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Exploring the Characterization of Ni doped MgO Nanoparticles using Co-precipitation Method

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Abstract

Nanotechnology is a field of applied science focused on design, synthesis and characterization of nanoinaterials. The nickel and magnesium have improved then- applications in transparent electrodes and nano electronics. In addition, magnesium oxide has moisture resistance and high melting point properties. In the present work has been carried out in the development of green crystalline powder of nickel doped magnesium oxide nanoparticles by Co-precipitation method, from the mixture of nickel chloride and magnesium chloride with KOH as solvent. From the XRD results, crystalline size of the particle can be observed. Spherical structure of Ni doped MgO nanoparticles were indicated by SEM results and powdered composition of samples were obtained from FTIR. EDAX represents the peak composition of the nanoparticle. The above analytical techniques have confirmed that the Ni doped MgO nanoparticles obtained from the mixture of $NiCl_2$ and $MgCl_2$

Keywords: Nickel, Magnesium Oxide, KOH. Co-precipitation method.

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1. Introduction

Nanotechnology has the ability to frame components of molecular size and precise machine. It has the ability to understand, manipulate and control matter at the level of individual atoms and molecules. Recent advances in the field of nanotechnology, particularly the ability to prepare highly ordered nanoparticles of any size and shape, have led to the development of new biocidal agents.[1-2] Nanotechnology has potential application in many sectors of the American economy, including consumer products, health care, energy and agriculture. In addition, nanotechnology presents new opportunities to improve how to measure monitor, minimize the contaminants in the environment. Nanomaterials are already being used or tested in a wide range of products such as sunscreen, composites, medical and electronic devices.[3] Nanoparticles get produced by plants are more stableand the rateof synthesis is faster than mother caseof organisms.[4].

Co-precipitation method offers advantage like simple and rapid preparative method. It has various salts like sulphates, chlorides, oxides under a fine control of pH by using NaOH or NH_4OH solutions.[5] Nickel Oxide is considered as good absorbent due to its chemical and magnetic properties.[6] They have the wide range of applications in various fields including the fabrication of catalysis, fuelcell electrodes and gas sensors.[7] However, with the volume effect, the quantum size effect and the surface effect, nickel oxide nanoparticles are expected to possess many improved properties and even more attractive applications than those of bulk-sized nickel oxide nanoparticles.[8] Magnesium Oxide nanoparticles have unique properties like high chemical stability, high photocatalytic activity, high electrical permittivity and non-toxicity. It also finds extensive applications in catalysis, super conductivity products, and electronic, antiseptic and toxic waste remediation.[9] In this present study, synthesis of nickel doped magnesium oxide nanoparticles using nickel chloride, magnesium chloride with the help of KOH solution

2. Experimental Procedure

To synthesis nickel doped magnesium oxide nanoparticles, about 0.6 M of MgCl2 was taken and it was dissolved in 100 ml of distilled water under constant stirring for 10 mins. Then 0.01 M of NiCl2 was taken and it was dissolved in 100 ml of distilled water under constant stirring for 10 mins. Both the solutions were made to be mixed together. The prepared KOH solution was added drop by drop to be and stirred it for 3 hrs. Allow the solution to cool at room temperature. The solution was centrifuged for 10 mins to form the precipitate and surfactant. The precipitate was repeatly washed with distilled water to remove the impurities. Then the sample was dried in oven at 100°c for 3 hrs and calcinated at 300°c for 2 hrs. Finally, the brown colored nickel doped magnesium oxide nanoparticles were obtained. It was grained well and kept for further studies

3. Results and Discussions

3.1 X-ray diffraction analysis

The XRD patterns of Nickel doped Magnesium Oxide nanoparticles were synthesized by co-precipitation method. The presence of some sharp peak reveals that the synthesized nanoparticles were nano crystalline in nature.[10] The graph is plotted between intensity and 2 theta values. The diffraction peaks were appeared at the angle of 42.81, 28.12, 62.29 (in degrees).

The average crystalline size was calculated using the Debye Scherrerformula,

$$D = K\lambda/\beta \cos\theta.$$ [3]

Where, D is the crystalline size in nm, K is the proportionality constant approximately equal to unity, P is the full-width maximum peak in radians, A is the wavelength of X-rays (1.5406A), θ is the angle of diffracted X-ray pattern in degrees.

From the above formula, the average crystalline size was found to be 11 nm.

