XANES study of the ferromagnetic mechanism of MoS_2 nanosheets modulated by doping and sulphur vacancy

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Great interest has been focused on the MoS_2 nanosheets, in order to render more unique physical properties to MoS_2, band gap engineering has been applied. The defects is an excellent way, multivariate hyphenated types of defects may engineer the MoS_2 into a compensated semiconductor with multi-component band gaps by managing the defect type and concentration.

In this work, we made the MoS_2 nanosheets doped with V atoms through a simple hydrothermal method as well as vacancy defects created by mild Ar plasma treatment. The location of the V atoms and the created S vacancies can be confirm by HAADF and EPR, respectively. The room-temperature ferromagnetic behavior of the V/MoS_2@6s (V doped MoS_2 nanosheets with 6s irradiation) was demonstrated by the magnetizations curves ($M-H$), which significantly higher than pure MoS_2 nanosheets. For deeper insights into the source of doped atoms and sulfur vacancies in tuning the magnetic behavior of MoS_2 nanosheets, we employed the X-ray absorption near edge structure (XANES) spectra to probe their local atomic structures, which indicated that the magnetism are due to the modulation of the electronic properties of MoS_2, but not the structural variations.

In summary, we have successfully made the V-doped MoS_2 nanosheets decorated with sulphur vacancies, which properties of magnetism have been improved. We ascribed the improved properties to the localized S vacancies which active the ferromagnetic interactions between V ions within the polaron radius. This scheme provides a new avenue to the further development of the low-dimensional materials.

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