Available online at www.worldscientificnews.com

World Scientific News

WSN 37 (2016) 220-231 EISSN 2392-2192

# Study the Radiation Time Effect of Synthesis Silver Nanoparticles by Photo Reduction Method

**H. I. Abdullah[a], K. J. Kadhim[b,*], I. H. Hilal[c]**

[a]Department of Chemical, College of Science, Al- Mustansiriah University, Baghdad, Iraq

[b]Department of Physics, College of Science, Al- Mustansiriah University, Baghdad, Iraq

[c]Regenerated Energies, Technology & Researchs Directorate,
Al-Ministry of Science & Technology, Baghdad, Iraq

*Email address: kadjhimj1111@gmail.com

**ABSTRACT**

Highly stable dispersion of nanosized silver nanoparticles were prepared by the reduction of silver salt (silver nitrite - $AgNO_3$ ) by photo reduction methods UV-lamps. The irradiation time from 6 min. to one hour effects on the morphology of dispersed silver nanoparticles were studied. The formation of silver nanoparticles characterized by means of ultraviolet-visible spectroscopy, X-ray diffraction spectroscopy and transmission electron microscopy (AFM). During the preparation of observed that the color of dispersion gradually changed from white, yellow, orange, brown finally dark brown by changing with irradiation time, it is also the acidic solutions (PH) have decreased by increasing the duration of irradiation in addition to get different nanoparticles size lies between (33.988-93.175) nm.

***Keywords*****:** silver nanocolloids; AFM; photo reduction

## 1. INTRODUCTION

Nanotechnology is the science of controlling matter at the atomic or molecular scale. As if metallic silver colloids dedicated to materials having at least one of the dimensions within 1 to 100 nm, the ratio of surface area to weight, and the ratio of the total number of atoms to the surface of the structure attain sufficiently high value. As well as the small size and of these materials has led to possess different characteristics and behavior of the of their behavior at larger scales of 100 nm. Nanoparticles are classified primarily into two types, viz., organic and inorganic nanoparticles, while the first preparation more than a century ago, where silver nanoparticles can be synthesized using various methods: laser ablation electrochemical method, thermal decomposition, microwave irradiation and chemical and physical methods produce pure and well-defined nanoparticles chemical, electrochemical, γ-radiation photochemical, laser ablation [1-5], etc.

The most popular preparation of silver colloids is photo-reduction of silver nitrite. This preparation is simple, but the great care must be exercised to make stable and reproducible colloid. Controlling size and shape of metal nanoparticles remains a challenge. Metal nanoparticles in various size ranges play an increasingly important role in many different fields of science, technology and used by physicians in the early 20th century, but their use was largely discontinued in the 1940s following the development of safer and effective modern antibiotics or plasmonic active structures in optical sensing. Water purification, and in the potential electrical, dielectric, magnetic, optical, imaging, catalytic, biomedical, also silver in nanosize are also used in the interaction with HIV which was demonstrated by Elechiguerra. It is an example of an excellent targeting the surface of certain cell types or specific areas and bioscience properties [6,7]

## 2. MATERIAL AND METHODS

The silver nanoparticles were prepared by a silver nitrate (99% $AgNO_3$) was dissolved in dimethylformamide (99.5%) was purchased from Sigma-Aldrich. Ag colloid s prepared with $1x10^{-1}$ M a this concentration using equation (1)

$$W = Mw*C*v/1000 \;\dots\dots\dots (1)$$

where:
w - weight
Mw - molecular weight
C - concentration
V - volume

We using different time of radiation using UV-lamp with 125watt, began 6minutes, 12, one hour, increasing each other, also using cold bath to protect low temperatures to get small grain size of nanoparticles constant as shown in Figure (1) radiation system.

UV-Visible absorbance spectroscopy has proved to be a very useful technique for studying metal nanoparticles because the peak position and shapes are sensitive to particle size. The synthèses of nanoparticles were recorded by UV-Visible spectra at every color change (Metertech UV-Vis SP8001), light source – combined deuterium-halogen, wavelength range: 200-1100 nm. AFM study carried out by (SPAA3000, Angstrom Advanced Inc. USA). The morphology of siver nanoparticles was observed by using JEOL JSM-5200 scanning electron microscope operating at 15 kV at a magnification of 10,000×. The formation of silver nanoparticles was identified by the XRD (Rigaku).

