E1-01: Effect of the first barrier thickness on resonance tunnelling in single quantum well infrared photo detectors

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To understand the nature of resonance tunnelling in double barrier/single quantum well (QW) structures, we investigated the current generation mechanisms of such structures. Since we were interested only in the resonance current from the emitter contact to the quantum well, the second barrier thickness was made to be large in order to stop the resonance tunnelling from the quantum well to the collector contact.

In this work we investigated the current-voltage characteristics at 77 K for 3 structures with emitter barrier thicknesses 100 Å, 150 Å and 200 Å of $Al_{0.27}Ga_{0.73}$ As a 40Å thick GaAs QW and 500 Å thick $Al_{0.27}Ga_{0.73}As$ collector barrier and the whole structure was sandwiched between 2 doped ($n=1.4x10^{18}$ cm^{-3})GaAs layers.

This work shows that our theoretical model provides a good agreement between the theoretically calculated and measured current-voltage relations for several orders of magnitude in current, for the sample with 150 Å thick emitter. We present here the theoretically calculated current-voltage relations for the other structures also. The theoretical model consists of resonance current obtained from the Transfer Hamiltonian technique of resonance tunnelling, non-resonance current from the emitter contact and thermally assisted field emission current from the QW.

Our results show that the total current and the electron accumulation in the QW increase with decreasing emitter thickness. Even though this effect enhances the performance of infrared detectors based on such structures, the parallel increase in the dark current will cause an increase in the noise level.