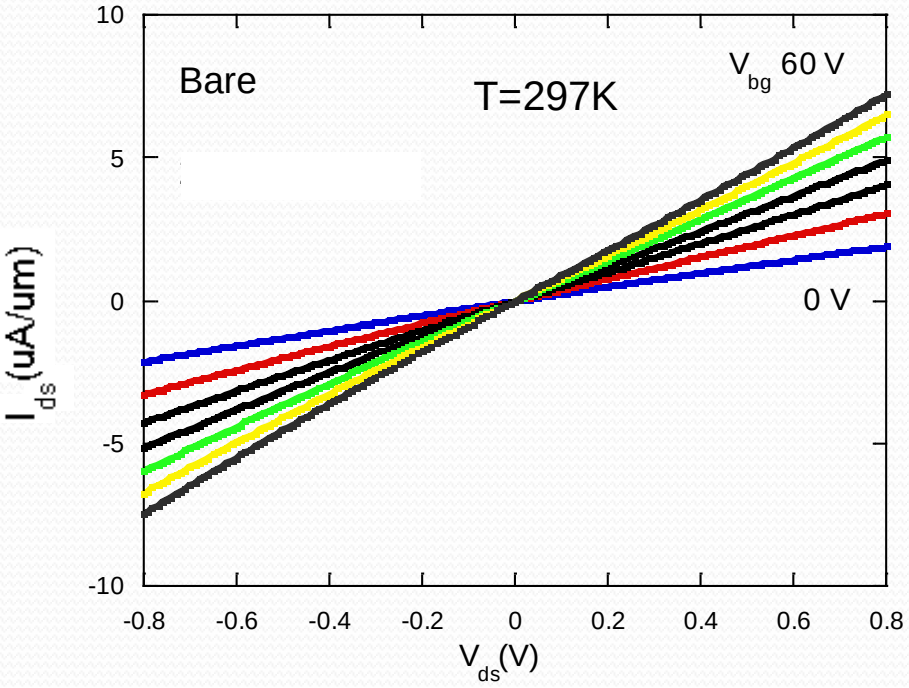
Cross section

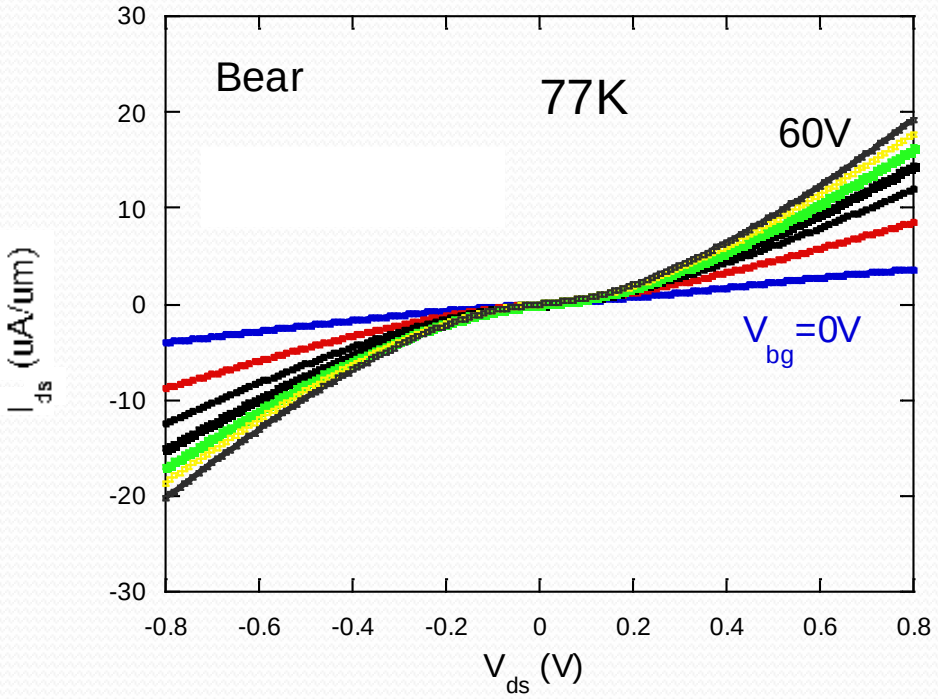
Graphene contacted MoS_2 FET with hBN encapsulated channel

