Negative Differential Resistance in Desulfurization Induced Mixed 1T'/2H Phase MoS_2 Field Effect Transistor

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Abstract

Phase transition in two-dimensional transistion metal dichalcogenide (TMD) materials such as MoS_2 and $MoTe_2$ have attracted wide interest recently. The metallic 1T or 1T' phase TMD thin films can be engineered from typical semiconducting 2H phase by alkali metal intercalation. Additionally, the band gap of MoS_2 can be tuned closer to the Fermi level by introducing sulfur (S) vacancies, which is due to the increasing number of sub-bands and doping effect. In this work, MoS_2-based field effect transistors (FETs) are fabricated by means of electron beam lithography following with wet-transfer process, in which the potassium-treated MoS_2 is obtained by intentionally immersing into KOH solvent. Both mixed 1T'/2H phase and S-vacancies behaviors can be perceived in X-ray photoemmision spectroscopy (XPS), Raman spectroscopy and photoluminacence (PL) analysis. Accordingly, the negative differential resistance (NDR) electrical property has been measured and observed in the mixed 1T'/2H phase MoS_2 FET with narrower bandgap induced by local S-vacancies. A correlation between electron transport characteristic and spectroscopy analysis in MoS_2 FET has been proposed for revealing future applications of other TMD-based FETs.