<table>
<tr><td> </td><td>Experiment title:
Structural origin of the electronic and optical properties of InGaAsN quantum wells</td><td>Experiment number:
HS 1408</td></tr>
<tr><td>Beamline:
BM 08</td><td>Date of experiment:
from: 26/4/01 to: 2/5/01</td><td rowspan="2">Date of report:
24/8/01
Received at ESRF:</td></tr>
<tr><td>Shifts:
18</td><td>Local contact(s):
F. D'Acapito</td></tr>
<tr><td colspan="3">Names and affiliations of applicants (* indicates experimentalists):
F. Boscherini, INFM and Dept. of Physics, University of Bologna, Italy
F. D'Acapito, INFM OGG, GILDA CRG, ESRF
M. Capizzi and A. Polimeni, INFM and Dept. of Physics, University of Rome, Italy</td></tr>
</table>

Report:

The aim of this experiment was to study local order and structural deformations in InGaAsN quantum wells using In K-edge X-ray absorption spectroscopy, in order to clarify the structural origin of the anomalous electronic properties of InGaAsN quantum wells. Use of a high-brilliance SR source at high energy was mandatory in order to perform these measurements on 5 nm epilayers at the In K-edge.

The interest in InGaAsN alloys is twofold. On the applicative side this quaternary alloy can be grown lattice matched to GaAs while varying the optical gap in the range 0 – 1.5 eV; hence it is used for the construction of laser diodes with improved temperature characteristics compared to more common InGaAsP/InP heterostructure diodes.

On the more fundamental side this material has intriguing physical properties which derive from the large mismatch between the dimensions of the N atom and the other constituents. The most obvious anomaly is that the optical band gap actually decreases, rather than increasing, with N concentration. Physical properties have been observed to be strongly non-linear with the N concentration and a strong dependence on atomic ordering of the constituent atoms has been observed or predicted. Very recently (Kim and Zunger, Phys. Rev. Lett. 86,

2609 (2001)) it has been predicted that there is a preference for In – N and Ga – As bonds, relative to the random case.

The experiment, recently conducted, was very successfull thanks to the advanced facilities present at ESRF: high quality data was obtained, notwithstanding the very thin InGaAsN layer and the low cross section at the In K edge. In the figure we show the raw, background subtracted XAFS oscillations for a series of samples. A quantitative data analysis is in progress. Preliminary inspection shows significant changes with N concentration.