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Fabrication and Characterization of InGaN/GaN LED structures grown on selectively wet-etched porous GaN template layer

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Much interest has been focused on InGaN-based materials and their quantum structures due to their optoelectronics applications such as light emitting diode (LED) and photovoltaic devices, because of its high thermal conductivity, high optical efficiency, and direct wide band gap, in spite of their high density of threading dislocations. Build-in internal field-induced quantum-confined Stark effect in InGaN/GaN quantum well LED structures results in a spatial separation of electrons and holes, which leads to a reduction of radiative recombination rate. Therefore, many growth techniques have been developed by utilizing lateral over-growth mode or by inserting additional layers such as patterned layer and superlattices for reducing threading dislocations and internal fields. In this work, we investigated various characteristics of InGaN multiple quantum wells (MQWs) LED structures grown on selectively wet-etched porous (SWEP) GaN template layer and compared with those grown on non-porous GaN template layer over c-plane sapphire substrates. From the surface morphology measured by atomic force microscope, high resolution X-ray diffraction analysis, low temperature photoluminescence (PL) and PL excitation measurements, good structural and optical properties were observed on both LED structures. However, InGaN MQWs LED structures grown on SWEP GaN template layer show relatively low In composition, thin well width, and blue shift of PL spectra on MQW emission. These results were explained by rough surface of template layer, reduction of residual compressive stress, and less piezoelectric field on MQWs by utilizing SWEP GaN template layer. Better electrical properties were also observed for InGaN MQWs on SWEP GaN template layer, specially at reverse operating condition for I-V measurements.