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Eco-Friendly Synthesis of MgO Nanoparticles from Orange Fruit Waste

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Abstract: *Green synthesis of nanoparticles supports reuse, reduce and recycle concept towards the environmental friendly synthesis and also produce the good results compare to chemical methods in some of the cases. MgO nanoparticles can be prepared by solution combustion synthesis using citric acid is a fuel. The same citric acid is available in the nature in so many form just like tamarind, lemon and orange peel. In this Present research work focused on to synthesis of Magnesium Oxide (MgO) nanoparticles from extract of orange peel using Green synthesis method. The obtained MgO nanoparticles have been characterized by X-ray Diffractometer (XRD), Particle Size Analyser (PSA), and Fourier Transform Infrared (FTIR) for average crystallite size, average particle size and bond respectively.*

Keywords: *Green Synthesis, MgO Nanoparticles, Orange Peel, XRD.*

1. INTRODUCTION

The nano science and technology is growing very faster phase, which is indicating by huge number of publications and reviews in this from past decade. Everyone is focusing on this, as its huge applications. Mgo nanoparticles are very promising nanoparticles as used more no of applications, which acts as catalysis, superconducting products, toxic waste remediation, anti-bacterial activities against food borne pathogens [1-3]. It can be prepared by different synthesis methods such as solution combustion [4], hydrothermal [5], Sol-Gel [6], Solvothermal [7], Microwave Assisted Sol-Gel [8], Co-precipitation [9] and green synthesis [10].

Green synthesis of nanoparticles is eco-friendly synthesis by avoiding harmful fuels and so many people have success in this synthesis of nanoparticles using extracts obtained from micro organisms like bacteria fungi as well as extracts from different plant parts (leaves, stem, flowers, fruits, seeds and roots).

In this current article MgO nanoparticles were synthesized using Green synthesis method under standard laboratory conditions in clean room as initial precursors Magnesium acetate and Orange fruit waste (peel). By Nature Orange peel is a light yellow colour, which gives absolute protection for the inner part fruit from outer world. It can be acts as reducing agent for synthesis of metal oxides (MgO, TiO_2, ZnO etc.) because it contains Citric acid as main source [11]. Orange peel can be used in bath oil, room freshen air, face creams, mosquito repellent and weight loss.

2. EXPERIMENTAL DETAILS

All the chemicals and reagents used for the preparation of TiO_2 nanoparticles were purchased from Merck India Ltd. Orange fruit waste collected from juice center at JNTUH campus, Hyderabad, Telangana.

Collected Orange peel was made into small pieces by hands only. Take a 50 g of orange peel directly into the beaker and extracted with 100 ml of distilled water for 2 hrs at 90^0C on hot plate. The extract was filtered using what man filter paper for the purification of extract. The filtrate was stored in the cool condition for the further synthesis of nanoparticles using refrigerator.

Fig1. *a) Orange Fruits, b) Peel of Orange, c) In Boiling process, d) Juice of peel Extract*

To synthesis the TiO_2 nanoparticles, dissolve 1.5 N of Titanium Chloride ($TiCl_4$) in 100 ml of distilled water. Added peel extract drop by drop under constant stirring upto the visibility of particle formation occurs. The mixture was subjected to stirring for 4 hours continuously at room temperature. In this period nano particles formation occurred and they become settling at bottom of the flask. Then, separate those nanoparticles using what man filter paper and washed the materials with distilled water repeatedly to remove the by-products from the sample. The nanoparticles were dried at 100^0C for overnight and calcined at 400^0C for 3 hours using muffle furnace.

3. Results and Discussion

3.1. X-Ray Diffraction

The XRD pattern of MgO nanoparticles was shown in Fig 2, which was obtained from green synthesis. The result showed that the structure was in Face Centered Cubic structure and these results were good agreement with JCPDS card number 89-4248. Peaks were absorbed at 36°, 42°, 62°, 74°, and 78° along with miller indices values (1 1 1), (2 0 0), (2 2 0), (3 1 1) and (2 2 2) respectively.

