Epitaxial Growth of $\alpha-(\text{Al}_x\text{Ga}_{1-x})_2\text{O}_3$ by Suboxide Molecular Beam Epitaxy on A-Plane Sapphire

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Introduction
Alloying $\alpha-(\text{Al}_x\text{Ga}_{1-x})_2\text{O}_3$ creates a material with a tunable ultrawide bandgap ranging from 5.3 - 8.5 eV. This is much higher than other semiconductors including Ga$_2$O$_3$.

Benefits of using Suboxide MBE
- Using suboxide MBE skips the growth rate-limiting reaction step.
- Suboxide MBE has drastically increased the growth rate of Ga$_2$O$_3$.[3] Hopefully, it will do the same for $\alpha-(\text{Al}_x\text{Ga}_{1-x})_2\text{O}_3$.

Experimental Goals
- To grow films containing 0% to 100% Aluminum.
- To achieve a growth rate of one $\mu$m/hr.

Experimental Methods
- MBE growth was achieved using Al, Ga$_2$O, and 80% distilled ozone sources.
- Al flux and ozone pressure were constant while Ga$_2$O flux was varied.
- All films were grown on A-plane sapphire substrates, with growth temperatures between 575 - 725 °C.

Results

Effects of changing temperature
Decreasing either the substrate temperature or the aluminum flux lowers the aluminum incorporation.

Calculating Aluminum incorporation
The aluminum incorporation was calculated using data collected from the XRD graphs and Vegard’s law.[2]

Conclusions
Suboxide MBE is an effective way of growing epitaxial $\alpha-(\text{Al}_x\text{Ga}_{1-x})_2\text{O}_3$. By changing ozone pressure, substrate temperature, and/or relative fluxes, $x$ can be tuned to anywhere within the range of 0-0.98. Growing at higher distilled ozone pressures allows for growth of high quality films with rates of over 1 $\mu$m/hr.

References

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