Growth of Narrow Stripe Active Regions for Blue and UV Lasers Using LEO

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Introduction

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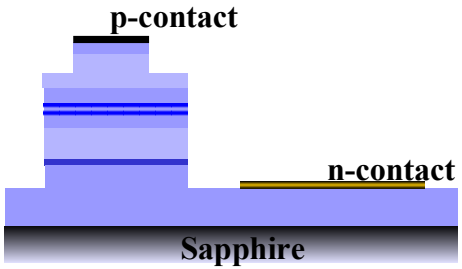
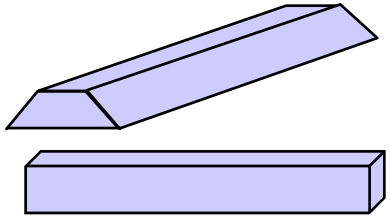
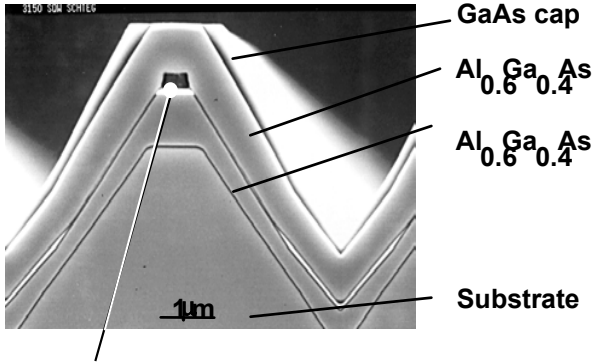
Nitride LD structure





InGaAs/GaAs BH Structure



Objectives:

- Utilize natural "planes" to form sidewalls of waveguide.
- Employ LEO to reduce defects in active region.
- Form a buried heterostructure laser design.

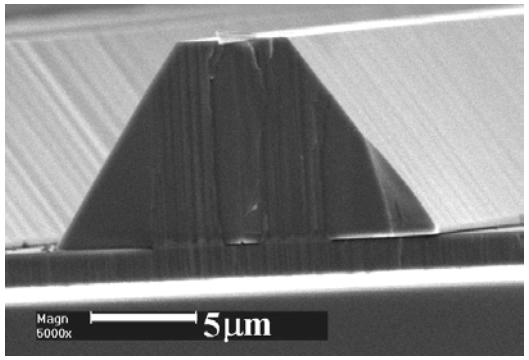
Approach:

- Utilize LEO to form TD free GaN stripes (triangular or rectangular)
- Grow InGaN QW's on LEO stripes to form BH structure employing In segregation to top of stripe

J. Electronic Mater., 29, 10 (2000)

LEO Growth Studies

- LEO grown stripe can be either triangular or rectangular under appropriate growth conditions.
- Aligning the stripe along <1$\underline{1}$00> promotes lateral growth and can lead to rapid coalescence.
- Triangular stripes promote defect free coalescence.



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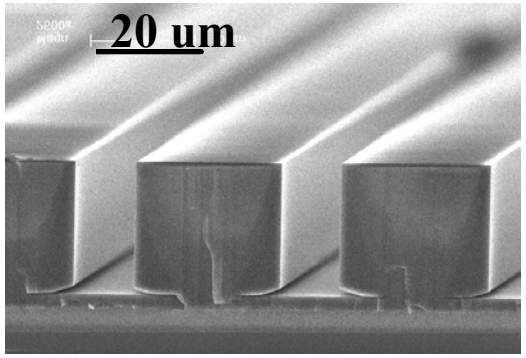

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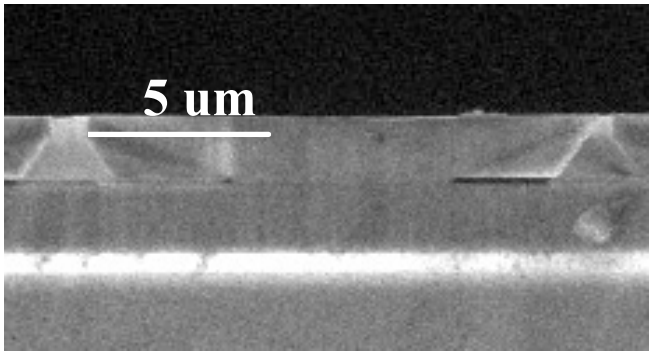

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APL, 77, 1496 (2000)

