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STRUCTURE AND PROPERTIES OF NANOSCALE AND MESOSCOPIC MATERIALS

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Investigation of MgO Powders Synthesized by Liquid-Phase Method

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Magnesium oxide (MgO) powders are prepared by liquid-phase method and are characterized by X-ray diffraction (XRD), SEM and EDX characterization studies. The characterization confirms that MgO particles obtained shows cubic structure. The synthesized powders have high purity. The XRD analysis shows that nanocrystalline size of MgO nanoparticles is accompanied with remarkably uniform grain size.

Key words: MgO nanoparticles, XRD, EDX, SEM.

Порошки оксиду магнію (MgO), що отримані рідкофазним методом, було охарактеризовано методами рентгенівської дифракції, сканувальної еле-

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ктронної мікроскопії (SEM) та енергодисперсійної рентгенівської спектроскопії (EDX). Дослідження підтвердили, що отримані частинки MgO мають кубічну структуру. Синтезовані порошки мають високу чистоту. Рентгеноструктурний аналіз показав, що нанокристалічний розмір наночастинок MgO супроводжується надзвичайно близькими розмірами зерен.

Ключові слова: наночастинки MgO, рентгеноструктурний аналіз, EDX, SEM.

Порошки оксида магния (MgO), полученные жидкофазным методом, были охарактеризованы методами рентгеновской дифракции, сканирующей электронной микроскопии (SEM) и энергодисперсионной рентгеновской спектроскопии (EDX). Исследования подтвердили, что полученные частицы MgO имеют кубическую структуру. Синтезированные порошки имеют высокую чистоту. Рентгеноструктурный анализ показал, что нанокристаллический размер наночастиц MgO сопровождается необыкновенно близкими размерами зёрен.

Ключевые слова: наночастицы MgO, рентгеноструктурный анализ, EDX, SEM.

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1. INTRODUCTION

Metals have a tendency to oxidized and form a large diversity of oxide compounds. Among the metal oxides, MgO is attractive for both fundamental and applicable research areas [1, 2]. The MgO has been in central theme of research as it offers applications in microelectronic circuits, sensors, piezoelectric devices, fuel cells, and semiconductor products [3–5]. The MgO has good additive properties in heavy fuel oil because of high oil dispersion ability and large specific surface area and also bactericidal performance in the aqueous environments due to the formation of super oxide [6, 7]. There are various techniques which are used to synthesize the MgO nanostructures by using methods such as precipitation [8], solvothermal [9], chemical vapour deposition [10], electrochemical [11], sonochemical [12], microwave [13], pulse laser deposition [14], laser ablation [15], sol-gel method [16] and carbothermic reduction [17].

In this work, magnesium oxide nanocrystalline particles were synthesized by liquid-phase method. The samples were prepared by liquid-phase method as it has many advantages over other methods of nanocrystalline material preparation [18]. The synthesized samples were subjected to characterizations such as powder X-ray diffraction analysis, SEM and EDX studies.

2. EXPERIMENTAL

Magnesium chloride hexahydrate ($MgCl_2 \cdot 6H_2O$) and sodium hydroxide (NaOH) of AR grade of high purity dissolved in ethanol. After mixing with a magnetic stirrer for 1 h at room temperature, the solution was kept on table at rest for 4 h so that, the precipitation is formed at the bottom of beaker. This precipitation was filtered and washed several times. The final product is dried for 6 h at 40°C. The magnesium oxide powder is collected and calcinated at 300°C for 2 h. The structural analysis of MgO powder were carried out by X-ray diffraction (XRD) with MoK_α ($\lambda = 0.70932$ Å) radiation. Morphological characterization of the sample was performed using scanning electron microscope (SEM). It is equipped with energy dispersive X-ray (EDX) facility for high resolution chemical analysis.

3. RESULTS AND DISCUSSION

Figure 1 shows the XRD spectrum of MgO powder synthesized at temperature 300°C. From the peak width it can be inferred that the powder is nanocrystalline. The X-ray diffraction pattern were indexed and the main diffraction peaks were assigned to (111), (200) and (220) crystal planes (JCPDS Card No. 87-0653) [19]. The lattice parameter of f.c.c. MgO is $a = 4.217$ Å. There are some peaks matching with the $Mg(OH)_2$ as marked with asterisk (*). The crystal structure of magnesium hydroxide is trigonal with lattice parameters as $a = 3.13$ Å, $c = 4.75$ Å.

