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Interface Engineering of ALD AlN on WS_2 FETs

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Abstract

For the development of advance two-dimensional (2D) electronic devices, the high-quality high-κ dielectric on 2D materials is essential. However, the growth mechanism on 2D materials by atomic layer deposition (ALD) has not been fully investigated. In this work, the 2D AlN interfacial layer on WS_2 was successfully formed by ALD for the first time. The 250 ℃ plasma-enhanced ALD (PEALD) 2D AlN on WS_2 demonstrates the feasibility of using low temperature ALD process to deposit high-κ dielectric directly on transition metal dichalcogenide (TMD) material. Comparing to h-BN, 2D-AlN is more suitable for IC fabrication process due to the low process temperature. The key is lattice matching between the TMD (WS_2) and the dielectric (AlN). Atomistic simulation reveals lower band distortion of WS_2 by 2D AlN interfacial layer (IL) than 2D h-BN IL, which has poorer lattice match with WS_2. The consequences are better transistor subthreshold swing and current drive. Experimental and theoretical results all indicate that the use of ALD 2D IL in TMD transistor gate stack is a promising step toward the development of future dense 3D IC.