

Bilayer graphene pn junction devices

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Bilayer graphene is the only material with an electrically tunable band gap.¹ This unique property can provide unprecedented schemes for novel functionalities in future electronic and optoelectronic devices.

In this work we prepared double gated structure devices of bilayer graphene to independently tune the charge density and the band gap as a function of the two gate voltages. Note that the top gate electrode is local, so it can be used to form a PN junction between the top-gated and ungated region. We applied relevant gate voltages to perform band engineering i.e. to tune the band gap value and shift the Fermi level and thereby realize the PN junctions. We observed a nonlinear I-V characteristic of PN diodes by successfully controlling the rectified direction of drain source voltage. A gate-tunable band gap value ranging from 20 meV to 180 meV was evaluated by analyzing the PN diode characteristics.

Our result indicates that the double gated bilayer graphene devices can be used to construct planar circuits made out of pp and nn channels and pn junctions, which are all gate tunable.

¹Y. Zhang, T-T. Tang, C. Girit, Z. Hao, M. C. Martin, A. Zettl, M. F. Crommie and F. Wang, *Nature* **438**, 201 (2009).