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Controlled synthesis and layer-number-dependent catalytic properties of few-layered MoS2/CdS Van der Waals heterostructures for efficient photocatalytic H_2 evolution

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In a typical photocatalytic reaction, efficient solar light harvesting and charge generation, as well as effective charge transport, are key factors that determine the efficiency of the photocatalytic system for H_2 production. Atomically layered heterostructures have attracted significant research interest due to their unique layer-dependent catalysis and electronic properties. Previous studies have reported that the catalytic properties of MoS_2 layered materials are highly dependent on the number of layers, and the difficulty of controlling the number of layers over a substrate has been a bottleneck for widespread use. Therefore, developing a simple, facile and environmental friendly method to fabricate Van der Waals heterostructures (vdWHs) with precisely controlled MoS_2 layers for achieving highly efficient H_2 generation is still a challenge. Here, we report for the first time that the H_2 bubbles generated by photocatalytic water splitting are effective in the layer-by-layer exfoliation of MoS_2 nanocrystals (NCs) into few layers. The as obtained few layers can be *in situ* assembled with CdS nanosheets (NSs) into vdWHs of few-layered MoS_2/CdS NSs which, in turn, are effective in charge separation and transfer, leading to enhanced photocatalytic H_2 production activity. The few-layered MoS_2/CdS vdWHs exhibited a H_2 evolution rate of 140 mmol $g(CdS)^{-1}$ h^{-1} and achieved an apparent quantum yield of 66% at 420 nm. This study provides a new strategy for the design of noble-metal-free few-layered MoS_2/CdS vdWH systems for photocatalytic H_2 generation. We believe that this bubble exfoliation strategy can be extended to a range of other layered transition metal dichalcogenide compounds.

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