ESRF	Experiment title:EXAFS **analysis on InGaAs/InP epilayers: a study on the short (vs long) range accomodation mechanisms of strain in alloy strained semiconductors**	**Experiment number: HS 52**
Beamline: **GILDA** BM	**Date of experiment:** from:July 31th 1996 to: Aug 2nd	**Date of report:** Feb 20th 1997
Shifts: 9	**Local contact(s):** Sakura' Pascarelli	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

- Filippo Romanato, Davide De Salvador, Massimo Tormen
  Dip. di Fisica "G.Galilei" Univ. di Padova, via Marzolo 8 35131 Padova
  tel + 39 49 827 7001; e-mail: romanato@padova.infn.it
- Sakura' Pascarelli, INFM, c/o GILDA CRG, BP 220,38043 Grenoble Cedex (France)
  e-mail: sakura@esrf.fr
- Carlo Lamberti Dip. di Chimica Inorganica, Fisica e dei Materiali Univ. di Torino;
  Via P.Giuria 7, I-10125 Torino (Italy) e-mail: lamberti@to.infn.it

Report: The aim of this EXAFS experiment concerned the investigation of the microscopic deformations in pseudomorphic strained epilayers. The relationships between long and short range strain accomodation mechanisms have been investigated on a series of 4 InGaAs epilayers MOCVD grown on [001] InP substrates. The atomic concentration of indium and the thickness of the film have been chosen in order to scan the tetragonal distrortion of the unit cell over a large range, from tensile to compressive. The results of the pre-characterization of the samples performed with techniques probing the long range coherency of the crystal, such as Rutherford Backscattering Spectrometry in channeling configuration and conventional X-ray Diffraction (XRD), have been compared to the EXAFS microscopic description.

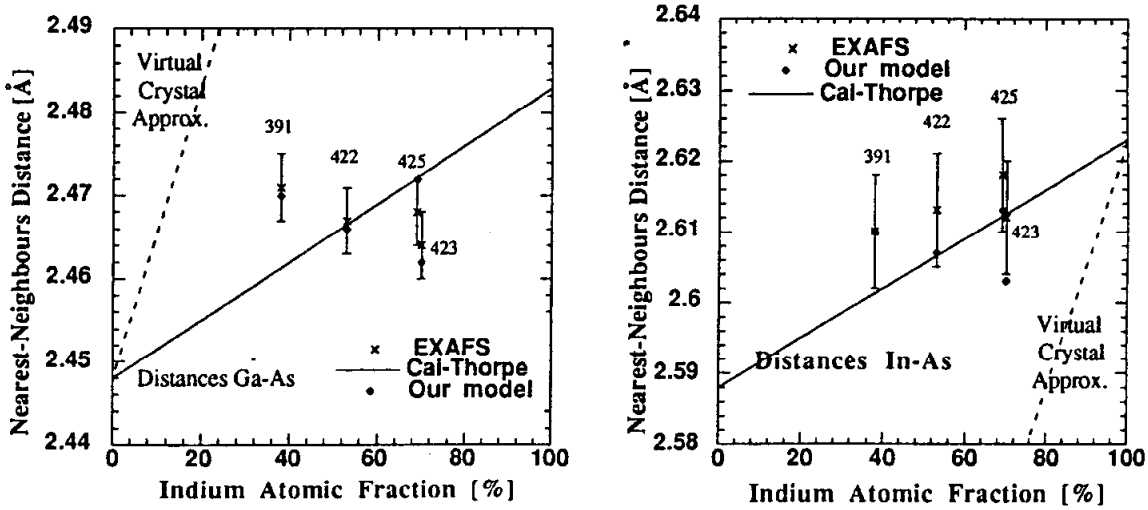
EXAFS spectra have been collected at GILDA beam line in flourescence detection mode at the K-edge of Ga and **As** at liquid nitrogen temperature. **Two** geometric configurations of the experimental set-up have been used in order to probe the a-symmetries of the lattice unit cell induced by tetragonal distortion: i.e. the polarization of the electric field has been set quasi parallel and quasi perpendicular to the film-substrate interface.

For this experiment 9 shifts were allocated, from July 31th to August 2nd. During this time, the life time of the beam was shorter than usual with refilling every 8 hours.

Moreover, the beam was down several times for a total of 4 hours lost while 2 hours were to technical problems with the beam line. Due to the long collection time of the spectra, inherent to the high diluition of the samples, the frequent interruptions for the injection and beam losses caused an overall loss of more than 20% of the allocated beam-time. In the remaining time we have collected all the spectra (2 geometrical configurations, 2 edges) for 4 samples i.e. the most compressive (#423, strain parallel=$\varepsilon_{//}$=-1.2%), the most tensile (#391, $\varepsilon_{//}$=+1.0%), one lattice matched (#422) and a completely strain relaxed sample after misfit dislocation nucleation (#425).

Results. Up to now the analysis of the EXAFS first shell have been performed while we are carring on the second shell analysis. In fig.1 the distances for the first nearest neighbours (NN) are shown. The two solid lines represent the predictions of a model valid for bulk pseodobinary alloys [1]. Moreover, we have developed a model describing the effects of tetragonal distortion on the distances of the first and second shell.

The unstrained samples #422 and #425 are expected to be fit by both model, ours and that of ref 1. On the contrary, the NN distances of the strained samples (#391 and #423) show a deviation from the behaviour of unstrained alloys. These deviations, even if they must be confirmed by a more meaningful statistical set of data, is a clear evidence that NN bond is effectively influenced by the degree (and sign) of tetragonal distortion. These data are in good agreement with the predictions of our model that necessarily takes in account the long range tetragonal distortion of the samples measured by XRD (fig. 1). Work is in progress to confirm these deviations also for the second shell where the geometrical configuration should be more sensitive to the effects of the tetragonal distortion. It is worth noting that the collection of EXAFS at both As and Ga k-edge allowed to keep small the error bar during the analysis data reduction.



Ref. [1] Y.Cai and MF. Thorpe Phys. Rev. B46 (1992) 15872, 15879