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ELECTROLUMINESCENCE OF Er^{3+}-IMPLANTED ZnSe MIS DIODES

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The ZnSe:Er^{3+} MIS diodes were prepared using Er^{3+}-implantation technique at room temperature. The origin of the I layer was investigated, and the green high-field electroluminescence of Er^{3+} was obtained in the forward biased ZnSe:Er^{3+} MIS diodes.

1. INTRODUCTION

ZnS:RE^{3+} and ZnSe:RE^{3+} MS diodes[1,2,3] have been fabricated by using ion implantation technique, and give high-field electroluminescence of RE^{3+} in reverse bias. In this paper, the ZnSe:Er^{3+} MIS diodes were first prepared by Er-- implantation at room temperature. The origin of I layer was investigated, and the green high-field electroluminescence of Er^{3+} was first obtained in the forward biased ZnSe:Er^{3+} MIS diodes.

2. EXPERIMENTAL

ZnSe crystals used in this study were grown by sublimation method in our laboratory. Erbium ions with energy of 100 keV and dose of $1X10^{15}/cm^2$ were implanted into low resistivity ZnSe crystals at room temperature. Annealing was performed in N_2 atmosphere, after annealing the ZnSe: Er^{3+} diodes were prepared by evaporating Au electrode on the implantation surface and making an ohmic contact on the opposite surface of dice.

The C-V characteristics were measured by M-410 C-V plotter, and the optical DLTS(ODLTS) spectra were measured using a Model NJ-M-DLTS instrument added light pulse of a flash lamp and the EL spectra were measured using a Model 44W grating monochromator with a C31034 photomultiplier.

3. RESULTS AND DISCUSSION

The result of C-V measurement indicates that Er^{3+}-implanted ZnSe diodes annealed in N_2 atmosphere have MIS structure. Fig. 1 shows the thickness of the I layer d_i in the ZnSe:Er^{3+} diodes as a function of annealing temperature T.

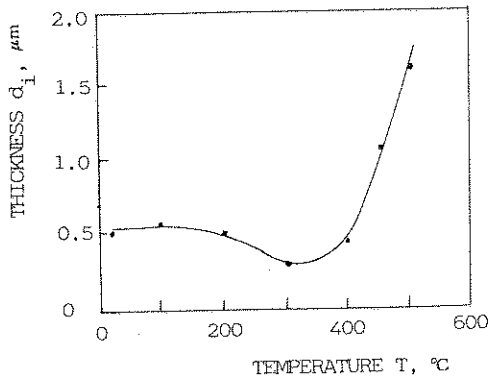

FIGURE 1
Dependence of the thickness of the I layer d_i on annealing temperature T in ZnSe:Er^{3+} diodes.

Fig. 2 shows the ODLTS spectra of unimplanted ZnSe (a), unannealed ZnSe:Er^{3+} (b) and ZnSe:Er^{3+} annealed at 300 °C (c). It is found that there are two levels, E_c-0.42eV and E_c-0.72eV, in the ZnSe:Er^{3+} diode. The ODLTS

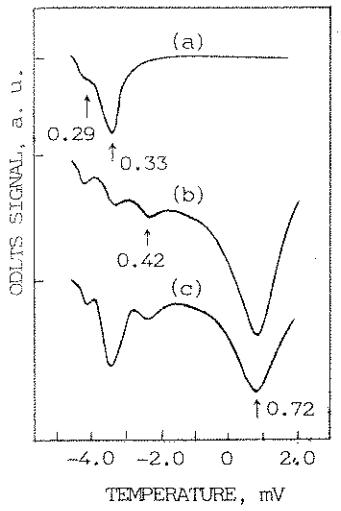

FIGURE 2
ODLTS spectra in ZnSe crystals.

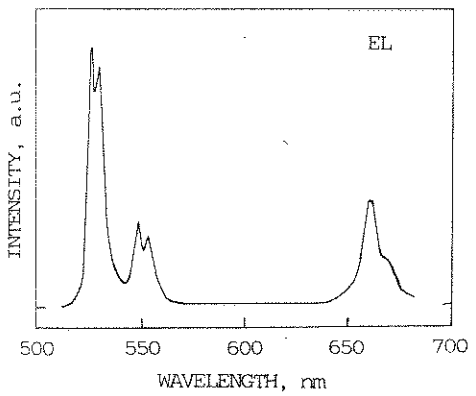

FIGURE 3
EL spectra in the forward-biased ZnSe:Er^{3+} MIS diodes.

spectra of an unannealed Er^{3+}-implanted ZnSe wafer at different etching depth in implanted layer were also measured. It is obvious that the range of radiation damage is approximately equal to the thickness of the I layer in the diode. From these results it can be concluded that the I layer in the diode is caused by radiation damage.

From the theory of ion implantation[4], it can be calculated that the projected range of the Er^{3+} ions lie in the I layer of the diodes. Green electroluminescence of Er^{3+} in forward-biased ZnSe:Er^{3+} MIS diodes is obtained, as shown in Fig. 3. Since the dependences of B and I on V of the diodes can be expressed as $B \propto \exp(-b/\sqrt{V})$, $I \propto \exp(-b/\sqrt{V})$, respectively, and the intensity ratio of 5300 Å line to 6700 Å line increases with increasing the forward voltage, the Er^{3+} ions are excited by hot electron through direct excitation. Thus the luminescent mechanism of the diodes is similar to that of GaN:Zn MIS diodes[5]. Since rare-earth ions are effective luminescent center in high electric field, the luminescent efficiency is likely to be high in this kind of diodes.

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