

Fabrication of strain-free InGaAs/InAlAs quantum dots as C-band single photon emitters

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Abstract: We present single photon emitters in the telecom C-Band (~1550 nm) realized via strain-free, self-assembled InGaAs/InAlAs quantum dot by local droplet etching on GaAs(111)A substrates. The quantum dot exhibit a second order correlation function as low as $g^2(0) = 0.141 \pm 0.027$

Semiconductor quantum dots (QDs) are essential candidates to enable the single photon emission for long-distance telecommunication applications. To obtain telecom C-band emission at ~1550 nm, lattice matched In_{0.7}Ga_{0.3}As quantum dots (QDs) were fabricated by local droplet etching on a In_{0.7}Al_{0.3}As metamorphic buffer barrier layer realized on a GaAs(111)A substrate. The (111)A-orientation makes it possible to employ thin metamorphic buffers while maintaining intrinsic C_{3v} symmetry to promote highly symmetrical QDs [1]. Atomic force microscope (AFM) revealed the C_{3v} symmetry of the etched nanoholes through triangular pyramid shape. The nanoholes were then filled with In_{0.7}Ga_{0.3}As to fabricate the targeted C-band QDs. The QDs dimensions, electronic structure and emission characteristics were theoretically optimized using **k.p** and envelope function models. The photoluminescence measurements made on the optimized sample show emission in 1388-1553 nm range, consistent with our theoretical predictions.

Second-order autocorrelation measurements show single-photon emission with measured $g^2(0)$ value of 0.141 ± 0.027 . Lifetime in the 1.3-1.9 ns range was measured by time-resolved PL measurements. These results demonstrate the fabricated strain-free InGaAs/InAlAs QDs as state-of-the-art single photon emitters in the C-band window (i.e. ~1550 nm).

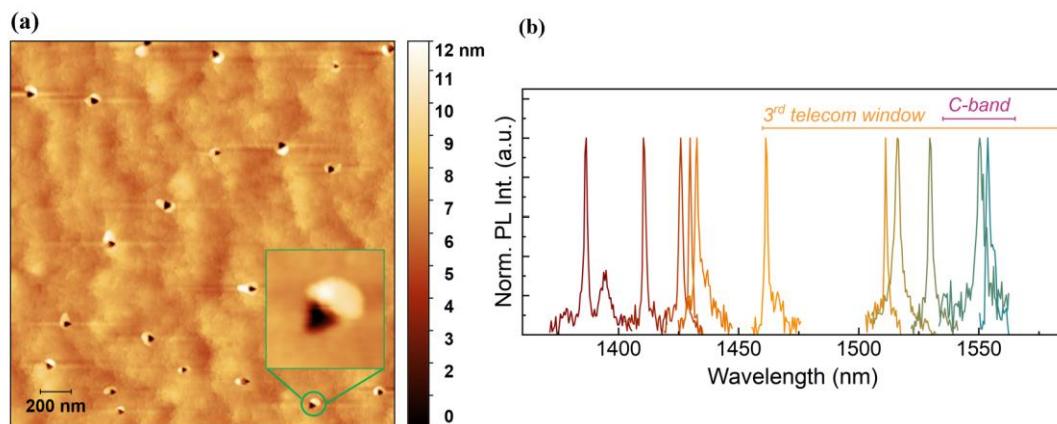


Fig. 1 (a) AFM image of nanoholes with 1024×1024 resolution at 2.5×2.5 μm² scale, Inset: nanohole with C_{3v} symmetry (b) μ-PL measurements of the fabricated InGaAs/InAlAs QDs showing the emission in C-band.

References

[1] Tuktamyshev, A. et al. Appl. Surf. Sci, 669, 160450 (2024).