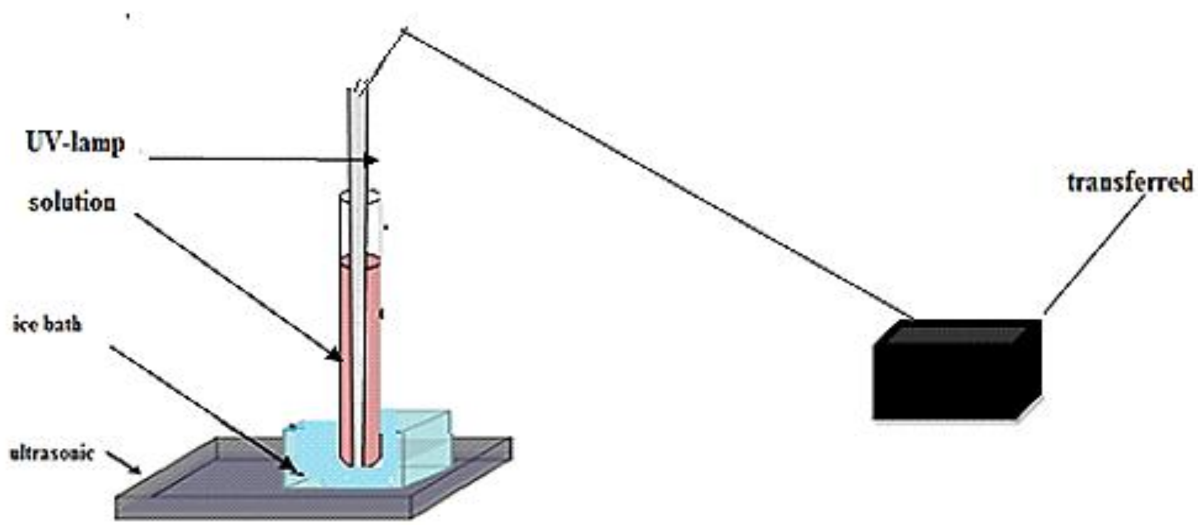



**Fig. 1.** Radiation system.

## 3. RESULTS AND DISCUSSION

Figure (2) showes that changing radiation time caused changing colors from white, yellow, orange, brown finally dark brown.

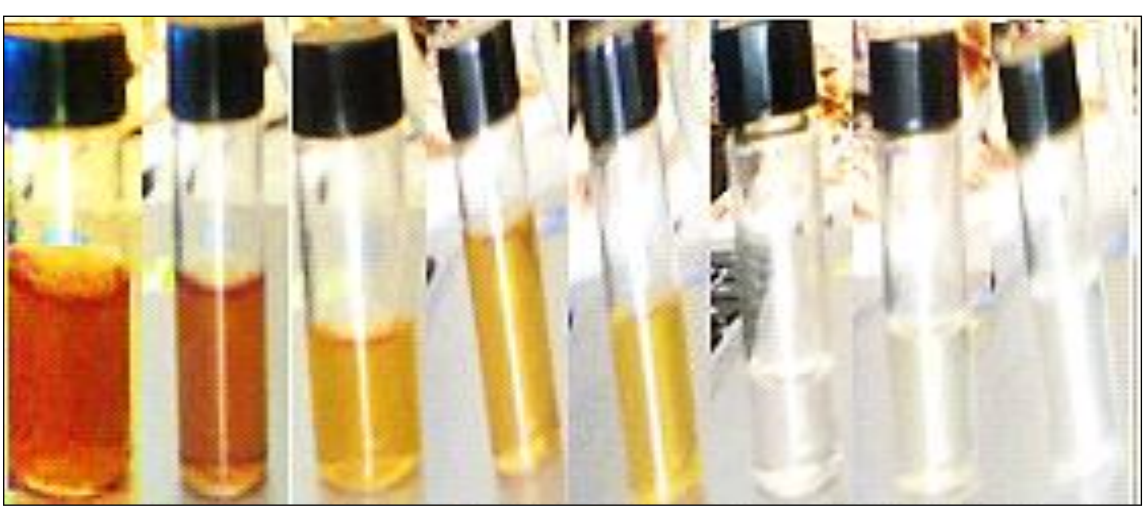


**Fig. 2.** Nanosilver Colloid colors.

Figure (3) shows the effect of pH on the characteristics of Ag-NP was studied over a wide range of pH values, but the formation of Ag-NP was only effective in basic condition. Where that at pH 6.25 and 7 the colloid solution was colorless and the yellowish brown color emerged at minimum pH of 9.27. The higher the pH,and the more intense the color, indication that the formation of Ag-NP was more effective.

