CPUH-Research Journal: **2018**, *3(2)*, 88-90
ISSN (Online): 2455-6076
http://www.cpuh.in/academics/academic_journals.php

A Study of Structural and Morphological Properties of Zn, Co Co-Doped Copper Oxide Nanoparticles

Anu[1*], Naveen Thakur[1], Jitender Kumar[2]
[1]*Department of Physics, Career Point University Hamirpur (H.P.) INDIA*
[2]*Department of Physics, Govt. College of Shillai (H.P.) INDIA*
**E-mail: anubasu550@gmail.com*

ABSTRACT: Zn, Co co-doped copper oxide nanoparticles were prepared by microwave assisted method. The size of particles has been obtained as 20 nm. The synthesized nanoparticles have been characterized by using X-ray diffraction (XRD) and scanning electron microscopy (SEM). From X-ray diffraction study, it is established that synthesized particles are monoclinic in nature. Scanning electron microscopy (SEM) pattern gave the spherical morphology of the synthesized nanoparticles.

Keywords: Nanoparticles; zinc; cobalt; copper; XRD; SEM

INTRODUCTION

Over the past few decades, metal oxide nanoparticles or materials have received great attention due to their outstanding physical, chemical properties and their potential applications in nanoscale devices [1]. Besides, doping with different chemical elements such as Ni, Fe, Mn, Co, Cd etc. had key control on the physical properties of the metal oxide nanoparticles. By controlling the doping level, which can get metal oxide nanoparticles with enhanced properties and useful applications in various fields [2]? Thus, there is great awareness to study the effect of doping their physical properties of metal oxide nanoparticles and the concentration of doping elements. In recent times, doping of two typess of atoms (co-doping) into a metal oxide nanoparticles has paying more interest, as it could give a better result in a higher photocatalytic activity and unusual characteristics as compared with single element doping into metal oxides, such as (La, Ni), (Fe, Co) and (Mn, Co) [3].

CuO is a p-type transition metal oxide semiconductor with a narrow band (E_g = 1.2 to 2.2 eV) and has monoclinic crystal structure [4]. CuO has received much attention because of various applications such as gas sensors, biosensors, solar energy, transformation, catalysis, batteries and high- T_c superconductors [5]. To fabricate co-doped copper oxide nanoparticles (metal oxide nanoparticles) have various chemical synthesis methods used such as precipitation method [1], sol-gel method [2], hydrothermal method [6], spray pyrolysis method [7], SILAR method [8] and sonochemical method [9]. These methods require larger time to complete the reaction and high energy consuming for synthesis of metal oxide nanoparticles.

On the other hand microwave assisted method is more favorable because of shorter processing time, energy efficiency, and which provides better control of stoichiometry, enhanced purity and homogeneity.This paper is focused to investigate the (Zn, Co) co-doping on CuO nanoparticles by using microwave assisted method.

MATERIALS AND METHODS

Chemicals: All chemicals were purchased from Merck India which are used for research work. Copper (II) acetate monohydrate, cobalt (II) acetate tetrahydrate, zinc acetate dihydrate and sodium hydroxide (NaOH) pellets are used.

Synthesis Procedure: All the reagents used in this study were of analytical grade obtained from Merck, India. Copper (II) acetate monohydrate and sodium hydroxide (NaOH) pellets as precursors and for co-doping, zinc acetate dehydrate, cobalt (II) acetate tetrahydrate are used. (Zn, Co) co-doped CuO nanoparticles were synthesized by following procedure. Initially 0.02 M copper (II) acetate monohydrate was dissolved in distilled water and magnetically stirrer for 15 minutes, to obtain clear transparent solution. For the Zn and Co dopant, zinc acetate dehydrate, cobalt (II) acetate tetrahydrate solution prepared separately in distilled water and has been added drop-wise combinedly to the above prepared solution of copper (II) acetate monohydrate. NaOH pellets were dissolved in distilled water separately. Then the drop wise addition of sodium hydroxide solution to above prepared solution was carried out with constant stirring. The prepared solutions were kept in the microwave oven operated with frequency 2.45 GHz and power 800W. Microwave irradiation is carried out till the solvent is evaporated completely. After the microwave processing, the prepared solution was cooled at room temperature. The completion time of reaction and color of the samples are noted at the end of reaction. Obtained precipitate centrifuge for 15 minutes, then washed with distilled water and ethanol for several times to remove impurities and finally obtained pre-

cipitate was dried in an oven at 60^0C for 24 h. The prepared samples have been characterized through X-ray diffraction (XRD), scanning electron microscopy (SEM).