- **L:2.5 um**
- **W: 4.1 um**
- **d: 9 nm**

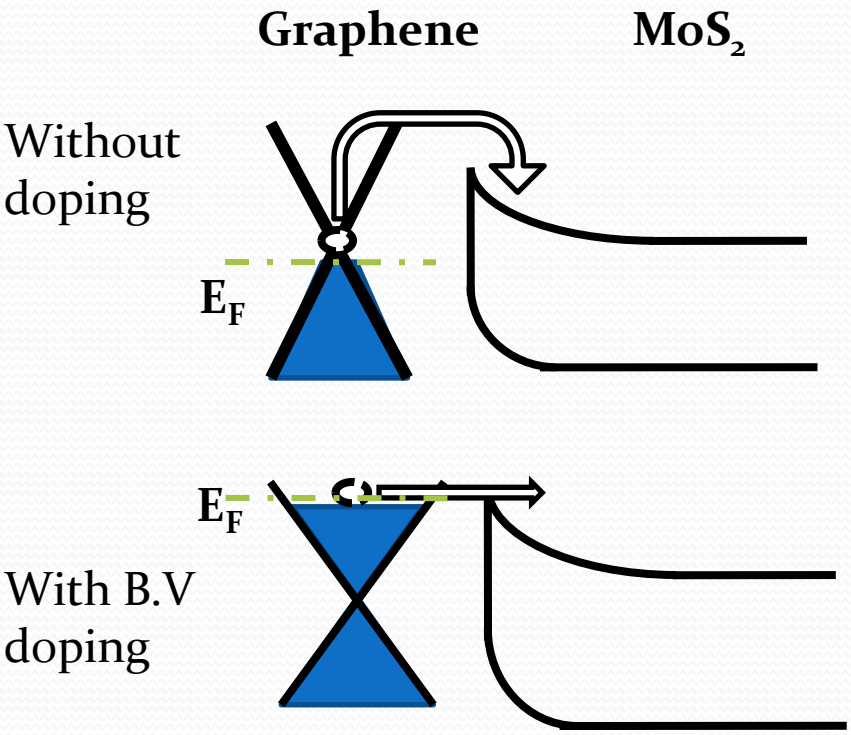


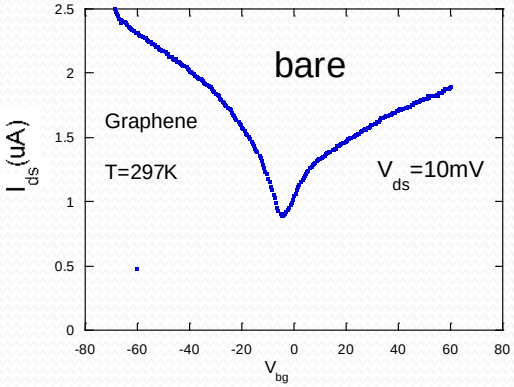
I_{ds} Vs V_{ds} of MoS_2 FET with graphene drain/source electrodes at 77K and RT

