Synthesis of CuO and ZnO Nanocopmosite and Study its Dielectric Characterization at Microwave Frequency

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ABSTRACT

Nanocomposite materials of metal oxides have tremendous applications in the fields such as coating industries, sensing of gases, medical industries, solar cells. Generally CuO acts like P-type semiconductor and ZnO acts like N-type semiconductor. These two metal oxides are used to form the proper nanocomposite junction. The powder of these two metal oxides of analytical grade are taken in equal weight ratios.The powder of CuO and ZnO metal oxide is the mixed together and crushed continuously in Mortar and Pestle for five clock hour at room temperature to form the nanocomposite. It is then characterized by XRD and FTIR. The XRD characterization showed that the nanocomposite of CuO and ZnO is formed properly and crystal size is well in nanometre scale. The FTIR spectra of CuO and ZnO nanocomposite also showed the result in good agreement with the expected one. The proper and strong pellet of the nanocomposite is formed. The dielectric characterization of prepared CuO and ZnO nanocomposite is performed at microwave frequency and its dielectric behaviour is studied in this work.

Keywords: nanocomposite, XRD, FTIR, dielectric characterization.

INTRODUCTION:

CuO andZnO are metal oxides find tremendous applications in various fields such as optoelectronics, in polymers, agriculture etc.[1-3]. Copper (II) oxide (CuO) is another metal oxide semiconductor having narrowband gap ~ 1.2 eV in bulk. CuO has monoclinic crystal structure. It is intrinsically p-type semiconductor [4]. ZnO is a metal oxide n-semiconductor with wurtzite structure under ambient condition [5-6]. The wurtzite structure has hexagonal unit cell. In this crystal structure, two interpenetrating hexagonal-close-pack (hcp)sublattices are alternatively stacks along the c-axis.One sublattice consist of four Zn atoms and the other sublattice consists of four Oxygen O atoms in one unit cell; every atom of one kind is surrounded by four atoms of the other kind and forms atetrahedron structure. The nanoparticles of CuO and ZnOmetal oxides show the interesting properties as compared to their bulk material [7-8]. There is tremendous improvement in their electrical, mechanical and conducting behaviour of nanoparticle. In this work we tried to prepare the nanonocomposite of the CuO and ZnO and study its dielectric property at microwave frequency. The mechanical milling method is used to synthesize the nanocomposite of CuO and ZnO [9-11]. The analytical grade powder mixture of CuO and ZnO is taken in equal weight ratio and crushed continuously for five clock hour at room temperature. The obtained material is then heated at 3000C for three hour. The material is then undergone the XRD and FTIR characterization. The analysis of XRD and FTIR showed that nanocomposite of CuO and ZnO is formed. The particle size of nanocomposite found well in nanoparticle range. The dielectric characterization of obtained nanocomposite is performed using Broadband Dielectric Spectrometer at microwave frequency.

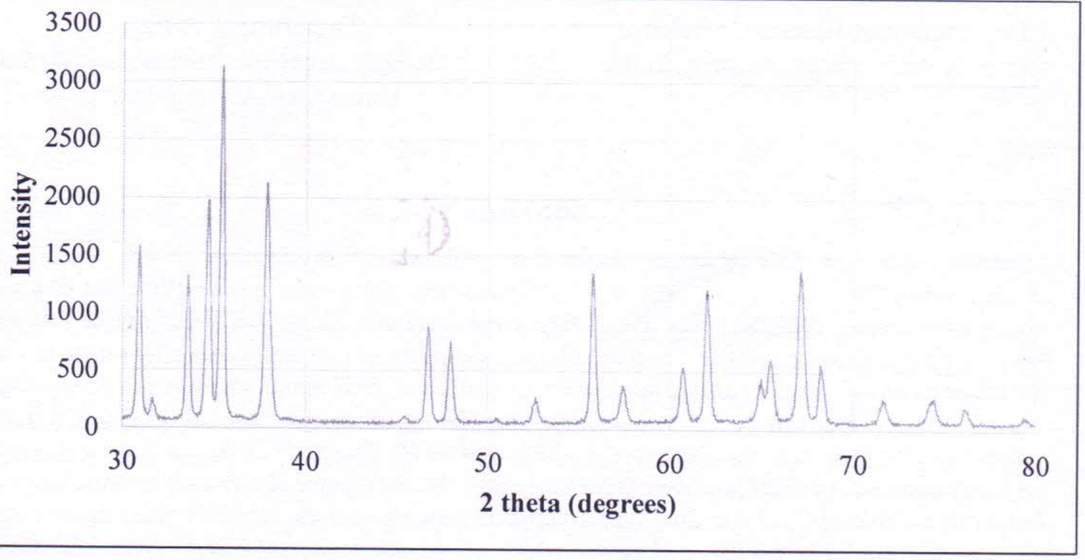
EXPERIMENTAL:

