Junctions and Contacts in 2D semiconductor devices

Aleksandar Matkovic

Chair of Physics, Department Physics, Mechanics and Electrical Engineering,
Montanuniversitaet Leoben, Austria
aleksandar.matkovic@unileoben.ac.at

As the 2D materials-based electronics develop towards very large-scale integrated circuits, one of the major challenges is to obtain high quality contact to 2D semiconductors. Carrier injection barriers, metal induced gap states, and consequently Fermi level pinning at the electrode interfaces hinder the integration of 2D semiconductors. Intrinsic properties of the channel 2D material are rarely accessible as usually majority of the bias intended for the carrier transport is used to overcome the contact-related junctions. Further, in the case of polycrystalline films and assembled nanosheet networks also junctions between adjacent domains and nanosheets govern the macroscopic response of the devices.

This talk will focus on single crystalline MoS_2, WSe_2, $PtSe_2$, and on liquid phase-exfoliated and liquid-liquid interface assembled MoS_2 nanosheet networks. We will review several possible electrode choices, from organic self-assembled monolayers functionalized conventional metals, to van der Waals semi-metallic contacts. The focus will be on ways to evaluate contact-related losses considering macroscopic electrical measurements, device modelling, and local probing of the electrostatic potential by in-operando Kelvin Probe Force Microscopy. We will see how contact engineering can enhance the properties of 2D semiconductor devices, and also tailor carrier injection into 2D channels.

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