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Synthesis and Structural Characterization of Cadmium Oxide(CdO)-Magnesium Oxide (MgO) Nanocomposite by Sol Gel Method

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Abstract :

A resistive material CdO-MgO nanocomposite was developed by sol gel method. X-ray diffractometer confirms the formation of CdO-MgO nanocomposite phase having average crystalline size 64.2 nm . Spherically shaped grains and surface structure of CdO-MgO had revealed in Field emission scanning electron which having size 30.62 nm range. Energy Dispersive spectroscopic analysis confirms presence of Cd,Mg and O element with concentration 23.9 %, 27.1 % and 49 % in weight percentage respectively. Fourier transforms infrared spectroscopy absorption peak also confirm the CdO-MgO nanocomposite formation. CdO-MgO may use for gas sensing application which may useful for civilian and industry.

Keywords : nanocomposite, cadmium oxide, magnesium oxide, analysis

Introduction :

There are numerous application of CdO like gas sensing and photosensitive application because of band gap of CdO is 2.5.eV and CdO is n-type conductor. Now a days CdO is modifies for enhancing structural and morphological properties. CdO-ZnO is use for Photocatalytic activities[1]. Zinc Oxide (ZnO)–Cadmium Oxide (CdO) nanocomposite has been synthesized by reverse microemulsion method and used as adsorbent to remove methyl blue from aqueous solution [2]. CdO-ZnO is used for ethanol sensing due to its modified properties [3,4]. Selective and sensitive Bilirubin sensor are develop using CuO-CdO nanocomposite and practically implemented in real sample applications [5]. Gas sensing properties of MgO modified $LaFeO_3$ was studied [6]. MgO:TiO_2 developed for methane gas sensing application and it shows good response to methane gas [7].

From last few decades, Semiconducting Metal Oxide (SMO) gas sensors have grow to be a prime technology in numerous industrial, domestic and commercial gas sensing application. Now a days gas sensors are mostly available into three different types of solid state[8-9]. These sensors are derived from catalytic combustion, electrochemical behaviour, or resistance modulation of SMO [10-17]. Due to advantages such as small size, low cost , durability, measurement simplicity, low detection limits (< ppm levels) and ease of fabrication in SMO gas sensor device over the methods of sensing methods. Nanocomposites based on CdO have become familiar for gas sensing technology [18-20]. CdO-MgO is synthesized for structural and morphological studies, may be having the excellent properties for gas sensing application.

Experimental

Cadmium nitrate Hexahydrate from sdfine with AR grade and Magnesium nitrate hexahydrate from Merk with emplura grade were taken as source for synthesis while ethanol ,water and alcohol is used as solvent to dissolve. For rigidity to gel network PVA (Polyvinyl alcohol) is used. Drying temperature is 110 ^{0}C and time for drying is 24 h. While synthesised solution was stirred by magnetic stirrer with Teflon coated magnetic paddle.

Ethanol is mix with distilled water and stirred up to 15 min with magnetic stirrer to get homogenous solution. Appropriate quantity of $Cd(NO_3)_2.4H_2O$, $Mg(NO_3)_2.6H_2O$ and PVA were

weighted by using electronic balance separately. Cadmium nitrate and Magnesium nitrate were added to solution and stirred continuously after that PVA added to solution and stirred continuously up to 2 h. Viscous gel of solution was formed then kept in furnace for 24 h for drying. Obtained product was calcined at 550 ^{0}C in silica crucible. It is crushed with mortar and pestle to obtained fine powder of CdO-MgO nanocomposite.

Results and discussion

Fig.1 shows X-Ray Diffractometer (PANalytical Xpert Pro Cu Kα- 1.54 A^0) pattern of synthesized CdO-MgO powder sample .Characteristic peak of CdO-MgO have higher intensity shows crystalline nature of sample. Observed peak in XRD pattern are matching well with peak of JCPDS card no. 00-005-0640 (Monteponite-CdO) and 01-074-1225 (Periklase-MgO). From Debey Scherrer's Formula, average crystalline size of CdO-MgO nanocomposite is 64.2 nm. Crystallinity of prepared CdO-MgO nanocomposite is found to be 75.78 percentage.

