

Measurement of the lattice parameter dependence versus composition in InGaAs alloy

C. Ferrari* (Ferrari@maspec.bo.cnr.it), E. Villaggi[§] (Villaggi@maspec.bo.cnr.it), N. Armani* (Armani@maspec.bo.cnr.it), G. Carta[@] (carta@nt.ictr.pd.cnr.it), G. Rossetto[@] (rossetto@nt.ictr.pd.cnr.it)

*CNR Maspec Institute, Parco Area delle Scienze 37/A, 43010 Fontanini, Parma, Italy;

[§]INFM at Physics department, Parco Area delle Scienze 7/A, 43100 Parma, Italy;

[@]CNR Ictima Institute, Area della Ricerca di Padova, Corso Stati Uniti 4, 35127 Padova, Italy

The determination of the composition of in a semiconductor alloy is usually made by the measurement of lattice parameter by X-ray diffraction since the measurement is completely non destructive and may easily reach an accuracy of 10^{-4} . The method is based on the exact knowledge of the lattice parameter dependence versus composition. Mainly due to the lack of accurate analytical techniques, for a long time the Vegard law has been applied which assumes a linear dependence of the lattice parameter versus the stoichiometric coefficient x in alloys of type A_xB_{1-x} .

Nevertheless studies of the lattice parameter dependence in SiGe [1] and, more recently, in GaAlSb [2] and SiC [3] alloys have appeared which evidenced deviations in the composition from the linear relationship of up to several percents of the total lattice parameter range near the stoichiometric value $x=0.5$.

In the case of $In_xGa_{1-x}As$ alloy, which has several applications in the field of micro and optoelectronic, the only experimental works published, based on analytical techniques like Electron Probe Microanalysis, Rutherford Backscattering and X-ray fluorescence, reported a linear dependence in the full composition range from $x=0$ to 1 (see for instance Nakajima et al. [4]).

In the present work a new method based on the measurement of X-ray absorption in the diffraction mode has been used to measure the composition of a InGaAs/InP heterostructure grown by the Metal Organic Chemical Vapour Deposition Technique near the lattice match value. Based on the known X-ray absorption coefficients of In, As and Ga for the $CuK\alpha$ wavelength, a deviation of 6% from the Vegard law toward higher In content has been found, thus shifting the composition of the lattice matched InGaAs/InP alloy from $x=0.53$ to 0.59 ± 0.01 .

Such results have been confirmed by Electron Probe Microanalysis measurements on standards prepared from InAs and GaAs fine ground crystals (Fig. 1).

The agreement with the theoretical prediction of Fournet et al. [5] suggests that the deviation from linear relationship is a general behaviour in semiconductor alloys.

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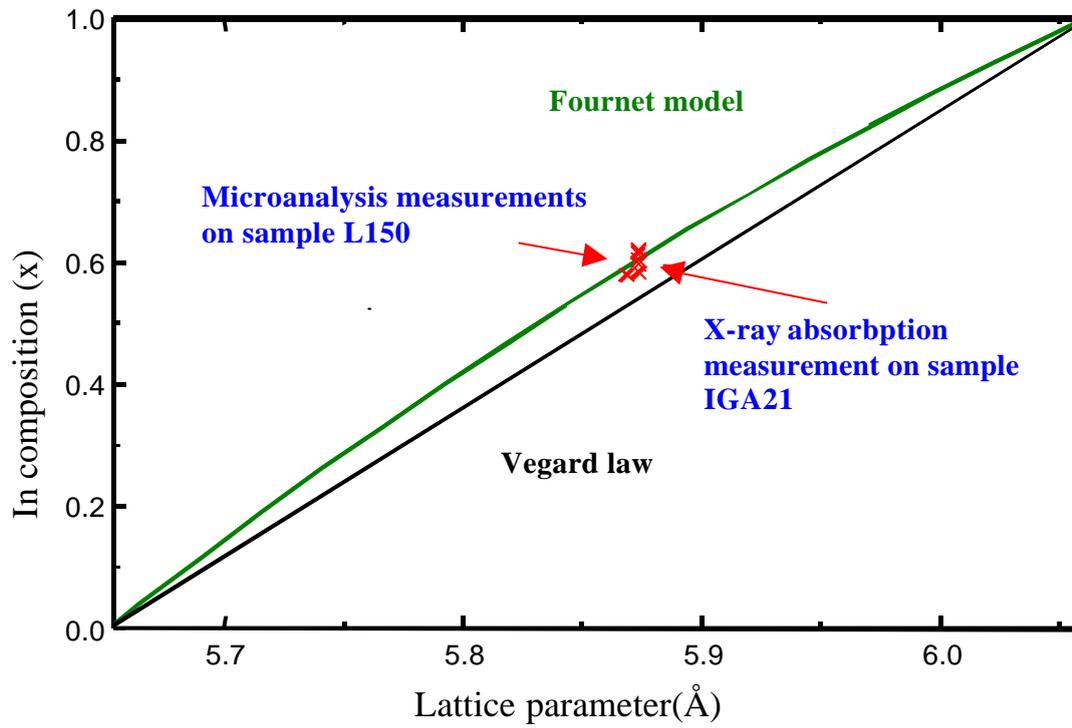


Fig. 1 summary of composition determination in lattice matched InGaAs/InP epitaxial heterostructures.