

The impact of strained layer superlattice (SLS) to the emission and internal quantum efficiency (IQE) of a GaN LED

Abstract

Gallium nitride (GaN) light emitting diode (LED) has been used as highly efficient solid-state light sources to radiate a wide range of wavelengths in the visible spectrum. Larger currents drive bright LEDs, causes reduced efficiency which known as LED droop. Insertion of strained-layer superlattice (SLS) in GaN LED gives uniform electron distribution, lead to high emission and efficiency. The primary aim of this work is to investigate the operation of LED with the inclusion of SLS by simulation. The GaN LED was designed in cylindrically symmetrical configuration with the insertion of the InGaN/GaN SLS of 3 nm thick. This work investigates the effect of different number of SLS layers, which is represented by 1, 2 and 3 periods of SLS, which represent the total SLS thicknesses of 3 nm, 6 nm and 9 nm respectively. A GaN cylindrical chip of 700 nm diameters was designed with p- and n-type doped active region. The results has shown that the efficient operation of the LED can occur within the lowest current of 0.1 mA for the 2 periods of SLS with the total emission rate displayed linearly increased. A sharp decline of internal quantum efficiency (IQE) droops close to zero despite the increasing current was significantly observed for the 2 periods of SLS, which has also resulted to operate at a low turn-on voltage of 2.5 V. However, it was found that higher than 3 periods with SLS total thickness of higher than 6 nm cause the pn junction failure with no emission.