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Aluminum nitride thin films deposited by hydrogen plasma enhanced and thermal atomic layer deposition

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Abstract

Plasma enhanced atomic layer deposition (PE-ALD) of aluminum nitride (AlN) thin films often utilizes NH_3 or a mixture of N_2 and H_2 as a plasma source. However, the possibility of separating the activation step from the nitridation step by using H_2 alone as the plasma source has never been explored. In this paper, we study the deposition of AlN by PE-ALD by using trimethylaluminum, H_2 plasma and NH_3 for deposition temperatures below 400 °C. The self-limiting ALD growth was achieved between 325 °C and 350 °C. As a comparison, AlN was also deposited by thermal ALD (T-ALD), where surface reactions between TMA and NH_3 occurred with reasonable growth rates only at temperatures above 400 °C. The PE-ALD films showed low oxygen (1.5 at. %) and carbon contaminations (1 at. %). The T-ALD films contained carbon (5 at. %) mainly attributed to the presence of C-Al bonds that was insignificant in PE-ALD films. The flow rate of H_2 used in H_2 plasma was found to have a significant impact on the preferred orientation of AlN films, where higher H_2 flow rate promoted the (002) preferred orientation. Besides, the electrical resistivities were probed to be 10^8 Ω cm, as expected in an insulating material.

As an example, AlN was used to infiltrate porous sintered silicon carbide (SiC). Both AlN deposited by PE-ALD and by T-ALD operating with exposure mode deposited at 400 °C were attempted. Even though, there is a greater risk for TMA precursor to decompose at 400 °C, infiltration of AlN was more successful by T-ALD operating with exposure mode.