Ultra-clean interfaces between 2D MoS_2, contact metals, and high K dielectrics

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The interface between two-dimensional transition metal dichalcogenide (2D TMDs) semiconductors and metal contacts has been extensively studied. Clean van der Waals contacts now allow both high quality n- and to lesser extent p-type contacts. In contrast, the 2D semiconductor/dielectric interface has not been as widely studied as the metal/2D TMD junction. Here I will summarise our work on contacts and provide new results on the 2TMD/dielectric interface. The dielectric for 2D TMD devices must be thermodynamically and mechanically stable as well as being chemically inert. The band offset between the conduction and valence bands of the dielectric and 2D semiconductor should be at least 1eV. The 2D TMD/dielectric interface should be clean and free of defects. In this presentation, we present detailed synchrotron XPS study of 2D TMD and oxide interface. Specifically, we have studied the band offsets between MoS_2 and SiO_2, HfO_2, and ZrO_2 using XPS. We find that the dielectrics strongly dope the 2D MoS2 with significant shift (>1eV) in the Fermi level. Our results provide insight into suitability of different dielectrics for 2D MoS_2 FETs.