Charge Trap Memory Devices of Balanced Ambipolar 2H-$MoTe_2$ Field Effect Transistors

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Transition metal dichalcogenides (TMDs) have been studied as alternatives of graphene since they are believed to overcome limits stemming from graphene's low ON/OFF ratio. TMDs solved this problem by having bandgap of about 1 eV ~ 2 eV.[1] Among them, 2H-molybdenum ditelluride (2H-$MoTe_2$) has bandgap of about 1.0 eV and high mobility of 200$cm^2V^{-1}s^{-1}$ at room temperature was theoretically predicted.[2] The ON/OFF ratio was observed to be 5X10^2 and 2X10^3 for n-channel and p-channel 2H-$MoTe_2$ field effect transistors (FETs), respectively.[2] Most importantly, up to 10 layers, 2H-$MoTe_2$ field effect transistors showed ambipolar characteristics which were applicable for reconfigurable logic circuits.[3]

In this work, we fabricated and characterized few layer 2H-$MoTe_2$ field effect transistors annealed at different temperatures in the range of 200~300 °C. The annealed 2H-$MoTe_2$ field effect transistors showed balanced ambipolar behaviors while as-fabricated ones exhibited asymmetric n-type dominant ambipolar behaviors. These behaviors could be explained by adsorption of oxygen atoms on the Te vacancy sites and desorption of excess Te, which could reduce n-doping effect. Charge trap memory devices based on the ambipolar 2H-$MoTe_2$ field effect transistors were also fabricated by depositing top gate dielectric layers with charge trap sites through atomic layer deposition method.

References

[1] Wang, Qing Hua, et al. "Electronics and optoelectronics of two-dimensional transition metal dichalcogenides," *Nature nanotechnology* 7.11 (2012): 6

[2] Lin, Yen-Fu, et al. "Ambipolar MoTe2 transistors and their applications in logic circuits." *Advanced Materials* 26.20 (2014): 3263-3269.

[3] Fathipour, S., et al. "Exfoliated multilayer MoTe2 field-effect transistors." *Applied Physics Letters* 105.19 (2014): 192101.

Figures

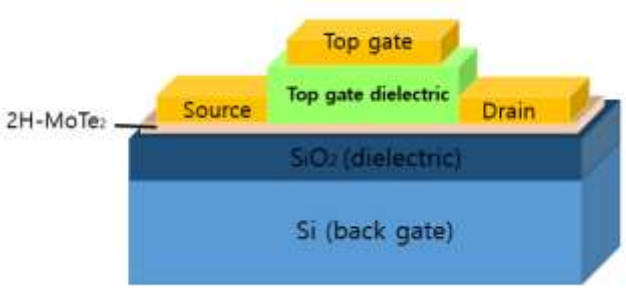

Figure 1. Schematic diagram of few-layer 2H-$MoTe_2$ charge trap memory.

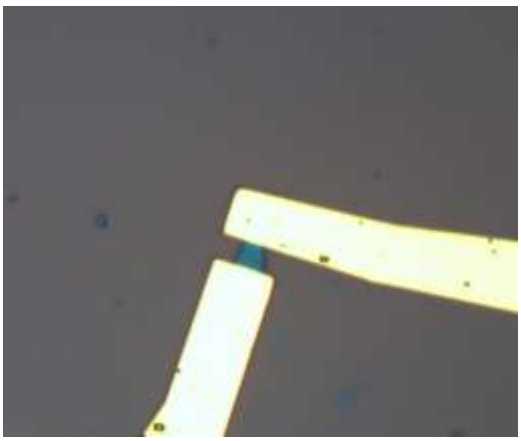

Figure 2. Optical image of few-layer 2H-$MoTe_2$ FETs