SYNTHESIS AND CHARACTERIZATION OF CDO NANOPARTICLES BY MICROWAVE ASSISTED IRRADIATION TECHNIQUE

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Abstract:
CdO nanoparticles were synthesized by a simple cost effective microwave assisted irradiation technique using PEG-400 as surfactant. The structural properties of CdO nanoparticles have been studied using X-ray diffraction pattern (XRD). XRD pattern confirms purity and phase formation of CdO nanoparticles. Particle size hasbeen calculated for these nanoparticles using XRD data. These nanoparticles have also been characterized by UV-visible (UV-vis) spectroscopy.The blue shift evident from the absorption spectra clearly indicates formation of CdO nanoparticles.
Keywords: CdO nanoparticles, X-ray diffraction, UV-visible spectra.

1. Introduction:

Cadmium oxide (CdO) is one of the most prominent n-type metal-oxide semiconductors which exhibit narrow band gap (2.2 to 2.7 eV) with relatively low electrical resistivity (10^{-2} to 10^{-4} ohm cm) due to defects of oxygen vacancies and cadmium interstitials and hightransmission (nearly 90%) [1,2]. Due to its high electrical conductivity and optical transmittance in the visible region of solar spectrum, it has great potential for advanced applications such as flat panel display, organic light emitting diodes, gas sensors, etc. Several techniques have been used to prepare CdO nanostructures, including sol-gel [3], hydrothermal [4], solvothermal [5], chemical bath deposition [6], pulse laser deposition [7], spray pyrolysis [8], DC magnetron sputtering [9], radio-frequency sputtering [10] etc.All of these methods have some advantages, but often require long reaction time, needs costlyequipment, handling of large amounts of organic salt, solvent or surfactant, causesenvironment pollution. In past few years microwave assisted irradiation technique is becoming an increasingly popular method of nanomaterial synthesis due to its unique features such as eco-friendly method with very less reaction time, rapid and uniform heating, energy saving, high reaction rate, high chemical yield and pure homogeneous product.Therefore, the temperature distribution is homogeneous and transferred to the materials interior, making explosion reaction followed by vigorous evolution of gases to form nanostructure [11-13].

In the present work, CdO nanoparticles were synthesized by a simple microwave assisted irradiation technique which is very fast and cost effective method compared to the other methods. The synthesized sample was characterized by X-ray diffraction (XRD) and ultraviolet–visible spectroscopy (UV–vis absorbance).

2. Experimental:

2.1 Synthesis:

All of the reagents involved in the experiments were of analytical reagent (AR) grade and were directly used without further purification. A cadmium hydroxide solution (0.1 M) was prepared by dissolving cadmium acetate dehydrate with double distilled water. The ammonia solution was added drop wise to above precursor solution under constant stirring until the pH of the solution is 8. Then 3 ml poly ethylene glycol(PEG-400) was added very slowly to the resultant solution under continues stirring. Poly ethylene glycol (PEG-400) 3 ml has been also added very slowly understirring as a surfactant and stirred for 1 h under constant stirring. The resultant solution was placed in a household microwave-oven (2.45 GHz, 800 W) for 5 minin microwave mode while maintaining the temperatureat 80 ^{o}C.The final whiteprecipitation product was filtered and washed several timesusing double distilled water and ethanol and dried at 100 °C in a conventional oven. The solidprecipitate was then finely ground in an agate mortar to get fine powder and then thermally treated at 300 °C using a muffle furnace for 2 h to remove residuals that may present even after irradiation.

2.2 Characterization:

The product was characterized by UV-visible spectrophotometer (Model-Black-C-SR, Stellarnet Inc. USA) in the spectral range 190 - 1000 nm. The XRD pattern of as synthesized sample was recorded using a Rigaku X-ray diffractometer Miniplex II with nickel filtered Cu Kα radiation (λ=1.5406 Å).

3. Results and discussion:

3.1 XRD studies:

Fig 1 indicates XRD spectrum for CdO nanoparticles. All the d-values corresponding to the XRD peaks show the presence of cubic phase of crystalline CdO with cell parameters a = b = c = 4.7300Å which is in good agreement with the reported values (PDF 01-075-1529). Peak broadening can be seen which confirms the nano crystalline nature of CdO crystals. Considering the spherical nature, particle size of these nanoparticles are calculated by Debye-Scherrer formula ; [14] where k is a constant (k=0.93) and β is width of the diffraction peak at half maxima. The average crystallite size calculated for (111), (200), (220), (311) and (222) planes was found to be 33 nm for CdO nanoparticles.

