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TOWARDS HIGHLY EFFICIENT OPTOELECTRONICS AND ELECTRONICS UTILIZING STRAIN-RELAXED III-NITRIDES

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ABSTRACT

The invention of blue LED revolutionized the lighting and display industry owing to their high energy efficiency. The use of LEDs in displays has been limited to backlight units of LCDs, relying on yellow phosphors for conversion of blue light into white light followed by the use of color filters to produce RGB primary colors. This process has an efficiency of about 5%. Self-emissive light emitters like organic LEDs (OLEDs) have gained the status of the most premium displays on market currently due to their ability to produce high contrast images. However, these displays degrade over time due to their organic nature and are only about 20% efficient. Self-emissive inorganic micron-sized LEDs or micro-LEDs are considered the next in line display technology with theoretical efficiency limit of about 60%. The materials of choice for inorganic RGB micro-LEDs are Indium Gallium Nitride or InGaN for blue and green emission, and Aluminum Gallium Indium Phosphide or AlInGaP for red emission. For cost-efficient commercialization, these micro-LEDs much be scaled to dimensions below 10 microns. While InGaN based emitters can be scaled with minor efficiency degradation, AlInGaP based emitters suffer from drastic efficiency reduction with size scaling due to their inherent material properties. This has motivated the exploration of dimensionally scalable red emitting inorganic materials.

InGaN based materials can emit in the red regime with a higher indium content in the InGaN/GaN quantum wells. This quantum well structure is usually in a high strain state due to the 10% lattice mismatch between GaN and InN, thus, lowering the efficiency of InGaN based red emitters. We targeted the reduction of this strain using a flexible porous GaN based substrate technology and achieved device level demonstrations. In my talk, I will discuss the conceptualization, fabrication and optimization of the strain relaxed substrates followed by process optimizations which led to our demonstration of world's first <10 µm sized red LED with measurable efficiency. In the later part of my talk, I will discuss few challenging research problems in the areas of electronics and optoelectronics, broadly covering displays, bio-photonics, high frequency communications and power electronics. I will conclude my talk with potential pathways towards overcoming these hurdles.

BIO

Shubhra S Pasayat received her B.Tech. degree in Electronics and Electrical Communications Engineering from Indian Institute of Technology (IIT) Kharagpur in 2013 and worked at Samsung R&D Institute as a Senior Hardware Engineer till 2015. She joined University of California Santa Barbara (UCSB) in 2015 to pursue her master's and Ph.D. in Electrical and Computer Engineering. As a Graduate Student Researcher, she is currently working on ultrasmall (< 10 µm sized) InGaN based micro-LEDs emitting in yellow, orange, and red regime. She was awarded the Szilagyi Energy Breakthrough Fellowship by the Institute of Energy Efficiency at UCSB and Outstanding Graduate Student Researcher award by the Solid-State Lighting and Energy Electronics Center at UCSB for her research. Her current research interests include growth, fabrication, and characterization of III-N devices for electronics and optoelectronics as well as exploration of novel semiconductor materials.

DETAILS

Thursday, February 25, 2021 at 3:00 pm CST.

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