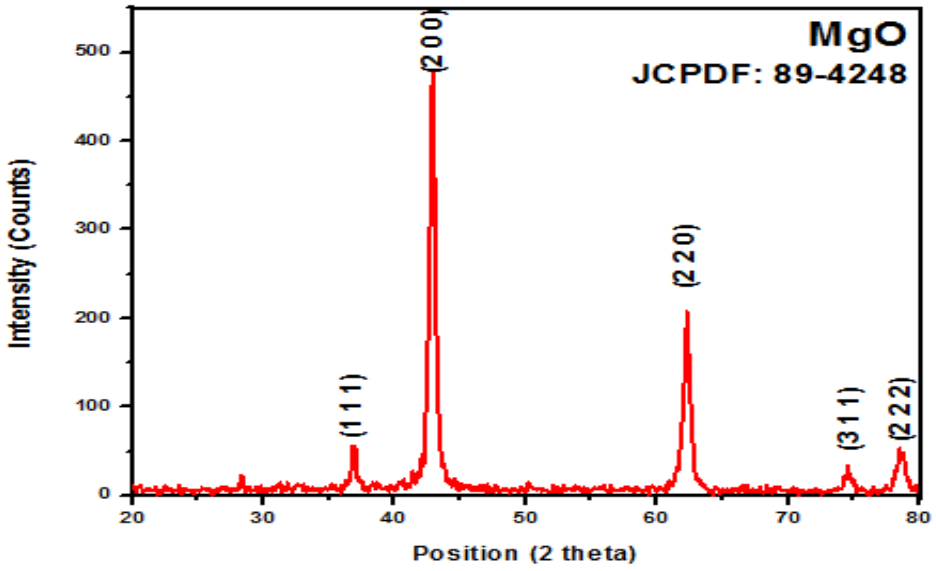

Fig2. *XRD Pattern of MgO NPs*

As the width of the peak increases size of particle size decreases, which resembles that present material in nano range [12].

The lattice parameters were obtained a=b=c=0.421 nm.

The average crystallite size was measured by Debye-Schereer's equation as mentioned below.

$$D = \frac{0.9\lambda}{\beta cos\theta}$$

where D is the average crystallite size of the particles, K- is Debye scherrer's constant (=0.94), λ- is the wavelength of the CuKα-radiation (=0.154 nm), β is the full width half maximum (FWHM) of the peak, θ is the Bragg's angle.

The average crystallite size was measured as 18 nm using the above formula.

3.2. Williamson Hall Equation

Williamson Hall equation was used to calculate the crystalline size as well as Micro strain of the sample, which equation was shown in below.

$$\beta Cos(\theta) = \frac{K\lambda}{D} + 4\varepsilon\, Sin(\theta)$$

Where D is the average crystallite size of the particles, K- is Debye scherrer's constant (=0.94), λ- is the wavelength of the CuKα-radiation (=0.154 nm), β is the full width half maximum (FWHM) of the peak, θ is the Bragg's angle and ε is the micro strain of the sample.

For this analysis a graph is drawn between βcosθ against 4 sinθ along y and x axis respectively. Linear extrapolation is employed to this plot, the crystallite size is given by the intercept Kλ/D and the strain (ε) is given by slope [13].