The Case for Sub-micron LEO

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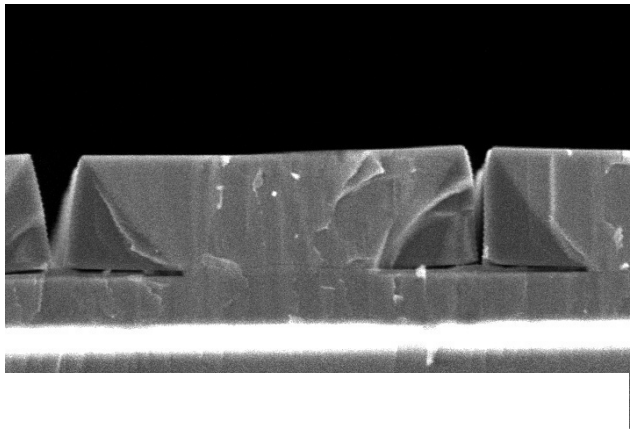
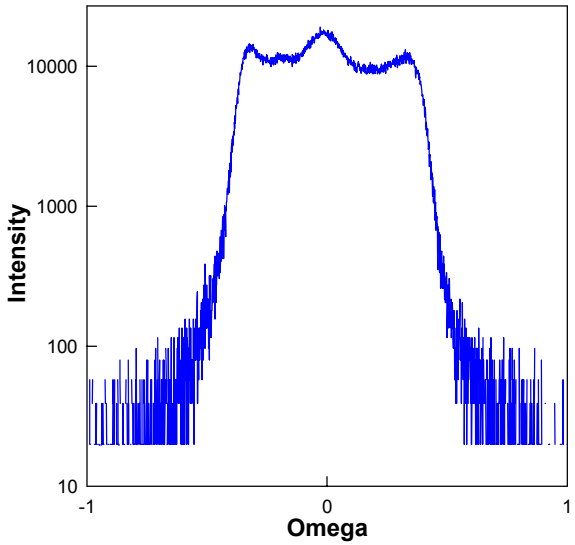
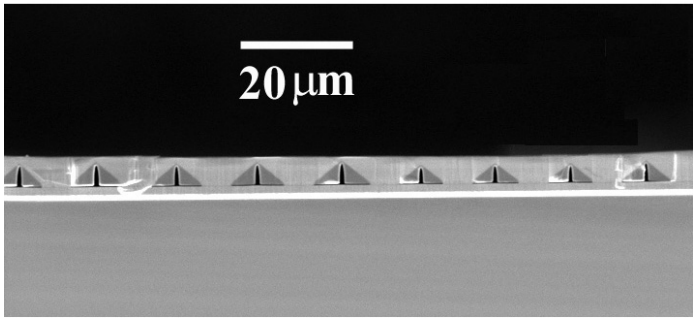
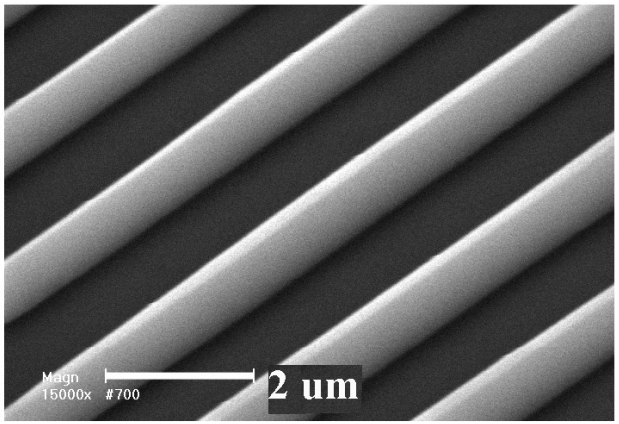


1. Wing-tilts ≥ 1 °, Increase with L/V ratio.
2. Fill factor, V/III, Growth T
3. Coalescence Front: stress, dislocations
4. Long growth time, very thick LEO film.

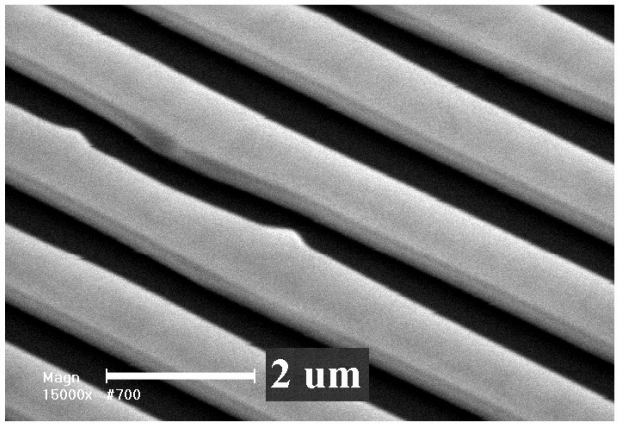




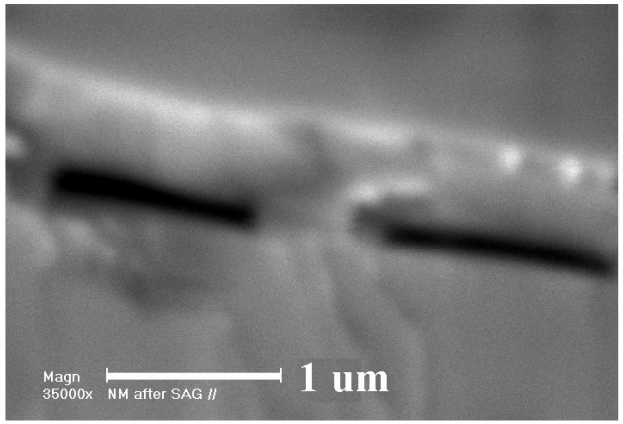
Fast Coalescence of Sub-Micron LEO GaN Stripes



