Synthesis And Studied Structural and Morphological Properties of 1-Dimensional Zno-Ag2O-Ag Nanowire

Lujain nazeeh yousif1, Noor M. Ibrahim2, Reham Ihssan Kamel3, Muntadher I. Rahmah4

1,2,3,4 AL-Esraa University College, Baghdad, Iraq

Corresponding author Email: superhydrophobicsurfaces@mail.ru

Abstract. 1-dimensional zinc oxide (ZnO) - silver oxide (Ag2O) – silver (Ag) nanowire was prepared using a simple and inexpensive bottom-up chemical method. X-ray diffraction (XRD) results showed the presence of diffraction peaks of ZnO and Ag2O with hexagonal wurtzite phase of ZnO. Energy Dispersive X-ray (EDX) results showed the presence of energy peaks of Zinc (Zn), Silver (Ag), and Oxygen (O) elements. Filed Emission Scanning Electron Microscopy (FE-SEM) results showed that the surface morphology is nanowire (1-dimensional structure) with shapes similar to hedgehog spines and have small nanoscale diameters. The present work represents a promising step in the preparation of a 1-dimensional nanowire.

Keywords: Morphological Properties, Zno-Ag2O-Ag Nanowire, 1-Dimensional Zno

1. Introduction

ZnO nanomaterial are considered one of the most important metal oxides because of their energy gap (~3.37 V) and their distinctive physical and chemical properties, where the demand for them is unparalleled for their inclusion in medical, biological, and industrial applications[1, 2]. Also, ZnO is known to possess antimicrobial properties and a very high ability to absorb ultraviolet rays[3]. Metallic silver oxides (Ag2O) are known to have unique chemical and physical properties that can be used in many fields, especially in antibacterial applications, cancer treatment, cosmetics and photocatalysts[4-6]. It is a p-type semiconductor with a bandgap (1.2 - 3.4 eV) and a wavelength of less than 400 nm that extend within visible areas [7, 8]. Accordingly, the fabrication of ZnO-Ag2O composite is one of the important issues that contribute to improving the various properties of great importance in many applications [9-11]. Recently, many studies have been conducted to prepare and diagnose ZnO nanoparticles, and many of these studies suffer from the high cost, complex preparation methods, the difficulty of controlling the shape of nanostructures and the long time to manufacture nanostructures[10, 12-19].
In this work we present a simple and low-cost chemical method for the fabrication of a 1-dimensional ZnO-Ag2O-Ag nanowire with distinct structural and morphological properties. The authors suggest that the present work opens up a broad horizon for the fabrication of ZnO nanomaterial and Ag2O with multiple applications.

2. Materials and methods

Zinc nitratehexahydrate (Zn(NO3)6H2O) and Sodium hydroxide (NaOH) were purchased from Sigma Aldrich company with a purity of 99%. Silver nitrate (AgNO3) was purchased from Merck Millipore company with a purity of 99%.

To preparation of 1-dimensional ZnO-Ag2O-Ag nanowire. 1g of (Zn(NO3)6H2O) was mixed with 1g of (AgNO3) using a magnetic stirrer for 30 min through dissolving nitrate materials in distilled water (DW).

Then, a certain amount of NaOH was added to change the pH from 7 to 13 under the influence of a stirring. After this, a lead-silver precipitate was obtained which was left for a certain period. The precipitate was rinsed and washed with ethanol and DW several times. Then, the specimen dried by heat treatment at 120 °C to remove any impurities.

Crystal structure analysis of (1-dimensional ZnO-Ag2O-Ag nanowire) was accomplished by XRD used (SHIMADZU XRD-6000 diffractometer) from Shimadzu Company, Japan country, which records the intensity as a function of Bragg angle with Cu-Kα and a wavelength of 1.54 Å. Morphological properties study by FE-SEM (TESCAN Mira-3 made in the Czech Republic). The elemental analysis or chemical characterization of a sample was measured by EDX (Bruker Nano GmbH (Germany)).

