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Characterization of Optical Properties of Light-Emitting Diodes Grown on Si (111) Substrate with Different Quantum Well Numbers and Thicknesses

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In recent years there have been many studies of InGaN/GaN based light emitting diodes (LEDs) in order to progress the performance of luminescence. Many previous literatures showed the performance of LEDs by changing the LED structures and substrates. However, the studies carried out by the researchers so far were very complicated and sometimes difficult to apply in practice. Therefore, we propose one simple method of changing the thickness and the numbers of multiple quantum wells (MQWs) in order to optimize their effects. In our research, we investigated electrical and optical properties by changing the well thickness and the number of quantum well (QW) pair in LED structures by growing the structure -inch Si (111) wafer. We defined the samples from LED_1 to LED_3 according to MQW structure. Samples LED_1, LED_2 and LED_3 consist of 5-pair InGaN/GaN (3.5 nm/ 4.5 nm), 5-pair InGaN/GaN (3 nm/4.5 nm) and 7-pair InGaN/GaN (3.5 nm/4.5 nm), respectively. We characterized electrical and optical properties by using electroluminescence (EL) measurement. Also, Efficiency droop was analyzed by calculating external quantum efficiency (EQE) with varying injection current. The EL spectra of three samples show different emission wavelength peaks, FWHM and the blueshift of wavelength caused by screening the internal electric field because of the effect of different MQW structure. The results of optical properties show that the LED_2 sample reduce the internal electric field in QW than LED_1 from EL spectra. the increase in the number of QW pairs reduces the strain and increase the In composition in MQW. And, the points of efficiency droop's peak show different trend from LED_1 to LED_3. It is related with the carrier density in active region. Thus, from the results of experiments, we are able to achieve high performance LEDs and a reduction of efficiency droop and emission wavelength blueshift by optimizing MQWs structure.

Keywords: Si(111), electroluminescence, MQWs, efficiency droop