III-V quantum light source and cavity-QED on Silicon

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'On-demand' generation of single photons or entangled photon pairs is of fundamental importance for quantum cryptography [1], quantum lithography [2] and quantum information processing applications [3]. Successful generation of such non-classical light has been achieved using III-V semiconductor quantum dots (QDs) [4,5]. Recently, III-V QDs were also used in ridge lasers monolithically grown on silicon substrates [6], which provides first steps to unification of III-V based communication technologies with silicon photonics and electronics. Here we demonstrate single photon QD emission in photonic crystal nano-cavities fabricated from a III-V material grown by direct molecular beam epitaxy on a Si substrate. The high quality of the obtained III-V material and photonic structures is emphasized by observation of strong light-matter coupling between the two-level system of a single self-assembled InGaAs/GaAs QD and the optical field of a nano-cavity. This work [7] paves the way for the direct integration of quantum optical systems on a sustainable and low cost silicon platform, and will also enable in a long term unprecedented scalability of III-V quantum devices on large diameter Si substrates.

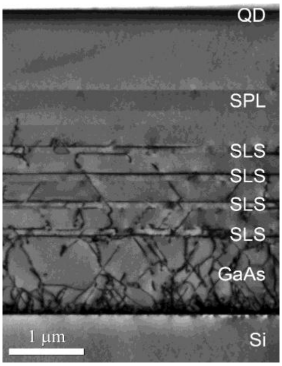

Fig.1. TEM image of the unprocessed sample, showing that threading dislocations are efficiently captured by the quantum well strain filters (marked SLS) and a short-period superlattice (SPL).

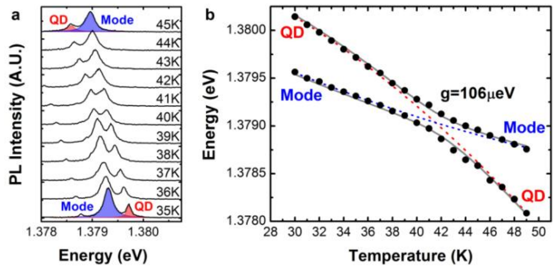

Fig.2. Strong coupling of an InGaAs/GaAs QD to the optical mode in an L3 nano-cavity in a photonic crystal fabricated from GaAs grown on Si (sample shown in Fig.1). The characteristic anti-crossing behaviour is observed in photoluminescence measurements carried out for different temperatures (a). The Rabi splitting, *2g*, exceeding 200 μeV is observed (b).

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