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Electrical Properties of $Zn_{1-x}Cu_xO/Si$ Thin Film

Min Maung Maung¹ and Aye Myat Minn²

Abstract

As a wide band semiconductor with a large binding energy (about 60 meV) ZnO is a promising candidate semiconductor material for the next generation of optoelectronic light emission or high power and high frequency devices. $Zn_{1-x}Cu_xO$ films have been grown on Si substrate by using Thermal diffusion method. The structural properties of these films were examined by XRD. The electrical properties of these thin films are also described. In these research work, quantum yield, fill factor (F_f) and conversion efficiency (η_{con}) are evaluated at different light intensities.

Key words: optoelectronic, quantum yield, fill factor, and conversion efficiency.

Introduction

ZnO is promising candidate for photovoltaic devices and group II-VI compound semiconductor. Interesting aspects of ZnO include the anisotropy in crystal structure, a wide band gap, refractive index, and its large piezoelectric constant. Recently wide-band semiconductors have attracted great interest, because their future possible applications in many areas, such as UV sensors, light-emitting diodes (LEDs), laser diodes (LDs), and other high-speed high-power electronic devices. ZnO is a promising candidate for the next generation electronic devices due to its good properties. ZnO is a direct wide band gap semiconductor ($E_g \sim 3.3$ eV at 300 K), which is suitable of production of high emitting devices in the visible range of green, blue, ultraviolet, or white light.

Since ZnO films are most expected to be applied in optical area, it is important to investigate the optical properties of different ZnO films. Not only does it help us to analyze the structure and other properties of ZnO, but also it contributes to the optimization of the growth process of ZnO, or to the application of optical devices. Currently it is hard to find a highly efficient p-type dopant. Usually, undoped ZnO films show to be n-type with a high electron densities, due to intrinsic defects. n-type ZnO doped with Al, Ga, and In metals can achieve high conductivity property. Due to the compensation of the low-energy native defects, it is difficult to grow p-type

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ZnO films. Lithium, Copper, Silver, Zinc are the possible candidates of acceptor in ZnO.

The ultimate aim of this study was to investigate some of the important electrical properties of the Cu doped ZnO thin films deposited on the silicon at different temperatures (700°C, 800°C and 900°C). The structural properties of these films are examined by XRD. Four point Probe and press-contact are used for detection of the electrical properties. The efficiency and lattice parameters of these thin films are also calculated.

Experimental Procedure

The p-type Si (100) wafers are used as substrate material. ZnO and Cu (1:1) are mixed and is ground together to obtain the homogeneity. 2-methoxyethanol ($\text{CH}_3\text{OCH}_2\text{CH}_2\text{OH}$) is added to the mixture and then stirred and heated in a vessel with water both at 90°C for one hour. The homogeneous precursor solution is obtained when the mixture was cooled down to room temperature. The substrates used in the study are p-Si (100) with dimensions 1.0 cm x 1.0 cm, the 0.625 mm thickness and the resistivity is (1-100 Ωcm). Firstly the substrate is immersed in acetone for 30 minutes. After that, it is rinsed by deionized water (DI water) for 10 minutes and subsequently dry at room temperature.

After clearing process, the precursor solution was deposited onto substrates by spin coating technique. Later, layers were first dried at room temperature and annealed at 700°C, 800°C, and 900°C respectively by conventional annealing process. After annealing step, these samples were cleaned in the mixture of $\text{HF}:\text{H}_2\text{O}$ (1:5) for 3 minutes. Finally, $\text{Zn}_{0.5}\text{Cu}_{0.5}\text{O}/\text{Si}$ junction layer were achieved.

Result and Discussion

Within $\text{Zn}_{0.5}\text{Cu}_{0.5}\text{O}:\text{Si}$ thin films were analyzed by (i) X-ray diffraction (XRD), (ii) The investigation of current-voltage (I-V) characterization by press-contact probe (four-point) method. The room temperature XRD pattern is shown in figure 1. From XRD result, it is found that (100), (002), (102), (110), (103), (200), (112) and (201) diffraction peaks from these films where the corresponding 2θ values are 31.8°, 34.45°, 36.3°, 47.6°, 56.65°, 62.9°, 66.4°, 68° and 69.1° respectively. $\text{Zn}(\text{Cu})\text{O}/\text{Si}$ films are hexagonal wurtzite crystal structure and agree with the standard JCPDS. The lattice parameters are also in the Table.

