

# SYNTHESIS AND CHARACTERIZATION OF NANOSCALE MAGNESIUM OXIDE BY USING CO-PRECIPITATION METHOD

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**Abstract.** *This research paper concern the study on the nanoscale magnesium oxide production from magnesium nitrate hexahydrate ( $Mg(NO_3)_2 \cdot 6H_2O$ ) by using co-precipitation method. Magnesium nitrate hexahydrate ( $Mg(NO_3)_2 \cdot 6H_2O$ ) and sodium hydroxide ( $NaOH$ ) were selected as synthesis materials. There are four main processes used to produce nanoscale magnesium oxide. They are preparation of magnesium nitrate and sodium hydroxide solution, co-precipitation of magnesium hydroxide, filtration of magnesium hydroxide, washing and calcination of nanoscale magnesium oxide. The produced nanoscale MgO was characterized by using Scanning Electron Microscope (SEM) method and X-ray diffraction (XRD).*

*Keywords: Magnesium Oxide; Co-precipitation method; Nanoparticles;*

## 1. INTRODUCTION

Human dreams and imagination often give rise to new science and technology. Nanotechnology, a 21<sup>st</sup>-century frontier, was born out of such dreams. Nanotechnology is defined as the understanding and control of matter at dimensions between 1 and 100 nm where unique phenomena enable novel applications [1]. Although human exposure to nanoparticles has

occurred throughout human history, it dramatically increased during the industrial revolution. The study of nanoparticles is not new. The concept of a “nanometer” was first proposed by Richard Zsigmondy, the 1925 Nobel Prize Laureate in chemistry. He coined the term nanometer explicitly for characterizing particle size and he was the first to measure the size of particles such as gold colloids using a microscope. Modern nanotechnology was the brain child of Richard Feynman, the 1965 Nobel Prize Laureate in physics. During the 1958 American Physical Society meeting at Caltech, he presented a lecture titled, “There’s Plenty of Room at the Bottom”, in which he introduced the concept of manipulating matter at the atomic level. Almost 15 years after Feynman’s lecture, a Japanese scientist, Norio Taniguchi, was the first to use “nanotechnology” to describe semiconductor processes that occurred on the order of a nanometer [2].

In a timeframe of approximately half a century, nanotechnology has become the foundation for remarkable industrial applications and exponential growth. For example, in the pharmaceutical communities of practice, nanotechnology has had a profound impact on medical devices such as diagnostic biosensors, drug delivery systems, and imaging probes [3]. In the food and cosmetics industries, use of nanomaterials has increased dramatically for improvements in production, packaging, shelf life, and bioavailability [4]. Some of the potential benefits of medical nanomaterials include improved drug delivery, antibacterial coatings of medical devices and detection of circulating cancer cells.

## **2. METRIALS**

In this research work, magnesium nitrate hexahydrate was used as precursor material and sodium hydroxide was used as precipitant. All the reagents used in this experiment, magnesium nitrate hexahydrate, sodium hydroxide, ethanol were analytical grade and were used without any others purification.

The nanoscale magnesium oxide was produced from magnesium nitrate hexahydrate by using co-precipitation method. Magnesium nitrate hexahydrate ( $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ) and sodium hydroxide ( $\text{NaOH}$ ) were purchased from local market.

## **2. METHODS**

There are many available methods for synthesis of nanoparticles. Some of them are-

1. Co-precipitation
2. Hydrothermal
3. Inert gas condensation
4. Microwave
5. Sol-gel

6. Biological
7. Microemulsion, etc.,

Among them the co-precipitation method had been selected for my research work. Because of the advantages of co-precipitation method, nanoscale metal oxide can be obtained the high yield, high product purity, low cost, easy control of particle size ,and composition and low temperature. In this section, nanoscale magnesium oxide production was described as followes.

#### *A. Raw Sample*

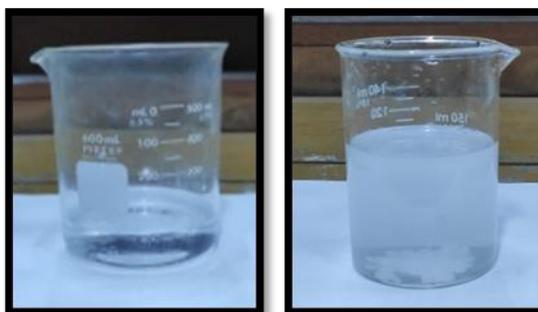
Magnesium nitrate hexahydrate ( $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ), sodium hydroxide ( $\text{NaOH}$ ), DI water and ethanol were used for my research work. Magnesium nitrate hexahydrate ( $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ) was used as starting material and sodium hydroxide ( $\text{NaOH}$ ) was used as precipitant. Ethanol and DI water were used for washing. Magnesium nitrate hexahydrate ( $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ), sodium hydroxide ( $\text{NaOH}$ ) and ethanol were purchased from local market. The prepared raw samples are shown in figure1.



