International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Special Issue: 09 | Sep -2017 www.irjet.net p-ISSN: 2395-0072

One Day International Seminar on Materials Science & Technology (ISMST 2017)
4th August 2017
Organized by
Department of Physics, Mother Teresa Women's University, Kodaikanal, Tamilnadu, India

Green synthesis of MgO nanoparticles for antibacterial activity

G. Palanisamy[1] and T. Pazhanivel*[2]

[1,2]*Smart materials interface laboratory, Department of Physics, Periyar University, Salem, India.*
**Corresponding author E-mail: pazhanit@gmail.com*

Abstract - *Leaf extract based synthesis of metal oxide nanoparticles facilitates the production of non-toxic nanoparticles due to the presence of various photochemical and biochemical compounds that are beneficial for sensor and pharmaceutical applications. The magnesium oxide nanoparticles were synthesized chemically and naturally (Leaf extraction). Without any stabilizing and reduced agent we have synthesized the MgO nanoparticles from betel leaf extract. The assynthesized samples were subjected to different analysis technique to know the materials physical and chemical properties. The asprepared samples were characterized by X-Ray Diffraction (XRD) to investigate the structure and size of crystal. Optical properties of the asprepared samples were investigated to UV-Visible spectroscopy analysis. Functional groups were confirmed by using FTIR analysis. Both the samples were subjected to carried out the antibacterial activity. Relatively, naturally synthesized nanoparticles shows better result as compare to other.*

Key Words: *Leaf extract, Metal oxide, Precipitation method, antibacterial activity*

1. INTRODUCTION

In the recent years, green chemistry methods for synthesis of metal oxide nanoparticles has become a major focus in current society [1]. Its more eco-friendly, low toxicity and exhibit long term stability. Generally green synthesis nanoparticles extract from fungi, bacteria, algae and green plants [2-5]. Plant leaf extracts have been extensively used for green synthesis. A wide range of bioactive phytochemicals as plants are widely available, safe to handle and possess a variety of metabolites that function as reducing agents in nanoparticle synthesis. It's used various fields such as, sensor, biological and pharmaceutical applications [6]. Magnesium oxide (MgO) is an attractive and basic metal oxide material. It's generally used as a catalyst [7], electrochemical biosensor [8], and pharmaceutical industry [9] and paints [10]. The highly crystalline MgO nanoparticles exhibit low electrical conductivity and higher thermal stability. Conventionally, MgO nanoparticles are synthesized by different methods such as, hydrothermal, solgel, chemical gas phase deposition and wet precipitation methods. MgO nanoparticles produced from conventional methods are toxic and not used in medical application. In other hand green synthesized nanoparticles are very efficient and nontoxic [11].

The aim of this study was to compare MgO nanoparticles prepared by chemical and green synthetic routes for structural characterization, biological effects and photophysical properties was investigated.

2. Experimental section

2.1. Chemicals and reagents

Betel leaf were purchased from the local market in Salem, India. The magnesium precursors magnesium nitrate hexahydrate [Mg $(NO_3)_2$. $6H_2O$, 98%] and Sodium hydroxide [NaOH] were procured from Alfa Aesar. All reagents were used without further purification. Double distilled water was employed as the solvent.

2.2. Synthesis process

Preparation of plant extracts: Fresh betel leaves were separately added to deionized water in ratio (w/v) of 1:8. The mixtures were mixed using a magnetic stirrer for 30 min at 80°C. The extracts were allowed to cool down to room temperature before sequentially filtering through a mesh and Whatman No: 1 filter paper to remove solid particulates. The filtered extracts were stored in a refrigerator (5°C) for further use.

Preparation of green and chemical based MgO nanoparticles synthesis

In the green synthesis of MgO nanoparticles, the betel leaf extracts were added to magnesium precursors and the mixtures were stirred. After 3 hours the reaction mixture solution was precipitate. After that, the precursor was collected and washed with double distilled water several times. The obtained materials dried in oven at 100°C for overnight. Finally, the precursor was annealed at 400 °C for 4 h to obtain the MgO nanoparticles. The chemically synthesis of MgO nanoparticles get 0.2 M of

NaOH was used, in place of betel leaf solution, we prepare the nanocrystalline magnesium oxide.

2.3. Antibacterial assay of MgO nanoparticles

Chemically and green route of MgO nanoparticles were tested against Gram negative (*Pseudomonas aeruginosa*) and Gram positive bacteria (*Bacillus subtilis*) using Agar well diffusion method to determine their ability as a potential antimicrobial agent. 10% dimethylsulfoxide (Qualigens) was used as the solvent for tested samples. The disk plates were streaked with bacteria for 3-4 times by rotating the plate at 60° angles for each streak to ensure homogeneous distribution of inoculums. The asprepared nanoparticles were tested in a different concentration of 20µg/µl - 80 µg/µl and incubated at 37 °C for 24 h. The bacterial growth, and variation in inhibitory zone for nano-sized chemical and green route of MgO nanoparticles showing antimicrobial activity were determined.