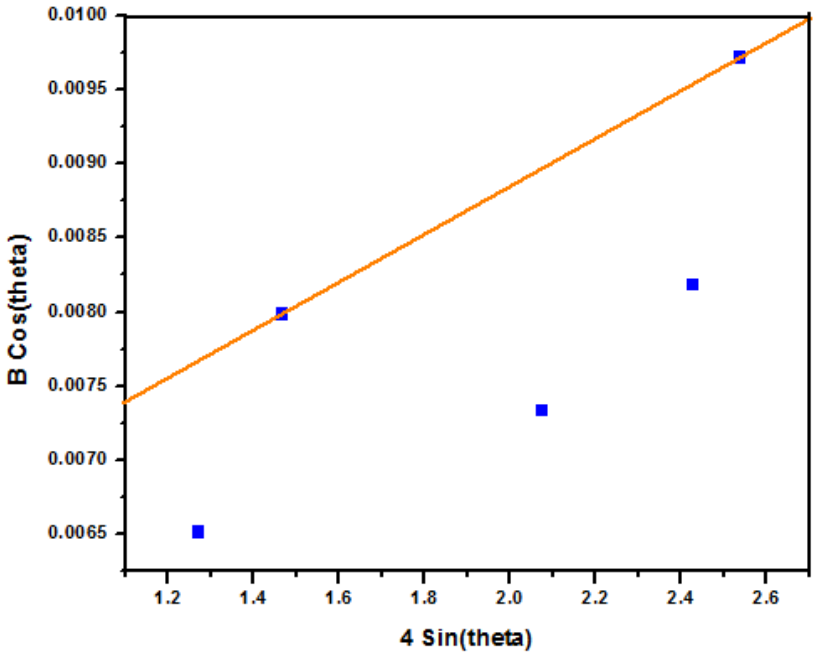

Fig3. *Williamson hall Plot for MgO NPs*

The micro strain was calculated as taken the slope of the curve by taking any two points as reference using two points slope formula shown below and calculated as 0.001613

$$m = \frac{(y2 - y1)}{(x2 - x1)}$$

The average crystallite size was measured by taking Kλ/D to y intercept in the above figure. Then the results carried out as 19.56nm as average crystallite size of the sample using Williamson Hall Equation.

3.3. Particle Size Analyzer

The average particle size was obtained by Particle Size Analyzer shown in the following figure. The material was dispersed completely in ethanol using ultra-sonicator for the sample preparation. Below figure represents the histograms of the dispersed nanoparticles.

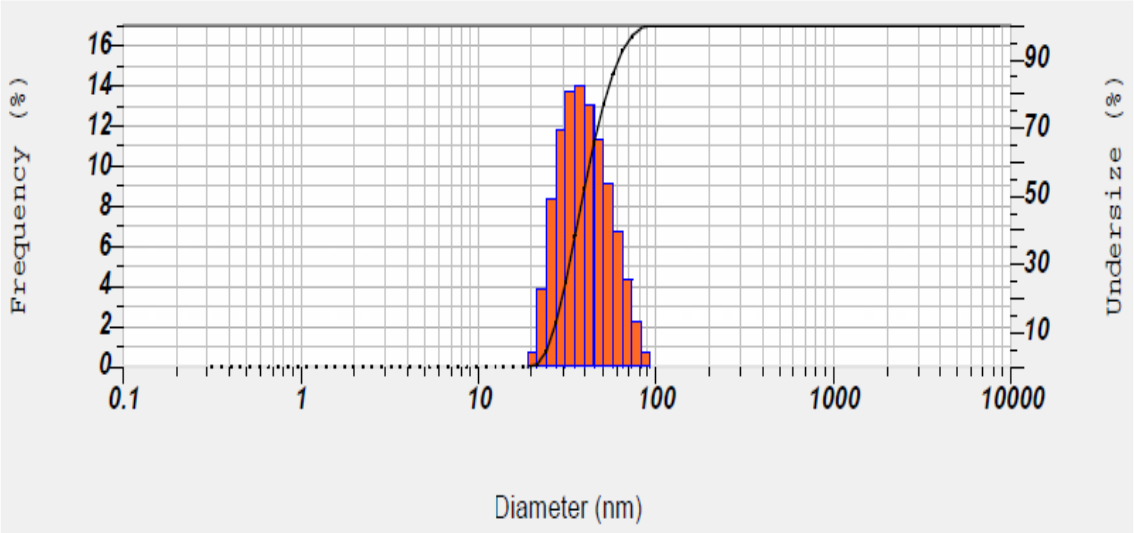

Fig4. *Particles Distribution of TiO_2 NPs*

The mean value of the histograms was taken as the average particle size. The average particle size was obtained 29 nm. These results were supported to XRD average crystallite size [14].

