Abstract of Ph.D. thesis of Tomasz Jakubczyk
„Effects of photonic confinement on the emission from CdTe quantum dots”

The thesis describes phenomena related to the control of the spontaneous emission from excitons in CdTe/ZnTe quantum dots (QDs). It describes development of ZnTe-based planar and micropillar cavities followed by the demonstration of modification of various aspects of QDs spontaneous emission.

In the first step basic optical properties of the microcavities were investigated. The experiments were conducted on structures with a large spectral density of quantum dot emission lines in the range of energies close to the energies of photonic modes. Thus, QDs acted as probes for the photonic characteristics of the structures. We determined energy of microcavity modes together with their Q-factors. We performed mode mapping of micropillar cavities and measured angular distribution of the emission originating from planar microcavity.

In further experiments micropillars with single QDs emission lines in the vicinity of the fundamental modes were investigated. The method of tuning the energy difference between an excitonic state and a cavity mode by a variation of the temperature of the sample was used. In the step we measured the intensity of emission related to quantum dot and cavity mode. This experiment shoed, that the emission from the mode is funneled from the emission of spectraly closest QD transition. In the next experiment we investigated time-resolved photoluminescence of the system. We measured the decay time of QDs placed inside micropillars for varied cavity mode - QD detuning. Additionally, we measeured decay time for QDs embedded in standard semiconductor matrix. This demonstrated enhancement of the decay rate of spontaneous emission from the micropillars if the emission is resonant. an Purcell-factor above 5 was demonstrated, in agreement with the model simulations

Next topic covered by the thesis is related to the development of the micropillars with an enhanced radial confinement. This project was realized in collaboration with the University of Leipzig, where an additional radial Bragg reflector was deposited on the micropillars. In the obtained structures we observed decrease of spontaneous emission rate of QDs detunde from the cavity mode by factor more than~3. This demonstrates, that the coupling of QD emission into the undesired continuum of radial decay channels has been successfully decreased.

Finally, the last part of the thesis describes the development of epitaxial growth of ZnTe-based nanostructures on GaSb substrates. A series of samples with both quantum wells and distributed Bragg reflectors were grown by the molecular beam epitaxy. The photoluminescence and reflectivity of samples was characterized. The crystal quality and lattice constant was measured using High Resolution X-ray diffraction.