ICNS-10: Conference Report

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Introduction

The 10th International Conference on Nitride Semiconductors (ICNS-10) was held from the 25th – 30th August. The conference was located at the Gaylord Convention Centre at National Harbour, Washington DC, USA. ICNS is organised biennially by MRS and the conference chairs were J A Freitas Jr. and C Wetzel.

There were 893 abstracts received by the conference organisers of which there were 320 from America, 297 from Europe, 6 from Australia and 270 from Asia. In total there were 5 plenary speakers, 18 invited speakers, 249 oral presentations (21 of which were from the UK) and 516 posters presented.

Sessions were divided into four categories, Bulk and film growth, Optical devices (visible), Optical devices (UV) and Electrical devices. These were split up into 36 technical sessions including: Bulk Crystal Growth, Theory and Simulation, Epitaxial Growth, Nanostructures, Optical and Electronic Properties, Light Emitting Devices, Processing and Fabrication, Electron Transport Devices, Defect Characterization and Engineering, Photovoltaics and Energy Harvesting, Structural Analysis, New Materials and New Device Concepts.

Plenary Talks

There were 5 plenary talks given by Mike Krames from Soraa, Inc., Miroslav Micovic from HRL Laboratories, LLC, Chris Van de Walle from University of California, Hiroshi Amano from Akasaki Research Centre and Jürgen Christen from Otto von Guericke University of Magdeburg.

Chris Van de Walle's talk on loss mechanisms in nitride light emitters was extremely interesting. He first talked about problems affecting III-nitride LED devices, mainly the problem of efficiency droop, green gap and other problems facing the LED community. A brief overview of the "ABC" recombination model was given and how big an affect Schottky-Read-Hall recombination and Auger losses have on efficiency droop. Ab-initio studies were performed to characterise the effect of Auger recombination in nitrides.

Key findings included that Auger recombination effects are intrinsic to wide band gap materials such as GaN and is thus hard to minimise. Auger recombination has a very small dependence on temperature (and is still present at 0K) however it is very dependent on carrier density n, so to reduce the effect need to lower n and increase the active volume of LEDs.

Jürgen Christen's talk on nanoscale luminescence of III-N Semiconductors was extremely interesting; focussing on a new cathodo-luminescence (CL) system which has been incorporated into a scanning transmission electron microscope (STEM) at the University of Magdeburg and how this allows the characterisation of III-nitrides.

CL is generally performed in scanning electron microscopes (SEM) where bulk samples are probed with an electron beam and the luminescence observed. In such a system the resolution is limited by the excitation volume (which can be microns in the case of bulk material) and the diffusion of electrons inside the sample. A CL-STEM system requires that the sample is thinned so that the width is ~100nm which has the effect of drastically reducing the volume from which luminescence is generated. This combined with a typical STEM system where the size of the electron probe may be reduced to less than 1nm means that one can take maps of samples with a resolution of about 5nm. A STEM generally has other features such as electron energy loss spectroscopy (EELS) and high angle annular dark field (HAADF) which may be used simultaneously to CL measurements.

The technique presented was used to study the growth of quantum wells and to look at the composition variation in InGaN nanostructures and analysis of defects from peak emission shifts.

Selected Papers

The first talk of the conference was given by **Mark Durniak** on novel cubic-GaN LED structures grown by MOVPE. First a (100)-Si wafer is patterned and to produce v-grooves which have {111} side walls. GaN grows on these side-walls initially in the hexagonal phase however when the when opposing GaN growths collide this induces a phase change to cubic GaN and growth continues in the (001) direction. CL was used to demonstrate the change of phase from hexagonal to cubic. The cubic GaN grown in this way does not suffer from strong internal electric fields or piezoelectric fields which make it ideal for LED devices.

Johannes Ledig gave a talk on InGaN/GaN Core shell LEDS which utilise the non-polar side wall of nanorods to make LED structures. These have the benefit of having a much larger (~20x) active area when compared to the substrate. Cathodo-luminescence and electron beam induced current (EBIC) in an SEM was used to demonstrate the core shell structure and show that there was an indium gradient along the length of the nanorods.

Toni Markurt discussed the role of Si in acting as an anti-surfactant in the epitaxial growth of GaN. A nano-porous layer of “SiN_x” is deposited on GaN using a high Si flux treatment then GaN is grown over this reducing the threading dislocation density by one order of magnitude. By HAADF-STEM imaging of this interface in the <11-20> and <1-100> projections and by comparison with STEM simulations and DFT calculations the “SiN_x” was shown to be a $SiGaN_3$ monolayer. This monolayer was shown to inhibit further GaN growth which grows only where there are holes in the $SiGaN_3$ layer.

Fernando Ponce spoke about Metal-modulated epitaxy (MME) growth of thick InGaN layers over the compositional range x~0.22-0.66. These films were very poor below with $x<0.6$ and had a high density of stacking faults, dislocations and phase separation. However for $x>0.6$ the films exhibited strong luminescence, had a vast improvement in dislocation density and did not present phase separation. This improvement was attributed to the critical thickness of relaxation being close to the lattice parameter, meaning that in just a few monolayers the crystal relaxes and subsequent growth is of a good quality.

Conclusions

Attending this conference was beneficial for me as I met a lot of new people and gained a lot of invaluable knowledge in the field of III-Nitrides. I would like to thank the UKNC for financial support which allowed me to present my work at this prestigious international event.