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Research Article

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Synthesis and Characterizations of Cadmium Doped Aluminium Oxide Nanoparticles

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Abstract: The cadmium doped aluminium oxide ($CdAl_2O_3$) nanoparticles were prepared by reverse precipitation method. The prepared $CdAl_2O_3$ nanoparticles were characterized by Powder X-Ray Diffraction in order to confirm the crystalline nature of the sample and found average crystallite size in the range 27.6 nm. Fourier transform infrared spectroscopy confirms the presence of metal oxygen bonds in the $CdAl_2O_3$ nanoparticle.

Keywords: Nanoparticles; Reverse precipitation; Structural

1. Introduction

Size of nano particles system is usually being in range between 1-100 nm. The materials often exhibit novel optical, electric, chemical properties [1, 2]. Among aluminum oxide nano particles annealed different temperature η(cubic), θ(monoclinic) and δ (tetragonal) phase are reported [3]. Moreover γ-Al_2O_3 is adsorbents, catalyst, high surface area and chemical activity [4-8].

Although, several methods to synthesize γ-aluminium oxide nano particle chemical methods include precipitation methods, sol gel, combustion method, thermal, pyrolysis process and son chemical method [9-16]. Synthesis of γ-Al_2O_3 nano particles wet chemical method [17]. Previously, Aluminium oxide (Al_2O_3) nanoparticles prepared by a Mechanical milling process and during this sintering process the γ-Al_2O_3 were obtained at 350 ºC and α-Al_2O_3 were obtained about at 1250 ºC [18, 19] have been studied. In this present investigation, the research work, made on synthesis and characterization of Cadmium doped aluminium oxide nano particles by reverse precipitation method and obtained $CdAl_2O_3$ NPs subjected to various characterization studies in order to study the physico-chemical properties of the $CdAl_2O_3$ NPs.

2. Experimental details

2.1 Materials

Aluminium chloride (AR grade 99% pure) and cadmmium chloride anhydrous powder (AR grade 99% pure) and 25% ammonia solution (Merck) chemicals were used for the synthesis of nanoparticles. All other chemicals used were of reagent grade and double distilled water the solvent.

2.2 Synthesis

A 0.1M concentration solution of aluminium chloride was prepared by dissolving it in sodium hydroxial solution and stirred well. Then cadmium chloride of 10 weight percentage was added aluminium hydroxyl solution. pH value of the solution was maintained at 11. The collected precipitation was irradiated by microwave radiation frequency 2.45 GHz and power up to1 KW for 5 minutes continuously. The prepared sample was annealed at a temperature of 500 °C for 4 hours.

2.3 Characterization

The crystalline phase of the sample was analyzed by Powder X-Ray Diffraction using Bruker D8 advance model instrument. X-rays of monochromatic wavelength 1.5406 Å was used within the scan range of 10°-80° scattering angle. Fourier transform infra-red spectroscopy (FT-IR) was recorded by using a Nicolet 5DX FTIR spectrometer.

3. Results and Discussion

3.1 Powder X-ray diffraction (P-XRD)

To analyze the crystalline nature of the samples powder XRD spectra of cadmium doped cobalt oxide nanoparticles were recorded spectra are shown in Fig.1.The presence of a sharp peak at 2θ angles 31°,37°,45° corresponding planes (220), (311), (400) confirmed aluminium oxide nanoparticles. The diffraction pattern matched the reported as (JCPDS NO 29-003). The prepared nanoparticles average crystallite size, micro strain, dislocation density, stacking fault presented are Table.1.

The crystallite sizes (D) of these samples are calculated using the Scherrer equation

$$D = \frac{K\lambda}{\beta \cos\theta} \qquad (1)$$

Where D is the crystallite size, K Shape factor (K=0.9), λ is the wavelength of X-rays used (1.5406 Å), θ is the angle of diffraction, β Full width of half maximum.

Micro strain induced broadening in powders due to crystal imperfection and distortion small crystallite size calculated strain broadening using ε formula

$$\varepsilon = \beta/4tan\theta \qquad (2)$$

Dislocation density δ amount of the defect in the sample the length of dislocation lines per unit volume calculated from using the grain size 'D' using the formula

$$\delta = \frac{1}{D^2}\,\text{lines/m}^2 \qquad (3)$$

When crystallizes there is a possibility of imperfection in stacking of atomic planes which are known as stacking fault (τ)

$$\tau \left[\frac{2\pi^2}{45(3\tan\theta)\ 45(3\tan\theta)^{\frac{1}{2}}}\right]\beta \quad (4.7) \qquad (4)$$

