The Photocurrent Studies of ZnTe Thick Films as a Function of Different Parameters.

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Abstract

Thick films of ZnTe compound of fix composition and varying thicknesses are to be formed on glass substrates using simple screen printing technique . The photocurrent study is to be made at dark and illuminated conditions. The spectral response of photocurrent as a function of certain wavelength of incident radiations, bias voltage, time delay and thickness of the films.

Keywords: ZnTe, thick films, glass substrate, photocurrent, wavelength, light intensity.

Introduction

The Zinc tellurium is a II-VI semi conducting material of direct band gap 2.26 eV at room temperature, for the fabrication of high efficiency solar cells and other optoelectronic devices [1]. The ZnTe films grown at room temperature and high temperature substrate are found to be polycrystalline in nature [2]. Optical and thermal activation processes in ZnTe thin films show variation of photo current density for different applied bias voltages and wavelengths [3]. Thermally stimulated current of ZnTe thin films for different dc bias voltages show $I \alpha V^2$ at room temperature [4].

The spectral photo response of ZnTe crystal as a function of wavelength and temperature shows sharp peak at particular wavelength [5]. Mott and Davis [6] looked at the photoconductive response in amorphous semiconductors and presented equations to explain the observed behavior of these materials. Webb and Brodie [7] reported the photoconductivity of amorphous ZnTe have been measured both as a function of temperature and light intensity.

The recombination mechanism was observed to change from monomolecular recombination at high temperature and low light intensity to bimolecular recombination at low temperature and high light intensity.

Experimental details

Thick films of ZnTe (Zinc and tellurium) for photoconductivity measurement are to be prepared by screen printing technique. ZnTe powder (99.99% pure) was calcinated at 400 ^{0}C for 2 hrs in a muffle Furnace. Then this powder is crushed and thoroughly mixed with organic vehicles such as butyl carbitol

acetate (BCA) and ethyl cellulose (EC) are added to this mixture to achieve proper thixotropic properties of the paste.

The ratio of inorganic to organic parts was maintained at 70:30 (ZnTe powder 70 % and the ratio of EC to BCA was 98:2 in 30 %). ZnTe thick films were prepared on glass substrates. The screen of nylon (40 s, mesh no 355) was selected for screen printing. The required mask (2 x1.25 cm) was developed on the screen using a standard photolithography process. The paste was printed on clean glass substrates (5 x 2 cm)with the help of mask.

The pattern was allowed to settle for 15 to 20 minutes in air. The films were dried under infrared radiations for 45 minutes and fired at temperatures of 200, 300, 400 and 500 ^{0}C for 1.5 to 2 hrs (which includes the time required to achieve the peak firing temperature and then constant firing for 30 minutes at the peak temperature) in a muffle furnace.

The film thickness (d) was measured by gravimetric method[8,91] using the relation

$$d=M/(g\ A)\ cm \qquad (1)$$

where

A - is surface area of the film

M - mass of the film

g - the density of the film material, expressed as

$$g = x_1 g_1 + x_2 g_2 \qquad (2)$$

where g_1, g_2 and x_1, x_2 are densities and atomic fractions of Zn & Te elements respectively.

The spectral response of photo current of Zn-Te films were measured at different wavelengths of light , bias voltage, intensity of light and thickness of the film at room temperature. The intensity of incident light was measured with luxmeter (Model 5200, Kyoritsu, and Electrical Instruments works Ltd. Japan)

Results and discussion:-

ZnTe films of different thicknesses are used for dark and illuminated photoconductivity studies under different conditions of measurements. The exposed area for illumination of such radiation intensities was ~2.5 cm2 . The photo response of the films were recorded for different radiation energies at room temperature and under different applied bias voltages.

The spectral response of photocurrent I_{ph} as a function of wavelength (λ) of incident radiations is shown in fig. 1. At a certain wavelength maximum photocurrent I_{ph} was observed irrespective of thickness and composition of the film. The maximum photocurrent was developed at about λ=500 nm corresponding to energy of incident radiations ~ 2.48 eV. This energy of λ_{max} radiation would correspond to energy of activation.