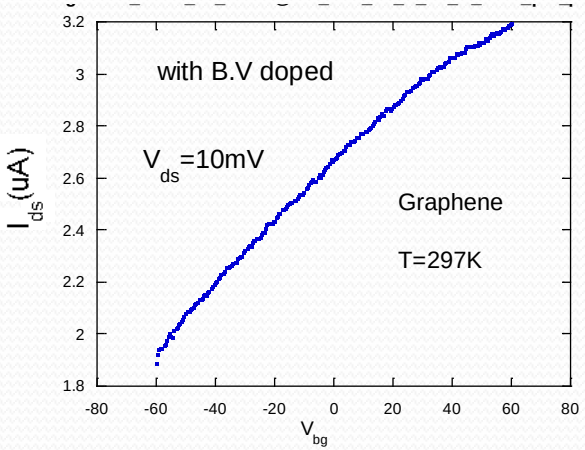




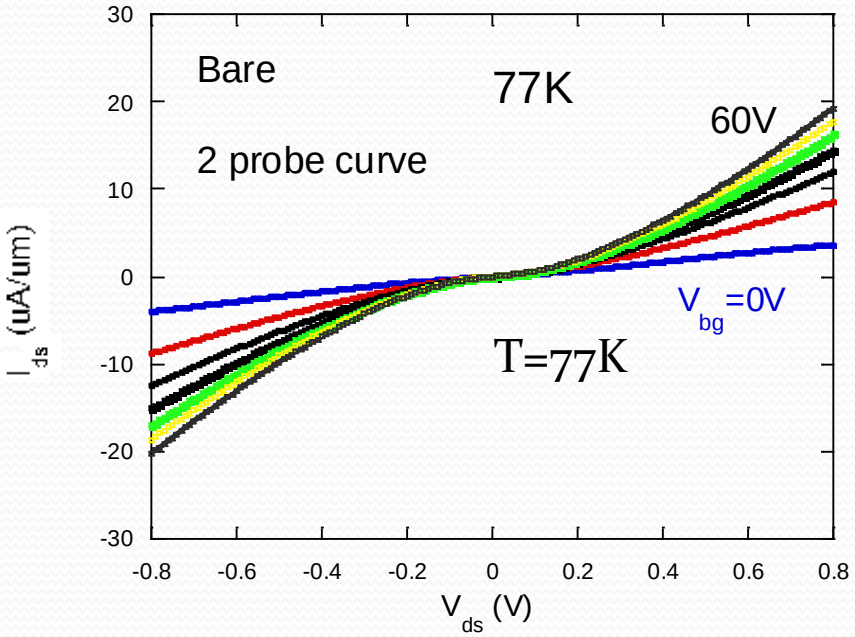
Before and after BV doping of graphene contacts

