SOME OPTICAL PROPERTIES OF CVT GROWN ZnNiSe AND Se TREATED ZnSe SINGLE CRYSTALS.

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Abstract

Good quality ZnSe single crystals were grown by chemical vapour transport (CVT). A group was grown with 5% nickel while a second group was post heat treated in a selenium atmosphere. By measuring some of their optical properties, it was found out that ZnNiSe is a good material for infrared windows since the FTIR measurements confirmed its transparency up to 400 cm^{-1} with a 65% transmittance; while the Se treated ZnSe produced a good photosensitive material in the 400nm region attributed to a high density of state within the valance band caused by the excess selenium 4s electrons.

Keywords: CVT Zinc-Nickel-Selenide and Se treated Zinc Selenide.

INTRODUCTION

Ni based ZnSe alloy posses a high melting point and therefore, the Bridgman high pressure technique is generally used to obtain good quality material.

Also, in a quest for p type ZnSe blue material, some attempts have been carried out by heat treating in Se [1], but photoconductivity, which is an important property for photonic devices, has not been thoroughly examined.

On the other hand, the gap between develop countries and developing ones is increasing so fast, that these must implement their own inexpensive techniques in order to be competitive within themselves.

The aim of the present work, therefore, is to demonstrate that, in third world countries, it is possible to use a relatively cheap technique, as CVT, to grow good quality material for industrial applications like infrared windows and state detectors in the near UV region.

EXPERIMENTAL

The crystals were grown using iodine as the transport agent, which details are explained elsewhere [2], and small but good crystals were obtained. The selenium treatment was carried out at 3.5 atm of Se (800°C) for 24 h. For the ZnNiSe, a fine mixture of ZnSe and NiSe was employed.

The photoconductivity spectra of the Se treated material were recorded with a computer controlled apparatus [3], while the FTIR measurements on the ZnNiSe were carried out with a Perkin Elmer FTIR PE 1725X spectrometer, in the 4000 to 400 cm^{-1} range.

RESULTS AND DISCUSSION

Figure 1. shows the transmission spectrum for the $Zn_{0.95}Ni_{0.05}Se$ crystal at room temperature. A small reduction in transparency near 4000 cm^{-1} is probably due to Ni^{2+} intraionic transition $3F(T_1)$ to $3F(T_2)$ [4], but keeps the overall transmittance well above 65% in the investigated range.

Figure 2. shows the normalized photoconductivity spectrum at room temperature of the ZnSe treated in a Se atmosphere. Four peaks are clearly visible, denoted as A (2.98 eV), B (2.72 eV), C (2.55 eV) and D (2.1 eV).

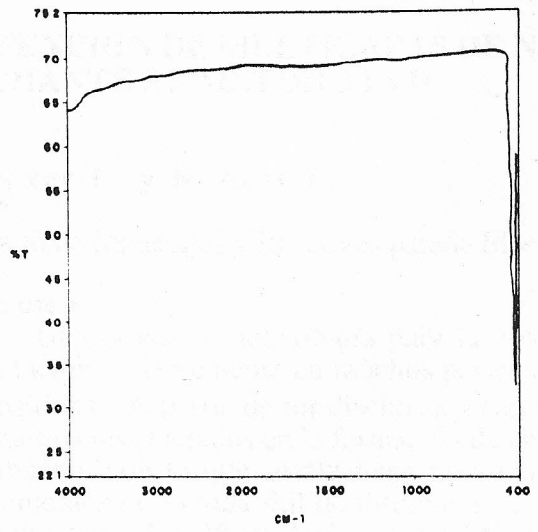

Fig.1.- Transmission spectrum of a CVT grown $Zn_{0.95}Ni_{0.05}Se$ measured by FTIR at room temperature.

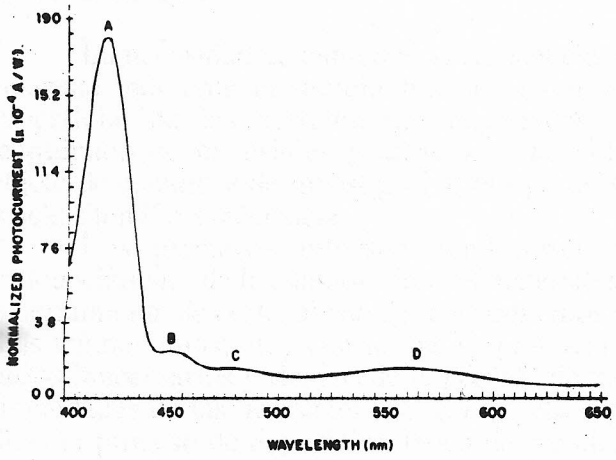

Fig.2.- Normalized Photoconductivity of a Se treated ZnSe CVT grown single crystal recorded at room temperature.

The spin-orbit splitting for this material is expected to give a transition at about 3.1 eV, very close to peak A, but not enough to be its origin. Moreover, comparison with as grown or Zn treated material, confirms that this peak A is only present in Se treated samples; hence, we associate its origin to an excess of selenium atoms, which produce a high density of state within the valance band.

Since the band gap at room temperature for ZnSe is 2.7 eV, peak B must then correspond to this band gap transition.

Peak C has been given much attention and its origin seems to be due to transitions of selenium induced states within the band gap (see for example ref. [5]).

Finally, the broad band C, which has been the purpose of several reports (see for example ref. [6]), is still an open issue; and it is not the object of the present work to give more details on this matter except for the fact that this band D is also present in our CVT grown ZnSe with a selenium samples with a selenium post-treatment.

CONCLUSIONS

In this last ZnSe sample treated in a selenium atmosphere, the relative intensities between peak A (in the near UV, i.e., at 415 nm) and peak B, show that this CVT material with a selenium post treatment, becomes a strong candidate as a photonic device in UV light detection.

Both ZnSe crystals reported in this work confirm that a cheap but reliable technique as chemical vapour transport growth may be used in developing countries towards device fabrication.

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