Coalescence within the Thickness of 0.25~0.3 μm and Growth Time of 10~15 mins



5 mins FM-LEO Growth at 1030



20 mins FM-LEO Growth at 1030

AFM Images of Sub-μ LEO GaN

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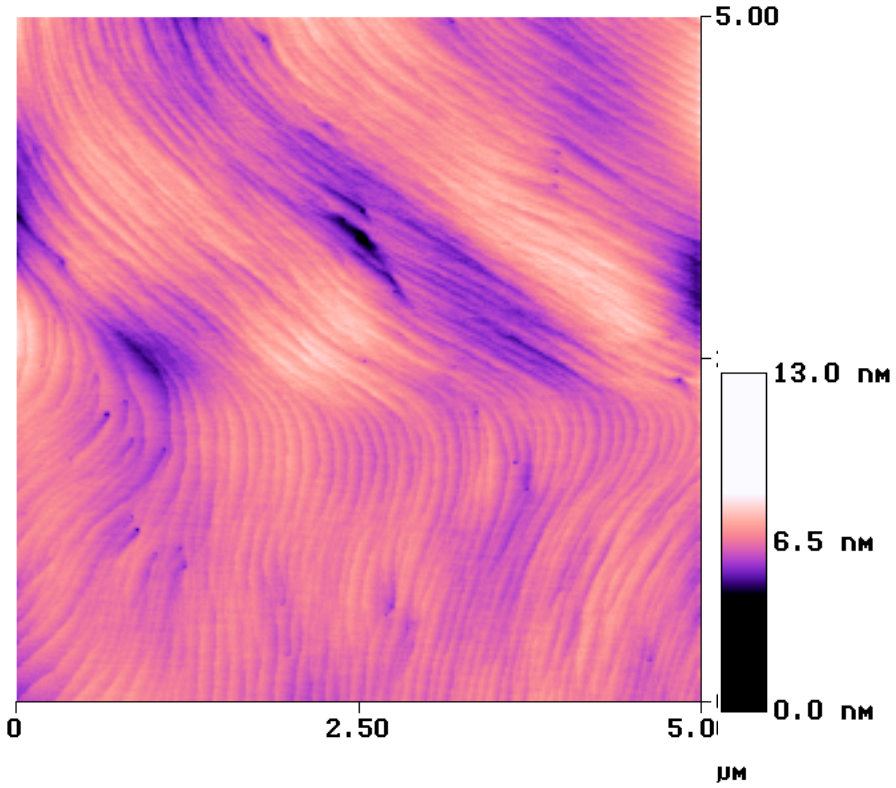

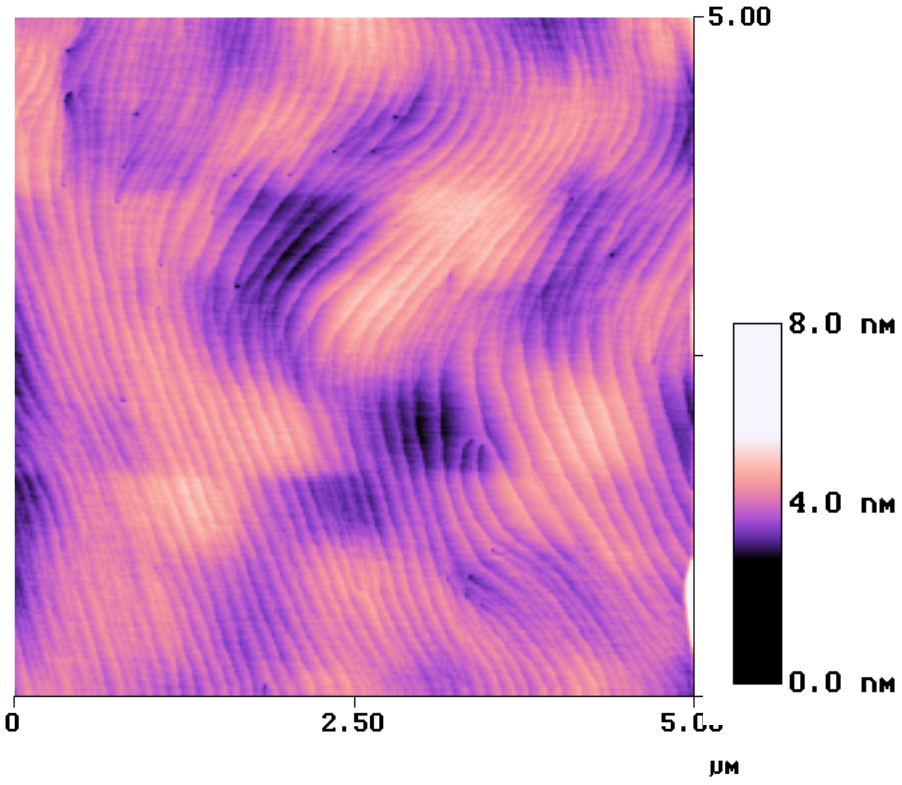

#706 low pressure after flow mod<1.7nm fluctuation
gan706.002

Improved Crystal Quality by Sub-µm LEO

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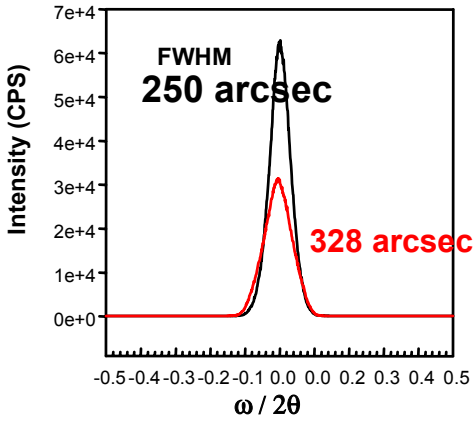

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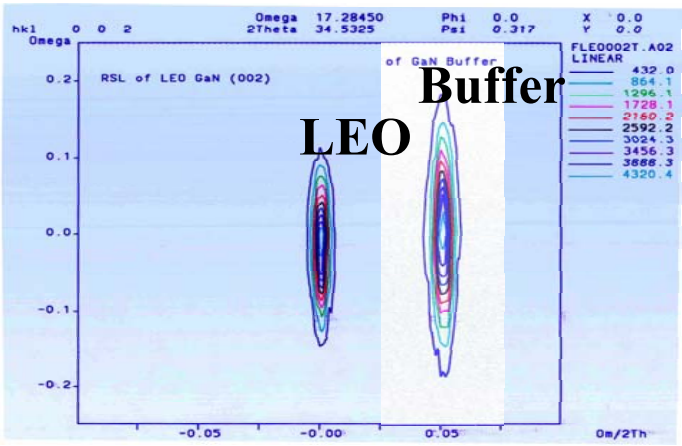

