

A study on phase separation in InGaN/GaN multi-quantum wells

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Phase separation in InGaN/GaN multi-quantum wells (MQWs) grown with various annealing time is studied for obtaining the high brightness green LED. For this purpose, transmission electron microscopy (TEM), and photoluminescence (PL) are used.

InGaN/GaN MQWs for the Green LED with high Indium composition up to 30% are grown at 800-900 °C by metal organic chemical vapor deposition (MOCVD) and annealed during 0, 5, 12.5 minutes at 1000 °C. It is found that the phase separation in InGaN/GaN multi-quantum wells under the condition of annealing for 5 minutes is severe according to PL spectrum and indium ratio map. It is directly obtained indium concentration map images with energy filtered transmission electron microscopy (EFTEM) which can be interpreted as indium compositional fluctuation in Fig 1. The PL intensities of MQWs with annealing for 5 minutes increased when compared to MQWs prepared without annealing at 1000 °C and The PL spectra separated blue and green emission peaks as the result of indium phase separation in Fig. 2. As the annealing time increases, the emission peak shows a blueshift in Fig 2. The presence of indium clustering with high indium composition results in high luminescence efficiency. It is likely to see the recombination center of excitons localized in indium clustering regions.

References

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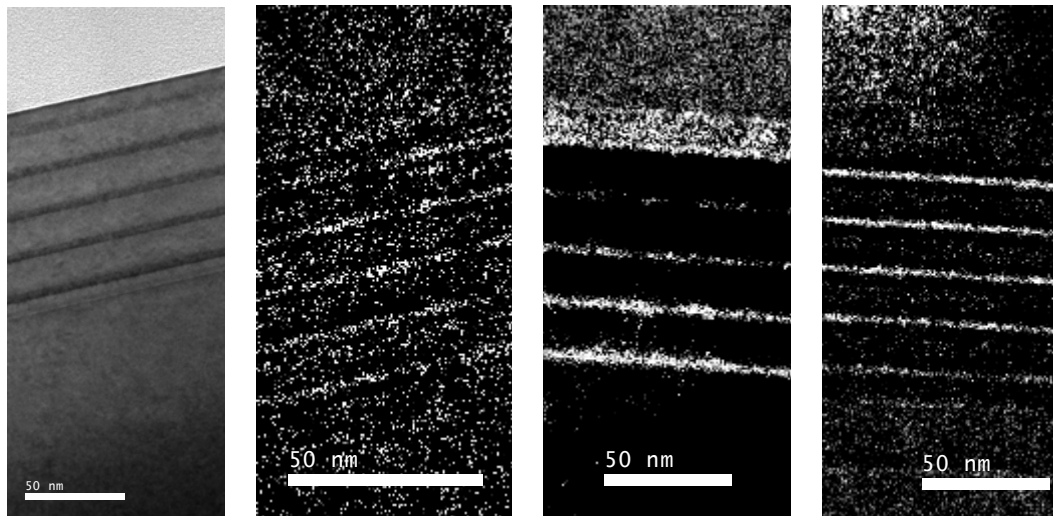


Fig 1. Element mapping results of indium with EFTEM (a) as grown (b) annealing at 1000°C for 5minutes (c) for 12.5minutes.

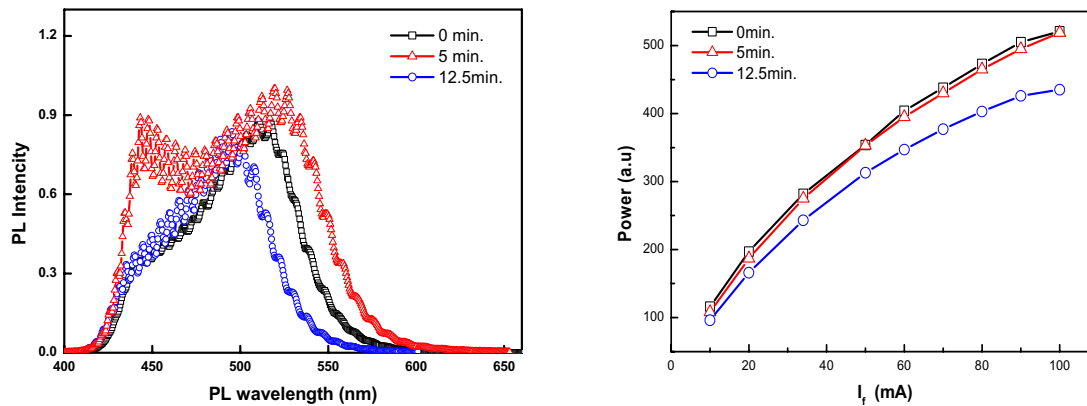


Fig 2. Photoluminescence spectra at RT of InGaN/GaN multi quantum wells of annealing 1000°C for 0, 5, 12.5minutes.

Fig 3. Light output power versus injection current of InGaN/GaN green LEDs at room temperature of annealing at 1000°C for 0, 5, 12.5 minutes.