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FESEM, XRD AND UV-VISIBLE SPECTROSCOPIC STUDIES ON PURE AND EDTA CAPPED ZINC OXIDE NANOPARTICLES BY WET CHEMICAL METHOD

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Abstract: *The Pure and EDTA Capped ZnO nanoparticles were synthesized via Wet-Chemical method. The surface morphology of the Pure and EDTA capped ZnO nanoparticles have been studied using FESEM. The structural morphology of the pure ZnO nanoparticles has obtained in non-uniform manner. When we added EDTA as capping agent the surface morphology of the radial hexagonal shapes of the particles are individually separated when compared to the pure ZnO. From the X-ray diffraction (XRD) study, it reveals that the synthesized ZnO product has the hexagonal phase structure. The average crystallite size of the Pure and EDTA capped ZnO nanoparticles are 16.17 nm and 9.22 nm respectively. The synthesized samples were examined through UV-Visible spectrometer; the UV absorption at around 373 nm with the estimated direct band gap energy is 3.32 eV for pure Zinc oxide and is 3.25 eV for EDTA Capped ZnO.*

Keywords: *FESEM, XRD, UV-Vis, ZnO nanoparticles, and EDTA.*

1 Introduction

ZnO is a wide band gap semiconductor with optoelectronic properties that make it an attractive candidate for a variety of device applications. Zinc oxide is a versatile material that has achieved applications in photo catalysts, solar cells, chemical sensors, piezoelectric transducers, transparent electrodes [1-3], electroluminescent devices, and ultraviolet laser diodes [4, 5]. There are various methods in order to synthesize ZnO nanomaterials viz. solvothermal synthesis, sol–gel [6], combustion synthesis, Spray analysis, thermal hydrolysis, hydrothermal synthesis etc [7-10]. Hydrothermal synthesis is one of the most extensively used and cost effective methods for the preparation of nanomaterials. In this study, the ZnO nanomaterials have been synthesized and their optical and surface morphological properties are investigated.

2 Materials Synthesis:

In the typical synthesis, 0.1 mol of Zinc acetate and 0.2 mol of Sodium Hydroxide were dissolved in 100 ml of deionized water under vigorous stirring at room temperature. The stirring is continued for 18 hours. Pure ZnO was precipitated. The precipitated ZnO was washed thrice with water and thrice with ethanol to remove the unreacted precursor and the by-products. The samples were dried using Hot Air oven at 12 hours. The obtained sample is labeled as pure ZnO. To the above same procedure and adding 0.025 mol of capping agent Ethylenediaminetetraacetic acid (EDTA) was added to get EDTA capped ZnO nanoparticles.

3 Results and discussion:

3.1 Powder – XRD Analysis:

The X-ray diffraction analysis of the pure ZnO and EDTA capped ZnO nanoparticles were studied using Rigaku miniflex II X-ray. Fig.1 show the Powder XRD patterns of the pure ZnO and EDTA capped ZnO nanoparticles samples scanned in 2θ range from 20° to 70°. A number of strong Bragg reflections are observed originating from the synthesized ZnO samples. The peak observed at 2θ = 32.5°, 34.5°, 37.2°, 47.5°, 56.5°, 63.8°, 67.2°, 68.1° and 69.6° correspondence to the lattice plane (100), (002), (101), (102), (110), (103), (200), (112) and (201) respectively, which indicates wurtzite hexagonal structure of ZnO [11]. All the peaks are matched with standard JCPDS card no-890510. The crystallite size (D) of the prepared nanopowder can be calculated by using Debye-Scherrer's formula $\mathbf{D} = 0.9\lambda/\beta \cos\theta$

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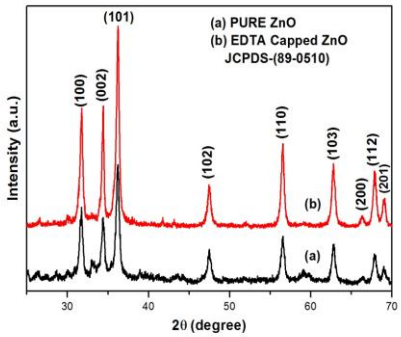

Fig.1 Powder XRD patterns for (a) pure and (b) EDTA capped ZnO Nanoparticles

The crystallite size of prepared nanoparticles is found to be 16.17 nm for pure ZnO nanoparticles and 9.22 nm for EDTA capped ZnO nanoparticles which are in the order of nano size.

3.2 FESEM Analysis:

In fig.2 FESEM has been used to examine the surface morphology and to estimate the pure ZnO nanoparticles has obtained in non-uniform surface morphology. When we added EDTA capping agent the surface morphology of Fig.3 shows the radial hexagonal shapes of the particles are individually separated when compared to the pure ZnO [12].

