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Transport Studies in Graphene and Black Phosphorus Field Effect Transistors

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Over the last few years 2D materials have been heavily explored for a wide range of device application. Recently, in addition to pristine graphene, other 2D materials have started to play a more visible role. For example, black phosphorus (BP), is unlike graphene is a semiconductor with a sizeable band gap that allows both high carrier mobility and large on/off ratios [1]. Its excellent electronic properties make it attractive for applications in transistor, logic, and optoelectronic devices. However, it is also the first widely investigated two dimensional electronic material to undergo degradation upon exposure to ambient air. Here, I will show that atomically thin graphene and hexagonal boron nitride crystals can be used for passivation of ultrathin black phosphorus [2]. I will discuss experiments where we characterize few-layer black phosphorus field effect transistors on hexagonal boron nitride (BN) [3] and share recent results on thermal power measurements.

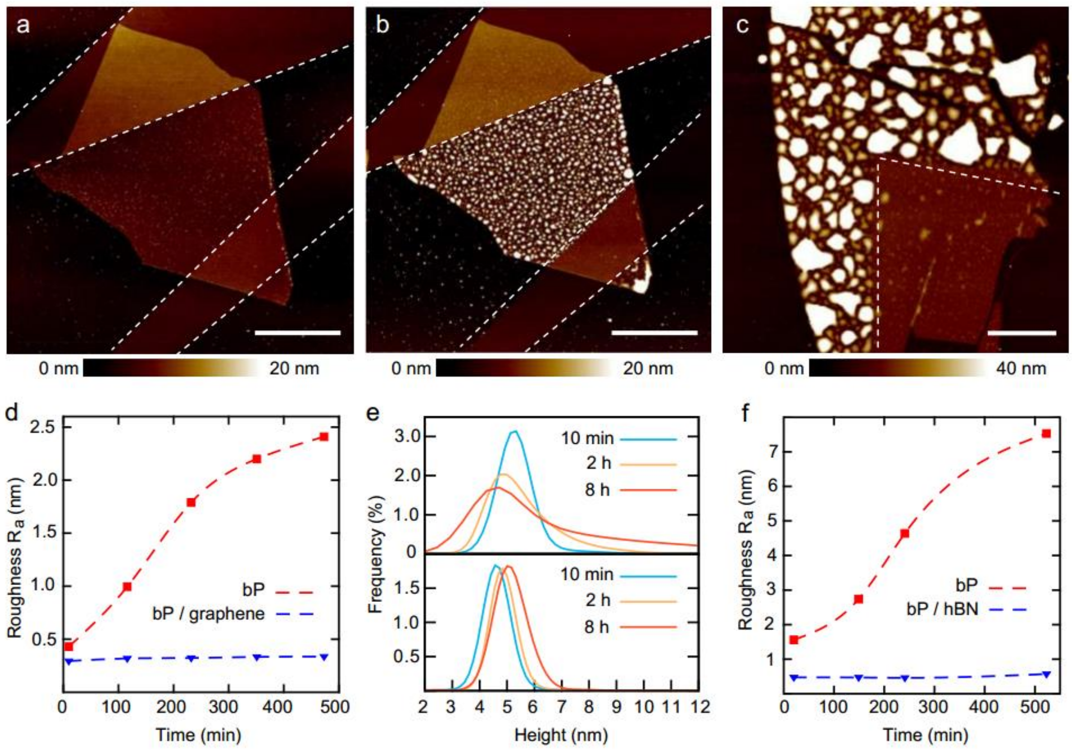

Figure 1: Comparison of surface roughness of black phosphorus with and without encapsulation.

In the second half of my talk, I will discuss graphene experiments where the decoration of graphene with either hydrogen or metal adatoms gives rise to a strong enhancement of its spin orbit coupling. I will show that such strong enhancement can give rise to a spin Hall effect even at room temperature.

References:

[1] S. P. Koenig, R. A. Doganov, Hennrik Schmidt, A. H. Castro Neto and B. Özyilmaz; Appl. Phys. Lett. 104, 103106 (2014).

[2] R. A. Doganov, E. C. T. O'Farrell, S. P. Koenig, Y. Yeo, A. Ziletti, A. Carvalho, D. K. Campbell, D. F. Coker, K. Watanabe, T. Taniguchi, T., A. H. Castro Neto and B. Özyilmaz, Nature Comms., 6: 6647 (2015).

[3] A. Avsar, I. J. Vera-Marun, J. Y. Tan, K. Watanabe, T. Taniguchi, A. H. Castro Neto, and B. Özyilmaz,; ACS Nano, ACS nano 9 (4), 4138-4145 (2015).