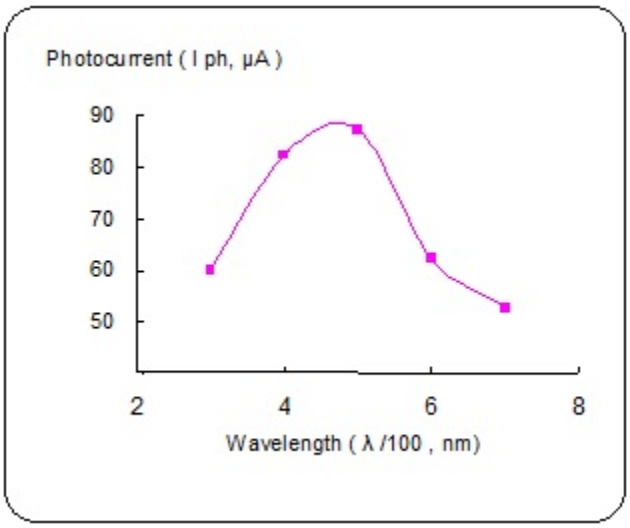

Fig.1: Plot of Photocurrent ($I_{ph,\ \mu A}$) verses wavelength (λ /100, nm) of Zn-Te films at room temperature.

It was observed by previous researchers earlier [8, 9]. The position of peak is same for all curves irrespective of thickness of the deposits. This indicates the fundamental band edge is an intrinsic property of the material.

A close analysis of fig.1 indicates that at a short wavelength the photocurrent rises exponentially to reach maximum value corresponds to λ=500nm. It falls at longer wavelength side from the peak position due to carriers from defects and impurity levels. The fall of photocurrent on the high energy side (short wavelength) arises from bimolecular recombination.

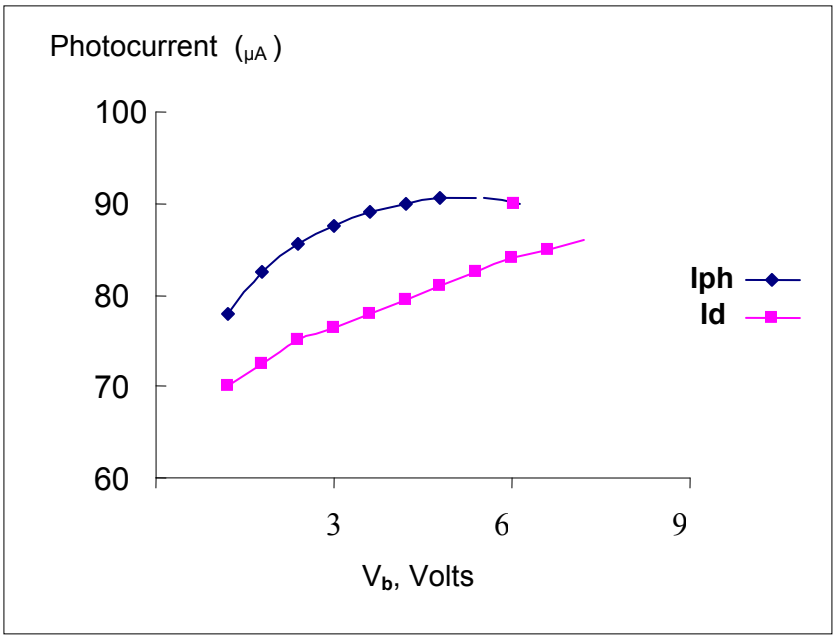

Fig.2: Plot of photocurrent ($I_{ph,}$) at verses applied bias voltage (V_b) of ZnTe films at room temperature of d~22 μm .

The spectral distribution of ZnTe films of fixed thickness at different voltages is shown in fig.2. The photocurrent shows the same behavior for all applied potentials, it is observed from the curves that there is no effect from the applied bias voltage except for making an upward shift to the peak for $I_{t\sim}$ 1500 Lux and at dark conditions. An increase of photocurrent under the influence of increasing light intensity may be due to the generation of new charge carriers liberated from trap centers due to absorption of incident radiation.

