Controllable Construction and Electronic Properties Investigation of Two-Dimensional TMDs Heterojunction and Homojunction

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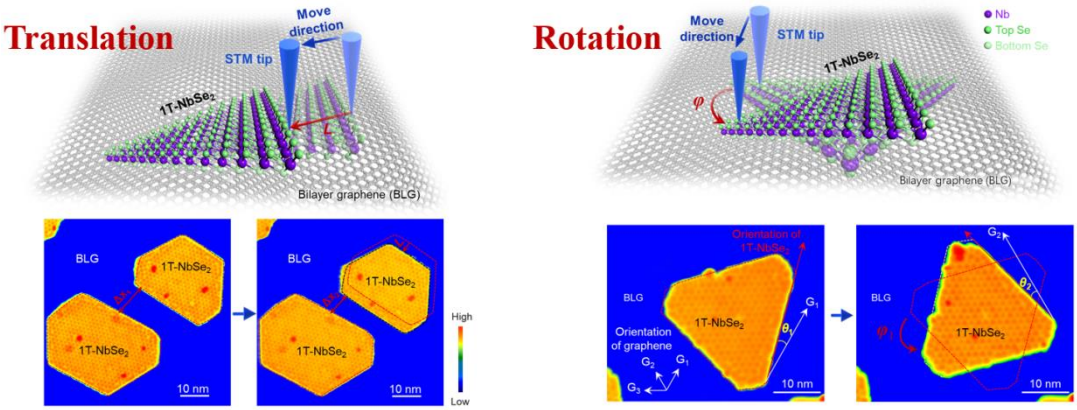
Abstract

Two-dimensional (2D) materials have drawn intensive attention since they can be manipulated to form different electronic structures, which gives rise to a variety of strongly correlated physical properties, once the long-range Coulomb interaction exceeds kinetic energy of electrons. Moreover, the construction of low-dimensional homostructures and heterostructures based on 2D transition-metal dichalcogenides (TMDs) has attracted widespread attention recently. Among them, the in-plane one-dimensional (1D) structures that consist of atomically thin TMDs with strongly correlated electrons are especially important, since they hold potential for exploring low dimensional correlated electronic properties.

Here we demonstrate that, using STM manipulation technique, we can precisely construct the 2D TMDs homojunctions and heterojunction based on the 2D atomic crystal thin T-$NbSe_2$ and H-$NbSe_2$ films, which provides a dynamic way to modify the correlated electronic states at the junctions. In the homojunction, we confirm the existence of 1D-confined potential at the homojunction of two single-layer 1T-$NbSe_2$ islands.[1] Such potential is structurally sensitive, and shows a non-monotonic function of their interspacing. In the heterojunction, the H-$NbSe_2$ metallic state penetrates the Mott insulating T-$NbSe_2$ at the H/T phase interface, with a prominent 2D charge density wave (CDW) proximity effect.[2] Moreover, an insulating Mott gap collapse with the disappearance of the upper Hubbard band is detected at the electronic phase transition region.



Pic.1 Controllable translation and rotation movement of $NbSe_2$ islands using STM manipulation technique.

Bibliography
[1] Q. Zhang, et al, Nano Letters 12, 1910 (2022).
[2] Q. Zhang, et al, ACS Nano 15, 16589 (2021).