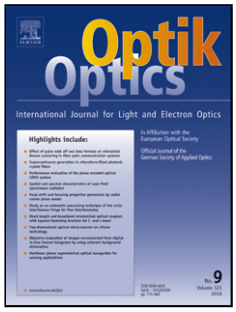

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Optical and electrical characterization of ZnO/CuO heterojunction solar cells

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Abstract

This paper reports the fabrication and characterization of nontoxic heterojunction of ZnO/CuO. The films were characterized through X-ray diffraction, UV spectroscopy and field emission scanning electron microscope (FESEM). The valence and conduction band edges were measured through Photo-Electron spectroscopy in air. The electrical parameter for FTO/ZnO/CuO/In heterojunction diode such as ideality factor, barrier height, and series resistance were calculated by using conventional forward bias I-V characteristics and also verified with the help of Cheung method. The high value of ideality factor was attributed to high series resistance, defects, other phases of CuO and recombination at interface and within bulk. The double logarithmic graph of current and voltage showed that the transport mechanism is due to the space charge limited current and trapped charge limited current. Photovoltaic parameters Voc of ~190 mV and Jsc of ~0.40 mA/cm^2 of FTO/ZnO/CuO/In heterojunction were recorded.

Keywords: seminconductor; optical properties; electrical properties; sol-gel; heterojunction

1. Introduction

Copper oxides (Cu_2O, CuO) have two different crystal structures, colors, and physical properties. Both the Cu_2O and CuO are being used as a good candidate for photovoltaic applications because of their low cost, nontoxic, electrical and high optical properties. Both are p-type semiconductor having a band gap of 2.1 and 1.2-1.75 eV respectively [1], which are good as an absorber for solar cells. CuO-based heterojunctions of CuO/SnO_2, [2], CuO/Si [3] and CuO/Cu_2O [4, 5] have been studied.

CuO/ZnO heterojunction have recently been shown to be of interest for potential application in the area of photovoltaic, chemical sensors, including the detection of reducing gases and humidity [3]. The Kwang et al reported the electrical properties of CuO/ZnO heterojunction [6, 7] but still the investigation of this heterojuction is limited in the literature. This heterojunction was prepared by thin-film of p-type CuO and n-type ZnO; and the electrical properties were measured. Kazuya et al [8] and Hiroki et al [9] fabricated the CuO/C_{60} solar cells with the lower power conversion efficiency (η) of 9.0×10^{-5} and 1.8×10^{-6} respectively. In CuO/Cu_2O [4, 5] solar cells both films have high absorption due to which light cannot reach to junction for electron-hole pair generation. Therefore we used high transmission thin film ZnO as window layer and electron transporting layer.

The purpose was to use the low cost, abundant, non-toxic and to utilize the whole spectrum of light for electron-hole pair generation. CuO (absorber) and ZnO (window layer) was prepared by simply spin coating and Rf sputtering techniques respectively. The structural and electrical characterizations of this heterojunction are studied in details by using Cheung's via current–voltage (I–V) characteristics. Different diode parameters such as ideality factor, barrier height, and series resistance are determined using different methods. Also the photovoltaic characteristics of the FTO/ZnO/CuO/In heterojunction have been measured.