ESRF	**Experiment title:** Local structure of InGaAs/InP short period superlattices by XAFS	**Experiment number:** HC 505
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Report:

We have performed a fluorescence XAFS investigation on a series of short period (below 60 A) nominally matched $In_{0.53}Ga_{0.47}As/InP$ superlattices, epitaxially grown on InP (001) by MOCVD and CBE. The samples are characterized by different average mismatch ($Da/a \approx \pm 5\,10^{-3}$) originating from different interface structures deriving from the growth conditions. A sample composed of a single thick layer of lattice matched InGaAs/InP was also investigated. The goal was to estimate the widths of the unwanted interface layers InAsP and InGaAsP which accompany the growth of such heterostructures, and to verify whether there are variations in bond lengths due to the different interface structure. The samples investigated have been throughly characterized by more conventional techniques, such as HRXRD and HRTEM, which have revealed the crystalline quality of the superlattices, as well as values of average lattice mismatch between the InGaAs layers and the InP layers. Nominal InGaAs and InP layer thicknesses and lattice mismatch are listed in Table I. We have measured RT EXAFS at the Ga and As K-edges. The Fourier Transforms of the $k^2\chi(k)$ signals are shown in Fig. 1. A first shell analysis was performed using policrystalline InAs, GaAs and GaP as standards.

Results on the Ga edge clearly show that, besides the expected Ga-As interactions, in all samples with period ≤ 40 Å a non negligeable portion of Ga atoms are bonded to P atoms. This can be explained with the presence of "unwanted" InGaAsP interface layers between the InGaAs and the InP layers. The interatomic distance values relative to the Ga-As bond are close to those relative to unstrained alloys of similar compositions, while those relative to the Ga-P bond show significant deviations. Results on the As K-edge show that, as expected, As is surrounded by In and Ga atoms. However, the fraction of In atoms surrounding As is larger than that expected in a randomly distributed $In_{0.53}Ga_{0.47}As$ alloy. This can be explained by the presence of "unwanted" InAsP layers between the InP and the InGaAs layers. Values of bond lengths for both the As-Ga and As-In interactions are close to those relative to unstrained alloys of similar compositions. Table I also lists the layer thickness rations $n_{InGaAsP}/n_{InGaAs}$ ($n^0_{InGaAsP}$) and n_{InAsP}/n_{InGaAs} (n^0_{InAsP}) needed to justify both the number of Ga-P bonds observed and the excess in In coordination number for each sample, assuming a 50% substitution of the group V elements. It is interesting to note that these fractions tend to increase with decreasing period. We have tried to relate the values of the Ga-P bond length (also shown in Table I) with the observed structures at the interfaces and we have found that this bond has a tendency to stretch with increasing difference n^0_{InAsP}-$n^0_{InGaAsP}$. This is compatible with the effect of expansive and compressive strain incorporation due to the presence of InAsP and InGaAsP layers respectively. We are at the moment still working on the interpretation of the data.

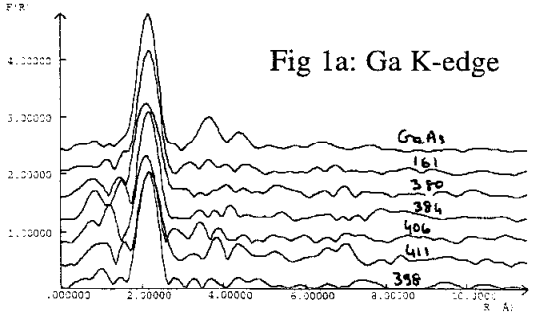

Fig 1a: Ga K-edge

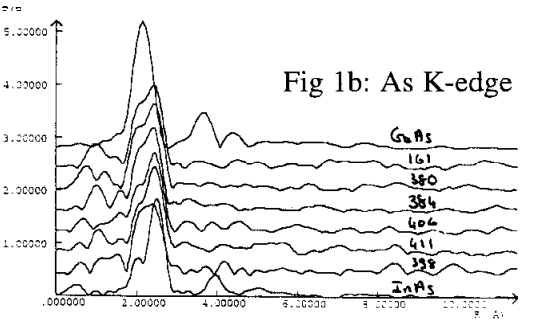

Fig 1b: As K-edge

Table I

sample InGaAs/InP	Δa/a	nominal layer thickness (Å)	n^0_{InAsP}	$n^0_{InGaAsP}$	R_{Ga-P} (Å)
398		3000			
161	+4900	30/30	--	--	--
384	+4900	20/20	0.78	0.66	2.39 ± 0.06
380	-790	20/20	1.96	2.33	2.37 ± 0.03
411	+2100	13/18	2.02	1.22	2.40 ± 0.06
406	+2600	13/18	3.23	1.86	2.45 ± 0.05