EEE3037 Nanotechnology Coursework

6420013

1 Quantum Engineering Design

1.1 Structure Design

In order to design a quantum well which emits light of wavelength 1.55μm, a well material must be chosen such that an interband electron transition emits photons of this wavelength.

This band gap energy can be found from the equation

$$E = hf$$

When considering photons, f can be substituted with

$$f = \frac{c}{\lambda}$$

In order to find the E in terms of wavelength

$$E = \frac{hc}{\lambda}$$

Returning to the specifications, this allows 1.55μm to be expressed as $1.28\text{x}10^{-19}$ J or approximately 0.8 eV.

This energy value will be the same as the total band gap for the well from the first hole energy level to the first electron enery level, shown as

$$\Sigma E_g = E_{1h} + E_g + E_{1e} \approx 0.8eV$$

see figure 1.

E_g should be the dominant term in this equation and as such in investigating suitable materials, the bulk band gap should be close to, but lower than 0.8eV.

None of the binary III-V Indium based alloys have bulk band gaps in a suitable range, as such ternary alloys were investigated.

Subsequently Indium Gallium Arsenide ($In_xGa_{(1-x)}As$) was identified as a viable well material candidate with an Indium Phosphide (InP) barrier material as this combination satisfied the two conditions of having a suitable bulk band gap and being lattice matched.

1.1.1 Band Gap

1.1.2 Lattice Matching

1.2 Probability Plot

1.3 Probability Intervals

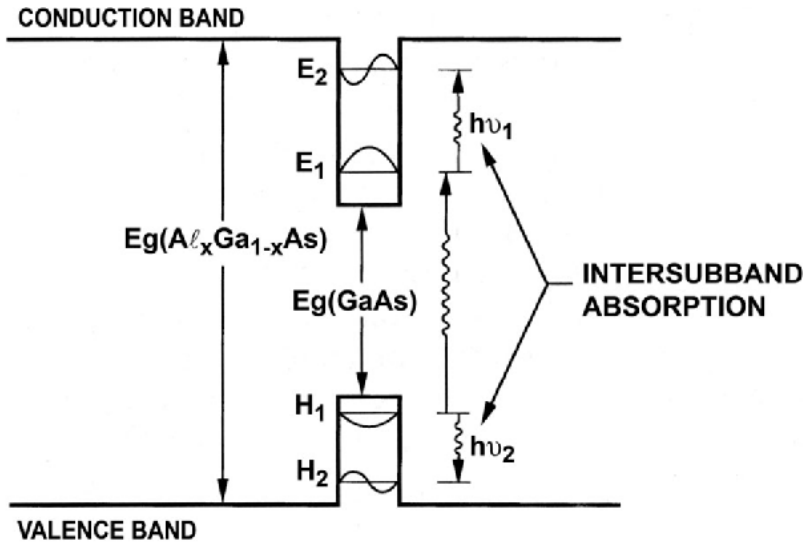

Figure 1: Band structure of an AlGaAs/GaAs/AlGaAs quantum well including discrete energy levels [1]

2 Application of Nanomaterials

References

[1] S. D. Gunapala, S. V. Bandara, J. K. Liu, J. M. Mumolo, S. B. Rafol, D. Z. Ting, A. Soibel, and C. Hill, "Quantum well infrared photodetector technology and applications", eng, *IEEE Journal of Selected Topics in Quantum Electronics*, vol. 20, no. 6, pp. 154,165, 2014-11, ISSN: 1077-260X.