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Photoluminescence Properties of InGaN/AlGaInN MQWs with Lattice-Matched AlGaN/InGaN Superlattices Barrier at Highly Excited Condition

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Extended Abstract

Group-III Nitrides have been widely employed in solid state lighting benefited by the adjustable bandgap varying with the alloy composition. However, due to large lattice mismatch (11%) between InN and GaN, InGaN multiple quantum wells (MWQs) are subjected to in-plane compress stress which induce a piezoelectric polarization, which results in the Quantum Confined Stark Effect and the reduction of the emission quantum efficiency. Therefore, the lattice-matched QWs should be created. The $Al_xIn_yGa_{1-x-y}N$ quaternary alloy can adjust the lattice constant and band gap independently by tuning Al or In composition, which can match to the InGaN well to obtain strain-free structure.

In this paper, we fabricate high-quality AlGaN/InGaN short period superlattices which shows the lattice matched to InGaN well, and then obtain the almost strain-free InGaN/AlInGaN MQWs. The optical properties are studied compared with a conventional InGaN/GaN MQWs by using highly excited photoluminescence (PL) measurement with the excitation density range from 10.7 kW/cm^2 to 2.13×10^4 kW/cm^2. The results show that the use of lattice-matched AlGaN/InGaN superlattices barrier layer can effectively improves the materials quality and suppress the efficiency droop.

With the increasing excitation power density, the peak position of InGaN/GaN MQWs has a blueshift of 19 nm while that of InGaN/AlInGaN MQWs just has a slightly redshift of 2 nm. The integral emission intensity of the InGaN/AlInGaN MQWs is four times that of the InGaN/GaN MQWs. At the excitation power density of 1.07×10^3 kW/cm^2 and above, the nonrabination recombination channel is saturated and radiative recombination play the prominent role in the InGaN/AlInGaN MQWs, while a new nanradiative recombination channel actives in the InGaN/GaN MQWs at the high excitation power density.