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Investigate and Prepare silver Nano Particles Using Jet Plasma

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Abstract

Nano- particles (Ag NPs) are synthesized by using plasma Jet argon gas. The prepared Ag NPs are characterized by Atomic Absorption Spectroscopy (AAS) The measure was performed for different time exposuring 15,30,45 and 60 sec. The results shows the low concentration of nano-silver time expose (15 sec) and very) and high concentration at 60 sec. The UV-VIS spectrometer for nano-silver different time exsposuring to plasma, shows the Surface Plasmon Resonance (SPR) appeared around 419 nm, and the energy gab is 4.1 eV for the 15 second exposure and 1.6eV for 60 second exposure. The Scanning Probe Microscope (SPM) is used to identify the characterization of silver nanoparticles, the average diameter of nano-silver for 15 second exposure is equal to 69.00 nm, for 60 second exposure the average is equal to 54.87 nm

Keywords: Silver nanoparticles, plasma Jet , UV-VIS spectrometer, Energy gab, Scanning Probe Microscope

تقصي وتحضير جسيمات الفضة النانوية باستخدام البلازما النفاثة

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الخلاصة

تم تحضيرالفضة النانويه باستخدام غاز الأركون بالبلازما النفاثه. الفضه النانويه المحضره تم دراسة خصائصها بمطيافية الامتصاص الذري (AAS) تم اخذت القياسات لتراكيز الفضه النانويه عند التعرض لازمان مختلفه (15 ، 30 ، 45 ، 60). ثانية تظهر النتائج تراكيز منخفضه عند 15 ثانية وتراكيز عاليا عند 60 ثانية. يُظهر مطياف UV-VIS للفضة النانوية التي تعرضت لاوقات مختلفًه للبلازما ، ظهور رنين البلازمون السطحي (SPR) حوال 419 (نانومتر) ، وفجوة الطاقة هي 4.1 الكترون فولت عند التعريض لمدة 15 ثانية و 1.6الكترون فولت عند التعرض لمدة 60 ثانية. يستخدم مجهر مسبار المسح (SPM) لتحديد خصائص الجسيمات النانوية الفضية ، وقد وجد ان متوسط قطر الفضة النانوية عند زمن التعرض 15 ثانية

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من التعرض يساوي69.00 نانومتر ، أما بالنسبة للتعريض لمدة 60 ثانية ، فإن المتوسط القطريساوي 54.87 نانومتر.

1. Introduction

Nanotechnology is a evolving science that involves the development and application of nano-sized particles with dimensions measured in nanometers. Because of its inherent antibacterial and antifungal properties, silver has been used to treat medical conditions for over a century. Recent advances in material synthesis provide a number of physical and chemical methods that have greatly affected the nanotechnology industry. In several opportunities, such as synthesis of nano particles of variable shapes and uniform distribution of particle size, these strategies are essential [1]. Gold and silver metal are precious metals that have been used in medical applications by people for thousands of years, since they are recognized without rejection by the body. Nontoxic and safe [2].

Nanotechnology is predominantly concerned with the synthesis of metal nano particles and their use in numerous fields of study, including chemistry, physics, materials science, and engineering. Metal nano particles such as gold (Au) and silver (Ag) have become important in chemistry, physics, and biology due to their peculiar optical, electrical, and photo thermal properties. Nano particles are usually created by a variety of non-environmentally sustainable physical and chemical processes. Researchers in nanotechnology have discovered that research into the production of metal nano particles has expanded in recent years owing to future applications in the development of emerging technologies [3][4][5]. The search aim to prepare Nano- particles (Ag NPs) which are synthesized by using plasma Jet argon gas.

Metallic Nano particles

Nano-sized metals with dimensions (length, width, thickness) within the size range of 1-100 nm are metallic Nano particles. With different chemical functional groups, these Nano materials can be manufactured and modified, allowing them to attach with antibodies, ligands and drugs. Metal nano particles have a broad range of applications in the field of therapy, biotechnology, vehicles. Metallic nano particles have a wide variety of used in gene and drug delivery due to the peculiar properties of noble metal nano particles, giving them a special location in the development of nano medicine. The most significant characteristic of nano particles is their ratio of surface area to volume, where they can easily connect with other particles[6].

