GaAs quantum dots grown by droplet etching epitaxy as quantum light sources

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GaAs quantum dots (QDs) grown via the local droplet etching (LDE) method on GaAs (001) substrates emerged as a promising platform for the generation of single photons and entangled photon pairs [1]. Under optimized growth conditions GaAs QDs can be grown with small excitonic fine structure splitting (FSS) [2] enabling the possibility to obtain a near-unity degree of photon entanglement [3]. These dots have shown near-zero multi-photon emission probability [4] under two-photon excitation and the highest two-photon interference visibility among photons emitted by two remote QDs [5]. Using different combinations of barrier material and the filling amount of nanoholes, the QD emission color can be tuned in a range from ~700-810 nm with dot densities around 0.2 μm^{-2}, ideally suited for single QD applications. In this work, we demonstrate the feasibility of extending the emission of QD up to 940 nm by selectively filling the nanoholes with InGaAs with varying concentrations.

Compared to established Stranski-Krastanow (SK) InGaAs/GaAs QDs, our InGaAs QDs in AlGaAs can be easily grown with small FSS and low density, allowing (for example) an emission at the wavelength of the D2 transitions of Cs atoms (852nm), which is difficult to achieve with standard InGaAs/GaAs QDs.
Moreover, these novel InGaAs dots exhibit a significant reduction in radiative lifetime when compared to SK QDs (from about 1 ns to about 300 ps). We anticipate that this reduction in the radiative lifetime will lead to significant improvement of the performance of InGaAs QDs as sources of polarization entangled photon pairs.

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