LBNL-59543 Abs.

Presented at
Photonics West 2006 – San Jose, January 21-26, 2006
SPIE—The International Society for Optical Engineering

Temperature dependent cross-relaxation of blue emission from Tm doped AlN epilayers

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We report on the temperature dependent cross-relaxation process of Tm implanted in AlN. Investigated AlN samples were grown on sapphire by molecular beam epitaxy, doped by implantation with Tm ions with 150 keV maximum implantation energy with a dose of 1×10^{16} At/cm^2 (the peak concentration of Tm^{3+} ions was 3.4×10^{21} At/cm^3). Samples were thermally annealed at 1050°C in ammonia at atmospheric pressure to remove implantation induced defects. The low temperature (12 K) 'blue' part (460-489 nm) of CL spectrum of Tm-doped AlN shows multiple transition lines originating from ^{3}P, ^{1}I, ^{1}D and ^{1}G manifolds. It was observed that the shape of the CL spectrum changes radically when temperature increases leaving dominant two groups of lines centered at 463 nm ($^1D_2\rightarrow{}^3F_4$) and 466 nm ($^3P_1\rightarrow{}^3F_{3,2}$) at 300 K. These changes resulted in one order of magnitude increase of 'blue' emission intensity with respect to low temperature emission. The experimental data are analyzed using the thermally dependent cross-relaxations processes between $^1I_6$, $^1G_4$ and $^1D_2$, $^3P_1$ terms.