

OPTICAL PROPERTIES OF $\text{Ga}_x\text{In}_{1-x}$ IN FAR
INFRARED SPECTRA

D.B. Popović

Electroengineering Faculty, University of Belgrade and Institute of
Physics, Belgrade

P. Mihajlović

Faculty of Natural Philosophy, University Niš

The study of semi conductor mixed-crystal $\text{Ga}_x\text{In}_{1-x}\text{As}$ as a representative of III-V group is presented in this paper. This type of two components behavior is an intermediate case between an "one mode" and a "two mode" behavior. For small values of $x(x \rightarrow 0)$ and $x \rightarrow 1$ criteris for existence of "one mode" behavior are satisfied and for other molar concentration "two mode" behavior is permitted.

The works of Mitra and Chang¹ and Brodsky, Lukovsky have influenced the idea of starting the studies presented here.

Introduction

It is well known that small concentration of impurities in crystalline lattice can result in local, resonance or gap vibrational modes⁵. Experimentally these modes are observable by impurity-induced infrared absorption or Raman scattering⁶.

MMP³ calculation shows as the occurrence of local or gap mode as a consequence of a substitution of particles in a linear chain in one dimension. The local mode frequencies were calculated as a function of mass defect E_1 , where $E_1 = 1 - \frac{M}{M_j}$. M is the mass of the impurity atom, and M_j the mass of the host-crystal atom. For $\text{Ga}_x\text{In}_{1-x}\text{As}$, $E_1 = 0,6$.

These model predicts a local mode 1 cm^{-1} below the longitudinal optical phonon.

Chang and Mitra (phys.rev.172, 1968) have predicted the behavior using the modified random element isodisplacement model. The predictions of their model are also based on local and gap mode behavior, but their criterion of local mode behavior is not equivalent to the MMP model.

Experimental results and analysis

The samples used in this investigation were made in the Laboratorie of the Institut of Physics in Beograd, and they were polycrystals with the carrier concentration of 10^{17} cm^{-3} .

The reflection spectra were taken at room temperature and at 77°K using spectrophotometer Perkin Elmer 577 and Fourier spectrometer Beckman FS 720.

The computer analysis were done on the IBM 1130 computer at the Electro engineering Faculty of Belgrade. Damped harmonic oscillator and program Simplex for optimization of parameters were used as a model.

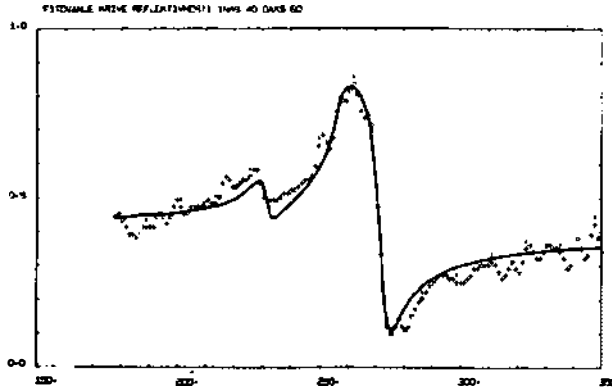


Figure 1.

Table 1. shows the results obtained from a computer analysis. Figure 1. shows the experimental curve and a curve which is a result of calculation for $\text{In}_{0.4}\text{Ga}_{0.6}\text{As}$.

It can be said that there exist nearly linear decrease of optical mode with a rise of molar concentration of In in this mixed crystal. There is also a decrease of the oscillator strength and increase of damping constant which occurs only by GaAs, as well as the increase of oscillator strength with decrease of damping constant of a InAs oscillator.

	ω_{TO}^1	S_1	γ_1	ω_{LO}^1	ω_{TO}^2	S_2	γ_2	ω_{LO}^2	ϵ_∞
GaAs	268	2,2	4,5	293					11,9
$Ga_{0,6}In_{0,4}As$	260	2,29	4,53	275	225	0,55	5,47	233	12,1
$Ga_{0,4}In_{0,6}As$	255	1,6	6,7	272	235	1,25	8,3	235	12,2
$Ga_{0,2}In_{0,8}As$	250	0,45	14,2	262	218	2,5	20,2	236	12,3
InAs					215	3,5	9,7	238	11,9

Conclusions

Analyse of the reflectivity of the $Ga_xIn_{1-x}As$ in far infrared spectra has been presented in this paper. The analyze was done with damped harmonic oscillator. Variation of TO and LO frequencies, oscillator strength (S) and damping constants (γ) for different molar concentrations are presented as well.

Acknowledgments

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