GaN Distributed Feedback Nanowire Lasers

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Why Lasers for Solid State Lighting?

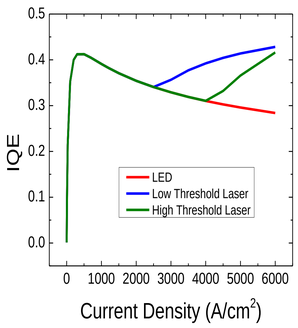
- Stimulated emission clamps the carrier density
- Lasers offer an avenue for bypassing efficiency droop at high current densities
- There are novel existence proofs for ultra-efficient lasers (>70%) at other (IR) wavelengths

Why Nanowires as Lasers?

- Relaxed strain opening up growth substrate possibilities
- Large optical confinement
- Can accommodate a wider range of alloy compositions
- Typically free of threading dislocations

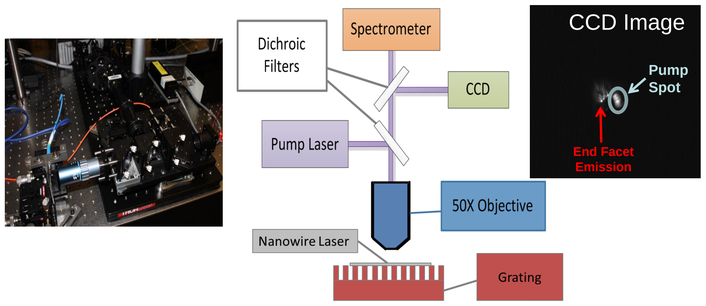
Importance of Single-Mode

The benefits of single-mode are low threshold and low intensity noise. When using stimulated emission to work around the efficiency droop of III-N emitters it is necessary to have a low threshold. Single-mode lasers typically have a lower threshold compared to multimode emitters.



In a device with feedback the onset of stimulated emission overcomes the efficiency droop of the LED. Having a lower threshold means the droop is minimized at lower current densities.

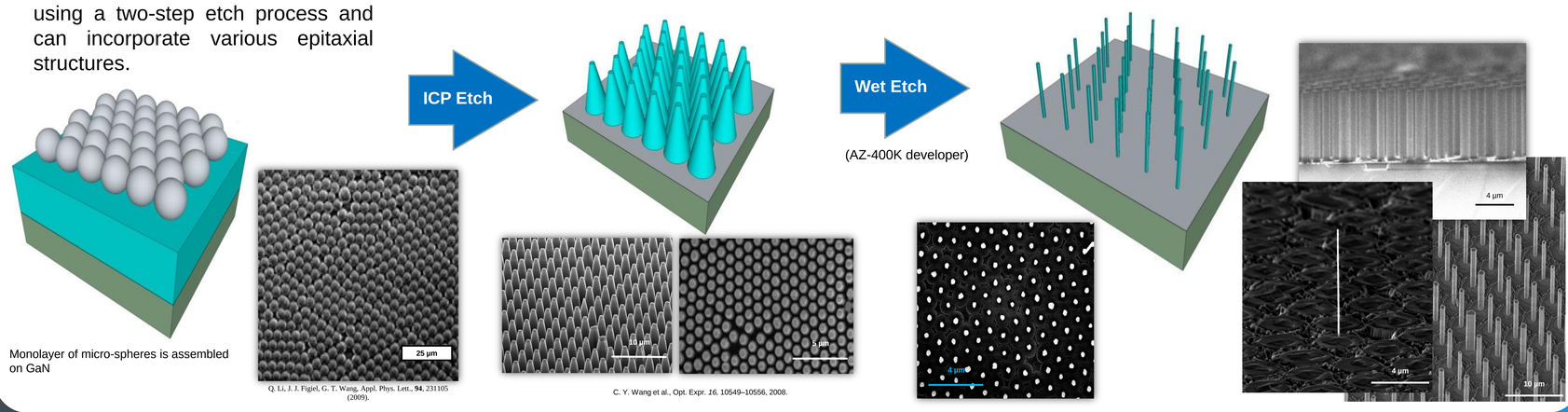
Characterization of III-N Nanowires



GaN nanowires lying on SiN gratings are optically excited through a 50x objective by a 266nm laser whose power is trimmed by a series of neutral density filters. Emission from the nanowire is collected through the same objective and is characterized by a spectrometer.

Fabrication of GaN Nanowires

III-Nitride nanowires are fabricated using a two-step etch process and can incorporate various epitaxial structures.

