Optoelectronic Properties of In(Ga)N/GaN and In(Ga)As/GaAs Ultra-Thin Quantum Wells

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Microelectronics-Photonics

Microelectronics

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Background/Relevance

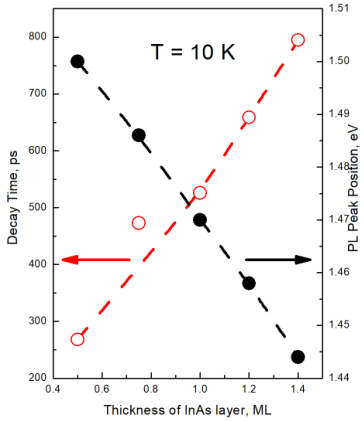
- Aluminum and Gallium Nitride (AlN/GaN) offer opportunity for UV emitters, detectors, quantum computing, solar energy systems.
- Wide band gap materials are also very important for high-power and high-frequency electronic devices.
- Ultra-thin InGaAs/GaAs single QW is crucial to understand as being a building block of novel IR photodetectors.

Innovation

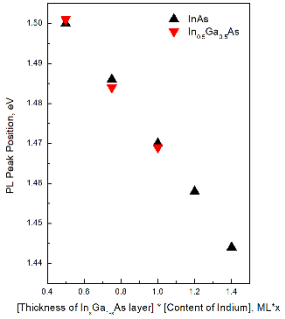
- Fabrication of short period InN/InAs is one possible way to form a material with novel 2D properties to meet these needs.
- We are currently successful at bringing new ideas to the growth, fabrication, and characterization of these novel materials.

Approach

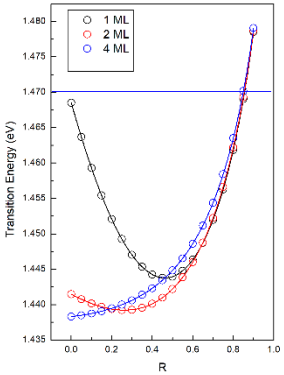
- InN/GaN multiple quantum well at different growth temperatures.
- TEM cross-section demonstrating high quality interfaces.
- Shown here: Photoluminescence is used to determine tunability.
- Shown here: Time-resolved PL measurements of sub-monolayer In(Ga)As/GaAs structures to demonstrate strong lifetime dependence on In content.



Key Results (on 2D Well)



We demonstrate that the wavelength for optical emission of the 2D well is tunable with high efficiency.



The transition energy of InGaAs QW vs. segregation coefficient supports a segregation mechanism of growth that allows tunability.

Conclusions

- The optimal growth temperature has been found by analyzing PL data which is equal to 580 C.
- The quantum well composition is determined to be InGaN instead of InN as was originally designed.
- We demonstrated the tunability of 2D wells which therefore can meet the intended applications

Future Work

- Perform TEM measurements on all samples in order to define the exact thickness and composition of InGaN layer.
- Perform full optical analysis of structures based on other materials.
- Investigate how some of the parameters of growth change optical characteristics of the sample.

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