IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 9, Issue 10 Ver. I (October. 2016), PP 06-09
www.iosrjournals.org

Silver nanoparticles: Synthesis, Characterization and their used a counter electrodes in novel Dye sensitizer solar cell

Ahmed M. Rheima[1], Dhia H. Hussain[2], Hussain I. Abdulah[3]
Department of chemistry, College of Science, University of AL-Mustansiriya

Abstract: *In this work, silver nanoparticles have been synthesized by chemical reduction method using silver nitrate with sodium borohydride. The synthesized nanoparticles characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD),scanning electron microscopy (SEM and Uv.visable spectroscopy. Results show that nanoparticles have uniform cubic shape with average size of 23 to 31 nm.The silvernanoparticles were applied a counter electrodes to fabricate novel Dye solar cellusing different phases iron oxides nanoparticles a photo anode by (ITO/ iron oxide Np$_s$/ Dye (Rhodamine 6 G) /iodine / Ag film/ ITO).*

I. Introduction

Silver nanoparticles have attracted and demand able research hofinte rest in the field of nano technology, due to its distinct properties such as catalytic activity, chemically stable, good conductivity; Surface enhanced Raman scattering and antimicrobial activity. Silver is widely used as a catalyst for the oxidation of methanol to formaldehyde and ethylene oxide. Due to colloidal nature it used as a substrate for surface enhanced spectroscopy copy, as it partly required electrical conducting surface. In this era, silver is the use as an antimicrobial agent. Chemical reduction is most commonly used for synthesis of silver nano particle. For the chemical reduction processes, some reductants are used such as borohydride, citrate, ascorbate and elemental hydrogen. By the reduction of silver ion in aqueous solution, a nano size colloidal silver particle formed. During chemical reaction various complexes with Ag^+ ions leads to formation silver particle(Ag^0),followed by the agglomeration into Oligomeric clusters, which leads to formation of colloidal silver nano particle. The first observation of nanoparticles synthesis is colour change of the aqueous solution, if a wavelength of the solution is from 380-400nm, then smaller nano particle is formed. The green synthesis of silver nano particle remainly three steps is considered: selection of solvent medium, selection of biological source related reducing agent, selection of nontoxic stabilizing agents. Acalypha indica leaves syn the sized20-30nm silver nano particle in chemical reduction method[(1-9)].

II. Experimental

All chemical were used without any purification, Silver nanoparticles have been synthesized used chemical reduction method from silver salt. A 30 ml volume of 0.01 M silver nitrate $AgNO_3$ is added drop wise (about 1 drop\ second) to 80 ml of 0.02 M sodium borohydride solution $NaBH_4$ that had been chilled in an ice-bath.The reaction mixture is stirred on a magnetic stir plate. The solution turned to light yellow after the addition of 10 mL of silver nitrate and to a dark yellow after the addition of 20 mL of silver nitrate,then turned to dark brown when all of the silver nitrate has been added. The entire addition took about three minutes, after which the stirring is stopped after 1 h.the precipitate of silver nanoparticles has been obtained [(10)].

Fabrication of a counter electrodes

Indium tin oxide, (ITO) coated class (resistant 8 ohm, transmission 83%) washed with acetone, ethanol, and distilled water several times in ultrasonic bath to remove impurities then dried using air blower.

The silver nano particles coated on the conductive side of the glass used as counter electrode, Vacuum thermal evaporation chamber is used for the deposition of silver nanoparticles electrode. A scheme of the system is shown in Fig (1). This method involves boiling or subliming a source to form a vapor and condensation of the evaporated material on the substrates. The ultimate pressure which can be obtained from this vacuum system is about (10^{-5} mbar). This can be achieved by two stages, the first stage is done by a mechanical rotary pump where the vacuum can reach 10^{-2} mbar, and the second stage is a stage that gives high vacuum by diffusion pump.

