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STRUCTURAL, OPTICAL STUDIES OF ZINC MAGNESIUM OXIDE AND ZINC COPPER OXIDE NANOCOMPOSITES

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Abstract

Nanocomposites of Zinc Magnesium Oxide (ZnMgO) and Zinc Copper Oxide (ZnCuO) were synthesized by chemical co-precipitation method. The nanocomposites annealed at 500ºC were used for further structural and optical studies. The Scherrer equation was used to calculate the average particle sizes of the prepared nanocomposites. The optical characterizations of the metal oxide nanocomposites were carried out by UV/Visible analysis. From the analysis of the absorption spectra, the optical bandgaps of the nanocomposites were calculated.

Keywords: Nanocomposite, XRD, Optical bandgap

1 INTRODUCTION

Metal oxide nano composites with large surface to volume ratio acquire unique magnetic, electronic, optical and chemical applications. Zinc oxide is a wide bandgap semiconducting material with a lot of applications including light emitting diodes, piezoelectric transducers, photocatalysts etc[1-3].

Nanomaterials exhibit large surface to volume ratio and thereby most of their properties are selectively controlled by engineering the size, morphology and composition. Such nano crystalline metal oxides exhibiting this large surface area can be applied to devices including sensors for which a betteAr surface effect is required. These new nanomaterials can have enhanced properties from their parent bulk materials[4]. The metal oxide nanocomposites exhibit exceptional UV absorbing ability, high stability at high temperatures and reactivity as catalyst[5-6].

2 EXPERIMENTAL

Nanocomposite of Zinc Magnesium Oxide (ZnMgO) was prepared by arrested precipitation using analytical grade 0.1M Zinc Nitrate, 0.1M Magnesium Nitrate, 0.02M citric acid and 0.5M sodium hydroxide as the reagents. However in the synthesis of Zinc Copper Oxide (ZnCuO), instead of Magnesium nitrate, 0.1 M copper nitrate was used. Among the reagents, citric acid was used as a stabilizer to prevent agglomeration. The precipitates so formed by stirring were separated from the reaction combination and washed with distilled water to remove all impurities. The dried precipitates at room temperature were thoroughly grounded using an agate mortar to obtain its fine powder. On heating to 500ºC, their corresponding nanocomposites were formed.

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2.1 CHARACTERIZATION

XRD analysis is a finger print tool for the structural analysis of nanocomposites. The XRD patterns of the powdered samples were recorded using XPERT-PRO powder diffractometer using Cu- K_α radiation in the 2θ range 10° to 80° at 30mA, 40kV. The UV spectra were recorded using Shimadzu UV-2550 UV visible spectrophoto meter.

3 RESULTS AND DISCUSSIONS

3.1 XRD STUDIES

The nano crystalline natures of ZnMgO and ZnCuO are verified using XRD analysis. There is a definite line broadening of the XRD peaks indicates the synthesized materials consist of particles in nanometer scale. The peak intensity, position and full width at half maximum data are obtained from the XRD pattern. The nanoparticle sizes are calculated using Debye-Scherrer equation, $t = k\lambda/(\beta\cos\theta)$; where k is the Scherrer constant and its value is taken as 0.9, β is the full width at half maximum of XRD peaks, θ is the Bragg diffraction angle and λ is wavelength of X-rays used in XRD analysis, λ = 1.54060 [Å]. The XRD patterns of ZnMgO and ZnCuO sintered at 500ºC are shown in fig 1A and 1B respectively. The average particle sizes for ZnMgO and ZnCuO nanocomposites are found to be 32 and 23nms respectively. The XRD peaks of ZnMgO and ZnCuO confirms that they are almost free from impurities.

