Int. J. Nano Dimens., 8(2): 159-163, Spring 2017

ORIGINAL ARTICLE

Photocatalytic degradation of Sulfathiazole using nanosized CdO in aqueous solution

*Leila Hoseini; Azar Bagheri Ghomi**

Department of Chemistry, Center Tehran Branch, Islamic Azad University, Tehran, Iran

Received 11 January 2017; revised 27 March 2017; accepted 06 April 2017; available online 25 April 2017

Abstract

Template synthesis is a powerful method for the preparation of nanoscale materials with specific size and shape. Cadmium oxide (CdO) nanoparticles were prepared by using sodium dodecyl sulfate (SDS), $Cd(OAc)_2.2H_2O$ and sodium hydroxide as starting materials. The sample was characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM). The XRD pattern proves that the final product has cubic phase and the particle size diameter of the nanoparticles are 36.4 nm. The SEM was used for direct visualization of the size and shape of the nanoparticles. The morphology of the CdO was found nanospherical. Antibiotics are a major class of drugs included in the designation of emerging contaminants, representing a high risk to natural ecosystems. We studied the degradation of Sulfathiazole antibiotic by nanosized CdO under ultraviolet irradiation. Various experimental parameters such as initial Sulfathiazole (STZ) concentrations, initial CdO concentration and initial pH were investigated. According to the results this method can be good performance in removal of Sulfathiazole.

Keywords: *CdO; Degradation; Nanoparticle; SDS; Sulfathiazole.*

How to cite this article

Hoseini L, Bagheri Ghomi A. Photocatalytic degradation of Sulfathiazole using nanosized CdO in aqueous solution. Int. J. Nano Dimens., 2017; 8(2): 159-163, DOI: 10.22034/ijnd.2017.25085

INTRODUCTION

The large interest in nanostructures results from their numerous potential applications in various areas such as materials and biomedical sciences, electronics, optics, magnetism, energy storage, and electrochemistry. Ultra small building blocks have been found to exhibit a broad range of enhanced mechanical, optical, magnetic, and electronic properties compared to coarser-grained matter of the same chemical composition. In this paper template technique suitable for nanotechnology applications with emphasis on characterization of created arrays of tailored nanomaterials have been studied. CdO, is a known n-type semiconductor with the direct band gap energy of 2.5 eV [1].

CdO is applied in solar cells [2], gas sensors [3], transparent electrodes [4], catalysts, photocatalysts [5-7], and photodiodes [8]. Numerous structures of cadmium oxide-like nanoparticles [9], nanowires [10], nanoneedles [11], nanosheet [12] and nanocrystals [13] have been reported in nanoscale. The introduction of antibiotics in to the environmental through anthropogenic sources can constitute a potential risk for aquatic and terrestrial organisms [14-18]. Sulfathiazole is extensively used in aquaculture, live stock production and also in human medicine to treat bacterial, protozoal and fungalin fections. Studies point to the presence of STZ in the environment, which is for the most part due to the inability to achieve a full elimination during sewage treatment. In this investigation, we demonstrated that SDS is an appropriate template for synthesising of CdO nanoparticles. Also, the objective of the present study was to evaluate of Sulfathiazole degradation by UV irradiation.

* Corresponding Author Email: azar.bagheri@iauctb.ac.ir

EXPERIMENTAL

Material

Cadmium acetate, (99.9% Sigma Co.) and ethanol (99.9% Sigma Co.) were used as received, without further purification. Other compounds used were prepared from MERCK Company.

Apparatus

Phase identification of the fabricated CdO metal oxide was carried out by a Holland Philips X-ray diffraction CuKα (λ=1.5417 Å) in the radiation range of 20°–80°. A Field emission scanning electron micrograph (SEM) of a Holland Philips XL30 microscope was used to observe the morphology and elemental analysis of the CdO. Spectrophotometric measurements were conducted using an UV-VIS Shimadzu 2101 spectrophotometer equipped with an Acermate 486 SX/25D computer and thermostically matched 10-mm quartz cells.

Preparation of CdO

All the reagents were used without any purification. In a typical experimental procedure, $Cd(CH_3COO)_2.2H_2O$ was dissolved in distilled water to form a 0.5M solution. The precursor solution obtained (4 ml) was added to a 100 ml conical flask containing 1.21 g of SDS and sodium hydroxide (0.07 mol) under magnetic stirring. The resulting solution was placed at room temperature for 2 days. After each synthesis white crystalline products were collected by centrifugation, washed with distilled water and ethanol several times. Then the resulting precipitate collected by centrifugation and was washed several times with water and ethanol. The cadmium hydroxide precipitate obtained, placed in the vacuum oven in temperature 60 °C for 12 hours and then put in the furnace for 2 hours at 420 °C was converted to cadmium oxide. Then, to ensure the formation of nanoparticles, XRD spectrum was taken.