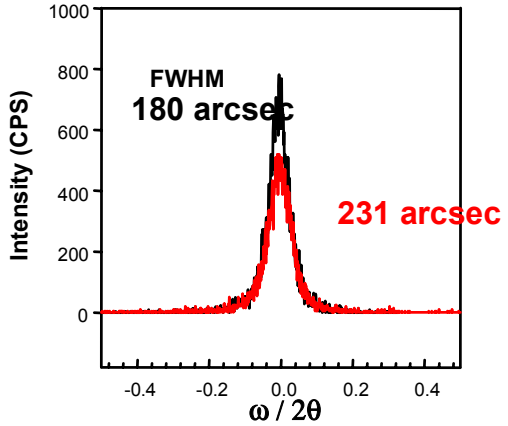

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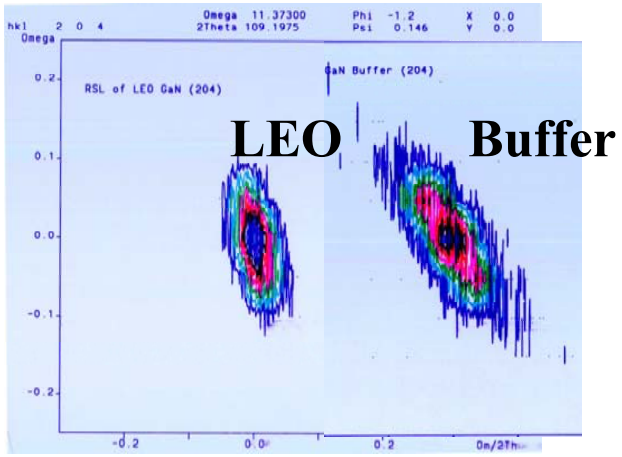
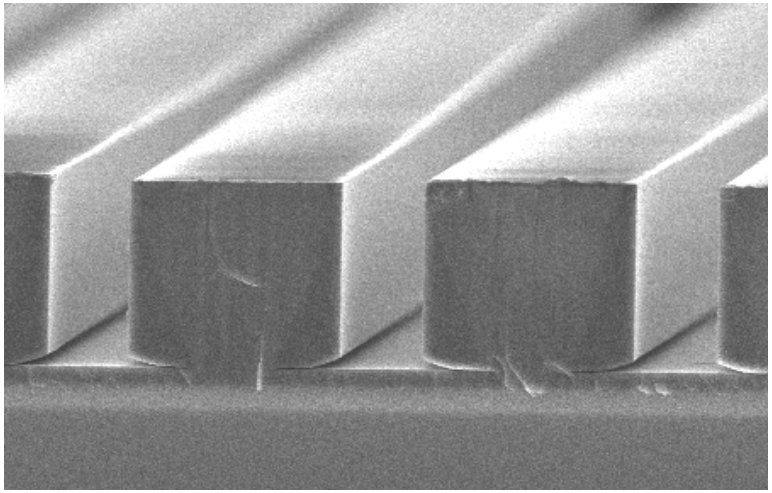
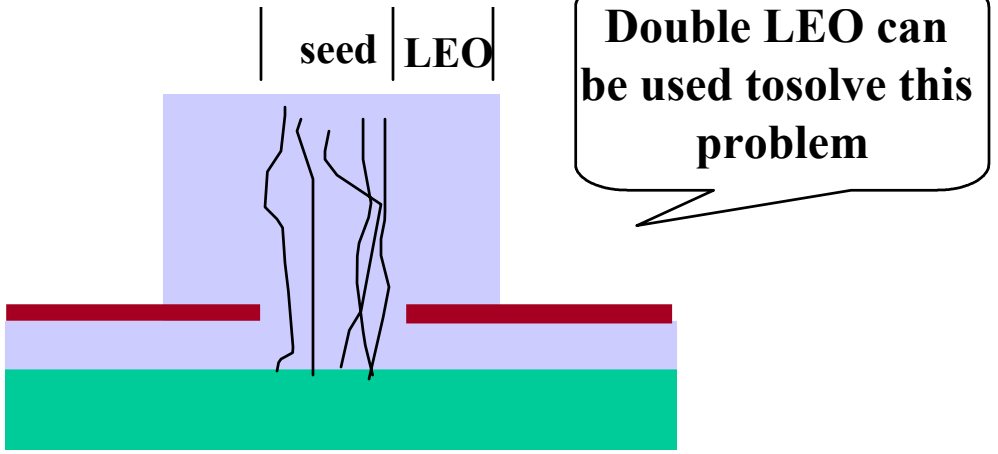


InGaN QW Growth on ■ Stripes

- Rectangular stripes produce mesas with wider tops ⟶ Mirrors?
- Single LEO growth results in high TD density in the center of the mesa.
- Coalescence to form arrays is difficult.





CL Characterization

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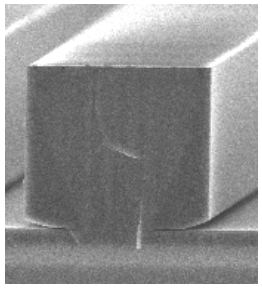
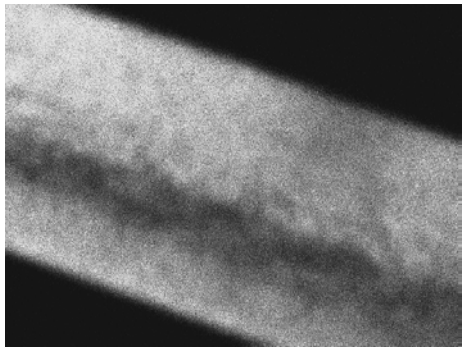
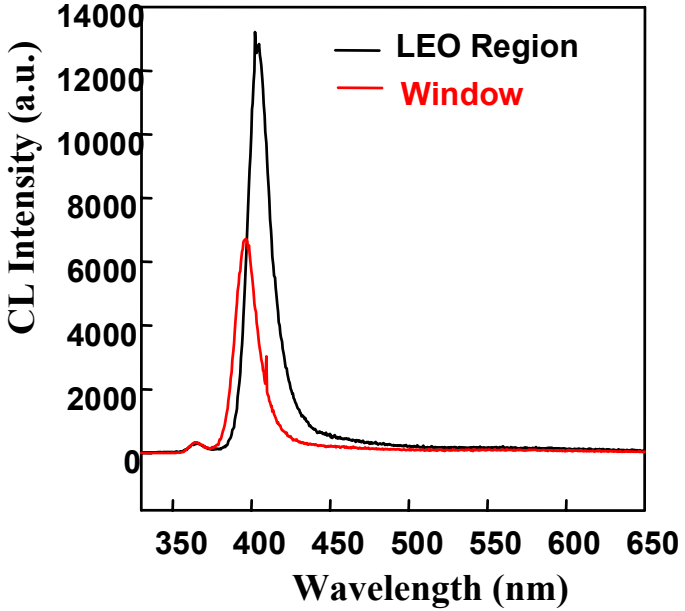
SEM



