SSNN O3 **INTERNAL QUANTUM EFFICIENCY ENHANCEMENT OF InGaN/GaN LEDs WITH Mg-Si pin-DOPED GaN QUANTUM BARRIER**

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In the past decade the InGaN/GaN-based light-emitting diodes (LEDs) have attracted attention of most researchers as a promising candidate to replace conventional lamps in lighting applications, including general illuminations, LCD display backlighting, and automobile lighting. However, the efficiency of LEDs is significantly reduced at high current density, which is known as the "efficiency droop" phenomenon [1]. In this work we study numerically the effect of Mg-Si pin-doping of GaN quantum barrier within InGaN/GaN multi quantum wells (MQWs) on the internal quantum efficiency (IQE) of LEDs in comparison with LED devices with undoped, Si(Mg)-doped or Si(Mg) delta-doped GaN barriers. The transport and optical properties of the InGaN/GaN LEDs with different structures are investigated numerically using the one dimensional Schrödinger-Poisson solver software 1D-DDCC [2]. Figure 1 shows the current-voltage dependences (a), IQE vs. current density (b), and IQE vs. doping level (c) characteristics for the LEDs with undoped (structure A), Mg-doped (structure B), Mg delta-doped (structure C), and Mg-Si pin-doped (structure D) of the GaN quantum barrier.

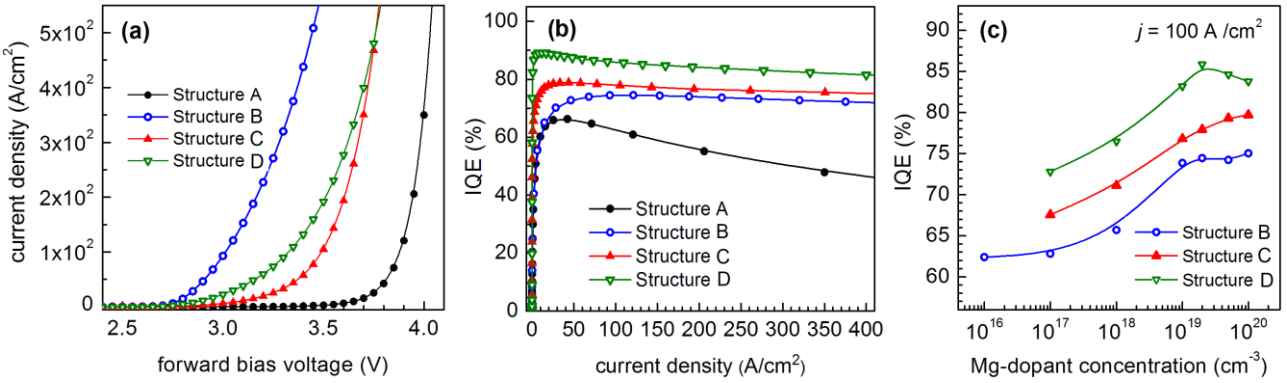

Figure 1. (a) Current-voltage characteristics of InGaN/GaN LEDs with undoped (structure A), Mg-doped (structure B), Mg delta-doped (structure C), and Mg-Si pin-doped of the GaN barrier (structure D). (b) IQE as function of current density for InGaN/GaN LEDs with structures A, B, C, and D. (c) Influence of Mg-doping, Mg delta-doping and Mg-Si co-doping of GaN barrier on IQE efficiency of InGaN/GaN LEDs.

It is found that Mg-Si pin-doping of the GaN barrier could improve carrier injection in the active region and its confinement significantly, as well as effectively screening the piezoelectric field and reducing the quantum confinement Stark effect. These improvements enhance the IQE and wall-plug efficiencies, as well as the optical output power of the InGaN/GaN LED devices. The simulation results show that our proposed MQW LED structure with Mg-Si pin-doped GaN barrier is a promising design, which have a maximum IQE efficiency of 85.9% at 100 A/cm^2 and the emission EL peak at 415.3 nm, which is blue-shifted in compare with original LED with undoped GaN barrier.

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