复旦大学物理系物质科学报告

Physics Department Colloquium

Electronic Transport and Device Applications of 2D Materials

Prof. Feng Miao

Nanjing University

During the last decade, tremendous research efforts have been focused on two-dimensional (2D) materials due to their rich physics and great potentials for many applications. Our group at Nanjing University is now focusing on electronic transport, electro-mechanical properties, optoelectronic properties, and related device applications of various 2D materials. The first part of my talk will focus on the electro-mechanical properties of suspended graphene, which is the thinnest flexible conductive material. I will present the positive piezoconductive effect we observed in suspended bi- and multi-layer graphene. The effect is highly layer-dependent, with the most pronounced response for tri-layer graphene. The effect, and its dependence on the layer number, can be understood as resulting from the strain-induced competition between interlayer coupling and intralayer hopping, as confirmed by the numerical calculation based on the non-equilibrium Green's function method. [1]

The second part of the talk will cover our recent studies on transition-metal dichalcogenides (TMD) with low lattice symmetry. In a predicted type-II Weyl semimetal (WSM) material, tungsten ditelluride (WTe_2), we observed notable angle-sensitive negative longitudinal

magnetoresistance (MR) and the strong planar orientation dependence which reveal important transport signatures of chiral anomaly. By applying a gate voltage, we further demonstrated that the Fermi energy can be tuned through the Weyl points via the electric field effect; this is the first report of controlling the unique transport properties *in situ* in a WSM system. [2] We also studied atomically thin rhenium disulfide (ReS_2) flakes exhibiting interesting in-plane anisotropic transport and mechanical properties, as well as excellent optoelectronic properties. We fabricated mono- and few-layer ReS_2 field effect transistors, which exhibit competitive performances and record-high anisotropic ratio. We further successfully demonstrated an integrated digital inverter with good performances by utilizing two ReS_2 anisotropic field effect transistors, suggesting the promising implementation of large-scale two-dimensional logic circuits. [3] Our latest results on the ultra-high responsivity phototransistors based on few-layer ReS_2 and broadband photovoltaic detectors based on an atomically thin heterostructure will also be presented. [4,5]

References:

[1] Xu, *et al*. "The positive piezoconductive effect in graphene", ***Nat. Comm.*** 6, 8119 (2015).

[2] Wang, *et al*. "Gate-Tunable Negative Longitudinal Magnetoresistance in the Predicted Type-II Weyl Semimetal WTe2", ***Nat. Comm.*** (2016) (in press).

[3] Liu, *et al*. "Integrated Digital Inverters Based on Two-dimensional Anisotropic ReS_2 Field-effect Transistors", ***Nat. Comm.*** 6, 6991 (2015).

[4] Liu, *et al*. "Ultra-high responsivity phototransistors based on few-layer ReS_2 for weak signal detection", ***Adv. Func. Mater.*** 26, 1938 (2016).

[5] Long, *et al*. "Broadband photovoltaic detectors based on an atomically thin heterostructure", ***Nano Lett.*** 16, 2254 (2016).

Time: 2:00pm, Monday, 2016.9.20

Location: Physics Building, Room 221B

(Cookies and coffee are served from 1:30 pm)