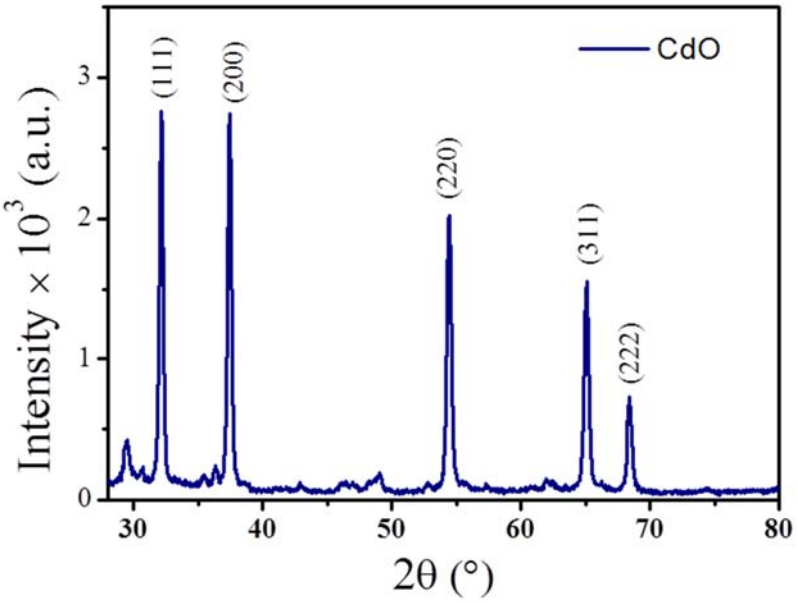

Fig 1. XRD spectrum of CdO Nanoparticles

3.2 UV-visible studies:

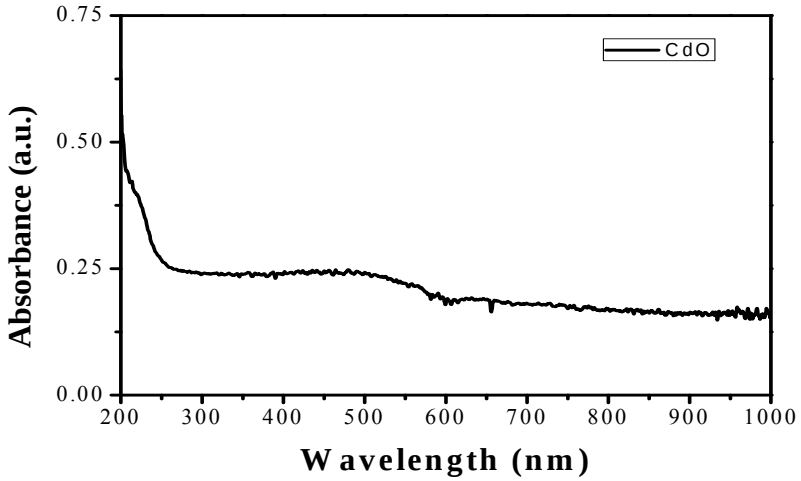

Fig 2. Optical absorption of CdO nanoparticles

The proper quantity of CdO nano powder was taken in double distilled water and ultra-sonicated to form stable suspension. The liquid solution was then taken into 10 mm path length quartz curette for UV-vis absorption spectroscopy. Fig.2 indicates absorption spectra of CdO nanoparticles. It can be seen that CdO nanoparticles show absorption in the range 250-500 nm. The onset of absorption is at 250 nm which clearly indicate formation of nanoparticles. The blue shift is evident from the absorption spectra. UV-vis spectra show that CdO nanoparticles exhibit different blue shift in comparison with that of the bulk CdO [15].

Conclusion:

A simple and low cost microwave assisted technique has been proposed for the synthesis of cadmium oxide nanostructures. This fast and low cost method may be suitable for the preparationin few minutes of other crystalline metal oxide nanostructures. XRD pattern confirms highly purecubic phase formation of CdO nanoparticles with particle size 33 nm. In addition, the UV–visible absorption spectrum of the CdO nanoparticles exhibit different blue shift in comparison with that of the bulk CdOclearly indicates formation of CdO nanoparticles.

References:

1) A.S. Kamble, et.al. Materials Letters 65 (2011) 1488–1491
2) A. A. Dakhel, Journal of Materials Science 46 (2011) 6925–6931
3) D.M.Carballeda-Galicia, et.al. Thin Solid Films 371 (2000) 105-108
4) Weijun Xia et.al. Analytical Methods 8 (2016) 6265-6269
5) MoumitaGhosh, C.N.R. Rao, Chemical Physics Letters 393 (2004) 493–497
6) R. N. Bulakhe, C.D. Lokhande, Sensors and Actuators B 200 (2014) 245–250
7) M. Yan, et.al. Applied Physics Letters 78 (2001) 2342-2344
8) R. H. Bari, S. B. Patil, International Letters of Chemistry, Physics and Astronomy18 (2014) 31-46
9) P.Dhivya, et.al. Journal of Solid State Chemistry 214 (2014) 24-29
10) B. Saha, et.al. International Journal of Nanoscience 10 (2011) 713-716
11) V. Vasanthi, et.al. Journal of Magnetismand Magnetic Materials 324 (2012) 2100–2107
12) YükselKöseoğlua, Ceramics International 40 (2014) 4673-4679
13) A. Manikandan, Journal of Industrial and Engineering Chemistry 20 (2014) 2077–2085
14) B. D. Cullity, Elements of X-ray diffraction, Addison-Weseley series in Metallurgy and Materials, 1978.
15) Jinsong Liu et.al. Advanced Materials Research Vols. 228-229 (2011) 580-58