3. Results and Discussion

Figure 1 shown XRD spectra of 1-dimensional ZnO-Ag2O-Ag nanowire. The diffraction peaks situated at 30.14°, 34.22°, 36.35°, 47.68°, 56.81°, 63.16°, 68.13°, and 69.21° have being pointed as hexagonal quartzite phase of ZnO, have miller indices of (100),(002),(101),(102),(110),(103),(200) and(112) respectively. These peaks reinforced with the criterion ZnO (JPCDS card number: 36-1451). Also XRD pattern appears strong peak at 32.22, which identify to (111) of Ag2O. The diffraction peaks at 46.32, 54.94 and 67.44 have been guided to (211), (220) and (222) planes enhanced with the criterion Ag2O (JCPDS 76-1393). Furthermore, A number of Bragg peaks noticed at angles 33.26°, 38.18°, 43.96°, 55.15°, 64.12°, 77.89° which are indicating to (122), (111), (200), (142), (220), (311), planes of pure Ag established on the face-centered
Fig. 2 depicts the EDX spectra of 1-dimensional ZnO-Ag\textsubscript{2}O-Ag nanowire. From this figure, the results prove that the synthesized specimen principally includes elements of Zinc (Zn), Silver (Ag), and Oxygen (O); with a peak of Zn appears at 8.610 keV and a peak of O appear at 0.5 keV while Ag appears at peaks of 2.970 keV as shown during figure (2). The results EDX match perfectly with XRD spectra which supports the success of the work in preparing this sample.

Figure 1. XRD pattern of 1-dimensional ZnO-Ag\textsubscript{2}O-Ag nanowire

Figure 2. EDX spectrum of 1-dimensional ZnO-Ag\textsubscript{2}O-Ag nanowire
Fig. 3 shows the FE-SEM results, the morphology of 1-dimensional ZnO-Ag₂O-Ag nanowire from the figure. The results confirm the appearance of nanowire-like structures that resemble the spines of a hedgehog.

Figure 3. FESEM image of 1-dimensional ZnO-Ag₂O-Ag nanowire

4. Conclusions

From the results, it can be concluded the following (i) the current method is efficient and effective to prepare 1-dimensional ZnO-Ag₂O-Ag nanowire (ii) XRD and EDX result extensively match and confirm the presence of the ZnO and Ag₂O structures (iii) FESEM results confirm the presence of 1-dimensional nanowire-structure (IV) the authors recommend using the methodology used in the work to prepare nanostructures that contribute to the development of various applications.

Acknowledgements

The authors would like to thank Al-Esraa University College, Baghdad, Iraq for supporting the current work.
Reference

[1] Czyżowska A., Barbasz A., A review: zinc oxide nanoparticles–friends or enemies?, *International`

[2] Smijs T.G., Pavel S., Titanium dioxide and zinc oxide nanoparticles in sunscreens: focus on their safety and effectiveness, *Nanotechnology, science and applications*, 2011, 4, 95.

[3] Newman M.D., Stotland M., Ellis J.I., The safety of nanosized particles in titanium dioxide–and zinc oxide–based sunscreens, *Journal of the American Academy of Dermatology*, 2009, 61, 685-692.

[4] Shaffiey S., SHAFFIEY S.F., Ahmadi M., Synthesis and evaluation of bactericidal properties of Ag2O nanoparticles against Aeromona hyphrophila, 2015.

[5] Chen L., Hua H., Yang Q., Hu C., Visible-light photocatalytic activity of Ag2O coated Bi2WO6 hierarchical microspheres assembled by nanosheets, *Applied Surface Science*, 2015, 327, 62-67.

[6] Emadi A., Feizbakhsh A., Niazi A., Synthesis and Characterization of Carboxymethyl Chitosan–Methyl Cellulose Containing Drug Loaded Ag 2 O–Fe 3 O 4 Nanocomposites as a Drug Delivery System, *Journal of Inorganic and Organometallic Polymers and Materials*, 2020, 1-13.

