Production of Silver Nanowires From Silver Nanoparticles by Thermal Treatment

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ABSTRACT

Silver nanowires (Ag NWs) have been attracted much attention in recent years .view of the extensive its use in various fields. Ag NWs were successfully prepared by two steps firstly electrochemical method and heating secondly silver nanoparticles colloidal solution at different temperature. The optical results show that the position of the plasmon absorption peak depends on the particle size and shape and the adsorption of surfactant to the particle surface. It was noticed that the plasmon absorption peak shifts toward shorter wavelengths (blue shift) as increased temperature.SEM result appeared that silver nanoparticles transformed to Silver nanowires by heating. XRD results explained that the intensity of peak at 64.46° was increased as heating increase much higher at 38.18° which indicted wire growth . The results zeta potential showed that all samples preparation shown across all the zeta potential tests were negative .

Keywords: Silver nanoparticles; Silver nanowires (Ag NEWs), zeta potential.

INTRODUCTION

Silver nanoparticles (Ag NPs) have been extensively studied due to their surface enhanced properties with fascinating structures and unique electrical, chemical, optical and antimicrobial properties. [1] The first instance of applications of silver nanoparticles (Ag NPs) dates back to 1857 when they were used to give a permanent, non-fading yellow and red color to church windows in Britain. Science than a large number of fields have been identified where silver NPs play significant role. These NPs are used to control infections & spoilages, due to their well-known anti-bacterial, anti-fungal, anti-biotic properties and high toxicity for microbes. They are also used in microbial delivery vehicles targeting pest insects. [2]

Silver nanoparticles have been prepared by a variety of methods, such as chemical reduction laser irradiation Greensynthesis, and electrochemical. [3] because of one the extremely main one-dimensional nanostructures,metal nanowires own attracted a big quantity of benefit in exploration modern years because they had electronic and optical properties and potential applications in nano devices.[4]In this research ,we will have report about production silver by electrochemical method to product of nanoparticle and then convert to nanowire with a very fine diameter of 30 nm by heating liquid of nanoparticles at different temperature.

Experimental work

Silver preparation process consists of two parts the two principal :-

First part Synthesis of silver dioxide nanoparticles

The electrochemical method involved of electrochemical cell 400 ml filled with distilled water, two electrode of silver vertically placed face to face with small distance apart ,and

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applying 25 volt on the electrode and changing the polarity of the direct current every 4 minute , and heat the distilled water in range 50 °C. The synthesis of silver dioxide nanoparticles was done by electrochemical method for narrow volume distributed mineral nanoparticles. In the total procedure the bulk mineral is oxidized at the anode, the metal cations bailup to the cathode and decrease happen with forming of mineral or mineral oxide in the zero oxidation state.As shown in Figure(1) in the first experiment we have utilized a silver mineral slab (1 • 1 cm) as anode and a silver slab (1 • 1 cm) as the cathode. where electrodes were on distance 1 cm as apart . silver dioxide nanoparticles were found to be light yellow in color.

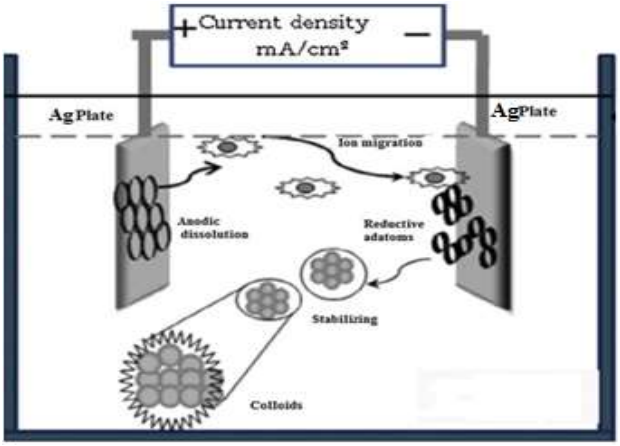


Figure (1) Diagram representing the synthesis process of silver nanoparticles

Second part convert silver dioxide nanoparticles to nanowire

After preparation silver nanoparticles colloidal solution with light yellow in color heating with different temperature from (100 -150) °C and stirring for one hour for each sample following the color change from light yellow color to brown .

