Atomic Layer Deposition of Layered BN

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Abstract

Hexagonal boron nitride is a promising dielectric for two-dimensional (2D) material based electronics due to its atomically smooth and charge-free interface with an in-plane lattice constant similar to that of graphene.[1] In this work, we studied the deposition of boron nitride thin films using atomic layer deposition (ALD) with BCl_3/NH_3 precursors directly on various substrates including HOPG, SiO2 as well as 2D channel materials. X-ray photoelectron spectroscopy (XPS) shows that the ALD-BN thin films grow linearly with a growth rate of 0.042 nm/cycle at 600 °C. This growth temperature is significantly lower than chemical vapor deposition of *h*-BN. In Addition, our atomic force microscopy (AFM) results confirmed the formation of uniform and smooth ALD-BN thin films with a low roughness of 0.45 nm. Electrical characterization suggests that the ALD-BN film shows a high breakdown field of 8.5 MV/cm and a dielectric constant of 3.8 which is close to the theoretical value of *h*-BN.2 This ALD-BN thin film also shows reduced charge scattering for graphene devices as evidenced by a twice increase in carrier mobility of graphene field effect transistor (G-FETs) in comparison to that fabricated on thermal SiO_2. Therefore, this work indicates the feasibility of using low temperature ALD-BN as a substrate for futuristic 2D materials.

References

[1] Molaei, Younas, Rezakazemi, ACS Appl.Electron.Mater. 3 (2021) 5165
[2] J. Lee et al, ACS Appl. Mater. Interfaces, 12 (2020) 36688

Figures

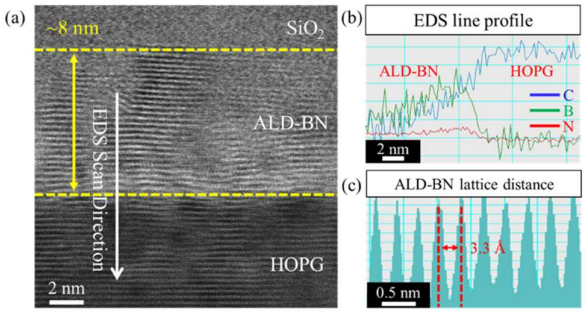

Figure 1: (a) HR-TEM image, (b) EDS line profile (along the solid white arrow in Fig. 2(a)), and (c) a lattice distance of the 200 cycles ALD-BN deposited on HOPG at 600 °C.

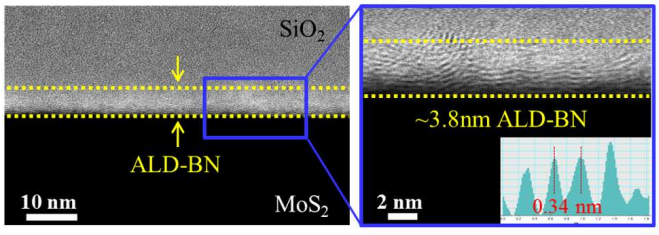

Figure 2: Cross sectional images of ALD -BN on top of MoS2