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Synthesis and Characterization Studies of Pure MgO by Sol-Gel Method

M. Anchana[1], E. Komathi[2], S.Oviya[3], V.Sabari[4]
PG and Research Department of Physics
Marudhar Kesari Jain College for Women, Vaniyambadi, India
vrsabari86@gmail.com

Abstract: *Magnesium oxide nanoparticles were synthesized by Sol-gel Method. The synthesized nanoparticles were characterized by Powder XRD, UV-VIS, SEM and EDAX. The XRD studies of the sample confirmed the formation of cubic structure and the particle size and lattice constants were analyzed. SEM results show Spherical shape for MgO. A broad absorbance band from UV-Vis spectra is located at around 2.32eV. EDAX is used to analyze the functional groups of synthesized nanoparticles. This is the simple synthesis method and they are used in optical and gas sensor applications, telecommunication cables, conductor wires, connector wires and automotive switches.*

Keywords: Mg(NO3)2; C2H5OH, XRD, UV, SEM, EDAX

I. Introduction

Magnesium oxide (MgO) is a versatile oxide material, with high melting point (2850^0C) and high boiling point (3600^0C); thereby it is thermally so stable. In bulk, to make pure MgO, one of the methods is burning magnesium ribbon in the presence of pure oxygen, but metallic magnesium is considerably expensive. Due to its high melting point, MgO possesses inflexible properties, so it can be used as a body material, furnace and crucibles. MgO compounds were prepared by conventional methods like combustion and thermal decomposition which yield a relative small surface area and provide low reaction activity [1].Besides, magnesium oxide has also shown a promising application in catalysis applications of many organic reactions [2].Many synthesis processes such as sol-gel, hydrothermal, flame spray pyrolysis, combustion, aqueous wet chemical, surfactant and chemical gas phase deposition methods have been studied for the synthesis of MgO nanoparticles[3].

Various fabrication techniques are also employed to synthesize MgO nanoparticles having their own advantages and disadvantages [4]. Spherical shaped magnesium oxide nanoparticles were synthesized successfully by sol-gel method using magnesium nitrate and sodium hydroxide [5]. A sol-gel method is an important technique for the formation of magnesium hydroxide followed by annealing at room temperature to form MgO.

II. Experimental Details

2.1. Materials

Magnesium nitrate with gelating agent reagents included ethanol are used for the synthesis Pure MgO nanoparticles. All chemicals, double distilled water and reagents used were procured from Sigma-Aldrich (United States of America) and Merck (Germany) and were of analytical grade.

2.2 Preparation of the Magnesium Oxide Nanoparticles

Magnesium oxide nanoparticles were synthesized by employing a simple sol-gel method using angelating agent. To prepare magnesium oxide [MgO] nanoparticles, (1gm) Magnesium nitrate [Mg (NO3)] was dissolved in 20 ml of ethanol and this solution was stirred using magnetic stirrer above 10 minutes .and 1g of oxalic acid was dissolved in another 20 ml of Ethanol .This solution of stirred using magnetic stirrer above 10 minutes. After stirred oxalic acid which acts as Gelating agent is poured into the Magnesium nitrate .White Gel agent was formed .Then both Magnesium

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Nitrate and oxalic acid was stirred into magnetic stirrer for half an hour and dried the sample at 100 degree celcius for 24 hours. Finally Magnesium Oxide nanoparticle was attained.

