New Materials, Compounds and Applications
Vol.5, No.3, 2021, pp.151-156

INFLUENCE OF SILVER NANOPARTICLES ON THE PHYSICAL PROPERTIES OF NAPHTHALENE OIL

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Abstract. Have been synthesized and stabilized of silver nanoparticles using the chemical reduction method. The structure of the synthesized nanoparticles was studied by scanning electron microscopy (SEM) microscopy, X-Ray diffraction (XRD), and energy-dispersive analysis (EDS) methods. The optical properties of Naphthalene oil have been studied before and after the incorporation of silver nanoparticles. The PL spectra of Naphthalene oil before and after the introduction of nanoparticles were investigated. It was shown that after the introduction of nanoparticles, the intensity of the PL peaks belonging to oil decreases sharply, and new peaks belonging to nanoparticles of silver nanoparticles appear.

Keywords: *naphthalene, oil, silver, nanoparticles, photoluminescence.*

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Received: *27 July 2021;* ***Accepted:*** *12 November 2021;* ***Published:*** *7 December 2021.*

1. Introduction

It is known that Naphthalene oil is a unique type of oil in the world that has no analogs in terms of physical, chemical, and biological properties, as well as medicinal features. Naphthalene oil is characterized by relatively high density, oxygen content, organic compounds with a cyclic structure. The unique properties of Naphthalene oil are related to the simplest structure which consists of the fused ring hydrocarbon. Naphthalene oil is determined by the large number of hydrocarbons it contains, their combination in separate fractions, as well as the nature of naphthenic acids, nitrogen, and sulfur-containing compounds, and others.

Although there is a lot of literature on the study of the composition and physicochemical properties of naphthalene oil, there are very few scientific results on the study of its antibacterial, antiseptic, optical, and other properties and its mechanism. With the development of nanotechnology, it has become known that many metals and metal oxide nanoparticles have different superior physical and chemical properties. It is assumed that the inclusion of various nanoscale particles, including silver nanoparticles, in naphthalene oil, which has many therapeutic properties, can enhance the physical and chemical properties of the oil as well as provide additional properties (Mamedaliev *et al.*,1953; Musaev *et al.*,1953, 1980; Guliev *et al.*, 2017; Babaev *et al.*, 2015, 2017).

This paper is devoted to studying the effect of silver nanoparticles, synthesized and stabilized by the chemical reduction method on the physical properties of naphthalene oil.

2. Experimental part

2.1. Materials

Silver nitrate ($AgNO_3$, CAS 7761-88-8, Product Code 141459), sodium tetrahydroborate ($NaBH_4$, 632287 Aldrich); CTAB (cetyltrimethylammonium bromide, $C_{19}H_{42}BrN$, AB 117004, 98% chemically pure), acetone (PLC 141007, 99% chemically pure).

2.2. Synthesis of silver nanoparticles

The silver nanoparticles (Ag) were prepared by a chemical reduction of silver nitrate salts using sodium borohydride as a reducing agent with the presence of cetyltrimethylammonium bromide((CTAB) as a stabilizing agent. 30 ml of 0.5% CTAB solution was added to 100 ml of AgNO3 solution and mix on a magnetic stirrer for 10 minutes. Then 0.03 M sodium tetrahydroborate (NaBH4) solution was added to the initial mixture and stirred for another 20 minutes. The formed Ag nanoparticles were separated from the solution by ultracentrifugation and washed several times with water and acetone. The colloidal silver solution is also subjected to ultrasonic treatment for 10 min on an ultrasonic sonicator VSX 500 2008. The nanoparticles were transferred to a Petri dish and dried in the air for 1 day.

Silver nanoparticles at various contents were added to naphthalene oil taken from a natural well and mixed on a magnetic stirrer for several minutes until homogenization.

2.3. Methods

XRD analysis

To determine the crystalline structure of silver nanoparticles, X-ray diffraction was used. The samples were evaluated in a diffractometer Rigaku Mini Flex 600 XRD, operated at a current intensity of 15 mA and a voltage of 30 kV to obtain the radiation corresponding to the Cu K-α at a longitude wave of 1.54056 Å. The scanning in the 2θ scale was from 10° to 120° with a sample velocity of 0.02°/s.

