Novel 2D interfaces with silicon, graphene, $MoTe_2$ and Ca_2N

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Two-dimensional (2D) interfaces with diverse three-dimensional materials' contact have long been an issue familiar to scientists and engineers. These days, together with 2D materials and emerging 1D edge contact, the 2D interfaces are attracting renewed interests for various applications such as next-generation devices. In particular, polymorph engineering in group 6 TMDs, such as MX2 with M=(Mo, W) and X=(S, Se, Te), has allowed an intriguing theme in the interface science, a formation of homojunction in a single material.

In this talk, I will briefly review interesting features of 2D interface including graphene [1]. Then, homojunctions between metallic (1T') and semiconducting (2H) $MoTe_2$, generated by two methods (laser irradiation and contacting to low work function material), will be discussed [2]. The synthesis of high quality $MoTe_2$ has been a key for these studies [3]. We demonstrate that our high quality single-crystalline and semimetallic 1T'-$MoTe_2$ exhibits a maximum carrier mobility of 4,000 $cm^2V^{-1}s^{-1}$ and a giant magnetoresistance of 16,000% in a magnetic field of 14 Tesla at 1.8 Kelvin in the bulk form, and the few-layered 1T'-$MoTe_2$ reveals a bandgap of up to 60 meV in its monoclinic form. The small energy difference between 2H and 1T'-$MoTe_2$, resulting in the presence of the two polymorphs, is also used for a novel way of structural phase transition, contact-driven phase change. Extremely low work function of Ca_2N, ~2.3 eV, realizes a large charge transfer that can switch the material's symmetry in a long range of ~100 nm. These interface studies suggest novel contact-based 2D materials design and applications.

[1] Heejun Yang *et al.*, Science 336, 1140 (2012).

[2] S. Cho *et al.*, Science 349, 625 (2015)

[3] D. H. Keum *et al.*, Nature Physics 11, 482 (2015)