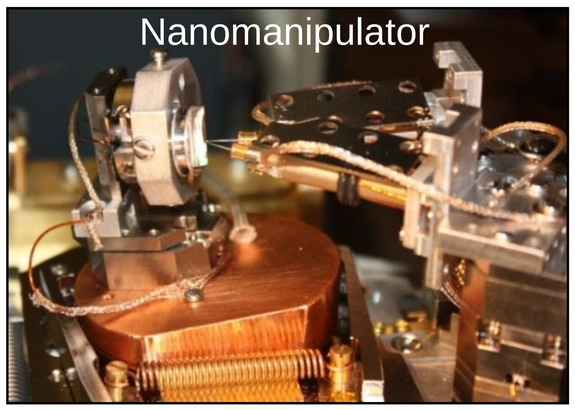


Monolayer of micro-spheres is assembled on GaN

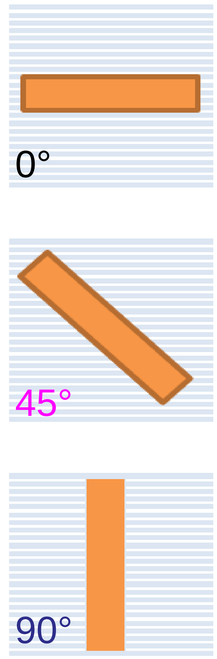
Q. Li, J. J. Figiel, G. T. Wang, Appl. Phys. Lett., **94**, 231105 (2009).

C. Y. Wang et al., Opt. Expr. *16*, 10549–10556, 2008.

Manipulation of Single Nanowires

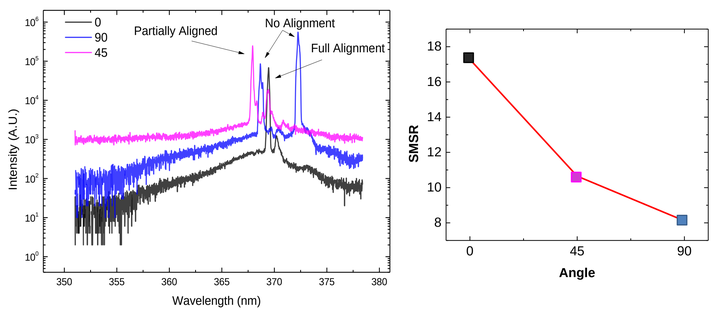


Nanowires were oriented on the grating substrates using a custom made nanomanipulation tool. Two probes on piezo driven stages were used to tune the angle between the grating and the nanowire.

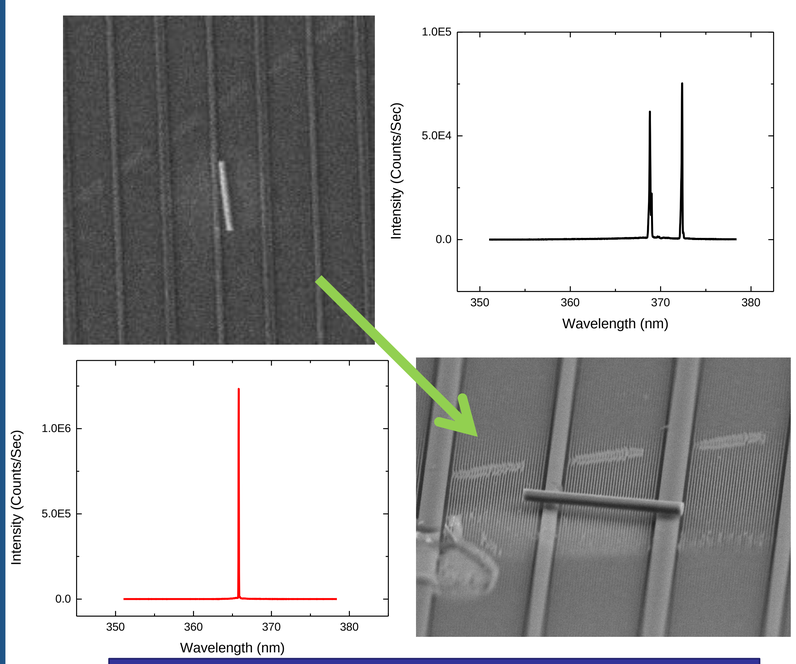


Variable Angle Tuning

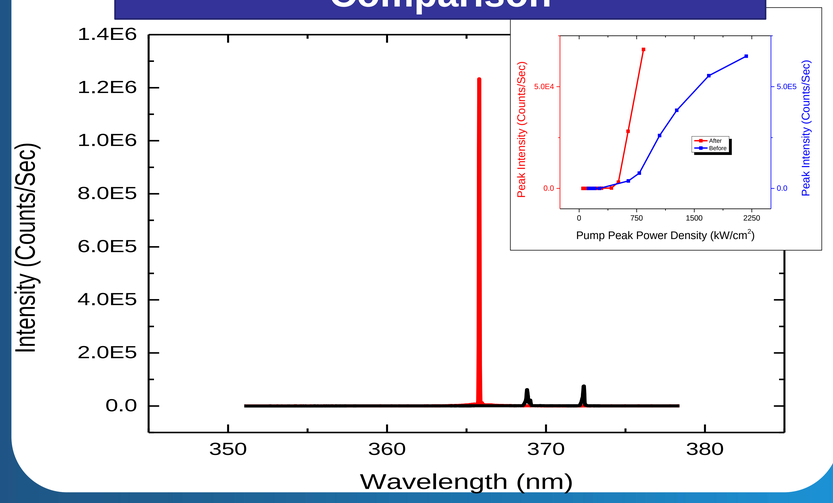
Changing the angle allows for tuning of side mode suppression.



Rotation can Improve Lasing Characteristics



Before and After Rotation Comparison



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