Cold Atmospheric Plasma Jet

Atmospheric plasmas have contributed to the development of ion temperature cold plasmas near to room temperature. It was determined that the content provider head charge is about 10^8 electrons, the electrical field is about 10^7 V/m in the vicinity of the head, and the streamer column electron density is about $10^{19} m^{-3}$ [7].

Recently, a mixture of noble gases, potential difference and a strong dielectric material has been used to build atmospheric plasma jets[8]. The ionized gas generated at atmospheric pressure and at room temperature by the atmospheric plasma jet allows the gas to flow into a small tube with gas flow of 3 L/Min flow rate and the higher voltage supplied to the field about 20 kilovolt with DC current 1.5 Ampere and the used gas is Argon under Atmospheric pressure. Figure 1 shows the cold Atmospheric Plasma Jet system.

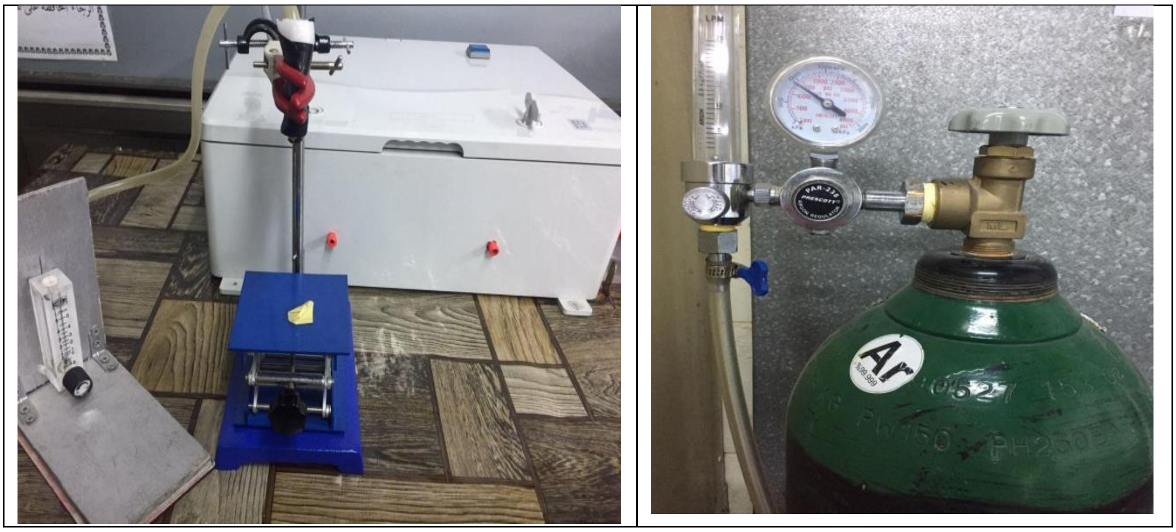


Figure 1-the cold Atmospheric Plasma Jet system

Material and Method. The plasma system with argon gas was used to expose the silver metal, it used the argon gas because, In low and high pressure plasma technology, high-purity argon gas (about 99.999 percent) is widely used. Its applications vary from pure science to specialized areas such as medicine (e.g. dermatology, ophthalmology), the semiconductor industry, analytical chemistry, nanotechnology, etc [9][10].

2.1 Preparation of Nano-Silver

Silver metal is bought from goldsmiths 5 grams of 0.999 carats of silver were manufactured and dissolved in 5 ml of distilled water and set 10 cm away from the plasma target of argon gas and flow rate 3 L/min and the outer voltage 16 kilovolt with different period of time (15, 30, 45 and 60 sec), the silver metal are show in the Figure 2.

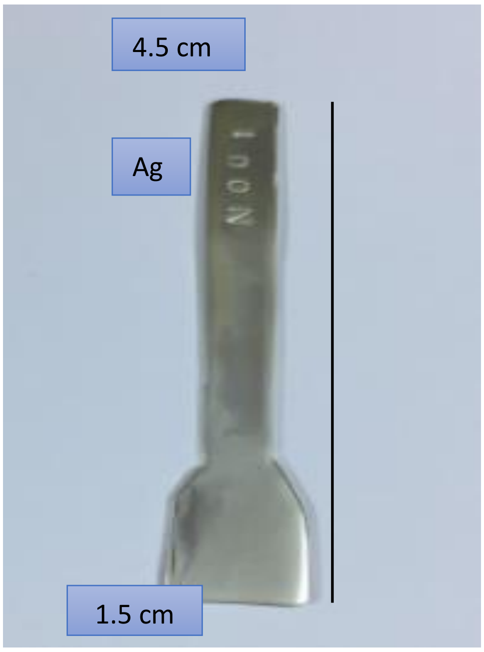


Figure 2-Grams of 0.999 Carats of Silver (Ag) Metal.

