Optical Properties of In(Ga)As/GaAs and In(Ga)N/GaN Ultrathin Quantum Wells

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Microelectronics-Photonics

Microelectronics

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Background/Relevance

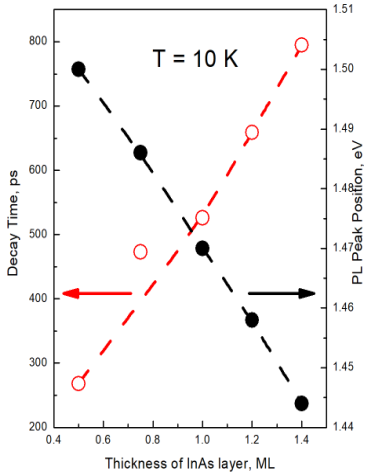
- Gallium Nitride (GaN) offers opportunity for UV emitters, detectors, quantum computing, solar energy systems.
- Wide band gap materials are also very important for high-power and high-frequency electronic devices.
- Ultrathin InGaAs/GaAs single QW is crucial to understand as being a building block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

Innovation

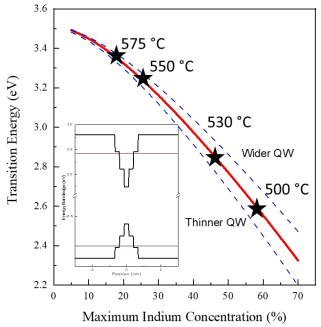
- Fabrication of short period In(Ga)As/GaAs and In(Ga)N/GaN is one possible way to form a material with novel 2D properties.
- We are currently successful at bringing new ideas to the growth, fabrication, and characterization of these novel materials.

Approach

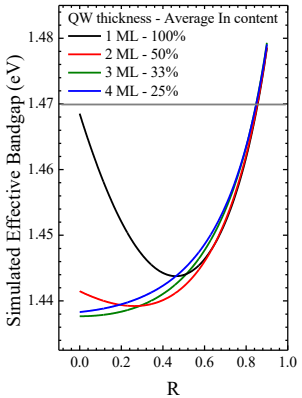
- InN/GaN multiple quantum well at different growth temperatures.
- TEM cross-section demonstrating high quality interfaces.
- Shown here: Photoluminescence is used to determine tunability.
- Shown here: Time-resolved PL measurements of sub-monolayer In(Ga)As/GaAs structures to demonstrate strong lifetime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



Key Results (on 2D Well)



The effective bandgap simulation of the triangular InN/GaN QW as a function of the content of indium in the maximum



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

Conclusions

- Vertical In/Ga intermixing plays crucial role in determining optical characteristics of ultrathin QW.
- Unique PL technique for determining the depth profile of indium has been established for In(Ga)As/GaAs QW.
- Growth temperature plays the major role in In/Ga intermixing process.
- Indium content profile can be effectively modified by controlling the thickness of the LT GaAs cap layer.
- Emission energy of In(Ga)N/GaN QWs can be controlled in range from 2.5 eV (496 nm) to 3.3 eV (376 nm) by increasing the growth temperature from 500 °C to 575 °C.

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