Journal of Luminescence 40&41 (1988) 333–334
North-Holland, Amsterdam

A STUDY OF TWO DEEP ELECTRON TRAPS IN ZnSe CRYSTALS

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The properties of two deep electron traps with activation energies E_c-0.29eV and E_c-0.33eV in ZnSe crystals are studied by ODLTS and DLTS techniques. The former trap is attributed to a defect and the latter is ascribed to an impurity or a complex center associated with an impurity.

1. INTRODUCTION

In recent years, interest in ZnSe has increased considerably as a potential condidate for blue light emitting diode[1]. The role of deep levels in ZnSe crystal has been a major subject in the fabrication of low resistivity bipolar materials, but the exact nature is controvertible[2,3]. In this paper we describe the properties of two deep electron traps with activation energies of E_c-0.29eV and E_c-0.33eV in ZnSe crystals.

2. EXPERIMENTAL

Nominally undoped ZnSe crystals were grown by subilimation. ZnSe dice with thickness of 1mm were annealed in molten zinc at 900 °C for 100h to obtain low resistivity. Er^{3+} ions with energy of 100keV and dose of $1x10^{15}cm^{-2}$ were implanted into the low resistivity ZnSe substrate at room temperature. Annealing ZnSe:Er^{3+} was performed in N_2 atmosphere. After annealing,a diode was fabricated by making an ohmic contact on the substrate and evaporating Au electrode on the implantation surface of the substrate. ODLTS spectra[4] were measured using a Model NJ-M-DLTS instrument added light pulse from a flash lamp.

3. RESULTS AND DISCUSSION

Fig. 1 shows the ODLTS spectra of undoped ZnSe (curve a), Unannealing ZnSe:Er^{3+} (curve b) and ZnSe:Er^{3+} annealed at 350 °C for 20 min in N_2 atmosphere (curve c). From the Arrhenius plot the activation energies of four deep electron traps are obtained at E_c-0.29, 0.33, 0.42 and 0.72eV, respectively. It was found that the concentration n_1 of E_c-0.29eV trap in ZnSe could be increased by Er^{3+} ions implantation and decreased by annealing the ZnSe:Er^{3+} crystal in N_2 atmosphere. We know that the implantation with high energy ions can produce the radiation damage and form some defects in the crystals, which can be removed by annealing. According to the experiment results, it is reasonable to think that the E_c-0.29eV trap could be ascribed to some defects which increased by radiation

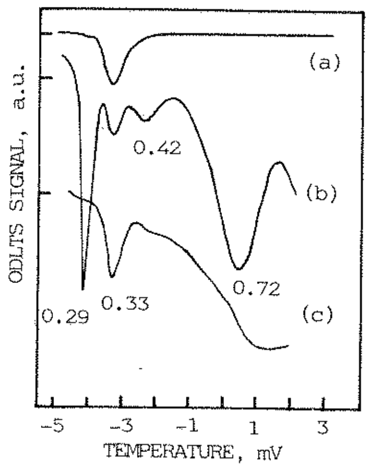

FIGURE 1
ODLTS spectra of ZnSe and ZnSe:Er^{3+}, e_{max}=9.48s^{-1}.

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(North-Holland Physics Publishing Division)

TABLE 1
The dependence of n and n_2 on number of purification cycle (PC) of ZnSe materials.

ZnSe No.	408	413	420
PC	0	1	2
$n(cm^{-3})$	2.0×10^{15}	7.0×10^{14}	1.1×10^{14}
$n_2(cm^{-3})$	1.2×10^{15}	1.6×10^{13}	1.8×10^{12}

damage and disappeared by annealing.

In contrast the concentration n_2 of E_c-0.33eV trap remained unaltered as shown in Fig. 1. Table 1 shows the electron concentration (n) and the concentration (n_2) of E_c-0.33eV trap as a function of repetition of purification cycles (PC) of ZnSe materials. n is determined by measuring C-V dependence and n_2 is by DLTS. It is clear that n and n_2 decrease with increasing the number of purification cycles of ZnSe materials. Fig. 2 shows that the intensity of E_s band related to the free exciton emission increases and the emission bands related to impurities decrease and disappear in the EL spectra at 77K with increasing the number of purification cycles of ZnSe materials. On the basis of mentioned results, it is possible to consider that the electron trap with activation energy of E_c-0.33eV can be ascribed to an impurity or a complex related to an impurity, such as a complex of a native defect and a residual impurity[6].

In conclusion, we describe the origin of two deep electron traps with activation energies of E_c-0.29eV and E_c-0.33eV in ZnSe crystals. The former is attributed to a defect and the latter is ascribed to an impurity or a complex center associated with an impurity.

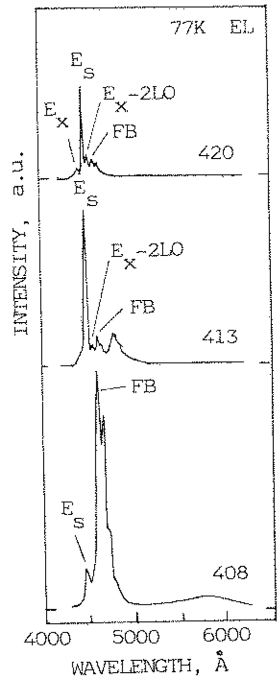

FIGURE 2
EL spectra in No. 408, 413 and 420 ZnSe crystals.

This work was supported by the National Natural Science Foundation of China.

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