Single crystal growth of GaN films on sapphire using plasma assisted atomic layer deposition

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Motivation

Figure 1: ALD unit cycle utilizing two distinct precursors (X, Y) sequentially dosed to the substrate producing a chemical reaction. Image: AVEM.org

Experimental Details

All samples are loaded to the ALD reactor chamber at 240 °C. Then, after reaching the base pressure at 80 mTorr, a 10 min in-situ plasma cleaning with nitrogen (50 sccm) only plasma is done at 100 W, followed by the recipe

Recipe:
The parameters for the GaN recipe is:
- 60 msec of TMGa (99.99%) pulse
- 10 sec purge (50 sccm N₂ and Ar)
- plasma power and duration 150 W and 30 sec respectively
- 600 cycles
- Forming gas as a plasma gas at 50 sccm

Measurements:
- Ellipsometry (Thickness and refractive index) and
- GIXRD and Theta-2theta XRD (Crystal quality)

Results

Figure 3: GIXRD measurements for ALA grown GaN films on Si(100), Si(111) and sapphire substrate with in situ Ar annealing using 50 sccm 30s 50W Ar plasma. Deposition plasma power is fixed at 150W, and the deposition temperature is 240 °C

Conclusions

In conclusion, the GaN films grown on sapphire substrates showed superior crystalline quality approaching epitaxial films with monocrystalline signature from XRD measurements by showing a very strong and single (002) peak, whereas GaN films grown on Si substrates showed multiple hexagonal peaks corresponding to polycrystalline h-GaN layers.