The nanocomposite of CuO and ZnO is synthesized using mechanical milling method. The powder form material of CuO and ZnO is taken in equal weight ratio and mixed together. The composite material is then crushed in mortar and pestle continuously for five clock hour at room temperature. Then it is heated in furnace at 3000Cfor three hour. The XRD and FTIR of resultant material is performed to find the particle size. To perform the dielectric characterization of CuO and ZnO nanocomposite, the pellet are formed by using hydraulic press. The microwave dielectric characterization of the CuO and ZnO nanocomposite is performed and studied its behaviour at microwave frequency.

RESULT AND DISCUSSION:

XRD:

Fig.1: XRD of CuO and ZnO nanocomposite



The figure1 shows the XRD spectrum of the CuO and ZnO nanocomposite. The analysis of XRD is given in table1.

Table 1: Analysis of XRD Spectrum of CuO and ZnO Nanocomposite

CuO			ZnO		
Intensity(counts)	2Θ angle	(h k l) values	Intensity	2Θ angle	(h k l) values
1320	33.56	1 1 0	1520	30.89	1 0 0
3047	35.42	0 0 2	1974	34.67	0 0 2
2116	37.85	1 1 1	886	46.7	102
761	47.93	-2 0 2	1359	55.76	1 1 0
383	57.41	2 0 2	1220	62	1 0 3
412	65.54	0 2 2	280	74.39	2 0 2

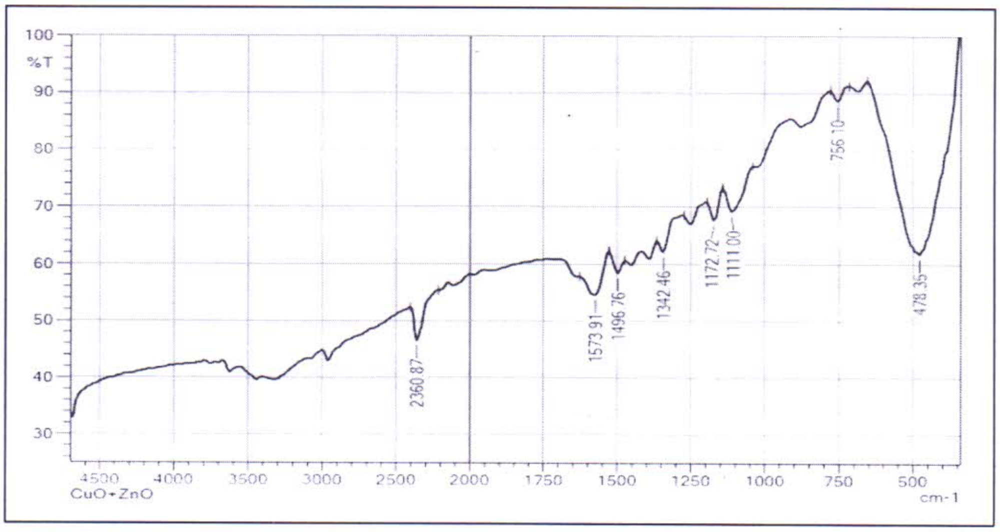
The XRD pattern shows the presence of both CuO and ZnO particles in the nanocomposite. The average crystallite was measured by Debye-Scherrer's equation:

$D = K.\lambda / \beta cos\theta$

Where K is Debye-Scherrer's constant (0.9), λ- wavelength of the radiation (for CuKα1=0.154 nm), β-full width half maximum of the particular peak, θ- Bragg's angle.

