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Photoacoustic Studies on Annealed Indium Zinc Oxide Thin Films

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Abstract

High quality indium doped zinc oxide (IZO) films are prepared by electron beam evaporation technique. The effect of annealing temperature on optical properties was studied in detail. Indium zinc oxide films were subjected to photoacoustic spectroscopic (PAS) analysis and the optical band gap value is estimated from the normalized photo acoustic signal with respect to the wavelength. To check the band gap values and its variation with annealing temperature, the films were subjected to UV-Vis-NIR spectroscopic analysis. The obtained band gap values are well comparablewith the values obtained from PAS studies. The optical band gap values are found to increase with increase in annealing temperature.

Keywords: indium zinc oxide films, optical properties, photoacoustic spectroscopic studies, UV-Vis-NIR spectroscopic studies.

INTRODUCTION

Photoacoustic spectroscopy (PAS) has emerged as an important tool for the accurate evaluation of the optical properties of a large variety of materials, especially semiconductors [1]. It plays a vital role in the material science since it covers its use from metallurgy to nano –science. The first report on the photoacoustic effect goes back to the eighteenth century when Bell [2] heard the sound generated by the sample that was illuminated with the modulated sunlight.

EXPERIMENTAL TECHNIQUES

IZO thin films were deposited on glass substrates using a sintered gallium zinc oxide target by electron beam deposition technique. Pre cleaned glass substrates were loaded in the vacuum chamber for IZO film preparation. The target material was prepared which was required for the electron beam evaporation by mixing of high purity ZnO and In_2O_3 powder in the proportion 99:1 (wt. %)using ball mill for 2 hrs and the material was made as a pellet and was sintered at 1100 ^oC. Thin films were deposited for 3 minutes with the approximate current of 30 mA and 5 kV as accelerating voltage. The films were prepared at room temperature and annealed at200 ^0C and 400^0C.

The Prepared thin films were subjected to photoacoustic spectroscopy and HR-2000 ocean optics UV-Vis-NIR spectroscopy to determine its optical band gap.

Instrumentation

An open photoacoustic cell configuration [3] is employed in the heat transmission configuration in the present study. In this configuration, the sample is enclosed in the air-tight cell with the electrets microphone to keep the cell from the outside atmosphere. The sample is mounted on the top of the electrets microphone, leaving a small gap between the sample and the microphone. The sample is exposed to the chopped beam of polychromatic light. After absorption of light, it is converted into heat through non-radiative de-excitation processes. The pressure fluctuations produced in the gas which is surrounded the sample and the microphone inside the cell causes deflections on the microphone diaphragm, which generates the voltage in the output of the microphone. This voltage is fed to the lock-in amplifier to record the signal amplitude and phase with respect to the chopping reference of the light incident.

In the present photoacoustic spectroscopy experiment, 450 W Xe-lamp (Horiba Jobin Yvon, USA) is used as the source. The sample is placed in the photoacoustic cell and the mike is placed very close to the sample. To get the modulated light, a mechanical chopper (C-995, Tetrahertz technologies Inc., USA) is used with the source. The PA signal from the microphone is fed to a lock-in amplifier (SR-830 DSP Standard Research, USA). The light is allowed to fall on the sample through a monochromator (Triax 180, Horiba JobinYvon, USA). The schematic diagram of photoacoustic spectrometer is shown in Fig.1.

Result And Discussion

Photoacoustic Spectroscopic Analysis

The photoacoustic spectra of indium zinc oxide films deposited at room temperature and annealed at 200 and 400 ^{0}C is shown in Fig.2. The band gap is estimated from the normalized photoacoustic signal with respect to wavelength. From the origin of the absorption (dips), the optical band gap values are obtained.

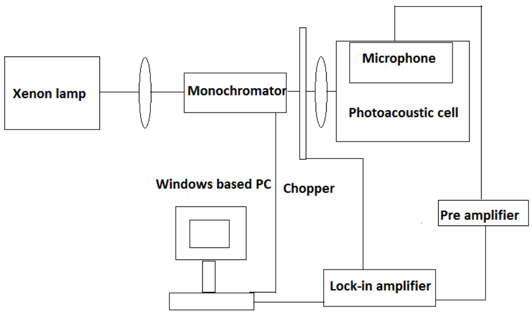

FIGURE 1. Schematic diagram of photoacoustic spectrometer.

The band gap value of as prepared IZO film is 3.06 eV. When annealing temperature increases, the band gap value is also increases. Its value is 3.18 and 3.22 eV for 200 and 400 ^{0}C annealed IZO thin films.