2.3 Flow Chart for MgO Nanoparticles

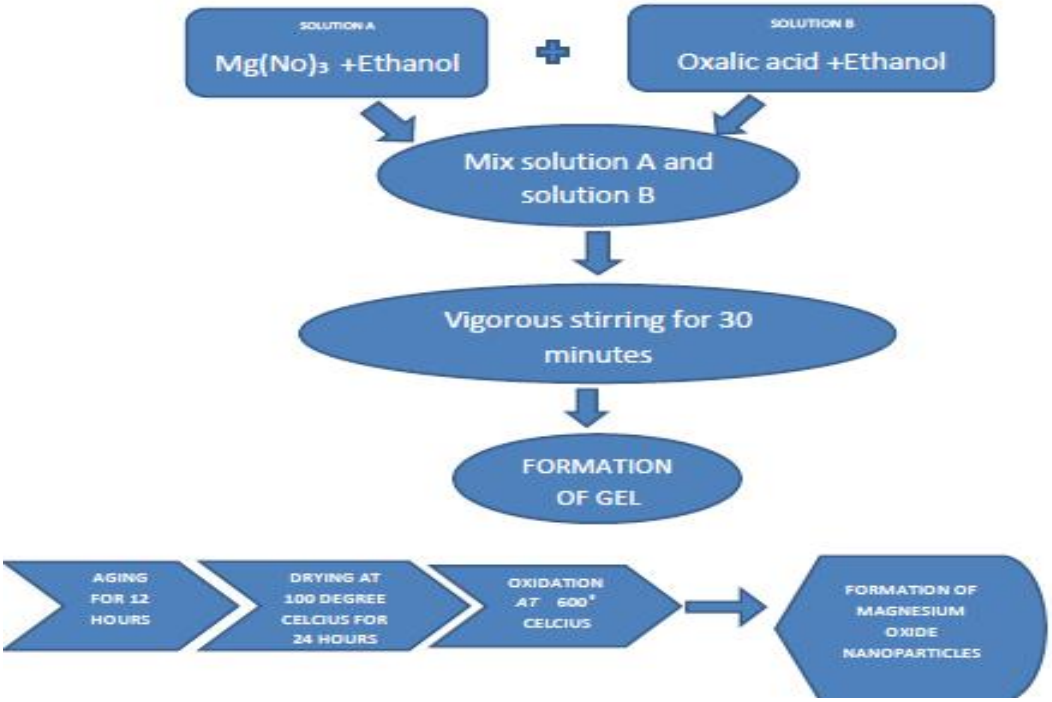

Figure: Flow chart for the synthesis of MgO nanoparticle.

III. Results and Discussion

3.1 Powder X- Ray Diffraction Analysis

Structural Analysis

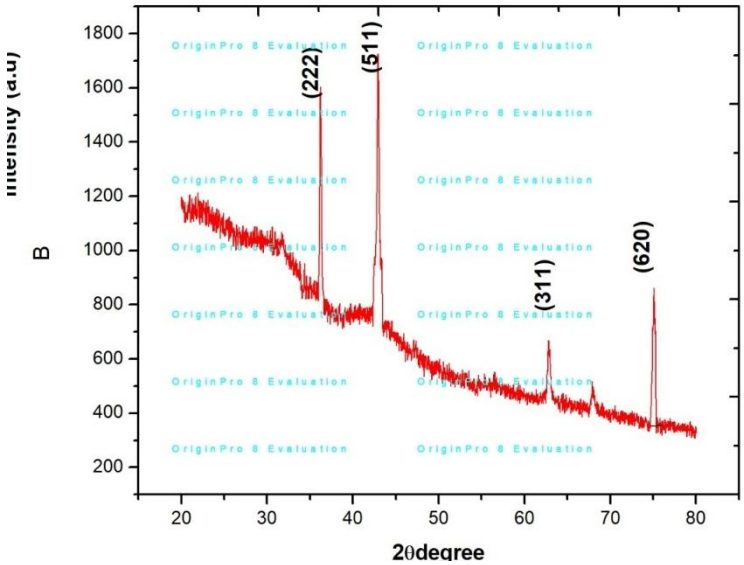

Figure 3.1: Shows the powder XRD analysis for MgO nanoparticles

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Powder X- Ray diffraction technique is used to identify the crystal structure, phase purity and grain size of the materials. The XRD pattern of MgO nanoparticles obtained from Sol-gel synthesis were as shown in figure 3.1. All the diffraction peaks appearing at corresponding 2θ values at 36.22, 42.92, 62.82, 67.95 and75.09 are miller indices values (222), (400), (511), (440), (311), and (620) respectively. These results were matched with JCPDS card (No.30-0794). The result showed that the structure was in cubic structure[6]. The average grain size calculated using Debye- Scherer's formula was 12nm.

Debye- Scherer formula,

$$\mathbf{D=\kappa\lambda/\beta\ cos\theta\ (nm)}$$

Where, **D** is theparticle size (nm)
K is the shape factor (0.94)
λ is the wavelength of X- ray(1.5418 $\AA$)
β is the full width at half maximum intensity
θ is the Bragg diffraction angle

3.2 EDAX

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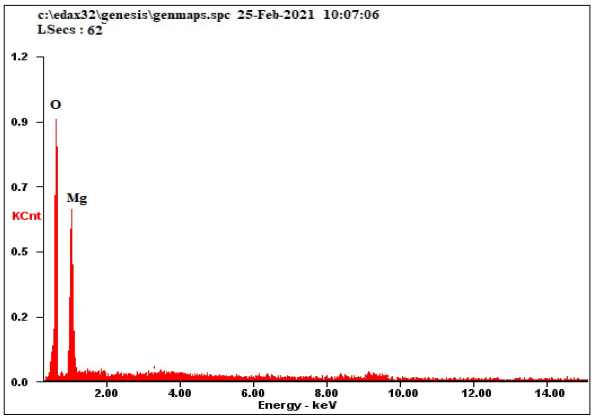

Figure 3.2: EDAX spetrum analysis of Magnesium oxide nanoparticles.