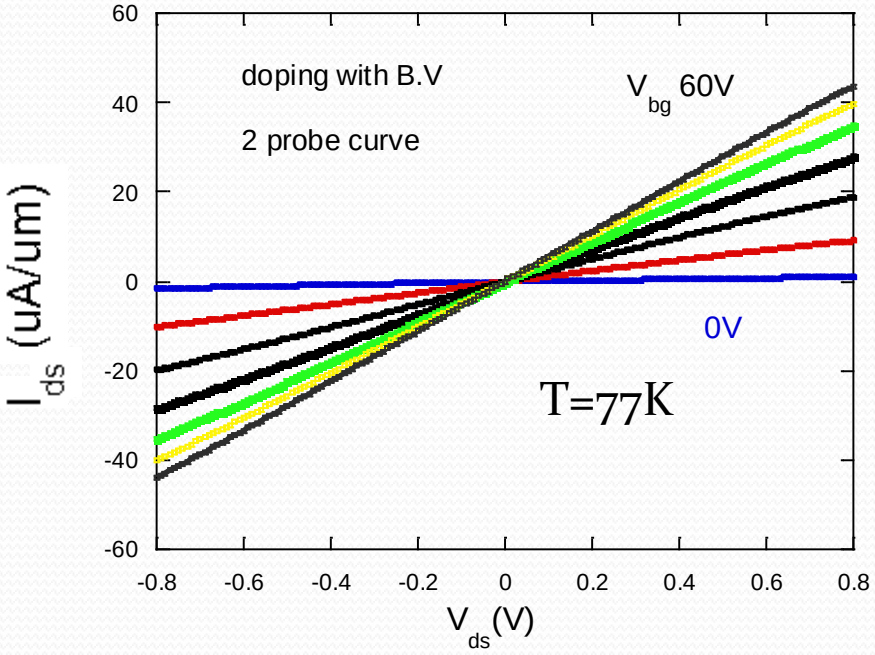




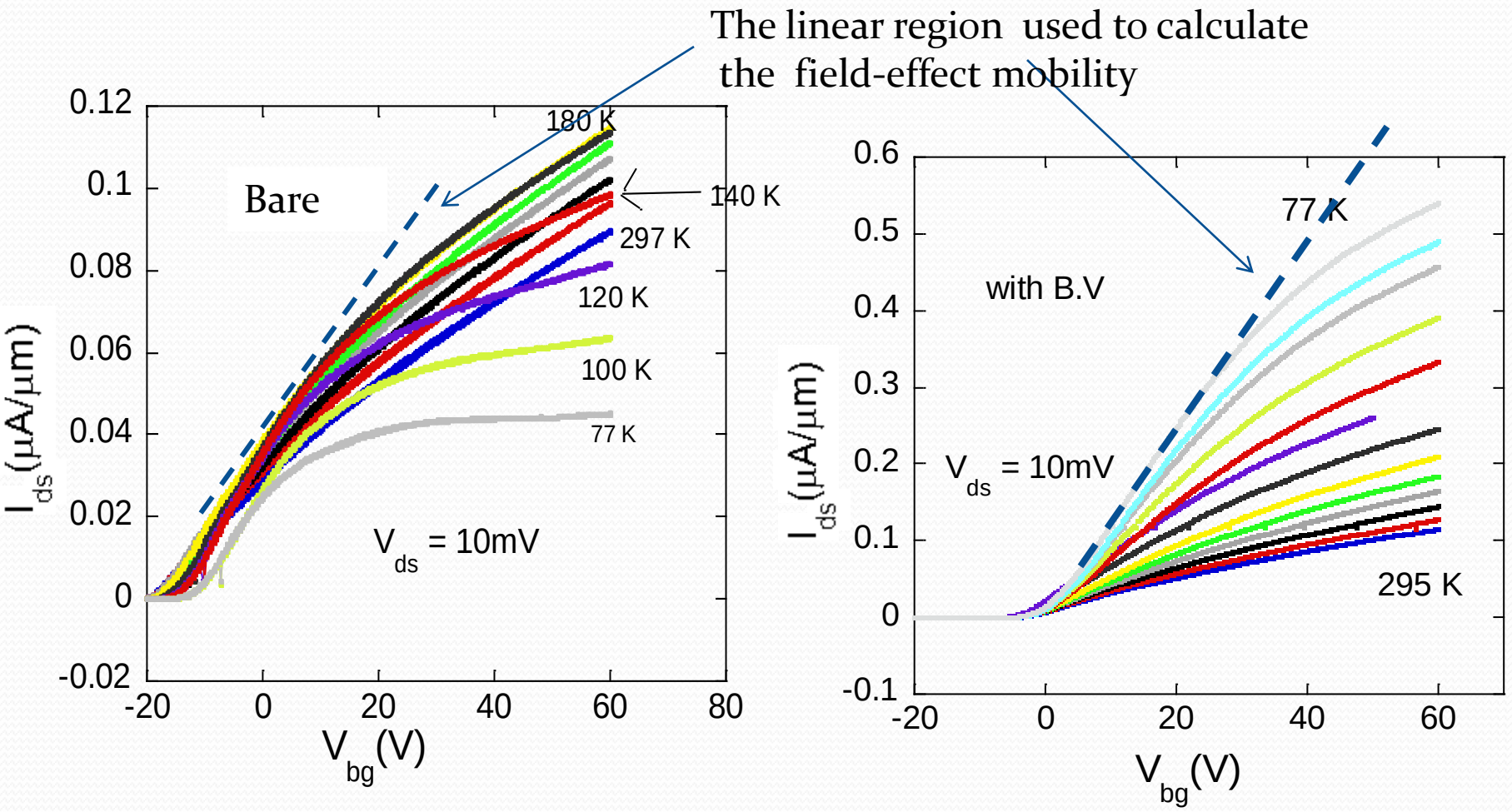


I_{ds} Vs V_{ds} at 77K before and after BV doping of graphene contacts

