Synthesis and Applications of Two-Dimensional Transition Metal Dichalcogenides

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Transition metal dichalcogenides (TMDCs) are layered materials that possess interesting electronic and optical properties. When TMDCs are thinned down to a single monolayer, their electronic structure and physical symmetries are radically altered, leading to new behavior such as indirect to direct bandgap transitions. Furthermore, modifying the coordination between the transition metal atom and chalcogen atoms can lead to new phases with radically different electronic properties. Because of these properties, TMDCs have been considered as promising materials for future electronics and optoelectronics. To increase their potential uses in these applications, we have developed new chemical vapor deposition techniques for synthesizing novel TMDCs such as their two-dimensional (2D) heterostructures. Using a phase-selective synthetic strategy, we have synthesized in-plane few-layer 2H-1T′ $MoTe_2$ junctions that are regarded as edge-contacted 2D materials, which are very attractive for high-performance 2D electronics. Furthermore, we have demonstrated a two-step strategy for synthesizing in-plane and vertical heterostructures composed of monolayer MoS_2 and WS_2, which could serve as new building blocks for future optoelectronics.