E1-07 Electrical behaviour of an undoped GaAs quantum well sandwiched between two asymmetric AlGaAs barriers

K K M N Gurusinghe, K Premaratne, K M S V Bandara
(*Dept. of Physics, Univ. of Peradeniya*)

The optimization of the design of Quantum Well Infrared Photo Detectors requires the knowledge of the processes that control the background dark current. In this work, a single quantum well structure was studied theoretically and experimentally taking thermionic and tunnelling processes into consideration.

The structure studied, was grown by Molecular Beam Epitaxy and consists of a 1ìm GaAs contact layer (doping density n=2 x 10^{18} cm^{-3}) grown on semi-insulating substrate followed by a 150Å $Al_{0.27}Ga_{0.73}$ As emitter barrier,a 40Å undoped GaAs quantum well, a 500Å $Al_{0.27}Ga_{0.73}As$ collector barrier. The other GaAs contact layer was 0.5ìm and n=2 x 10^{18} cm^{-3}. Mesas of 200ìm diameter, produced by chemical etching, were used in the measurements.

The Current - Voltage measurements under dark condition were carried out using a Closed Cycle Refrigerator setup for different temperatures from 14 to 120 K. The density of states of electron in the well was calculated theoretically using the known parameters of the structure. In this calculation the resonant current from the emitter was assumed to be equal to the field emission current from the quantum well. The total current through the sample was taken to be the sum of resonant and non-resonant currents through the thin emitter barrier.

Agreement between theory and experiment indicates that the carrier transport process through the quantum well structure is due to the combined effects of resonant tunnelling, non-resonant tunnelling and thermionic emission.

This theoretical model predicts the variation of electron density in the well with the applied voltage as well as with the temperature. This information is needed in the design and optimization of Quantum Well Infrared Photo Detectors.