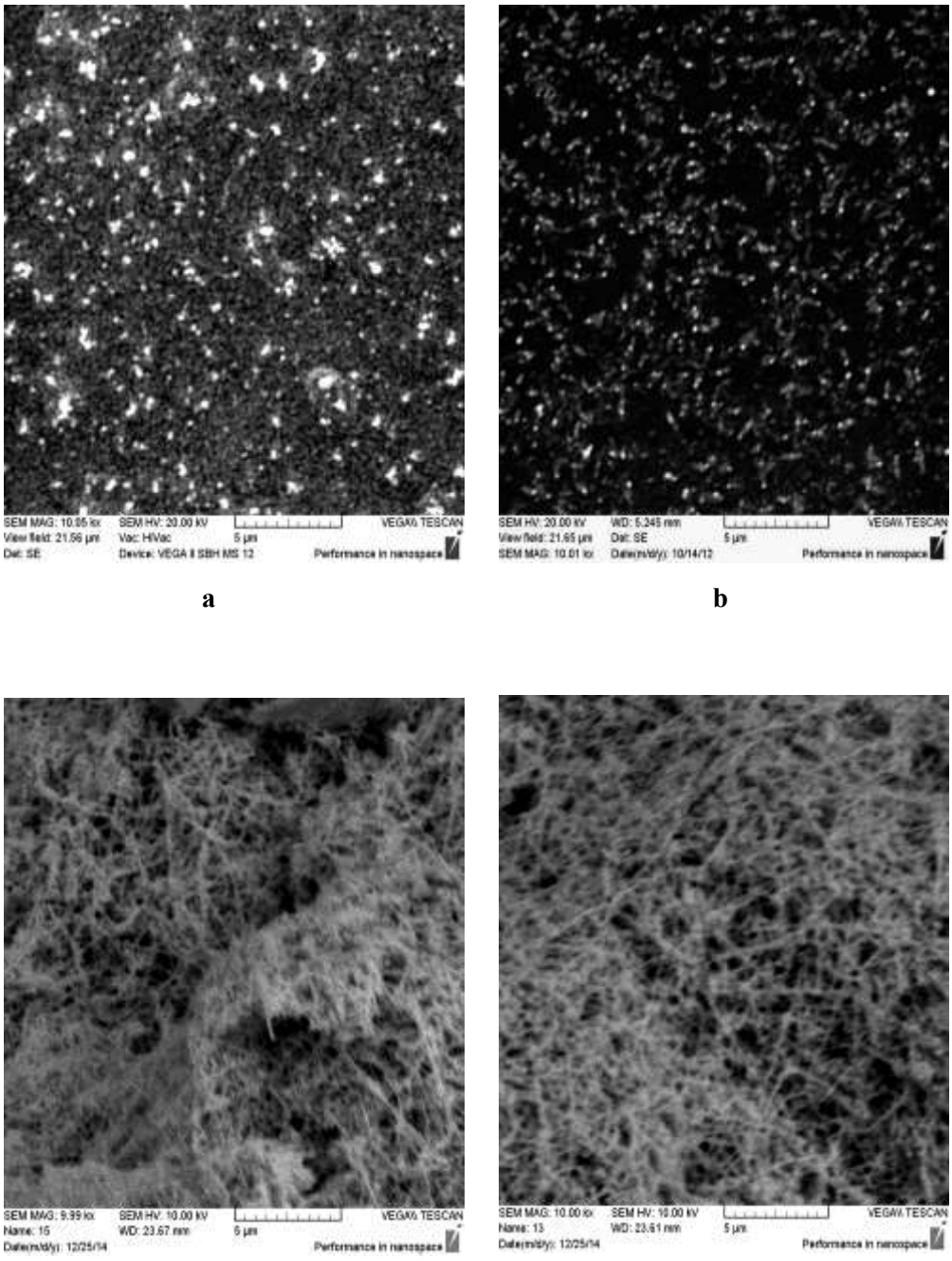
Characterization techniques

The crystalline structure of the silver has been determined by using X-ray diffraction (Philips PW 1050 X-ray diffract meter of 1.5°A from Cu-Kα. Additionally. The surface morphology of thin films was examined using Scanning Electron Microscopy (SEM ,the VEGA easy probe).The optical properties was examined using Optical absorption spectra of all the films were recorded using a UV-VIS spectrophotometer (Perkin Elemer Company). (Zeta Potential Analyzer Ver.572,Brookn Instruments corp.) of Ag NPs and NWs according to the Smoluchowski equation. Measurements were conducted for 5 min at room temperature (25 °C).

