وقائع المؤتمر العلمي الثالث لكلية العلوم جامعة ديالى ٦-٢٠١٢/٥/٧

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Preparation of Nano Colloidal Silver with Three Physical Technique and Studying Their Physical Properties

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Abstract

Silver is powerful natural antibiotic noble metal has been used for thousands of years with no harmful side effect since have being observed , Today colloidal silver is rapidly gaining favor in the medical community and water treatment reflecting a kind of revival in the public health community sector . In this research three technique and the most efficient one was the arc discharge technique ,we design colloidal silver (CS) generator using two rods of silver connectedly to pulsed DC high power supply to get arc discharge caused evaporate silver rods which immersed in water . Later, we made improvement on this design by using DC . Power supply with high purity silver. Rods arranged in certain arrangement then we get many silver water samples according to different parameters. In order to determined physical properties of (CS) solutions, AFM, UV. Visible spectrometry, AAS, and electrical conductivity were applied to each samples. The results show (CS) generator(method B) is effective tool to get narrow range nano- colloidal silver water suspension with size distribution (40 – 560) nm , color of each solution is characterized to particle size silver particle – ionic solution . The electrical conductivity of sample depended on the ionic – particle silver concentrations (10-32) p .p. m

Keywords: Nano Colloidal Silver, Electro polishing Technique, Dc arc-discharge Technique, Electrolysis technique, Electrical conductivity, Size Distribution, optical properties.

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تحضير عالق الفضة النانومتري بثلاث تقنيات فيزياوية ودراسة خصائصه الفيزياوية

الخلاصة:

الفضة هي مادة مضادة بكتيرية حيوية طبيعية استخدمت منذ مئات السنين في عمليات حفظ السوائل لخلوها من الاعراض الجانبية عند الاستخدام. يستخدم عالق الفضة الفضة بشكل واسع وباهتمام كبير في المجال الصحي وتنقية المياه ومجالات الاستخدام البشري الصحي. في هذا البحث قمنا بتحضير عالق الفضة النانومتري بثلاث طرق فيزياوية وكانت اكفا طريقة هي تقنية التفريغ الكهربائي بين قطبي فضة مغمورين بالماء ومربوطين بمجهر عالي القدرة مستمر ونبضي . تم الحصول على محاليل لعالق الفضة المائي بالوان متعددة تبعا لتغير عوامل التحضير وبهدف دراسة الخصائص الفيزيائية لعالق الفضة المحضر استخدمت التقنيات

(AFM, OM, AAS, UV-visible and electrical conductivity, spectra photometry)

اضهرت النتائج ان عالق الفضة المحضر بتقنية التفريغ الكهربائي ذات كفاءة جيدة للحصول على عالق فضة بحبيبات ذات توزيع حجم حبيبي (٤٠-٥٦٠)نانومتر. يعزى تغير الخصائص البصرية واللونية تبعا لتغير الحجم الحبيبي للفضة وتركيز الايونات.كما ان التوصيلية الكهربائية لعالق الفضة النانومتري يعتمد على تركيز ايونات- حبيبات في حدود(١٠-٣٢)ppm

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Introduction

Colloidal silver (CS) is an natural antibiotic which has been used through out the world for centuries as means to destroy microbes for all kinds and to correct many health problems [1,2] .The use of colloidal silver is spreading rapidly throughout the medical community in the healing of burn victims . Silver acts as second immune system for all humans by destroying bacteria and viruses of all kinds. It is toxic to *bacteria* , *viruses* , *yeasts* , *fungi (molds)*, *protozoa* and parasites in the egg stage[3,4] . (CS) will destroy *Staph* and *Strep* bacteria which are so common in health problems. Silver does not attack bacteria directly , but rather decomposes certain enzymes the an aerobic bacteria viruses , *yeast* ,and *molds* required the silver acts as a catalyst and is not consumed in the process . It is probable that this indirect action is also the reason bacteria can not develop a resistance to silver, as they do to is antibiotic[5,6] .(CS) are extremely minute silver particles suspend with particle size at rang (4-650nm) in water, with positive electric charge . The smaller the particles, the more effective (CS) has proven to be .The best colloid silver is produced at a molecular level.

This paper describes three physical technique of water silver suspension; first method by electro polishing method, arc-discharge method [4] and electrolysis method. Chemical methods for nano metal, particles, require the use of stabilizer to protect the Ag nano – colloiadal particles against agglomeration. Additionally, the chemical methods are usually expensive and potentially dangerous for the environment [5].