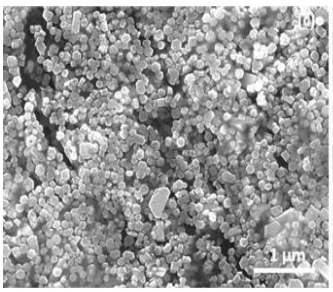

Fig.2 FESEM images of Pure ZnO (a,b)

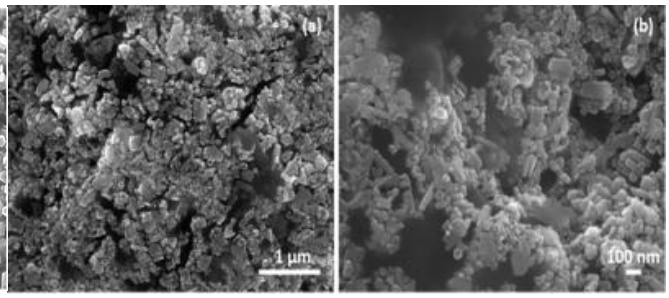

Fig.3 FESEM images of EDTA capped ZnO (c,d)

3.3 UV-Vis spectral analysis and Optical study

In fig.4 shows the UV-Vis absorption spectra of the Pure ZnO and EDTA capped ZnO respectively. The Optical absorption edge of both samples was observed at around 373 nm which corresponds to bulk ZnO nanoparticles [13].

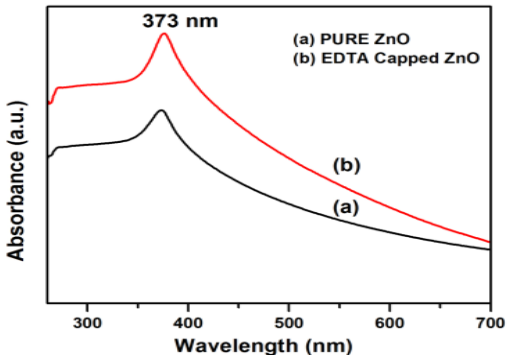

Fig.4 Optical absorption spectra for Pure and EDTA capped ZnO

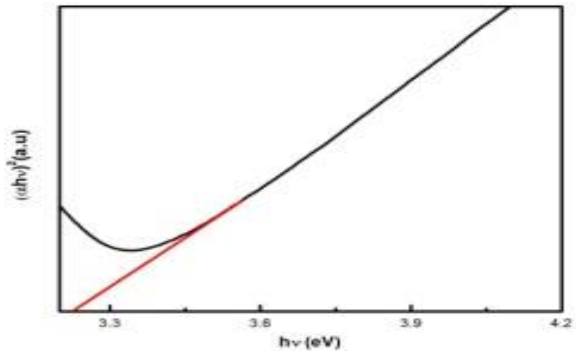

Fig.5 UV tauc plot pure ZnO

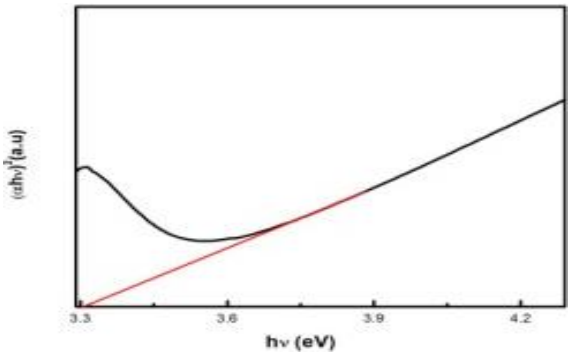

Fig.6 UV tauc EDTA capped ZnO

The absorbance peak was observed at 373 nm for both pure and EDTA capped ZnO nanoparticles. In Fig.5 and 6, the band gap estimated for pure Zinc oxide is (3.32 eV) that is slightly varied than the EDTA Capped zinc oxide (3.25 eV). So the new materials of EDTA capped Zinc Oxide nanoparticles is good Optical and conducting properties.

4 Conclusions:

In the present work, ZnO nanoparticles were well synthesized, which can be used as Dye Sensitized solar cell, thermoelectric applications and Photo catalytic activity. The XRD average crystallite size of Pure ZnO and EDTA capped ZnO nanoparticles are 16.17 nm and 9.22 nm respectively. FESEM has been used to examine the surface morphology and the obtained image has radial hexagonal shapes of the particles which are individually separated when compared to the pure ZnO. The Optical absorption edge of Pure ZnO and EDTA capped ZnO nanoparticles samples was observed at around 373 nm which corresponds to bulk ZnO nanoparticles. The calculated optical band gaps were found to be 3.32 eV and 3.25 eV for pure ZnO and EDTA capped ZnO nanoparticles respectively.

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