Strong suppression of conductance in dual-gated h-BN/bilayer graphene/h-BN device

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Bilayer graphene (BLG) has been receiving much attention for the application of graphene-based nano devices. Since the band gap of BLG could be opened by applying perpendicular electric field with a dual-gated (DG) structure, this material could be used for fabrication of various types of gate-defined nano structures such as a quantum point contact or a quantum dot. However, the low temperature transport characteristics of DG-BLG devices have not exhibited strong suppression of conductance [1]. It is believed that the hopping transport between localized states due to the impurities in SiO_2 substrate is dominant at low temperature. In this study, instead of SiO_2 substrate we use h-BN, which is atomically flat and impurity free, for substrate and top gate dielectric material in the DG-BLG device.

We fabricate the DG-BLG device, showed in the inset of Fig. 1, using the dry transfer method. This system enables independent control of charge density and perpendicular electric field amplitude. Fig. 1 shows the sheet resistance R_{sheet} measured as a function of top-gate voltages V_{TG} at various back gate voltages V_{BG}. The resistance peaks correspond to the charge neutrally point (CNP). As increasing V_{TG} and V_{BG} to opposite direction, perpendicular electric field D increases. R_{sheet} at the CNP increases exponentially with D due to the induced band gap and reaches to 10 MΩ at D ~ 0.85 V/nm. We measure the temperature dependence of the conductivity at the CNP. The conductivity of our h-BN-based device is 2 orders of magnitude smaller than that of the SiO_2-based device at 4 K [1] (Fig. 2). Thus our study reveals that the h-BN-based DG-BLG devices have significant advantages for fabricating the gate defined nano electronics devices.

[1] T. Taychatanapat, *et. al.*, Phys. Rev. Lett. **105**, 166601 (2010).

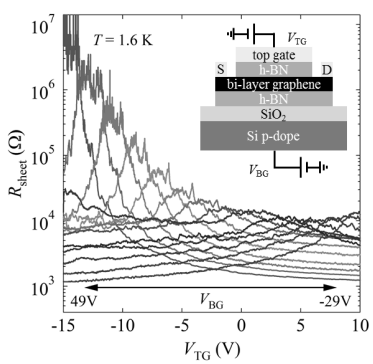

Fig. 1 R_{sheet} of DG-BLG at various V_{TG} and V_{BG}. Inset is the illustration of the device.

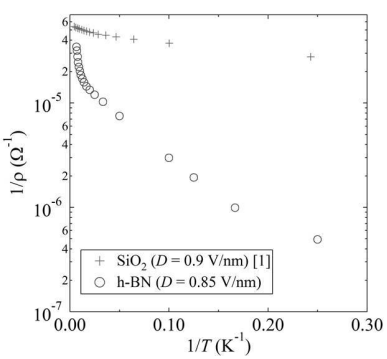

Fig. 2 Temperature dependence of the conductivity in h-BN- and SiO_2-based [1] devices.