2.4. Materials Characterization

To study the, phase purity and structure of the as prepared MgO nanoparticles identify from XRD patterns which is carried out using Riguku miniflux-II X-ray diffractometer. The XRD patterns were recorded in the range 30°≤ 2θ ≤ 80° using Cu Kα radiation (1.5406Å). The FTIR spectra were taken using a Bruker model Tensor 27 instrument. Optical absorption spectra were recorded using a SHIMADZU 3600 UV-Vis-NIR model spectrophotometer.

3. Results and discussion

Structure properties

Fig.1 shows the XRD patterns of the chemical and green route synthesis of MgO nanoparticles. The observed diffraction peak positions correspond to the cubic phase of pure MgO nanoparticles for the both samples. The high intensity peaks clearly indicating high phase purity and crystallinity of the product.

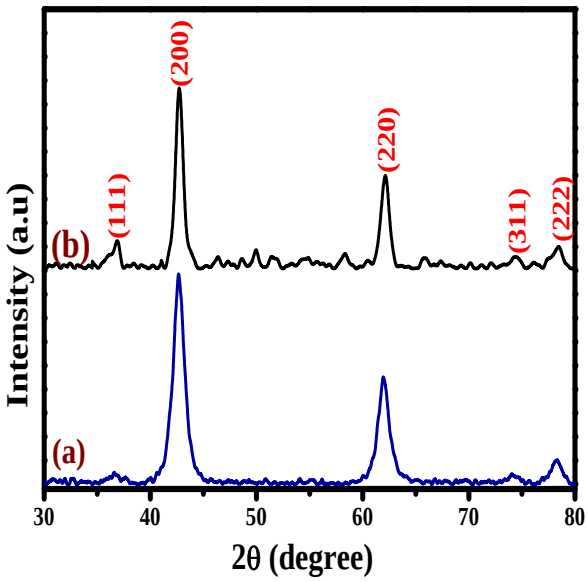

Fig -1: XRD pattern of (a) Chemically MgO (b) green synthesis of MgO nanoparticles

The calculated lattice parameter and crystalline size value for both samples corresponds to 4.2373, 4.2264 Å and 18, 25 nm respectively. It is well matched with JCPDS file no. 45-0946.

Functional group analysis

FTIR spectroscopy is used to study the change in chemical composition, impurity content and interaction between different species. Fig. 2 shows the FTIR spectra of MgO nanoparticles synthesized by green and chemical routes recorded in the range of 500-4000 cm^{-1}. FTIR results confirm that plant precursors act as stabilizing and reduced agents. The peaks at 1666 and 1662 cm^{-1} were attributed to the symmetric and asymmetric vibrations of the carbonyl group. The peaks at 1124 and 1388 cm^{-1} was assigned to the C–O symmetrical stretching and O–C=O bending vibrations in both samples respectively. The presence of peak at 500-800 cm^{-1} strongly confirms the stretching vibrations of metal-oxygen (Mg-O) in the both samples [7, 12].

One Day International Seminar on Materials Science & Technology (ISMST 2017)
4th August 2017
Organized by
Department of Physics, Mother Teresa Women's University, Kodaikanal, Tamilnadu, India

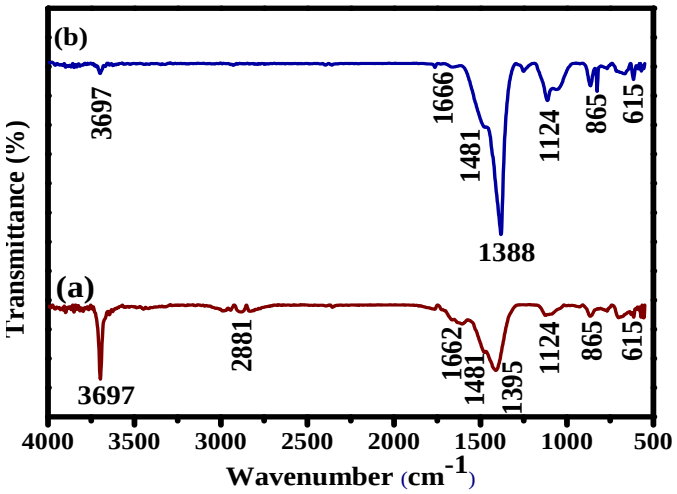

Fig -2: FTIR Spectra of (a) Chemically MgO (b) green synthesis of MgO nanoparticles

The peaks corresponding to the physically absorbed water molecule attributed at 3697 cm^{-1}. The bands observed at 1481 cm^{-1} corresponds to the absorption of carbonate impurities on the surface of the sample [**13**].