Scanning electron microscopy (SEM)

The morphology of the silver nanoparticles were determined by means of a scanning electron microscope model Jeol JSM-7600 F. Scanning was performed in secondary electron detecting (SEI) mode at an accelerating voltage of 15 kV and a working distance of 4.5 mm. Energy dispersive micro-X-ray analysis was performed using the device X-Max 50 (Oxford Instruments). In order to make their surface conductive, the samples were coated with a thin films of platinum using a sputtering technique.

Photoluminescent (PL) analysis

Photoluminescent properties were examined using a spectrofluorimeter Varian Cary Eclipse at wavelength range 200-900 nm.

3. Results and discussion

Fig. 1 shows the XRD diffraction pattern of silver nanoparticles. XRD pattern shows that the silver nanoparticles were well structured, and there is practically no amorphous phase. The main peaks at 2θ 38,10^0 (111), 44,43^0 (200), 64,36^0 (220), 77,33^0 (311), 81,28^0 (222), 110,25^0 (331), 114,81^0 (420) 2θ belong to silver nanoparticles

(Salmiati *et al.*, 2017; Khodashenas *et al.*, 2019; Gudikandula *et al.*, 2016; Iravani *et al.*, 2014; Kisyelova *et al.*, 2014*).*

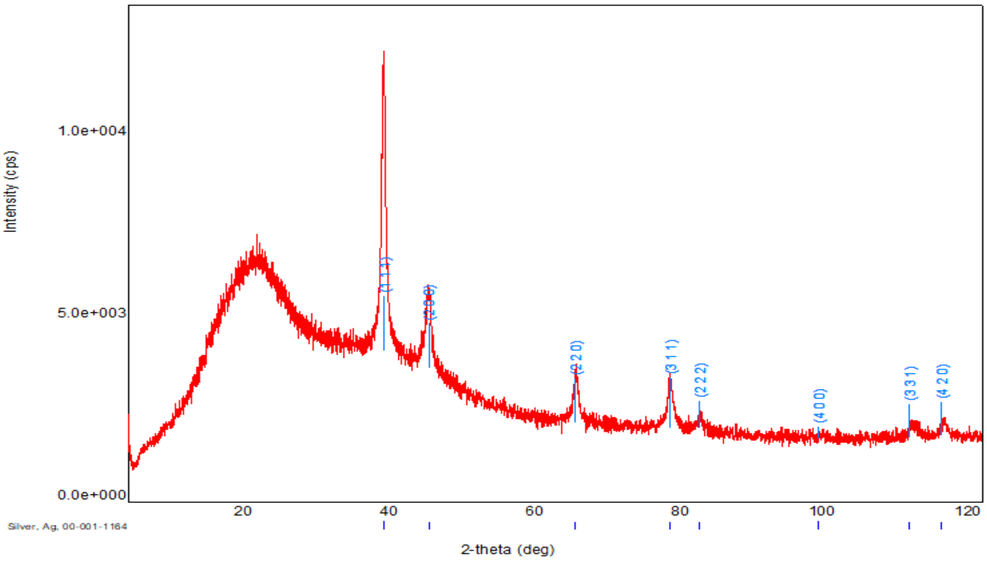

Figure 1. XRD pattern of silver nanoparticles

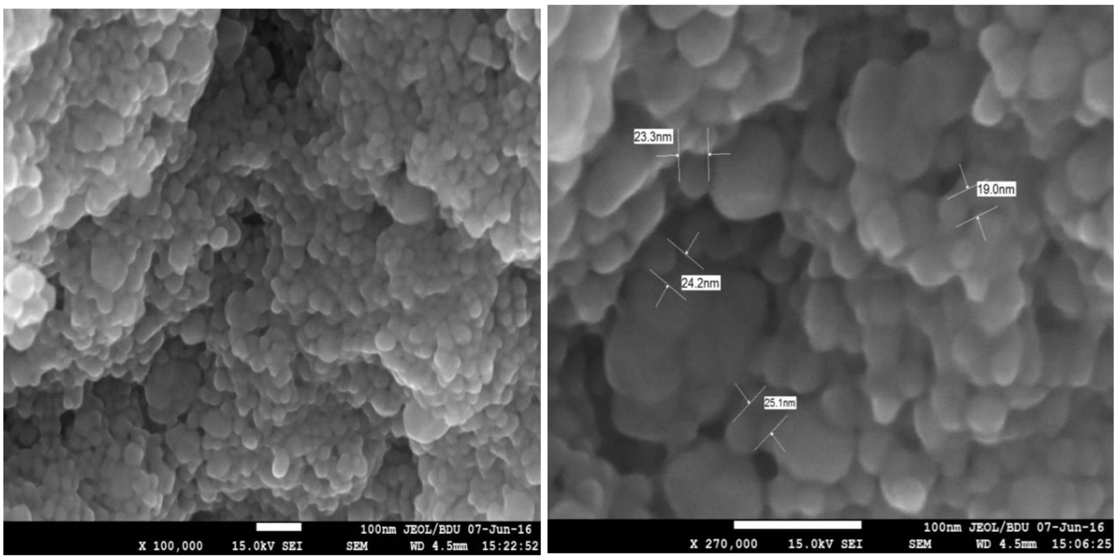

Figure 2. SEM images of silver nanoparticles