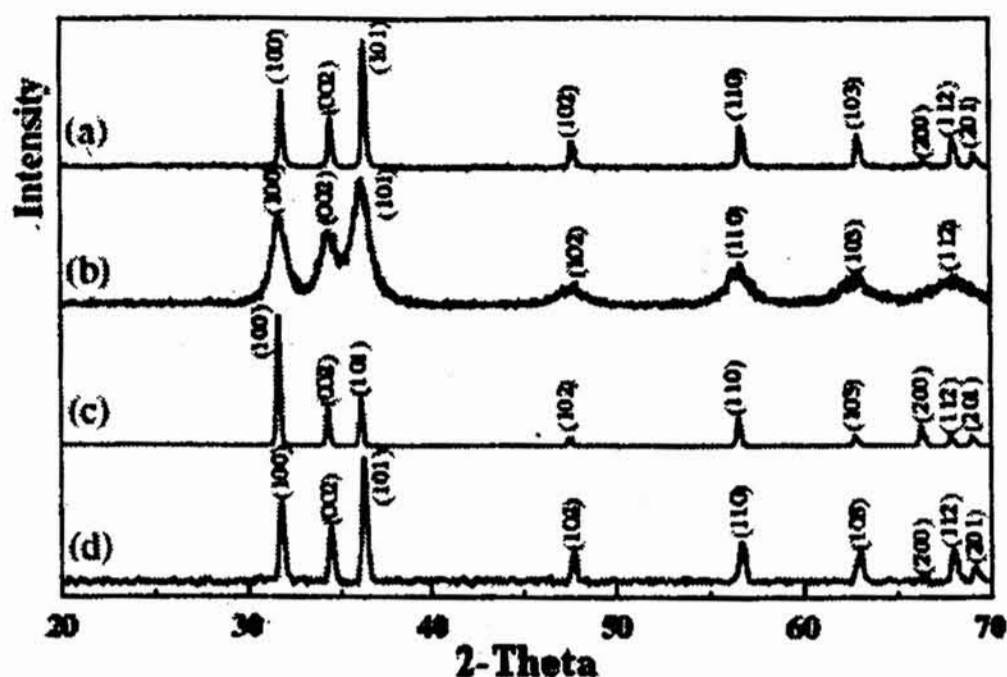


Fig 1: The room temperature XRD spectrum of $Zn_{0.5}Cu_{0.5}O/Si$ thin film. (a) $700^{\circ}C$ (b) $800^{\circ}C$ (c) $900^{\circ}C$ (d) standard (JCPDS)

Table: The lattice parameters of $Zn_{0.5}Cu_{0.5}O/Si$ thin film

	a(Å)	c(Å)	c/a
$Zn_{0.5}Cu_{0.5}O$ ($700^{\circ}C$)	3.2551	5.2134	1.6016
$Zn_{0.5}Cu_{0.5}O$ ($800^{\circ}C$)	3.2452	5.2086	1.6050
$Zn_{0.5}Cu_{0.5}O$ ($900^{\circ}C$)	3.2501	5.2172	1.6052

From current-voltage (I-V) characterization, the current was increased exponentially with increased applied voltage across $Zn_{0.5}Cu_{0.5}O/Si$ cells structure in normal condition, dark condition and illumination condition. The value of photovoltage was slowly increased with an increased illumination range from 500 lux to 1500 lux and slightly increased after 2000 lux in all present thin films. The maximum photovoltage was obtained 3.18 V at $700^{\circ}C$, 4.05 V at $800^{\circ}C$ and 4.15 V at $900^{\circ}C$. The value of photocurrent was gradually increased when irradiated condition from 500 lux to 2000 lux but slowly decreased after the light intensity after 2000 lux in all present thin films. The maximum photocurrent was obtained 19.21 mA at $700^{\circ}C$, 24.01 mA at $800^{\circ}C$ and 25.38 mA at $900^{\circ}C$. The maximum value of conversion efficiency (4.86 %) at process temperature $800^{\circ}C$ and quantum yield (0.085) of $Zn_{0.5}Cu_{0.5}O$ epilayer at temperature $800^{\circ}C$ and fill factor value (0.68) are achieved at this temperature process.

