

Refining m -plane α -Al₂O₃ Substrates for Conductive α -(Al_xGa_{1-x})₂O₃ Thin Films

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Introduction

α -Al₂O₃ has gained increasing popularity due to its ultra-wide bandgap making it highly compatibility with α -Ga₂O₃ among other benefits like affordability, high structural quality, thermal stability, and corundum structure.

Some key factors in controlling surface quality is growing on the m -plane as it remains phase-pure and growing on vicinal surfaces as they are expected to improve thin film quality. The 0°, 0.1°, 0.2°, 0.4° miscut angles were used in this project.

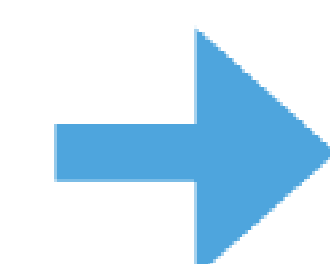
The goal is to explore how sapphire substrates with varying miscut angles respond to thermal annealing using a CO₂ laser heater and to identify the conditions that produce the most favorable morphology; step-flow growth.

Methodology

Miscut Options:

0°, 0.1°, 0.2°, 0.4°

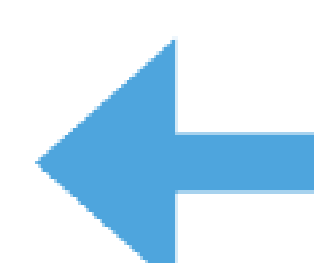
Annealed in MBE Chamber using a CO₂ Laser Heater



Viewed in AFM checking for even step formation on surface
Used results to make adjustments to parameters

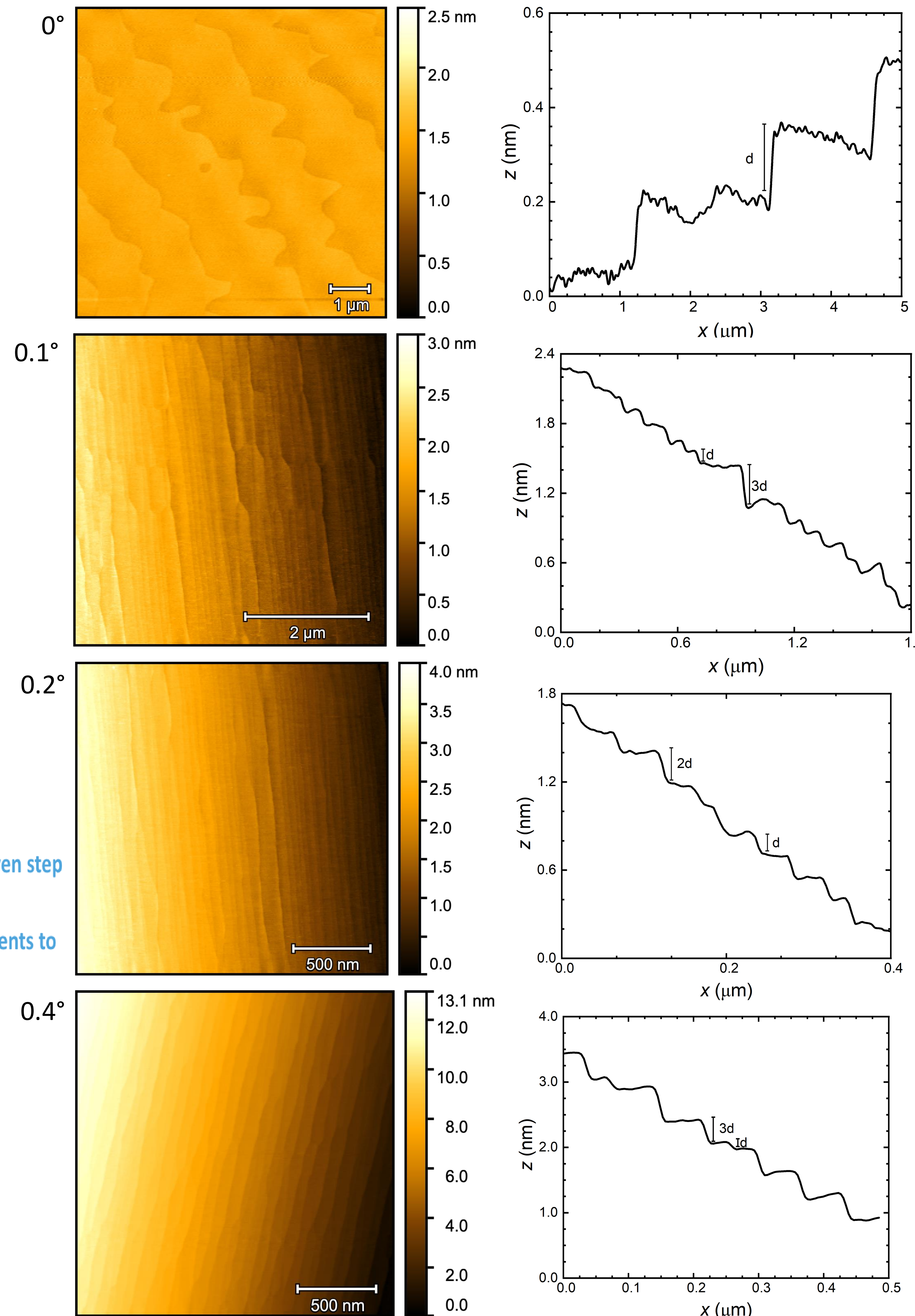


Used recipe with best results to help guide the parameters for the next miscut



Geared focus toward finding a recipe for one miscut at a time

Results:



Proposed Preferred Parameters:

0°	0.1°
Temp: 1400 - 1450°C	Temp: 1400- 1420°C
Ramp: 500°C/min	Ramp: 500°C/min
R.S. : 20rpm	R.S. : 20rpm
Time: 5min	Time: 5 min
Cool Rate: Quenched	Cool Rate: Quenched
0.2°	0.4°
Temp: 1200 - 1225°C	Temp: ≥ 1200
Ramp: 100°C/min	Ramp: 500°C/min
R.S. : 20rpm	R.S. : 20rpm
Time: 5 min	Time: 5 min
Cool Rate: 100°C/min	Cool Rate: 500°C/min

Conclusions/Future Work:

AFM images showcase best step formation possible for each miscut in the given 2-month timeframe at PARADIM Lab.

Next steps include:

- Making improvements to parameters
- Growing α -Ga₂O₃ thin films — comparing electrical properties and surface quality of each
- Demonstrating consistency
- Allowing for new applications of α -Al₂O₃ substrates

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