

Synthesis and Applications of Low-Dimensional Transition Metal Dichalcogenides

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Abstract:

Transition metal dichalcogenides (TMDCs) are layered materials that feature electronic properties comparable to those of conventional semiconductors. 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 heterostructures. Using a phase-selective synthetic strategy, we have synthesized in-plane few-layer 2H-1T' MoTe₂ junctions regarded as edge-contacted 2D materials, which are essential for high-performance 2D electronics. Furthermore, we have demonstrated a two-step strategy for synthesizing in-plane and vertical heterostructures composed of monolayer MoS₂ and WS₂, which could serve as new building blocks for future optoelectronics.