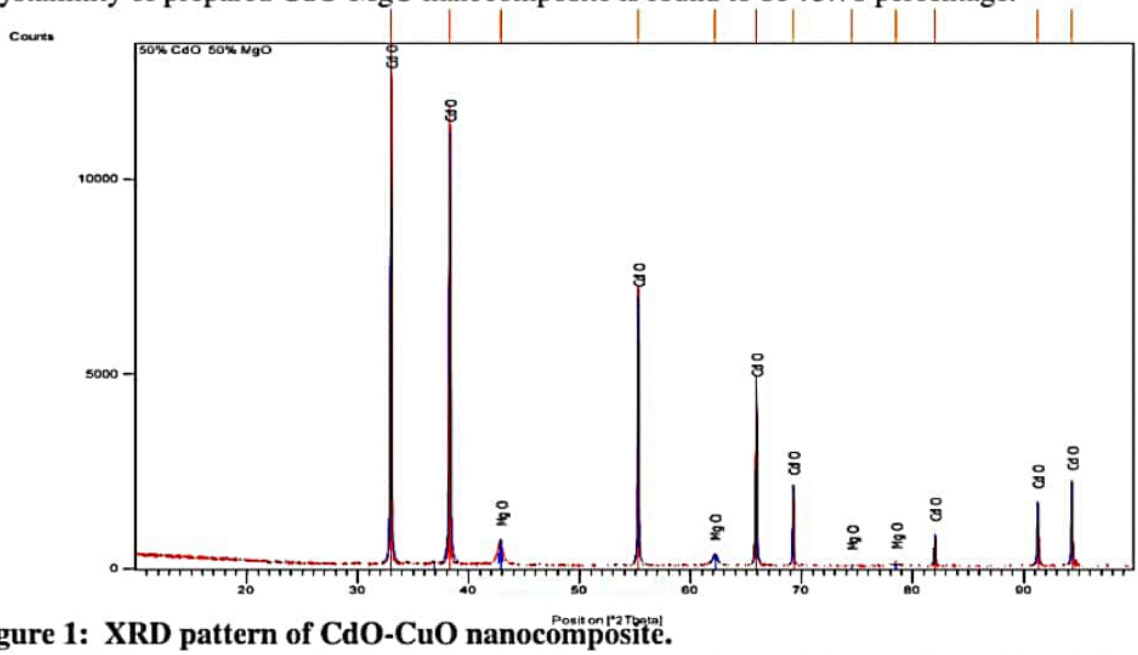

Figure 1: XRD pattern of CdO-CuO nanocomposite.

CdO-MgO nanocomposite was mixed with KBr powder and Fourier Transform Infrared Spectroscopy (FTIR) spectra was measured. FTIR assessment from fig. 2 was performed in region of 450 to 4000 cm^{-1} under normal condition of the solid CdO-MgO nanocomposite was recorded by FT-IR Spectrometer (Perkin Eimer instrument).

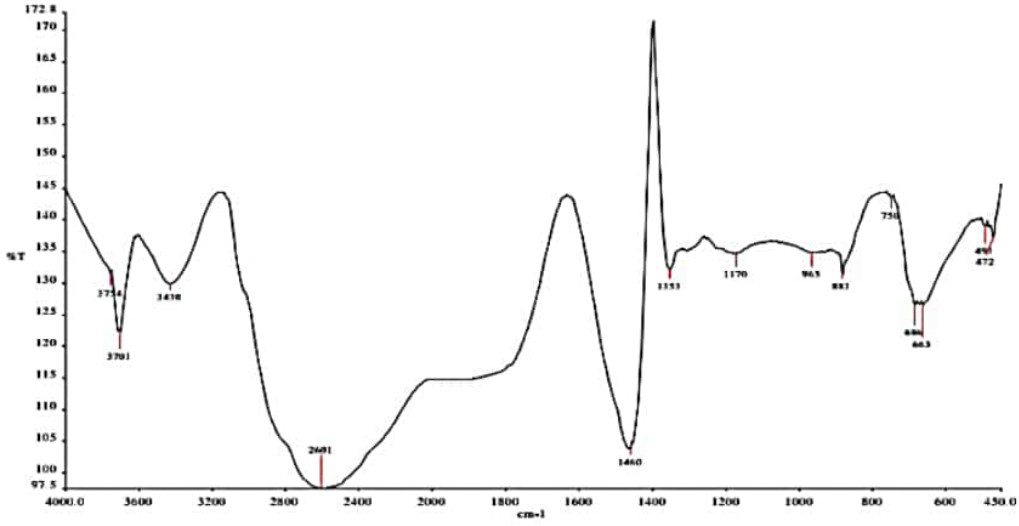

Figure 2: Fourier Transform Infrared detector FTIR spectrum of CdO-CuO nanocomposite.

Field Emission Scanning electron microscope (FESEM) is great application for analyse the morphology of CdO-MgO nanocomposite. Basic nature and morphology of synthesized CdO-MgO nanocomposite was observed by FESEM (JEOL JSM7610F) equipped EDS (Oxford). Typical Surface micrograph of CdO-MgO nanocompposite were examined at low to high magnified range (Fig. 3 a-b). Crystalline size of CdO-MgO nanocomposite was measured from FESEM images in range of 27.2 to 32.8 nm. Crystal shape of CdO-MgO aggregated nanostructural material were displayed in FESEM images. FESEM images clearly indicate that prepared material is nanocomposite of CdO-MgO, which is revealed in standard shape nanostructures.

