Improvement in LED structure for enhanced light-emission

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To increase the light-emission efficiency of LED, we increased the internal and external quantum efficiency by suppressing the defect formation in the quantum well and by increasing the light extraction efficiency in LED, respectively. First, the internal quantum efficiency was improved by investigating the effect of a low temperature (LT) grown p-GaN layer on the $In_{0.25}GaN/GaN$ MQW in green LED. The properties of p-GaN was optimized at a low growth temperature of 900oC. A green LED using the optimized LT p-type GaN clearly showed the elimination of blue-shift which is originated by the MQW damage due to the high temperature growth process. This result was attributed to the suppression of indium inter-diffusion in MQW layer as evidenced by XRD and HR-TEM analysis. Secondly, we improved the light-extraction efficiency of LED. In spite of high internal quantum efficiency of GaN-based LED, the external quantum efficiency is still low due to the total internal reflection of the light at the semiconductor-air interface. To improve the probability of escaping the photons outside from the LED structure, we fabricated nano-sized cavities on a p-GaN surface utilizing Pt self-assembled metal clusters as an etch mask. Electroluminescence measurement showed that the relative optical output power was increased up to 80% compared to that of LED without nano-sized cavities. I-V measurement also showed that the electrical performance was improved. The enhanced LED performance was attributed to the enhancement of light escaping probability and the decrease of resistance due to the increase in contact area.