Photomodulation Spectroscopy in Multiple Quantum Wells

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The electronic levels of multi quantum wells structures such as GaAs/GaAlAs, are usually studied by optical transitions between the conduction and the valence bands[1]. Recently large optical absorption strength associated with an electronic transition between the ground state (e1) and the first excited state (e2) in n-doped multi quantum wells has been reported by several authors[2]. In all these experiments the conduction band electron quantum well levels are partially filled, thus allowing the observation of infrared transitions polarized with the ligth electrical field, E, parallel to the multi quantum wells growth direction (z axis).

In this work we report the first observation of direct, IR intersuband photoinduced absorption (PA) by photogenerated free excitons, in an undoped GaAs/GaAlAs MQW structure[3]. Electrons and holes were optically created, in undoped multi quantum wells, forming ground state excitons (e1:hh1). In spite of the short exciton lifetime, the infrared transition between the (e1:hh1) and the first excited excitonic state (e2:hh1) was observed. These excitons are associated, respectively, with an electron in either the e1 or the e2 conduction subbands and the heavy hole lowest subband, hh1. The assignment is based on polarization measurements and on a comparison with the energies of the electron and hole subbands as measured by photoluminescence excitation. A consistent energy level scheme is obtained and the model calculations provide the quantum well parameters. The oscilator strength of the PA is found to be $\simeq 25$ times stronger than the corresponding absorption by bare electrons in doped quantum wells[2]. Recent theoretical calculations of the oscilator strength of interband excitonic absorption in quasi-two dimensional QW (i.e. free motion in the x–y plane and confinement in the z direction) showed that it is greatly enhanced due to the large coherence area of the exciton[4]. Using the experimental oscilator strength we estimate the exciton coherence length to be ~ 5 exciton radii, or $\sim 250\mathring{A}$.

References

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