Lihong Bao
Guocai Wang, Tengfei Pei, Ruisong Ma, Shixuan Du, Hong-Jun Gao
Institute of Physics, Chinese Academy of Sciences, Beijing, 100190, P. R. China
lhbao@iphy.ac.cn, hjgao@iphy.ac.cn

Black Phosphorus and Its Anologue: Electrical Transport Properties and Devices

Black phosphorus (BP) has attracted great attention due to its high hole mobility, and a sizable and tunable bandgap, meeting the basic requirements for logic circuits application. To realize a complementary logic operation, it needs to control the conduction type in BP FETs, *i.e.*, the dominant carrier types, holes (P-type) or electrons (N-type). Absence of reliable substitutional doping techniques makes this task a great challenge, however. In this talk, I will demonstrate that capping the thin BP film with a cross-linked poly-methyl-methacrylate (PMMA) layer can modify the conductivity type of BP by a surface charge transfer process, converting the BP layer from p-type to n-type. Combining BP films capped by cross-linked PMMA to a standard BP, a family of planar devices can be created, including BP gated diodes (rectification ratio $>10^2$), BP barristors (on/off ratio $>10^5$), and BP logic inverter (gain～0.75), which are capable of performing current rectification, switching, and signal inversion operations. Furthermore, the conversion of a bidirectional rectifier to a polarity-controllable transistor in black phosphorus (BP) by dual gate modulation can be realized. Employing cross-linked PMMA as a top gate and combining it together with the global back gate of the SiO_2 substrate, well-defined unipolar transport (n- or p-type) in BP could get accessed.

References:

1. L. H. Bao, H. –J. Gao et al. Nano Letter 16, 6870 (2016).
2. L. H. Bao, H. –J. Gao et al. Adv. Electron Mater. 2, 1600292 (2016).
3. L. H. Bao, H. –J. Gao et al. 2D Mater. 4, 025056 (2017).