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Study on Efficiency Droop in a-plane InGaN/GaN Light Emitting Diodes

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Light-emitting diodes (LEDs) based on III-nitrides compound semiconductors have achieved a high performance device available for display and illumination sector. However, the conventional c-plane oriented LED structures are still showing several problems given by the quantum confined Stark effect (QCSE) due to the effects of strong piezoelectric and spontaneous polarizations. The QCSE results in spatial separation of electron and hole wavefunctions in quantum wells, thereby decreasing the internal quantum efficiency and red-shifting the emission wavelength. Due to demands for improvement of device performance, nonpolar structure has been attracting attentions, since the quantum wells grown on nonpolar templates are free from the QCSE. However, current device performance for nonpolar LEDs is still lower than those for conventional LEDs. In this study, we discuss the potential possibilities of nonpolar LEDs for commercialization.

In this study, we characterized current-light output power relation of the a-plane InGaN/GaN LEDs structures with the variation of quantum well structures. On-wafer electroluminescence measurements were performed with short pulse (10 us) and low duty factor (1 %) conditions applied for eliminating thermal effects. The well and barrier widths, and indium compositions in quantum well structures were changed to analyze the efficiency droop phenomenon.

Keywords: a-plane InGaN/GaN LEDs, Efficiency droop