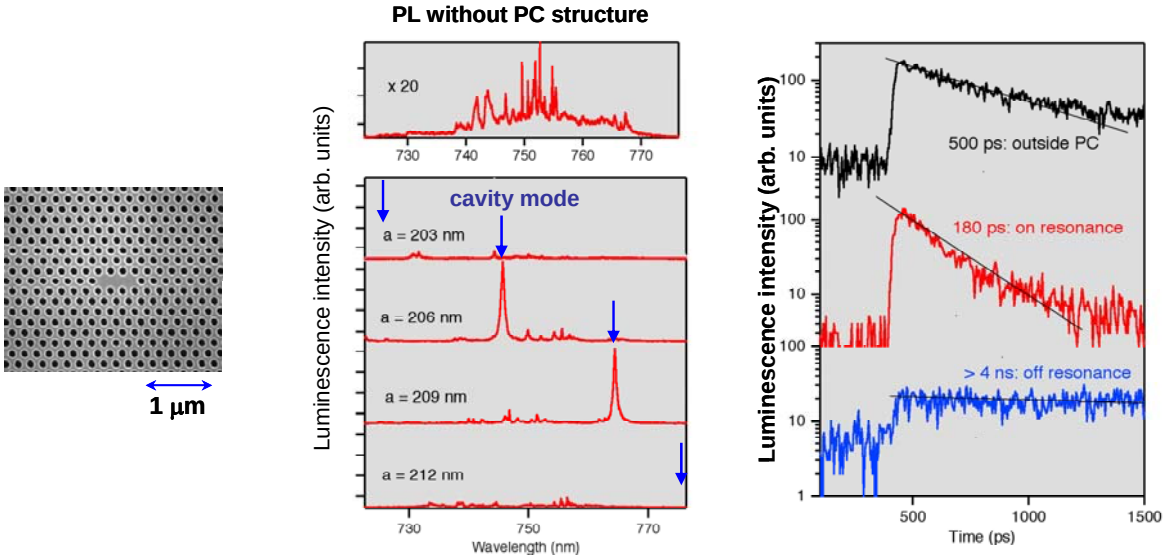
Purcell Effect of GaAs Quantum Dots

Nanophotonics Group aims at realization of effective interaction between two remote quantum dots and their two-qubit operation via photons in photonic crystal micro cavities and waveguides. For this purpose, it is extremely important from the experimental point of view to detect photons as efficiently as possible. Thus the usage of silicon photo detectors of high sensitivity is desirable, so we need light emitters in visible or near infrared frequencies. Therefore we use GaAs quantum dots for light emitters, and developed photonic crystal micro cavities for them in collaboration with Tsukuba University, NEC, and Nanotechnology Innovation Center of NIMS.

We fabricated photonic crystal micro cavities with a lattice constant of about 200 nm embedded with GaAs quantum dots made by the droplet epitaxy, and observed the shift of their resonance wavelength as a function of the lattice constant. Then we measured the emission lifetime of single quantum dots by micro photoluminescence technique and verified suppression of spontaneous emission of photons by the photonic band gap (blue line in the right panel of the figure) and its acceleration by the Purcell effect (red line in the right panel of the figure). (The black line shows the genuine decay of emission in the absence of the photonic crystal structure.)



(Left) SEM image of a photonic crystal micro cavity embedded with GaAs quantum dots, (middle) shift of resonance wavelength as a function of the lattice constant, a, and (right) suppression and acceleration of spontaneous emission. T. Kuroda et al., Appl. Phys. Lett. **93**, 111103 (2008).