

Polariton laser in micropillar cavities

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Semiconductor microcavities in the strong coupling regime have been the subject of intensive research efforts these last years. In this system, the eigenstates are exciton-photon entangled states (named cavity polaritons). Polaritons present strong non-linearities due to their excitonic part and obey to bosonic statistics, thus being able to massively occupy a single quantum state (quantum degeneracy).

We address here the physics of cavity polaritons confined in micron-sized micropillars. The photon lateral confinement defines a discrete spectrum of polariton states with an increasing energy separation as the pillar size is reduced. Low temperature photoluminescence measurements are performed on single micropillars. A marked threshold is observed in the excitation power above which a very large polariton population accumulates in the ground state (more than 1000 polaritons in the same quantum state). Spectral narrowing in the emission is the signature for the onset of coherence. A detailed analysis allows concluding that the observed features are due to polariton lasing and not to Bose Einstein condensation.

The advantages of micropillar cavities with a discrete polariton spectrum as compared to the quasi-continuum of a 2D cavity will be discussed.

At higher excitation powers, the strong coupling regime is bleached and the system behaves as a standard photon laser (VCSEL). The present zero-dimensional system thus offers the possibility to study both regimes, polariton lasing and photon lasing, in the very same device. The threshold for polariton lasing is found to be two orders of magnitude smaller than the threshold for photon lasing. Polariton lasers could potentially provide ultra low threshold sources of coherent light.

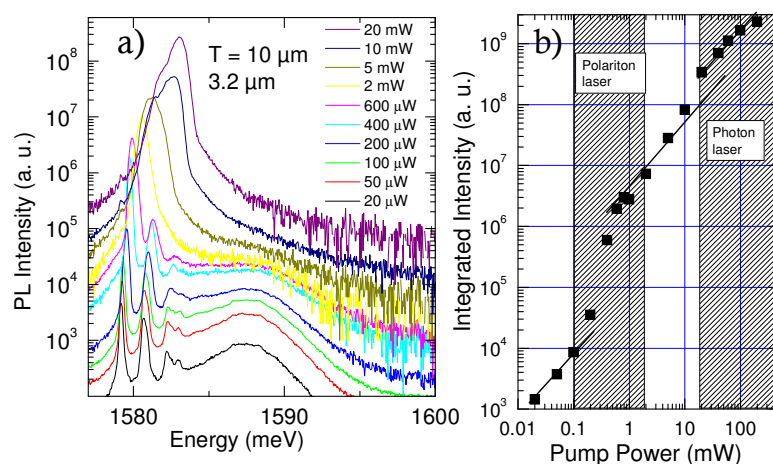


Fig: a) Emission spectra measured under non resonant excitation on a $3.2 \mu\text{m}$ micropillar; b) Integrated intensity measured on the lower energy mode as a function of the excitation power. Shaded areas indicate the excitation range for polariton lasing and for photon lasing.

“Polariton laser using single micropillar GaAs-GaAlAs semiconductor cavities”, D. Bajoni, P. Senellart, E. Wertz, I. Sagnes, A. Miard, A. Lemaître, and J. Bloch, Phys. Rev. Lett. 100, 047401 (2008)