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Synthesis and Properties of CdO and Fe doped CdO Nanoparticles

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Abstract

This paper deals with the comparative studies of synthesis and properties of CdO and Fe doped CdO nanoparticles by chemical co-precipitation method. The properties of synthesized nanoparticles were studied by XRD, FESEM, UV-visible, FTIR, and EDX**.** The XRD pattern shows that the obtained sample has face centered cubic structure. The morphology of the synthesized sample was studied by a field emission scanning electron microscope (FESEM).The absorption spectra was recorded in the UV-Visible region and analyzed. The FTIR vibration spectra confirmed the composition of the product. The EDX analysis confirmed the elements present in the samples and quantitative elemental analysis had been carried out. The results are reported and discussed.

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Keywords: Nanoparticles, Co-precipitation, Face centered cubic, quantitative analysis.

1. Introduction

In recent years, the synthesis of nano-crystalline metal oxide materials has been a focal point of research owing to their role in various technological applications. Cadmium Oxide (CdO) is an n-type semiconductor material. It has interesting properties like large band gap, low electrical resistivity and high transmission in the visible region etc[1]. Cadmium oxide and metal doped cadmium oxide are useful for a wide range of optoelectronic applications like

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transparent conducting oxide (TCO), solar cells, photo transistors, photo diodes, transparent electrodes, gas sensors etc[2]. Hence some researchers have tried to dope metals like Ni, Al, Fe etc to CdO via sol-gel spin coating[3], sol-gel calcinations[4] and solid state reaction methods[5]. But no earlier report exists on the preparation of CdO and Fe doped CdO by co-precipitation method. This study focuses on the synthesis of pure and Fe doped CdO nanoparticles by chemical co-precipitation method and the influence of doping element on the physical properties of CdO nanoparticles.

2. Experimental methods

2.1. Materials

All the chemicals used for the preparation of CdO and Fe doped CdO were of AR grade and were used as such without any further purification.

2.2. CdO nanoparticle synthesis

For the synthesis of CdO sample,1M solution of sodium hydroxide (NaOH) was added to0.5 M solution of cadmium nitrate (Cd $(NO_3)_2$). This Solution was stirred for 2hrs at room temperature. The solution was kept undisturbed for 8 hrs. A white precipitate was obtained, it was washed several times using double distilled water to remove the impurities. The hydroxide, thus formed was dried at 80^{o}C.Finally, the powder was calcined at 500^{o}C for2hrs. During the calcinations, the as prepared powder was decomposed as follows:

$$Cd(NO_3)_2.4H_2O + 2NaOH \rightarrow Cd(OH)_2 + 2NaNO_3 + 4H_2O\uparrow$$
$$Cd(OH)_2 \rightarrow CdO + H_2O\uparrow$$

2.3. Fe doped CdO nanoparticle synthesis

For the synthesis of Fe doped CdOnanoparticles,0.5M cadmium nitrate(Cd $(NO_3)_2.4H_2O$)and 0.05M Iron nitrate (Fe $(NO_3)_3.9H_2O$) was prepared in double distilled water. To this solution, 1 M of sodium hydroxide (NaOH) was added. And then the solution was stirred for 2hrs at room temperature. The solution was left undisturbed for 8 hrs. Resulting precipitate was washed several times using double distilled water to remove the impurities. The hydroxide, thus formed was dried at 80^{o}C and grinded into powder. Finally, the powder was calcined at 500^{o}C for 2hrs. During the calcinations, the as prepared powder was decomposed as follows:

$$Cd(NO_3)_2.4H_2O + 2Fe(NO_3)_3.9H_2O + 2NaOH \rightarrow Cd(OH)_2 + 2NaNO_3 + 4H_2O\uparrow$$
$$Cd(OH)_2.Fe_2(OH)_6 \rightarrow CdFe_2O_4 + 4H_2O\uparrow$$

3. Results and Discussion

3.1. XRD analysis

The XRD pattern of undoped and Fe doped CdO are shown in fig.1 and 2.There is no change in the XRD patterns of undoped and Fe doped CdO. The peaks are indexed using JCPDS card no:75-0594.Both undoped and Fe doped CdO have Face Centered Cubic structure. The crystallite size of the undoped and Fe doped CdO are analyzed by using Debye Scherrer equation,

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

Where, D-is the crystalline size, λ-is the wavelength of CuKα radiation used, β-is full width Half Maximum (FWHM). The average crystallite size of the undoped and Fe doped CdO calcined at 500^{o}C are found to be 35.5 nm and 27.9 nm respectively.