Preparation of MgO Nanoparticles With Water

M. A. Shah
Department of Physics, Faculty of Sciences, King Abdul Aziz University, Jeddah, Kingdom of Saudi Arabia

The nanoparticles having diameters of 40±20nm were synthesized by a novel technique at very low temperature of ~90ºC using de-ionized water as solvent. The synthesized particles were characterized by field emission scanning electron microscope (FESEM), high resolution transmission electron microscopy (HRTEM) and X-ray diffractometer (XRD). The synthesized nanoparticles are under investigation for their bactericidal mechanism.

1. Introduction

Discoveries in the past decade have shown that once materials are prepared in the form of very small particles, they change significantly their physical and chemical properties, sometimes to the extent that completely new phenomenon are established as recently mentioned by Shah and Tokeer [1]. However, little is known about how the biological activity of certain materials changes as the size of the constituting particles decreases to nanoscale dimensions. There are some reliable reports in the literature that show encouraging results about the activity of different drugs and antimicrobial formulations in the form of nanoparticles [2,3].

Nano-MgO is a functional material that has been widely used in various areas and recently it has been reported that MgO has a good bactericidal performance in aqueous environments [4,5]. The two pioneers in this area are Klabunde et al., [6] and Aharan et al. [7], who demonstrated that nano-MgO exhibits high activity against bacteria, spores and viruses because of its large surface area. The positively charged particles can interact strongly with negatively charged bacteria. Compared with TiO_2, silver, copper and other kinds of solid bactericides, nano-MgO has the advantage of being prepared from readily available and economical precursors and solvents, and therefore has considerable potential as a solid bactericidal material under simple conditions. Encouraged by the preliminary results of one dimensional structures by the producers adopted by Shah and Ahsan [8], interestingly uniform nanoparticles having diameters in the range of 50-70nm were prepared by a simple reaction of magnesium foil and de-ionized water at very low temperature of about 90ºC. The reported method, besides being simple, is non toxic, economical, fast, effective, and environmentally benign.

2. Methods and Materials

Magnesium foil (Ranbaxy Chemicals, > 5μm) has been used without any preheated producer or any further purification and de-ionized water has been prepared in laboratory.

2.1 Preparation of samples

In a typical synthesis, 3 mg of magnesium foil was taken in a vial containing 30 ml of de-ionized water and was well sonicated for 10 minutes before placing at desired temperature in a Teflon bomb. The reaction mixture was transferred to teflon-lined stainless steel chamber and kept at 90ºC in an oven for 9h. After the desired time, the system was naturally cooled to room temperature. The reaction mixture was centrifuged to reclaim the precipitated sample and was washed with distilled water. After drying in air, the final white powder was obtained.

2.2 Characterization

Phase structure and the purity of the prepared samples were characterized by powder X-ray diffraction (XRD) taken on a Philips (X'Pert PRO PW-3710) diffractometer with 2θ ranging from 10-80º, using Cu Kα (λ =0.15141 nm) radiation operated at 40kV and 30mA. The morphology of the products was carried out using Field Emission Scanning Electron Microscope (SEM, LEO-1530VP) coupled with energy dispersive X-ray spectrometer EDX (Gensis). Transmission electron microscopy images were obtained using a high resolution transmission electron microscope HRTEM on JEOL (JEM-2100F, Japan) at an

[1] mashahnit@yahoo.com

accelerating voltage of 200kV to confirm the morphology of the products.

3. Results and Discussion

For the micro-structural analysis, the synthesized samples were directly transferred to the FESEM chamber without disturbing the original nature of the products. Figs. 1 (a) and (b) show the low and high magnification FESEM images of the nanoparticles and confirms that the nanoparticles are grown in a very high density. The typical diameters of the as-grown nanoparticles are ~ 40 ± 20nm. A closer view reveals that most of the nanoparticles have uniform diameter. The particle size was also examined using TEM. Fig. 2 displays TEM micrographs of MgO, revealing that the particle size is approximately 50nm. The influence of reaction conditions on physical properties of synthesized nanoparticles as well as mechanism is yet to be investigated.

To identify the crystallinity and crystal phases of the as-grown structures, an X-ray diffraction (XRD) analysis was performed. The XRD spectra, which is presented in Fig. 3, reveals that the nanoparticles are single crystalline and can be marked as cubic-phase (a = 0.421nm) MgO (JCPDS card 45-0946). There are no peaks detected for other phases, indicating that a single phase of MgO with high purity has been prepared. The inset in Fig. 3 demonstrates the typical EDX analysis of the as-grown MgO nanoparticles. It is confirmed from the EDX analysis that the grown nanoparticles are composed of Mg and oxygen only. The molecular ratio of Mg:O of the grown nanoparticles, calculated from EDX and quantitative analysis data, is close to that of 1:1. Except Mg and O, no other peak for any other element has been found in the spectrum, which confirms again that the grown nanoparticles are pure MgO.