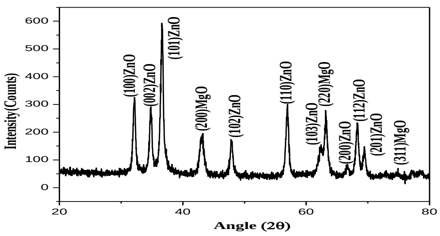

Fig. 1A XRD Patterns of ZnMgO

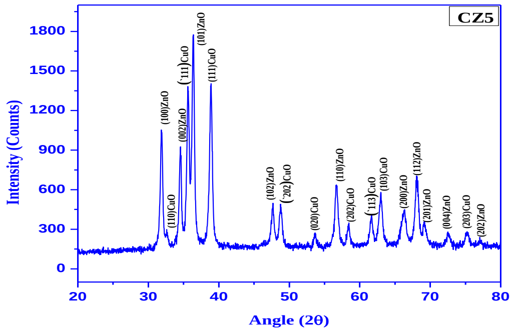

Fig. 1B ***XRD Patterns of*** **ZnCuO**

3.2 UV-SPECTRAL STUDIES

The UV spectra of ZnMgO and ZnCuO nanocomposites sintered at 500ºC taken in the wavelength range of 210 to 870 nm are shown in fig 2A and 2B respectively. The optical bandgap details of the nanocomposites can be directly calculated using UV absorption spectra. The decrease in absorbance with increase in wavelength from the UV spectra is due to the presence of optical bandgap in the nanomaterials. Using Tauc's relation, the direct optical bandgaps of the nanomaterials are calculated[8]. The value of direct optical bandgaps of ZnMgO and ZnCuO nanocomposites are 3.29eV and 3.95eV respectively and are depicted in the figures 3A and 3B respectively.

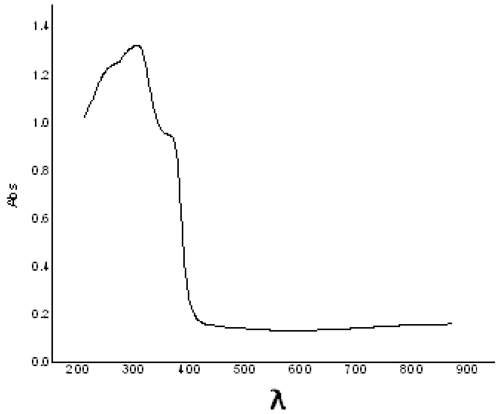

Fig. 2A UV spectrum of ZnMgO

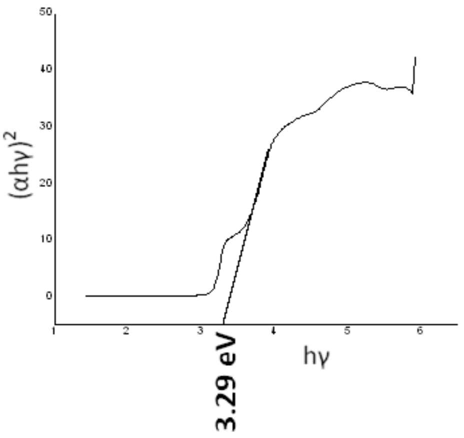

Figure 3A: Optical bandgap calculation of ZnMgO

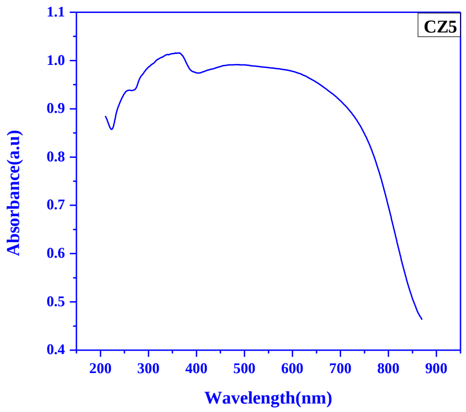

Fig. 2B UV spectrum of ZnCuO

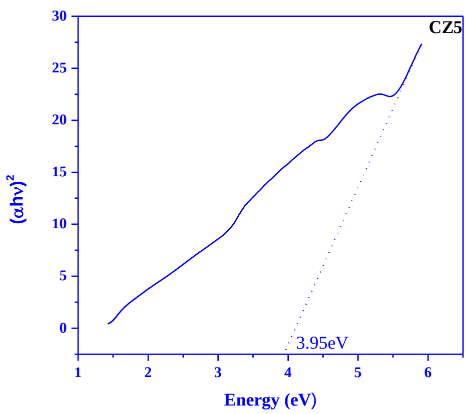

Fig. 3B Optical bandgap calculation of ZnCuO

4 CONCLUSIONS

Nanocomposites of Zinc Magnesium Oxide and Zinc Copper Oxide are prepared by chemical co-precipitation method. Average particle sizes obtained from XRD studies are 32nm for Zinc Magnesium Oxide nanocomposite and 23nm for Zinc Copper Oxide nanocomposite and are in the nano meter scale. Value of direct optical bandgaps of Zinc Magnesium Oxide and Zinc Copper Oxide nanocomposites are is 3.29eV and 3.95eV respectively.

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