In the aec discharge technique of colloidal silver (CS)formation where the Dc voltage between silver electrodes in pure water is a good technique , and is not only cheap process , but also environmentally friendly . During arc discharge, the temperature between the Ag electrodes can reach several thousand [6] and the Ag rods etched in water medium. In method (C) , the electrical potential between the Ag electrodes induced Ag positive particles , to suspended in electrolyte medium (water) in smooth , safe, and cheap way . Ag narrow rang nano-size colloidal in water seem to be thermodynamically stable for long time (especially if kept in cold and dark place).

2. Experimental

2.1 Materials

Silver wires (99.99) purity , 1-1.5 mm in diameter , distilled water (PH 5.1), DC pulsar power supply, magnetic stirrer.

2.2 METHODS OF PREPAIRING colloidal silver (CS)

2.2 .1 A : Electro polishing Technique

First method we start with the idea of electro polishing Ag wire using electro solution as recorded in handbook of materials [7]. Ag wire used as a node surrounded by Al foil as a

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cathode immersed in polishing solution (200ml H_2O, 300ml C_2h_sOH, 400ml H_3PO_4) as shown in fig (1). Dc power supply applied potential difference in arrange (0.2 - 10)V for 1hr . Five samples prepared characterized white to grey [colo[8,9]r]. The (CS) produced in this method show high adhesion degree related to phosphorus acid, so we made chemical - physical separation process to separate (CS) from phosphoric compounds.

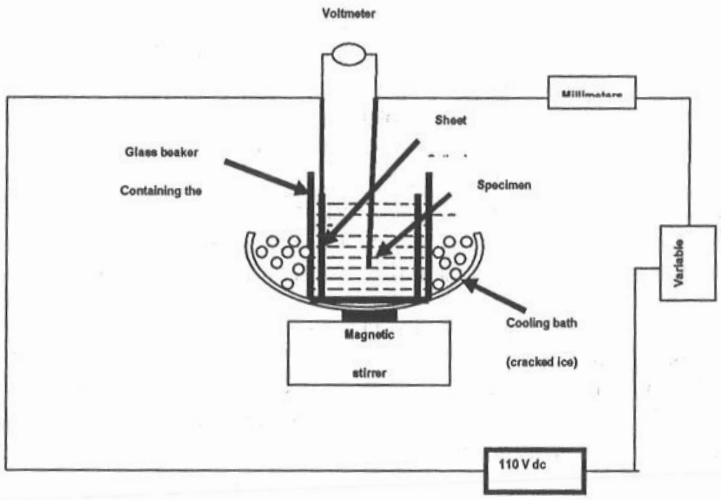

Figure (1): Ag electropolishing system

2.2.B : Arc-discharge Technique:

The Dc arc-discharge system in Fig(2) consist of DC pulser power supply provides a pulse voltage of (70 - 100) V for 2 ms and (20 -40) V around 10 μs . The electrical current could reach during that moment (4-10 A) where the etching current caused arc-discharge pulse etched Ag wires (anode and cathode) as in figure (3). Ag wire evaporated and condensed in water. Servo control system keep the gap between the Ag electrodes in few microns . Other parameters should be control during this technique such as the speed of stirring - time of process, water volume, distance of the gap , arc-discharge current and other parameters . The transparent solution converts to characteristic pale yellow color[10] .

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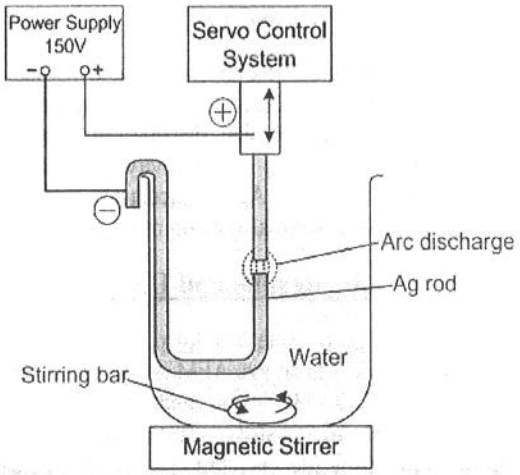
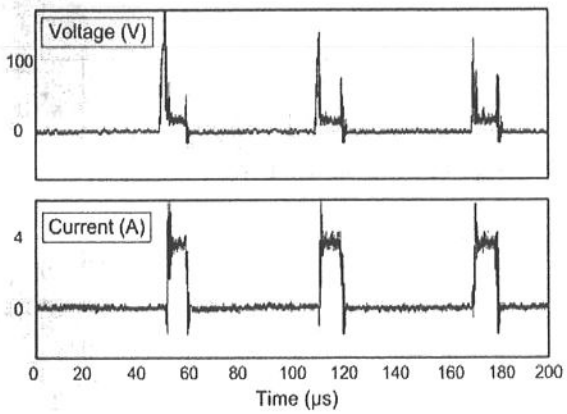


Figure(2): The arc-discharge system fornano-colloidal Ag suspension.



