Spin polarization of semimagnetic exciton-polariton condensates in semiconductor microcavities

M. Król[1], R. Mirek[1], K. Lekenta[1], J.-G. Rousset[1], M. Matuszewski[2], M. Nawrocki[1], W. Pacuski[1], J. Szczytko[1], B. Piętka[1]

[1] *Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Poland*

[2] *Institute of Physics, Polish Academy of Sciences, Warsaw, Poland*

Exciton-polaritons attracted a significant attention over the last years, leading to the observation of such phenomena like non-equilibrium Bose-Einstein condensation [1] or polariton lasing [2]. The investigation on the effect of magnetic field on exciton-polariton coherent phenomena is still at an early stage, even though many interesting phenomena such as the spin Meissner [3] or magnetopolaron [4] effects were predicted.

The influence of magnetic field on polariton properties can be increased by the use of semimagnetic semiconductors [5,6]. In these materials s,p-d exchange interactions between localized d-shell electrons of the magnetic ions and the s-shell electrons and p-shell holes leads to magneto-optical effects such as giant Faraday rotation [7] or giant Zeeman splitting. In Ref. [8] we demonstrated the giant Zeeman splitting of exciton-polaritons in the microcavity where manganese magnetic ions were present in the quantum wells, affecting the excitonic contribution in the polariton state.

With increasing excitation power of a non-resonant pulsed laser we exceed the linear regime of polariton-polariton interactions and observe the manifestation of non-equilibrium polariton condensation as nonlinear increase of the emission intensity, energy blue-shift, line narrowing and buildup of linear polarization, in agreement with previous works performed on non-magnetic structures [1]. Conditions at which the condensate is formed are strongly dependent on the magnetic field and we demonstrate that the threshold power is reduced in applied external magnetic field.

Magnetic field induces also a strong imbalance between spin-up and spin-down polaritons by introducing energy splitting between polarized polariton subsystems. This affects polarization of light emitted from the condensate. Initial linear polarization of the condensate changes through elliptical up to almost circular σ+ polarization. The build up of a circular polarization degree of the condensate is however much weaker than that expected for the semi-magnetic exciton-polaritons, where the giant Zeeman splitting leads to the separation of the two spin-component of lower polariton branch already at the magnetic field as low as 1 T. The observed increase of the degree of circular polarization in magnetic field is however faster for higher polariton concentration due to the bosonic stimulation.

Our experimental observations demonstrate the existence of single-frequency elliptically polarized non-equilibrium polariton condensate in magnetic field. This opens a new field in the studies of exciton-polariton spinor condensates, where the magnetic interactions play a crucial role.

References

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