2.2 Characterization of Nano-Silver

To characterize the percentage of Nano-Silver, three type of analysis are used to identify that :

Atomic Absorption Spectroscopy (AAS)

Examine the amount of nano-material concentration for silver metal, after exspousing to argon gas plasma and converting it into nano-particles, the exam is done by (Atomic Absorption Spectroscopy). The measure was performed for different time exposuring (15, 30, 45 and 60 sec). The results show the low concentration of nano-silver at the lower time expose (15 sec) and very between (30 sec and 45 sec) the high Concentration, at (60 sec) of argon gas at plasma system, this is shown in Table 1 and there is change in the color with time as shown in Figure 3.

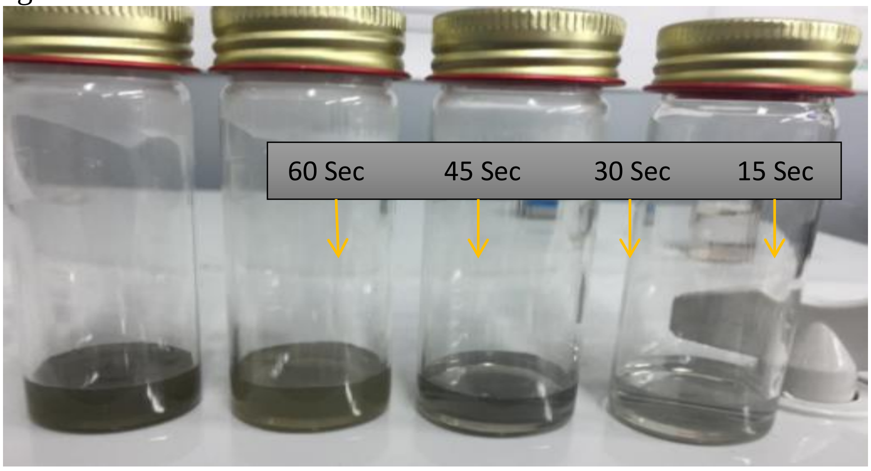


Figure 3-The Change in the Color with exspousing.

Table 1- The Concentration of Nano-Silver at Different Time of Exsposuring to plasma.

Time of Exposing to Plasma (sec)	Conc. (mg/L)
15	380.8163992384
30	408.3015991834
45	427.3165991454
60	439.6391991207

The UV-VIS spectrometer

The UV-VIS spectrometer for nano-silver different time exsposuring to plasma (15, 30, 45 and 60 sec). Show the Surface Plasmon Resonance (SPR) appeared around 419 (nm), the result are show in the Figure 4

