Room temperature polariton lasing in a ZnTe based microcavity containing a single CdSe/(Cd,Mg)Se quantum well

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Exciton-polariton condensates exhibit several unique features motivating researchers to develop new microcavity systems. One of the most important observations in this field was a polariton lasing achieved under either optical or electrical pumping. Reports on polariton lasing at room temperature, which is a prerequisite for device implementations are, however, still limited to UV and blue spectral range. They concentrate on GaN, ZnO and ZnSe based structures, where exciton binding energy is much higher than in semiconductors with moderate band gaps.

In this work, we report on a room temperature polariton lasing in red spectral range. It is achieved under optical pumping in a new microcavity system with a CdSe quantum well (QW). Studied structures contain a single ($Cd_{0.8}$,$Mg_{0.2}$)Se $\lambda/2$-microcavity embedded between Distributed Bragg Reflectors (DBR). The DBRs are constituted by ZnTe layers and short period superlattices MgSe|ZnTe|MgTe|ZnTe. A 10 nm thick CdSe QW is placed inside the microcavity with Q over 3700 (determined at T = 7 K). The DBRs, and both the CdSe QW and (Cd,Mg)Se are almost lattice matched to ZnTe, which enables pseudomorphic growth mode, without relaxation. The sample does not exhibit degradation when exposed to the ambient atmosphere, despite a relatively high Mg content in the DBRs and barriers. The micro-photoluminescence is excited at 300 K or 10 K using a femtosecond laser (λ_{exc} = 580 nm).

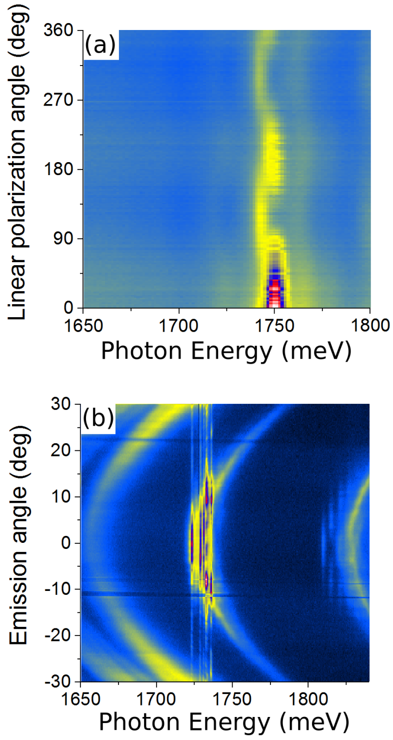

Figure 1: μ-Photoluminescence spectra as a function of a) linear polarization angle and b) emission angle.

The emission intensity *vs* the excitation power reveals a complex dependence including two lasing thresholds. The lower one is attributed to the polariton lasing characteristic for the strong coupling regime, due to the observed emission blueshift and narrowing being the signature of massive occupation of the lowest energy polariton states. The higher threshold is associated with the photon lasing, when the conditions of strong coupling vanish due to a heating of the sample and the increase of carrier concentration. The threshold powers at 300 K are about 42 kW/cm^2 for polariton lasing and about 707 kW/cm^2 for photon lasing. The thresholds decrease with the temperature, attaining respectively 7 kW/cm^2 and 28 W/cm^2 for 10 K. Expected linear polarization of the polariton lasing (Figure 1a) is observed. Momentum space measurements reveal a quantization of energy levels from which the lasing occurs (Figure 1b), which suggests that local traps might be responsible for spontaneous condensation of polaritons triggering the lasing action.

The presented new type of structure enabling the polariton lasing at room temperature provides new perspectives into the both fundamental studies and applications.