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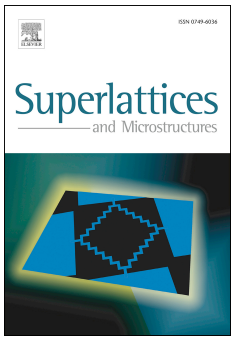

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Investigation of Efficiency Enhancement in InGaN MQW LED with Compositionally Step Graded GaN/InAlN/GaN Multi-Layer Barrier

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Abstract- The advantage of InGaN multiple Quantum well (MQW) Light emitting diode (LED) on a SiC substrate with compositionally step graded GaN/InAlN/GaN multi-layer barrier (MLB) is studied. The Internal quantum efficiency, Optical power, current-voltage characteristics, spontaneous emission rate and carrier distribution profile in the active region are investigated using Sentaurus TCAD simulation. An analytical model is also developed to describe the QW carrier injection efficiency, by including carrier leakage mechanisms like carrier overflow, thermionic emission and tunnelling. The enhanced electron confinement, reduced carrier asymmetry, and suppressed carrier overflow in the active region of the MLB MQW LED leads to render a superior performance than the conventional GaN barrier MQW LED. The simulation result also elucidates the efficiency droop behaviour in the MLB MQW LED, it suggests that the efficiency droop effect is remarkably improved when the GaN barrier is replaced with GaN/InAlN/GaN MLB barrier. The analysis shows a dominating behaviour of carrier escape mechanism due to tunnelling. Moreover, the lower lattice mismatching of SiC substrate with GaN epitaxial layer is attributed with good crystal quality and reduced polarization effect, ultimately enhances the optical performance of the LEDs.

Index Terms **– InAlN, GaN/InGaN, Light Emitting Diode (LED), Multiple Quantum Well (MQW), Multi-Layer Barrier (MLB), and Quantum well.**

I. INTRODUCTION

Solid state light emitting technology has a prospicient benefits over the other lighting technologies, they are getting better and cheaper on a predictable curve. It holds the promise of immense energy savings and durable light sources. An efficient LED bulb could save energy and billions of money, it decreases the dependence on petroleum oils, and significantly reduce greenhouse gases [1,2]. However, to achieve this the LEDs has to overcome the efficiency degradation problem at high injection current, which is also named as efficiency droop effect. It is considered as one of the major hurdles in the growth of high luminescent LED lighting, and it can be