Bulk GaN based violet light-emitting diodes with high efficiency at very high current density

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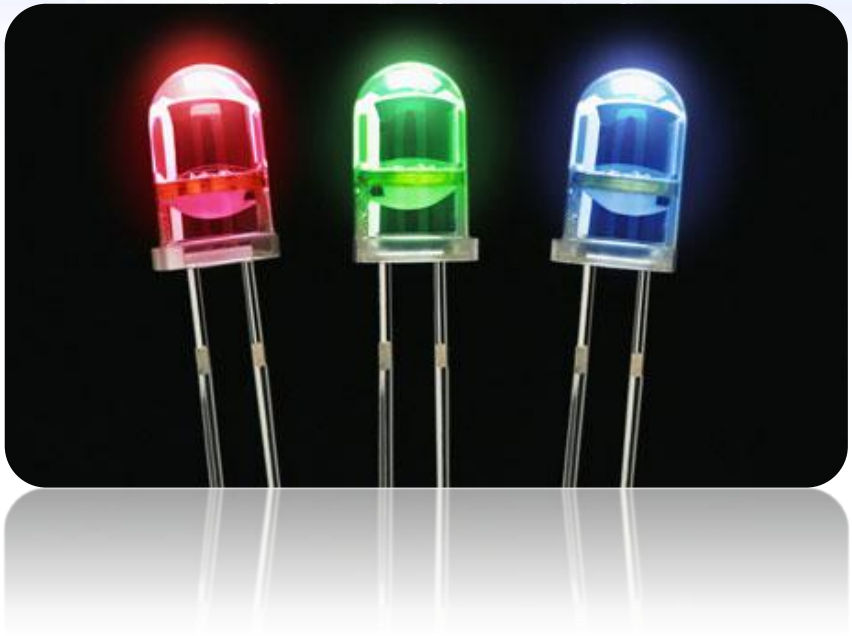
Outline