CL Image at 403 nm



Local CL Spectrum



AFM Images of InGaN QW Surface

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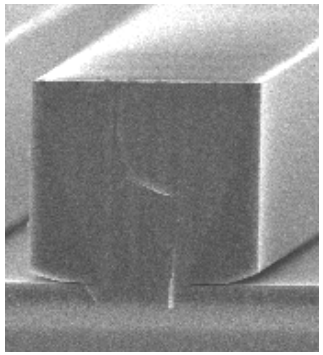
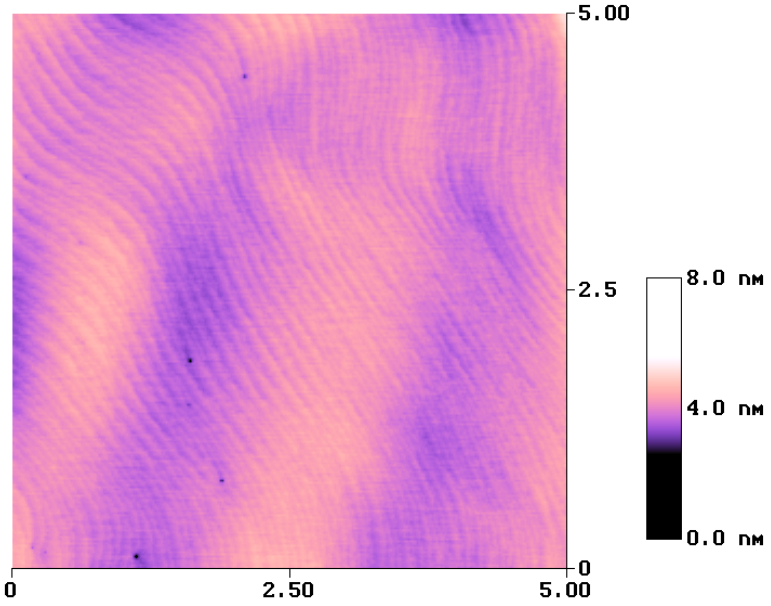
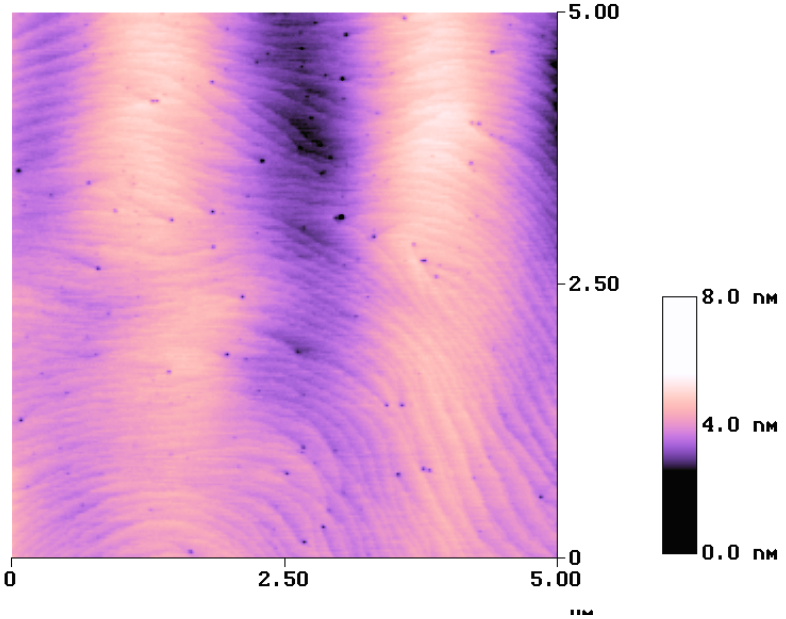


