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Multiple non-equilibrium condensates of semimagnetic exciton-polaritons in localized potential minima in magnetic field

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There is an increasing interest in the study of exciton-polaritons in semiconductor microcavities over the last years. It was caused by the observation of non-equilibrium Bose-Einstein condensation [1] and polariton lasing [2] in these structures. Exciton-polaritons, the mixed exciton – photon quasi-particles, have a very low effective mass, which allows them to localize in micrometer size traps. Structures that allow reducing spatial dimensions of exciton-polaritons to low-dimensional systems (zero and one-dimensional) play a significant role due to the increased nonlinear phenomena and lower condensation threshold for polariton condensation [3].

In our work we present spatial emission maps and spectrally resolved momentum-space images of the multiple polariton condensates in a localized potential minima. We focus on magnetic field dependence of the condensation threshold and energy distribution in these localized traps.

Our structure contains four semimagnetic quantum wells (QWs) with 0.5% of manganese, placed between two non-magnetic Distributed Bragg Reflectors [4, 5]. The incorporation of manganese in QWs leads to the increased magnetic effects due to the *s*,*p*-*d* exchange interaction between localized electrons of the d^5 shell of Mn^{2+} and band electrons [6]. By using a confocal microscope with built in magnet up to 9 T we scanned a large area of a sample surface and detected angularly resolved photoluminescence spectra for different positions on the sample.

The emission maps below and above the condensation threshold are illustrated in the Figure 1. For small pumping power in zero magnetic field we observe incoherent emission distributed over a large area, revealing the photonic potential landscape of our structure. With increasing the excitation power, we observe the accumulation of polaritons in localized potential minima. However, at very high excitations the condensate becomes multimode with number of localized states of different energies. The condensation is also induced by the external magnetic field. The threshold for the condensation in localized minima is reduced in magnetic field and polaritons start to condense in potential traps even though the excitation power is constant. The energy red-shift induced by magnetic field and the energy blue-shift due to the polariton-polariton interaction lead to the non-trivial energy behavior. We have observed that with increasing magnetic field two separate condensates can merge into one overlapped mode and the inverse process is also possible, where one condensate separates into two.

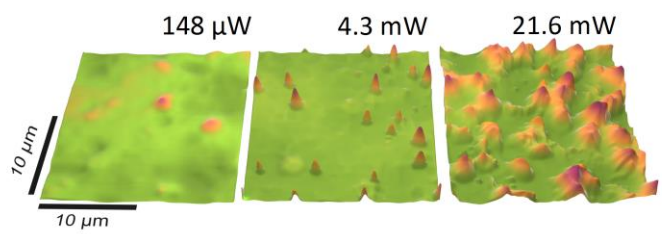

Figure 1. Energy-integrated real space distribution of exciton-polariton emission with increasing excitation power.

[1] J. Kasprzak et al. Nature 443, 409 (2006) **[2]** R. Balili et al., Science 316, 1007 (2007) **[3]** T. K. Paraiso et al., Phys. Rev. B 79, 045319 (2009) **[4]** J.-G. Rousset et al., J. Cryst. Growth 378, 266 (2013) **[5]** J. G. Rousset et al., Appl. Phys. Lett. 107, 201109 (2015) **[6]** J. A. Gaj, R. Planel, G. Fishman, Solid State Commun. 29, 435 (1979).

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