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THE EFFECT OF ANNEALING ZnSe CRYSTAL IN MOLTEN ZINC ON ITS ELECTRICITY AND LUMINESCENCE

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With annealing ZnSe crystal in molten Zinc, the mobility (μ) and the carrier concentration (n) increase, as well as the blue exciton emission also increases in ZnSe crystal, it indicates that the quality of ZnSe crystal and the blue electroluminescence (EL) emission in ZnSe MIS doides at RT can be improved.

1. INTRODUCTION

There has been considerable interest in blue EL emitted by forward-biased ZnSe MIS diodes[1-3]. In our earlier work, attention was focused on the origin of the blue emission band in ZnSe crystal[2]. Recently we have reported the effects of ZnSe crystal quality on its blue EL[4]. This paper describes the effect of annealing ZnSe crystal in molten zinc on the properties of its electricity and electroluminescence.

2. EXPERIMENTAL

Nominally undoped ZnSe crystals were grown by sublimation. Dice with thickness of 1mm were cut from the crystal, then annealed in molten zinc at 900°C for different time to obtain different resistivities, and the ZnSe MIS diodes were prepared from these annealed crystals[3].

The resistivity (ρ), carrier concentration (n) and electron mobility (μ) are measured using van der Pauw method. The luminescence spectra are measured using a 44W grating monochromator with a C31034 photomultiplier which is cooled down to the temperature of -30°C.

3. RESULTS AND DISCUSSION

Fig. 1 shows the variation of ρ , n and μ of ZnSe crystal, as a function of the annealing time (t). It is found that ρ decreases with t increasing, but n and μ increase with t

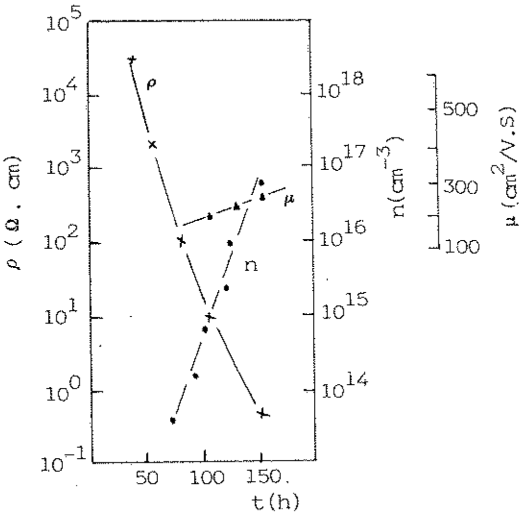

FIGURE 1
Variation of ρ , n, μ of ZnSe crystal with t.

increasing.

It is well known[5] that annealing ZnSe dice in high purity molten zinc could remove the compensating acceptors like copper, and the native charge defect centres like zinc vacancy. Thus the ZnSe dice after annealing are found to have high conductivity and large mobility. The increase of the mobility shown in Fig. 1 indicates the improvment of ZnSe crystal quality with increasing the annealing time.

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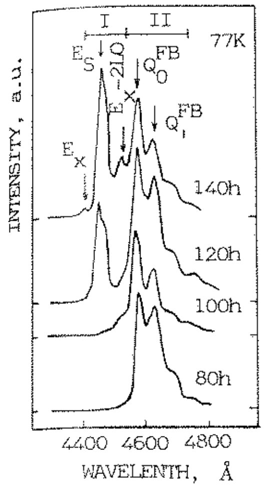

FIGURE 2
EL emission spectra of ZnSe at 77K.

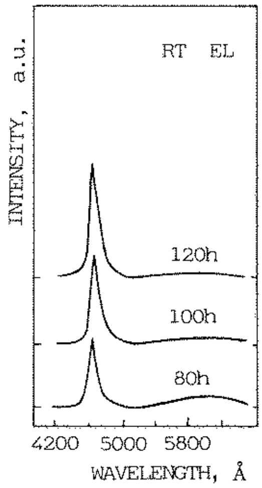

FIGURE 3
EL emission spectra of ZnSe at RT.

Fig. 2 shows the EL emission spectra at 77K in forward-biased ZnSe MIS diodes with different annealing time. The emission bands have been labeled according to the nomenclature adopted by Fan and Woods[2]. When the ZnSe crystal is annealed in molten zinc at 900°C for 80-100h, the dominant feature of the EL emission spectra in region II in Fig. 2 is a series of bands labeled Q_0^{FB}, Q_1^{FB}, ..., which are the free-to-bound recombination[2]. As the annealing time increases to 120h, the exciton emission band E_s appears in region I. After the annealing time increases to 140h, the emission intensity in region I is stronger than that in region II, and no deep center emission can be detected. It is worthwhile to note that the E_x band at 4437Å-(2.794eV), and the E_x-2LO band at 4540Å(2.731eV) can be resolved in Fig. 2. The E_x and E_x-2LO bands are referred to as free exciton emission with zero and two LO phonons, respectively[2], where the energy separation between E_x and E_x-2LO bands corresponds to the energy of two LO phonons in ZnSe. The results indicate that the quality of ZnSe crystal is improved after annealing ZnSe crystal in molten zinc.

The EL emission spectra at RT in the ZnSe MIS diodes mentioned above with different annealing time are shown in Fig. 3. A blue emission E_s band at 4600Å is prominent in the spectra, which is related to free exciton recombination[2], and a weak deep center emission SA band is located at about 6000Å, which is associated with self-activated center. An increase of intensity ratio of E_s blue band to SA deep center band is found with increasing the annealing time. The results show that the blue EL in ZnSe at RT can be improved by annealing in molten zinc.

In summary, therefore, it can be concluded that the quality of ZnSe crystal, as well as the blue EL in ZnSe MIS diodes at RT can be improved by annealing ZnSe crystal in molten zinc.

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