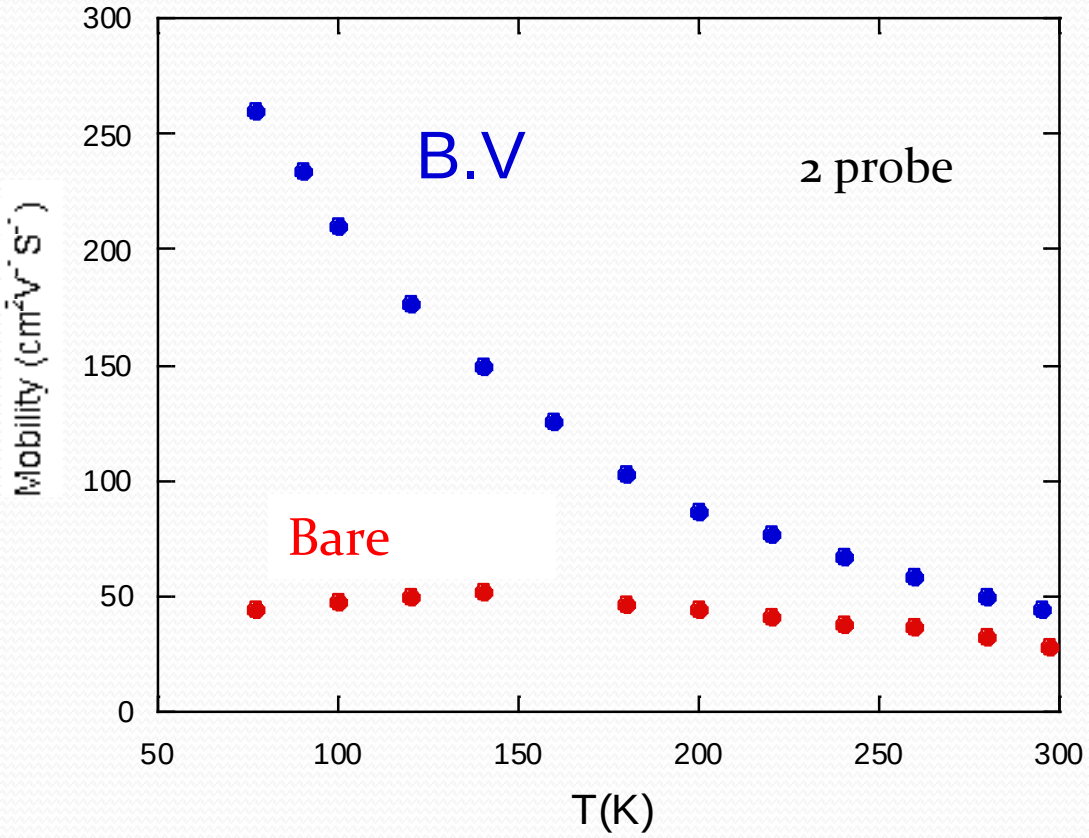




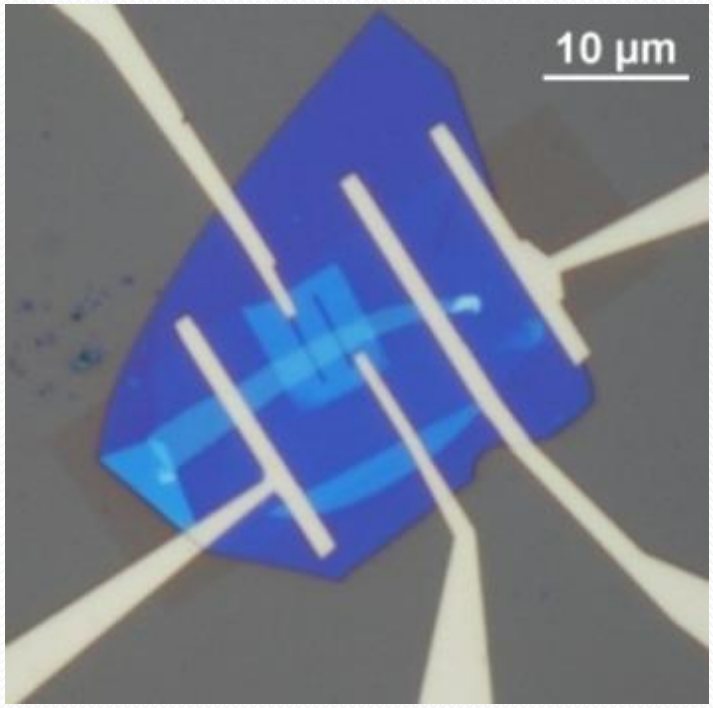
I_{ds} Vs V_{bg} before and after BV doping of graphene contacts