LEO Region

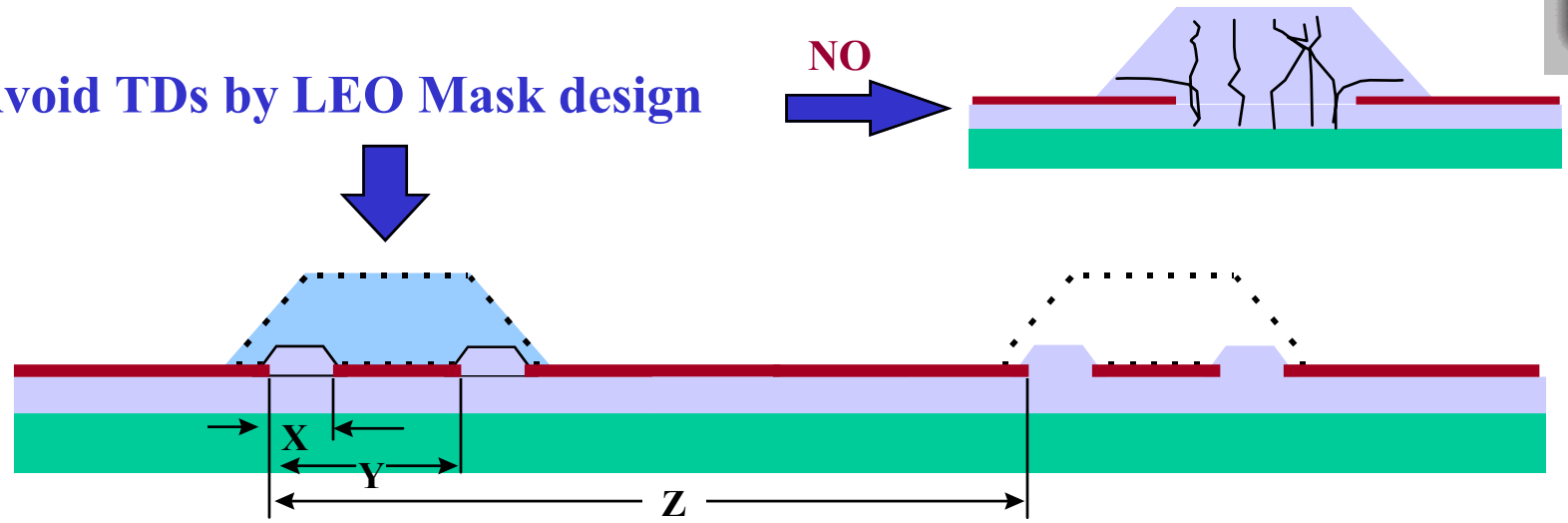


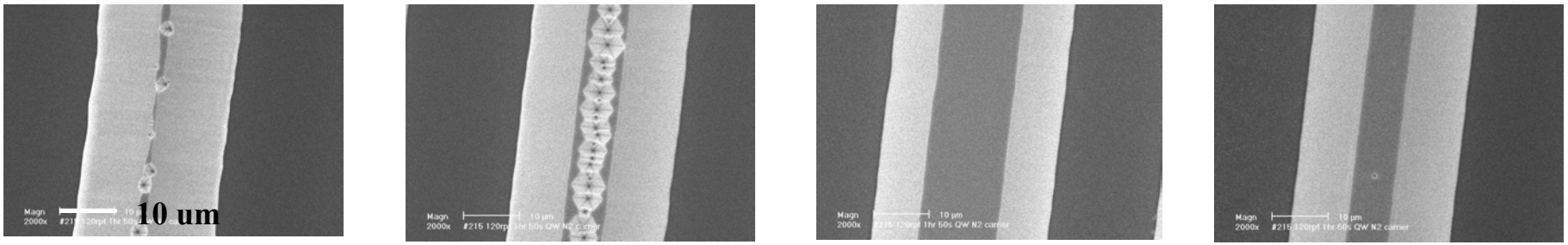
Window Region



InGaN QW Growth on ▲ Stripes

Avoid TDs by LEO Mask design





Growth Demonstration

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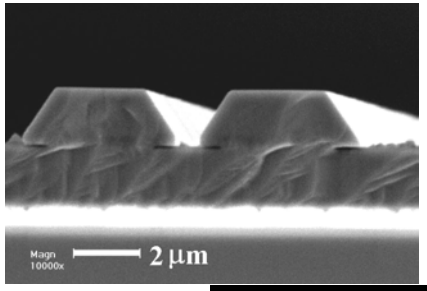