FTIR:

Fig. 2: FTIR of CuO and ZnO Nanocomposite



The figure2 shows the FTIR spectrum of CuO and ZnO nanocomposite. It shows the sharp absorption peak at wavelength 478.35 -1cm and is assigned to CuO and ZnO.

Dielectric characterization of CuO and ZnO nanocomposite:

Fig. 3: ε' and ε" versus Frequency at 00C Temp.

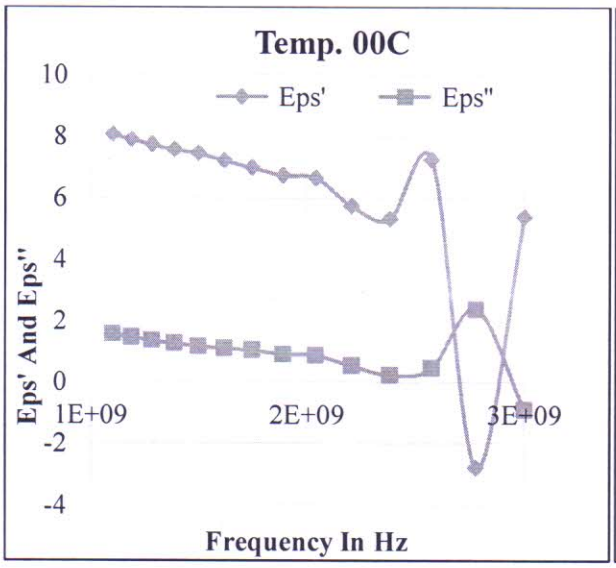


Fig.4: ε' and ε" versus frequency at 1000C

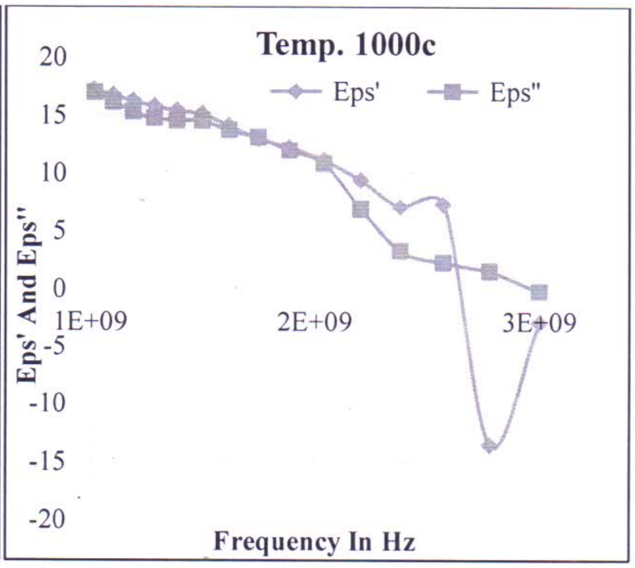


Figure3 and figure4shows variation of real and imaginary permittivity of CuO and ZnO nanocomposite at 00C and 1000C temperature respectively. From graph it is clear that both Eps' and Eps" decreases with in in frequency [12-14]. There is sudden drop in the value of Eps' at 2.7GHz frequencyat both 00C and 1000C temperature [15]. This is due to change in mobility of nanocomposite atoms at microwave frequency.

CONCLUSION:

From the XRD of CuO and ZnO nanocomposite,the particle size and crystallinity of CuO and ZnO nanocomposite is found to be 4.18 nm and 88% respectively.From the figure3 and figure 4, we come to know that, the dielectric constant of nanocomposite decreases with increase in frequency. There is sudden drop in real part of permitivity value at 2.7GHz frequency. The result are well in agreement with previous study.

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