Self Organized InAs Quantum Dot Arrays on Patterned GaAs Substrates

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Self-assembled semiconductor nanostructures such as quantum dots (QDs) have been under intense investigation during the last years due to their appealing electronic and optical properties. Unique physical properties have been observed in QD structures, and device applications using QDs, such as lasers, detectors and memories, have been explored. However, for novel QD devices like single photon sources or transistor structures, it is desirable to control the lateral position of the QDs. To achieve this, nanoscale grid patterns can be used to laterally align the QDs.

In this work, the self organization of InAs quantum dots grown with molecular beam epitaxy (MBE) on pre-patterned GaAs substrates was investigated. To create the grid patterns on the substrates, holographic lithography has been used.

Holographic lithography was studied because it provides an easy and efficient way to create nanosized patterns over large areas. For holographic lithography a He-Cd laser at a wavelength of 325 nm was used as an ultraviolet (UV) light source. After coating the GaAs substrate with photoresist it was then exposed in a holographic apparatus. The nanoscale grid patterns were then transferred onto the GaAs using wet chemical etching.

After preparing the substrates they were thoroughly cleaned, inserted into the MBE chamber and prepared for the growth. After growing a GaAs-based buffer layer on the substrates, they were consequently covered with self assembled QDs. These dots are either embedded into GaAs or serve as surface dots for further investigations.

The dot density, lateral and size distribution is measured using atomic force microscopy (AFM). Photoluminescence (PL) measurements performed on the samples with and without patterns give further information on dot size and size distribution. Furthermore, the influence of different dot growth conditions on dot quality and density is examined.