Vanadium Tetrasulfide Nanowires: half-metal antiferromagnetic semiconductor with Carrier Doping towards antiferromagnetic spintronics

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Abstract

Antiferromagnetic (AFM) spin devices could be one of the representative components for spintronic applications because of many advantages, resistance to magnetic field perturbation, stray field-free operation, and ultrahigh device operation speed. However, detecting and manipulating the spin in AFM materials is still a challenge because of the absence of a net magnetic moment and spin degeneracy in the band structure. Engineering the electronic and magnetic structures of material systems enables the novel exploration of new physical properties, which could be promising solutions to these problems. We discovered three phases of vanadium tetrasulfide nanowires (VS_4) which are AFM. Results indicate that gate voltage can manipulate the spin orientation of VS_4 leading to a transition from AFM to half-metal antiferromagnets (Figure 1). It means that we can manipulate the orientation of spin currents by using different gate voltages. This opens a new strategy towards AFM spintronics for expanding applications of the spin field effect transistor in one dimensional nanowires.

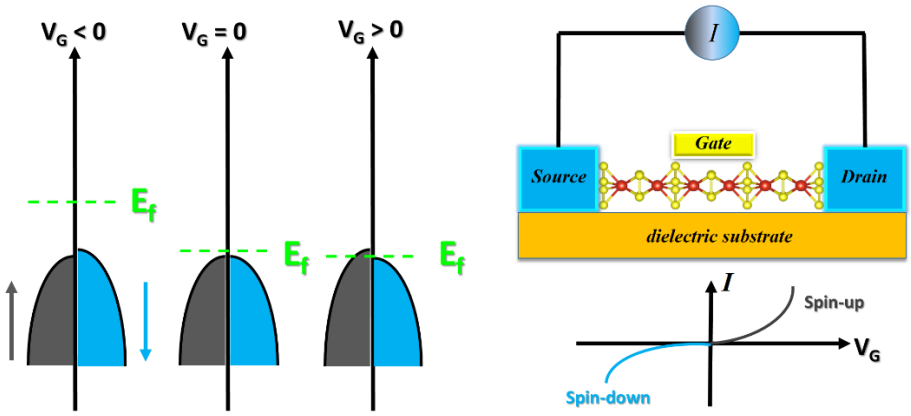

Figure 1: Diagram of manipulation of the spin orientation by the gate voltage