Electric barrier performance of monolayer hexagonal boron nitride

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In the two dimensional (2D) van der Waals (vdW) materials family, hexagonal boron nitride (h-BN) is a unique dielectric material with a wide band gap (5.9 eV). In the last JSAP meeting, we report the chemical vapor deposition (CVD) growth of single-orientation h-BN on Cu.[1] Here, to further evaluate its electrical performance, we utilize a conductive atomic force microscopy (cAFM) technique. As shown in Fig.1a, a tunnel device is modelled with a h-BN layer sandwiched between the Cu substrate and a Pt/Ir coated AFM probe. In a contact AFM mode, current-voltage (I-V) curves of h-BN and Cu are taken with a sample bias ramped between ±1.5 V (Fig.1b). An Ohmic contact is observed between the probe and Cu surface, as evident by the linear I-V curve. The h-BN layer shows very small current at low bias probably due to direct tunneling, and an exponential rise in current at high bias. The nonlinear tunnel current in the high bias regime can be well explained by the Fowler-Nordheim model, as indicated in the inset of Fig. 1b. Current mapping is conducted to investigate the spatial dielectric uniformity of h-BN on a large scale. The single-orientation h-BN exhibits more uniform barrier behavior than the multi-orientation one.

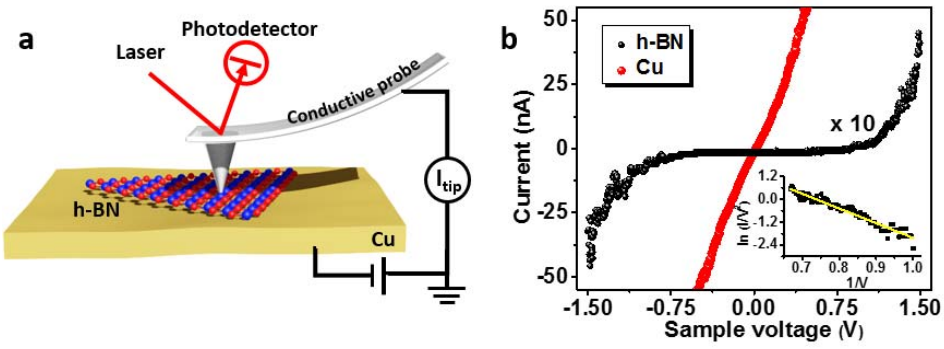

Fig. 1. (a) Schematic of cAFM measurement of h-BN on Cu. (b) I-V curves of h-BN and Cu. Inset is $\ln(1/V^2)$ vs. 1/V curve of h-BN.

[1] S. Wang et al. 2018 JSAP Autumn Meeting, 18a-224B-1.