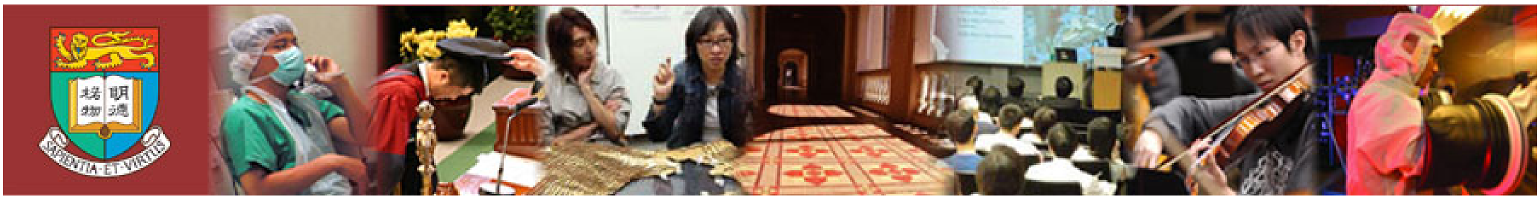

Title	Broadband emission from an ensemble of nano-pillars with multiple diameters
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depositon bath for ZnO doping. The doping could be tuned by changing their concentration in the bath and yielded to a bandgap narrowing. LEDs prepared with the doped nanowires exhibited low-threshold emission voltage and the single electroluminescence emission peak was shifted from ultraviolet to violet-blue spectral region compared to pure ZnO/GaN LEDs. The emission wavelength could be tuned by changing the Cd or Cu atomic concentration in the ZnO nanomaterial. The shift, due to the bandgap reduction, will be discussed, including insights from DFT computational investigations: the bandgap narrowing has two different origin for Zn1-xCdxdO and Zn1-xCuxO.

8641-63, Session 4

Broadband emission from an ensemble of nano-pillars with multiple diameters

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Generating white light from monochromatic light sources is commonly achieved via one of two common methods: exciting fluorescence phosphors from a shorter wavelength LED, or mixing light from three or more LED chips, commonly known as RGB LEDs. Phosphor efficiency degrade over time, and have lifetimes shorter than the chip itself. RGB LEDs require turning on three or more p-n junctions and suffer from color mixing issues. We introduce a promising approach towards achieving phosphor-free white light emission, tapping on strain engineering and nanoscale processing.

The proposed approach makes use of a long wavelength chip, which is invariably strained due to the high Indium content. By relaxing the built-in strain in a controllable manner, through the formation of dimension and site-controlled nano-pillars, the emission wavelength of individual pillars of varying sizes will blue-shift towards short wavelengths. The extent of blue-shift (strain relaxation) depends on a number of factors including dimension and lateral ion penetration.

Nano-pillars of a continuum of dimensions are patterned by nanosphere lithography, making use of a nanosphere colloid containing spheres with a wide range of diameters. The resultant structure contains an ensemble of nano-pillars each emitting a slighting different wavelength according to its dimension, producing a continuous broadband spectrum with FWHM of 72.23nm. With the right mix of nano-pillar dimensions, different shades of white light can be generated from a single array, representing a viable single-chip phosphor-free white light generating solution. Most importantly, the strain-relaxed nanostructures offer both high internal quantum efficiencies and light extraction efficiencies.

8641-22, Session 5

MOVPE-grown n-InxGa1-xN (x?0.5)/p-Si(111) template as a novel substrate *(Invited Paper)*

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After the finding of the low band-gap energy (~0.7 eV) for InN, InN-based nitride semiconductor alloys have had much attention as materials for a variety of optical and electronic devices. This is because a wide range of band-gaps, for example from 0.7 to 3.4eV for InGaN, can be realized by changing only composition of the alloys. The use of conductive Si substrates for InGaN growth as well as for GaN growth can expand the freedom of the device design, improve the device performance mainly due to the high thermal conductivity of Si, and reduce device costs. Furthermore, a low resistance ohmic contact predicted at the n-In0.45Ga0.55N/p-Si interface is another advantage for the n-InxGa1-xN (x~0.5)/p-Si system. This means that an n-InxGa1-xN (x~0.5)/p-Si template can serve as a unique substrate for a variety of optical and electronic devices. This paper reports the successful preparation of n-InGaN/p-Si structures by MOVPE. A thick (~0.5 ?m) InGaN with an intermediate In composition has been successfully grown at around 600ºC on Si(111) substrates using an AlN interlayer. No cracks are found in the InGaN layer because such a low growth temperature results in a small tensile stress in the epilayer. Ohmic I-V characteristics are obtained between n-InGaN and p-Si and the resistance is markedly decreased with increasing In content in InGaN. It is found that the presence of the AlN interlayer does not have a significant contribution to the series resistance.

8641-23, Session 5

Epitaxial growth of nonpolar ZnO and ZnxMg1-xO on LiAlO2 and MgO substrates *(Invited Paper)*

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Zinc oxide (ZnO) and magnesium oxide (MgO) are both II-VI compound semiconductors but possess different crystal structures, i.e. wurtzite for ZnO and rock-salt for MgO, in thermodynamic equilibrium. In addition, both ZnO and MgO can be substituted by each other to a great extent of ~40 % without losing their structural stability. The resultant ternary oxides have a great importance on bang gap engineering for optoelectronic applications. A thorough review on studies of epitaxial growth, defects and optical properties of nonpolar (10 -10) ZnO and Zn1-xMgxO epilayers on (100) gamma-LiAlO2 substrates by chemical vapor deposition is given. Basal stacking faults, threading dislocations and inversion domains were observed in the ZnO epilayer with densities on the order of 10-5 cm-2, 10-9 cm-2 and 10-4 cm-1, respectively. On the other hand, only basal stacking faults and threading dislocations were found in the Zn0.9Mg0.1O epilayers with densities of about an order of magnitude lower its ZnO counterpart. Monochromatic cathodoluminescence images revealed the non-radiative nature of the basal stacking faults. In addition, rock-salt Zn1-xMgxO epilayers with high substitutions of ZnO (50-80%) in MgO were obtained on the MgO (100) substrate by plasma-assisted molecular beam epitaxy. The epilayers are smooth and possess low FWHM values (0.30o-0.47o) of the (002) rocking curves. The bandgap energy of the Zn0.8Mg0.2O epitaxial layer is measured as low as 4.73 eV. The stability of the epilayer is also discussed.

8641-24, Session 5

Properties of bulk nitride substrates and epitaxial films for device fabrication *(Invited Paper)*

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The III-V nitride semiconductor material system continues to play a significant and growing role in a wide range of device technologies. The typical low intrinsic carrier density of this material system, leading to low leakage and low dark current, place it as one of the most promising material systems for the fabrication of photodetectors and high-temperature electronic devices.

Despite improved performance of devices fabricated on films deposited on foreign substrates, the properties of thin heteroepitaxial nitride films are still seriously limiting the performance of devices demanding higher material yields. The high growth temperature required to produce these wide bandgap materials exacerbates fundamental material problems such as residual stress, difference in thermal expansion coefficient, low energy defect formation and impurity incorporation. In addition, doping activation and self-compensation are difficult to control at the typically high deposition temperatures. Furthermore, the high concentration of dislocations, resulting mostly from lattice constant mismatch, typically on the order of 10E9 to 10E10 cm-2, must be reduced to improve device performance. Overcoming these limitations will require the use of native substrates to grow electronic grade homoepitaxial films.

AlN substrates grown by physical vapor transport and sublimation-