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Conference report

5th International Conference on Nitride Semiconductors (ICNS-5), Nara, Japan, 25–30 May 2003

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Conference Reports are meant to offer an authoritative view on a recently held scientific meeting rather than a comprehensive list of the conference presentations. Authors are invited to describe what they feel were the most interesting contributions.
The full Proceedings of the 5th International Conference on Nitride Semiconductors (ICNS-5) will be published in phys. stat. sol. (c) **0**, No. 7 in November 2003. Conference papers will also be published in phys. stat. sol. (b) **240**, No. 2 and phys. stat. sol. (a) **200**, No. 1.

The 5th International Conference on Nitride Semiconductors (ICNS-5) was held at Nara-Ken New Public Hall in Nara, Japan, splendidly organized by F. Hasegawa. The conference brought together 638 scientists from 21 countries presenting 426 papers. 136 oral talks (including 20 invited and 4 late news) and 290 poster presentations (including 23 late news) added valuable contributions to the ICNS 5. Organizing the conference in Japan has made it easier for researchers from this country to participate. The strong fraction of 400 local participants represented the traditionally strong research on group-III nitride semiconductor structures in Japan.

The conference covered the diversity of the current nitride research, ranging from optical, electrical and structural characterization over growth to processing and devices of nitride materials. The latest achievements of nitride-based high-speed/high-power electronic devices were discussed in special sessions. Three rump sessions were held to stimulate discussion on the current hot topics: (a) actual issues of substrate materials for nitride Laser Diodes (LDs), Light.Emitting Diodes (LEDs) and Field-Effect Transistors (FETs), (b) white lighting – a bright future, and (c) nitride-based diluted magnetic semiconductors – new phenomena, physics and their impacts.

On Monday morning the conference started with two plenary sessions that conveyed the spirit behind fundamental scientific advances in group-III nitrides. A detailed report on microstructure and electronic properties of InGaN alloys was given by F. Ponce. Compositional inhomogeneities and dislocation distributions in InGaN epilayers and quantum wells were evaluated in great detail by analyses of Rutherford backscattering, transmission electron microscopy (TEM) and cathodoluminescence. The electrostatic

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potential has been profiled across quantum wells and dislocations using electron holography that provides information on the electrostatic charge distribution. H. Ogawa (Sony Corporation) reported on high-power GaN laser diodes and explained the optical disc system, named "Blu-ray Disc System", which is co-developed together with 9 companies of Japan, Korea and Europe. With a 400 nm laser, a numerical aperture of 0.89 of the objective lens and the thinnest substrate as optical path, 25 GB capacity was achieved in April 2003. The perspective number for 2005 is 50 GB. The progress of III–N electrical devices was reported by M. A. Khan. InGaN-based Metal–Insulator–Semiconductor Double Heterostructure Field-Effect Transistors (MISDHFETs) with extremely low gate leakage current ($<10^{-10}$ A/mm), up to 26 GHz rf-power in excess of 6 W/mm and no current collapse were presented.

One of the predominant issues in the growth of the group-III nitrides has been the progress in bulk and defect-free substrates. In an invited talk of A. Krost the state of the art of GaN epitaxy on silicon was given. Using in-situ stress measurements and appropriate strain engineering, up to 7 μm thick, crack-free GaN layers on Si with dislocation densities well below 10^9 cm^{-2} have been fabricated. On this material, high-quality electronic devices and light emitters were demonstrated.

The diluted magnetic and nitride materials debated in the third rump session brought a new impact into the conference series of ICNS. On Thursday the latest developments in room temperature ferromagnetism and its applications for spintronics was given by T. Dietl. Besides Mn as favorite doping material for the ferromagnetism, it was demonstrated that Cr doping in GaN and AlN yields very high Curie temperatures. The progress in the material quality of the quaternary InGaAsN system for light emitters in the 1.3 to 1.55 μm spectral range was presented and discussed.

Fig. 1 (online colour at: www.interscience.wiley.com) The conference venue at Nara-Ken New Public Hall in Nara, Japan.

Fig. 2 (online colour at: www.interscience.wiley.com) Just some of the conference participants (apparently of all ages) in front of the marvelous Todai-ji (Todai Temple).

Progress in the Stranski–Krastanow growth of self-organized GaN quantum dots with intense photoluminescence in the ultraviolet (UV) spectral range was achieved. Furthermore, in some papers the successful growth of InN quantum dots was demonstrated.

The growth and the electronic structure of InN were the subject of two sessions. In several papers the optical properties of InN epilayers were shown to exhibit a low-energy gap between 0.7 and 0.8 eV. Furthermore, good progress was achieved in the growth of high-quality InN. A background carrier concentration down to 1×10^{18} cm^{-3}, measured by different techniques, was demonstrated.

A talk on optical microcharacterization of nitride semiconductors and devices was given by J. Christen. Cathodoluminescence investigations performed on TEM-prepared InGaN epilayers showed that the size of areas with constant emission wavelengths varied between <50 nm and 500 nm, corresponding to the individual sizes of the potential minima. Scanning near-field optical microscopy of the electroluminescence of LEDs performed as function of the injection current visualized the nanoscopic nature of the blue-shift with increasing current: The growing contribution of high-energy emission due to the saturation of the electroluminescence from low-energy potential minima was observed.

A. Kavokin discussed polariton lasers based on GaN microcavities operating in a strong light–matter coupling regime. This is in contrast to Vertical Cavity Surface Emitting Lasers (VCSELs) that operate in a weak coupling regime. A strong exciton–photon coupling in a GaN cavity with a polariton Rabi splitting of 30 meV was demonstrated.

Only a few reports on UV laser diodes were presented. A flavor was given of the present status of lasers based on the quaternary AlInGaN quantum well system. The trend of emitting wavelengths is moving further into the UV range. Emission wavelengths from 365 to 480 nm were demonstrated. An

operating power of 0.2 W at room temperature was achieved. Several groups reported on highly efficient or deep-UV LEDs. In addition, great success in the white LED field in relation to the warm white color as well as the output power was achieved.

Also very fascinating is the progress on the high-speed and high-power electronic devices. This was demonstrated on Friday. High voltage RF operation of AlGaN/GaN power heterojunction FETs was demonstrated by M. Kuzuhara. A single FET chip at 30 GHz has an output power of 2.3 W (6.4 W/mm), a power-added efficiency of 38% and a linear gain of 8.8 dB. Field plate AlGaN/GaN High Electron Mobility Transistors (HEMTs) that achieved switching current densities of 900 A/cm^2 and 660 A/cm^2 at switching voltages of 200 V and 300 V, respectively, were demonstrated by Toshiba. In the invited talks of U. K. Mishra and N. Maeda, new designs of AlGaN/GaN diodes and transistors were presented.

The conference venue has a very pleasant surrounding and was convenient for participants. The open atmosphere enabled a lot of detailed discussions.

D. Hommel, from the University of Bremen, Germany, will organize the next conference in 2005.

The full Proceedings of ICNS-5 will be published in *physica status solidi (c) – conferences and critical reviews*, Vol. 0, No. 7 in November 2003. Conference papers will also be published in two forthcoming issues of *physica status solidi (b)* Vol. 240, No. 2 and *physica status solidi (a)* Vol. 200, No. 1.