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Matthias Schwab

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M. Schwab, Summary:

Exciton Dynamics in Semiconductor Quantum dot Structures

This thesis presents results of time resolved measurements done on Quantum Dot Molecules (QDMs) and Quantum Dots (QD). Different techniques were used, like four-wave mixing (FWM) to measure the dephasing time of coupled QDs as a function of the barrier thickness and time resolved photoluminescence to measure the radiative decay time. The results are briefly summarized here: Dephasing measurements on quantum dot molecules have revealed a pronounced pure dephasing channel for quantum dot molecule excitons. In FWM experiments and time resolved photoluminescence a smooth dependence of various quantities on the barrier dependence has been found: The radiative lifetime T_1 as well as the dephasing time T_2 show a decrease with the barrier width d. The linewidth γ, obtained for QDMs by fitting the first part of the long decay and the weight of the zero phonon line (ZPL) increase with smaller barrier widths. Interpretations of this behaviour could be given, assuming an increase of the molecule coupling and a coherence volume that doubles when going from QDs to molecules. By a combination of both measurement types the pure dephasing rate was extracted by $1/T^*_2=1/T_2 - 1/2T_1$. The same trend has been observed for the pure dephasing as the lifetime and the dephasing as a function of the barrier thickness had shown. A strong influence for the pure dephasing is given by the dephasing time T_2. An increase at a barrier width of 4 nm to 6.7 (normalized to the QD sample) corresponding to 730 ps has been found for the pure dephasing.

Moreover, experiments on the influence of external fields gave new insight to manipulation of radiative processes in quantum dots. Creating *p*- and *n*-doped regions around an intrinsic QD area made the application of lateral electric fields possible. Under carefully adjusted conditions, electron and hole in the intrinsic QDs can be separated spatially by applying an external voltage to the devices. Measuring the radiative lifetime showed up the possibility to significantly change the electron-hole recombination processes. Asymmetries due to a build-in field were overcome by using *n-i-n*-devices instead of *p-i-n*-devices. Leakage currents and a resulting onset of electroluminescence give upper limits to this method. Application of magnetic fields in Faraday configuration was a second way of influencing the recombination probability in QDs by magnetic confinement effects. As the relative confinement due to a magnetic field depends strongly on the QD confinement, annealing plays a major role here. A magnetic field gives an initial increase of the lifetime with increasing B-field due to a higher confinement at low fields. Experimentally the lifetime-increase has been observed only up to a certain magnetic field. A vertical redistribution of the wavefunction may be the origin of an increased overlap of electron and hole wavefunction, which may rule the recombination for higher magnetic field strengths and results in a faster recombination.

In addition to tuneable external fields the influence of an increased light field on the spontaneous emission was measured by embedding QDs in a micropillar resonator and in a photonic crystal defect. For Fabry-Perot type microcavites the pillar-size dependencies of the mode structure and lifetimes have been observed for a number of cavity modes. Origins of non-exponential decays were addressed and compared to new model calculations on
these systems, revealing a fundamental dependence on the number and distribution of QDs inside the pillar structure. Measurements on photonic crystals have been discussed, showing reasonable Q-factors at small mode volumes and therefore high Purcell factors.