2-probe mobility before and after BV doping of graphene contacts

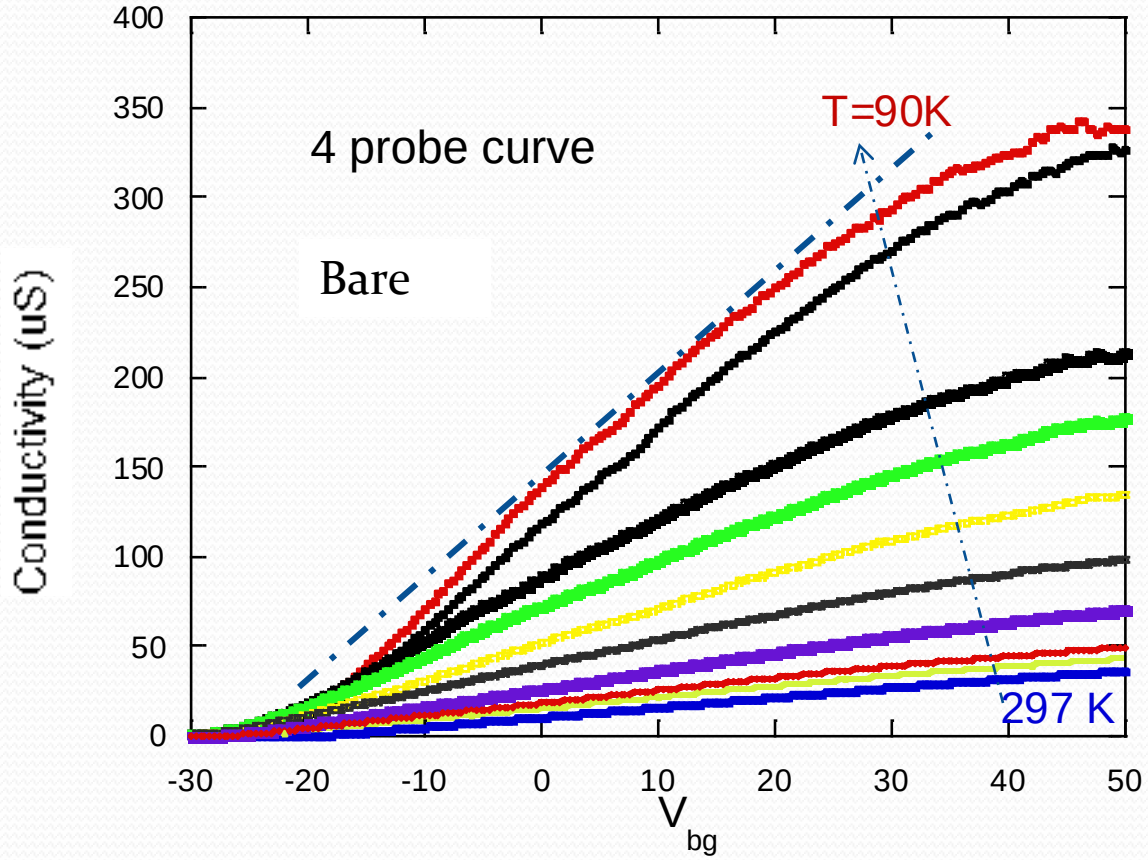


Four probe MoS2 FET ,to understand the intrinsic transport properties and scattering mechanisms