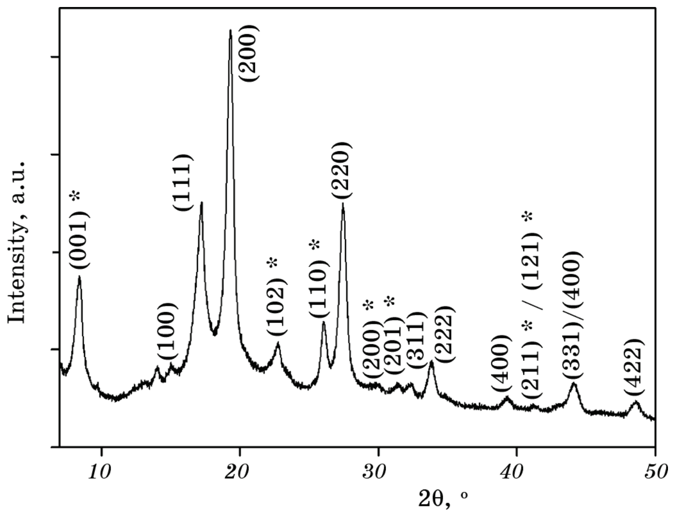

Fig. 1. X-ray diffraction pattern of the synthesized MgO; the $Mg(OH)_2$ peaks are marked by asterisk (*).

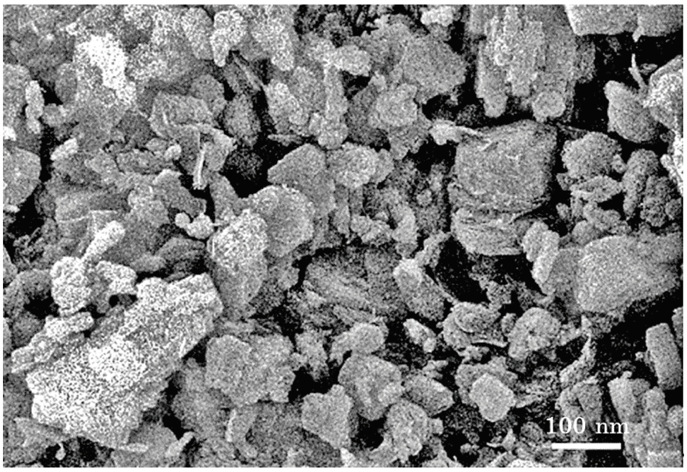

Fig. 2. SEM image of MgO powder.

The grain size calculated by using Scherrer formula and selecting all the 7 main peaks attributed to MgO in Fig. 1 is (4.4 ± 1) nm.

SEM was used for the morphological study of MgO nanoparticles. The SEM images of MgO nanoparticles are presented in the Fig. 2. It is observed that the MgO nanoparticles formed were highly agglomerated and porous in nature with uniform size distribution.

In Figure 3 we have reported a typical EDX spectra recorded in MgO powder. As can be seen, powder is composed with O and Mg. In addition to these, signals from Au element, which presumably could have ap-

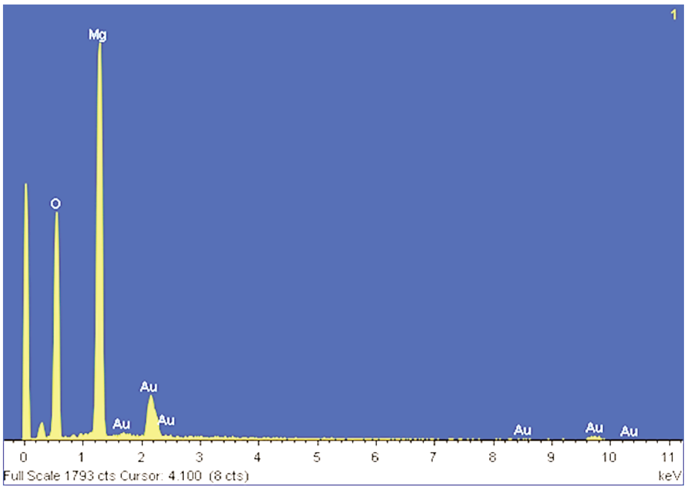

Fig. 3. EDX spectrum of MgO powder.

peared from the sample holder. Gold very thin over samples with a thickness of 3 nm have been deposited by DC magnetron sputtering.

