InAs on InP quantum dashes as single photon emitters at the second telecommunication window: optical, kinetic and excitonic properties

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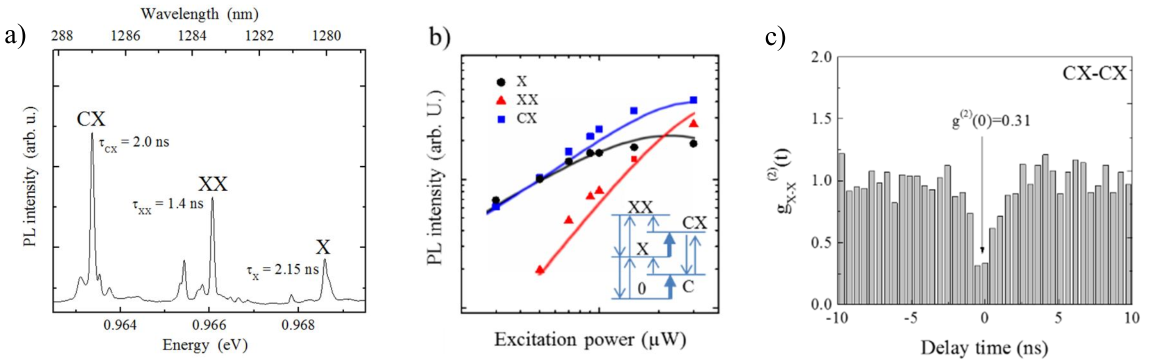
In this work, InAs/InGaAlAs/InP quantum dashes (QDashes) grown by molecular beam epitaxy have been investigated in terms of optimizing the optical, kinetic and excitonic properties with respect to efficient quantum emitters operating in the spectral range of the telecommunication O-band. There has been utilized the spectral emission tunability of QDashes controlled by the amount of deposited InAs material affecting mainly the cross-sectional size and hence the quantum confinement. Microphotoluminescence measurements in function of the excitation power density, emission polarization and magnetic field in both Faraday and Voigt configurations allowed identifying various excitonic complexes, detecting the dark exciton states, determining details of the exciton fine structure, the g-factors, diamagnetic shifts and the related wave function extensions. Time-resolved photoluminescence on single dashes, supported by a few level rate equations' modelling, explained the complex kinetics of the cascaded recombination involving both the neutral and charged complexes. It has appeared to be driven by a significant disproportion between the capture rates of electrons and holes due to residual, unintentional n-doping and high concentration of the excess carriers. We examined the decay times of neutral exciton, biexciton and negatively charged exciton showing 2 ns radiative decay for the highest intensity trion emission. The distribution of decay times obtained for many dashes is related to possible fluctuations in the confinement potential of these strongly elongated structures. Eventually, photon auto-correlation measurements for the negatively charged excitons revealed a clear sub-Poissonian statistics which is the confirmation of single photon emission. All these results present InAs on InP quantum dashes as a competitive solution to commonly considered GaAs-based quantum dots to be applied as sources of single or entangled photons in the short-distance quantum communication systems.



Figures: a) μPL spectra of a single quantum dash; b) excitation power dependence fitted by rate equation model; c) photon autocorrelation $g^{(2)}$ function for charged exciton.