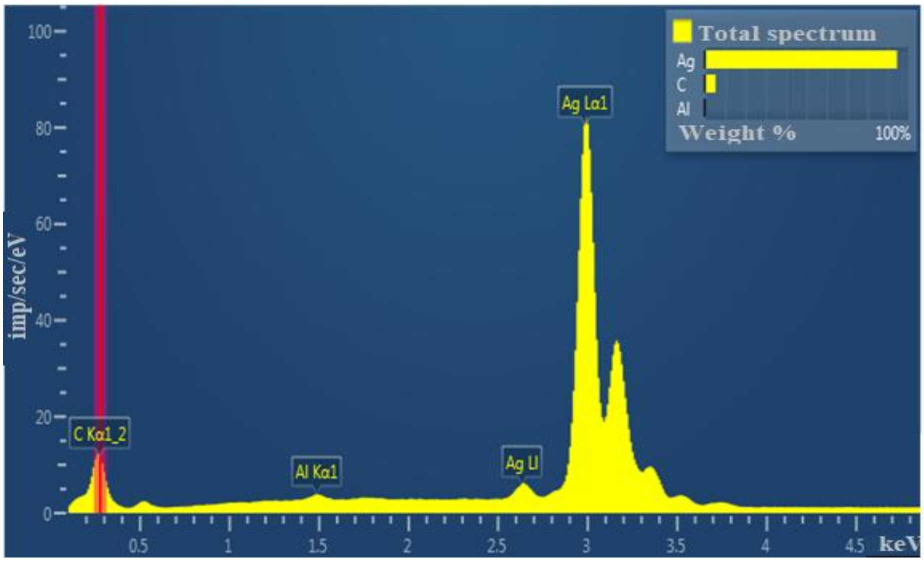

Figure 3. EDS spectrum of silver nanoparticles

Fig. 3 shows the energy-dispersive spectrum (EDS) of silver nanoparticles. As can be seen from the EDS spectrum, the nanoparticles are composed of silver particles. The signal of the aluminum element comes from the substrate used during SEM analysis, and the carbon element comes from the carbon tape applied to the substrate.

Fig. 4 shows the photoluminescence spectra of Naphthalene oil with silver nanoparticles. Photoluminescence spectra were obtained by irradiation with light of wavelength 250 nm. It was found that the maxima of PL spectra of Naphthalene oil without Ag nanoparticles were at wavelengths of 551 nm and 565 nm. It has been determined that these peaks are the luminescence peaks of Naphthalene oil. After the introduction of Ag nanoparticles into the polymer matrix intensity of the maxima at 551 nm and 565 nm wavelength decrease sharply. In contrast, two new peaks were observed at 466 nm and 492 nm in the PL spectra of naphthalene oil after the incorporation of Ag. The formation of both photoluminescence peaks belonging to silver nanoparticles is explained by the relaxation of electron motion in a surface plasmon and the recombination of sp-electrons in the d-level holes, respectively (Ramazanov *et.al.*, 2020).