**Figure 1** ( $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ) and ( $\text{NaOH}$ )

#### *B. Magnesium Oxide Nanoparticles Preparation*

Magnesium nitrate hexahydrate solution (0.6M) and sodium hydroxide (2M) were separately prepared with deionized water. Instantly, the solution was stirred on stirring by means of magnetic stirrer for 2 hours.



**Fig.2** Dissolution of ( $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ) and ( $\text{NaOH}$ ) in DI water

In this time, sodium hydroxide solution was slowly added into the above stirred magnesium nitrate solution drop by drop within 2 hours. And then, precipitated magnesium hydroxide was settled at the bottom of the beaker.



***Fig.3 Precipitation of Magnesium Hydroxide***

The precipitated magnesium hydroxide was filtered with filter paper. The filtrated precipitates were washed firstly with DI water and subsequently washed with ethanol 3 times.



***Fig.4 Washing and Filtration of Magnesium Hydroxide Precipitate***

After washing step, the washed magnesium hydroxide was dried at 100°C for 2 hours at muffle furnace and calcimined at 500°C for 4 hours at carbolite to get sample of MgO powder.



***Fig.5 Drying and Calcination Magnesium Hydroxide Precipitate***

Eventually, the Magnesium oxide nanoparticles were obtained. The obtained MgO is a white powder.

