D8 **THREE SPECIES INTERDIFFUSION AND THEIR EFFECT ON THE VARIATION OF STRAINS IN $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ QW**

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Abstract

Three species interdiffusion in $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ quantum wells (QW) structure is investigated by using the expanded form of Fick's second law Determination of the interdiffusion coefficients and the applications of sample in QW are discussed.

1. Introduction

There are immense interests in the InGaAs/InAlAs QWs. The application of thermal processing of QW materials is now extended to both multiple species and phases. However most of the effort has been put towards two species interdiffusion in group III and V Although, after diffusion, this above system only confines to the III metals but it consists of three interdiffused elements. This complicates the diffusion process because it cannot be described by the simple one diffusion coefficient model. In general all the three diffused elements (Al, In, Ga) should be described by their own diffusion rate together with the cross rates.

2. Modeling

A number of models have been presented for investigating interdiffusion involving the use of only one error function in approximating the compositional profiles. In this paper, $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ Diffused QW (DFQW) structure is described by the expanded form of Fick's second law·

$$\frac{\partial C_1}{\partial t} = \frac{\partial}{\partial x}\left(D_{11}\frac{\partial C_1}{\partial x}\right) + \frac{\partial}{\partial x}\left(D_{12}\frac{\partial C_2}{\partial x}\right)$$

$$\frac{\partial C_2}{\partial t} = \frac{\partial}{\partial x}\left(D_{21}\frac{\partial C_1}{\partial x}\right) + \frac{\partial}{\partial x}\left(D_{22}\frac{\partial C_2}{\partial x}\right)$$

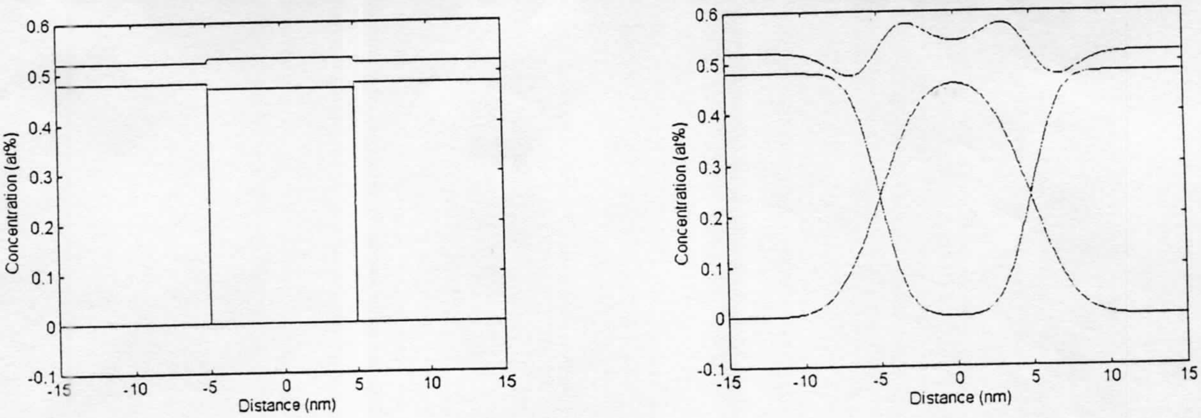
where C_1 stands for Ga and C_2 stands for In, and D_{ij} (i,j=1,2) are the interdiffusion coefficients. D_{ii} is the diffusion rate of species i and D_{ij} is the cross diffusion rate between species i and j. The properties of D_{ij} has been discussed before by Kirkaldy et al. [1-3]. In order to determination the interdiffusion coefficients, we fitted our diffusion model to the measured concentration data [4] by using least square to minimize the error Table 1 shows the results of coefficients D_{ij}.

Table 1 The experimental data fitted interdiffusion coefficients

	GaGa	GaIn	InGa	InIn
D_{ij}	6.96	0.18	-4.01	2.98
Unit:	$10^{-18}\,cm^2\,s^{-1}$			

3. Concentration profile

Fig.1(a) shows concentration profile for an as-grown $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ DFQW sample. Fig.1(b) shows the concentration profile by our diffusion model after annealing a structure identical to that in Fig.1(a) for 1 hour at 812°C. The result shows Al is not constant, but Ga profile has spread out relatively to the Al profile. Most dramatically, there are abrupt changes in In profile.



(a) (b)

Fig.1 Concentration profiles for $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ DFQW
(a) as grown, (b) annealed for 1 hour at 812°C.

4. Application

The diffusion process can be used to tune the wavelength of InGaAs/InAlAs QW material in the region of 1.5μm which is the optimum wavelength for operation of fiber optic systems with the lowest attenuation. In addition to shifting the operating wavelength, the effect of tensile strain QW on the laser application which is the first light-hole subband as the top valence subband can perform a smaller threshold current density as well as compressive strained QW Moreover, this material system can also be used to develop both electro-absorptive and electro-refractive modulators in the optimum wavelength so that an integration of these optoelectronic devices can be developed in next stepped.

5. Acknowledgment

The authors acknowledge the financial support of the RGC Research Grants and the HKU-CRGC Research Grants.

6. References

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