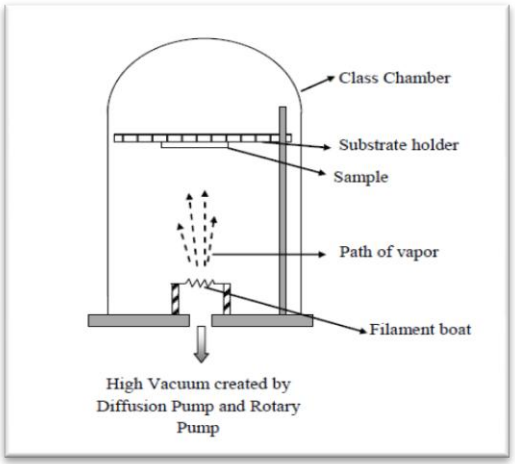

Fig. (1) The vacuum evaporation system.

The procedure for preparing electrodes as thin films could be described as follows:-
The required weight of silver nano particles was charged into Tungsten boat, and then the boat is mounted between two electrodes in the vacuum chamber. The substrates are fixed on a spherical holder and placed in position at a height of about 10 cm above the boat. When the system is pumped down to a vacuum of 2.5 x 10^{-5} mbar, an electric current is passed through the boat gradually to prevent breaking the boat. After these steps the current supply is switched off and the samples have been left in the high vacuum. After two hours the air is admitted to the chamber. Then the films have been taken out from coating unit with thickness (34 nm) and kept in the desiccators until the measurements were made.A dye-sensitized solar cell (2 X 1 x 0.1 cm) was fabricated according to the process using Sensitized different phases iron oxide nanoparticles that synthesis by novel method a photo anode[(11)].

III. Results And Discussion

The structure of the silver nanoparticleswere investigated by X-ray diffraction (Cu Kαradiation line of wavelength of 1.54 ˚A in 2θrange from 10◦to 80˚.The XRD pattern of the synthesized Ag nanoparticles is shown in fig (2) Peaks related to the (1 1 1), (2 0 0), (2 2 0) and (3 1 1) diffractions of the cubic Ag structure (JCPDS 04-0783) can be seen, indicating that the Ag particles are made of pure crystalline Ag. There are a significant amount of broadening lines which are characteristic of nanoparticles. The crystal size can be calculated according to Debye-Scherrer formula [(12)]

$$D = \frac{k\ \lambda}{\beta COS\ \theta} \qquad (1)$$

Where k=0. 9 scherrer constant, λ is the wavelength of the Cu-Kα radiations, β is the full width at half maximum and θ is the angle obtained from 2θ values corresponding to maximum intensity peak in XRD pattern. The application of Scherrer's formula to the 38.08 deg (111) reflection peak indicated the formation of nanoAg with approximately 23.6 nm in diameter.

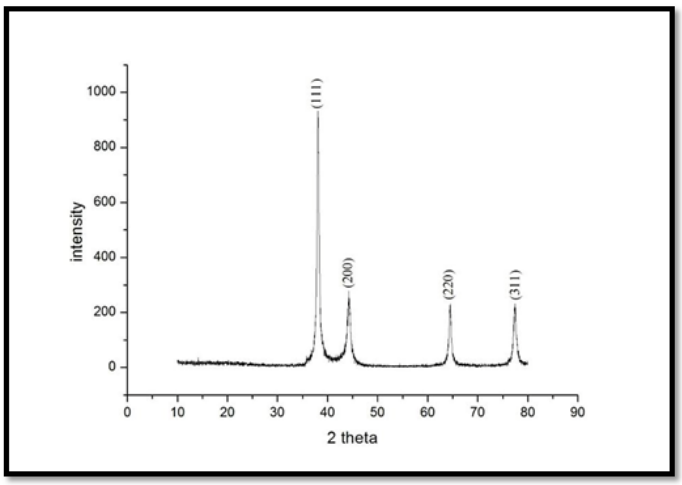

Fig. (2)XRD pattern of Ag nanoparticles

The TEM image fig (3) of AgNPs is a useful approach to determine the size of Ag nanoparticles. The mean particle size and distribution were determined randomly on the TEM image. The TEM image shown that the mean particle size of the AgNPs is about 25 nm.

