Tunning the electrical transport of WS_2 by V substitution

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Abstract

Substitutional doping of two-dimensional transition metal dichalcogenides (2D-TMDs) has been proven to be effective way to modify the electronic properties for their applications in electronic and photonic engineering. However, control of p-type conductivity in tungsten disulfide (WS_2) remains challenging. Herein, we report controllable growth of vanadium (V) doping monolayer WS_2 with various doping concentrations by mixing of a tungsten source and vanadium dopant. The atomic-resolution scanning transmission electron microscopy (STEM), photoluminescence spectroscopy (PL), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS) evidence the V substitution doping in the WS_2 lattice. The V-doped WS_2 FET shows a transformation from n-type at 0%V to ambipolar (10%V), p-type (20%V) and degenerate (30%). A vertical p-n homojunction based on pure WS_2 and V-doped WS_2 shows a good rectification ratio. This work will can be extended for controllable doping in other TMDs materials for further electronic and optoelectronic application ns.

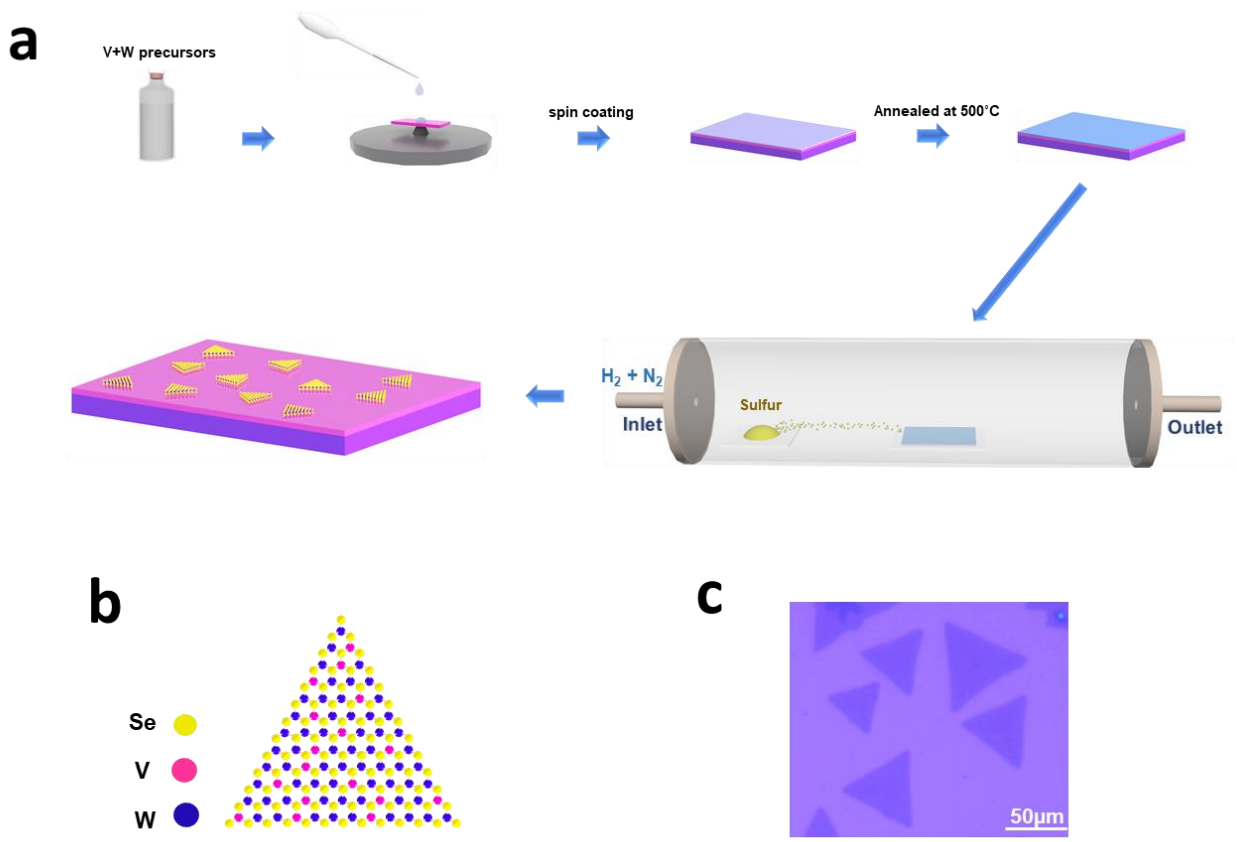

Figure 1: Growth of V-doped WS_2

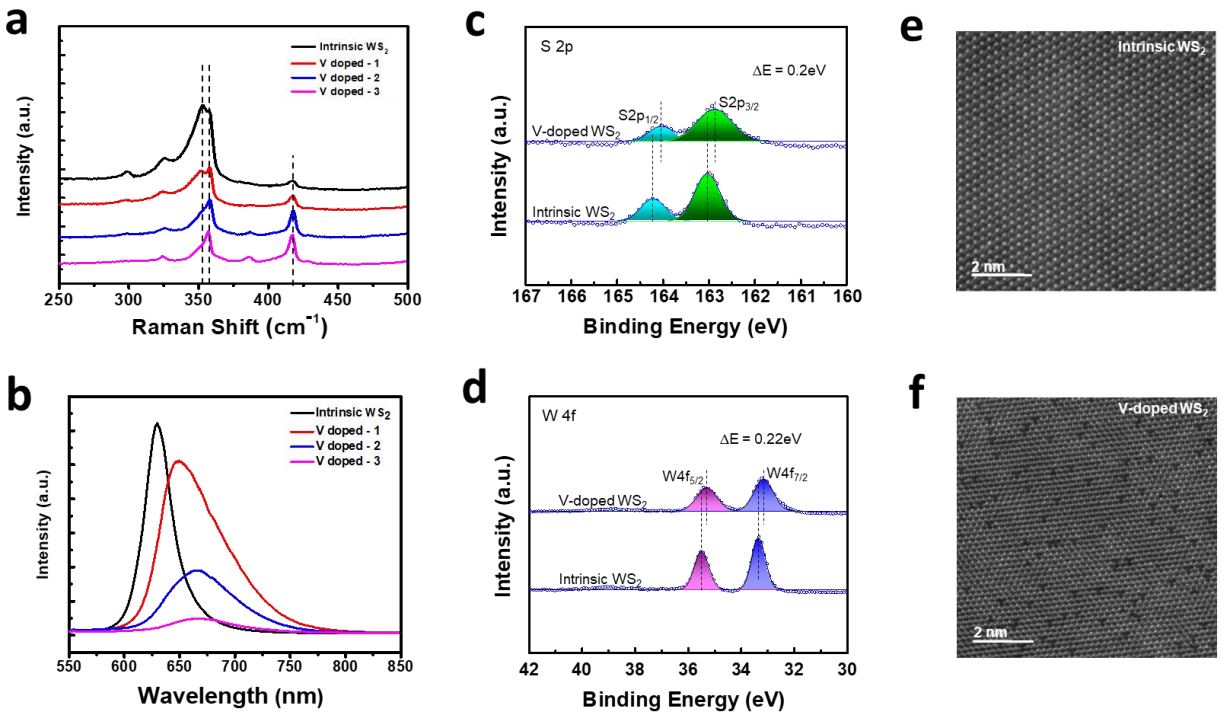

Figure 2: (a, b) Raman and PL spectra of undoped and doped monolayer WS_2 with different V percent, respectively. XPS scans of (c) S 2p and (d) W 4f core-level binding energies for intrinsic and doped monolayer WS_2. (e, f) HAADF-STEM images of undoped and doped monolayer WS_2. Scale bars are 2nm.