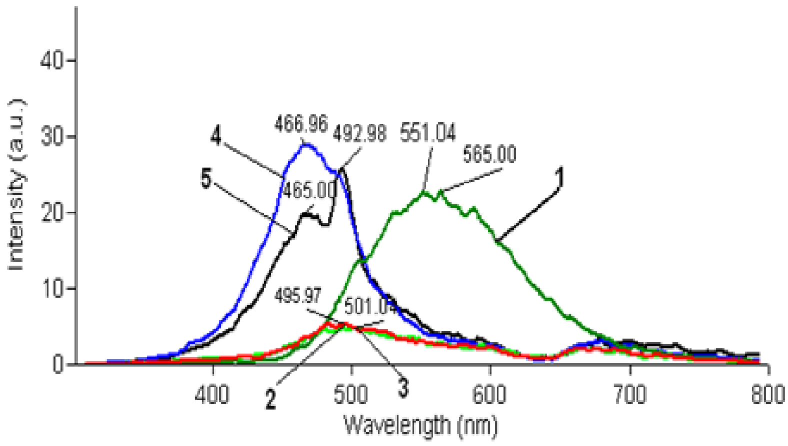

Figure 4. Photoluminescence spectra of naphthalene oil with silver nanoparticles: 1. Naphthalene oil, 2. Naphthalene+0,001M Ag, 3. Naphthalene+0,005M Ag, 4. Naphthalene+0,05 M Ag, 5. Naphthalene+0,01M Ag

Fig. 5 (a) and (b) show the emission and excitation spectra of Naphthalene oil containing silver nanoparticles. As can be seen, the excitation and emission spectra are a mirror image of each other, which indicates that these maxima are photoluminescence peaks.

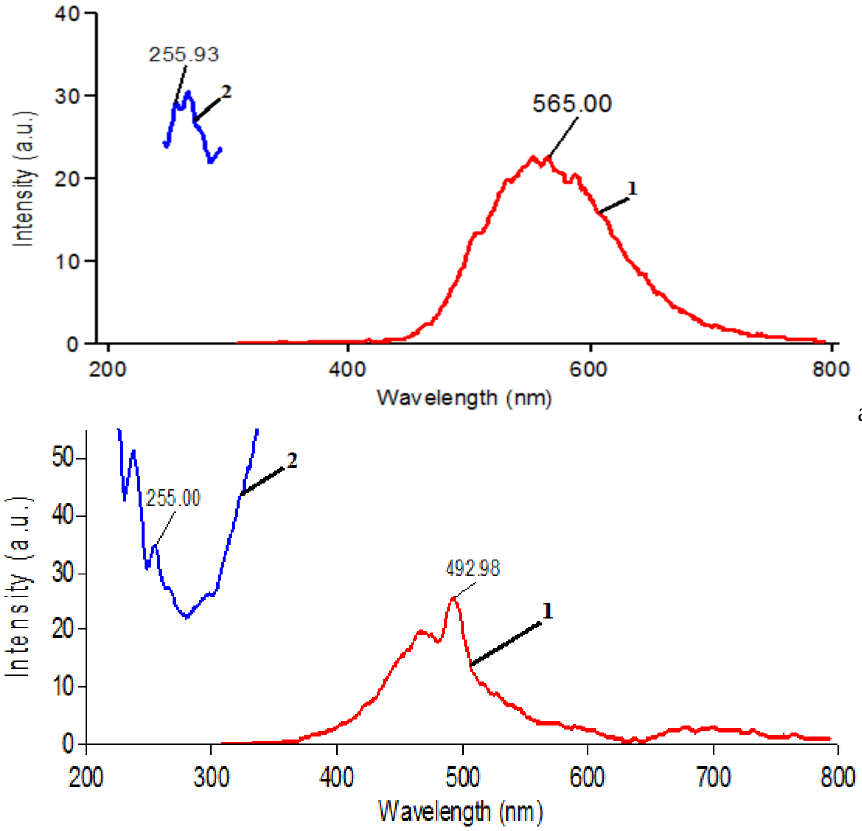

Figure 5. Excitation and excitation spectra of naphthalene oil containing silver nanoparticles: 1. emission spectra, 2. excitation spectra