Figure(3): Current-Voltage pulse during arc-discharge duration.

2.2. C : Electrolysis technique

By using Dc power supply (30 V) and two Ag high purity rodes immersed in distilled water. We get (CS) simply, cheaply, clean and faster than other methods.We prepared samples in different applied voltage (10 - 30 V) for hr. and samples in same voltage with a different time (20 min - 1 hr). The transparent solution characterized with different degree of white-yellow color[11].

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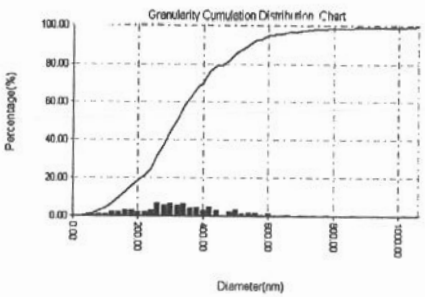
2.3 Characterization Of Ag nano colloidal (CS) :

The Ag colloid solutions were examined optically using UV-Visible spectrophotometer (type shamedzo 20), and by using ultrasonic thermal spray paralysis technique .Silver solutions were sprayed on glass substrates for size distribution determination by AFM(Angstrom dvanced-typeAA3000)) and Electrical conductivity measured by using (COM 83 – Radiometer Copenhagen), PH , Ag concentration determined by AAS (AA Spectrophotometer phoenix -986) were also examined for each sample[12,13].

3. Results and Discussion

Fig (4) shows the AFM image of spherical Ag particles (method A) with size distribution about (40-500) nm while Fig (5) shows AFM image of spherical Ag particles (method B) with size distribution about (120 - 360) nm and Figure (6) AFM image of Ag particles (method C first group) with size distribution (100-650) nm . Figure (7) show surface morphology of Ag thin films using thermal spray parolysis on glass substrate.



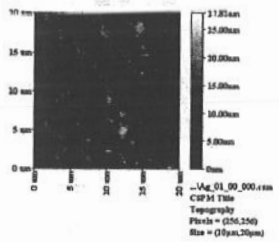
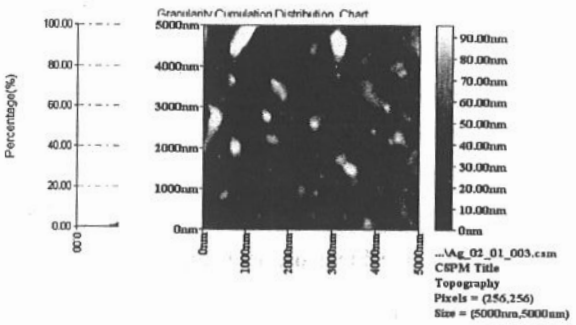


Fig (4) : AFM image of CS by method A.



Fig(5) : AFM image of CS by method B.

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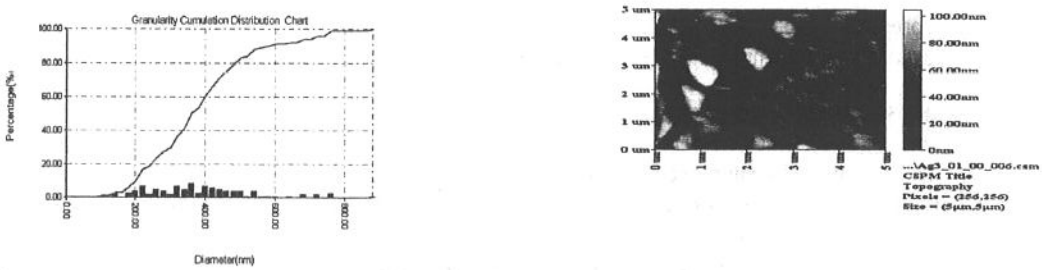

Fig(6) :AFM image of CS by method C.

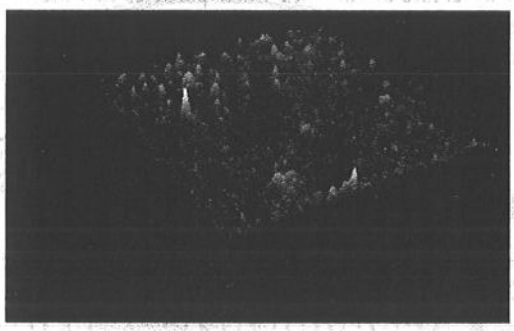

Fig.(7): The 3D. image of Ag nano-colloidal suspension spread on glass substrate.

Table(1): Characterization of CS samples prepared by method C.

