Electroluminescence Spectra of Light-Emitting $In_xGa_{1-x}N/GaN$ Heterostructures at Reverse Bias at $T = 300$ K and 77 K

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Separated bands and peaks of the luminescence spectra, also displayed at lower temperatures, contain valuable information on the energy levels of recombination centres and various defects. For effective non-destructive control of quality and characterization of GaN (InGaN, AlGaN) structures often used the local photo-, electro-, cathode-luminescence (PL, EL, CL). At the same time, application of a reverse voltage to GaN structure produces controlled microplasma (MP) breakdown that takes place mainly in the regions of extended defects, and is accompanied by luminescence. In general, the EL spectra at reverse bias investigated in typical InGaN/GaN AlGaN/GaN heterostructures, GaNP, ZnO / GaN, Si and GaAs structures (for example, see [1]).

But depending on the indium (In) content in the $In_xGa_{1-x}N$ quantum well EL spectra at reverse bias is not investigated, also at $T = 77$ K. For the first time we measured EL spectra of the LED $In_xGa_{1-x}N/GaN$ heterostructures at reverse bias for $x = 0.05$, 0.15, 0.2, 0.3, and also at liquid nitrogen temperature.

In the MP spectrum, one can observe the main peak of quantum wells (QW) $In_xGa_{1-x}N$ with the maximum corresponding to the energy of the band gap E_g $In_xGa_{1-x}N$ and the shoulder (or peak) near 400 nm related to GaN layers. The shoulder corresponds to recombination on donors and (or) acceptors in the *p*- and *n*- GaN layers. Also "yellow" (defect) luminescence is observed.

It is revealed appearance of EL bands from defects, as well as bands, the form of which is identical to typical EL spectra at forward bias. The observed both temperature narrowing of the width of EL spectra and shift of the peak of EL spectra of microplasmas.

It was found that at $T = 77$ K electroluminescence spectra of microplasmas for $In_{0.2}Ga_{0.8}N/GaN$ structures are divided into two peaks, which correspond to recombination in two areas - the quantum well and *p*-GaN layer. EL spectrum microplasmas $In_{0.3}Ga_{0.7}N/GaN$ structures at $T = 77$ K contains main 1 peak due to the higher conductivity $In_{0.3}Ga_{0.7}N$ layer.

1. M. Lahbabi, A. Ahaitouf, M. Fliyou, E. Abarkan, J.-P. Charles, A. Bath, A. Hoffmann, S.E. Kerns and D.V. Kerns. Analysis of electroluminescence spectra of silicon and gallium arsenide p-n junctions in avalanche breakdown // J. Appl. Phys. **95** (2004) 1822.