**Formation of unstrained quantum dots**

- A combination of Stranski-Krastanov growth mode and in situ etching technique leads to unstrained GaAs/AlGaAs quantum dots.
- Low temperature photoluminescence spectra show that GaAs/AlGaAs quantum dots are optically active at ~700-780 nm wavelength.
- An inverted quantum dot shape is assumed.
- Cross-sectional scanning tunneling microscopy (XSTM) is used for structural investigation of these buried nanostructures.

**Photoluminescence spectra**

- The GaAs quantum well thickness varies between 0.5 and 2.5 nm. Furthermore, a decomposition of the AlGaAs is observed. Therefore the interfaces of GaAs and AlGaAs layers are not abrupt.
- The observed thicknesses of the other layers fit well to the nominal thickness variations of the GaAs quantum well.

**Cross-sectional scanning tunneling microscopy (XSTM)**

- The GaAs/AlGaAs quantum dots have a low density of $4 \times 10^7$ cm$^{-2}$, which is directly correlated to the density of the former InAs QDs.
- To locate GaAs/AlGaAs QDs, XSTM images have to be examined for regions were the lower AlGaAs layer reaches down to the InAs wetting layer.

**Conclusion**

First XSTM images of unstrained, inverted GaAs/AlGaAs QDs grown by a combination of SK growth mode and an in situ etching technique as AsBr$_3$ shown.

From atomically resolved images we found thickness variations of the GaAs quantum well between 0.5 and 2.5 nm and a decomposition of the AlGaAs layers.

GaAs QDs were observed with base lengths of about 35 nm, heights of 5-6 nm and a reversed truncated cone shape.

**XSTM Experiment**

- Top-view AFM and STM
  - Atomic force microscopy (AFM) and STM images are taken to control the new technique and characterize the surface morphology before depositing the GaAs QD material.
  - AFM image after 5 nm etching and therewith after forming the nanohole.
  - STM image of the AlGaAs nanohole and height profile.

- Photoluminescence spectra
  - PL and PLE spectra of a single GaAs/AlGaAs quantum dot.
  - The bottom graph is a calculated excitonic absorption spectrum and the inset shows 3D representations of ground and first excited state wave functions for electrons (E) and holes (H) in the quantum dot.

- Cross-sectional scanning tunneling microscopy (XSTM)
  - The GaAs/AlGaAs quantum dots have a low density of $4 \times 10^7$ cm$^{-2}$, which is directly correlated to the density of the former InAs QDs.
  - To locate GaAs/AlGaAs QDs, XSTM images have to be examined for regions were the lower AlGaAs layer reaches down to the InAs wetting layer.

**References**


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