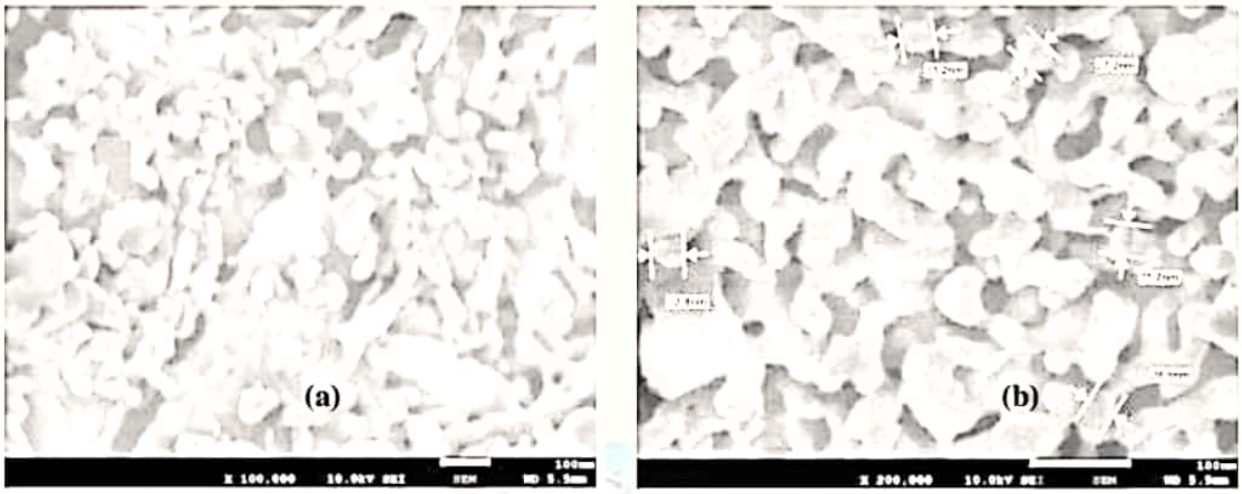

Figure 3: FESEM microstructure for (a) CdO-MgO microstructure at 100000 magnification, (b) CdO-MgO microstructure at 200000 magnification with grain size measurement

Synthesize material show presence of Cadmium (Cd), Magnesium (Mg), and Oxygen which is based on the Energy Dispersive Spectroscopy (EDS) of Oxford company analysis. Nanocomposite having concentration of Cd, Mg and O in weight percentage 23.9, 27.1 and 49.0 respectively (Fig. 4). Prepared material is so pure that there is no any additional peaks reported regarding that the impurities.shows that nanocomposite were composed of Cd, Mg and O.

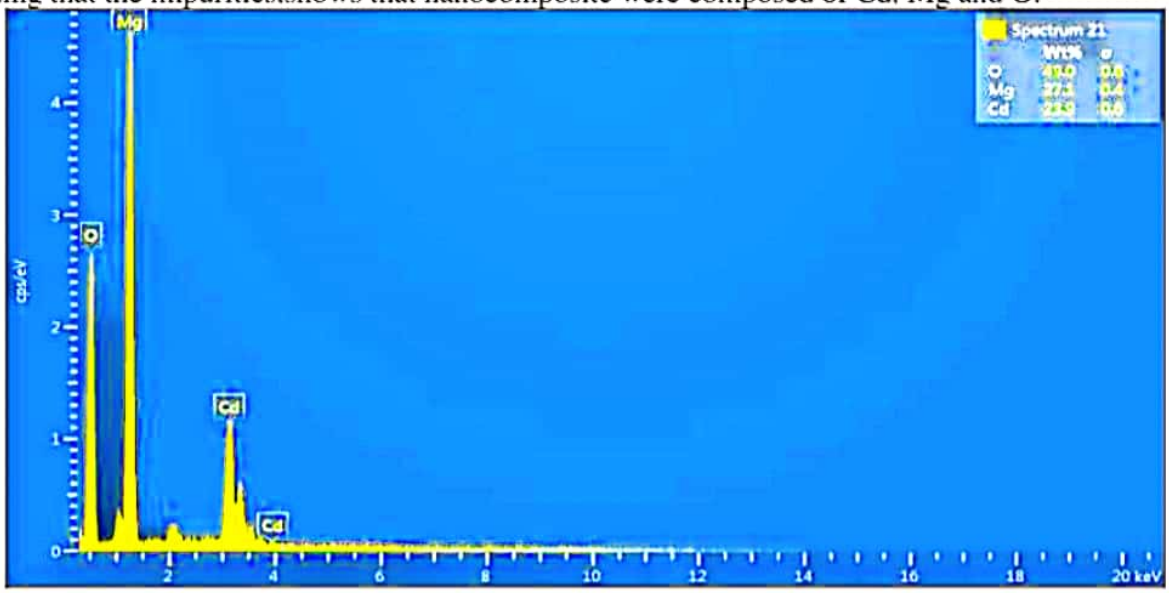

Figure 4 : EDS spectrum of CdO-CuO nanocomposite.

Conclusions

CdO-MgO nanocomposite was prepared successfully by using sol gel pyrolysis method. In XRD analysis, observed peak are well matches with CdO and MgO peaks, so it indicate that material composed of CdO-MgO nanocomposite. As sharp peak develop in material shows excellent crystalline nature having crystallinity 75.78 percent. Average crystalline size is 64.2 nm which indicate nanostructured nature of material. FTIR spectrum shows that observed absorption peak of CdO and MgO composite. When analyse with FESEM, particle are in nano meter range with crystal structure and standard shape. EDS report suggest that material include Cd , Mg and O element only. Due to characteristic and morphological properties, synthesized material may be use for gas sensing.

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