Origin of Point Defects in $AgInS_2$ Epilayer Obtained From Photoluminescence

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Abstract : The $AgInS_2$ epilayers with chalcopyrite structure grown by using a hot-wall epitaxy (HWE) method have been confirmed to be a high quality crystal. After the as-grown $AgInS_2$/GaAs was annealed in Ag-, S-, and In-atmosphere, the origin of point defects of the $AgInS_2$/GaAs has been investigated by using the photoluminescence (PL) at 10 K. The native defects of V_{Ag}, V_S, Ag_{int}, and S_{int} obtained from PL measurement were classified to donors or acceptors type

Key Words : $AgInS_2$, hot-wall epitaxy, point defects, Varshni's relation, photoluminescence

1. Introduction

Ternary chalcopyrite crystals are currently of technological interest since they show promise for application in the areas of visible and infrared light-emitting diodes, infrared detectors, optical parametric oscillators, upconverters, and far infrared generator In this paper, to estimate the predominant point defects of the as-grown $AgInS_2$ through various heat-treatment, we carried out measurements of the optical absorption and the PL spectra. Based on these results, we will discuss the origin of native defects of the $AgInS_2$.

2. Results and Discussion

The absorption and PL spectra of $AgInS_2$/GaAs epilayers grown by using HWE method were investigated. The energy band gap obtained from the absorption spectra was well described by the Varshni's relation of $E_g(T) = 2.1365$ eV - $(9.89 \times 10^{-3}$ eV$)T^2/(2930 + T)$. The free excitons of the lhx and hhx have found in the as-grown $AgInS_2$/GaAs and its splitting energy gap between the lhx and the hhx was determined to be 109 meV. Also, the binding energy of the free exciton was estimated to be 48.2 meV. The I_2 emission was confirmed to be related to the V_S or Ag_{int} generated by non-stoichiometric composition. These defects were proved to be acted as donors. Therefore, these defects indicate one of the reasons why the $AgInS_2$ grown is generally the n-type. At the same time, the binding energy of the donor-impurity was calculated to be 92.7 meV. The I_1 emission became the dominant peak in the $AgInS_2$/GaAs:S after the S-atmosphere treatment.

References

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