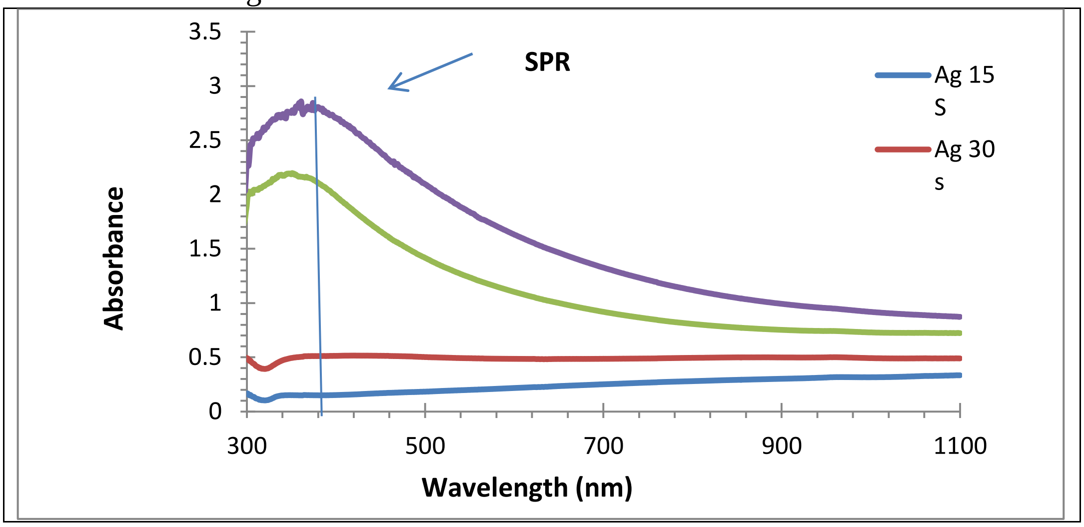
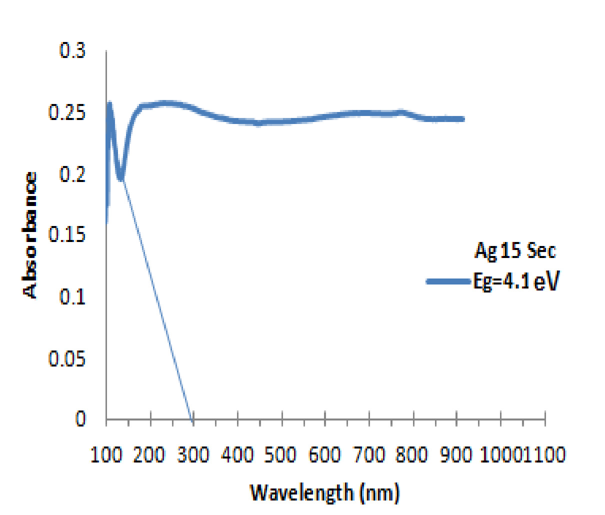


Figure 4-UV-VIS Spectroscopy for Nano-Silver Shows the SPR (nm).

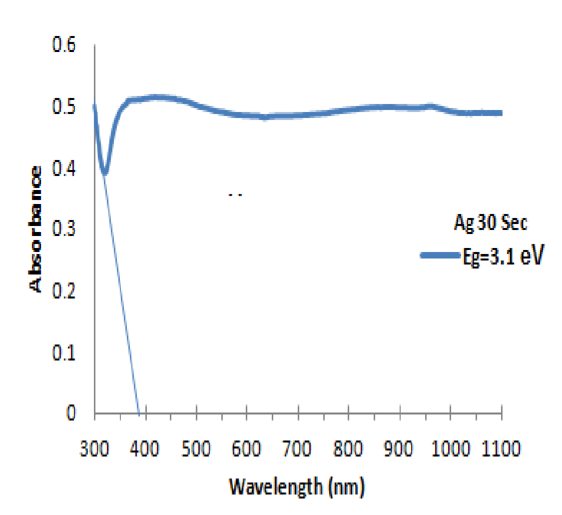
The UV-VIS shows the energy gap for the nano-silver at different time exposing to plasma (15, 30, 45 and 60 sec) has a direct energy gap and that electronic transmission is of the direct permissible type, the energy gap decrease with increase time of the argon plasma gas, this show in Table 2 and Figure 5.

Table 2- The Energy Gap for Different Time Exposing to plasma.

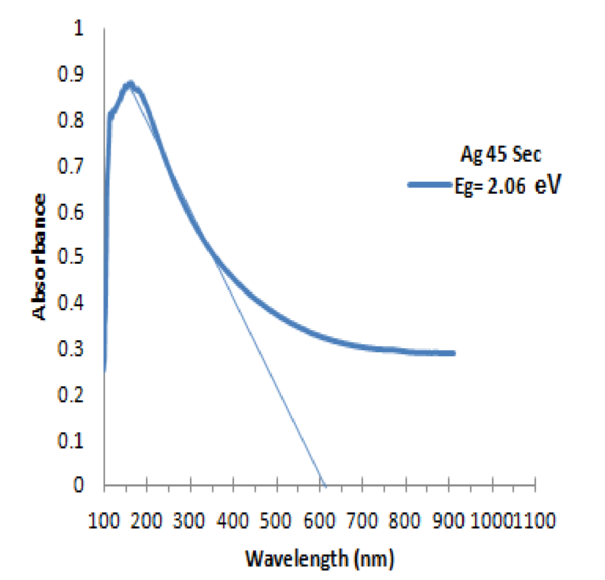
Time of Exposing to Plasma (sec)	**Energy Gap (eV)**
15	4.1
30	3.1
45	2.06
60	1.6



