Point-defect study from low-temperature photoluminescence of ZnSe layers through the post-annealing in various ambient

Sangyoul Lee, Kwangjoon Hong†, Haejeong Kim

Depatrment of Physics, Chosun University, Kwangju 501-759, South Korea

Abstract : The ZnSe epilayers were grown on the GaAs substrate by hot wall epitaxy. After the ZnSe epilayers treated in the vacuum-, Zn-, and Se-atmosphere, respectively, the defects of the epilayer were investigated by means of the low-temperature photoluminescence measurement. The dominant peaks at 2.7988 eV and 2.7937 eV obtained from the PL spectrum of the as-grown ZnSe epilayer were found to be consistent with the upper and the lower polariton peak of the exciton, I_2 (D^o, X), bounded to the neutral donor associated with the Se-vacancy. This donor-impurity binding energy was calculated to be 25.3 meV. The exciton peak, I_1^d, at 2.7812 eV was confirmed to be bound to the neutral acceptor corresponded with the Zn-vacancy.

Key Words : ZnSe; hot wall epitaxy; annealing treatment; defect; photoluminescence

1.Introduction

In this paper, the ZnSe epilayer was grown using HWE and its crystal quality was investigated by means of the double crystal x-ray diffraction technique. The ZnSe epilayers treated in the various atmospheres were investigated using the PL spectra. Based on these results, we will discuss the origin of point defects formed in the ZnSe epilayer.

2. Result and discussion

The ZnSe/GaAs epilayers were grown on the semi-insulating (100) GaAs by HWE method. The optimum growth temperatures of the substrate and the source containing ZnSe powder were found to be 400 ℃ and 670 ℃, respectively. FWHM from the x-ray rocking curves and thickness were obtained to be 195 arcsec and 1.8 μm, respectively. The PL measurement showed that the dominant peaks at 2.7988 eV and 2.7937 eV obtained from the as-grown ZnSe epilayer corresponded to the upper and the lower polariton peak of the exciton, I_2 (D^o, X). This polariton peak is associated with the strain due to the lattice mismatch between substrate and epilayer. When the samples were treated in the vaccum, Zn, and Se-atmosphere, respectively, the I_2 peak was observed and its origin was not related to V_{Zn} but V_{Se}. The donor-impurity binding energy was calculated to be 25.3 meV . The exciton bounded to a neutral acceptor, I_1^d, was also seen. However, the I_1^d emission and its LO phonon replicas were dominate peak in the spectrum of ZnSe/GaAs:Se. The PL measurement showed that the ZnSe/GaAs:Se epilayer was obviously converted into the p-type and its origin of the I_1^d is related to V_{Zn}. The acceptor-impurity binding energy of the I_1^d was estimated to be 268 meV. The I_1^d was related to the Zn-site replaced by the residual Cu-impurity. The origin of the SA emission may be associated with a complex donor like a $(V_{Se} - V_{Zn}) - V_{Zn}$.

References

[1] O. Madelung, in Landolt-Brönstein : Numerical Data and Functional Relationships in Science and Technology, Springer-Verlag, Berlin, 1982, New series, Group III, Vol. 17b.

† corresponding author): Kwangjoon Hong, e-mail:kjhong@chosun.ac.kr:, Tel:062-230-6637

Address: Department of Physics, Chosun University