THP-(SS1)-2

DEPENDENCIES OF OPTICAL AND MATERIAL PROPERTIES ON NOMINAL INDIUM CONTENT AND WELL WIDTH IN InGaN/GaN QUANTUM WELL STRUCTURES

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Abstract—*Optical properties and material microstructures of InGaN/GaN quantum wells structures with various nominal indium contents, quantum well widths, and different thermal annealing conditions were compared to show the effects of indium aggregations and strains.*

In this paper, we report the different thermal annealing results in InGaN/GaN QW structures of different nominal indium contents and different QW widths. Various optical characterization and material analyses were conducted to reveal the photon emission behaviors under different conditions. The two sets of samples were grown on c-plane sapphire with MOCVD. Following the deposition of 30 nm GaN buffer layer and a 2.3 μm GaN layer, QW structures consisting of five pairs of InGaN well and 10 nm-thick GaN barrier were grown. In the first set of sample, three samples of the same QW geometry of 2.5 nm in well width but different nominal indium contents (with lower to higher indium contents designated as samples A, B, and C) were prepared. In the second set of sample, three samples of the same nominal indium content but different well widths at 2, 3, and 4 nm were prepared and referred to as samples w20, w30 and w40, respectively.

It is shown that generally PL spectral peak blue shifts upon thermal annealing in each sample. Such a blue shift is particularly significant in sample A, which has the lowest indium content. For the samples of lower indium contents (Samples A and B), higher thermal annealing temperatures lead to larger blue shift. However, for sample C of higher indium content, 800 °C results in the largest blue shift. Fig. 1 shows the variations of normalized integrated PL intensity with temperature of various conditions. Such a variation is usually used for representing the radiative efficiency of a sample. One can see that generally thermal annealing results in high radiative efficiency except the case of 850 °C annealing of sample C. For the samples of different QW widths, thermal annealing results in blue shifts of PL peak in w20 and red shifts in w30 and w40. Also, in all samples thermal annealing at 800 °C leads to the largest spectral shifts. As thermal annealing temperature increases, the blue shift or red shift is reduced. Fig. 2 shows the temperature-dependent variations of integrated PL intensity of the as-grown and annealed samples. The integrated PL intensities were enhanced upon thermal annealing in w20 and w30, particularly significant in w20. However, that of w40 was reduced.

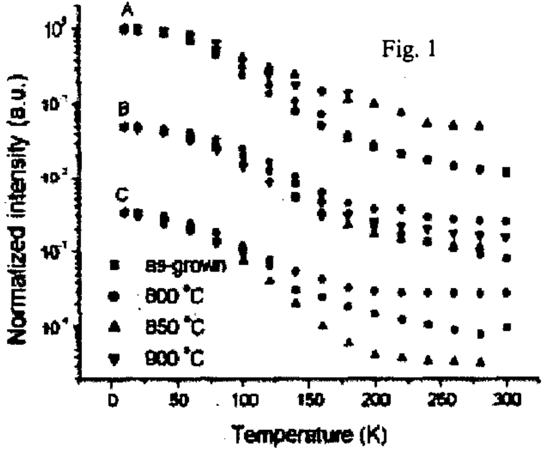

Fig. 1

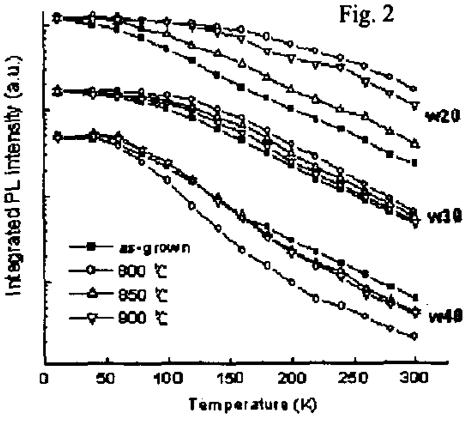

Fig. 2

0-7803-7766-4/03/$17.00 ©2003 IEEE