Electron Lifetime Measurement in Stepped Quantum Wells for Far Infrared Lasers

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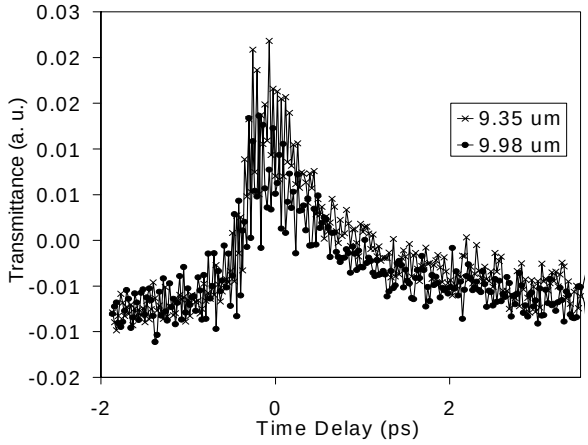
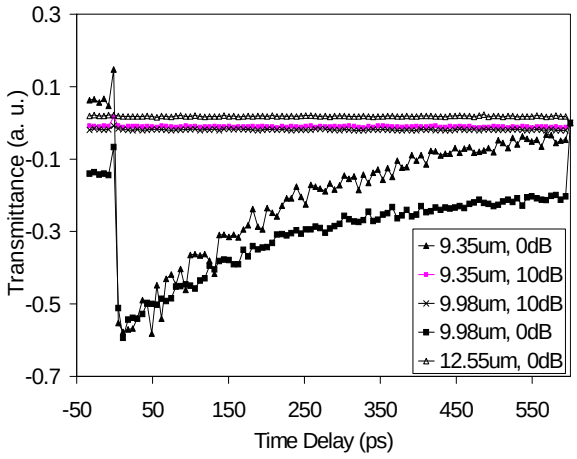
A theoretical study shows that electron population inversion can be realised by optically pumping an asymmetric quantum well (QW) by elegantly designing the subbands. In our previous work, we proposed a three-level system using multiple stepped QWs and a four-level system using multiple coupling QWs to work in the range 40 – 300 μm as an analogue of a far infrared (FIR) gas laser and a Nd^{3+}:YAG laser systems. Research has shown that the gain could be significantly reduced due to hot electron phonon emission and inhomogeneous broadening induced during the QW growth.

In this work we have measured the infrared absorption spectra and electron lifetime of two samples containing multiple stepped QWs to provide information of hot electron intersubband transitions and inhomogeneous broadening. An FTIR spectrophotometer was used to measure the spectral absorption and a short pulsed free electron laser was used to pump-probe the electron lifetime in the lasing subbands, in the temperature range 6 – 300 K.





A short lifetime of 0.7 ps (Figure on the left) was measured at 4 K with very high pump power. An anonymously long decay (Figure on the right) was also observed following the short decay at high pump powers. A coherent phenomenon was also seen which was closely associated with pumping intensity. These could have side-effects on the action of a far infrared QW laser. Further data analysis and interpretation are still under way.