Optical properties

Fig. 3 shows the optical absorption spectra of the chemical and green based synthesis of MgO nanoparticles. Sample (a) exhibit a similar absorption spectrum with a maximum at 320 nm and sample (b) shows first excitation wavelength in the region of 220 nm and the wide absorbance occurred in the range of 320 nm.

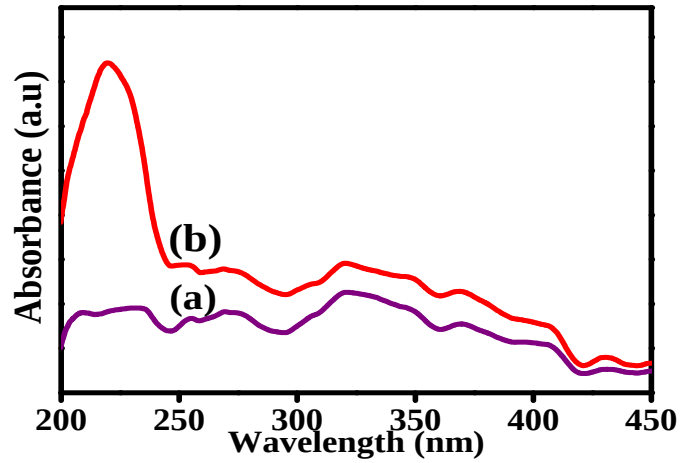

Fig -3: Absorption spectra of (a) Chemically MgO (b) green synthesis of MgO nanoparticles

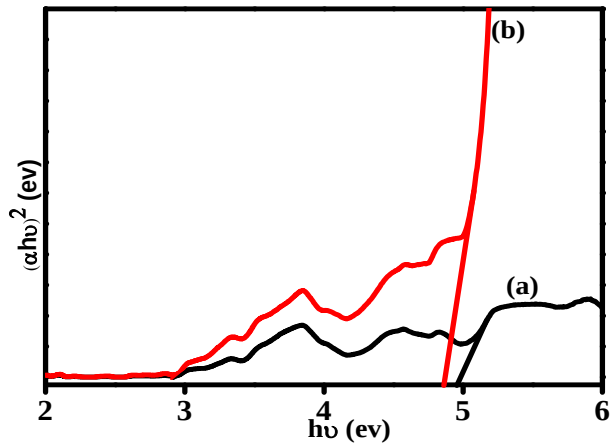

Fig -4: band gap energy of (a) Chemically MgO (b) green synthesis of MgO nanoparticles

The absorption edge at 220 nm (a) and 320 nm (b) corresponds to the excitation of four-fold coordinated O^{2-} anions in the edges and corners **[13].** The optical bandgap of as prepared samples were calculated from tauc plot as. 5.00 and 4.86 eV are shown in Fig. 4. The bandgap value of naturally synthesized nanoparticles was low, when compared to the chemical synthesis based MgO nanoparticles.

Antibacterial activity

Antibacterial activity of chemical and green route of MgO nanoparticles were evaluated against by Pseudomonas aeruginosa and Bacillus subtilis by the agar well diffusion method, as shown in Fig. 5.

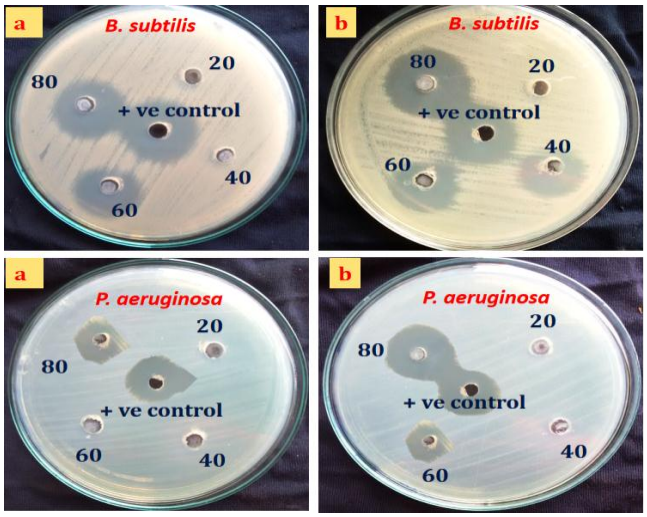

Fig -5: Antibacterial activity against Pseudomonas aeruginosa and Bacillus subtilis: (a) Chemically MgO (b) green synthesis of MgO nanoparticles

The positive control antibiotics chloramphenicol were used in this antibacterial study. The bacteria cell wall thickness were different behavior for gram positive and gram negative. The green synthetic route of MgO nanoparticles showed a clear shown of inhibition around the disc indicating the bacterial inhibition. An interesting consideration made from this study is that a small zone of inhibition was observed around the chemically synthesis MgO nanoparticles for B. subtilis.