Results and Discussion

Figure (2.a) shows the morphology of sample before heating this sample was mostly composed of spherical nanoparticles with average size as seen from the scale of the photograph of SEM is approximately 100 nm Ag nano particle aqueous solution was heating from (100-150°C) and stirring, the shape of particle change from spherical nanoparticles to nanowire.when heating at 100 ° C shows the morphology of sample of the small spherical silver nanoparticles formed in the first step were converted to larger silver particles of various shapes as shown in Figure(2. b)when increasing heating temperature of sample in 125 °C and 150 °C, the small particles have grown into nanowire with symmetrical diameter scuttle in the domain of 60 to 40 nm and long tallness of up to 5-10 μm, as exhibit in Fig. (2c,d).In this step , the diameter of the silver NPs and the silver nanowires as highly trusted on temperature, as exhibit in Fig 2. These

outcome confirm that there is a relationship among the volumes of particle and an aggregate of molecules in a colloidal solution, so as to get precise and extra regular nanostructures. These results is in agreement with the work of M. H. Chang et al. [5]



a **b**

c **d**

Figure(2 (a)) image of SEM for silver nano particle prepared by electrochemical method in first step (b) Ag synthesized using temperature 100° C (c) Ag synthesized using temperature 125° C (d) Ag synthesized using temperature 150° C

figure (3) All of characteristic peaks for silver (2θ = 38.2°, 44.4°,64.46°, 77.5° and 81.6°), corresponding to Miller indices (111), (200), (220), (311) and (222), are observed. It is surely that the sharpness of peak at 64.46° was increased as heating increase for samples (b,c,d) much higher at 38.18° (111), as compare with sample (a) which means that our Ag NWs have preferred (220) orientation. In truth , for silver , the nearby packed (111) face own the minimum energy, pursue by the (200) and(311) faces for minimum over potentials, it is famous that the (111) face is distinguish due to its lower in surface energy for the thermodynamic reason. At this do the impact of contest among the adsorption and desorption of H ions at the border development surfaces of mineral NWs have to be possessed into account higher over potentials kinetically support the forming of (220) and the H adsorption stabilizes the process [6] Then, variation of the up potential induced the thermodynamic to kinetic transition and prefered the (220) face at little higher over potentials, steadied by means of the H ion adsorption, it leads to the preferred (220) orientation noted in the mineral crystallographic silver NWs [4].

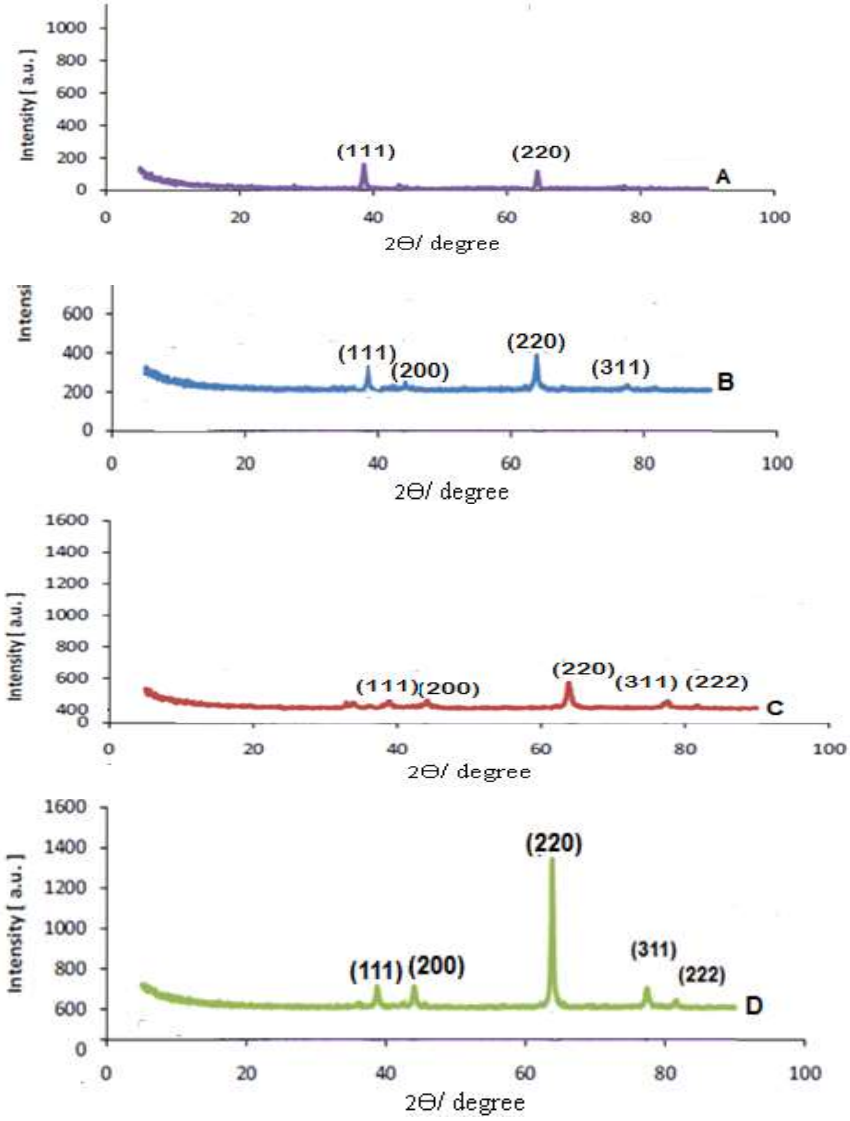


Figure (3). XRD pattern of silver at same conditions.

