Binding energy study from photocurrent signal inphotoconductive a $ZnIn_2S_4$ thin films

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Abstract: The chalcopyrite $ZnIn_2S_4$ epilayers were grown on the GaAs substrate by using a hot-wall epitaxy (HWE) method. The crystal field and the spin-orbit splitting energies for the valence band of the $ZnIn_2S_4$ have been estimated to be 0.1541 eV and 0.0129 eV, respectively, by means of the photocurrent spectra and the Hopfield quasicubic model. These results indicate that the splitting of the Δso definitely exists in the Γ_5 states of the valence band of the $ZnIn_2S_4$/GaAs epilayer. The three photocurrent peaks observed at 10 K are ascribed to the A_1-, B_1-, and C_1-exciton peaks for n = 1. Also, we obtained the A_∞- and B -exciton peaks from the PC spectrum at 293 K

Key Words : semiconductors, epitaxial growth, crystal fields, electrical properties, binding energy

1. INTRODUCTION

In this paper, the electric and the optical properties of the chalcopyrite $AgInS_2$ epilayer have been measured at temperatures ranging from 10 K to 293 K. Also, we will find the values of Δcr and Δso of the chalcopyrite $AgInS_2$ epilayer by using the photocurrent (PC) spectra and Hamiltonian matrix. By comparing these values with Shay's results, we will determine the exciton quantum number, n, of the peaks that appeared in the PC spectra.

2.RESULT AND DISCUSSION

The chalcopyrite $AgInS_2$/GaAs epilayers were grown by the HWE method. The carrier density of these epilayers was obtained to be $\sim 10^{17}$ cm^{-3} at 293 K and $\sim 10^{16}$ cm^{-3} at 10 K by means of the Hall effect measurement.The dependence of the energy band gap of the $AgInS_2$/GaAs epilayer on the temperature obtained from the absorption spectra was found by the Varshni's relation to be $E_g(T) = 2.1365$ eV - $(9.89 \times 10^{-3}$ eV$)T^2/(2930 + T)$. Also, we obtained the free exciton binding energy, 0.1115 eV, for the chalcopyrite $AgInS_2$/GaAs by using Shay's result. From the PC measurement, we confirmed that Δcr and Δso were 0.1541 eV and 0.0129 eV, respectively. The result indicates that the splitting of Δso clearly existed in the Γ_5 states of the valence band in the chalcopyrite $AgInS_2$/GaAs epilayer.

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