Sample code	Concentration p. p. m	PH	Electrical conductivity µs
1	4.3	5.81	2.99
2	10	6.64	3.07
3	22.1	6.73	3.35
4	22.8	6.82	4.85
5	32.2	7.18	9.97
6	34.6	10.05	28.10

One of the observation, was the effects of light and temperature on colloidal silver where the agglomeration process detected by UV analysis and color appearance; so we concentrate on

right preparation parameters and storage conditions of silver samples. Table 1 show the variation of Ag concentration with ph and electrical conductivity for applying 30V[14,15].

During silver nano particles production by(B,C) method , water decomposition (e.g electrolysis) was observed. This result in generation of gaseous hydrogen and oxygen, which appear in the water medium. Hydrogen and oxygen start to interact with newly prepared silver nano particles. Since Hydrogen (molecular or atomic forms) does not adsorb on silver particle surface (method B, C) at room temperature[15] , and also is not signefficiently dissolved in water. It is ultimately removed from water suspension to gas phase while oxygen (especially atomic) could adsorb and react with silver surface at room temperature[16], Ag cluster could easily create bonds with water particles in water environment (method B, C) . Finally negatively or positively charged Ag narrow rang nano particles can be create in water as shown in the model figure(8)[17].

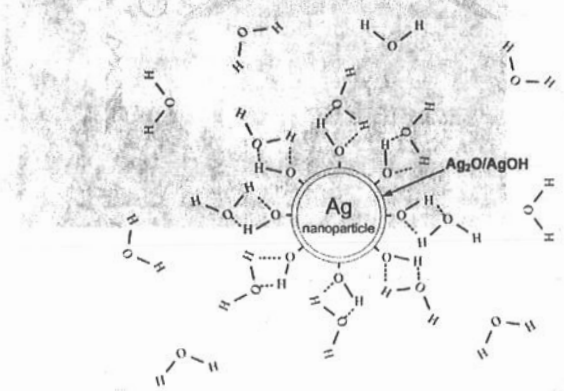

Fig.(8):model scheme of charged Ag particles suspended in water.

Figure (9) shows typical UV-visible absorption spectra for the silver colloid suspension and this results show maximum absorbance in some band of spectra at rang abut 420nm according to method A [18,19].

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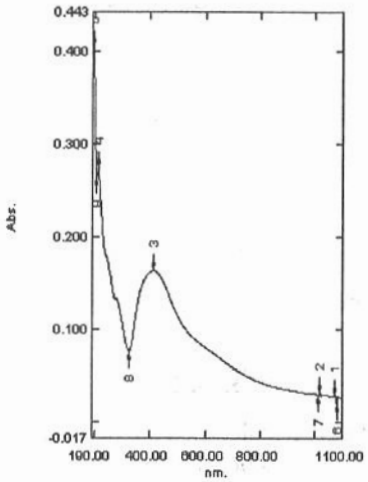

Figure (9) UV-vis of colloidal silver suspension

The Ag nano narrow range particles (CS) due to hydrogen bonding were suspended in water without any stabilizers or surfactants . Positively charged particles (method C) Ag nano particles surrounded by water molecules having (4-34.6) ppm and electrical conductivity about (2.99-28.1) µs with PH (5.81-10.05).Ag (CS) (method B) could be heated to l00c° without affecting its structures[20,21] . The DC method (B,C) based on pure components, e,g metal rods and deionizer water , seems to be promising alternative for metal noble metal such as nano gold and nano titanium since the high surface - area to volume ratio of nano particles can create their unique physical chemical, mechanical, and quantum size effected proprieties [22] . That lead to their potential application such as catalysis for plants , animals and human [23,24] . Silver is well known bacterstatic and poisonous agent for different bacteria and viruses, no side effect were observed when using drugs, diet, based on metallic nano-silver in clinical trials .Toxic effect of silver substances are proportional to the rate of release of free silver ions Ag from them.According to (WHO) Ag ions are too low to lead to toxicity to environemental and human [25].

The (CS) could be followed by filtration process and centrifugation technique many times in different ways to get dominate nano size particles with low cost cl

ean environmental process .

4. Conclusions

1- The current DC method in pure water to prepare (CS) has been successfully developed for narrow range nano particles Ag production.

2- The present work prepares low cost effective scientific route to form nano silver powders by controlling (I,V,T, and Ph,)parameters .

3-Silver nano particles are formed in water has characteristic x-ray diffraction peak at plane (111 and 200).

4- Colloidal silver solution has characteristic UV-vis spectrometry with UV band at resonance peak about 420nm.

5- According to AFM and OM ; silver particle solution has semi spherical shape with size distribution 40-560 nm.

6- The silver nano particles less than 50 nm could be obtained using arc discharge technique followed by filtration and centrifugation process.

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