Growth of high-density InGaAs/AlInGaAs quantum dots by MOVPE targeting the 1.3 micron window

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Quantum dots (QDs) as the active medium for the semiconductor lasers have attracted much attention because of their properties, e.g. potential low threshold current density and reduced temperature sensitivity when compared with quantum-well lasers [1]. The Stranski-Krastanov (SK) growth mechanism, which utilizes strain-driven growth kinetics, has been investigated extensively over the years to grow self-organized quantum dots. However, with the advent of the droplet epitaxy (DE) technique [2], which is not restricted to lattice-mismatch, it has become possible to grow a variety of strain-free nanostructures like quantum dots, quantum rings, quantum discs. So far, many groups have reported InAs/InP –based quantum dot system for quantum emission using the DE technique [3]. However, high density droplet epitaxial InP based QDs for laser operation and reduced strain at telecom wavelength have been investigated only scarcely in the literature. Here we report the DE fabrication of high-density InGaAs QDs within an AlInGaAs barrier structure lattice-matched to InP (001), aiming for lasing operation around 1.3 µm.

First, we have grown single layer InGaAs QDs at a reduced temperature of ~550°C on AlInGaAs barrier with an InGaAs interlayer between them and achieved a high aerial density of $2x10^{10}$ cm^{-2}. Morphological characterization of the grown QDs were done by atomic force microscopy, and capped dots were studied optically via micro-photoluminescence at cryogenic and room temperature. The optimized single-layer dot structure was used to further stack a second layer and a detailed study as a function of a number of growth parameters of the distribution of size, density, and emission of the dots was performed.
Present results suggest that laser structures by multiple stacking of double DE QD layers is an interesting option.

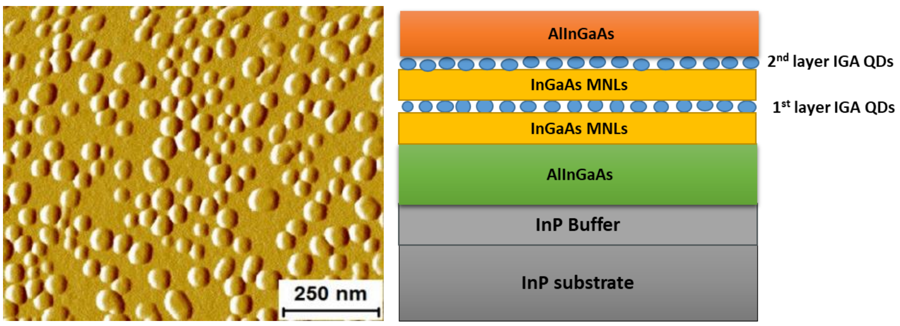

Figure 1: single layer QD AFM image (left) and stacked QD design (right).

References

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