Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title: Grazing incidence diffraction study of GaAs layers grown epitactically on Ge(001) wafers and Ge/SiGe buffer layers**	**Experiment number**:
Beamline: ID10B	**Date of experiment**: from: 03.07.2002 to: 09.07.2002	**Date of report**: 30.10.2002
Shifts: 18	**Local contact(s)**: N. Galatanu	*Received at ESRF:*

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Report:

Aim of the experiment is the structural characterization of GaAs layers grown on group IV semiconductor substrates. Such layers are of technological interest, because they would allow for a combination of III-V-optoelectronical elements and standard CMOS logic (data storage and procesing) on one device. In principle, Ge has a lattice paramter very close to that of GaAs (a_{Ge}=5.657 Å, a_{GaAs}=5.653 Å), and therefore is suited for the epitaxial growth of GaAs on Ge. However, the final aim for technological application will be the growth of GaAs on Si substrates. Due to the lattice mismatch of more than 4% between Si and GaAs, an intermediate layer (virtual substrate) to compensate this mismatch is required. As the growth of SiGe and Ge virtual substrates is increasingly important also for other applications, the use of such a strain-relaxed Ge buffer as virtual substrate for GaAs has been suggested.

We have investigated two samples, where GaAs has been deposited onto a buffer layer of pure Ge which was in turn deposited directly onto a Si (001) wafer, without the use of a intermediate graded SiGe buffer. A major problem in the epitaxial growth of III-V semiconductor on group IV layers is the occurrence of antiphase boundaries. I.e., growth will initially start either with the group III or the group V element with approximately the same probability. Hence growth may start with both elements in different domains, and upon coalescence of the domains, antiphase boundaries result. In

order to avoid this effect, in the investigated samples the first monolayers of GaAs have been deposited in an atomic layer epitaxy mode. In this mode, Ga and As are deposited alternatingly, and hence the growth should start only with one element on the whole wafer.

Reciprocal space maps have been recorded around various reciprocal lattice points in order to obtain information on the strain status of both the Ge and the GaAs buffer. From the diffuse scattering, information on the dislocations in the GaAs buffer, as well as on possibly still present anti-pahse boundaries shall be obtained. Due to the good lattice matching between Ge and GaAs, and because the Ge buffer is completely relaxed, as our invetigations showed, the GaAs and Ge signal are superimposed over each other around the strong relfections like (004) or (224). Using reflections which are weak for GaAs, but forbidden for Si or Ge, it is possible, however, to measure diffuse scattering only from the GaAs buffer. Figure 1 shows several reciprocal space maps around symmetric (002), (004) and (006), as well as around the asymmetric (224) and (204) Bragg reflections.

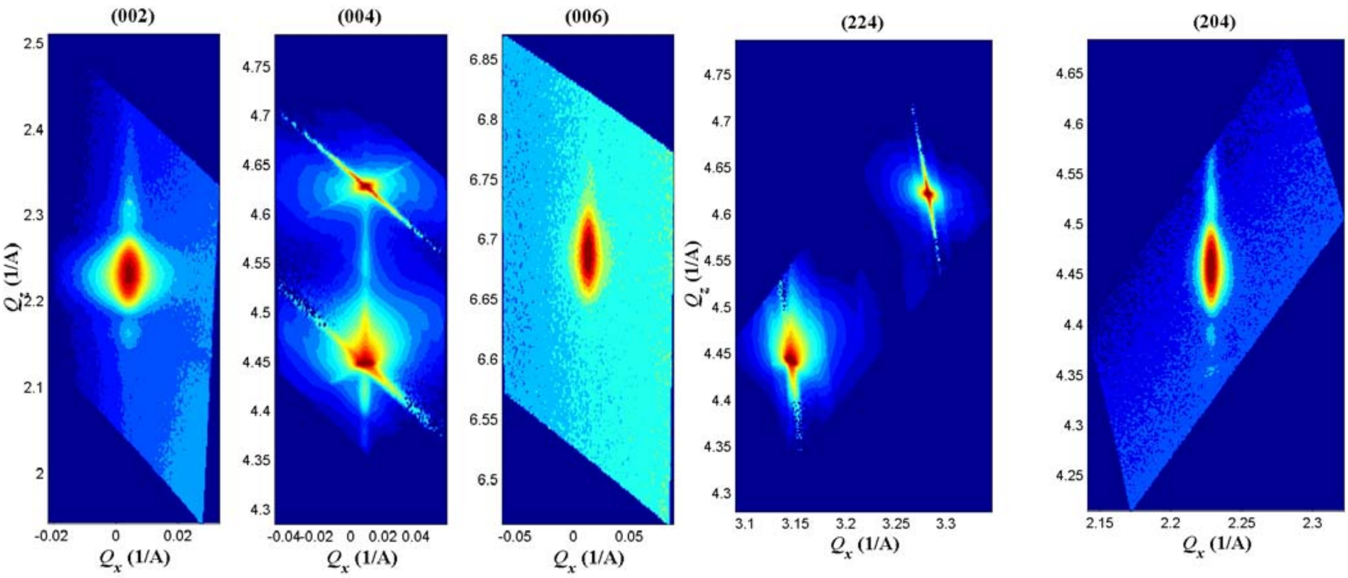

Figure 1. Reciprocal space maps of sample Ge14 around various Bragg reflections. The diffuse scattering around (002), (006) and (204) is only due to the GaAs layer, as this reflections are forbidden for Si and Ge.

In order to be more sensitive to the topmost GaAs layer, diffraction in the grazing incidence configuration has been employed. Also here, reciprocal space maps have been recorded around the (400) reflection (strong reflection for GaAs and Ge) as well as around the (200) reflection (weak in GaAs, forbidden in Ge).