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TOPIC:
AlGaN Based Multiple Quantum Wells and their applications in Ultraviolet Emitters and Detectors

ABSTRACT:
AlGaN alloys have been studied extensively due to their use in ultraviolet optoelectronic devices, both emitters and detectors. While both UV light emitting diodes as well as solar blind photodetectors have been reported, their device performance requires improvement: UV LEDs based on AlGaN MQWs typically show poor external quantum efficiencies while UV detectors have limited speed and wavelength selectivity.

A major difficulty faced in the development of AlGaN based optoelectronic devices, especially for high AlN mole fraction, is the presence of complex alloy phenomena that leads to compositional inhomogeneities in these alloys. This is due to the difference in the surface mobility of the reactant species during the growth of these alloys, which leads to nanoscale variation of the alloy composition. This in turn causes a localization of free carriers, and affects the trapping and recombination properties. This effect is exacerbated in AlGaN based quantum wells.

In this talk we report on the growth of AlGaN based multiple quantum wells grown by plasma assisted Molecular Beam Epitaxy. The thickness of wells and barriers were 1.5nm and 2nm respectively. The effect of the growth kinetics on the optical properties of these quantum wells were determined by room and low temperature photoluminescence measurements. Our results indicate that the degree of carrier localization in AlGaN alloys can be controlled without affecting the overall alloy composition, thus tuning the optical properties to match the specific and distinct requirements of optical emitters and detectors.

MBE growth parameters were optimized to increase the internal quantum efficiency of these QW structures, in order to increase their suitability in development of UV LEDs. Photoconductive and MSM photodetectors were formed by photolithographic techniques using Ni/Au and Ti/Al/Ni/Au stacks. The photoconductive detectors exhibit a sharp peak at the 280- 300nm range showing increased sensitivity due to excitonic transitions.

PROFILE:

Anirban Bhattacharyya obtained his B. Sc. Degree in Physics and M. Sc. Degrees in Electronic Science from the University of Calcutta in 1993 and 1995 respectively. After spending a year at the Indian Association for the Cultivation of Science Calcutta as Junior Research Fellow, he joined the M. Tech. in Materials Science program at IIT Kanpur and obtained his degree in 1999. Subsequently he moved to the Wide Band-gap semiconductors Laboratory at Boston University (USA) for his doctoral research. He received his Ph. D. in electrical engineering from Boston University in 2005, working on the development of Ultraviolet Emitters based on the III-Nitrides materials under the supervision of Prof. Theodore D. Moustakas. He continued at the same Laboratory till 2009 working as a senior Research Associate on various aspects of growth of AlGaN alloys by the molecular beam Epitaxy technique.

In 2009, he joined the University of Calcutta as Assistant professor at the Institute of Radio Physics and Electronics. Recently, Dr Bhattacharyya has been involved with setting up of advanced semiconductor growth and fabrication facilities at the Center for Research in Nanoscience and Nanotechnology, University of Calcutta, where work on III-Nitride based optoelectronic devices have been initiated. Recent developments include the growth of AlGaN based quantum wells and fabrication of solar-blind MSM and photoconductive detectors.

Dr Bhattacharyya's research contributions have covered a wide range of topics in III-Nitride materials, from the fundamental aspects of the growth of thin films and nanostructures by MBE, efficient p-type doping techniques, to the development of ultraviolet light emitting diodes, detectors and optical modulators. Dr Bhattacharyya has a number of research publications in this field and in Nov. 2013, obtained an US Patent on "optical devices featuring nonpolar textured semiconductor layers". His other research interests include the physics of quantum optoelectronic devices, nanostructures, organic semiconductors, micro-electromechanical systems and micro-fluidics.

RESEARCH INTERESTS:

- *III-nitride Optical and electronic devices*
- *Molecular Beam Epitaxy of III Nitrides and SiGe Alloy phenomena: Ordering and Phase Separation*
- *Sol-gel processing of semiconductors*
- *Organic semiconductors and hybrid structures*

CURRENT FOCUS:

- *UV LEDs for white lighting and water purification*
- *Deep UV lasers*
- *Solar Blind Photodetectors*
- *Solar photovoltaics*
- *MEMS and Microfluidics for Lab-on-chip applications*