Journal of Luminescence 31 & 32 (1984) 957-959
North-Holland, Amsterdam

SPATIAL DISTRIBUTION OF BLUE ELECTROLUMINESCENCE IN ZnSe MIS DIODES

Fan Xi-wu, Zhang Ji-ying, Zhang Zhi-shun, Wang Shou-yin, Lu An-de, Li Wei-zhi, Jiang Jin-xiu and Sun Yao-wu

Changchun Institute of Physics, Academia Sinica, Changchun, China

Blue electroluminescence (EL) in ZnSe MIS diodes using ZnS polycrystal film as an insulating layer appears as a few scattered bright spots. The origin of these electroluminescent spots (ELS) could be attributed to the introduction of insulating ZnS layer. The homogeneity of blue EL has been improved when a ZnSe polycrystal film instead of a ZnS polycrystal film was used as an insulating layer in ZnSe MIS diodes.

1. INTRODUCTION

In recent years there has been considerable interest in blue EL emitted by forward-biased ZnSe MIS diodes[1-4]. In our earlier work[3, 4], attention was directed to determining the origin of two emission bands in the blue at 4655 and 4770 Å at room temperature. In the present paper the main interest is focused on the spatial distribution of blue EL in ZnSe MIS diodes.

2. EXPERIMENTAL

Nominally undoped ZnSe crystal, grown in this laboratory, were used in the present experiments. The boule crystals were grown from the vapour phase in sealed capsules containing slight excess of zinc[5]. Dice with dimensions of 3X3X1 mm^3 were cut from the boules, and annealed in molten zinc at 850 °C for 100 h to reduce their resistivities to the range 1-10Ωcm. After polishing and etching, one large area face of the dice was then provided with an indium ohmic contact. A thick (500-1,000 Å) layer of ZnS was deposited on the opposite face by electron beam, and finally a circular gold electronde 1 mm in diameter was evaporated on top of ZnS layer.

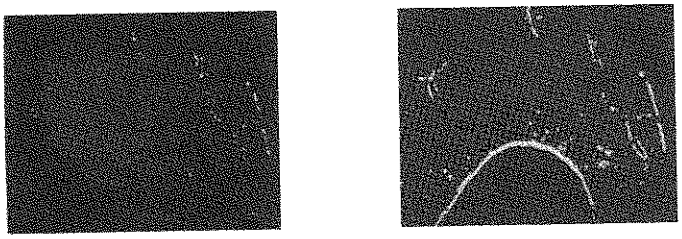
The photo of EL spots was taken from the surface of the dice carrying the gold contact with Model XJL-01 optical microscope.

Model HHS-2X scanning electron microscope has been used to study the ZnSe diodes.

3. RESULTS AND DISCUSSION

With an optical microscope it was observed that the blue EL in ZnSe MIS diodes appears as a few scattered bright spots dispersing on the crystal surface closed to the gold electrode. The number, size and intensity of the EL spots increase with the increase of the current density passing through the diode.

Using scanning electron microscope, it was found that the electron beam-induced current image (EBICI) corresponded to the EL spots observed with optical microscope for ZnSe MIS diodes, as shown in Figure 1. However both the absorbed electronic current image of low-resistivity ZnSe dice and the EBICI of ZnSe MS diodes are homogeneous.

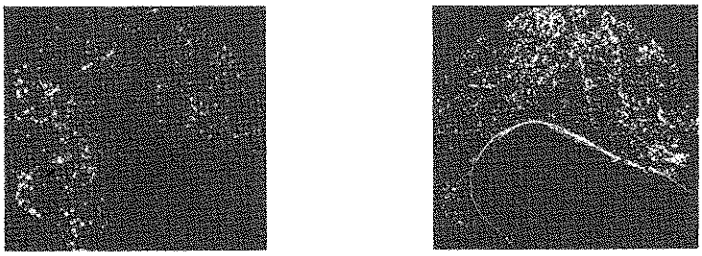


(a) ELS (X50) (b) EBICI (X50)

FIGURE 1
ELS (a) and EBICI (b) in ZnSe MIS diode with ZnS polycrystal film as an insulating layer

On the ground of the above results, it is concluded that the distribution of resistivity of ZnSe dice along the crystal surface is homogeneous and the ZnSe crystal is flawless. The origin of nonuniformity of EBICI as well as of ELS must be attributed to the introduction of the insulating ZnS layer. Since in this case there is considerable mismatch of energy band, it is reasonable to think that more nonradiative recombination centers exist in the insulator-semiconductor interface of the ZnSe MIS diode.

It was expected that if a homo-insulating layer is used in fabricating the ZnSe MIS diode, the homogeneity of EL emission could be improved. A new ZnSe MIS diode was made in which a ZnSe polycrystal film instead of a ZnS polycrystal film was used as an insulating layer. It was found that the ELS as well as the EBICI became densely packed spots in the diodes, as shown in Figure 2, and the ELS in the diodes appeared homogeneous when observed with naked eyes.



(a) ELS (X50) (b) EBICI (X50)

FIGURE 2
ELS (a) and EBICI (b) in ZnSe MIS diode with ZnSe polycrystal film as an insulating layer

We believe that perfectly uniform EL emission could be obtained for ZnSe MIS diode if a ZnSe epitaxial layer is used as the insulating layer.

REFERENCES

1) M. Yamaguchi, A. Yamamoto and M. Konde, J. Appl. Phys. 48 (1977) 196.
2) M. Yamaguchi and A. Yamamoto, Japan J. Appl. Phys. 16 (1977) 77.
3) X.W. Fan and J. Woods, IEEE Trans. ED ED-28 (1981) 428.
4) X.W. Fan and J. Woods, J. Phys. C. Sol. St. Phys. 14 (1981) 1863.
5) J.R. Cutter and J. Woods, J. Crystal Growth 47 (1979) 405.