Site-selective growth of InAs quantum dots on pre-patterned GaAs substrates

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Semiconductor quantum dots (QDs) are promising candidates for the realisation of quantum information devices. Integrating QDs into optical resonator structures may be one way to realise such a device. Therefore, it is necessary to fabricate QDs with controllable properties at predefined locations. It has been demonstrated that pre-patterning of the substrate offers a tool to achieve good control of QD nucleation sites [1, 2]. However, site-controlled QDs still lack in quality compared to randomly nucleated QDs. This is partly attributed to defects which are due to a change in morphology at the patterned sites and thus originate from the regrowth interface below the QDs [3]. This obstacle is often circumvented by growing QD stacks in order to increase the distance between the last QD layer and the regrowth interface. Though, obtaining a single array of ordered QDs of high optical quality remains a challenging but meaningful task with regards to device integration.

A different approach to improve QD distribution and optical properties utilises an in-situ post-growth treatment. Under certain annealing conditions, QD sizes remain constant while the QD density as well as the In concentration can be controlled by annealing time [4]. It should be possible to improve the spatial distribution of site-controlled QDs without degrading their optical properties. Furthermore, the number of defects might be reduced during the annealing process due to rearrangement of material inside the QDs. The effect of post-growth annealing on the QD properties is investigated in this study. InAs QDs are grown on pre-patterned GaAs (100) substrates by molecular beam epitaxy and are analysed by atomic force microscopy (AFM), scanning electron microscopy (SEM) and spatially resolved micro-photoluminescence (μ-PL) measurements.

References

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