PEALD Ga_2O_3 as dielectric interlayer on GaN

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GaN based transistors remain one of the most promising next generation power devices due to the large band gap (3.4 eV), high saturation velocity and high breakdown field. While oxygen terminated GaN surfaces have often been used as a starting surface for dielectric layer growth, these dielectric layer structures suffer from a range of defects and impurities. However, studies have suggested that an ordered O-Ga-O layer could provide an excellent low defect starting surface for dielectric layer growth. In this study we have employed plasma enhanced ALD (PEALD) to prepare Ga_2O_3 layers on GaN and determined the band alignment using photoemission spectroscopy. Ga_2O_3 is a transparent material with 4.1 to 4.9 eV band gap. The PEALD growth of Ga_2O_3 is achieved in our laboratory using gallium acetylacetonate ($Ga(acac)_3$) precursor and an O_2 plasma as oxidizer. $Ga(acac)_3$, also referred to as $Ga(C_5H_7O_2)_3$, has a melting point of 197 °C and is non-pyrophoric. The PEALD system is connected by UHV transfer to an x-ray and UV photoemission system (XPS and UPS), which is used to determine saturation coverage and layer thickness in addition to band alignment. The results establish that the Ga_2O_3 growth window starts from 150 °C, saturated coverage of $Ga(acac)_3$ is achieved in 0.4 s, complete oxidation occurs with an O_2 plasma exposure time of 8 s and a N_2 purge time of 60 s was employed. Within the growth window a growth rate of 0.4 Å per cycle was determined using X-ray diffraction (XRD) and photoemission indicated a uniform growth per cycle. The band gap of PEALD Ga_2O_3 derived from the XPS energy loss spectra was 4.1 eV. The results indicated nearly flat bands for the GaN and a valence band offset of 0.1 eV for the oxidized GaN surface.

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