A Novel Method of a high-k Oxide Layer Fabrication and Phase Control for 2D MoTe2 Materials

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Abstract

As Moore's Law continues to drive the miniaturization of semiconductor devices, channel dimensions have now reached the Angstrom scale, pushing silicon-based devices to their physical limits. This results in undesirable effects such as short-channel effects, DIBL, and current collapse. Consequently, transition metal dichalcogenides (TMDs) have emerged as excellent alternatives in the realm of 2D materials. Compared to silicon, TMDs exhibit higher carrier mobility, higher on/off current ratios, and lower leakage current at the 2D scale. However, due to the inert surfaces of 2D materials (2DMs) lacking nucleation sites, standard oxide deposition techniques cannot be applied to 2DM channels. For example, direct growth of oxides via atomic layer deposition (ALD) can lead to uneven structures, resulting in island-like growth on 2DM surfaces and incomplete coverage, causing interface and dielectric defects. To enable uniform attachment of an oxide layer onto the 2D material MoTe2, this study employs tellurium as a sacrificial layer to create good contact with a high-k oxide layer. The study also reveals that varying annealing parameters can achieve phase transitions in MoTe2, and by adjusting tellurium deposition thickness under different annealing pressures, the phase transition of MoTe2 films can be effectively controlled, offering new methods and insights for the preparation and application of oxide layers on 2D materials.

Keywords

Two-dimensional materials, MoTe2, High-k oxide layer, phase transition, sacrificial layer.