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Electronic Current Overflow and Inhomogeneous Hole Distribution of InGaN Quantum Well Structures

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Abstract

The InGaN semiconductor materials have important application in visible light-emitting diodes (LED) and short-wavelength laser diodes. In this work we investigate the electronic current overflow and the inhomogeneous hole distribution of the blue InGaN quantum well structures with a LASTIP (abbreviation of LASer Technology Integrated Program) simulation program. The simulation results show that the InGaN quantum well structure has an appreciable electronic current overflow at room temperature. The electronic current overflow problem becomes even more severe at elevated temperatures, which not only affects the emission efficiency of the quantum well structure, but also deteriorates the operation lifetime of the InGaN optical devices. The simulation results indicate that it is possible to improve the electronic current overflow by increasing the doping level of the p-type epi-layers and adding an AlGaN blocking layer in the p-type region. On the other hand, our numerical simulation also shows that, in addition to the electronic current overflow issue, the distribution of the holes in the InGaN active region is very inhomogeneous. It turns out that the laser performance of a single quantum well InGaN laser is better than that of the multiple quantum well lasers. According to our studies, if the barriers between the quantum wells are properly doped, the inhomogeneous hole distribution in the active region may be improved and hence the laser performance of the multiple quantum well InGaN lasers may be enhanced.