Integration of single site-controlled InAs quanum dots, fabricated by nanoimprint lithography and molecular beam epitaxy, into optical micropillar cavities

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Single, coherently strained InAs quantum dots (QDs) are promising candidates for building blocks in novel information processing applications. The optical properties of QDs, e.g. the widely tunable wavelength range, the narrow emission linewidth, the ability to emit single photons on demand and the tuning of carrier spins in QDs show great promises for novel devices. In order to use the advantageous optical opportunities for single QD devices it would be beneficial to have control over the lateral position of individual QDs. This can be achieved by defining the nucleation sites by patterning substrates prior the QD deposition.

Here we present our recent developments in deterministic integration of single site-controlled InAs QDs into optical micropillar cavities (inset in Fig. 1(b)). We used a combination of UV-nanoimprint lithography (NIL) and molecular beam epitaxy (MBE) for creating large arrays of widely spaced QDs [1-3]. Figure 1(a) shows a scanning electron microscopy (SEM) image of single site-controlled QDs with a period of 2.5 µm. Figure 2(b) shows exciton emission spectra (red curve) tuned into resonance with the cavity mode (blue curve) via changing the temperature. We observed the crossing of the exciton and the cavity mode and an increase in the PL intensity as an indication of QD-cavity coupling.

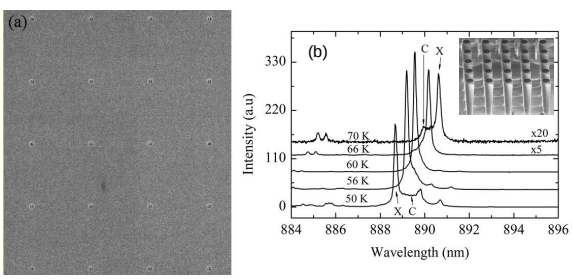

Fig. 1(a) shows single site-controlled InAs QDs with a period of 2.5 µm. (b) Temperature dependent micro-PL spectra of a single site-controlled QD embedded in an optical micropillar cavity. Exciton and cavity mode are denoted by X and C, respectively. The inset shows a SEM image of micropillars with diameters of 1 µm.

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