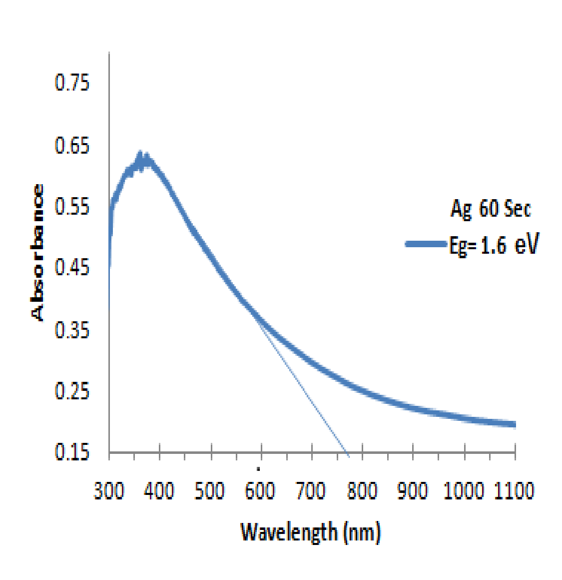
The Energy Gap at (15 sec) Plasma exposure.



The Energy Gap at (30 sec) Plasma exposure



The Energy Gap at (45 sec) Plasma exposure.



The Energy Gap at (60 sec) Plasma Exposure

Figure 5-Show the Energies Gap for Nano-Silver Particles

Scanning Probe Microscope (SPM). For this measurement we choose the less time of exposure 15 sec and the high time of exposure to plasma 60 sec depend on the their concentration at (AAS) measurement and didn't used the time exposure 30 sec,45 sec because they are very approach to each other.

Nano-Silver Particles at (15 sec) Plasma exposure. The scanning probe microscope used to identify the characterization of silver nanoparticles, the results shows that the average diameter of nano-silver for 15 second exposure to argon gas is equal to 69.00 nm and there is "10%" of the diameter less than 45.00nm and "50%" the diameter less than 65.00nm and "90%" less than 90.00nm,this result is shown in Table 3, and the distribution of nanoparticles and their volume to each diameter is ranging from 5.00 nm- 100.00 nm the volume and accumulation are shown in Table 4.

Table 3- The diameter of Nano-Silver for 15 Second Exposure to Argon Gas at Plasma System.

Avg. Diameter:69.00 nm	<=10% Diameter:45.00 nm
<=50% Diameter:65.00 nm	<=90% Diameter:90.00 nm

Table 4- Shows the diameter, Volume, and Accumulation of Nano-Silver at (15 sec) Exposure to Argon Gas at Plasma System.

Diameter (nm)<	Volume (%)	Accumulation(%)	Diameter (nm)<	Volume (%)	Accumulation (%)	Diameter (nm)<	Volume (%)	Accumulation (%)
15.00	0.32	0.32	45.00	3.83	7.99	75.00	8.95	61.98
20.00	0.32	0.64	50.00	2.88	10.86	80.00	8.95	70.93
25.00	0.32	0.96	55.00	5.43	16.29	85.00	9.27	80.19
30.00	0.64	1.60	60.00	13.74	30.03	90.00	8.63	88.82
35.00	0.96	2.56	65.00	10.86	40.89	95.00	6.39	95.21
40.00	1.60	4.15	70.00	12.14	53.04	100.00	4.79	100.00

Figure-6 identify the particle distribution, it represent the homogeneity structure for silver nano particles at time 15 sec exposure to plasma, the particle line are regular to each other.

