Epitaxial Growth of α-$(Al_xGa_{1-x})_2O_3$ by Suboxide Molecular Beam Epitaxy on A-Plane Sapphire

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Introduction

Alloying α-$(Al_xGa_{1-x})_2O_3$ creates a material with a tunable ultrawide bandgap ranging from 5.3 - 8.5 eV. This is much higher than other semiconductors including Ga_2O_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_2O_3.[1] Hopefully, it will do the same for α-$(Al_xGa_{1-x})_2O_3$.

Experimental Goals

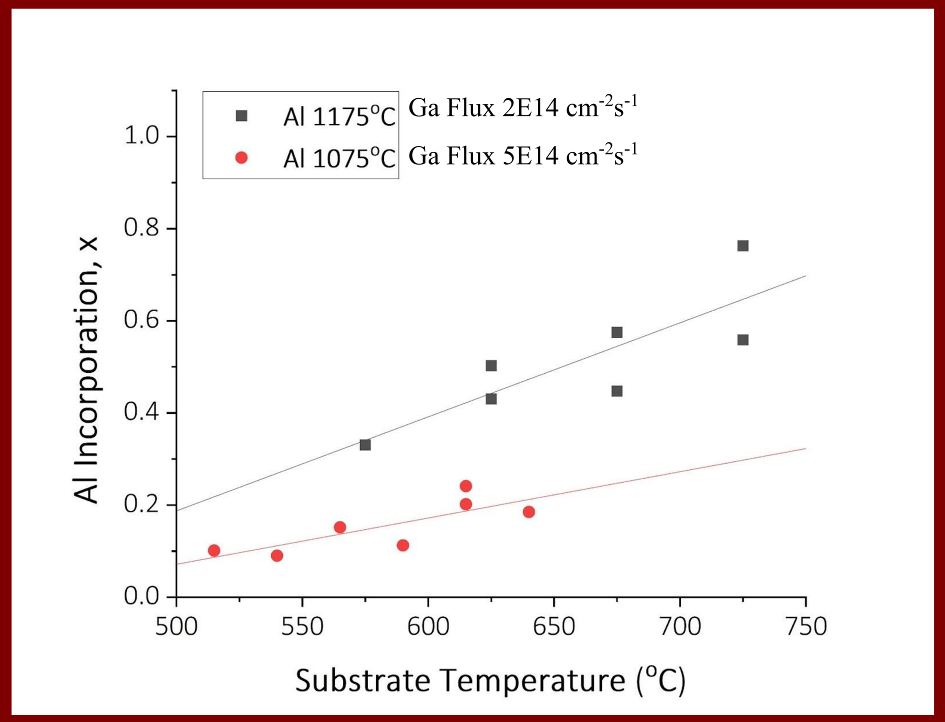
- To grow films containing = 0% to 100% Aluminum.
- To achieve a growth rate of one µm/hr.

Experimental Methods

- MBE growth was achieved using Al, Ga_2O, and 80% distilled ozone sources.
- Al flux and ozone pressure were constant while Ga_2O flux was varied.
- All films were grown on A-plane sapphire substrates, with growth temperatures between 575 - 725 °C.

Results

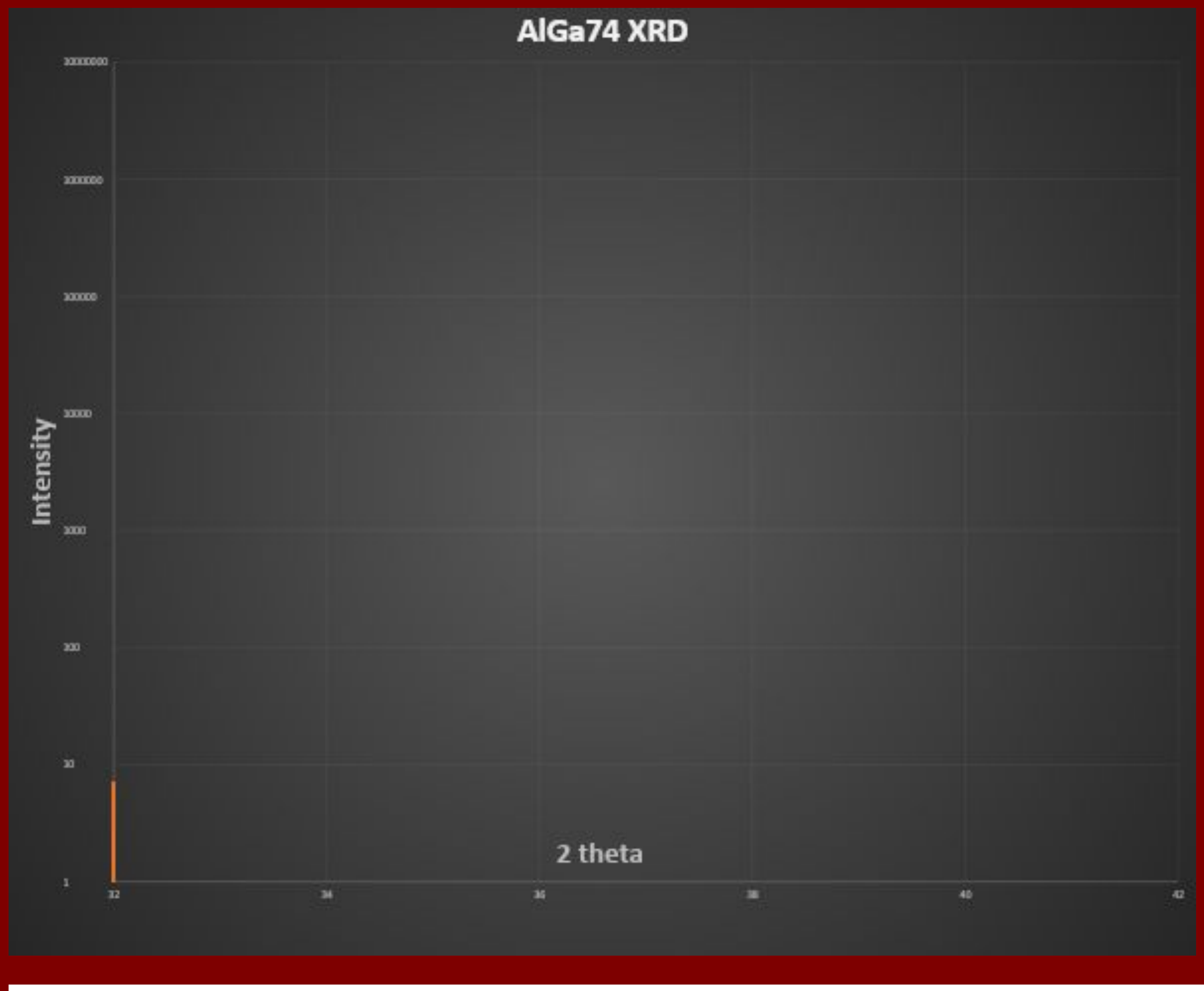
Effects of changing temperature



Steele, Jacob, Epitaxial Growth of α-$(Al_xGa_{1-x})_2O_3$ by Suboxide Molecular Beam Epitaxy, 8/8/2022, Cornell University

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 α-$(Al_xGa_{1-x})_2O_3$. 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 µm/hr.

References

1. Vogt, Patrick et al (2020). Adsorption-Controlled Growth of Ga2O3 by Suboxide Molecular-Beam Epitaxy.
2. R. Jinno, et al. Sci Adv. 7, eabd5891, (2021).

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