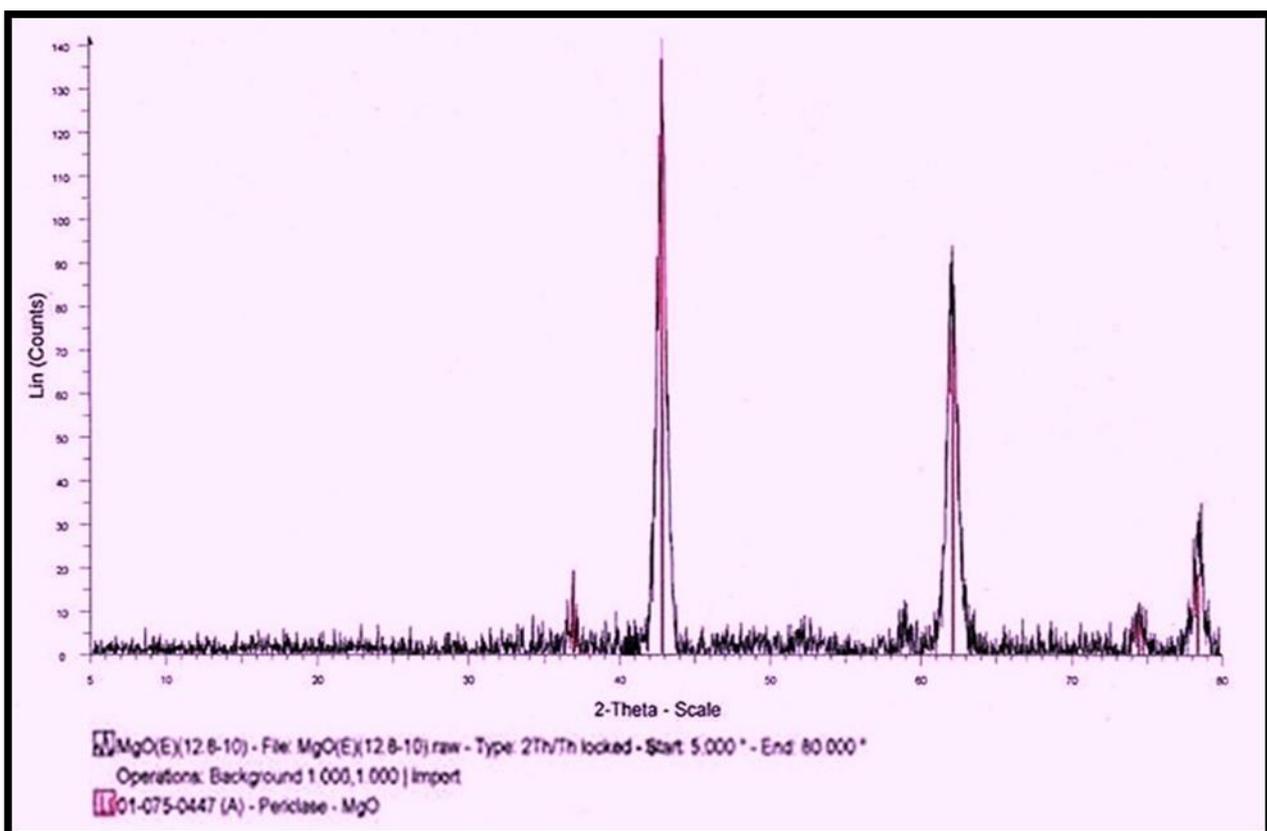


*Fig.6 Final Product Magnesium Oxide Nanoparticles Powder*

### 3. Results and Discussion

#### 3.1 Structural Analysis

X-ray powder diffraction pattern of MgO nanoparticle was illustrated in Fig.7. The results show that, the purity of the MgO nanoparticle. The sharp diffraction peaks showed in the figure indicate good crystallinity of MgO and no characteristic peaks of any other phase of MgO or any impurity were observed.



*Figure.7 XRD pattern of the product sample.*

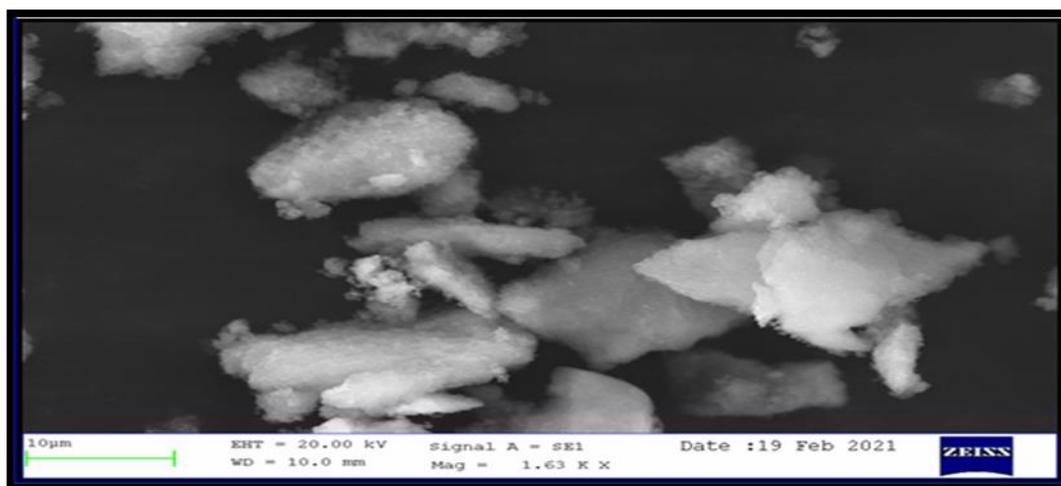
The size of the particle was determined by means of the X-ray line broadening method using the Scherrer equation. From XRD result, the crystallite size can be described by using the

Scherrer's formula,  $D = 0.9 \lambda / \beta \cos \theta$  Where, D = Crystallite size,  $\lambda$  = Wavelength (0.1541 nm),  $\beta$  = Full maximum half width and  $\theta$  = Diffraction angle.

By comparing XRD pattern of the produced nanoscale magnesium oxide in Figure, the diffraction peaks of the produced nanoscale MgO are analogous to JCPDS card number 45-0946. The matched  $2\theta$  angles are 36.96, 42.92, 62.25, 74.50 and 78.45° respectively and there is no peaks were detected in the pattern. It shows that the formation of the MgO nanoparticles was cubic structure and the average crystallite size of ~14 nm was obtained.

### 3.2 Surface Morphological Analysis

The surface morphology of the produced metal oxide nanoparticles were characterized by SEM. The SEM image of synthesized nanoscale magnesium oxide was illustrated in figure 8. The nanoscale magnesium oxide powder can be perceptibly observed from the image. The SEM result shows that the structure of MgO crystallites is spherical shape. Moreover, MgO nanoparticles are spongy and agglomerated.



*Figure.8 SEM images of MgO Nanoparticles*

## 4. CONCLUSION

Magnesium oxide nanoparticles were successfully synthesized by using  $(\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O})$  as precursors. In this research work, sodium hydroxide (NaOH) was used as precipitant and ethanol and deionized water were used for washing. In the nanoscale metal oxide production, 1:3 molar ratios of magnesium nitrate and sodium hydroxide for MgO is appropriate to produce the MgO nanoparticle. The optimum calcinations temperature for the MgO nanoparticles was 500°C. The produced nanoscale MgO was determined by using X-ray Diffractometer (XRD) and Scanning Electron Microscope (SEM). The SEM result shows that the structure of MgO crystallites is spherical shape. Furthermore, MgO nanoparticles are spongy

and agglomerated. According to the XRD result, the average crystallite structure of nanoscale MgO is ~14 nm.

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