Condensed Matter Physics Seminar
Department of Physics, National Taiwan University

Recent Progress of efficiency droop improvement for High efficiency (>200lm/W) GaN-based light-emitting diodes

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National Taiwan University

Dr. Hao-Chung Kuo
Distinguished Professor,
Institute of Electro-optical Engineering, National Chiao Tung University

All Are Welcome!

Abstract

GaN-based light-emitting-diodes (LEDs) have been developed in various applications due to its widely tunable wavelength from ultraviolet to blue/green. Nevertheless, the most expected application, solid-state lighting, is still developing, which means the state-of-the-art InGaN/GaN LEDs should be further improved. Although the light-extraction efficiency has been significantly improved by different techniques, the internal quantum efficiency (IQE) still suffers a major obstacle, i.e., the substantial decrease in efficiency with increasing injection current. This efficiency droop behavior strongly limits the development of many specific applications which require the operation current of the InGaN/GaN LEDs under high injection levels. In this paper, we first introduce the physical mechanisms of efficiency droop in GaN-based LEDs and its origin. Then we propose several methods to reduce this effect, such as alternative substrates, semi-polar (1-101) MQWs, low temperature insertion layer between n-GaN and MQWs, graded-thickness MQWs (GQWs), and graded-composition EBL (GEBLs). The results show that by reducing the polarization field in MQWS, enhancing hole transportation in MQWs, and enhancing hole injection across EBL, the efficiency droop behavior could be successfully reduced. Finally high efficiency white LED with efficacy >180 lm/W at 3000K was demonstrated.

Course TA: Wei-Lun Hsu Tel: 02-3366-5128 Email: ross6320@gmail.com