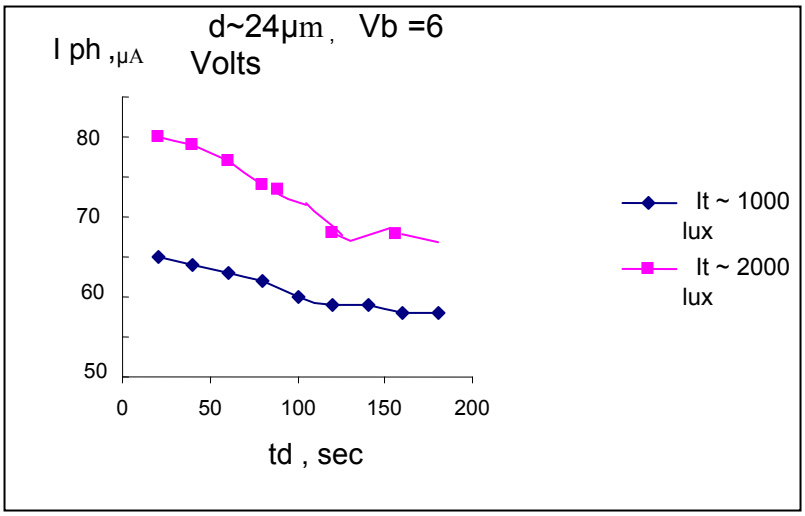

Fig.3: Plot of Photocurrent (I_{ph}) verses time delay (t_d) of ZnTe films at room temperature.

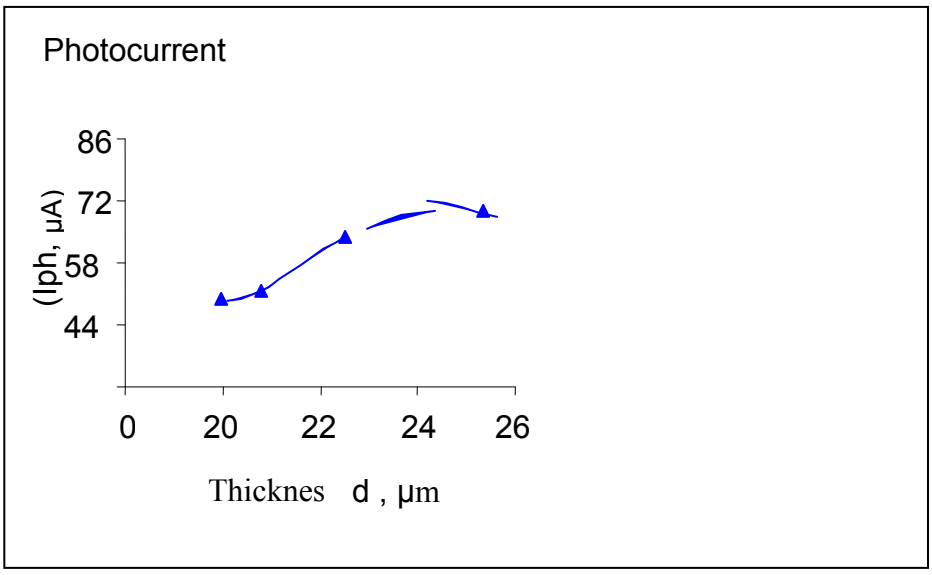

Fig.4: Plot of photocurrent (I_{ph}) verses thickness (d) of ZnTe films at room temperature.

The decay of I_{ph} as a function of time for constant composition and constant thickness at different light intensities shown in fig.3. It can be seen that , the decay rate at high intensity curve exceeds its value compared to lower intensity curve. This could be because at low light intensity, recombination through traps manifests itself and thereby decay rate decreases.

Variation of photocurrent with thickness of the films shown in fig.4. It is seen that photocurrent increases with increase of thickness of Zn-Te films, probably due to lesser density of defects in thicker films .

Acknowledgement

The author greatly thanks to the management authorities of M. G. Vidyamandir, the Principal L.V. H. College, Panchavati Nashik for giving valuable support to do this work.

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