4. Conclusion

A versatile route has been explored for MgO nanoparticles. This will help in broadening and modifying the present techniques for the oxides. Besides being simple, the process of preparation is promising and bright.

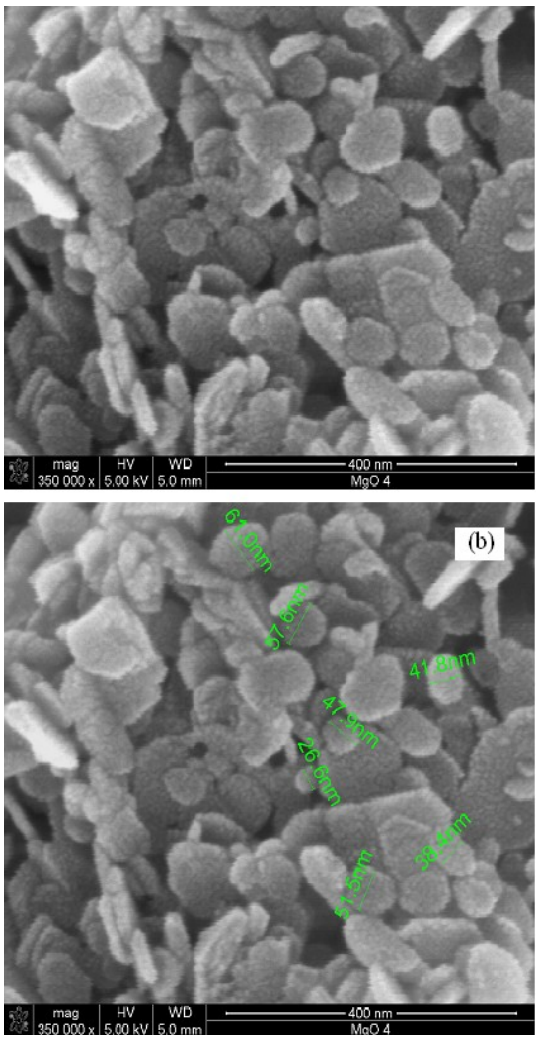

Fig.1: Shows the typical (a) low and (b) high-resolution FESEM images of nanoparticles obtained by the reaction of magnesium metal foil with water at 90°C for 9h.

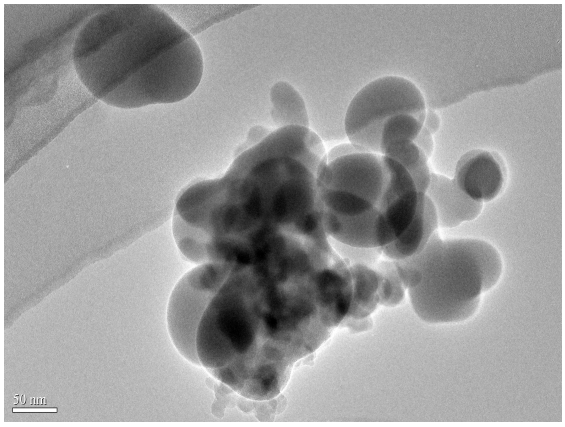

Fig.2: The TEM micrograph of MgO nanoparticle.

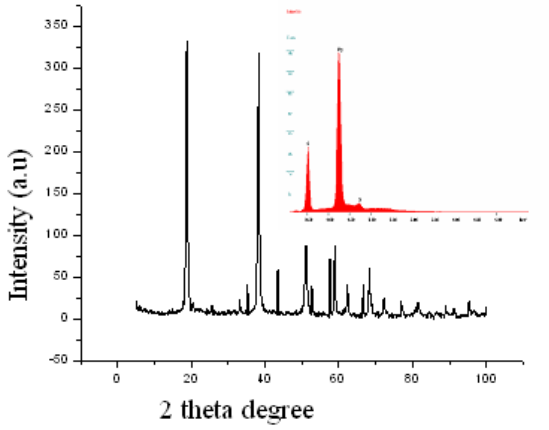

Fig.3: Shows XRD pattern of MgO nanoparticles. The inset shows the EDX pattern.

Acknowledgments

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