Studies of graphene doping in graphene/1T-TaS_2 heterostructure by STM/STS/LEED/ARPES/DFT methods

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We show effect of interactions of selected transition metal dichalcogenide (TMDC) on the properties of graphene in heterostructure system. The observed changes are caused by doping processes, breaking of pseudospin symmetry and spin-orbit coupling (SOC) combined with broken space inversion symmetry. For our studies we create graphene/1T-TaS_2 heterostructure, where 1T-TaS_2 shows high value of SOC, distinct metal-insulator-transition (M-I-T) and successive first order phase transitions accompanied with charge density waves (CDW). An undistorted normal phase of 1T-TaS_2 exists in the temperature range of 570–550 K. Upon lowering temperature an incommensurate CDW ordering (ICCDW) is observed below 550 K and then nearly commensurate phase (NCCDW) at about 350 K. Finally, a commensurate (CCDW) ground state is reached at 180 K.

We will present our recent LEED/STM/STS/ARPES experiments on 1T-TaS_2 carried out at different temperatures accompanied with DFT calculations showing successive transformation of CDW and evolution of the electronic structure expected from the theoretical calculations – see Fig.1 [1]. We also show evolution of the electronic structure of graphene/1T-TaS_2 heterostructure. We experimentally prove that graphene is p-type doped due to the proximity effect as predicted from our DFT calculations - Fig.2.

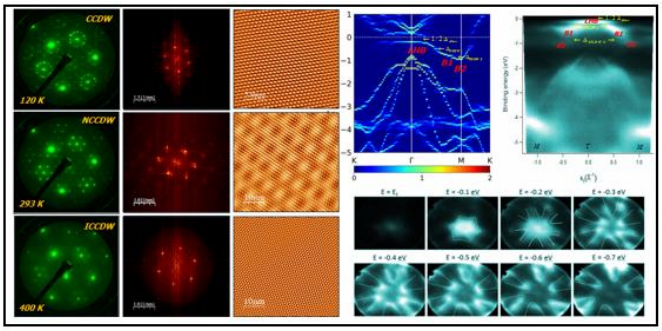

Fig.1

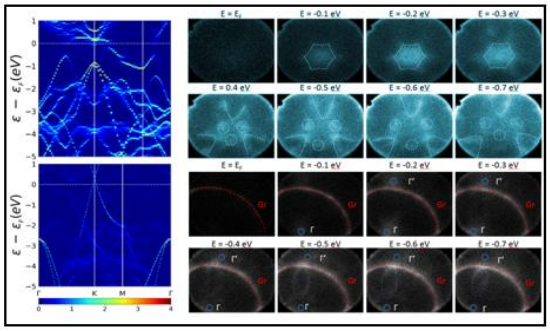
Fig.2

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[1] I. Lutsyk et al. *Phys. Rev. B.* **98**, 195425 (2018).