Impact of Disorder on Properties of CdTe-Based Strongly Coupled Quantum Well – Microcavity System: Temperature Dependence

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Exciton-polaritons are quasiparticles created by a strong coupling between photonic and excitonic modes in semiconductor microcavities. Their bosonic nature cause them to condenstate in temperatures higher than of atomic Bose-Einstein condensates, which makes them good candidates for both, the fundamental studies of complex and fascinating multiparticle physics by using the common tools of semiconductor spectroscopy, and the application in, for instance new coherent light sources and optical devices such as optically controlled polariton based transistors and logic gates [1]. One of the most critical issues is the fabrication of high-quality quantum well in a microcavity structures allowing for the condensate formation without the influence of additional static potential which could affect or prevent it. On the other hand, disorder can trigger interesting physics of polariton condensates, shaping their behavior in the "non-flat" potential environment. Thus, understandably, a lot of attention must be paid to characterize the naturally disordered samples. Future applications push scientist to development of high temperature research in the field of exciton-polariton observation in samples with the disorder.

We investigated a sample grown by molecular beam epitaxy growth, consisting of a λ cavity with three CdTe quantum wells enclosed between two Bragg mirrors build from altering of $Cd_{0.45}Zn_{0.05}Mg_{0.50}Te$ and $Cd_{0.83}Zn_{0.09}Mg_{0.08}Te$ layers of low and high refarcive indices, respectively [2]. Strong coupling between the excitonic and photonic modes was confirmed in k-space imagining of the photoluminescence dispersion. To make observation of high emission angles (high-k values) possible, the sample was mounted on a sloped cold-finger holder to overcome the NA limits of the optical system.

We performed power dependent emission measurements at different exciton-photon detunings to find parameters for polariton lasing under fs pulsed excitation, tuned to a reflectivity minimum of the microcavity. We obtained images of photoluminescence in real space, k-space and real space versus energy (wavelength). The study of disorder was performed by scanning the spectral and spatial distribution of the luminescence with a single micrometer resolution in the linear regime (below the lasing threshold). It was measured under optical pumping with 640 nm continuous-wave diode laser at temperatures from 10 K up to 120 K. Analysis of the obtained data allowed to derive the charactristics of temperature-induced delocalization and spectral distribution statistical properties. The temperature-dependent spectral shifts of the exciton and photon modes were taken into account. Finally, we present the dispersion ralations images which also reflect the varying importance of disorder in the structure at difrerent temperatures.

[1] E. Cancellieri et al., Phys. Rev. B 92, 174528 (2015).
[2] J.-G. Rousset et al., Appl. Phys. Lett. 107, 201109 (2015).