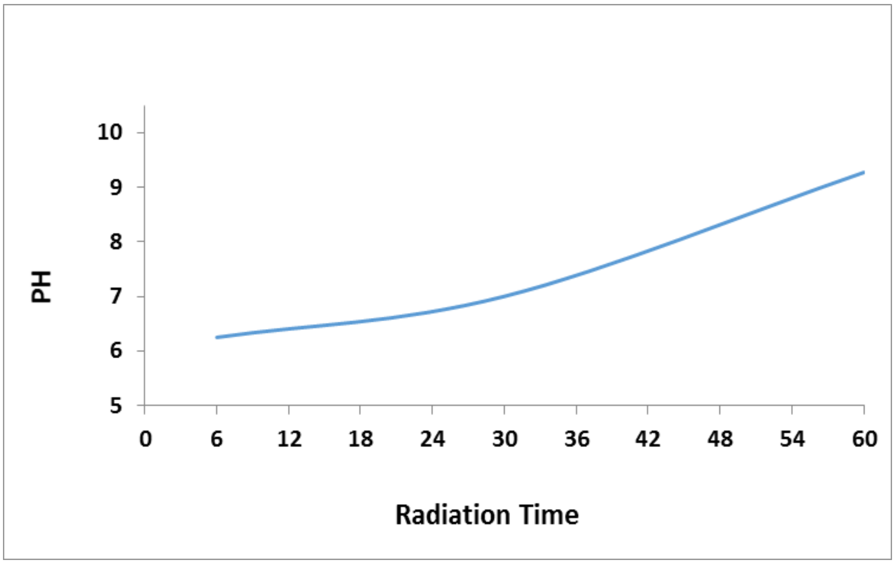



**Fig. 3.** PH  values as a function of radiations time.

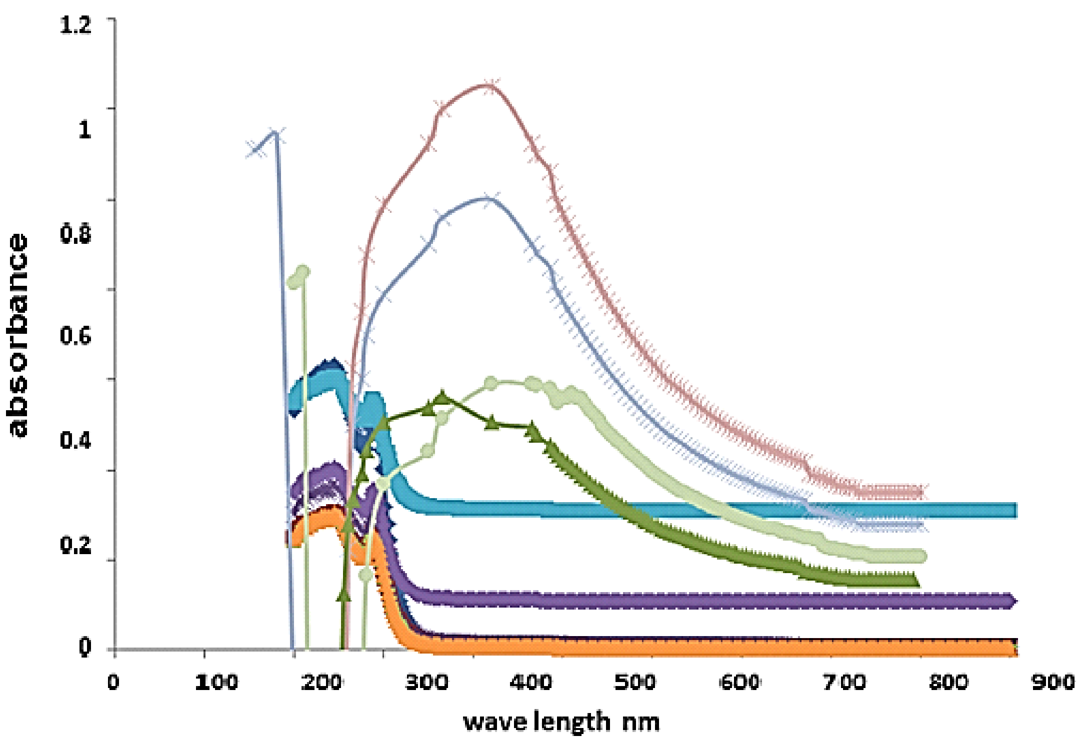



**Fig. 4.** Represent the absorbance intensity as a function to reduction time.

Figure (4) showed absorption spectrum of nanosilver Colloid which is prepared by Photo - reduction method for different radiation time of $AgNO_3$ solution, from the first sight to this figure on can observe that the absorption intensity increase with increasing the radiation time while, the maximum peak absorption for surface plasmon of silver nanoparticles which has a 6 minute as a reduction period was occurred at 290 nm while for 60 minutes was occurred at 410 nm, respectively this manner is clearly illustrated in in Table 1 and Figure 3 and this means that the general manner of peak absorption for silver nanoparticles as a function to reduction periods is "red shift" [8,9 ].

**Table 1.** Showed absorption spectrum of colloid.

| Time | Max. wavelength | intensity | Band width |
|---|---|---|---|
| 6 | 290 | 0.21 | 305 |
| 12 | 300 | 0.252 | 304 |
| 18 | 321 | 0.244 | 311 |
| 24 | 345 | 0.35 | 314 |
| 30 | 338 | 0.367 | 317 |
| 36 | 360 | 0.4 | 319 |
| 42 | 393 | 0.43 | 321 |
| 48 | 395 | 0.5 | 392 |
| 52 | 400 | 0.9 | 162 |
| 60 | 410 | 1.182 | 277 |

### 3. 1. X-Ray Diffraction Studies

In order to examine the physic-chemical make-up of unknown materials, the mineralogists and solid state chemists use primarily the Powder X-ray Diffraction techniques which are the most important characterization tools used in solid state chemistry and material science.

Figure 5 and Table 2 show the X-ray diffraction for silver nanoparticles, results we find Five peaks (111), (200), (220) and (311) plane of silver were observed and compared with the standard powder diffraction card of JCPDS, silver file No. 04-0783. The XRD study confirms that the resultant particles are (FCC) silver nanoparticles [10]. Particle size of XRD analysis by calculated using Debey-Scherrer formula (Instrumental broadening) the equation (2)

$$D = \frac{0.9\lambda}{\beta cos\theta}\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where:

'λ' is wave length of X-Ray (0.1541 nm),
'β' is FWHM (full width at half maximum),
'θ' is the diffraction angle and
'D' is particle diameter size. Surface Area, Volume and Surface Area to Volume Ratio are calculated and derived from particle size.

