Low-Voltage Ferroelectric Field-Effect Transistors with Ultrathin Aluminum Scandium Nitride and 2D channels

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Abstract: The continued evolution of CMOS technology demands materials and architectures that emphasize low-power consumption, particularly for computations involving large-scale data processing and multivariable optimization. Ferroelectric materials offer promising solutions through enabling dual-purpose memory units capable of performing both storage and logic operations. Ferroelectric Aluminum Scandium Nitride ($Al_{1-x}Sc_xN$) in particular stands out for its numerous beneficial properties such as low dielectric loss, high remnant polarization and low deposition temperatures compatible with modern CMOS production methods. In this study, we demonstrate ferroelectric field-effect transistors (FeFETs) with 2D MoS_2 channels fabricated on ultrathin 5 nm and 10 nm $Al_{1-x}Sc_xN$. By decreasing the thickness of the ferroelectric film, we achieve significantly reduced gate voltages (<3V) required to switch the conductance of the devices, enabling operation at low voltages. We observe a hysteresis behavior that varies with film thickness, 2D channel fabrication method, and environmental conditions. Through systematic investigation of these parameters, we provide pathways to improve device performance.