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

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Two-dimensional (2D) interfaces with diverse three-dimensional materials have been familiar to scientists and engineers. These days, together with 2D materials, 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 MX_2 with M=(Mo, W) and X=(S, Se, Te), has allowed an intriguing theme in science, a formation of homojunction in a single material.

In this talk, I will briefly review interesting features of 2D interface including graphene. 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. The synthesis of high quality $MoTe_2$ has been a key for these studies. We demonstrate that our high quality single-crystalline and semimetallic 1T'-$MoTe_2$ exhibits a maximum carrier mobility of 4,000 cm^2/Vs 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 then used for a novel way of structural phase transition, contact-driven phase change. Extremely low work function of Ca_2N, ~2.3 eV, realized a large charge transfer (more than 1014/cm^2) that can switch the material's symmetry.