Lifetime control of GaAs quantum dots by photonic crystal microcavities

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Abstract

We fabricated photonic crystal slab microcavities embedded with GaAs quantum dots by electron beam lithography and droplet epitaxy. The Purcell effect of exciton emission of the quantum dots was confirmed by micro-photoluminescence and lifetime measurements.

Increased quality factors of photonic crystal (PC) microcavities and their small mode volumes enabled us to realize strong coupling between the resonance cavity modes and light emitters. Yoshie et al. actually showed the vacuum Rabi splitting of a single InAs quantum dots (QDs) embedded in a PC microcavity [1]. Here we fabricated GaAs QDs by our droplet epitaxy technique [2] and embedded them in PC microcavities. Because the emission wavelength of GaAs QDs is much shorter than InAs QDs, the lattice constant of our specimen was decreased down to about 200 nm. We observed both acceleration of radiative carrier recombination by the Purcell effect and its suppression by the presence of photonic band gaps [3]. To our knowledge, our PC microcavities have the smallest lattice constants that realized the control of the radiative recombination rate.

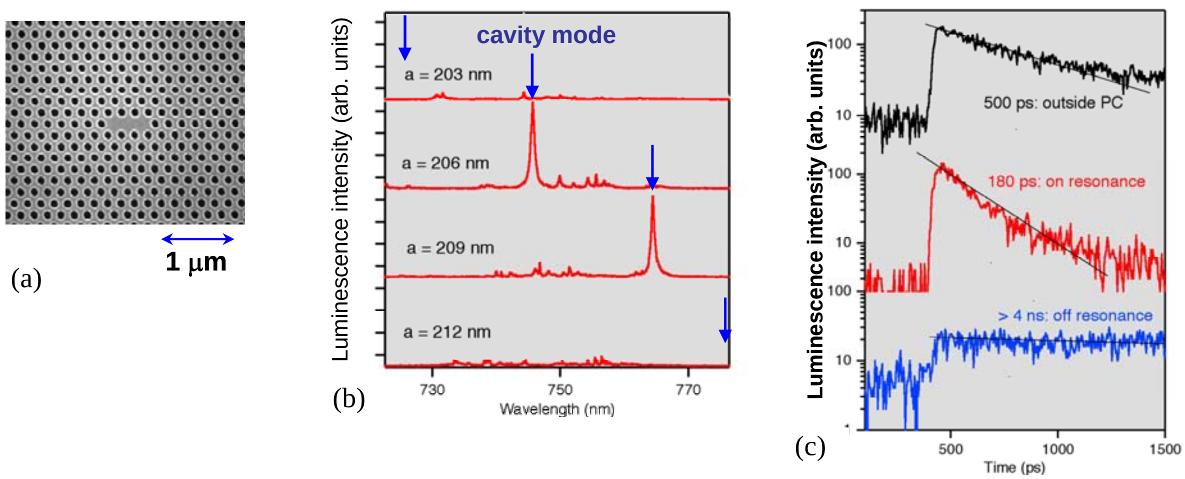

Fig. 1 (a) SEM image of the PC slab microcavity with a lattice constant of approximately 200 nm, (b) photoluminescence spectra of GaAs quantum dots embedded in PC microcavities with four different lattice constants, and (c) photoluminescence lifetime GaAs quantum dots outside the PC structure (black), on resonance of the cavity mode (red), and off resonance of the cavity mode (blue).

References

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