- Introduction
- Experiment
- Conclusion
- Reference

key technology

high-efficiency light sources



high external quantum efficiency

high current densities

commercial LEDs

due to the lack of availability of a native substrate

internal quantum efficiency

detrimental

efficient light extraction

advanced schemes

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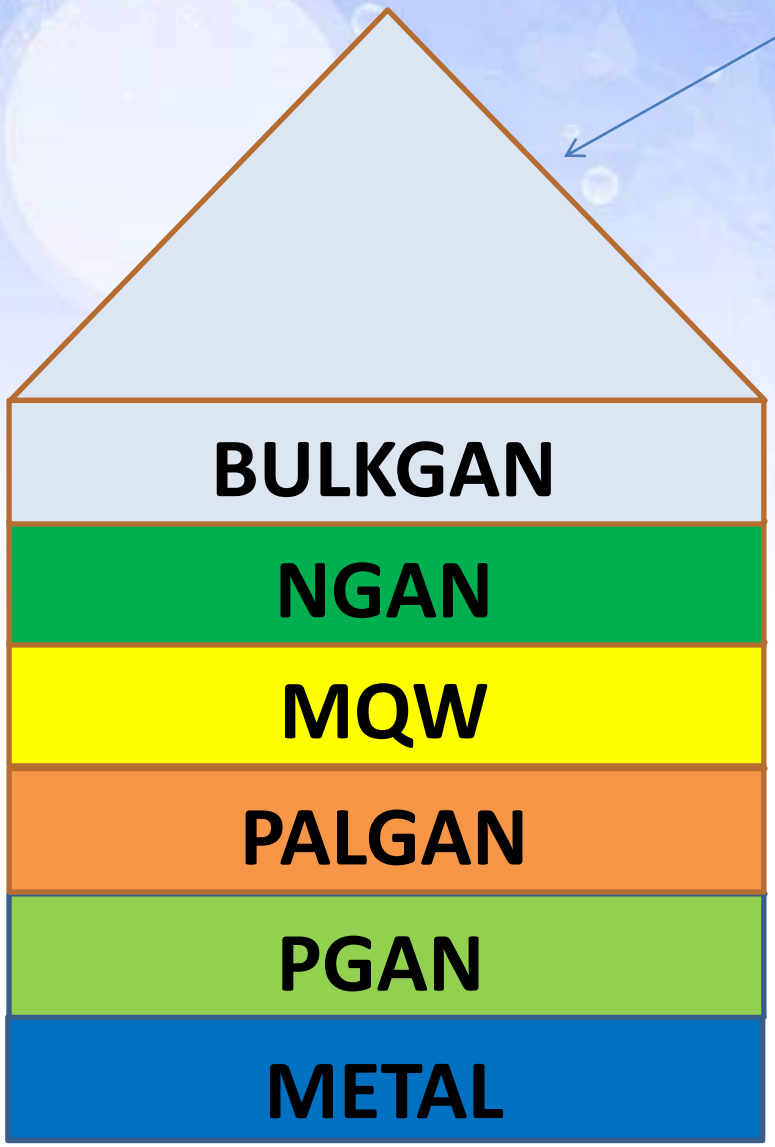
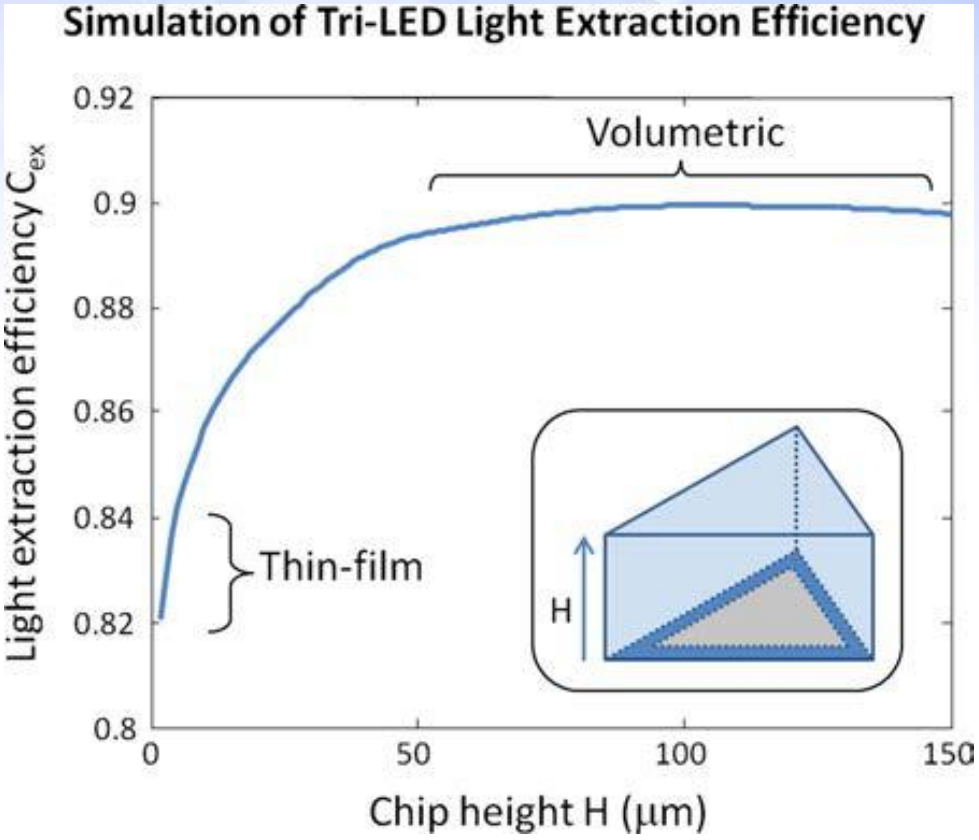
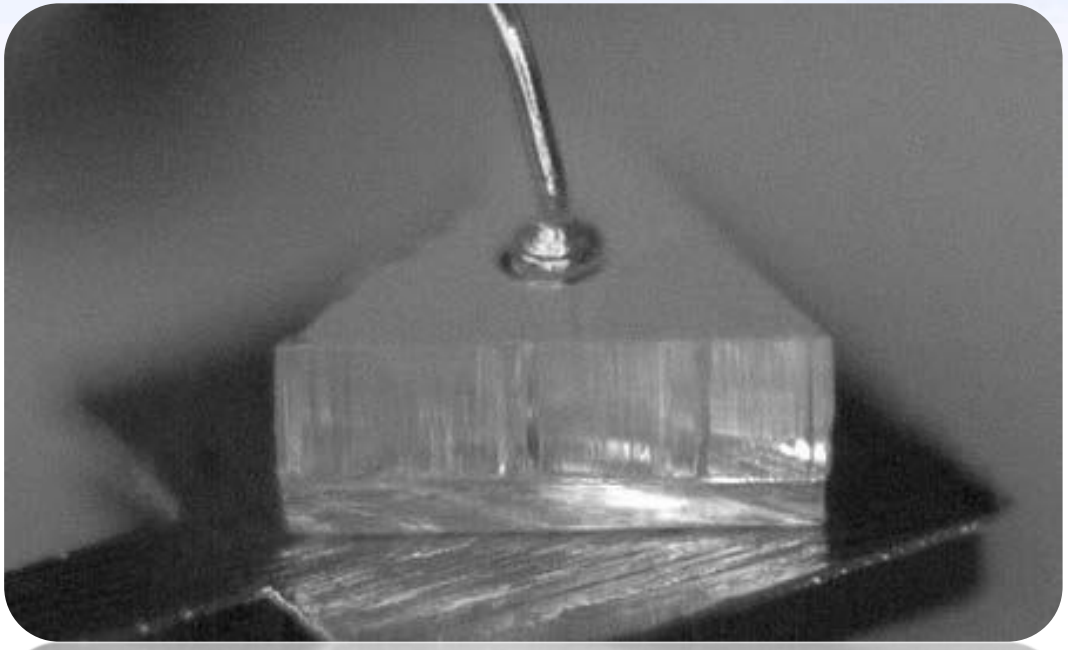