4. CONCLUSION

Magnesium oxide (MgO) nanoparticles are synthesized by liquid-phase method. The synthesized samples were characterized by various analytical techniques. The powder X-ray diffraction result shows that the nanoparticles are in crystalline form with cubic structure have been formed with an average particle size in the range (3.42–5.36 nm). The SEM reveals that powder is porous and large agglomerates of fine particles of uniform diameter. The EDX spectra analysis confirmed the signal characteristic of magnesium and oxygen.

REFERENCES

1. D. C. Reynolds, D. C. Look, and B. Jogai, *Solid State Commun.*, **99**: 873 (1996).
2. Yu. V. Naidich, I. I. Gab, T. V. Stetsyuk, B. D. Kostyuk, and D. B. Shakhnin, *Metallofiz. Noveishie Tekhnol.*, **40**, No. 10: 1359 (2018).
3. G. W. Wagner, P. W. Bartram, O. Koper, and K. J. Klabunde, *J. Phys. Chem. B*, **103**: 3225 (1999).
4. G. W. Wagner, L. R. Procell, R. J. O'Connor, S. Munavalli, C. L. Carnes, P. N. Kapoor, and K. J. Klabunde, *J. Am. Chem. Soc.*, **123**: 1636 (2001).
5. Y. Oh, S. Lim, S. D. Ahn, S. S. Lee, K. Cho, J. B. Koo, R. Choi, and M. Hasan, *J. Phys. D*, **46**: 285101 (2013).
6. Y. R. Li, Z. Liang, Y. Zhang, J. Zhu, S. W. Jiang, and X. H. Wei, *Thin Solid Films*, **489**: 245 (2005).
7. J. Sawai, H. Kojima, H. Igarashi, A. Hashimoto, S. Shoji, T. Sawaki, A. Hakoda, E. Kawada, V. Kokugan, and M Shimizu, *World J. Microb. Biotechnol.*, **16**: 187 (2000).
8. S. Veldurthi, C. Shin, O. S. Joo, and K. D. Jung, *Microporous Mesoporous Mater*, **152**: 31 (2012).
9. Z. Zhao, H. Dai, Y. Du, J. Deng, L .Zhang, and F. Shi, *Mater Chem. Phys.*, **128**: 348 (2011).
10. H. Li, M. Li, X. Wang, X. Wu, F. Liu, and B. Yang, *Mater Lett.*, **102**: 80 (2013).
11. R. Hahn, J. G. Brunner , J. Kunze, P. Schmuki, and S. Virtanen, *Electrochem Commun.*, **10**: 288 (2008).
12. M. A. Alavi and A. Morsali, *Ultrason Sonochem.*, **17**: 441 (2010).
13. R. Al-Gaashani, S. Radiman, Y. Al-Douri, N. Tabet, and A. R. Daud, *J. Alloys Compd.*, **521**: 71 (2012).
14. W. Rizwan, S. Absari, M. Dar, Y. Kim, and H .Shin, *Mater. Sci. Forum*, **558–559**: 983 (2007).
15. T. Phuoc, B. H. Howard, D. V.Martello, Y. Soong, and M. K. Chyu, *Opt. Laser. Eng.*, **46**: 829 (2008).
16. B. A. Morales, T. Lopez, and R. Gomez, *J. Solid State Chemistry*, **115**: 411 (1995).
17. M. Nusheh, H. Yoozbashizadeh, M. Askari, H. Kobatake, and H. Fukuyama,

J. Alloys Compd., **506**: 715 (2010).
18. A. Karatutlu, A. Barhoum, and A. Sapelkin, *Engineering Applications of Nanoparticles and Architectural nanostructures*, (Eds. Ahmed Barhoum and Abdel Salam Hamdy Makhlouf) (Elsevier: 2018), p. 1.
19. V. Smith, *X-ray Powder Data File, American Society for Testing Materials* (1960).