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Remote O2 plasma functionalization for integration of uniform high-k dielectrics on large area synthesized few-layer MoSe2

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Transition metal dichalcogenides (TMDCs) are promising layered structure materials for next-generation nano electronic devices. Many investigation on the FET device using TMDCs channel material have been performed with some integrated approach. To use TMDCs for channel material of top-gate thin film transistor(TFT), the study on high-k dielectrics on TMDCs is necessary. However, uniform growth of atomic-layer-deposited high-k dielectric film on TMDCs is difficult, owing to the lack of dangling bonds and functional groups on TMDC's basal plane.

We demonstrate the effect of remote oxygen plasma pretreatment of large area synthesized few-layer MoSe2 on the growth behavior of Al2O3, which were formed by atomic layer deposition (ALD) using tri-methyl-aluminum (TMA) metal precursors with water oxidant. We investigated uniformity of Al2O3 by Atomic force microscopy (AFM) and Scanning electron microscopy (SEM). Raman features of MoSe2 with remote plasma pretreatment time were obtained to confirm physical plasma damage. In addition, X-ray photoelectron spectroscopy (XPS) was measured to investigate the reaction between MoSe2 and oxygen atom after the remote O2 plasma pretreatment. Finally, we have uniform Al2O3 thin film on the MoSe2 by remote O2 plasma pretreatment before ALD. This study can provide interfacial engineering process to decrease the leakage current and to improve mobility of top-gate TFT much higher.

Keywords: TMDC, MoSe2, remote plasma, atomic layer deposition, high-k dielectric

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Nonvolatile Ferroelectric Memory Devices Based on Black Phosphorus Nanosheet Field-Effect Transistors

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Two-dimensional van der Waals (2D vdWs) materials have been extensively studied for future electronics and materials sciences due to their unique properties. Among them, black phosphorous (BP) has shown infinite potential for various device applications because of its high mobility and direct narrow band gap (~0.3 eV).

In this work, we demonstrate a few-nm thick BP-based nonvolatile memory devices with an well-known poly(vinylidenefluoride-trifluoroethylene) [P(VDF-TrFE)] ferroelectric polymer gate insulator. Our BP ferroelectric memory devices show the highest linear mobility value of 1159 cm^2/Vs with a 10^3 on/off current ratio in our knowledge. Moreover, we successfully fabricate the ferroelectric complementary metal-oxide-semiconductor (CMOS) memory inverter circuits, combined with an n-type MoS_2 nanosheet transistor. Our memory CMOS inverter circuits show clear memory properties with a high output voltage memory efficiency of 95%. We thus conclude that the results of our ferroelectric memory devices exhibit promising perspectives for the future of 2D nanoelectronics and material science.

More and advanced details will be discussed in the meeting.

Keywords: Black phosphorous (BP), MoS2, 2D nanosheet, P(VDF-TrFE), ferroelectric memory, dual gate transistor