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Research Article

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The Role of Reagents on Microstructural and Morphological Investigation of Surfactant based Synthesis of CdO Nanorods

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Abstract: Cadmium oxide nanostructures were prepared utilising a noval microwave irradiated wet chemical technique with sodium dodecyl benzene sulphonate as the surfactant and two distinct co-reagents (NH3 and NaOH). XRD, and FTIR were used to examine the microstructural properties of synthesised and heat-treated (300°C) CdO nanostructures. As prepared and annealed smaples, the fluctuation of crystallite size and morphology of CdO nanostructures with different co-reagents was investigated. The average crystallite size of the samples was 11.4 to 17.8 nm for the NH3 reagent and 9.7 to 16.8 nm for the NaOH reagent.

Keywords: Nanostructures, Wet Chemical synthesis, Cadmium oxide nanostructures, Microstructural analysis

1. Introduction

Metal oxide nanoparticles have become more important in a variety of current technologies. All nanotechnologists and researchers are interested in studying the size-dependent features of metal oxide nanoparticles because of their potential uses in gas sensors, supercapacitors, computer memory, device fabrications, photocatalytic, and antimicrobic activities [1–4]. Small size with a big surface area is another significant aspect to consider when choosing metal oxide nanopareticles for certain applications. Many metal oxide nanoparticles, such as ZnO, CuO, SnO2, TiO2, and FeO, have been produced and described in recent years. Cadmium oxide (CdO) nanoparticles, with their reduced energy band gap, low resistivity, and high conductivity, are also attractive materials for multifunctional applications such as sensors, solar cells, and photodetectors. CdO nanostructors can be made by vapour phase transport, solvothermal techniques, microemulsion, and template-assisted procedures. [5–7]. These technologies, on the other hand, necessitate high temperatures, large investments, multi-step development, advanced instrumentation, and so on [8–10]. As a result, achieving a simple cost effect synthesis of metal oxide nanostructures is a difficult task. This can be performed using a one-step template-free growth using a microwave-assisted hrdrothermal technique with surfactants or caping agents. Microwave synthesis creates CdO nanoparticles with a variety of morphologies, small particle sizes, great purity, and a rapid reaction time. In this study, we attempted to create CdO nanoparticles utilising SDBS as a surfactant and co-reagents ammonia (NH3) and sodium hydroxide (NaOH). XRD and FTIR were used to investigate the impact of surfactant and co-reagents on the structural behaviour of CdO nanoparticles.

2. Experimental Procedure

2.1. Materials

Analytical grade of Cadmium acetate, Cd $(CH_3COO)_2.\ 2H_2O$, SDBS, NH_3 and NaOH were used as raw materials purchased from SD fine chemicals, India. All the chemicals were used without further purification.

2.2. Synthesis of CdO Nanorods

Dissolving cadmium acetate Cd (CH3COO)2.2H2O in deionized water yielded a 0.1 M cadmium solution. 4g SDBS was mixed with 50 mL deionized water to make a solution of the surfactant SDBS. The pH of the solution was adjusted to 9 by adding NH3 solution drop by drop to the aforesaid mixture for 2 hours. With double distilled water and ethanol, the resulting product was filtered and cleaned until it was free of contaminants. A similar experimental procedure was used to make CdO nanorods using NaOH instead of NH3 to maintain the

pH of the solution. The precipitate was irradiated for 3 minutes in a household microwave oven and then directly cooked at 130 °C in convection mode for 2 hours to obtain a dried sample without the use of any further methods. Finally, the sample was annealed in a muffle furnace at 300°C for 6 hours.

2.3 Characterization

For the study of structural properties, the Bruker AXS D8 XRD instrument with a monochromatic CuK α1 wavelength of 1.5406 Å was used. Using Perkin Elmer Spectrum-1 (resolution 1.0 cm^{-1}), the FT-IR of the samples was registered.

3. Results and discussion

The phase composition of CdO nanostructures produced with SDBS as a surfactant and two distinct reagents (NH3 and NaOH) was investigated using an XRD pattern (Figure.1). Multiple hkl plans and a low crystalline character may be seen in the as-prepared CdO nanostructure (see Figure.1(a)). The hkl miller indecies (111), (200), (220), (311) and (222) with sharp peaks indicate enhanced crystallinity in the CSDNA annealed at 300°C (see Figure.1(b)). The indexed profile closely resembles the conventional JCPDS profile (05-0640). In CSDNA nanorods, similar distinctive peaks were identified (see Figure.1(c,d)). With SDBS, however, annealing produced similar crystallinity in both co-reagents NH3 and NaOH. The crystillite size (t) and lattice parameter (a) of the as prepared and annealed CdO nanostructures were calculated using the formula: $t = (0.9\ \lambda) / (\beta \cos \theta)$ and $a^2 = d^2 (h^2 + k^2 + l^2$ The annealing temperature increases the predicted structural characteristics of CdO nanostructures. The average crystillite size of the samples was determined to be between 11 and 18 nanometers. The samples' lattice constants were quite close to the theoretical value.

Figure 2 shows the FTIR spectra of CSDNH and CSDNA (a-d). The spectra (see Figure.2(a)) comprises Cd–O peaks at 690 cm-1 and 582 cm-1, as well as several peaks related to O-H groups (3444 cm-1), C-H bands between 2854 and 2954 cm-1, C=O, and C-O-C bands between 1010 and 1789 cm-1 [4,7]. In the finger print region, Cd–O peaks were seen at 613 cm-1, 470 cm-1, and 416 cm-1, as shown in Figure.2(b). The annealing process eliminated several weak bonds from the CdO samples after they were dried at 130°C. The CdO produced using SDBS surfactant and NaOH co-reagent exhibits the same behaviour. The Cd–O representative peaks at 621cm-1, 470cm-1, and 420cm-1 are confirmed by Figure.2(c,d). The presence of distinctive bands in the FTIR spectrum confirms pure CdO.

