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Band gap renormalization and work function tuning in $MoSe_2$/hBN/Ru(0001) heterostructures QIANG ZHANG, YUXUAN CHEN, CHENDONG ZHANG, University of Texas at Austin, CHI-RUEI PAN, MEI-YIN CHOU, Georgia Institute of Technology, CHANGGAN ZENG, University of Science and Technology of China, CHIH-KANG SHIH, University of Texas at Austin — The van der Waals interaction in vertical heterostructures made of two-dimensional (2D) materials relaxes the requirement of lattice matching, therefore enabling great design flexibility to tailor novel 2D electronic systems. Here we report the successful growth of $MoSe_2$ on single-layer hexagonal boron nitride (hBN) on the Ru(0001) substrate using molecular beam epitaxy. Using scanning tunneling microscopy and spectroscopy, we found that the quasi-particle bandgap of $MoSe_2$ on hBN/Ru is about 0.25 eV smaller than those on graphene or graphite substrates. We attribute this result to the strong interaction between hBN/Ru which causes residual metallic screening from the substrate. In addition, the electronic structure and the work function of $MoSe_2$ are modulated electrostatically with an amplitude of about 0.13 eV. Most interestingly, this electrostatic modulation is spatially in phase with the Moir pattern of hBN on Ru(0001) whose surface also exhibits a work function modulation of the same amplitude.

Qiang Zhang
University of Texas at Austin

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