380um
BULKGAN
NGAN
MQW
PALGAN
PGAN
METAL

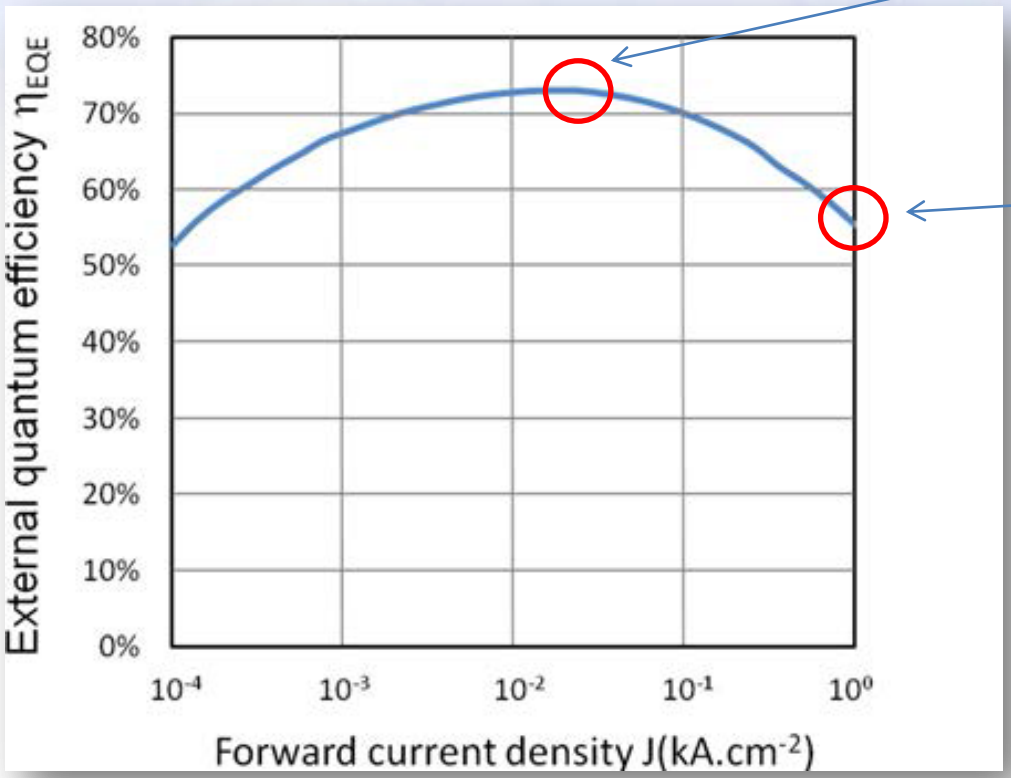

Simulation of Tri-LED Light Extraction Efficiency
Light extraction efficiency C_{ex}
0.92
0.9
0.88
0.86
0.84
0.82
0.8
Volumetric
Thin-film
H
0
50
100
150
Chip height H (μm)

- **The chip has an equilateral triangular base and a roughened top surface.**

- **taking care to minimize optical losses in the chip in order to improve Cex**



- **External quantum efficiency versus J shown in logarithmic scale,to clarify the device's behavior around Jpea**