In particular, a medium zone of inhibition was observed around the naturally MgO nanoparticles in P. aeruginosa but small zone of inhibition was observed in chemically synthesized MgO nanoparticles. The antibacterial activity against P. aeruginosa and B. subtilis revealed that the naturally synthesized nanoparticles exhibited more effective zone of inhibition when compared to chemically synthesis nanoparticles. The diameter of the inhibition zone is given in Table 1 which differs for different samples and organisms.

Table -1: diameter of the inhibition zone of asprepared MgO nanoparticles

Diameter of zone of inhibition (in mm)								
Bacteria	**Chemically MgO (µg/µl)**				**Naturally MgO (µg/µl)**			
	20	**40**	**60**	**80**	**20**	**40**	**60**	**80**
B. subtilis	-	-	22 ±0.5	23 ±0.3	-	20 ±0.4	20 ±0.5	26 ±0.5
P. aeruginosa	-	-	-	13 ±0.5	-	-	12 ±0.5	18 ±0.5

4. Conclusion

In summary, MgO nanoparticles were obtained by chemically and naturally (Leaf extraction) through precipitation method at relatively low temperature (400°C). Without any stabilizing and reduced agent we have synthesized the MgO nanoparticles from betel leaf extract. XRD patterns revealed that single phase formation of Cubic MgO with highly crystalline nature. Metal-oxygen stretching were confirmed by the functional groups analysis. The bandgap value of green synthesis MgO was decreased, when compared to the other. The result of the antibacterial activity against P. aeruginosa and B. subtilis revealed that the naturally synthesized nanoparticles exhibited more effective zone of inhibition when compared to chemically synthesis nanoparticles.

References

1. Metz, Kevin M., et al. "Green synthesis of metal nanoparticles via natural extracts: the biogenic nanoparticle corona and its effects on reactivity." ACS Sustainable Chemistry & Engineering 3.7 (2015): 1610-1617.

2. Sastry, Murali, et al. "Biosynthesis of metal nanoparticles using fungi and actinomycete." Current science 85.2 (2003): 162-170.

3. Iravani, Siavash. "Bacteria in nanoparticle synthesis: current status and future prospects." International scholarly research notices 2014 (2014).

4. Hulkoti, Nasreen I., and T. C. Taranath. "Biosynthesis of nanoparticles using microbes—a review." Colloids and Surfaces B: Biointerfaces 121 (2014): 474-483.

5. Ovais, Muhammad, et al. "Green synthesis of silver nanoparticles via plant extracts: beginning a new era in cancer theranostics." Nanomedicine 11.23 (2016): 3157-3177.

6. Jeevanandam, Jaison, Yen San Chan, and Michael K. Danquah. "Biosynthesis and characterization of MgO nanoparticles from plant extracts via induced molecular nucleation." New Journal of Chemistry 41.7 (2017): 2800-2814.

7. Choudary, Boyapati M., Ravichandra S. Mulukutla, and Kenneth J. Klabunde. "Benzylation of aromatic compounds with different crystallites of MgO." Journal of the American chemical Society 125.8 (2003): 2020-2021.

8. Lu, Limin, et al. "A MgO Nanoparticles Composite Matrix-Based Electrochemical Biosensor for Hydrogen Peroxide with High Sensitivity." Electroanalysis 22.4 (2010): 471-477.

9. Shen, Shoucang, et al. "Submicron particles of SBA-15 modified with MgO as carriers for controlled drug delivery." Chemical and pharmaceutical bulletin 55.7 (2007): 985-991.

10. Huang, Lei, et al. "Controllable preparation of Nano-MgO and investigation of its bactericidal properties." Journal of inorganic biochemistry 99.5 (2005): 986-993.

11. Krishnamoorthy, Karthikeyan, et al. "Mechanistic investigation on the toxicity of MgO nanoparticles toward cancer cells." Journal of materials chemistry 22.47 (2012): 24610-24617.

12. Ai, Lunhong, Haitao Yue, and Jing Jiang. "Sacrificial template-directed synthesis of mesoporous manganese oxide architectures with superior performance for organic dye adsorption." Nanoscale 4.17 (2012): 5401-5408.

13. Mageshwari, K., et al. "Template-free synthesis of MgO nanoparticles for effective photocatalytic applications." Powder technology 249 (2013): 456-462.

BIOGRAPHIES

THANGAVELU PAZHANIVEL is an Assistant Professor at Department of Physics, Periyar University, Salem, Tamilnadu, India. He received Ph.D. (Physics) from Bharathiar University, Coimbatore. He has five years post graduate teaching and ten year research experience.

Govindasamy Palanisamy is a Research Scholar at Department of Physics Periyar University, Salem, Tamilnadu, India. He is doing research in nano photocatalysis, sensor devices.