Far InfraRed Modulated Photoluminescence in InSb quantum dots

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The first FIRM-PL and ODCR measurements in InSb/GaSb quantum dots have been performed, using the FIR free electron laser FELIX. Measurements have been made of the influence of Far Infrared (FIR) radiation on the luminescence from InSb self assembled quantum dots grown in a matrix of GaSb. The FIR absorption induces transitions between the quantum dot energy levels which then influences the PL emission. At low FIR power densities the excitation promotes exchange between the different dot levels via the wetting layer and hence improves the thermalisation of the dot population. This effectively cools the system, leading to an increase in the population of large, low energy dots, an increase in the PL intensity and a shift down in emission energy (Fig. 1). At higher FIR powers the carriers eventually become heated and the PL intensity falls as the full range of dot states becomes populated. The spectral dependence of the FIRM-PL signal measures the energy spectrum of the full quantum dot distribution. This shows that in the high power limit there is a peak in the FIR response at 14.5 meV (Fig. 2), corresponding to the excitations between the first two confined states of the quantum dot energies. This agrees well with the confinement energies deduced from the magnetic field dependence of the transition energies. ODCR measurements in magnetic field show two features, the first corresponding to a light hole cyclotron resonance in the bulk GaSb which is observed for the quantum dot PL and the second corresponding to an internal transition in the acceptor bound exciton complex BE4.

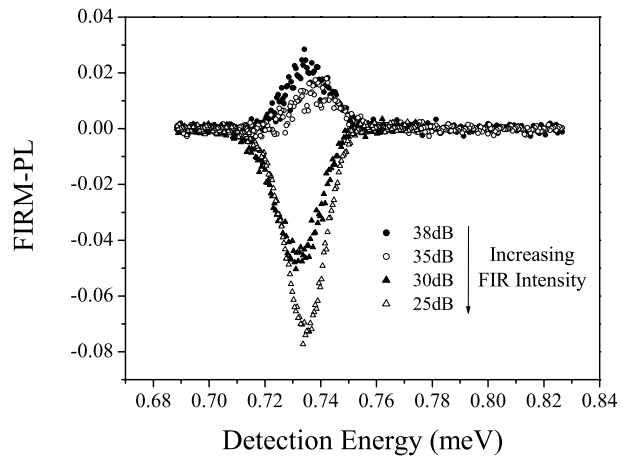

Fig. 1. The Modulated PL response (change in PL intensity produced by FIR illumination) from the quantum dots showing an enhancement of the PL intensity at low FIR Intensity which switches over to a suppression for high FIR intensity. The transition energy is shifted to higher values at larger FIR intensity, which causes the differential form of the lineshape for some illumination intensities.

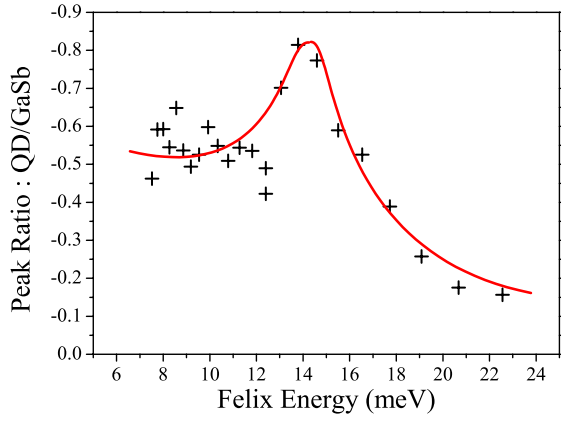

Fig.2: FIRM-PL response as a function of FIR energy showing the peak in response corresponding to the intra-dot excitation.