RESULTS AND DISCUSSION

Characterization of nanoparticle

The surface morphology of the product was studied by using SEM as showed in Fig. 1. The shape was appeared spherical. The XRD pattern of prepared CdO nanoparticle is shown in Fig. 2. No peak of any other phase or impurity was detected. The diffraction peaks at 2θ values of 33.08°, 38.43°, 55.31°, 65.90° and 69.28° corresponds to pure CdO matching with the (111), (200), (220), (311) and (222) planes having cubic structure (JCPDS Card No.05-0640), thus indicating the formation of CdO nanoparticles.

Degradation of STZ and removal under different oxidation systems

The results of Sulfathiazole degradation and removal under the optimum conditions are shown in Fig. 3.

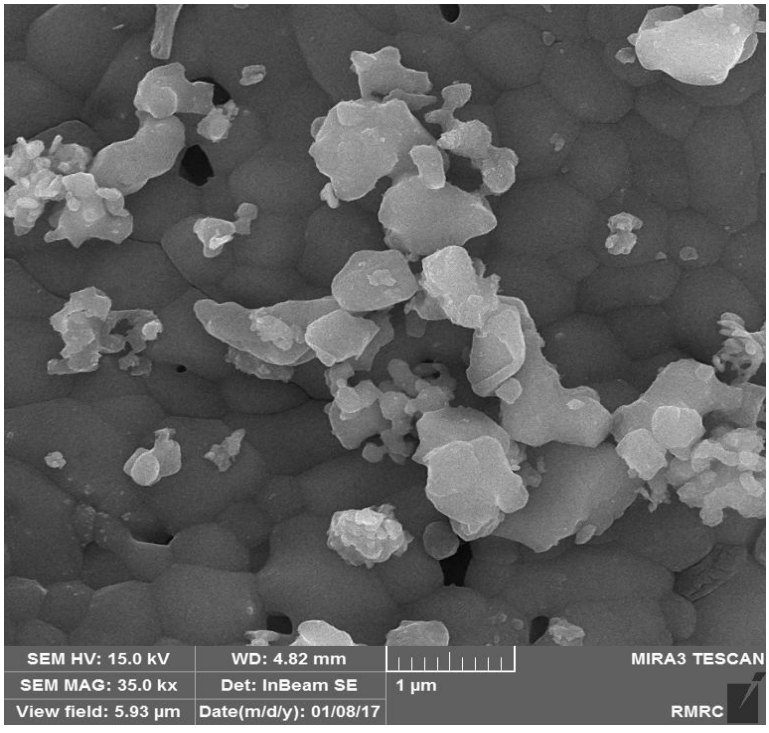

Fig. 1: SEM image CdO nanoparticles.

Influence of CdO concentrations on STZ degradation

To investigate the effect of CdO concentration on photocatalytic efficiency, a set of experiments were done at pH = 11 with different CdO concentration at range of 0.02-0.11 g/L. The results showed, the optimum concentration of CdO catalyst was 0.02 g/L(Fig. 4).

Influence of initial STZ concentration

We investigated the influence of initial STZ concentration on the removal efficiency of drug. Irradiation of STZ solution was done with the initial drug concentrations of 15, 30 and 45 mg/L for 90 min. The photodegradation conversion of drug increases with the initial concentration 30 mg/L.

Influence of initial pH on STZ degradation

To investigate the effect of initial pH of the solution on the photocatalytic degradation of STZ, the pH of the solution was adjusted at the range of 3-11 .The results indicate that the best pH for the degradation of STZ is the basic pH value (pH = 11).

