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Preparation of MgO Nanostructure Powder by Sol-gel Method

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Abstract

The sol-gel process for the synthesis of oxide base materials is currently attracting since it is a cheap and low temperature technique that allows for the fine control on the product. For the preparation of MgO powder magnesium chloride was used as precursor by sol-gel technique. This process involved hydrolysis and condensation. The prepared powder was fired at different firing temperature. Then prepared powder was characterized with X-ray and SEM techniques.

Keywords: Sol-gel; MgO; Precursor; XRD; SEM.

Introduction

The sol-gel technique is advantageous in the synthesis of nanosized materials because it has the advantages of simple procedure, low temperature processing and low cost. Factors such as temperature, time, pH and the environmental condition affect the final product. Sol-gel derived material has many applications in optics, electronics, sensors, medicine and separation technology [1]. This process involved hydrolysis and condensation. Fast hydrolysis and fast condensation result in the almost instantaneous formation of gel. Also slow hydrolysis and fast condensation result in controlled precipitation [2]. Sol involves the formation of an inorganic continues network containing a liquid phase gel. Normally alkoxide is dissolved in alcohol and hydrolyzed by addition of water under acidic or basic or neutral condition [3 - 5]. Hydrolysis replaces an alkoxide ligand with hydroxyl ligand.

$$M(OR)_z + H_2O \Longleftrightarrow M(OR)_z + (OH) + R\text{-}OH$$

Condensation reaction involving hydroxyl ligand produces polymer composed of M-O-H or M-OH-M bonds.Magnesium oxide is an interesting basic oxide that has many applications for gas sensing purpose [6] and also use as medical application [7 - 8].

Experimental Work

The MgO nanoparticles were synthesized by the precipitation of magnesium hydroxide gels in aqueous solution using AR grade magnesium chloride ($MgCl_2$) as precursor and ethanol as solvent. The mechanism for obtaining a gel from a sol is probably a nucleophilic substitution. The homogenous solution of $MgCl_2$ + ethanol of 1 M is prepared having pH 5.8 by stirring with magnetic stirrer for 30 min.

For the preparation of gel, the solution is dried for 24 hours at room temperature. The powder is collected and again dried for 1 hour under IR lamp. The prepared powder is fired at 200 ^{o}C. The resultant powder is characterized by using XRD and SEM.

Results and Discussions

X-ray diffraction studies

The prepared powder was analyzed with X-ray diffractogram (Bruker Model No. D8 Advance) using CuK_{α} radiation with a wavelength 1.5418 Å.

Figure 1 shows the X-ray diffraction pattern of the MgO powder obtained by heat treatment at 200 ^{o}C. According the standard JCPDS data file no. 45-946, the observed peaks are well matched with peaks of MgO. Also the observed 'd' values are closely match with standard 'd' values. The average crystallite size of MgO powder determined by Scherrer formula is found to be 60 nm.

Scanning electron microscopy studies

The surface morphology was analyzed using a scanning electron microscope (JOEL JED 2300). Figure 2 depicts the scanning electron microscope images of MgO powder obtained by heat treatment at 200 ^{o}C. It consists of randomly distributed grains with smaller size and shape distribution. The particle size is found to be in the range of 41 nm to 58 nm.

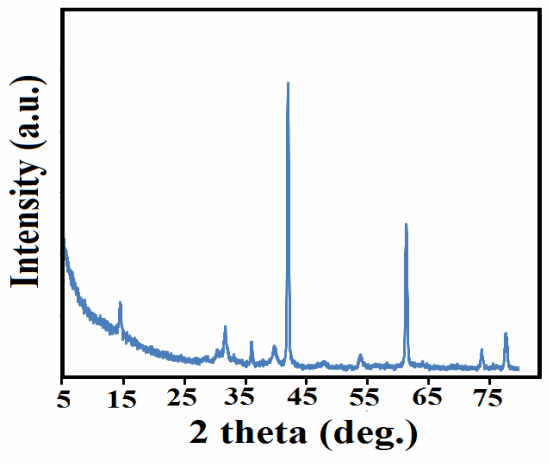

Figure 1. X-ray diffraction pattern of MgO powder obtained by heat treatment at 200 ^{0}C.

