Growth and fabrication of sub-320 nm and 340 nm UV LEDs with GaN interlayer

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Basic Technology Research Programme — RESEARCH COUNCILS UK — *A 1000 micro-emitters per square millimetre*

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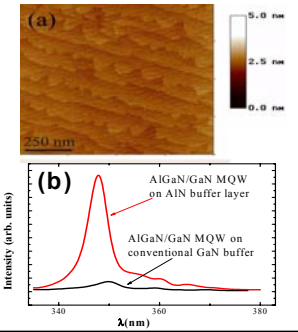
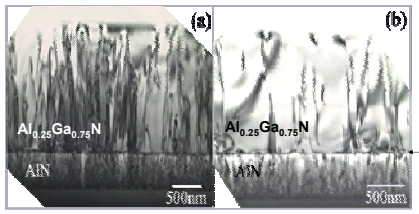
Introduction: Optical efficiency of nitride based devices especially ultraviolet (UV) light emitting diodes (LEDs) is sensitive to dislocation density. Therefore dislocation density reduction is a key issue for high performance nitride based UV emitters. Here, we reveal a novel technology to reduce the dislocation effectively by inserting a thin GaN interlayer between an AlN buffer layer and AlGaN layer. Based on this technology, we have developed high performance sub-320 nm and 340 nm UV LEDs.

High temperature AlN buffer layer

- atomically flat high temperature AlN buffer layer
- PL intensity of AlGaN/GaN MQW grown on AlN buffer layer is an order magnitude higher than the conventionally grown one



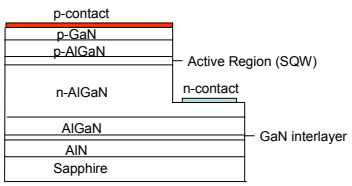
Thin GaN interlayer



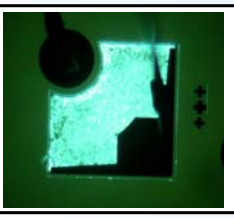
- Significant reduction of threading dislocations by insertion of a 20 nm GaN interlayer
- internal absorption by the GaN interlayer is not significant

Please see J. Bai et al. poster for details

Fabrication of UV LEDs



1) activation of p-type layer
2) mesa etching
3) n-contact deposition and annealing
4) p-contact deposition and annealing
5) bond pad deposition for n- and p-contacts



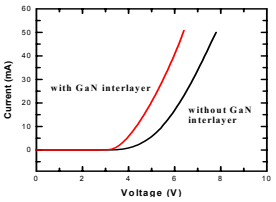
340 nm GaN/AlGaN SQW UV LEDs

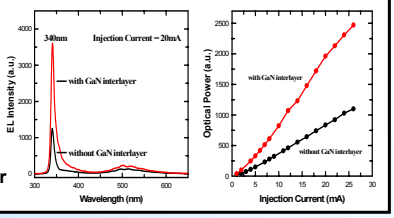
Electrical properties:

- Vf = 6.5 V @ 20 mA (without GaN interlayer)
- Vf = 5 V @ 20 mA (with GaN interlayer)

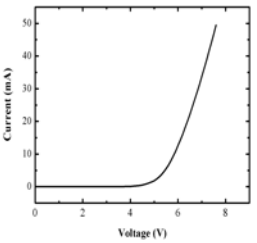
Optical properties:

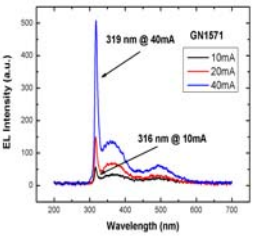
- Peak wavelength = 340 nm @ 20mA
- FWHM = 8 nm
- Output power of UV LEDs with GaN interlayer is 2.2x higher than the one without GaN interlayer





Sub-320 nm AlGaN SQW UV LEDs with GaN interlayer





Electrical properties:

- Vf = 6.4 V @ 20 mA

Optical properties:

- Peak wavelength = 317 nm @ 20mA
- FWHM = 10 nm

The sub-320 nm UV LEDs were processed in collaboration with IoP, University of Strathclyde. We are grateful to Dr. H. X. Zhang, Dr. Z. Gong and Dr. E. Gu for device processing.

Conclusions: A new technology to reduce dislocation density significantly by inserting a 20 nm GaN interlayer has been developed. We demonstrate greatly improved sub-320 and 340 nm UV LEDs by using a GaN interlayer technology. The electrical and optical performance of the UV LEDs with the GaN interlayer are significantly better superior than the one without.