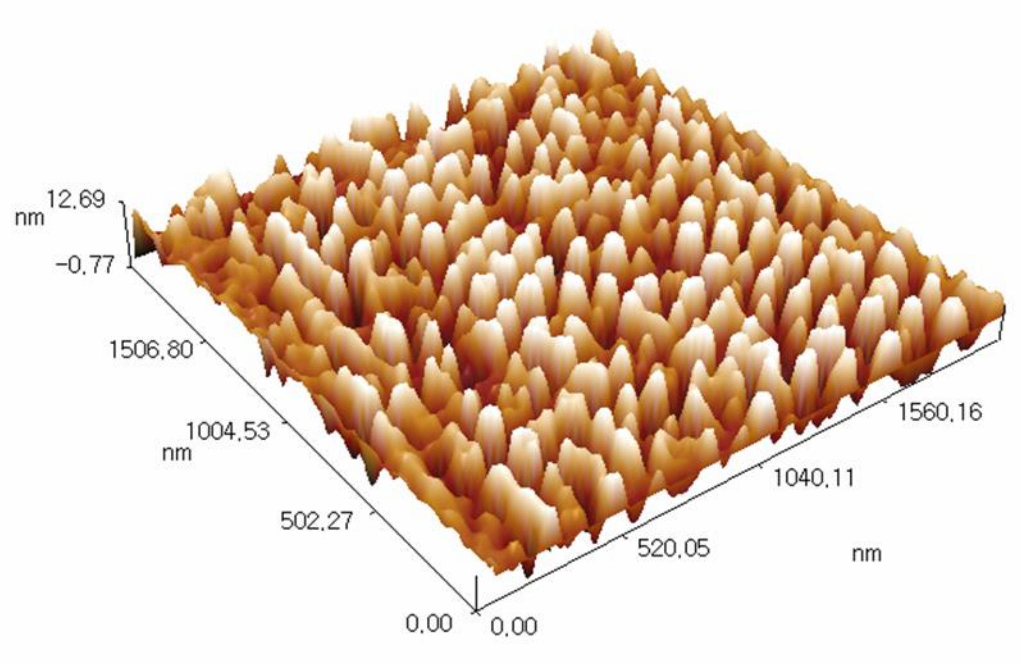


Figure 6-The Particle Distribution and Homogeneity Structure for Nano-Silver Particles at Time (15 sec) Exposure to Plasma.

Figure 7 represent the distribution and the scale of the particle size that ranging from 0 nm-12.00 nm depending on the color distribution black to white for time 15 sec exposure to plasma.

