Microcavity-enhanced emission from single (211)B InAs QDs for the generation of entangled photon pairs

S. Germanis[1,2*], A. Stavrinidis[2], G. Konstantinidis[2], Z. Hatzopoulos[2,3], N.T. Pelekanos[1,2]

[1] *Department of Materials Science and Technology, University of Crete, Heraklion, Greece*

[2] *Microelectronics Research Group, IESL-FORTH, Heraklion, Greece*

[3] *Department of Physics, University of Crete, Heraklion, Greece*

Semiconductor quantum dots (QDs) are the ultimate sources for single and entangled photon pairs "on demand", with many applications in quantum communication and quantum computing. Towards the realisation of an efficient single QD emitter, we propose an optically pumped scheme with a piezoelectric (PZ) (211)B InAs QD, embedded in an appropriately designed GaAs/AlAs microcavity in order to improve its photonic yield. A main advantage of PZ QDs is the presence of a large PZ field, which preserves the high symmetry of the confining potential, compensates the lateral anisotropies and leads to negligible fine structure splitting (FSS) values for the majority of the as-grown QDs, a necessary condition for entanglement applications.

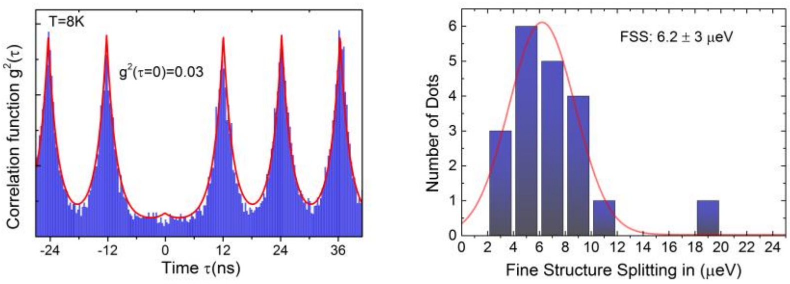

Figure 1: (*left*) Second order correlation function $g^2(\tau)$ exhibiting clear anti-bunching at zero delay time. Negligible FSS values for the majority of the as-grown PZ QDs.

The InAs QDs are grown at the center of a λ-thick GaAs microcavity, sandwiched between a top and bottom distributed Bragg reflectors, consisting of 3 and 14 $\lambda/4$ GaAs/AlAs mirror pairs respectively. The growth conditions are such that the self-assembled QDs have a density of about 10^9 cm^{-2}. Circular micro-pillars of different diameters are fabricated with e-beam lithography for μ-PL experiments. Fig.1 (left) shows clear anti-bunching behaviour in the statistics of photons emitted from a single QD exciton inside a micro-pillar. On the right hand side, are shown the inherently small exciton FSS values measured in this QD system. Such low FSS values, along with the clear single-photon emission characteristics of Fig.1, as well as the factor of 5 improvement in the photonic yield of these QDs due to microcavity effect, make the PZ InAs QDs good candidates for the implementation of highly efficient single and entangled photon sources.

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* germanis@materials.uoc.gr