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ESRF

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 via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can 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:** DAFS analysis of the local structure in InGaP/GaAs lateral compositional modulation	**Experiment number**: HC-875
Beamline: BM-02	**Date of experiment**: from: 25. 7. 2013 to: 31. 7. 2012	**Date of report**: 26.8.2013
Shifts: 18	**Local contact(s)**: Hubert RENEVIER	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*Ondrej CAHA, Masaryk University, Brno, Czech republic
*Martin SCHMIDBAUER, Institute for crystal growth, Berlin, Germany
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Report:

A spontaneous one-dimensional periodic surface corrugation on $In_{0.48}Ga_{0.52}P$ epitaxial layers grown lattice matched on GaAs(001) substrates (surface miscut smaller than 0.05°) has been observed, which can be used as a natural template for further growth of well aligned InP quantum dot chains [1,2]. The surface undulations exhibit a height of a few nanometers with a corresponding wavelength of about 50 nm. Its appearance strongly depends on the growth conditions: the corrugation is well pronounced at comparatively large growth temperatures (T = 470°C) whereas the surface is very smooth at low growth temperatures.

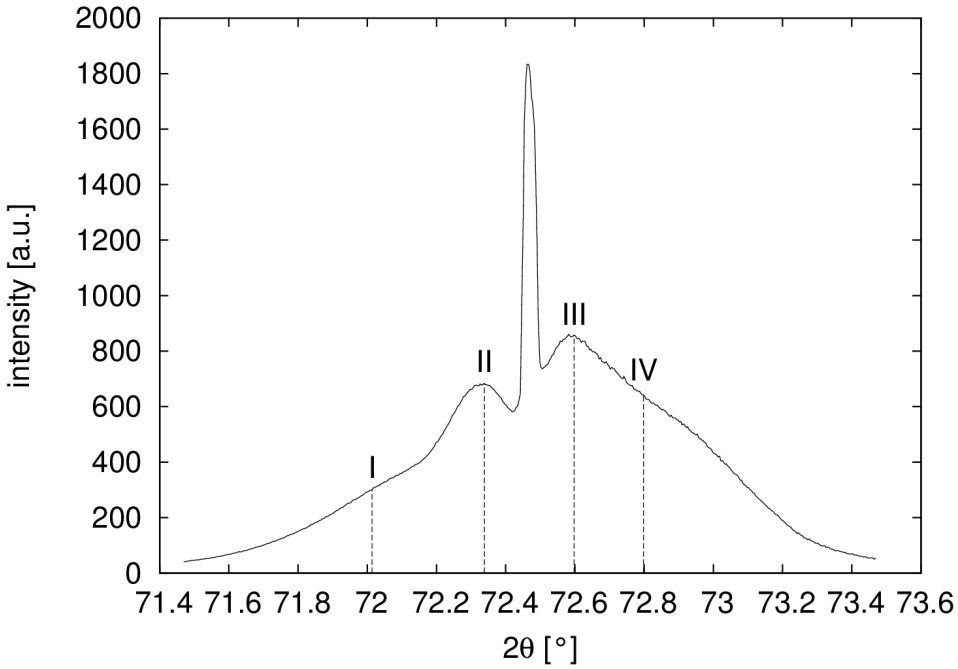

Figure 1: Radial scan in grazing incidence 440 diffraction using energy 10.5 keV and angle of incidence 0.24 deg. Thickness of (In,Ga)P layer is 250 nm. DAFS spectra at Ga K-edge were measured in denoted positions. Central peak corresponds to the average (In,Ga)P lattice matched to GaAs. Satellites denoted II and III are caused by the lateral compositional modulation.

We have measured three samples with different (In,Ga)P layer thicknesses. A lateral In and Ga composition modulation was investigated by probing the x-ray diffuse intensity and its dependence on the energy in the vicinity of the Ga K-edge. The proposed experiment in the vicinity of the In K-edge was not performed because of technical difficulties with BM02 monochromator at high energy range.

The measurement was performed in the grazing incidence geometry in vicinity of 440, $4\bar{4}0$, 600 and 060 reciprocal lattice points. The grazing incidence geometry is especially sensitive to the near surface region where the compositional modulation occurs and supresses GaAs substrate signal. The energy dependence was measured in several reciprocal space positions, namely in the lateral compositional modulation peaks positions (see Fig 1). The positions on the left side of the average lattice peaks (denoted I and II) originate mainly in the laterally expanded lattice with respect to the substrate and thus are expected to contain higher In content than average lattice. The opposite bahaviour was expected for the other reciprocal space positions (III and IV).