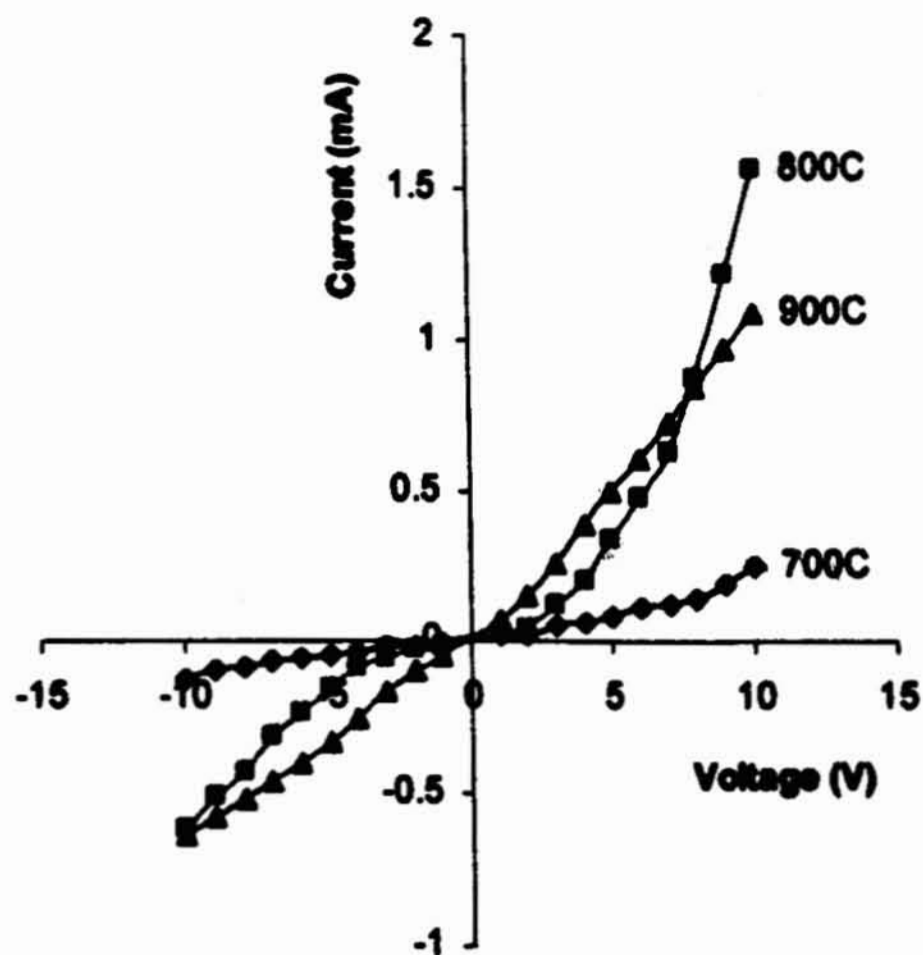


Fig 2: The I-V characteristics of Zn_{0.5}Cu_{0.5}O:Si thin film in dark condition