Characterization: The synthesized (Zn, Co) co-doped CuO nanoparticles studied by powder x-ray diffraction (XRD) technique with Cuk_α radiation (λ = 1.54056) in the 2**θ** range of 30-80 degree at room temperature. Scanning electron microscopy (SEM) has done for the morphology study of prepared (Zn, Co) co-doped CuO nanoparticles.

RESULTS AND DISSCUSSION

XRD Analysis: The characteristics X-ray diffraction patterns of (Zn, Co) co-doped CuO nanoparticles were recorded in the range of 2**θ** between 30-80 degree as shown in Figure 1. The obtained XRD diffraction peaks for (Zn, Co) co-doped CuO nanoparticles located at 2**θ** = 32.099, 35.797, 38.07, 48.04, 53.456, 58.576, 61.85, 66.470, 68.249, 72.525 and 75.513 correspond to (110), (-111), (111), (-202), (020), (202), (-113), (-311), (220), (311) and (004) planes respectively. The standard crystallographic planes confirmed the formation of the CuO monoclinic phase which matches with the standard JCPDS. Therefore there is no clear change in the peak position as well as the peaks are found to be quite sharp and intense.

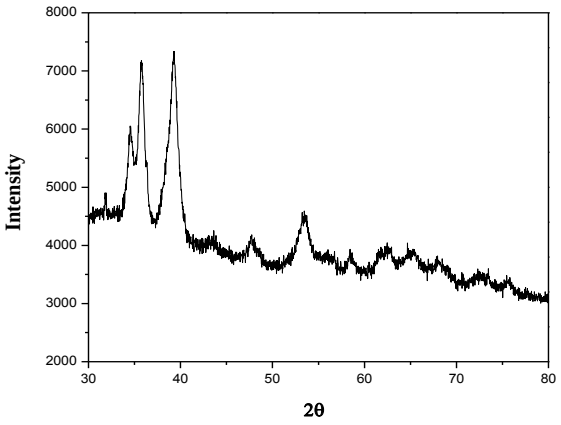


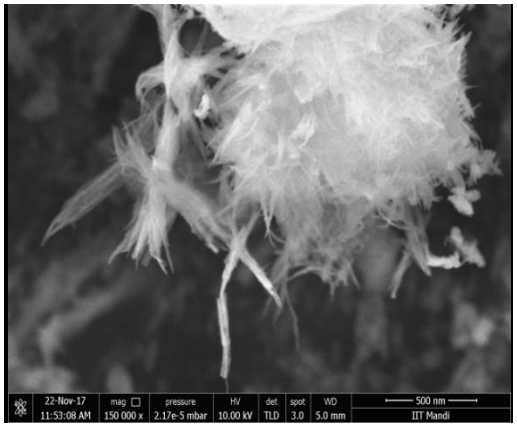
Figure 1: XRD spectra for (Zn, Co) co-doped CuO nanoparticles

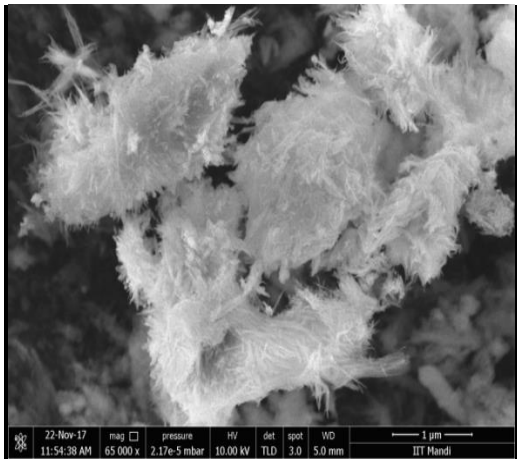
The average crystallite size was calculated by measuring the full width at the half maximum (FWHM) by using Debye-Scherrer equation