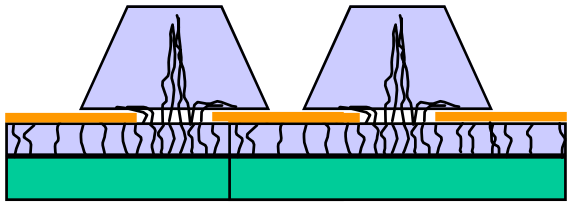

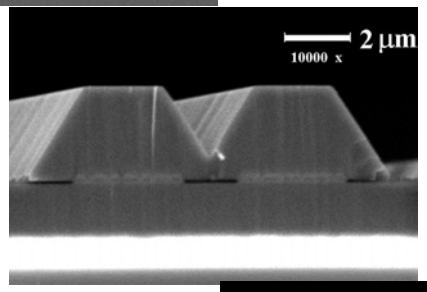

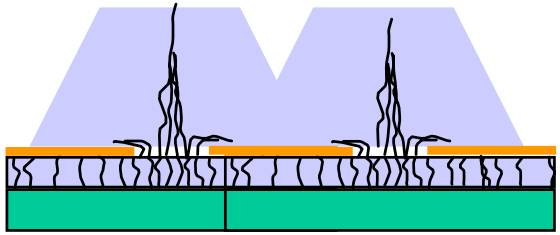

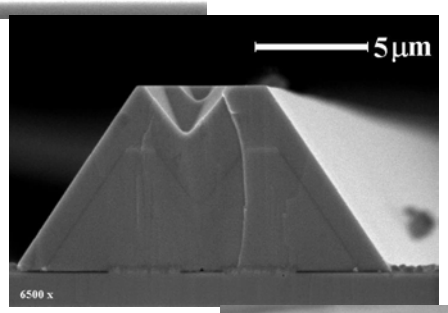

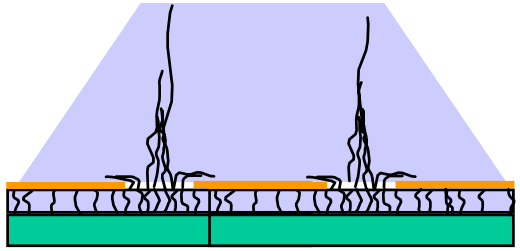

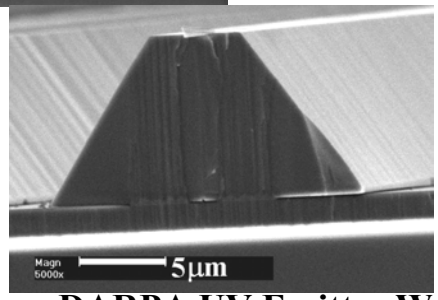

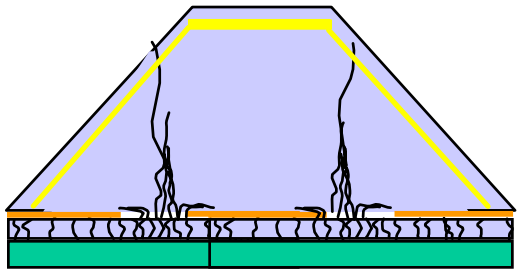

CL Characterization

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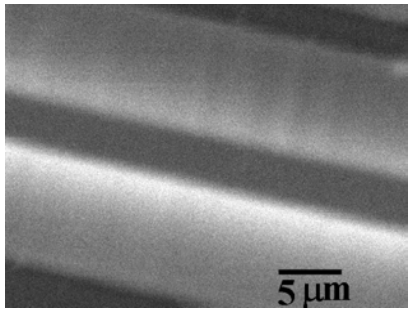
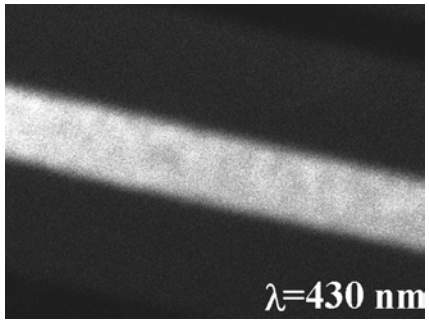
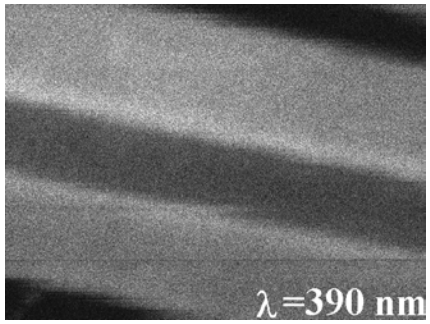
SEM

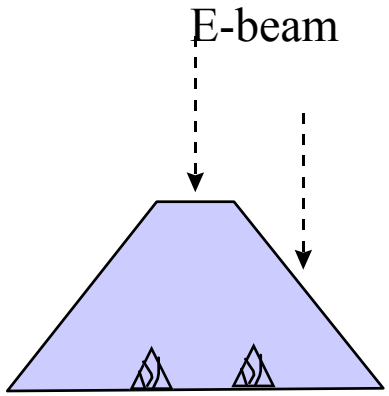


CL

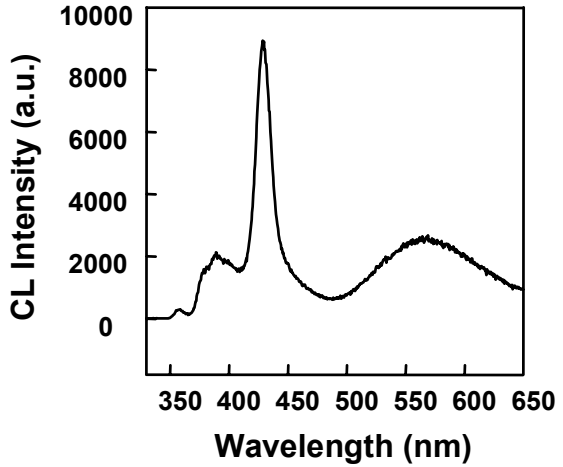


CL

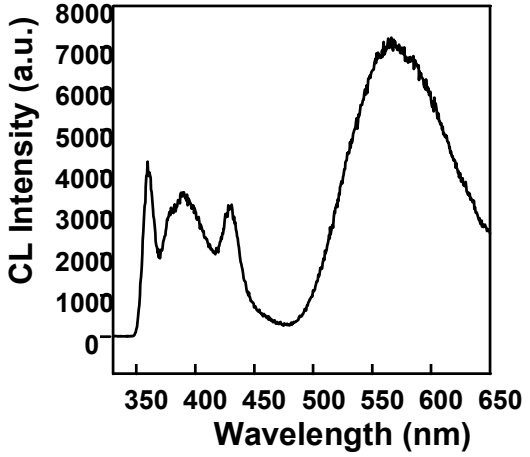




CL spectrum from mesa top



Spatially Integrated CL spectrum



Superior QW on LEO GaN Stripe

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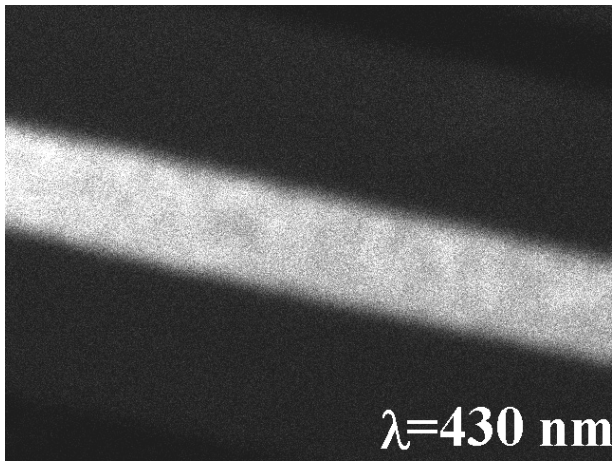
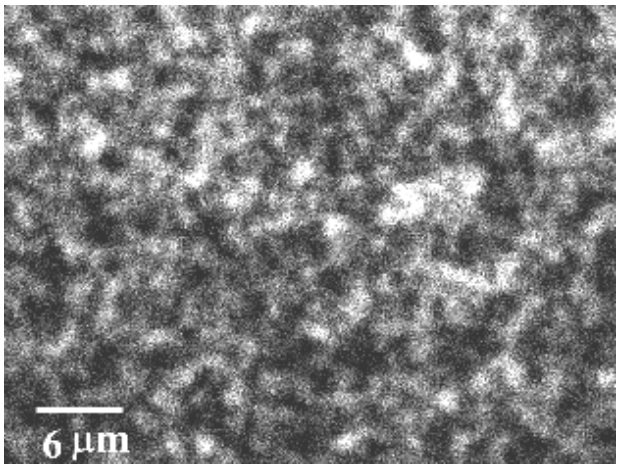
CL Images of InGaN QW Grown on LEO GaN Mesa