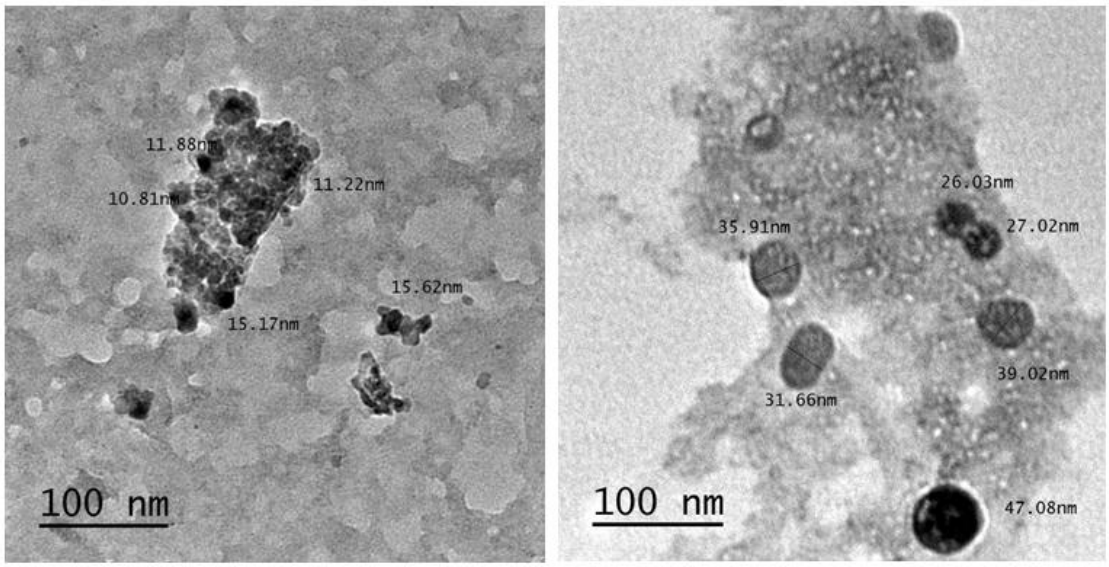

Fig (3) TEM image of Ag nanoparticles

The morphology of silver nanofilmewere determined using SEM, fig (4) shown the SEM images of samples.The surface of nano is smooth with good crystallinity. The SEM image shows that the main particle size of the Ag nanoparticles coated the glass is about 31 nm.

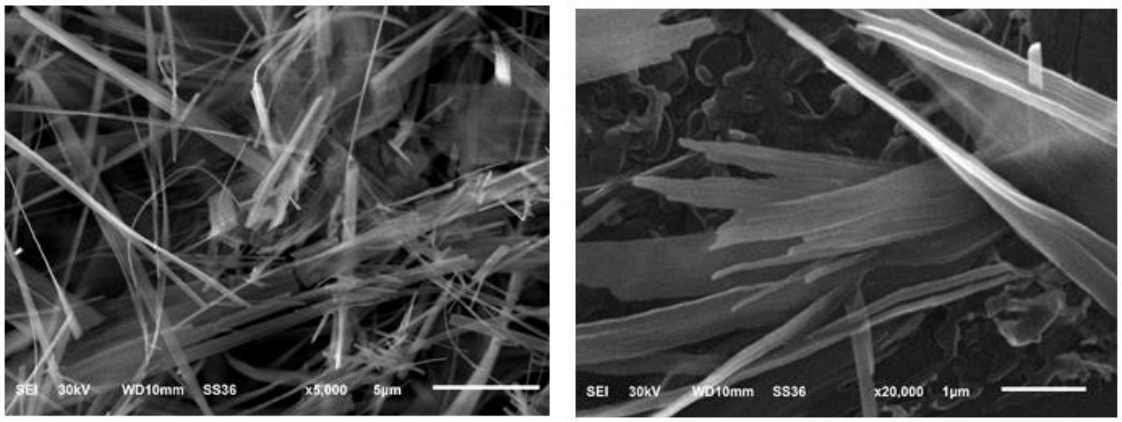

Fig (4) SEM images of Ag nanofilme coated the glass

The UV–vis spectra of silver Nano film was used to determine energy gap (Eg) by edge of absorption of Nano film. The energy gap (Eg) is determined by the formula,

$$Eg = \frac{1240}{\lambda} \qquad (3\text{-}2)$$

whereλ (nm) is the wavelength of the absorption edge in the spectrum. The energy gaps of silver nanoparticles was 3.48 ev. From these resulte we conclude that there are increasing in the band gap of the nanoparticles with the decreasing in particle size and it may be due to a quantum confinement effect [(13).]