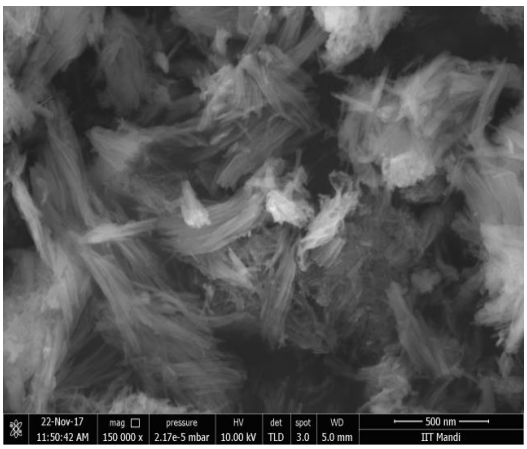
$$D = 0.9\lambda/\beta\cos\theta$$

where D is the average crystallite size, λ is the wavelength of the incident X-ray beam (1.5418Å), **θ** is the Braggs diffraction angle and β is the peak width at half maximum (FWHM). The average crystallite sizes of (Zn, Co) co-doped CuO samples were found to be in the range of 11-16 nm. This indicates that crystallite size of nanoparticles slightly increases with increasing the amount of Zn and Co content of doping.

SEM Analysis: The morphology of the powders of (Zn, Co) co-doped CuO nanoparticles were investigated by scanning electron microscope (SEM). (Zn, Co) co-doped CuO powder samples having glassy wool like structure and rod like structure through scanning electron microscope (SEM). Figure 2 shows the SEM images of (Zn, Co) co-doped CuO nanoparticles.







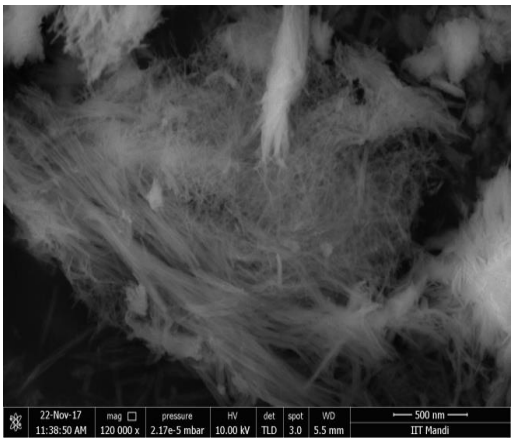


Figure 2: SEM analysis pattern of (Zn, Co) co-doped CuO NPs

CONCLUSIONS

Zinc and cobalt co-doped CuO nanoparticles are successfully synthesized by microwave assisted method. XRD patterns confirmed the formation of the monoclinic phase of nanoparticles. The average crystallite size of (Zn, Co) co-doped CuO nanoparticles is approximately 11-16 nm. This result shows that, the crystallite size of nanoparticles increases with the content of doping.

REFERENCES

1. Ahamed M., Alhadlaq H.A., Khan M.A.M., Karuppiah P., Al-Dhabi N.A. **(2014)** Synthesis, characterization, and antimicrobial activity of copper oxide nanoparticles. *J. Nanomater.*17, 1-4.
2. Sayed A.M. El, Shaban M. **(2015)** Structural, optical and photocatalytic properties of Fe and (Co, Fe) co-doped copper oxide spin coated films. *Spectrochim Acta Part A: Mol. Biomol. Spectroscopy.* 149, 638–646.
3. Viruthagiri G., Gopinathan E., Shanmugam N., Gobi R. **(2014)** Synthesis and characterization of ZrO2–CuO co-doped ceria nanoparticles via chemical precipitation method. *Spectrochimi Acta Part A: Mol. Biomol. Spectroscopy*. 131, 556–563.
4. Al-Amri S., Ansari M. S., Rafique S., Aldhahri M., Rahimuddin S., Azam A. Memic A. **(2015)** Ni doped CuO nanoparticles: structural and optical characterizations. . Curr. Nanosci. 11, 1-6.
5. Rejith S.G., Krishnan C. **(2013)** Synthesis of cadmium-doped copper oxide nanoparticles: optical and structural characterizations. *Adv. in Appl. Sci. Res.* 4, 103-109.
6. Mohebbi S., Molaei S., Azar A.R.J. **(2013)** Preparation and study of Sn-doped CuO nanoparticles as semiconductor. *J. of Appl. Chem.* 8, 27-30.
7. Mishjil K.A., Qader K., Jabber W.A., Toma Z.A. **(2015)** Study the effect of Mn-doped CuO thin film on its optical properties. *Mater. Sci. In. J.* 3, 388-392.
8. Bayansal F., Taskopru T., Sahin B., Cetinkara H.A. **(2014)** Effect of Co-Doping On Nanostructured CuO Thin Films. *Metall. Mater. Trans. A.* 45A, 3671-3674.
9. Joy Prabu H., Johnson. I. **(2015)** Flower-Shaped CuO nanostructure synthesized by sonochemical method and the effect of NaOH concentrations. *Int. J. Adv. Res.* 8, 1091 – 1096.