Phase Transition in $MoTe_2$ ferroelectric transistors with large memory window

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Abstract

Ferroelectric field-effect transistors (FeFETs) based on two-dimensional (2D) transition metal dichalcogenides (TMDs) have attracted significant attention as artificial synapses due to their non-volatile memory characteristics and strong gate controllability. However, conventional FeFETs rely on electrostatic charge doping induced by ferroelectric polarization, which limits the memory window to a narrow voltage range between the ON- and OFF-state threshold voltages (V_{th}). Here, we report a phase-transition FeFET (PT-FeFET) employing a $MoTe_2$ channel and a $HfZrO_2$ (HZO) ferroelectric gate insulator. The spontaneous polarization of HZO induces a non-volatile and reversible phase transition in $MoTe_2$ between the semiconducting 2H (OFF) and metallic 1T′ (ON) phases. This phase transition eliminates residual OFF current in the ON state and significantly expands the memory window beyond the conventional V_{th}limited range. Temperature-dependent transport measurements reveal a drastic reduction in contact barrier height from 360meV to 7meV, indicating a transition from Schottky to Ohmic contact. As a result, the device achieves a high ON/OFF ratio (~10^6) and a wide memory window (82.5%). Furthermore, the PT-FeFET enables full synaptic weight modulation (0–1), leading to 97% MNIST recognition accuracy, outperforming conventional FeFETs.

References

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Figures

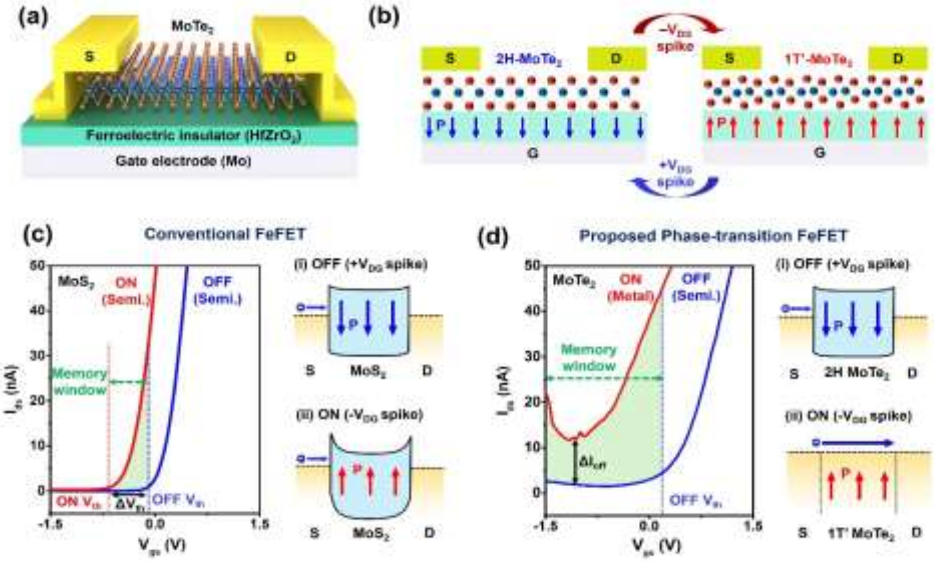

Figure 1: (a, b) Device structure and polarization-driven phase transition of $MoTe_2$ between semiconducting 2H (OFF) and metallic 1T’ (ON) states under V_{DG} spikes. (c, d) Unlike conventional FeFETs limited by $\triangle V_{th}$, the PT-FeFET suppress OFF current and achieves an expanded memory window with enhanced ON/OFF ratio.