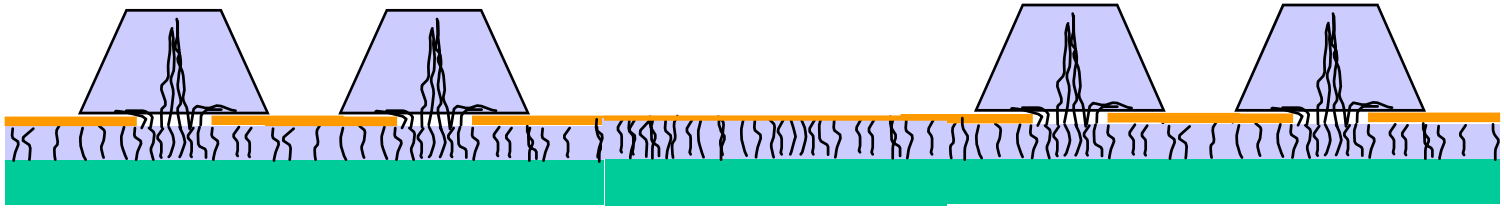
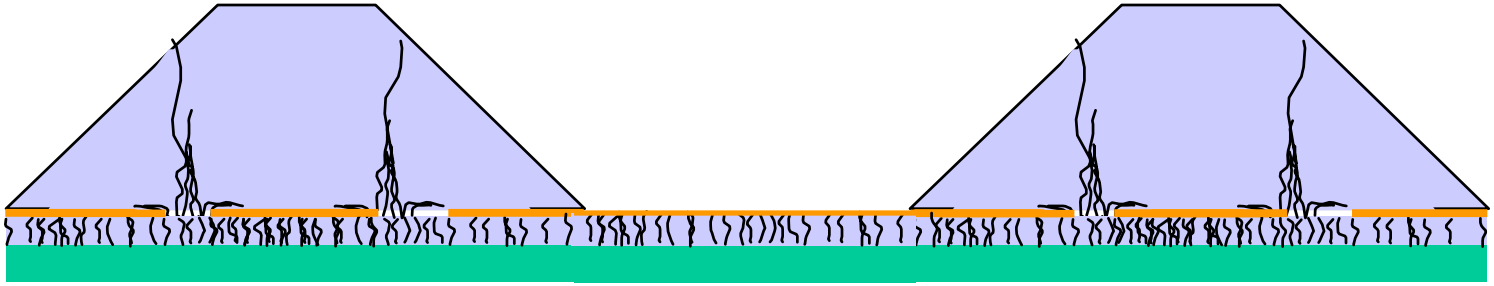
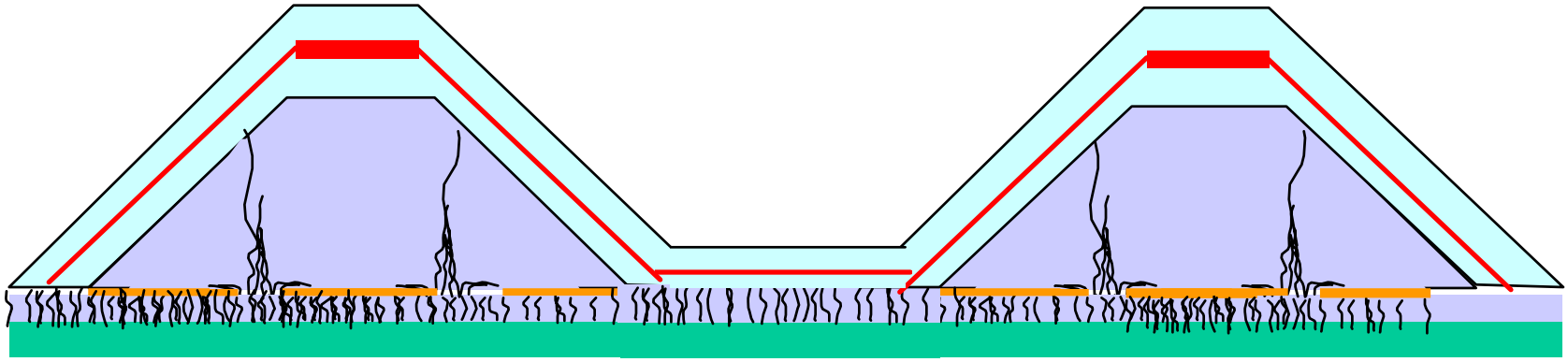


InGaN QW Grown on GaN Buffer



Summary

- By optimizing the MOCVD growth, mask design, GaN LEO stripes with different X-section and lateral growth rate were demonstrated.
- High quality InGaN QWs were successfully grown on two different GaN LEO stripes, as shown by AFM and CL images.
- Atomically smooth GaN waveguide stripes were demonstrated.

UV Lasers on Non-Planar Templates

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