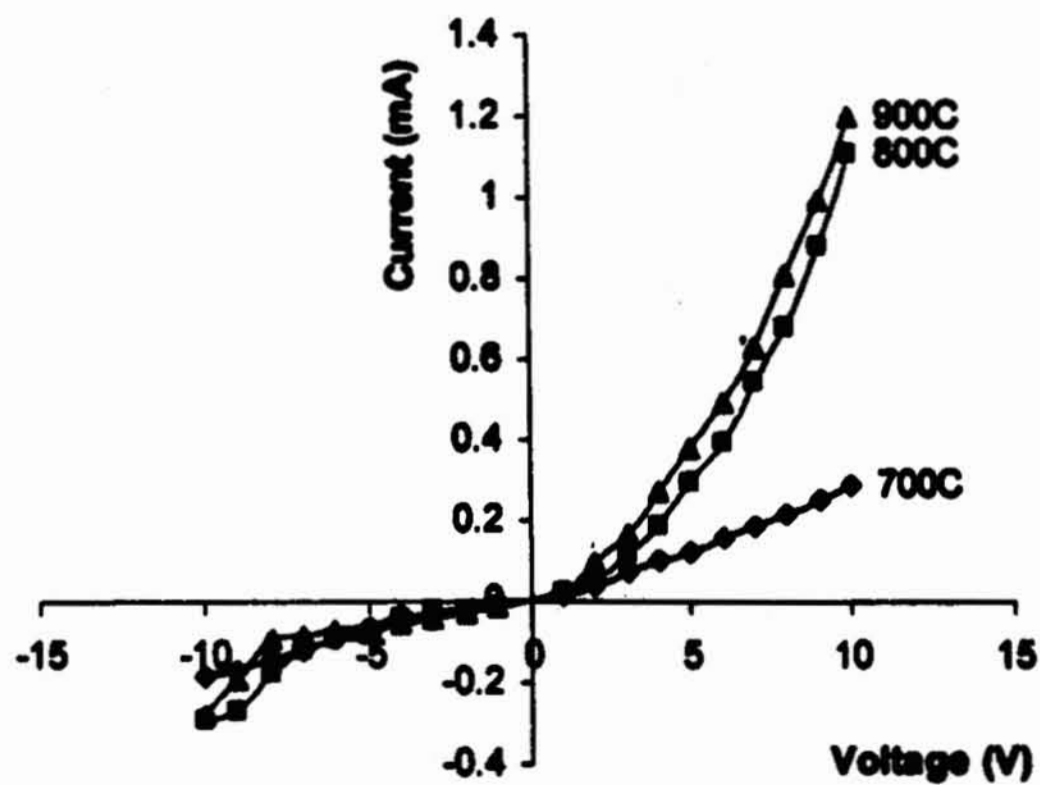


Fig 3: The I-V characteristics of Zn_{0.5}Cu_{0.5}O:Si thin film in normal condition.

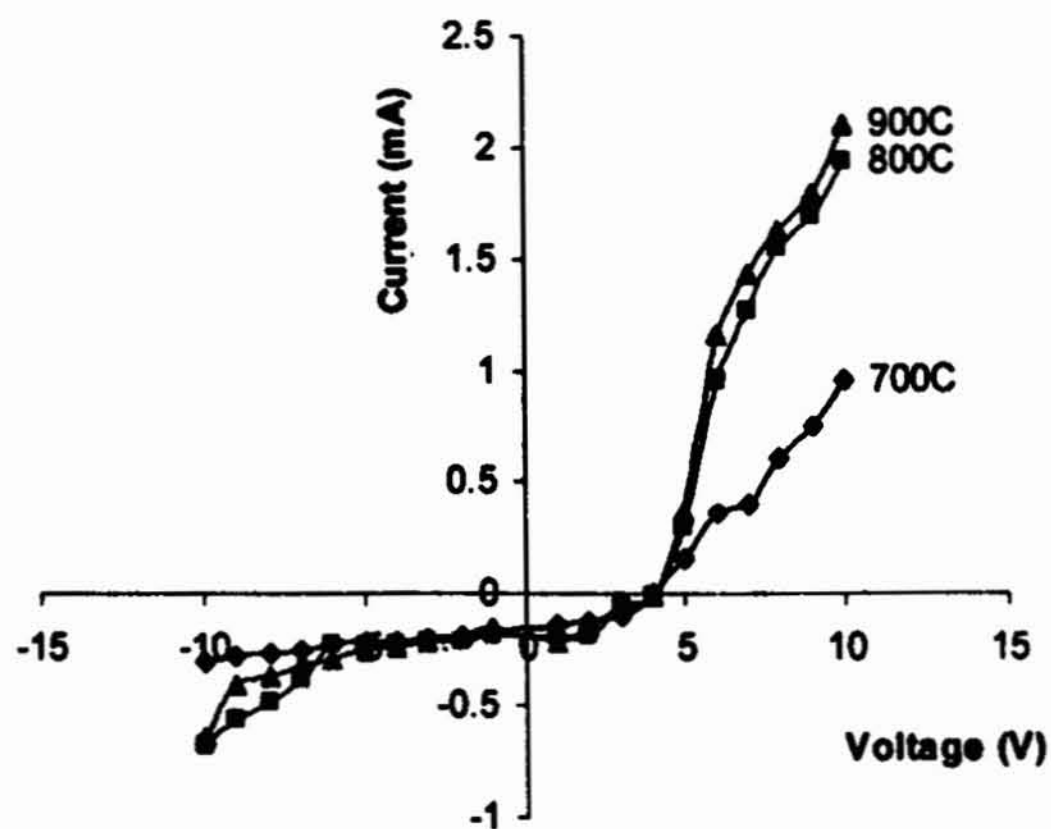


Fig 4: The I-V characteristics of Zn_{0.5}Cu_{0.5}O:Si thin film under 2000 lux illumination.

