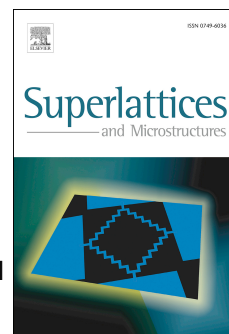


# Accepted Manuscript

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# Droop-Multimode Trade-off in GaN-InGaN LEDs: Effect of Polarization-Matched AlInGaN Blocking Layers

Vikas Pendem,<sup>a, b, c</sup> Sonachand Adhikari,<sup>a, b</sup> Manish Mathew,<sup>a</sup> Sumitra Singh<sup>a, b</sup> and Suchandan Pal<sup>a, b</sup>

<sup>a</sup> CSIR-Network of Institutes for Solar Energy, Opto-electronic Devices Group, CSIR-Central Electronics Engineering Research Institute, 333 031, Pilani, Rajasthan, India

<sup>b</sup> Academy of Scientific and Innovative Research (AcSIR), CSIR Campus, Taramani, 600 113, Chennai, Tamilnadu, India

<sup>c</sup> Corresponding author E-mail: [vikas6@outlook.com](mailto:vikas6@outlook.com); Ph.: +91-1596-252286; Fax: +91-1596-242294

**Abstract**—Polarization-matched graded AlInGaN electron blocking layer (EBL) and hole blocking layer (HBL) are proposed to reduce efficiency droop in GaN-InGaN light-emitting diodes (LEDs). Five different structures have been simulated to study the effect of different blocking layers and a significant reduction in the efficiency droop has been noticed, from 52% in conventional structure to 2% in polarization-matched graded AlInGaN EBL and HBL structure at a current density of  $1000 \text{ A cm}^{-2}$ . This has been achieved at the cost of multimode emission from such polarization-matched blocking layers which sets a trade-off between efficiency droop and multimode emission. The AlInGaN layer can therefore be characterized by droop cut-off condition (DCC) and multimode cut-off condition (MCC). For the best structure proposed in this paper, simulations indicate a DCC having Al and In composition of 0.10 and 0.15 respectively; and an MCC having Al and In composition of 0.08 and 0.23 respectively.

## Highlights—

- Efficiency droop is reduced by polarization-matched graded AlInGaN EBL and HBL.
- Droop reduced from 52% to 2% measured at a current density of  $1000 \text{ A cm}^{-2}$ .
- A high-intensity secondary emission is observed due to AlInGaN blocking layers.
- A trade-off exists between efficiency droop and multimode emission.

**Keywords**—droop cut-off condition (DCC), efficiency droop, internal quantum efficiency (IQE), light-emitting diode (LED), multimode cut-off condition (MCC), polarization-matched AlInGaN.

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