Assignment 4

EE 698N, Advanced Semiconductor Physics
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1 Bandstructure of Quantum Dots

Consider an InAs quantum dot in shape of a box of dimensions $L \times L \times L$ embedded in a GaAs matrix. Assume the conduction band offset between InAs and GaAs to be infinite for this problem.

a) If an energy separation of $k_B T$ is needed in the conduction band to observe 3-dimensional confinement effects, what should the maximum box size be for seeing such effects at $T = 4$K and $T = 300$K ? Use all material parameters of InAs and GaAs.

b) Sketch the conduction band DOS, and their electron occupation at both temperatures.

c) What application can such small dots with large energy separations have? Find out the smallest dimensions of InAs dots embedded in GaAs that have been grown epitaxially. What are their shapes? How far off are they from your design?

2 Relaxation time Approximation

Cardona and Yu, Problems 5.1 & 5.2 on "Drifted Maxwell-Boltzmann Distributions". They are related, and will summarize the discussion in the class on the origins of scattering rates.

3 Longitudinal Acoustic (LA) Phonon Scattering

Cardona and Yu, Problem 5.3 on "Intravalley Scattering by LA Phonons". Compare the results with the expressions given in the handout.

4 Longitudinal Optical (LO) Phonon Scattering

Cardona and Yu, Problem 5.5 on "Rate of Scattering by LO Phonons for Electrons in a Parabolic Band". Compare the results with the expressions given in the handout.

5 Magnetotransport

Cardona and Yu, Problem 5.7 on "Hall Factor in the limit of Strong and Weak Magnetic Fields". You have to read up section 5.5 on Hall transport, which was not covered in class.