Electric-field induced transport modulation in VO_2 FETs with organic parylene-C/high-*k* oxide hybrid gate dielectric

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Recently, the electrostatic modulation in correlated oxides system utilizing field-effect transistor (FET) has been widespread applied as an effective tool to probe underlying physics, especially in the prototypical correlated oxide VO_2, which undergoes dramatic resistance change from the insulating monoclinic phase to the metallic rutile phase at T_{MI}=340K [1]. Since the gate insulator of FETs is the key component for producing huge carrier modulation, many efforts have been focused on it. However, conventional dielectrics were restricted due to the defects induced to channel during theirs deposition. In addition, for a novel ionic liquid gating, whether the chemical reaction participates in the resistance change or not is still under debate [2]. In this study, we demonstrated the resistance modulation of VO_2 thin films triggered by field effect utilizing hybrid gate insulator consisted of organic polymer insulator parylene-C and high-*k* material Ta_2O_5, in which parylene-C was expected as effective insulating layer to reduce interface defects [3].

An epitaxial *c*-axis VO_2(001) thin film with thickness of 10 nm was deposited by pulse laser deposition (ArF excimer laser, λ=193 nm) on to a single-crystalline TiO_2(001) substrate, which was annealed at 700℃ in O_2 ambient to achieve step and terrace surface. Subsequently Cr/Pt was used for ohmic source and drain contact of VO_2 FETs. Hybrid gate structure of parylene-C/Y:Ta_2O_5 was grown using chemical vapor deposition and rf-sputtering in succession. A gold film was deposited as gate electrode using e-beam deposition. All electrical measurements were carried out on Peltier-controlled stage under dark and N_2 circumstance. An obvious and stabile resistance change was achieved at 300K through time-dependence resistance measurement at varied gate voltages, as plotted in Fig. 1. The maximum ratio of resistance change was approximately 0.6% in this study.

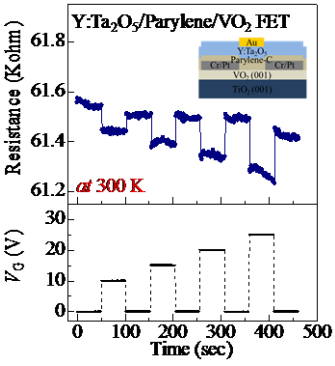

Fig. 1. Time-dependence resistance of VO_2-FET with hybrid gate dielectric. The inset shows cross-sectional schematic of FETs.

A change of resistance has been successfully triggered in VO_2 FET using hybrid gate insulator, and more field-effect studies at different temperatures will be presented.

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