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Growth of Low Noise Quantum Dot Heterostructures

Abstract:

Randomly grown self-assembled nanostructures like InAs or droplet etched nanoholes filled with GaAs quantum dots (QD) demonstrate excellent optical properties [1,2]. For device integration, it would be nice to have them positioned and at the same time high optical quality. Many methods to align these QDs have been developed over the last one and a half decade. However, so far none delivered wafer scale good photonic properties. Most probably because ex-situ processing steps are involved, i.e. the vacuum is broken in between the manufacturing steps. New and promising in-situ methods rely on strong pulsed lasers or shadow masks. These come along with chamber modifications and still have to fulfil their promises.

Here, we demonstrate a method that appears naturally during epitaxial growth. The process is possible without any chamber modification [3]. The result is a wafer-scale pattern of nanostructures that I am going to present in the talk.

Noise from fluctuating charges are detremential for quantum optics and spin qubit applications. In the past years, we applied strategies to calm the embedding heterostructures environments. In particular, we apply n- and p-doped layers as conducting gate layers. I will reveal how we achieve low-noise heterostructures [4] with little photon absorption by placing these gates at the right positions, and using appropriate doping and alloy matrix concentration.

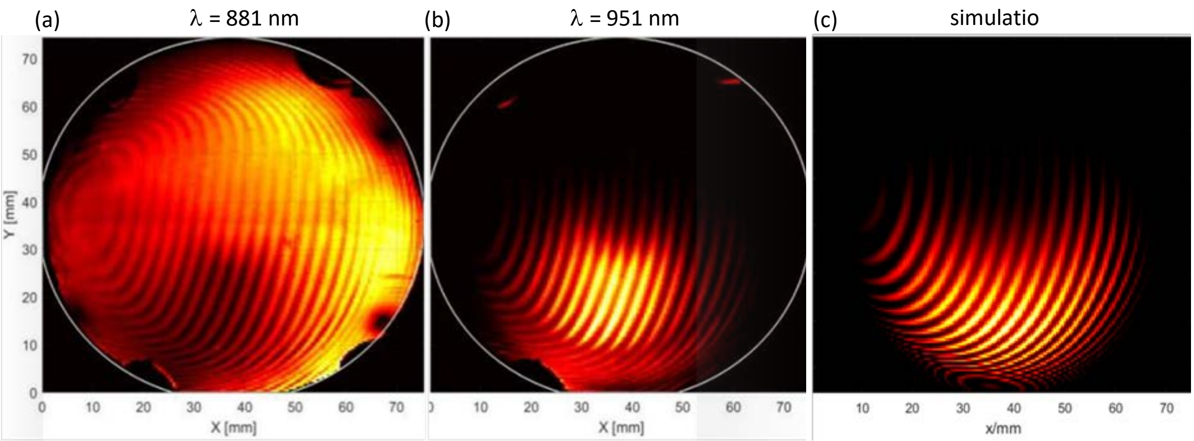

Figure 1 – (a) Photoluminescence of a quantum well and (b) self-assembled quantum dots on the same 3” GaAs wafer at T = 100 K. Bright corresponds to a high photoluminescence count at the specifiedwavelength. (c) Simulation of self-assembled quantum dot density. Bright corresponds to a high density.

References:

[1] A.V. Kuhlmann, et al. Transform-limited single photons from a single quantum dot. Nature communications 6, 8204 (2015).

[2] D. Huber, et al. Highly indistinguishable and strongly entangled photons from symmetric GaAs quantum dots. Nature Communications 8, 15506 (2017).

[3] N. Bart, et al. Wafer-Scale Epitaxial Positioning of Quantum Dots. arXiv:2011.10632. [4] A. Ludwig, et al, Ultra-low charge and spin noise in self-assembled quantum dots.
Journal of Crystal Growth 477, 193 (2017).

Datum: Mi, 16.12.2020 **Zeit: 13:30 Uhr** **ZOOM Meeting**

(for the link, please contact halbleiter@jku.at)