ESRF	**Experiment title:** Investigation of strain and correlations in InAs/GaAs superlattices containing a self-organised 2D quantum dot lattice	**Experiment number:** Si-345
Beamline: ID10B	**Date of experiment:** from: 1 July 1998 to: 07 July1998	**Date of report:** 31 July 1998
Shifts: 18	**Local contact(s):** Nathalie Boudet, Detlef Smilgies	*Received at ESRF:*

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Report:

Quantum dot samples from the InAs/GaAs system were studied applying Grazing Incidence Diffraction (GID). The main focus in this experiment was on the newly discovered quantum rings arising from overgrowth of InAs quantum dots with GaAs. Prior to a systematic study of the kinetic phenomena leading to this interesting spatial configuration (see long term proposal), basic procedures and analysing techniques have to be developed in order to extract information on strain and shape of quantum rings. A new application of GID where strain resolved analysis of lateral shape is possible is to be tested with these measurements. These iso-strain scans are carried out in the vicinity of a surface Bragg-reflection tracing reciprocal space in angular directions at constant lattice parameter. The resulting small angle scattering patterns can be analysed to yield information on strain status, lateral shape of iso-strain areas and the strain gradient within the dot.

During this experiment we surprisingly found that contrary to experiences at other beamlines the monochromatic photon flux of the TROIKA II beamline was so high that the resulting ozon concentration had serious etching effects on the sample surface. For non-destructive measurements a He-flow box had to be used.

The sample under investigation was composed of a GaAs(100) substrate on which InAs (7% lattice mismatch) has been deposited by MBE, exceeding the critical thickness for pseudomorphic growth. The resulting coherent InAs dots of density 10^{10} cm^{-2} have been overgrown by 40 Å of GaAs at 530 °C. Grazing Incidence small angle scattering has been applied in combination with AFM to determine the final shape as elliptical (semi-axes 902 ± 7 Å and 626 ± 18 Å in the two in-plane <110> directions) with a depression in the middle.

To investigate the relation of strain and shape including the role of the central hole as a means of strain relief, a large number of iso-strain scans have been carried out. While the recorded data is still under investigation (the beamtime took place just one month ago), we can present the general characteristics in figures 1-4 taken from the 220-reflection showing intensity maps in the q_z-q_a plane where q_a points along the $<1\bar{1}0>$ direction of the smaller semi-axis. Figure 1 has been recorded at a high relaxation (far away from the GaAs substrate reflection) and exhibits the form factor of a thin ring at the top of the quantum ring. Figure 2 shows the characteristics of a ring whose ratio of inner to outer radius has become smaller. In figure 3, the form-factor becomes disk-like. For still lower relaxation (Fig.4) the ring-like behaviour seems to be lost and the lateral dimensions of the disk tend to increase. From the vertical momentum transfer (along q_z) we expect to extract information on the strain gradient within the dot.

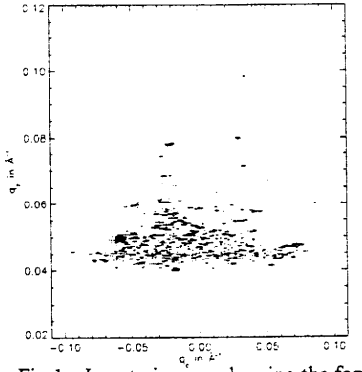

Fig.1: Iso-strain scan showing the form factor of a thin ring

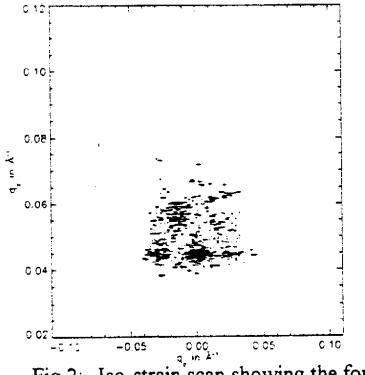

Fig.2: Iso-strain scan showing the form factor of a disk with a hole

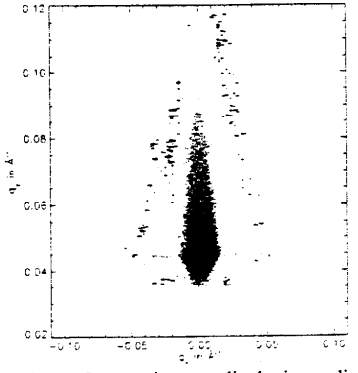

Fig.3: Iso-strain scan displaying a disk-shaped form factor

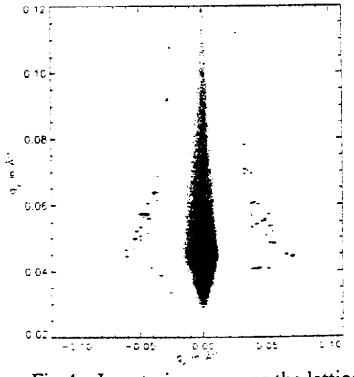

Fig.4: Iso-strain scan near the lattice parameter of the substrate