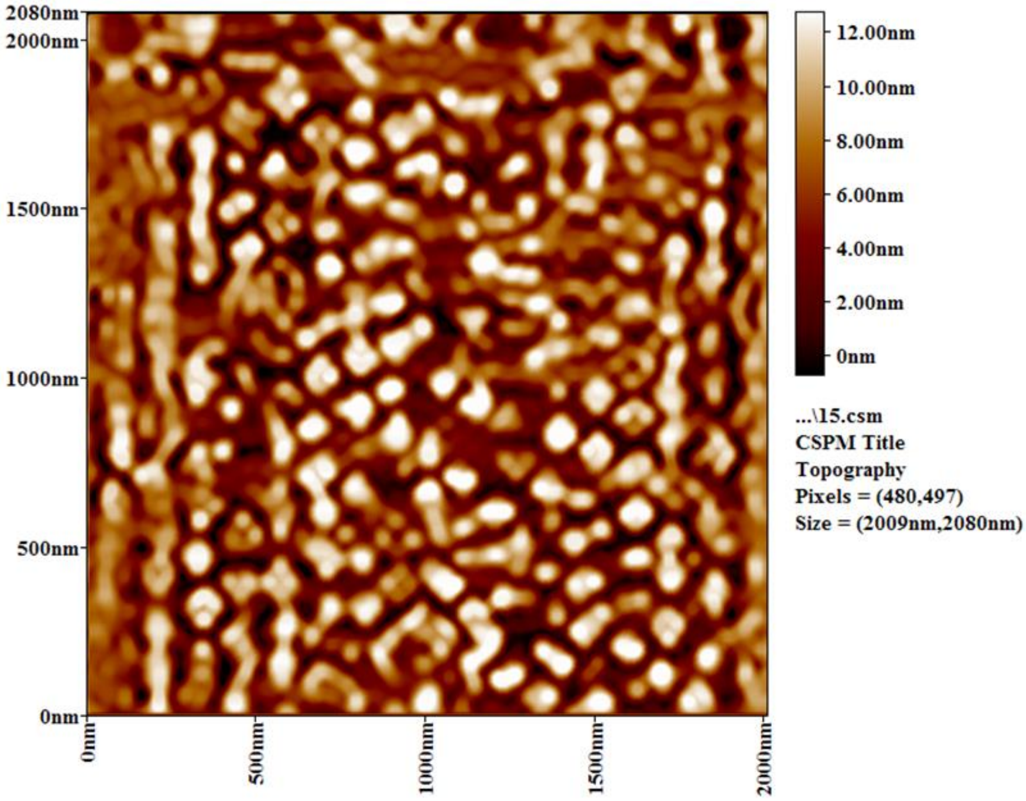


Figure 7-The Distribution and the Scale of the Particle Size that Ranging from (0 nm-12 nm) for Time (15 sec) Exposure to Plasma.

Nano-Silver Particles at (60 sec) Plasma exposure.

The scanning probe microscope shows the average diameter of nano-silver for 60 second exposure to argon gas at plasma system is equal to 54.87 nm and there is "10%" of the diameter less than 35.00nm and "50%" diameter less than 55.00nm and "90%" less than 70.00nm,this result are show in Table 5, and the distribution of nanoparticles and their volume to each diameter is ranging from 35.00 nm- 75.00 nm the volume and accumulation of Nano-Silver at (60 sec) are show in Table 6.

Table 5- The diameter of Nano-Silver for 60 Second Exposure to Argon Gas at Plasma System.

Avg.	Diameter:54.87 nm	<=10%	Diameter:35.00 nm
<=50%	Diameter:55.00 nm	<=90%	Diameter:70.00 nm

Table 6- The Diameter, Volume, and Accumulation of Nano-Silver at (60 sec) Exposure to Argon Gas at Plasma System.

Diameter (nm)<	Volume (%)	Accumulation (%)	Diameter (nm)<	Volume (%)	Accumulation (%)	Diameter (nm)<	Volume (%)	Accumulation (%)
35.00	4.00	4.00	50.00	7.67	34.67	65.00	17.00	77.00
40.00	10.67	14.67	55.00	12.00	46.67	70.00	10.67	87.67
45.00	12.33	27.00	60.00	13.33	60.00	75.00	12.33	100.00

Figure 8 identify the particle distribution, it represent the homogeneity structure for silver nano particles at time 60 sec exposure to plasma, the particle line are regular and visibly, their line following up to each other.

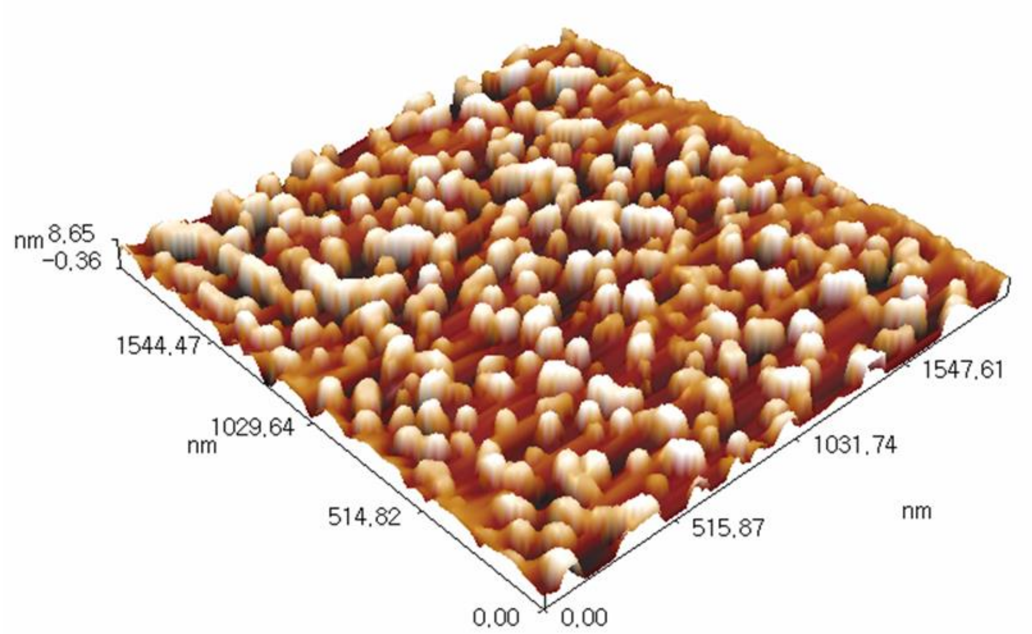


Figure 8-The Particle Distribution and Homogeneity Structure for Nano-Silver Particles at Time (60 sec) Exposure to Plasma.