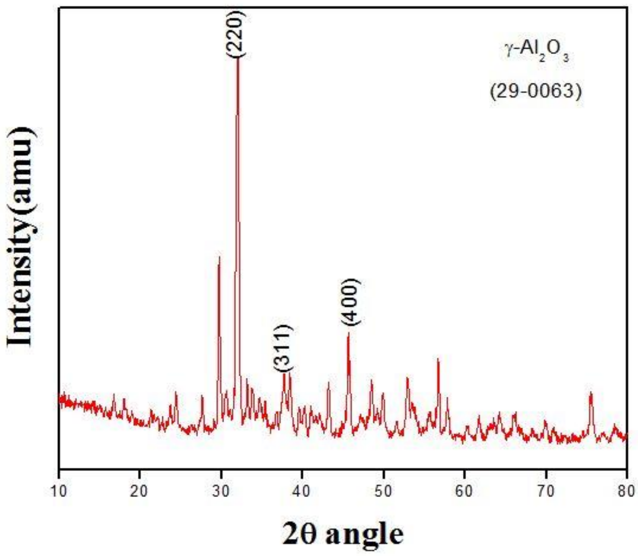

Figure 1. Shows the X-ray diffraction pattern of the samples CdAl2O3 nanoparticles

Table.1 shows the structural properties of the samples Cd Al_2O_3 nanoparticles

Sample	2θ	FWHM	Crystallite Size (nm) Equ (1)	Micro Strain Equ (2)	Dislocation density δ ($X10^{15}$) Equ (3)	Staking Fault τ ($X10^{-5}$) Equ (4)
Cd- Co_3O_4	29.720	0.245	33.545	0.230	0.885	5.863
	31.983	0.433	19.085	0.377	2.745	9.231
	43.199	0.323	26.452	0.203	2.092	4.240
	45.639	0.324	26.660	0.192	1.986	3.882
	56.683	0.275	32.822	0.127	1.622	2.270

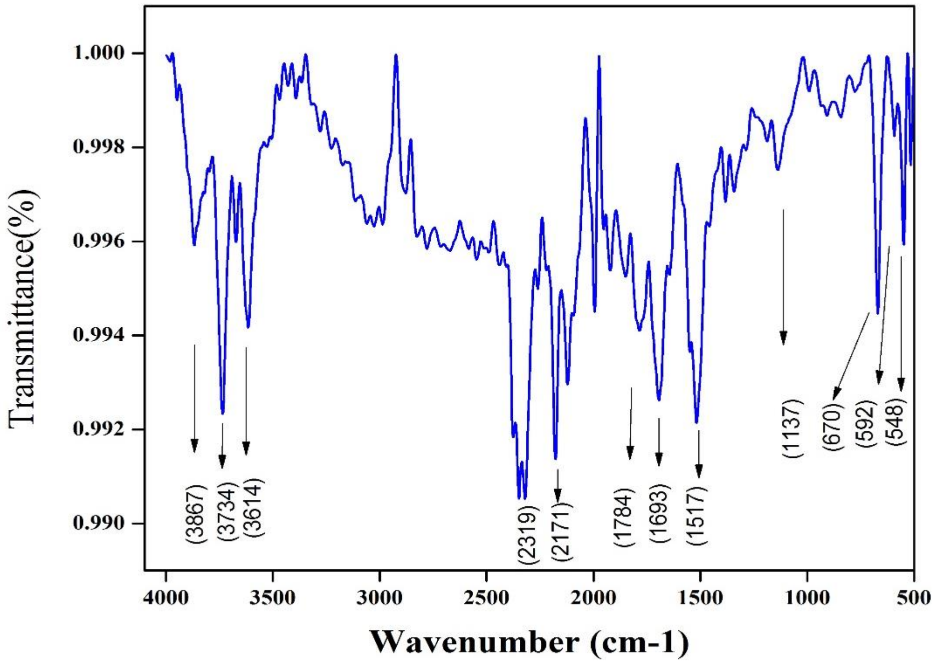

Figure 2. Shows the FTIR spectrum of the samples Cd Al2O3 nanoparticles

3.2 Functional group analysis

Figure.2 Shows the FT-IR spectrum of the samples Cadmium-doped aluminium oxide nanoparticles. The characteristic absorption peak at 548 cm^{-1},592 cm^{-1}, 670 cm^{-1} were due to the AlO_4 and AlO_6 stretching vibration of Al-O bond in γ-Al_2O_3 respectively. The peak 3734, 1693 cm^{-1} infers vibrational modes of O-H bond.

4. Conclusion

The cadmium doped aluminium oxide nanoparticles were synthesized by reverse precipitation method. The powder X-ray diffraction analysis confirmed the good crystallite nature. The W-H method crystallite size and micro strain values calculated. The presence of functional groups that were established by FTIR analysis.

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Does this article screened for similarity?

Yes

Conflict of interest

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