[7] Gao X.-Y., Feng H.-L., Ma J.-M., Zhang Z.-Y., Lu J.-X., Chen Y.-S., Yang S.-E., Gu J.-H., Analysis of the dielectric constants of the Ag2O film by spectroscopic ellipsometry and single-oscillator model, *Physica B: Condensed Matter*, 2010, 405, 1922-1926.

[8] Pierson J., Rousselot C., Stability of reactively sputtered silver oxide films, *Surface and Coatings Technology*, 2005, 200, 276-279.

[9] Song M., Qi K., Wen Y., Zhang X., Yuan Y., Xie X., Wang Z., Rational design of novel three-dimensional reticulated Ag2O/ZnO Z-scheme heterojunction on Ni foam for promising practical photocatalysis, *Science of The Total Environment*, 2021, 148519.

[10] Ahmad M., Zaidi S.J.A., Zoha S., Khan M.S., Shahid M., Park T.J., Basit M.A., Pseudo-SILAR assisted unique synthesis of ZnO/Ag2O nanocomposites for improved photocatalytic and antibacterial performance without cytotoxic effect, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 2020, 603, 125200.

[11] Rosman N., Salleh W.N.W., Mohamed M.A., Hafiza N., Phenol degradation behavior via photocatalytic of ZnO/Ag2CO3/Ag2O nanoparticles, *Malaysian Journal of Fundamental and Applied Sciences*, 2019, 15, 851-856.

[12] Sabry R.S., Aziz W.J., Rahmah M.I., Employed Silver Doping to Improved Photocatalytic Properties of ZnO Micro/Nanostructures, *Journal of Inorganic and Organometallic Polymers and Materials*, 2020, 30, 4533-4543.
[13] Rahmah M.I., Sabry R.S., Aziz W.J., Preparation of superhydrophobic Ag/Fe2O3/ZnO surfaces with photocatalytic activity, *Surface Engineering*, 2021, **37**, 1320-1327.

[14] Arya S., Mahajan P., Mahajan S., Khosla A., Datt R., Gupta V., Young S.-J., Oruganti S.K., influence of processing parameters to control morphology and optical properties of Sol-Gel synthesized ZnO nanoparticles, *ECS Journal of Solid State Science and Technology*, 2021, **10**, 023002.

[15] Mostafa A.M., Mwafy E.A., Toghan A., ZnO nanoparticles decorated carbon nanotubes via pulsed laser ablation method for degradation of methylene blue dyes, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 2021, **627**, 127204.

[16] Wang Z., Ye X., Chen L., Huang P., Wang Q., Ma L., Hua N., Liu X., Xiao X., Chen S., Silver nanoparticles decorated grassy ZnO coating for photocatalytic activity enhancement, *Materials Science in Semiconductor Processing*, 2021, **121**, 105354.

[17] Yazdi M.E.T., Nourbakhsh F., Mashreghi M., Mousavi S.H., Ultrasound-based synthesis of ZnO· Ag 2 O 3 nanocomposite: Characterization and evaluation of its antimicrobial and anticancer properties, *Research on Chemical Intermediates*, 2021, **47**, 1285-1296.

[18] Yang Z., Deng C., Ding Y., Luo H., Yin J., Jiang Y., Zhang P., Jiang Y., Eco-friendly and effective strategy to synthesize ZnO/Ag2O heterostructures and its excellent photocatalytic property under visible light, *Journal of Solid State Chemistry*, 2018, **268**, 83-93.

[19] Zhao S., Zhang Y., Zhou Y., Zhang C., Fang J., Sheng X., Ionic liquid-assisted photochemical synthesis of ZnO/Ag2O heterostructures with enhanced visible light photocatalytic activity, *Applied Surface Science*, 2017, **410**, 344-353.