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Table of Contents

Impact of Mole Concentration and Well Width on Band Gap and Optical Response of GaInP/AlGaInP Heterostructure

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***Abstract*— The paper presents the theoretical study of dependence of mole fraction concentration of materials and quantum well width on the bandgap energy of the GaInP/AlGaInP heterostructure. Due to the variations in mole fraction concentrations and well widths of the heterostructure material different wavelengths have been reported. The single quantum well GaInP/AlGaInP has been modelled on GaAs substrate at room temperature. The optical gains corresponding to different concentrations and well widths have been presented. The calculations for energy bandgaps and their corresponding wavefunctions have been done by using 6x6 Luttinger Kohn Hamiltonian model with conduction band. The simulated heterostructure design can be utilized for medical science, optical communications and displays, etc.**

***Keywords*— AlGaInP, GaInP, Heterostructure, Quantum well, Optical Gain**

I. INTRODUCTION

Electromagnetic spectrum belonging to visible light region spans the wavelengths ranging from 380 nm to 750 nm which emit violet to red lights respectively. Visible laser diodes in the 600 nm wavelength region have a wide range of applications. The III-V group alloys like AlGaInP, GaInAsP, GaAlAs, GaInP have been studies as important materials in the visible light lasers. AlGaInP quaternary material has the widest band gap among the above-mentioned materials along with complete lattice matching with GaAs substrate. It also consists of direct transition band gap energy from red to green light. AlGaInP has been studied as material for optical devices for applications in visible light region to mainly emit red light wavelengths [1-4].

Red laser diodes find applications in the field of biomedical in photodynamic therapy (PDT) for treatment of cancers, light sources for optical information processing systems including barcode readers and optical disks, laser displays, plant factories, distance measurement systems, visible light communication, visible light printing etc [5-9].

II. HETROSTRUCTURE DESIGN

The simulated heterostructure AlGaInP/ GaInP/ AlGaInP consist of p-type of $Al_xGa_yIn_{1-x-y}P$ as the barrier layer and n-type of $Ga_xIn_{1-x}P$ as the quantum well. The heterostructure is simulated on GaAs substrate at 300K room temperature. The study of bulk band structures is done for the materials. The bulk band structures of the compounds AlGaInP and GaInP are given in the Fig. (1) and Fig. (2). From these figures, the conduction and valence bands for both compounds can be studied. The band alignment of the heterostructure is shown in Fig. (3).

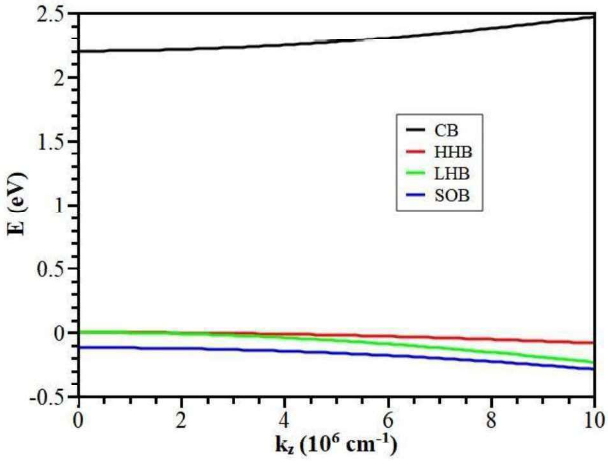

Fig.1. Bulk band structure of AlGaInP

The respective materials AlGaInP and GaInP have been selected as they are used to generate light in the visible region. The heterostructure design is dependent on the materials used, their compositions and the widths of the material layers. To increase the optical gain, the compositions and layer widths are selected after multiple calculations to ensure effective recombination of charge carriers and to maximize confinement of the charge carriers.

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