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Interfaces between transferred, CVD-grown graphene and MoS₂ probed with STM and ARPES

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Heterostructures made of different van der Waals materials are of increasing interest because of potential applications in energy harvesting and combination of spin- and valley-tronics. However, the interface properties of these materials are not yet well characterized. One challenge for their characterization is the preparation of large-area high quality materials that enable employment of surface characterization techniques such as scanning probe microscopy and photoemission spectroscopy. Here we demonstrate the transfer of CVD-grown graphene to bulk MoS₂ substrates and report the first STM and ARPES studies of such a system. As expected for weakly interacting materials STM studies only exhibit a very weak moire-superstructure and (nano) ARPES measurements show that the Dirac cone of graphene is maintained. However, (nano) ARPES also shows the formation of band-gaps in the pi-band of graphene where the out-of-plane molecular orbitals of MoS₂ intersect with the electronic-states of graphene. This modification of the electronic structure of graphene in the graphene/MoS₂ heterostructure is contrary to expectations of simple van-der Waals stacked materials. The high quality of the samples will enable further studies of the spin state of the graphene and MoS₂ substrate as well as enable preparation of other heterostructure materials and thus will give a detailed description of the interaction in these heterostructure systems.

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