Investigation of pre-structured GaAs surfaces for sub-sequent site-selective InAs QD growth

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Quantum dots (QDs) are promising candidates for quantum information devices such as quantum bits in quantum computers or quantum memories. Self-assembled QDs were investigated in this context in the past decade. However, for large scale applications it is essential to transfer the aforementioned schemes to well-positioned QDs in order to obtain a defined device architecture. One approach to site-selective QD growth utilises substrate pre-structuring [1, 2]. Small holes are created on the substrate surface in order to alter the surface chemical potential which leads to an increased growth rate at the hole sites. Thus, QDs preferentially nucleate at the defined locations.
Various tools such as electron beam lithography (EBL) or local oxidation are available to pre-structure substrates [3, 4]. In most cases the procedure of pre-structuring involves several process steps including different chemicals which influence the substrate surface. For subsequent QD growth, however, it is necessary to provide a clean surface in order to minimise defects and uncontrolled QD nucleation. Therefore, great care has to be taken for surface cleaning after pre-structuring. In this study we investigate the origin and effect of possible surface contamination which occurs during surface pre-structuring by means of atomic force microscopy (AFM) and transmission electron microscopy (TEM). We observe local defects which inhibit proper GaAs buffer layer regrowth after lithographic processing. The origin of those defects has yet to be identified, but remaining contaminants after cleaning or residual oxide compounds are likely candidates.
The samples are fabricated with molecular beam epitaxy (MBE) and pre-structured by EBL.

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