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Improvement of internal quantum efficiency in In GaN LED for SSL application

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InGaN has been widely investigated and developed as a semiconductor material suitable for LEDs and LDs emitting in the near UV to green spectral range. In the future most important application of InGaN LEDs will be a solid state lighting for general illumination. More technological improvement shoulde be made to realize commercial SSL-InGaN LED in severalyears.

In this talk, critical issues in InGaN blue LED R&D will be addressed in the aspect of device structure design and growth, and recent results to impove IQE (internal quantum efficiency)which were reported by various groups will also be introduced for discussion.

Keywords: InGaN, LED, IQE

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GaN계 발광다이오드에서 3차원 전류분포가 신뢰성특성에 미치는 영향

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The nonuniform current flow pattern in a light emitting diode (LED) results in serious problems such as a local heat generation, an early saturation of light emission power, an unexpected light emission pattern, color binning, and a short device lifetime. We present a theoretical method of analyzing 3-dimensional current flow in a complex light emitting diode (LED) structure. The method is based on 3-dimensional circuit modeling and its analysis so that it has advantages of short calculation time and simple algorithm over the method of solving semiconductor differential equations. Our software is able to know how to influence structural parameters such as epitaxial layers, electrode pattern, and chip shape on the current crowding without fabricating LEDs. Its accuracy is confirmed experimentally by investigating 2-dimensional light intensity patterns on lateral-electrode (LE) InGaN/GaN blue LEDs of 320x320 μm2 size. By utilizing the software, we designed and fabricated several different n-electrode patterns on the same epitaxial wafer and investigated the relation between nonuniform current flowing patterns with LED performances. It was found that the nonuniform current flow significantly affected the electrical and optical characteristics, electrostatic discharge voltage, and LED lifetime. Based on these experimental results, we successfully designed some electrode patterns giving high performances in LE-LEDs of the rectangular and the lozenge shapes.

Keywords: current spreading, light emitting diode, reliability