3.4. Fourier Transform Infrared Spectroscopy

The bond analysis of chemical reactions was investigated by FTIR. This spectra of MgO nanoparticles were shown in figure and analysis was done in the range of 500 cm^{-1} to 4000 cm^{-1}. The strong O-H stretching vibration bonds represented at 3439cm^{-1} are due to the water molecules. A small curve occurred at 2927cm^{-1} due to very weak bonding vibrations of water molecules.

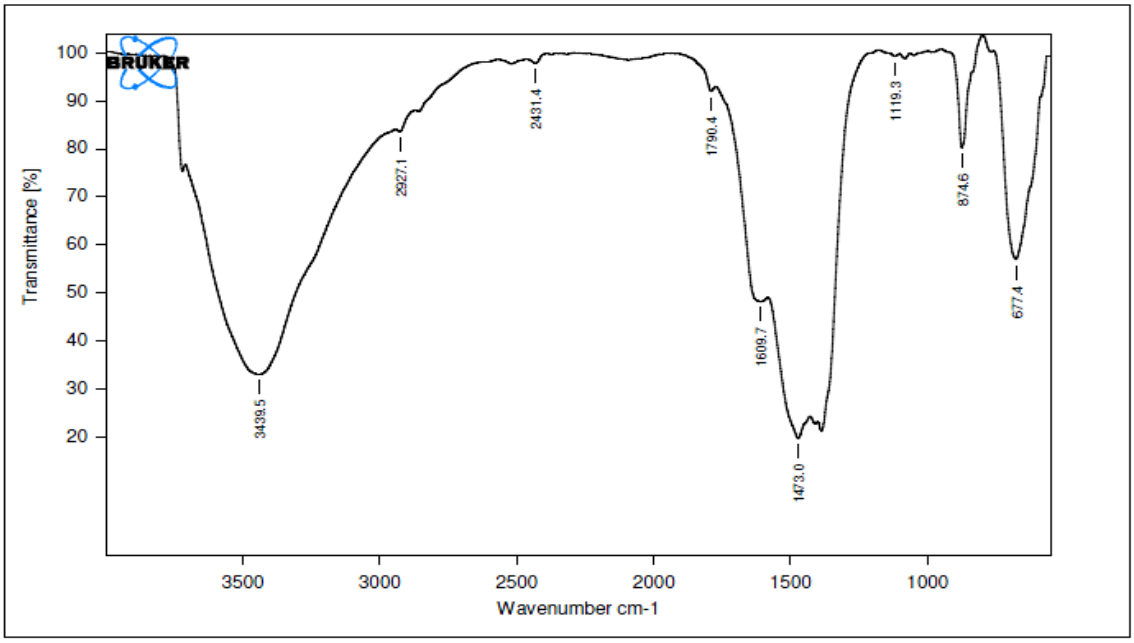

Fig5. *FTIR Spectrum Distribution of MgO NPs*

The stretching vibrations between 1400cm^{-1} to 1900cm^{-1} are observed due to the effect of C-C bonds. Around 1100cm^{-1} there was a C=O vibration bond and Mg-O vibration bonds were takes place at the 670cm^{-1} and 870cm^{-1} [6].

4. CONCLUSION

The MgO nanoparticles were successfully synthesized using green synthesis method. From XRD analysis average crystallite size of the sample was obtained 18 nm. It observed that Face Centred Cubic structure was formed. The average particle size was estimated 29 nm from particle size analyzer. The Bond analysis was done by using FTIR Spectrum. These above results showed that as prepared MgO particles were in the nano range.

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