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Abstract for an Invited Paper
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Scanning Tunneling Microscopy of Transition Metal Dichalcogenide Monolayers and Heterostructures[1]

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Monolayer transition metal dichalcogenides (TMDCs) have emerged as a new class of materials with interesting optoelectronic properties. In this talk, I will describe scanning tunneling microscopy and spectroscopy measurements of various TMDCs and their heterostructures on silicon oxide substrates. First, I will describe spectroscopy measurements on the gate dependence of the bandstructure in low doped monolayer MoS_2 films. These measurements show a continuous shift in valence and conduction band edges as defects are charged, allowing us to quantitatively estimate defect concentration. Next, I will discuss the nature of electrical contact between metals and TMDC layers. Atomically resolved spectroscopy at the edge of metal deposited contacts as well as few layer graphite contacts to highly doped MoS_2 reveals the presence of metal induced gap states (MIGS), the first experimental observation of MIGS in a two-dimensional semiconductor. We show that MIGS dominate contact properties in the highly doped limit. Third, I will discuss the atomic-scale structural and electronic properties of lateral and vertical heterogeneous stacks of TMDCs such as MoS_2, WSe_2 and WS_2. Finally, I will discuss how one can distinguish intrinsic and extrinsic defects in the TMDCs, and the correlation between defect concentration and optical properties in these materials.

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