

Exploring effects of stress and strain on electron transport and field-effect performance of few-layer MoS₂ transistors

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Abstract

Two-dimensional (2D) transition metal dichalcogenides (TMDs) are promising materials for future electronic devices due to their unique properties, such as thickness-tunable electrical features and semiconducting characteristics with high on/off ratios. However, those 2D TMD semiconductors still have drawbacks of lower electrical mobilities which limits their potential applications. In this work, we plan to artificially impose stresses and strains on the 2D TMD of the MoS₂ channel. We adopt the thermal evaporation to deposit titanium dioxide (TiO₂) nanoparticles on Si substrates to generate crested structures. The MoS₂ flake is mechanically exfoliated and placed with one part on flat and the other part on the artificially crested surfaces. The MoS₂ flakes on the crested surface possesses additional stresses and strains to modify electrical properties of the 2D channel. We will make MoS₂ FETs on flat and rough surfaces and investigate the variation of device performances. Through the effect of stretching, the MoS₂ FETs exhibit much higher electron mobility than those of MoS₂ devices fabricated on flat surfaces. This enhancement in mobility demonstrates a significant improvement in the performance of MoS₂-based electronic devices.

Keywords - Molybdenum disulfide (MoS₂), Stress-strain effect, Enhanced mobility, Raman spectroscopy, Patterned substrates