Fabrication and characterization of high quality Quantum Dots by Droplet Epitaxy for entangled photon emission on (111)A vicinal surfaces

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Abstract: we present the fabrication of GaAs/AlGaAs quantum dots on GaAs (111)A substrates 1° and 2° off toward [-1-12]. The dots exhibit narrow emission linewidths, limited Fine Structure Splitting and are suitable for polarization-entangled photon emission

Self-assembled quantum dots (QDs) are promising solid-state quantum emitters capable of generating pairs of polarization-entangled photons. The fabrication of III-V QDs along the [111] crystal axis, which possess intrinsic C3v symmetry, enables the suppression of fine structure splitting (FSS) between the bright exciton and bi-exciton emissions by inheriting the substrate high symmetry [1]. Such self-assembly is made possible by droplet epitaxy techniques, which allow the growth of perfectly symmetric, strain-free structures on (111) surfaces [2]. However, for the deposition of GaAs and AlGaAs on (111)A surface, growth parameters must be carefully selected to achieve a flat surface which limits its practical applications [3]. To enable future integration of GaAs/Al_x Ga_{1-x} As(111) QDs into photonic heterostructures, the use of misoriented substrates for their growth becomes necessary. The miscut facilitates higher grow rates and the deposition of defect free sacrificial layer with high Al-content AlGaAs. On the other side introduces surface steps that alter the QD symmetry, potentially affecting their optical properties and posing challenges for their practical applications [4].

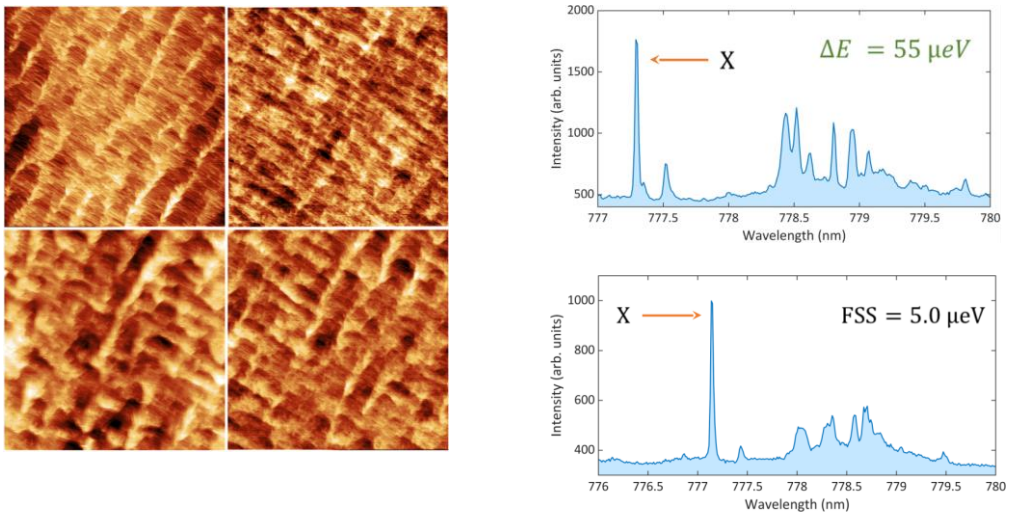

Fig. 1 Left panel: AFM 2 µm × 2 µm of AlGaAs/GaAs grown on GaAs(111)A 1° miscut towards [-1-12] with different As BEP and different group III rate showing layer by layer growth and step bunching. Right panel: preliminary results for PL measurements at low temperature QDs grown on the same surface.

We investigate the effect of 1 and 2 degree miscuts on the GaAs and AlGaAs layer growth on (111)A surfaces, along with micro-photoluminescence (µ-PL) measurements.
The morphological data of Atomic force microscope (AFM) reveal varying growth regimes and surface flatness based on growth rate and III-V ratio. Low temperature µ-PL measurements demonstrate the potential for fabricating GaAs QDs by droplet epitaxy with narrow emission lines and low FSS, suitable for single and entangled photon emission.

References

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