ABSTRACT:

Fermi Level Tuning In Transition Metal Dichalcogenides

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Transition metal dichalcogenides (TMDCs) are layered materials that exhibit unique physical properties owing to their low dimension, making them potential candidates for the next-generation optoelectronic devices. Amongst the different TMDCs, MoS2, MoSe2, WS2 and WSe2 have attracted significant attention due to their ease of (large scale) synthesis, high charge carrier mobility, direct bandgap, and large exciton binding energy in their single-layer form. However, because of the low dimension of these materials, applying some of the technologies long available for 3D semiconductors, such as impurity doping, can be challenging and more adapted methods may have to be developed. In this presentation, we use angle-resolved photoemission (ARPES) to explore the feasibility of Fermi level control of MoS2 monolayers by tuning of the substrate work function and by molecular doping. We will present the band line-up at interfaces between MoS2 and various substrates and show that Fermi level pinning occurs for substrate work functions below 4.5 eV while vacuum level alignment occurs above this value. In addition, we show that the charge injection barriers do not strictly follow the expected Schottky-Mott rule due to the non-negligible role of dielectric screening. Finally, we will examine the possibility of Fermi level tuning of TMDCs by adsorption of strong molecular acceptors and donors and demonstrate different charge transfer mechanisms depending on the conducting properties of the substrate.

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