The elemental analysis of Magnesium oxide Nanoparticles were carried put by energy dispersive X -Ray Analysis. Fig. (3.2) shows typical EDAX spectrum of Magnesium oxide Nano particles. The presence of Magnesium amd Oxide without contamination by other element was confirmed by EDAX spectrum analysis.

3.3. UV – Visible Spectroscopy Analysis

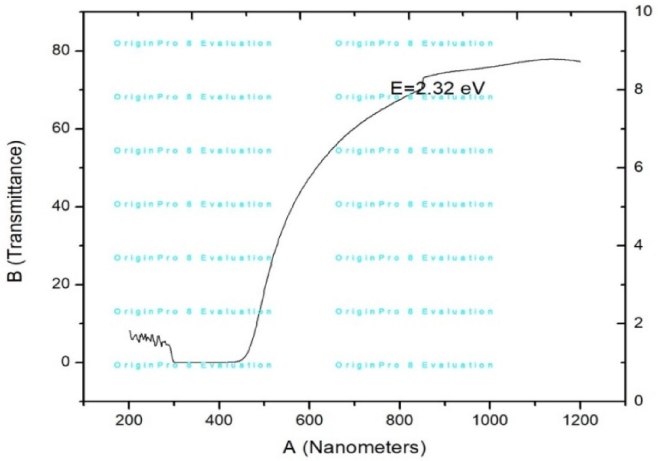

Figure 3.3: Shows the UV- Visible spectroscopy for MgO

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The band gap of the prepared sample MgO nanoparticles were determined by using UV- Visible studies. From the UV spectrum the optical band of MgO nanoparticles was found to be 2.32eV.

3.4 Scanning Electron Microscope Analysis (SEM)

The size and morphology of the synthesized MgO_2 nanoparticles are visualized by scanning Electron Microscope using ZEISS SCAN instrument for different magnification. The SEM image of magnesium oxide nanoparticles are shown in fig 4.6. The magnesium oxide nanoparticles are present in spherical in shape.[7]

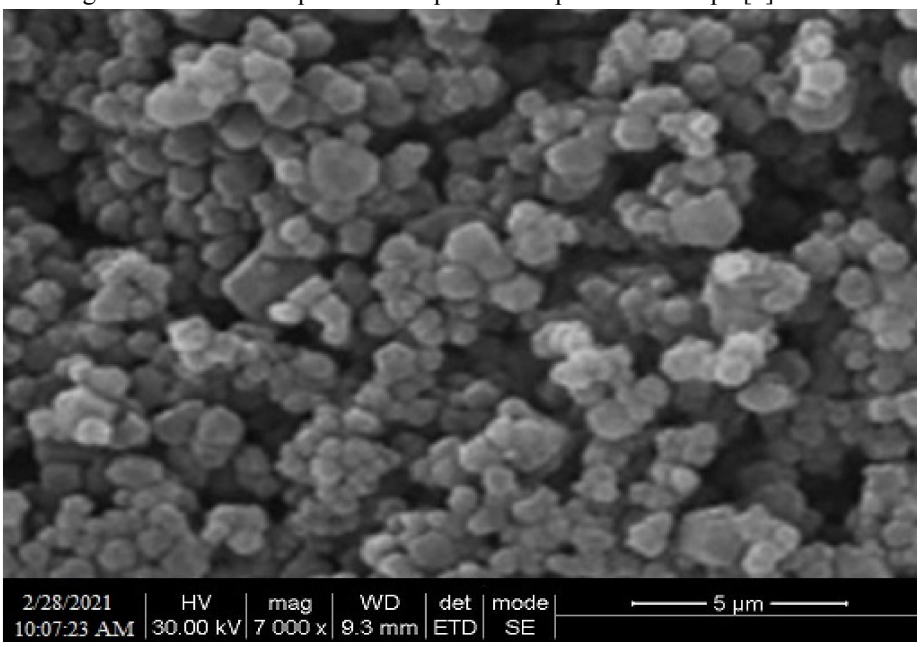

Figure 3.4: Shows the Scanning Electron Microscope for MgO nanoparticle

IV. Conclusion

- MgO nanoparticles and dried in furnace for 600℃ for 1 hour were synthesis using a solgel method and different characteristic like XRD, EDAX, UV- Vis Spectroscopy, SEM were studied.
- XRD pattern is used to determine the crystal structure, phase purity and grain size of the nanoparticles. The average size of the synthesized nanoparticles is 12 nm. and average diameter of the size of particle from the FWHM of XRD peak.
- EDAX spectrum analysis indicates that the product elements are Mg and O.
- From UV- Visible studies cut- off wavelength is found to be at 201nm and from that band gap energy of MgO is 2.3eV.
- SEM image of MgO reveals the well crystallized particle with spherical like morphology.

Data Availability

The data used to support the findings of this study are included within the article. More information could be obtained from the authors upon request.

Conflicts Of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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