Figure (4) shows UV-VIS spectroscopy have been used for testing the selfsame samples .In general, to explain of affecting shape and color of aqueous solution silver nanoparticles and nanowires on the absorption and scattering of light, In such job, the development operation of silver nanostructures was as well examined by looking on the surface plasmon resonance (SPR) spectra. so as to observe the development of the nanoparticles and nanowires .Surface Plasmon Resonance (SPR) has been watched at each stages of the assembly . It has been fully attested that nano sized metals, mostly silver nanostructures, offer a large field of optical phenomena immediately linked to surface Plasmon resonance, relying on the geometry and volume of the mineral particles for supporting the one dimensional outgrowth of the silver NPs[7,8]At the first stages for sample (a) the surface Plasmon resonance band of the Ag NPs with a volume the extent of 100 -125 nm showed a wavelength of 421 nm and with light yellow Color of aqueous solution silver Fig(4.a) After heating100^{o}C Figure (3.b), an absorption band offered at 418 nm with light cupreous Color of aqueous solution silver. Figure 3(c,d), the SPR absorption band clearly changed to the special two peaks at 366 and 372 nm, which have been NWs forming with dark cupreous and brown color of aqueous solution silver as showing in table 1 It is important to note that these two surface Plasmon resonance peaks occur at significantly shorten wavelengths compare with the SPR peaks (421 and 418 nm) of the before prepared NWs with diameters among 40 and 60 nm .because, the red shift originating from a increasing in NWsdiameter is also related to the rising of scattered light. narrowing peak width was observed upon decreasing the NWs diameter(blue shift) due to decrease NWs diameter .since heating of samples had from an very important factors in this process supporting the one dimensional growth of the silver nanoparticles.[9,10]

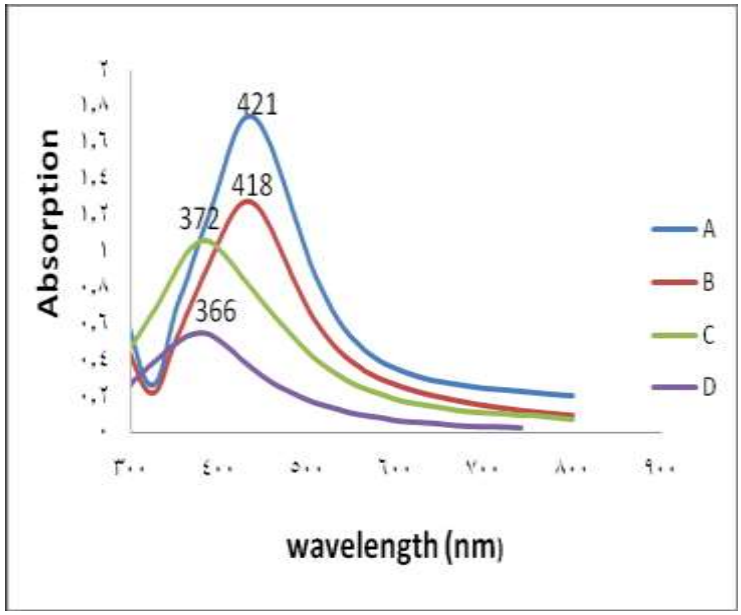


Figure (4) UV-VIS spectroscopy for sample preparation

Figure (5) shows zeta potential tests were employed for analyzing the same samples production were noted across all zeta potential experiment were negative . when shape and color of the samples preparation changed this led to increase zeta value where zeta potential different behavior of particles in aqueous medium indicated that their surface charge density vary from each other are presented in figure(a,bc,d) . To assure the well dispersed and electrostatically

stable dispersion of particles, the strong repulsive forces have to be generated on their surfaces where the general energy as a role of separation distance is the sum of a tall range electrostatic repulsive contribution, and a short range attractive contribution because Van der Waals interactions [11,12].Large zeta potentials of such mark maximize the electrostatic repulsive force and thus decrease accumulation the table(1) explain relation among zeta value and size of particle . in SEM and color colloidal solutions of silver.