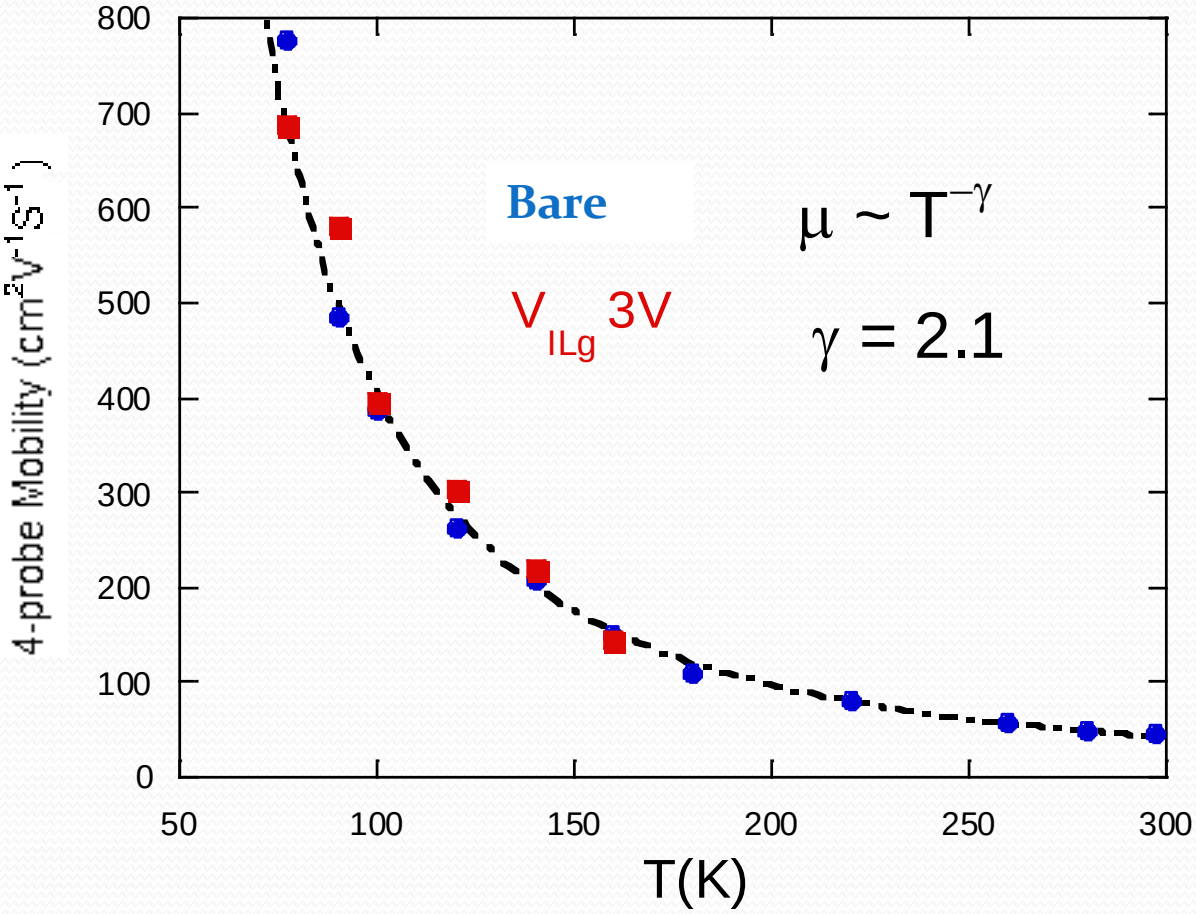


- Inner electrode separation (L): 2.4 um
- Channel Width(W): 2.5 um
- Channel length(length of hBN)= 7.32 um
- d= 4.9 nm

4-probe conductivity vs. gate-voltage of graphene contacted MoS_2



4 –probe mobility of h-BN encapsulated MoS_2 independent of graphene contact doping



Conclusions

- Used molecular doping on graphene to reduce the Schottky barrier height at graphene/MoS_2 contacts
- Highly doped graphene contacts lead to improve MoS_2 device performance
- Nearly intrinsic electrical transport has seen in hBN encapsulated MoS_2, which is independent of contact doping.