3.2Fourier Transfor Infrared Spectroscopy

The functional groups analysis has been performed using Fourier Transform Infrared analysis. FTIR spectroscopy is used to find the presence of specific functional groups in the synthesized nanomaterials. The FTIR spectrum of Ni doped MgO nanoparticles were synthesized by Co-precipitation method recorded in the range of 400 - 4000 cm-1. The results obtained from the studies are compared with the previous reported reprints and IR standards. For Ni doped MgO, the broad peaks at 3664.75 cm 1 that could be due to the O-H stretching vibration. The band at 1635.64 cm4can be attributed to the bending vibration of the molecules. The characteristic strong peak of MgO group appeared at 462.92 cm*1. The graph can be plotted between wave number and functional group.

3.3UV-Visible spectroscopy

The UV-Visible spectrum is carried out under the absorption and transmission conditions in the wavelength range of 200-1000nm. The graph is plotted between wavelength and absorbance. It is absorbed from the spectra that the synthesized particles exhibit absorption in the entire region.

The band gap energy of Ni doped MgO nanoparticles was calculated using the formula;

$$Eg = h^*c/\lambda \text{ max}$$

h = Planck's constant (6.626×10^{-34} J/S)
c = Speed of light (3×10^{5} m/s)
Amax=maximum transmission wavelength or cut off wavelength (945×10^{-9} meters)

$$Eg = 1.13\text{eV}$$

Table 1: Structural parameters of Ni doped MgO Nanoparticles

2θ	FWHM (deg)	Crystalline size D (nm)	Average crystalline size (nm)	Dislocation density(8×10^{15})	Micro strain ($c \times 10^{3}$)
42.8172	0.51880	17.17871		2.11032	2.10749
28.1210	0.46030	18.58274	11	3.17066	1.94826
62.2959	0.57880	16.90383		1.48922	2.14176

Table 2: Wave number and their corresponding functional groups involved in MgO nanoparticles

WAVE NUMBER	FUNCTIONAL GROUPS
1045.42	CO-O-CO Stretching
1423.47	O-H Bending
1635.64	C-C Stretching
2358.74	0=C=0 Stretching
3874.79	O-H Stretching

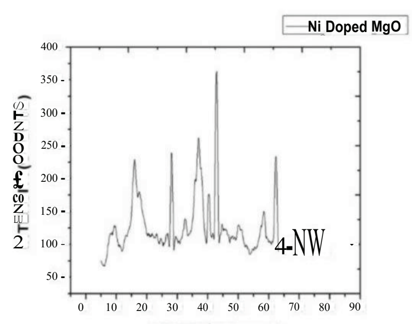

Fig.1: XRD Pattern for Fe_2o_3 Nanoparticles

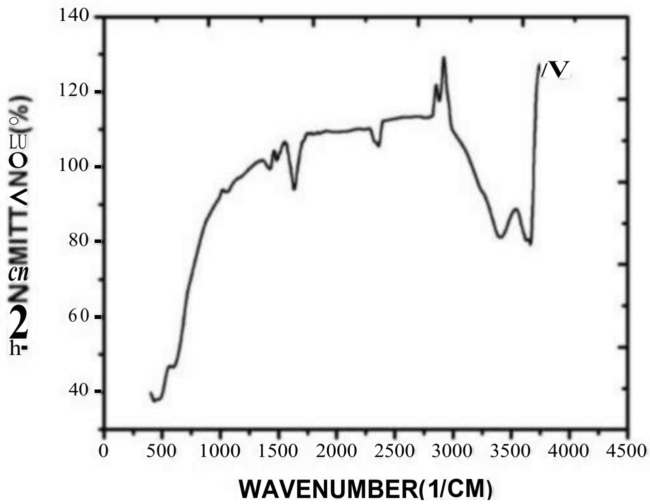

Fig. 2: FTIR image of Ni doped MgO nanoparticles

The conversion factor leV = 1.602 x 10^{-19} Joules. From the absorption spectra of MgO nanopaiticles, Band gap energy is found to be 1.13 eV

Table 3: Different wavelength of Ni doped MgO nanoparticles and its corresponding absorbance

WAVE NUMBER	ABSORBANCE
945.00	0.113
839.00	0.115
636.00	0.129

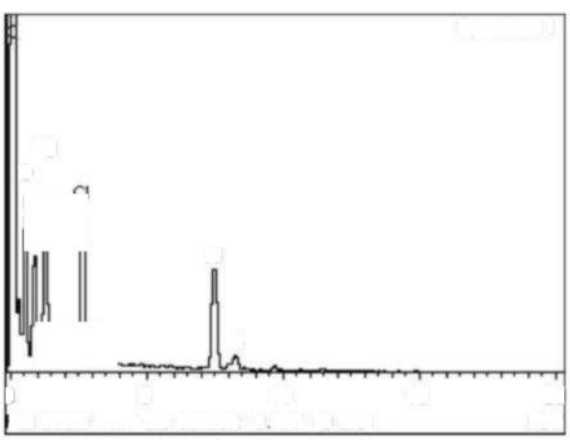

Fig. 3: UV image of Ni doped MgO nanoparticles.

