Proceedings of SPIE, 6669: 66691I
Seventh International Conference on Solid State Lighting
SPIE, September 2007

Effect of Spontaneous and Piezoelectric Polarization on the Optical Characteristics of Blue Light-emitting Diodes

Kuo, Yen-Kuang; Yen, Sheng-Horng; Tsai, Miao-Chan; Liou, Bo-Ting

Abstract

The effect of spontaneous and piezoelectric polarizations on optical characteristics of blue InGaN light-emitting diodes (LEDs) is investigated in this work with the APSYS simulation program. Specifically, the band diagram, carrier distribution, radiative recombination current, and light-current performance curves are discussed for various polarization situations. According to the simulation results, the amount of polarization charges is dominated by piezoelectric polarization. Therefore, the band diagram and overlap between electrons and holes in quantum wells are improved effectively and the light-current performance is raised apparently as the piezoelectric polarization is removed and only the spontaneous polarization is taken into account. The possible reason is that the influence of piezoelectric polarization due to lattice constant mismatch on optical properties is severe than the spontaneous polarization due to asymmetry of the wurtzite structure along the c-axis. Moreover, the simulation results suggest that the blue InGaN LED structures with spontaneous polarization may provide higher output power but are more sensitive to temperature, in a range from 300 K to 350 K, when compared to the LED structures with piezoelectric polarization.