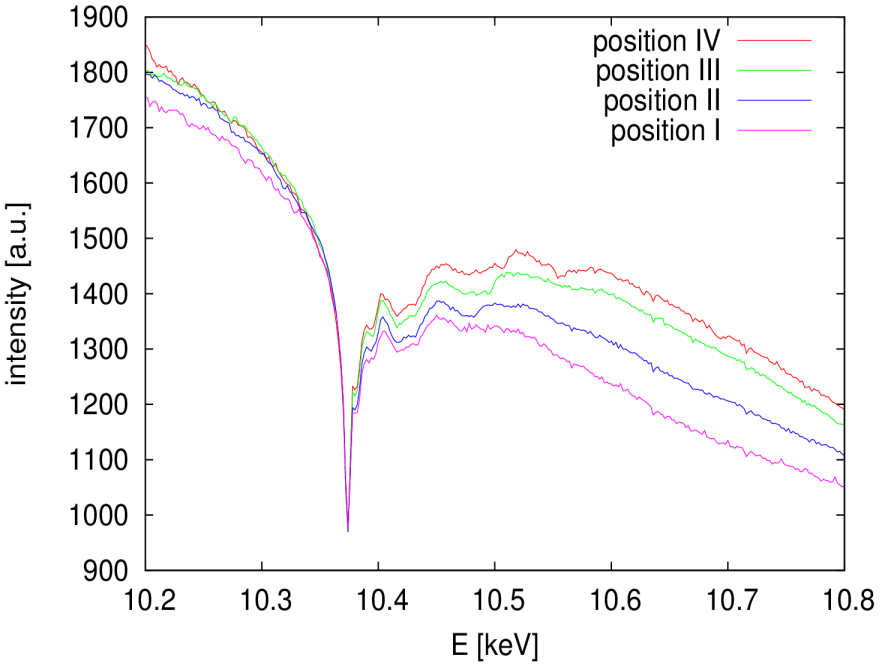

Figure 2: DAFS spectra at Ga K-edge in four selected reciprocal space positions shown in figure 1. The intensities in different positions are normalized to the pre-edge region.

The energy dependences of the scattered intensity are plotted in Figure 2. The results have shown slight difference in the anomalous diffraction signal at different reciprocal space positions. The expected behaviour of the anomalous diffraction intensity has been confirmed (compare experimental data and simulation in figures 2 and 3, respectively). The preliminary analysis has shown that the gallium concentration differs from the average one by 2% in the reciprocal space positions II and III and by up to 4% in the positions denoted I and IV.

The slight differences in the oscillating DAFS signal has been also observed. However, the quantitative analysis is subject of further work.

The experiment at In K edge was not performed due to technical problems; the completion of the experiment is proposed in the next round.

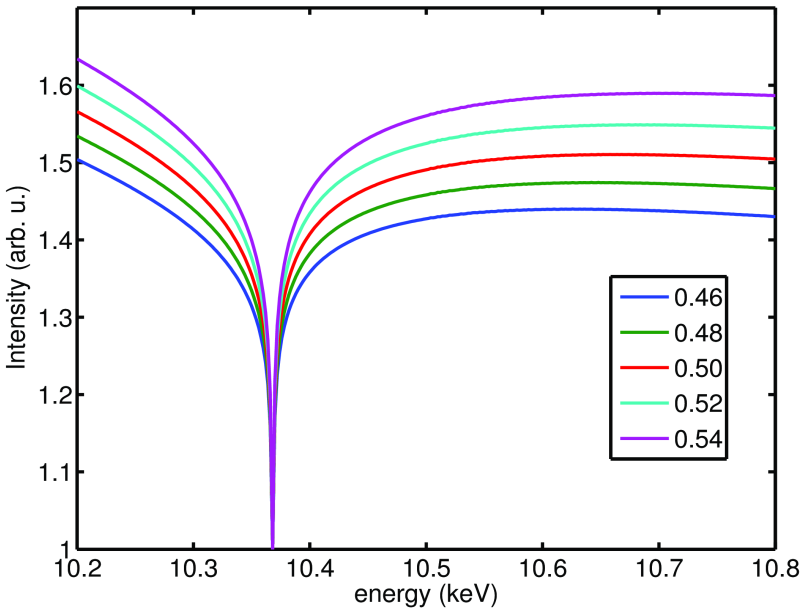

Figure 3: Simulation of the anomalous 440 diffraction intensity from (In,Ga)P for different values of Ga concentration.

References

[1] A. Ugur, F. Hatami, M. Schmidbauer, M. Hanke, and W.T. Masselink, J. Appl. Phys. **105**, 24308 (2009).

[2] M. Schmidbauer, A. Ugur, C. Wollstein, F. Hatami, F. Katmis, O. Caha, and W.T. Masselink, J. Appl. Phys. **111**, 024306 (2012).