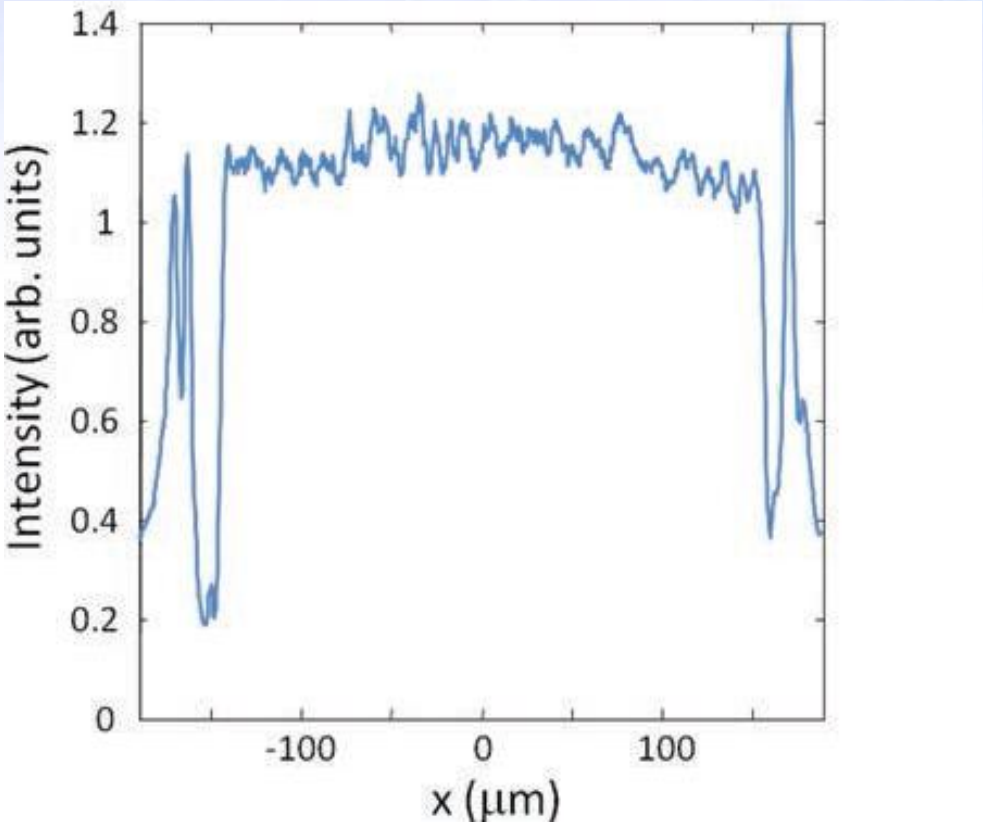


73.1%

55.3%

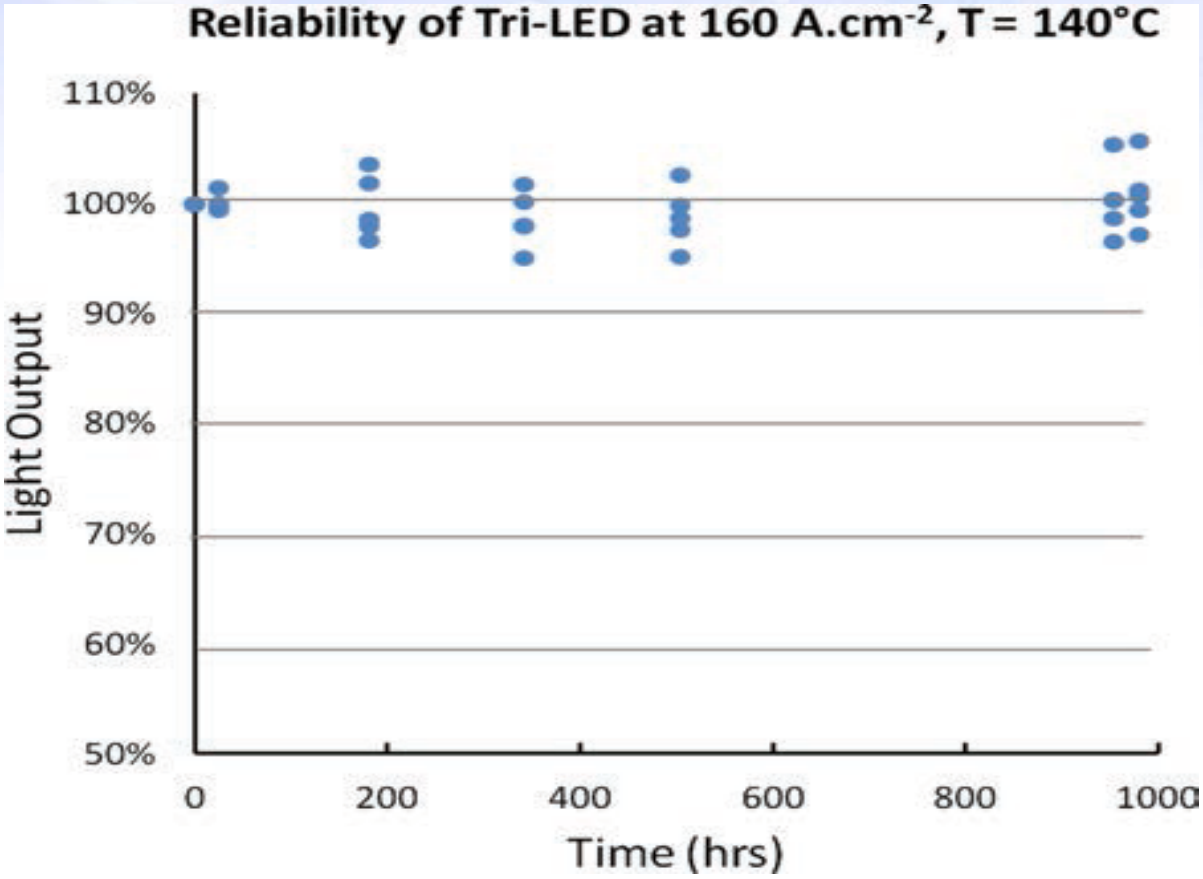
- **Microscope image of the active region of a Tri-LED under operation at 500Acm-2,evidencing the absence of current crowding**

- **The light output is uniform within 6 5% at this very high current density, as confirmed in the cross-section intensity profile.**



- **Stability of light output under stress conditions (J ¼ 160Acm 2 and T ¼ 140 C).**

- **Each point represents a device. No degradation is observed over 1000 h.**



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- **we have demonstrated LEDs grown on bulk GaN substrates, which exhibit very high external quantum efficiency at high current density**

- **We have also confirmed the absence of current crowding at high current density in our devices, and demonstrated their reliability under high-current**

- **this technological breakthrough is expected to enable a generation of solid-state lighting systems based on higher power density LEDs providing a fundamental shift towards dramatically improved cost per optical Watt.**

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Thanks for your attention