



# SEMINARIUM

Instytutu Technologii Elektronowej

## Our Recent Investigations on Blue and UV Light Emitting Diodes and Laser Diodes

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The lecture follows a previous lecture titled with *Electron microscopy studies of GaN-based violet laser diodes* presented here at Institute of Electron Technology, on June 13, 2005. The present lecture contains two parts.

Part I has a title: *Electron microscopy investigations of defects in InGaN/GaN MQWs and morphology of high Density InGaN QDS*, which were collaborated with Prof. J.R. Yang and Dr. H.L. Tsai, National Taiwan University (NTU) and Dr. J.T. Hsu, Industrial Technology Research Institute, Taiwan, Republic of China. As well known, InGaN-based multiple quantum wells (MQWs) have been widely manufactured for commercial light emitting diodes (LEDs) and laser diodes (LDs). They exhibit the exceptionally high photoemission efficiency despite very large defect density in  $\text{In}_x\text{Ga}_{1-x}\text{N}$  QWs. The high emission mechanism has not been fully understood. Rather, at the present, it has been becoming more confused. First, we talk about the structure and emission of the InGaN/GaN MQWs, reviewing some of EM investigations. Next, we show our structural investigation of a multiple stacked structure of ultra-high density InGaN quantum dots (QDs) that was fabricated, instead of QWs, in the active layer, as a trial to much improve the photoemission of LEDs.

Part II is on '*ZnO-based ultra-violet light emitting diodes fabricated using atomic layer deposition technique*', and has been presented with Profs. M.J. Chen and J.R. Yang, NTU. ZnO is a promising material for ultraviolet (UV) photonic devices owing to its large exciton binding energy of 60 meV and direct bandgap energy of 3.37 eV at room temperature. ZnO also offers several other advantages: simple processing due to its compatibility with wet chemical etching, relatively low material costs, long-term stability, environmental friendliness, biocompatibility, excellent radiation resistance, etc. We have just been investigating ZnO-based LEDs which are fabricated using atomic layer deposition (ALD) technique for the growth of the epilayers. ALD is a surface-controlled process of depositing materials with atomic-layer accuracy. The most distinctive feature of ALD is that each precursor is alternatively introduced into the chamber and the chemical reactions proceed solely at the substrate surface, leading to self-limiting and layer-by-layer growth. ALD offers many advantages, including accurate and easy thickness control, excellent conformality, abrupt interfaces, high uniformity over a large area, good reproducibility, pinhole-free structures, and low deposition temperatures. Here, we demonstrate our two investigations: *UV electroluminescence (EL) from n-ZnO/p-GaN:Mg heterojunction LEDs* and *UV EL from n-ZnO:Al/ZnO:SiO<sub>2</sub> nanocomposite/p-GaN:Mg LEDs at forward and reverse bias*.