Photovoltaic properties of dye-sensitized solar cells

Silver nanoparticles have been used a counter electrodes of DSSCs using different phases iron oxides a photo anode [(11)].

Table (1) summarizes the photovoltaic parameters of the samples.

Table (1) The parameters of dye sensitizer solar cell
(ITO/ iron oxide Nps/ Dye (Rhodamine 6 G) /iodine / Ag film/ ITO)

Photo anode	**V_{oc} (V)**	**J_{SC} ($A\backslash cm^2$)**	**V_{max} (V)**	**J_{max} ($A\backslash cm^2$)**	**P_{max} ($W\backslash cm^2$)**	**FF**	**η %**
Fe_3O_4	0.851	0.025	0.77	0.015	0.0115	0.542	11.5 %
γ-Fe_2O_3	0.699	0.014	0.59	0.007	0.0041	0.422	4.13 %
α-Fe_2O_3	0.641	0.010	0.50	0.005	0.0025	0.390	2.5 %

IV. Conclusion

1. Silver nanoparticles have been synthesis by chemical reduction method.
2. Vacuum thermal evaporation chamber is used for the deposition of silver nanoparticles electrode.
3. The systematic analysis for the evaluation the structural properties of synthesized nanoparticles was studied by XRD, SEM, TEM, and UV.visble , these techniques prove that the nanoparticles size was less than 31 nm.
4. silver nanoparticles were using a counter electrodes to fabricated solar cell: (ITO/ iron oxide Np_s/ Dye (Rhodamine 6 G) /iodine / Ag film/ ITO)

References

[1]. T.M. Tolaymat, A.M. El-Badawy, A. Genaidy, K.G. Luxton, T.P. Suidan; J. Sci Total Environ, No.408, pp: 999–1006, (2010).
[2]. S.T. Pimpan; J. Mater Lett, No.62, p: 2661, (2008).
[3]. M. Schrand, L.K. Schlager, J.J. Dai; J. Nanotechnology, No.19, pp: 104-235, (2008).
[4]. T. Klaus-Joerger, R. Joerger, E. Olsson, C.-G. Granqvist; J. TRENDS in Biotechnology, No.19, pp: 15-20, (2001).
[5]. G.B. Sergeev; J. Nanochemistry, Elsevier Science, 2006.
[6]. A.P. Alivisatos; J. Physical Chemistry, No.100 pp: 13226-13239, (1996).
[7]. G.B. Sergeev, T.I. Shabatina; J. Physicochemical and Engineering Aspects, No.313, pp: 18-22, (2008).
[8]. R. Jin, Y.W. Cao, C.A. Mirkin, K. Kelly, G.C. Schatz, J. Zheng; J. Science, No.294, p: 1901, (2001).
[9]. L.A. Peyser, A.E. Vinson, A.P. Bartko, R.M. Dickson; J. Science, No.291, pp: 103-106, (2001).
[10]. S. D. Solomon, M. Bahadory, A. V. Jeyarajasingam, S. A. Rutkowsky and C. Boritz; Journal of Chemical Education, Vol. 84, No. 2, p: 322, (2007).
[11]. A. M. Rheima, Dissertation of PhD in physical chemistry, college of science, al mustansiriyah university, 2016.
[12]. M. A. ahmad , A. Rahdar, F. Sadeghfar, S. Bagheri, M. R. Hajinezhad; Nanomed Res J, Vol. 1, No.1, pp: 39-46,(2016).
[13]. M. Geetha, K. Suguna, P. M. Anbarasan, and V. Aroulmoji; International Journal of Advanced Science and Engineering Vol. 1, No. 1, p: 1-5, (2014).