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Mapping the Electronic Structure of Two-Dimensional WS_2 Heterostructures with Spatially Resolved ARPES at the MAESTRO Facility

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Single-layer (SL) semiconducting transition metal dichalcogenides (TMDCs) such as WS_2 exhibit strong spin-orbit coupling around the valence band maximum and a direct band gap that is highly sensitive to the dielectric properties of the surrounding medium. High-resolution angle-resolved photoemission spectroscopy (ARPES) studies of these properties are lacking for TMDCs on truly insulating supports such as oxides or hexagonal boron nitride (hBN), which form the basis of a wide range of high performance two-dimensional (2D) heterostructure devices. Here, we use the new microARPES capability with spatial resolution on the order of 10 μm at the MAESTRO facility at the Advanced Light Source (ALS) to spatially map the electronic structure of micron-sized SL WS_2 heterostructures with transition metal oxides and hBN. We directly observe dramatic changes in the SL WS_2 band structure and the gap around the valence band maximum when we vary the substrate or the charge carrier concentration in WS_2. These findings are discussed in relation to how we can achieve control of the spin and optical properties of such 2D materials.

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