One-dimensional sandwiched Ultrathin p-n Heterojunction for Photodetectors

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Abstract

Vertically stacked van der Waals (vdW) p-n heterostructures have the important advantages in reduced power consumption, scalable active areas and short charge extraction channels, which contribute to efficient and fast-speed photodetection. However, the family of p-type 2D materials is very rare, which limits the performance of p-n heterostructures. Here, we demonstrate the controllable growth of vanadium-doped tungsten disulfide (V-doped WS_2) flakes by chemical vapor deposition (CVD). Taking the advantages of substitutional doping for modulating the band structure in 2D semiconductors, a type II p-n vertical heterojunction is fabricated using monolayer V-doped WS_2/monolayer MoS_2 sandwiched between two semimetal carbon nanotubes (m-CNTs). As a photodetector, this device exhibits a backward diode, the negative photocurrent responses under 375 nm to 685 nm lasers and fast-speed photoresponse for 2 nm channel length of a p-n vertical heterostructures. Our results pave the way for nanosized and fast response photodetectors in the future.

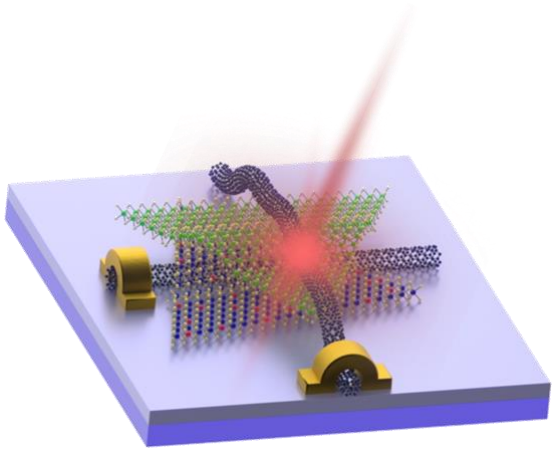

Figure 1: Schematic of vdW p-n vertical heterojunction sandwiched between two m-CNTs under laser illumination.