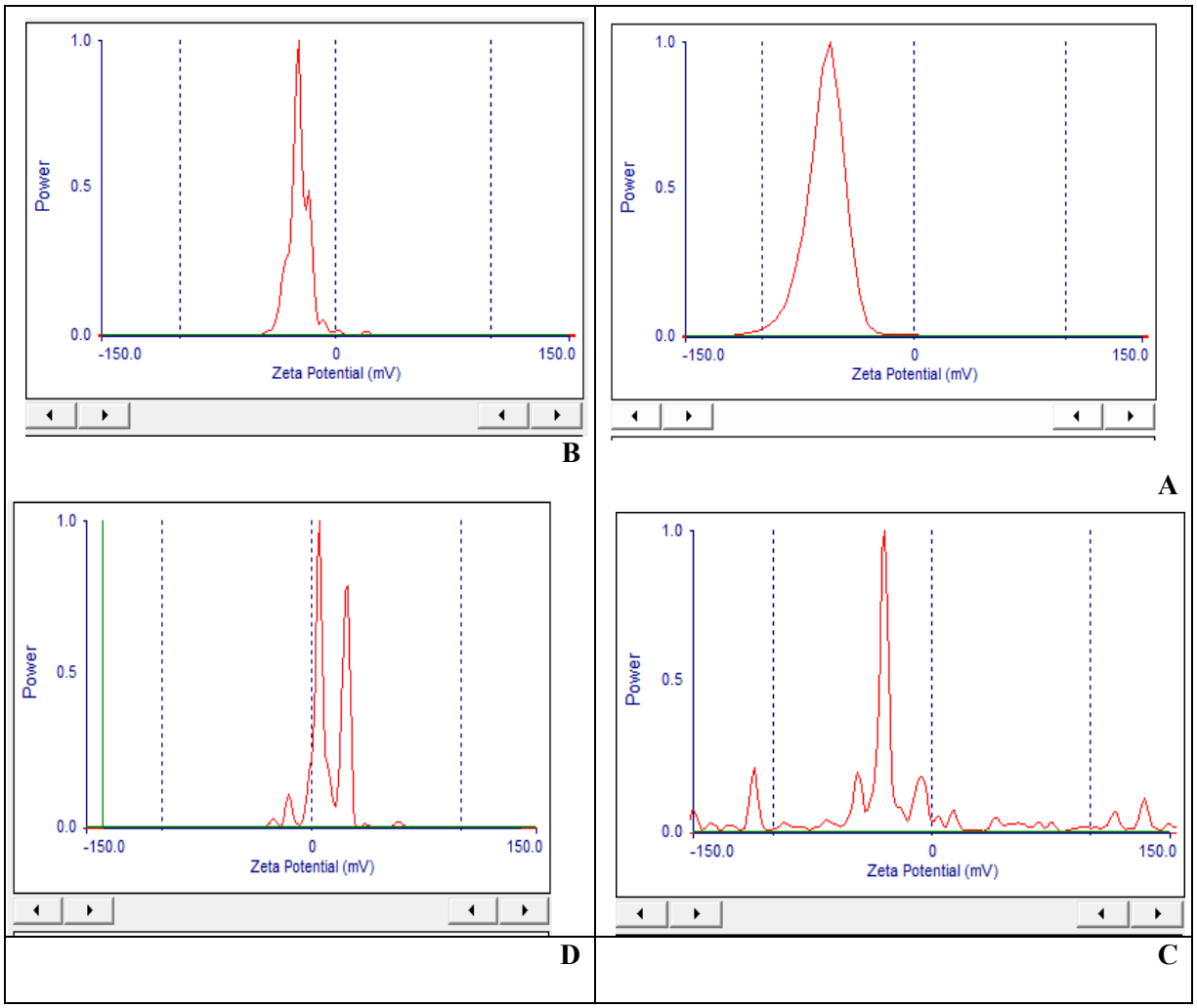


Figure (5) zeta potential analysis for same condition

Table 1: show the relationship Average size and zeta potential with color of aqueous solution

Sample	Zeta potential (mV)	Average size (nm) in SEM	Color of aqueous solution
A	-24.11	100 -150	
B	-25.59	80 -90	
C	-29.32	50 -60	
D	-39.04	30-40	

CONCLUSION

The present proceeding explain that silver nano wire able to make heating silver nanoparticle suspension liquid all results of structure (XRD) and morphological (SEM) transformation Ag NPs to Ag NWs. Ag silver nano wire able to be grown to very fine about 30 nm with length of almost 5-10 μm with thermal treatment . Additionally, absorbance spectra of silver nano wire was spotted at 372 nm , which is the guide of the growth of nanowire and also, silver nano wire were specified to owning negative zeta potential.

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