Considering that Naphthalene oil contains many saturated and unsaturated hydrocarbons, including aromatic hydrocarbons, the PL properties of naphthalene oil can be explained by the presence of double bonds in these molecules-the benzene nuclei. PL spectra analysis of naphthalene oil containing metal nanoparticles shows that the introduction of nanoparticles resulted in changes in photoluminescence intensity, and the appearance of new PL peaks is explained by electron-hole recombination.

4. Conclusion

Have been synthesized and stabilized of silver nanoparticles using the chemical reduction method. The structure of the synthesized nanoparticles was studied by scanning electron microscopy (SEM) microscopy, X-Ray diffraction (XRD), and energy-dispersive analysis (EDS) methods. The optical properties of Naphthalene oil have been studied before and after the incorporation of silver nanoparticles. The PL spectra of Naphthalene oil before and after the introduction of nanoparticles were investigated. It was shown that after the introduction of nanoparticles, the intensity of the PL peaks belonging to oil decreases sharply, and new peaks belonging to nanoparticles of silver nanoparticles appear.

References

Babaev, F.R., Martynova, G.S., Maksakova, O.P. et al. (2017). Features of the oil of the Naftalan field, *Geology of Oil and Gas*, 2, 71–75.

Babaev, F.R., Martynova, G.S., Mamedova, S.G. et al. (2015). On the composition of the unique oil of the Naftalan field, *Geology, Geophysics and Development of Oil and Gas Fields*, 3, 36-42.

Gudikandula K., Maringanti, S.C. (2016). Synthesis of silver nanoparticles by chemical and biological methods and their antimicrobial properties, *Journal of Experimental Nanoscience*, *11*(9), 714-721.

Guliev, I.S., Guseinov, D.A., Martynova, G.S. et al. (2017). Research of nanodispersity of Naftalan oil, *East European Scientific Journal*, *3*(19), 90–98.

Iravani, S., Korbekandi, H., Mirmohammadi ,S.V., & Zolfaghari, B. (2014). Synthesis of silver nanoparticles: chemical, physical and biological methods, *Res Pharm Sci*., *9*(6), 385–406.

Khodashenas, B., Ghorbani, H.R. (2019). Synthesis of silver nanoparticles with different shapes *Arabian Journal of Chemistry*, *12*(8), 1823-1838.

Kisyelova, T., Novruzova, A., Hajiyeva, F.V., Ramazanov, M.A., & Chianese, A. (2016). Effect of the reactor configuration on the production of silver nanoparticles. *Chemical Engineering Transactions,* 47, 121-126.

Mamedaliev, Y.G. (1953). On the chemical composition of the active therapeutic Naftalan oil. *Izvestiya AN Azerb. SSR*, *5*(9), 14–17.

Musaev, I.A., Zaikin, V.G., Kurashova, E.Kh., Bagriy, E.I., Ermakova, L.S., & Sanin, P.I. (1982). Tricyclic saturated hydrocarbons of Naftalan oil. *Neftekhimiya*, *22* (2), 18-23.

Musayev, I.A., Ushakova, I.B., Kurashova, E.KH., Zaikin, V.G., Yermakova, L.S., Gelekh, L.S., Mekhtiyev, M.A., Gadzhiyev, G.S., & Sanin, P.I. (1980). About the chemical composition of naphthalane oil. *Neftekhimiya*, 1, 14-20.

Ramazanov, M.A., Hajiyeva, F.V., Huseynov, I.N., & Gozelova, N.A. (2020). Naphthalene oil and nanotechnology. *Journal of Low Dimensional Systems*, *4*(1), 19-23.

Salmiati, A.S., Salim, M.R., Beng, A,, Hadibaratad, T., & Nur, H. (2017). A review of silver nanoparticles: research trends, global consumption, synthesis, properties, and future challenges. *Journals of the Chinese Chemical Society*, *64* (7), 732-736.