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Effect of Photoconductivity on Mn -CuO Nanoparticles by Chemical Co-Precipitation Method

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Abstract

The present work has been made to study the photoconductivity and dark conductivity characteristics of Mn doped CuO Nanoparticles. Photoconductivity and dark conductivity are measured at room temperature under visible illumination. The Mn-doped CuO Nanoparticles synthesized by co-precipitation technique are found to exhibit anomalous behavior of photocurrent which decreases with increased intensity of illumination. At 4500 lux of illumination photocurrent is found to be even lower than the dark-current. The variation of photocurrent with applied voltage is super-linear.

Key words: Photoconductivity, CuO, photocurrent, dark-current

I. INTRODUCTION

In research and scientific fields, the II-IV compound semiconductors with dimensions in the nano-meter range are becoming very important since last two decades. Among this group, CuO have great interest in the investigation of properties like photoconductivity under UV and Visible excitation. It is an optoelectronic material because of its wide band gap (2.6eV) and has binding energy of 50meV. Now the researchers are started to dope CuO particles with ions such as Co and Mn. In doped compounds, the impurity states play an important role in affecting the electronic energy structures and transition probabilities. Photoconductivity is considered to be an important tool for providing information about the nature of the photo-excitations.

These Mn doped CuO particles also have a wide range of applications in optical and electronic devices. A good photoconductive device requires not only efficient charge separation but also efficient transport of charge carriers to electrode. The Mn doped CuO particles are hence used as good photoconductive device materials.

There are a number of chemical methods for the synthesis of Nanomaterials like co-precipitation, Sol gel, hydrothermal, solvo-thermal and auto combustion etc. Among these methods, co-precipitation is a widely used method which provides simple, rapid preparation and control of size of the particle. In the present paper we prepared the samples by co-precipitation method and the photoconductivity and dark-conductivity measurements are taken as a function of illumination intensities and applied voltages.

II. EXPERIMENT

Polycrystalline CuMnO samples are prepared using a co-recipitation technique. Oxalate precursors $CuMn(C_2O_4) \cdot 2H_2O$ are obtained by adding 100 ml aqueous solution of oxalic acid (0.07 mol) into 100 ml aqueous solutions of zinc and manganese acetates (0.07 mol cations). The precipitates are collected, washed with copious quantities of deionized water, and dried in air at 373 K. CuMnO powders are obtained by thermal decomposition of the white precursors at 673K for 3 hrs in air. Fig. 1 shows the arrangement of measuring the photoconductivity and dark conductivity.

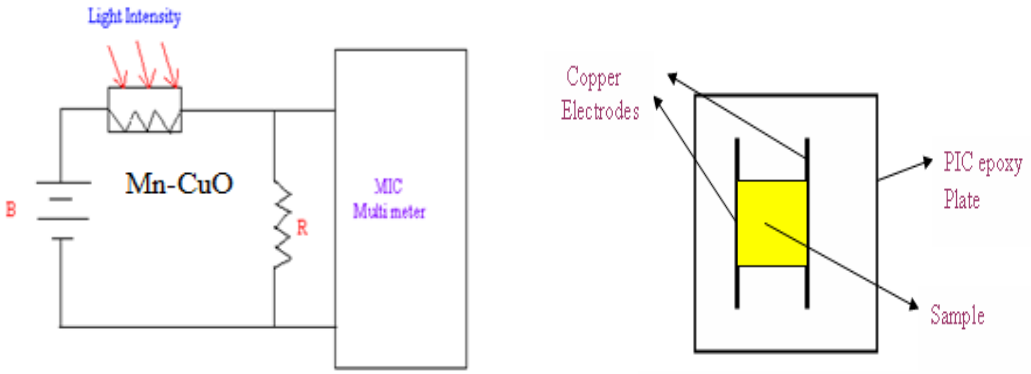


Fig 1: Measurement setup used for observation of Photocorductivity

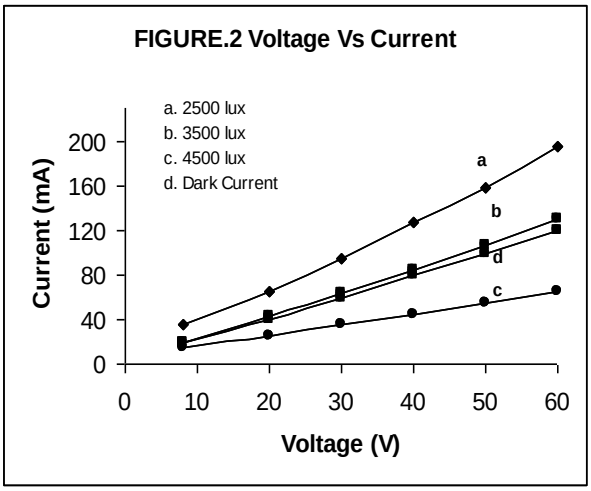
Photoconductive Cell

III. RESULTS AND DISCUSSIONS

The photoconductivity and dark-conductivity properties of the Mn-doped CuO Nanoparticles prepared by the method of chemical co-precipitation are observed. For this purpose, a cell is formed by spreading a thick layer of powdered samples in between two Copper electrodes etched on a Cu plate having a spacing of 1 mm as shown in Fig.1.

The powdered layer is pressed with transparent glass plate. This glass plate has a slit for providing illumination area of 0.31 cm. In this cell type device, the direction of illumination is normal to the field across the electrodes. The cell is mounted in a dark chamber with a slit from which the light is allowed to fall over the cell. The visible photo-response of the Nanoparticles is measured using a commercial bulb of 275W as a photo-excitation source. A stabilized dc field (50V/cm to 500 V/cm) is applied across the cell to which a digital multi meter for the current is connected in series (MECO-9A06). The light intensity over the cell surface is changed by varying the distance between the slit and light source. The graphs are drawn between dark current, photo current and applied voltage and ln of photo current, ln of dark current and ln of applied voltage.

FIGURE.2 Voltage Vs Current



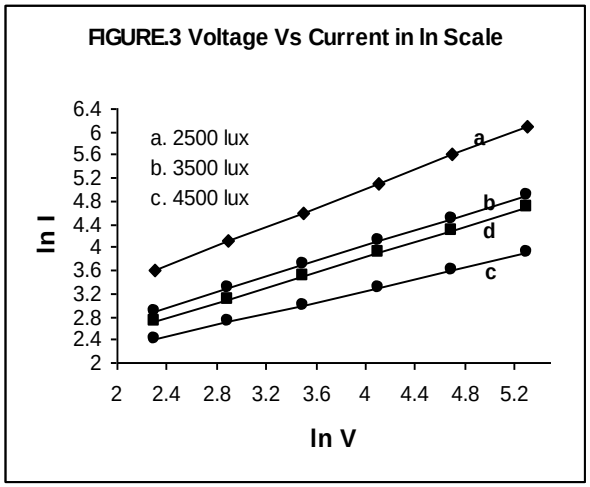


Fig.2 shows the relation between dark and photo currents with applied voltage, while Fig.3 shows the variation in photo and dark currents with applied voltage on ln scale. From Fg.3, it is observed that the behavior of dark current and photo current with applied voltage is super linear. From the two figures it is observed that the slope of a straight line, r is greater than unity and satisfy the power law (I α Vr). Super linear behavior suggests that some charge carriers are injected into the sample from one of the electrodes. As the intensity of illumination increases, the variation of the photocurrent with voltage remains super-linear but photosensitivity will be reduced this gives the anomalous behavior of the photocurrent.

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