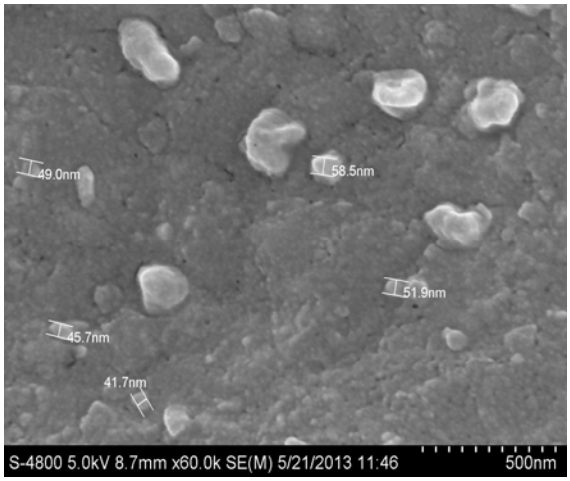

Figure 2. SEM image of MgO powder obtained by heat treatment at 200 ^{0}C

Conclusions

The conclusions drawn from present work are summarized as follows:

i) Sol-Gel processing is a typical wet chemical technique for preparation of nanostructured MgO material.

ii) The peaks of XRD pattern correspond to MgO material.

iii) XRD reveals that the observed peaks are well matched with standard value of JCPDS data file no. 45 - 946.

iv) SEM image of pure MgO fired at 200 ^{o}C depicts that the particle size was in the range of 41 nm to 58 nm.

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References

[1] Daniele, L,. Marchisio, Federica Omegna Antonell A., Barresi and Paul Bowen, "Effect of mixing and other operating parameters in sol-gel processes, Ind. Eng. Chem., vol. 47, pp. 7202 -7210, 2008.

[2] H. Liu, Wangxiaohul, and L. Li, "Sol-Gel synthesis and characterization of nano crystalline $(Ba_{0.5}Na_{0.5})TiO_3$ powders from poly vinyl alcohol evaporation route," 8^{tb} Inter. Nanoscience & Tech. Symp. (CINSTO9), J. Phys. Conf. Series, vol. 188, pp. 012058, 2009.

[3] S. Cizauskaite, V. Reichlova, G. Nenartaviciene, A. Beganskiene, J. Pinkas, A. Kareiya, "Sol-gel preparation and characterization of perovskite gadolinium aluminates," Material Science, Poland, vol. 25, pp. 3, 2007.

[4] E. Gutamann, A. A. Levin, I. Pommrich, and D. C. Meyer, "Preparation of aluminosilicate crystalline coating from sol-gel derived alumina films deposited on silica silica substrate," Cyst. Res. Technol. vol. 40, no. 1 - 2, pp. 114 - 124, 2005.

[5] T. Lopez, I. Garcia-Cruz, and R. Gomez, "Synthesis of magnesium oxide by the sol-gel method: effect of the pH on the surface hydroxylation," J. Catal., vol. 127, pp. 75 -85, 1991.

[6] A. N. Sergeev, V. I. Vershchagin, V.V. Evstigneev, V. Borodin, and A. A. Vikarev, "Al_2O_3 produced by the sol-gel method for micro composite ceramics," Glass and Ceram., vol. 55, no. 9 - 10, 1998.

[7] L. Mathews, R. K. Kunwar, S. Zhou, V. Punj, and J. R. Kanwar, "Application of nano-medicine in anti-bacterial medical the rapeuting and diagnostics," The Open Tropical Medicine J., vol. 3, pp. 1 - 9, 2010.

[8] P. K. Stol Menov, "Metal oxide nano particles as bactericidal agent," Langmur, vol. 18, pp. 6679 - 86, 2002.