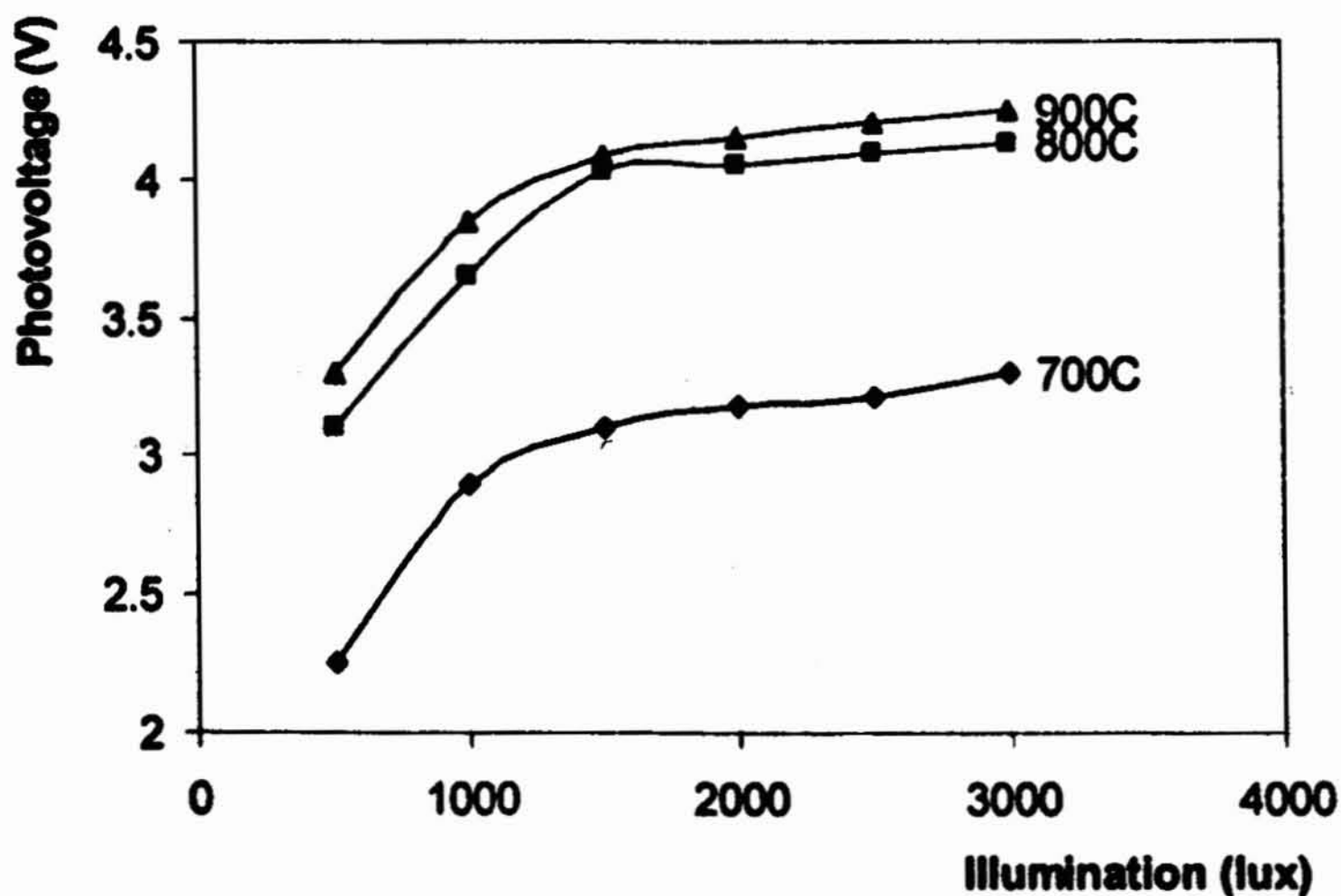


Fig 5: The photovoltage of Zn_{0.5}Cu_{0.5}O:Si thin film under illumination.