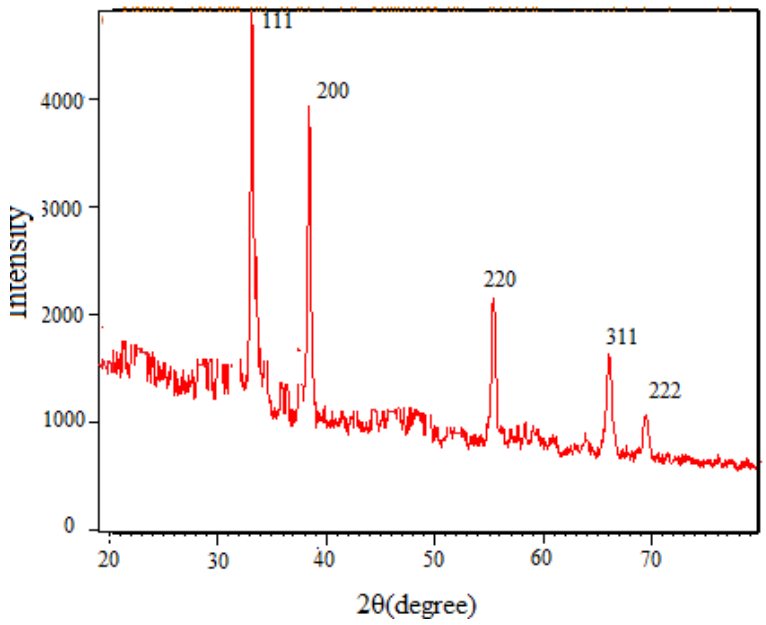

Fig. 2: XRD patern of CdO nanoparticles.

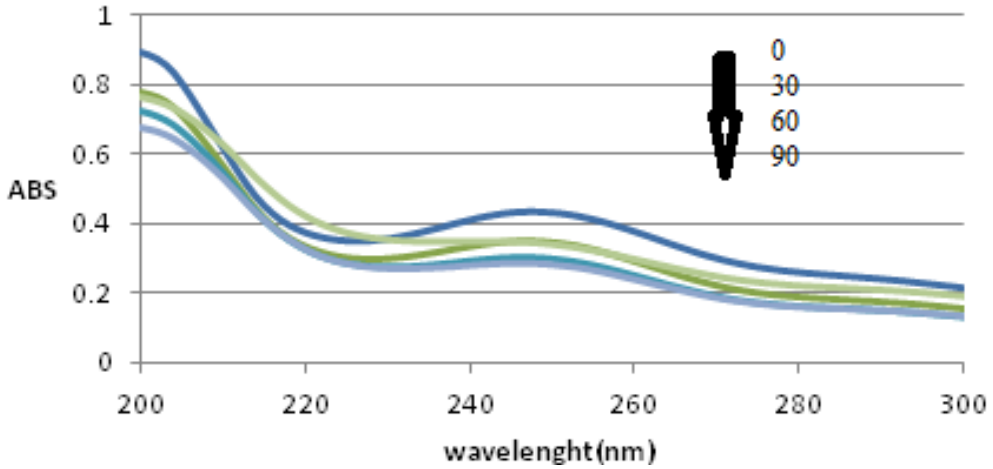

Fig. 3: Changes of UV–Vis spectra of 30 mg/L aqueous solution of STZ in pH = 11, during photocatalytic process of UV/CdO with irradiation time 0-90 min, respectively.

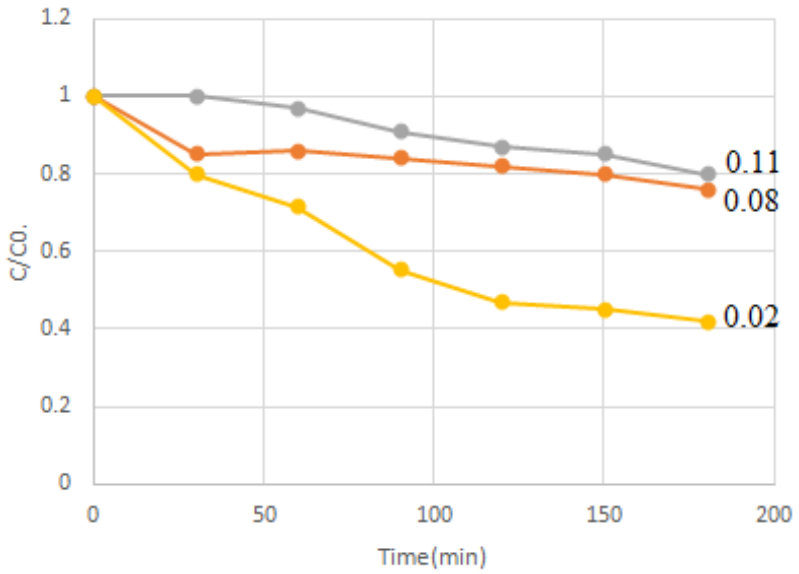

Fig. 4: Effect of CdO concentrations(mg/L) in removal efficiency.

CONCLUSIONS

Cadmium oxide nanoparticles have been synthesized using simple reflux method. The sample was characterized by X-ray powder diffraction and the peaks are quite agreeable with the pure phase cubic structure. The XRD pattern confirms the phase purity of the sample. The morphology of the metal oxide was found to be spherical in shape by SEM analysis. Then we were shown degradation of STZ occurred under UV irradiation in the presence of CdO. Results showed that the system was most efficient at 30 mg/L and 0.02 g/L concentrations STZ and CdO nanoparticles in basic conditions, respectively.