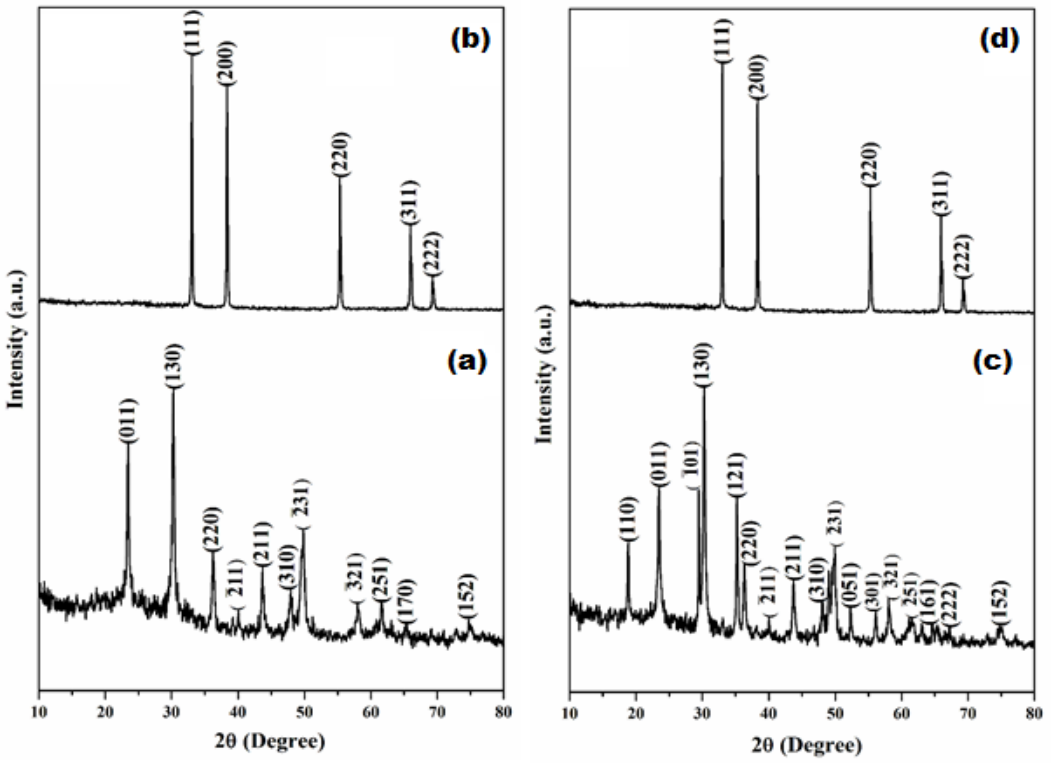

Figure 1. XRD pattern of CdO nanostructures using SDBS surfactant: **a)** as prepared with NH_3; **b)** annealed at 300°C; **c)** as prepared with NaOH; **d)** annealed at 300°C

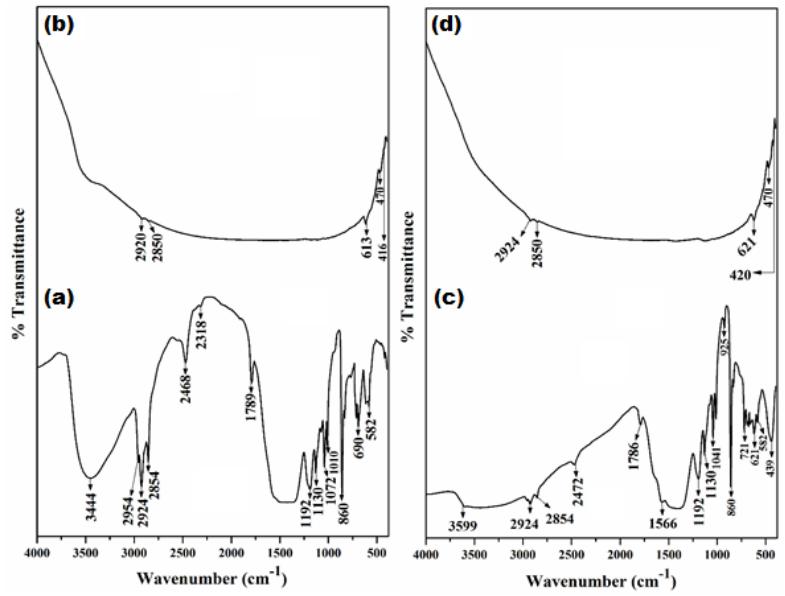

Figure 2. FTIR spectra of CdO nanostructures using SDBS surfactant: **a)** as prepared with NH_3; **b)** annealed at 300°C; **c)** as prepared with NaOH; **d)** annealed at 300°C

4. Conclusion

CdO nanostructures were effectively synthesised utilising the microwave irradiation approach with two distinct reagents employing SDBS as a surfactant (NaOH & NH3). XRD is used to analyse the structural properties of CdO nanostructure, such as crystallite size and lattice constant. The functional groups in the produced and heat treated CdO nanoparticles are confirmed by vibrational analyses.

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Does this article screened for similarity?

Yes

Conflict of interest

The Author has no conflicts of interest to declare that they are relevant to the content of this article.