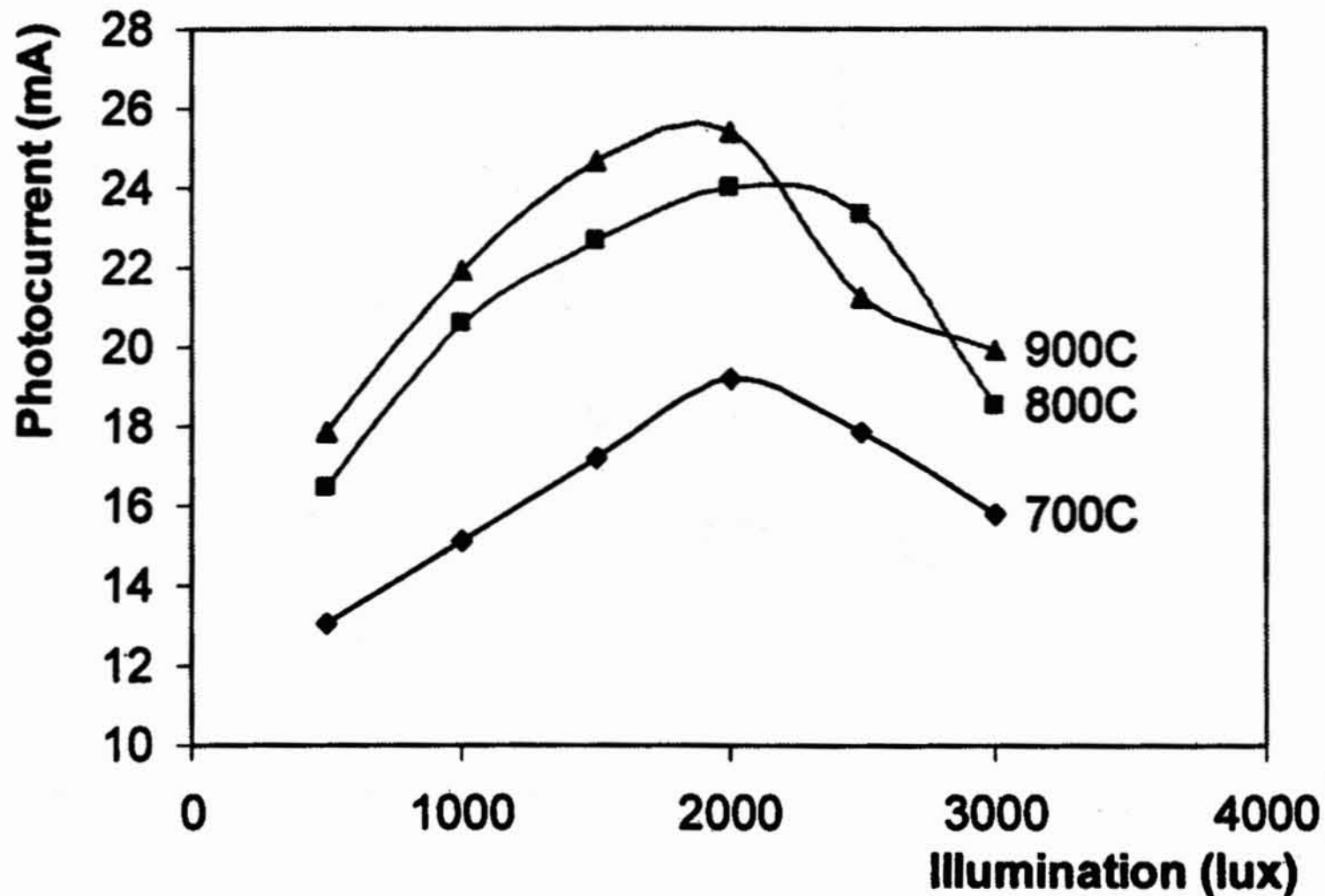


Fig 6: The photocurrent of Zn_{0.5}Cu_{0.5}O:Si thin film under illumination.

Conclusion

ZnO is becoming a hopeful candidate semiconductor material for the next generation of optoelectronic devices and light emission devices or high power and frequency devices. The photocurrent was significantly found that the variation of I-V curve in dark condition give the formation of p-n contact and this characteristic under illumination suggested that the photovoltaic behavior of fabricated cell because of the current generated from photovoltaic cell started from first quadrant increased gradually through the fourth quadrant and finally reach into first quadrant of the circle. The photovoltage and photocurrent were very satisfactory for Zn(Cu)O/Si PV cells. As the results obtained, fabrication technique, deposition procedure and choice of solar material were very acceptable for PV cell application.

References

- Adler R B, Smith A C & Longini R L 1964 "Introduction to Semiconductor Physics" SEE Vol 1 (John Wiley, New York)
- Bigger, John E & Edward C Kern Jr 1990 "Early applications of photovoltaics in the Electric Utility Industry Paper Presented at the 21st IEEE Photovoltaics Specialists Conference (Kissimmee, Florida)
- Bossert RH et al 2000 "Thin-Film Solar Cells", Technology Evaluation and Perspectives November
- Charles Johannes Sheppard 2002 "Structural and Optical Characterization of a Si:H and ZnO" (MSc Thesis, Rand Afrikaans University)
- <http://www.encyclobeamia.solarbotics.net/articles/solar-cell.html>
- <http://www.solarserver.de/index-e.html>
- <http://www.soton.ac.uk/~solar/News/strasbourg.pdf>