ACKNOWLEDGEMENTS

We wish to thank the Islamic Azad University Center Tehran Branch for its invaluable support through the project

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

REFERENCES

[1] Grado-Caffaro M. A., (2008), Quantitative discussion on band-gap energy and carrier density of CdO in terms of temperature and oxygen partial pressure. *Phys. Lett. A*. 372: 4858-4860.

[2] Yakuphanoglu F., (2010), Nanocluster CdO thin film by sol-gel for solar cell applications. *Appl. Surf. Sci*. 257: 1413-1419.

[3] Kamble A. S., Pawar R. C., Patil J. Y., Suryavanshi S. S., Patil P. S., (2011), From nanowires to cubes of CdO: Ethanol gas response. *J. Alloys Compd*. 509: 1035-1039.

[4] Gupta R. K., Ghosh K., Patel R., Kahol P. K., (2011), Low temperature processed highly conducting, transparent, and wide band gap Gd doped CdO thin films for transparent electronics. *J. Alloys Compd*. 509: 4146-4149.

[5] Singh G., Kapoor I. P. S., Dubey R., Srivastava P., (2011), Synthesis, characterization and catalytic activity of CdO nanocrystals. *Mater. Sci. Eng.*: B. 176: 121-126.

[6] Tadjarodi A., Imani M., (2016), Synthesis of porous CdO sheet-like nanostructure based on soft template model and its application in dye pollutants adsorption. *Int. J. Nano Dimens.* 7: 150-159.

[7] Vijaykarthik D., Kirithika M., Prithivikumaran N., Jeyakumaran N., (2014), Synthesis and characterization of Cadmium Oxide nanoparticles for antimicrobial activity. *Int. J. Nano Dimens.* 5: 557-562.

[8] Li J., Ni Y., Liu J., Hong J., (2009), Preparation, conversion, and comparison of the photocatalytic property of $Cd(OH)_2$, CdO. CdS and CdSe. *J. Phys. Chem. Solid*. 70: 1285-1289.

[9] Yakuphanoglu F., Caglar M., Caglar Y., Ilican S., (2010), Electrical characterization of nanocluster n-CdO/p-Si heterojunction diode. *J. Alloys Compd*. 506: 188-193.

[10] Dong W., Zhu C., (2003), Optical properties of surface-modified CdO nanoparticles. *Opt. Mater.* 22: 227-233.

[11] Chang Q., Chang C., Zhang X., Ye H., Shi G., Zhang W., Wang Y., Xin X., Song Y., (2007), Enhanced optical limiting properties in suspensions of CdO nanowires. *Opt. Commun.* 274: 201-205.

[12] Rashidi Ranjbar Z., Sheikhshoaie I., Bagheri Z., (2014), Solid state preparation of CdO nano-particles by thermolysis of a precursor as compacted nanosheet. *Int. J.Nano Dimens.* 5: 409-413.

[13] Liu X., Li C., Han S., Han J., Zhou C., (2003), Synthesis and electronic transport studies of CdO nanoneedles. *Appl. Phys. Lett*. 82: 1950-1952.

[14] Sarmah A. K., Meyer M. T., Boxall B. A., (2006), A global perspective on the use, sales, exposure pathways, occurrence, fate and effects of veterinary antibiotics (VAs) in the environment. *Chemosphere*. 65: 725-759.

[15] Schwartz T., Kohnen W., Jansen B., Obst U., (2003), Detection of antibiotic-resistant 493 bacteria and their resistance genes in wastewater, surface water, and drinking water 494 biofilms. *FEMS Microbiol. Ecol*. 43: 325-335.

[16] Schwartz T., Volkmann H., Kirchen S., Kohnen W., Schon-Holz K., Jansen B., Obst U., (2006), Real-time PCR detection of Pseudomonas aeruginosa in clinical and municipal wastewater and genotyping of the ciprofloxacin-resistant isolates. FEMS *Microbiol. Ecol*. 57: 158-167.

[17] Seifrtová M., Pena A., Lino C. M., Solich P., (2008), Determination of fluoroquinolone antibiotics in hospital and municipal wastewaters in coimbra by liquid chromatography with a monolithic column and fluorescence detection. *Anal. Bioanal. Chem.* 391: 799-805.

[18] Shaojun J., Shourong Z., Daqiang Y., Lianhong W., Liangyan C.,(2008), Aqueous oxytetracycline degradation and the toxicity change of degradation compounds in photoirradiation process. *J. Environ. Sci.* 20: 806-813.