ESRF	**Experiment title:** Locally resolved elastic strain and chemical composition in AlGaAs/GaAs(001) double quantum rings and InGaAs/GaAs(001) multi-quantum dot molecules	**Experiment number**: SI-1972
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Report:

In experiment SI-1972 we aimed to investigate InGaAs quantum dot molecules (QDMs) with high resolution hard X-ray nanodiffraction. QDMs consist of several quantum dots (QDs) and can be generated by self-assembling and self-ordering processes that are influenced by strain and shape within the QDs. The QDMs of this experiment have been grown by droplet homoepitaxy and form hexapod-like formations as depicted in Figure 1(a) or, depending on growth conditions, ring-like formations (not shown). High resolution X-ray diffraction in general is very sensitive to the strain distribution inside quantum dot objects as well as shape and positional ordering of the objects. Since nanofocused hard X-ray beams are feasible at synchrotron sources it is very interesting to test and develop further new methods that make use of this upcoming technology – as for instance X-ray nanodiffraction on semiconductor nanostructures.
On the one hand we planned to analyze the individual very small and shallow quantum dot molecules with the nm-sized X-ray spot and compare the results with experimental integral data [1]. On the other hand we intend to test and establish the nanodiffraction method on this kind of sample system since this has been successfully done previously on the well-known SiGe/Si(001) system with SiGe inslands and SiGe dot molecules [2, 3].

Figure 1(b) shows an example of reciprocal space maps (RSM) of the InGaAs/GaAs(001) QDMs measured by scanning nanodiffraction. Each RSM in this array depicts the diffusely scattered intensities near the GaAs (004) reflection. Different well separated spots can be seen if the beam spot hits a surface structure, whereas no spots are visible at the plane surface (compare first row of the array in Fig. 1(b) without intensity spots and the bottom of this array of RSMs showing complex diffraction patterns).

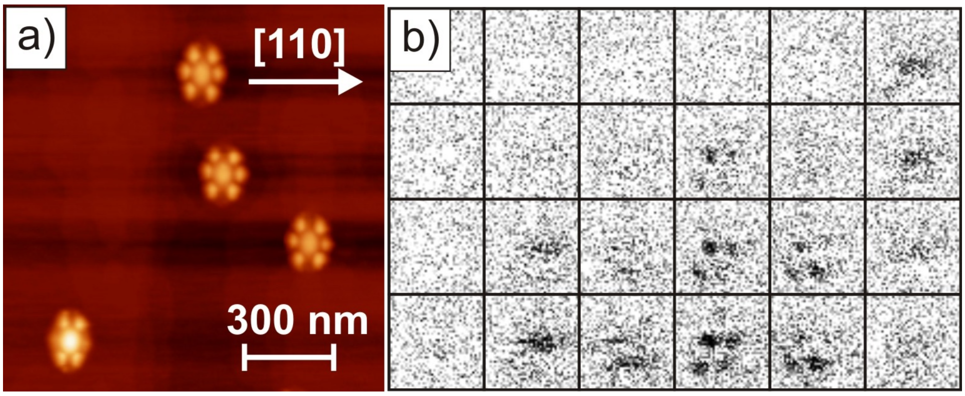

Figure 1. a) Atomic force micrograph of InGaAs/GaAs(001) quantum dot molecules (QDMs) grown by droplet epitaxy, b) experimental data of scanning nanodiffraction at the GaAs sample surface with a 100nm X-ray beam (FWHM, 15.25 keV). Each squared region of b) depicts reciprocal space maps near the GaAs (004) reflection taken from different adjacent spot positions at the scanned sample.

Further analysis will incorporate finite element method (FEM) calculations, which we have already performed. The derived deformation profile in a three-dimensional model of the grown nano-objects will then be used as an input for kinematic X-ray scattering simulations.

[1] M. Hanke, M. Dubslaff, et al., Appl. Phys. Lett. **92**, 193103 (2008).
[2] M. Dubslaff, M. Hanke, S. Schöder, et al., Appl. Phys. Lett. **96**, 133107 (2010).
[3] M. Hanke, M. Dubslaff, et al., Appl. Phys. Lett. **95**, 023103 (2009).