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Uncovering the Role of Crystal Phase in Determining Nonvolatile Flash Memory Device Performance Based on 2D Van Der Waals Heterostructures

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Abstract : Although the crystal phase of two-dimensional (2D) transition metal dichalcogenides (TMDs) has been proven to play an essential role in fabricating high-performance electronic devices in the past decade, its effect on the performance of 2D material-based flash memory devices still remains unclear. Here, we report the exploration of the effect of $MoTe_2$ in different phases as the charge trapping layer on the performance of 2D van der Waals (vdW) heterostructure-based flash memory devices, where the metallic 1T′-$MoTe_2$ or semiconducting 2H-$MoTe_2$ nanoflake is used as the floating gate. By conducting comprehensive measurements on the two kinds of vdW heterostructure-based devices, the memory device based on MoS2/h-BN/1T′-$MoTe_2$ presents much better performance, including a larger memory window, faster switching speed (100 ns) and higher extinction ratio (107), than that of the device based on MoS_2/h-BN/2H-$MoTe_2$ heterostructure. Moreover, the device based on MoS_2/h-BN/1T′-$MoTe_2$ heterostructure also shows a long cycle (>1200 cycles) and retention (>3000 s) stability. Our study clearly demonstrates that the crystal phase of 2D TMDs has a significant impact on the performance of nonvolatile flash memory devices based on 2D vdW heterostructures, which paves the way for the fabrication of future high-performance memory devices based on 2D materials.

Keywords : crystal Phase, 2D van der Waals heretostructure, flash memory device, floating gate
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