3.4Scanning Electron Microscope (SEM) analysis

SEM analysis is used for the morphological study of synthesized Ni doped MgO nanoparticles. The SEM analysis of MgO nanoparticles were shown in fig. The surface morphology of the sample was viewed through the high-resolution scanning electron microscopic analysis. The SEM images are scanned with a different magnification 10000, 20000, 30000, 55000. The SEM images of Ni doped MgO nanoparticles shows the agglomeration of spherical shape particles.

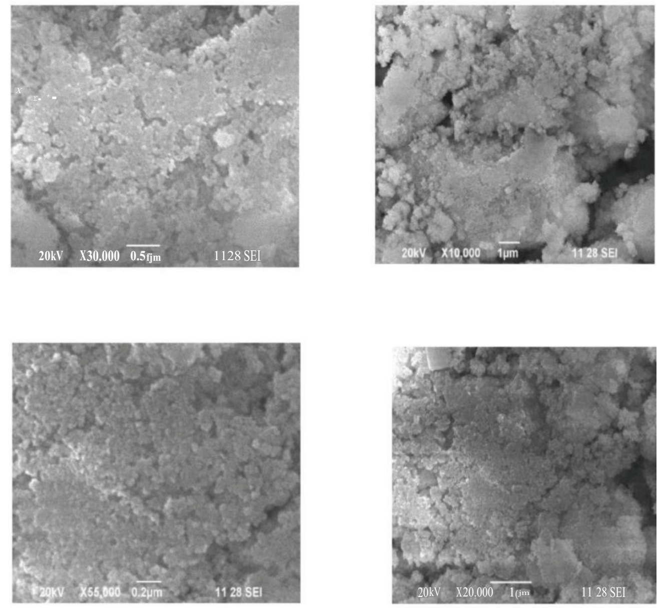

Fig. 4: SEM images of Ni doped MgO nanoparticles

3.5Energy Dispersive X-Ray Spectroscopic analysis

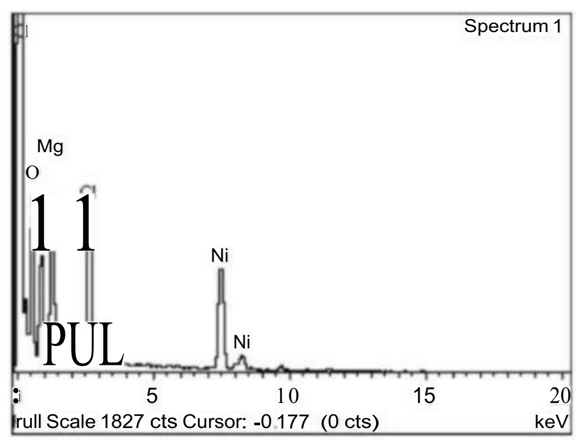

Fig. 5: EDS Analysis of Ni doped MgO nanoparticles

The analysis of MgO nanoparticles by EDS profile confirmed the single characterisitic of magnesium and oxygen. EDS profile is the additional evidence of the formation of pure MgO nanoparticles. The elemental composition of the MgO nanoparticles is characterized by EDAX analysis.[11]] The figure shows elemental composition of MgO nanoparticles.

4.Conclusion

Nickel doped MgO nanoparticles were successfully synthesized using $NiCl_2$ and $MgCl_2$ with the help of KOH under Co-precipitation method. SEM observations clearly show the spherical like structures of Ni doped MgO nanoparticles.

The average ciystal size of Ni doped MgO nanoparticles were found to be 11 nm. From the absorption spectra the Ni doped MgO nanoparticles, band gap energy is found to be 1.13 eV. From the EDAX analysis, the elemental compositions of nanoparticles were found out. The Nickel and Magnesium Oxide nanoparticles both have medical applications such as drugs, medicine etc. and industrial applications such as crucible, ceramics, and paints and in various fields.

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