UV-Vis-NIR Spectroscopic Analysis

The optical band gap of indium zinc oxide films were determined from the plot of $(\alpha h\nu)^2$ versus the photon energy called the tauc plot. The tauc plot of as prepared and annealed indium zinc oxide films were shown in Fig.3. The optical band gap of as prepared indium oxide thin film is 3.07 eV. Its value increases to 3.13 and 3.26 eV when the film is annealed at 200 and 400 ^{0}C respectively.

Conclusion

The optical band gap increases with increase in annealing temperature. The band gap value obtained from UV-Vis-NIR spectrometer is comparably equal to the value obtained from PA spectrometer.

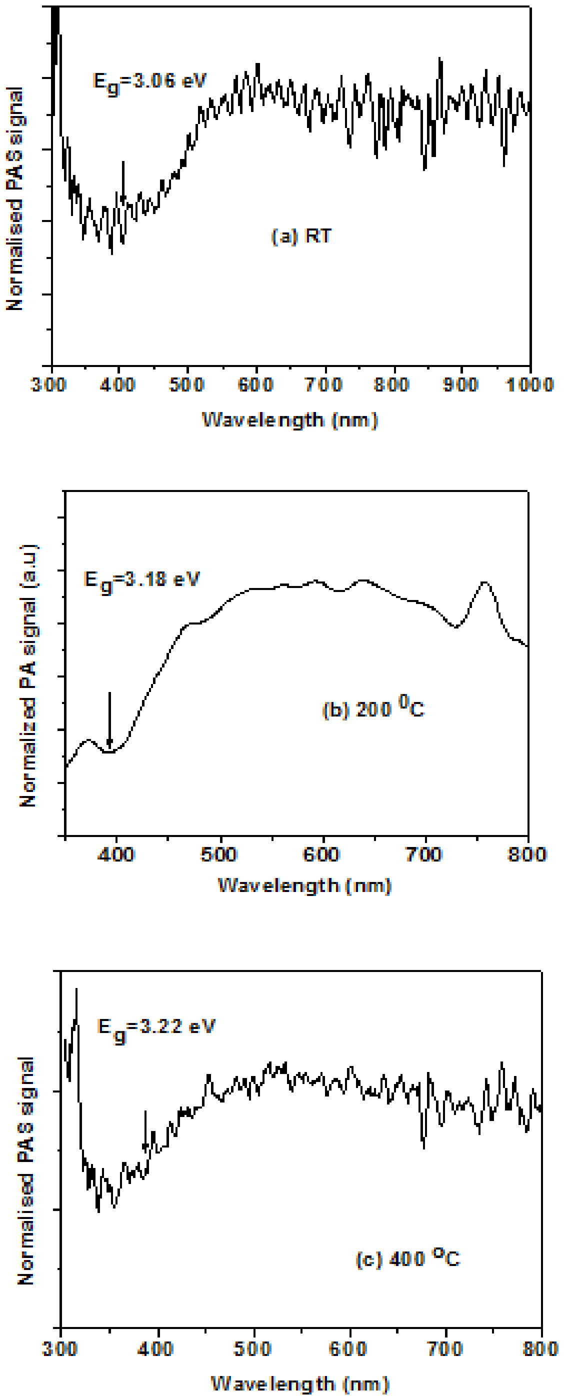

FIGURE 2.Photoacoustic spectra of IZO thin films.

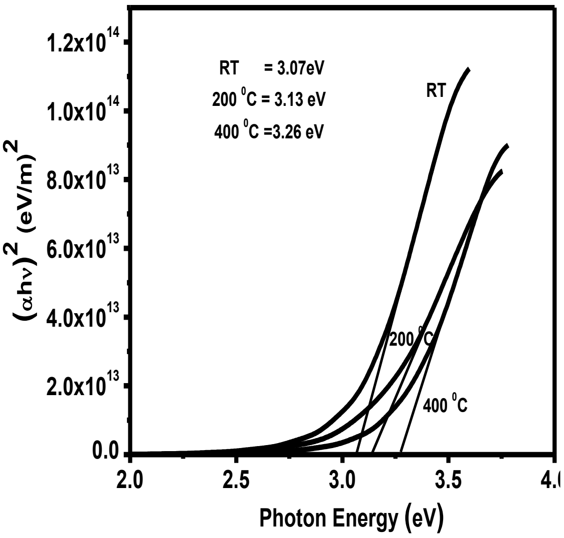

FIGURE 3. Plot of $(\alpha h\nu)^2$vs. photon energy of IZO films\

REFERENCES

1. W.M.M. Yunus, C.Y.J. Fanny, T.E.Phing, S.B. Mohammed, S.A. Halim, M.M. Moksin, J. Mater. Sci., 37 (2002) 1055.
2. Bell. A.G., Am. J. Sci., 20 (1880) 305.
3. P. Halender, J. Appl. Phys., 59 (1986) 3339.