Figure 9 represent particle size distribution and the scale is in the ranging from 0 - 8.65 nm depending on the color (black to white) for time 60 sec exposure to plasma .

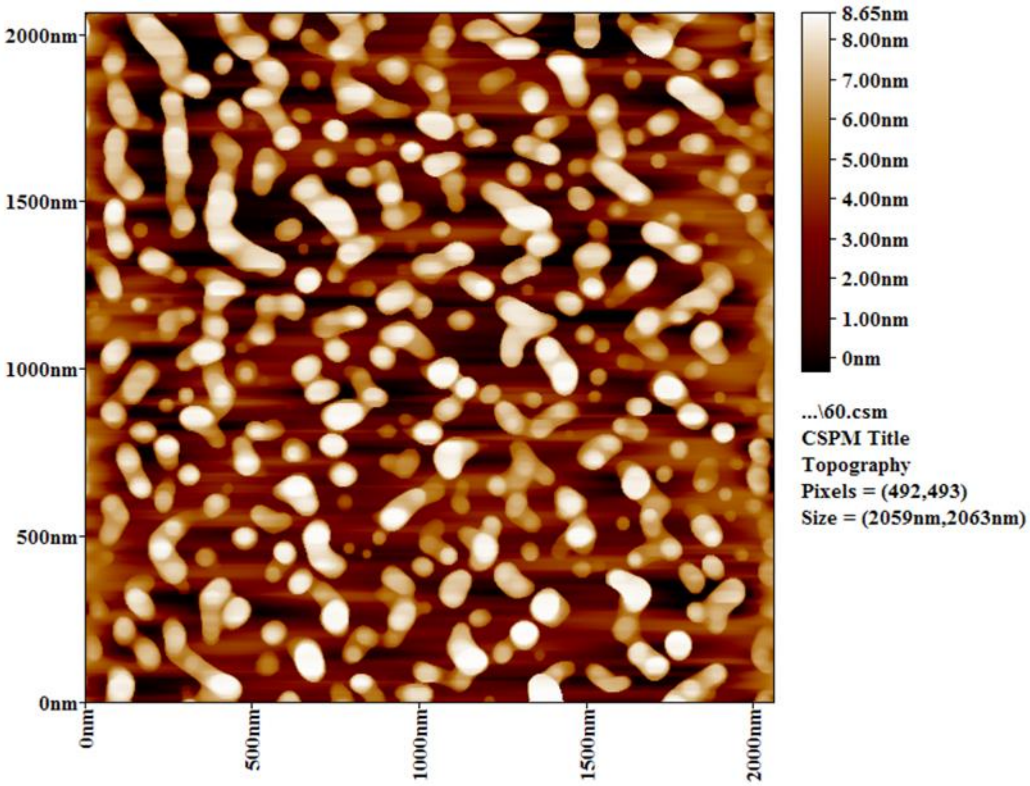


Figure 9-The Distribution and the Scale of the Particle Size that Ranging from (0 nm-8.65 nm) for Time (60 sec) Exposure to Plasma.

5. Conclusion

The nano sliver formed in a solution during the action of a plasma discharge, in the time duration 15, 30 ,45, 60 sec. The best result for obtaning nano sliver is with 60 second exposure, the average diameter is 54.87 nm. The solution color change to dark in the 60 second because the collective vibrations of the charged particles present on the surface of nano particles and the resonance. Silver nano- particles are extremely efficient at absorbing and scattering radiation with extraordinary efficiency. When excited by light at particular wavelengths, the conduction electrons on the metal surface undergo a mutual oscillation, resulting in a strong interaction with light. Surface plasmon resonance (SPR) is an oscillation that allows the absorption and scattering intensities of silver nano -particles to be much higher than non-plasmonic nano- particles of similar scale. Surface Plasmon Resonance (SPR) appeared around 419 (nm), as result the obtained the best time exposure is 60 second gives the smallest diameter with energy gab 1.6 eV and the concentration of nano particles increase it become 439.63(mg/L).

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