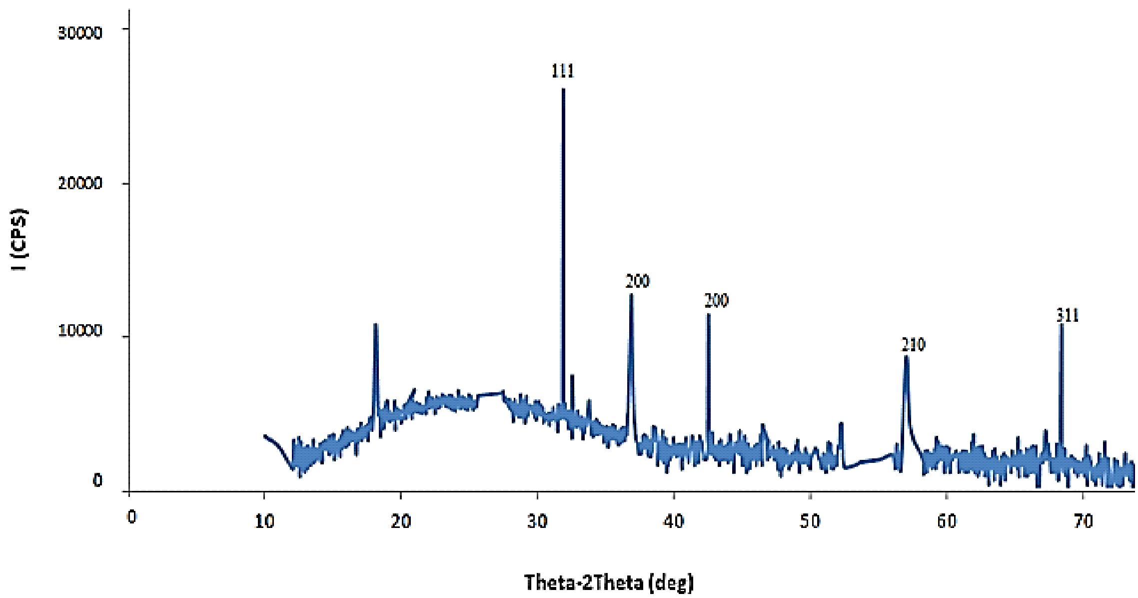



**Fig. 5.** Show the X-ray diffraction for silver nanoparticles which is prepared by photo- reduction.

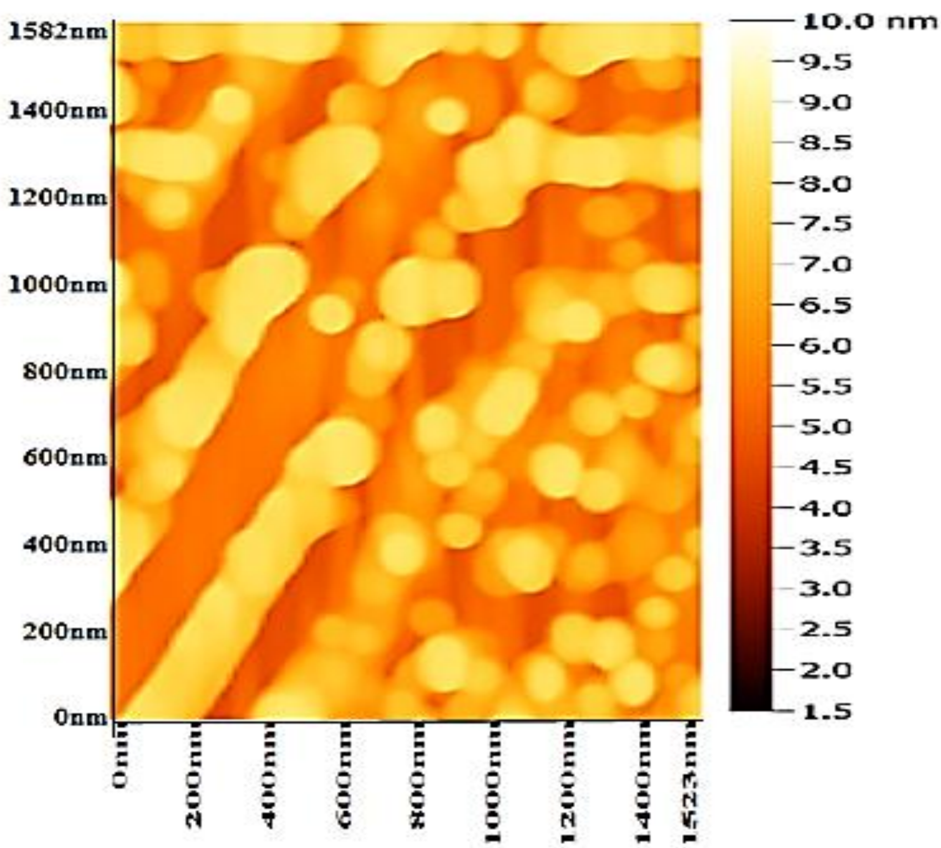
Atomic Force Microscope measured using indirect method for morphological analysis of the sample. Maximum scanning size of the microscope probe was (10x10 μm). Resolution of AFM was (300x300 pixels). The sample used in this thesis was measured in tapping mode. Nominal diameter of tip was (10 nm).

The reason for the usage of AFM for nanotubes analysis is very simple. AFM is a powerful tool in manipulating and characterizing the properties of nanostructures due to these method atomic planes of nanoparticles can be observed in Figure (7) showed the atomic force microscope results for AgNPs which had been prepared in different time of photo- reduction periods.

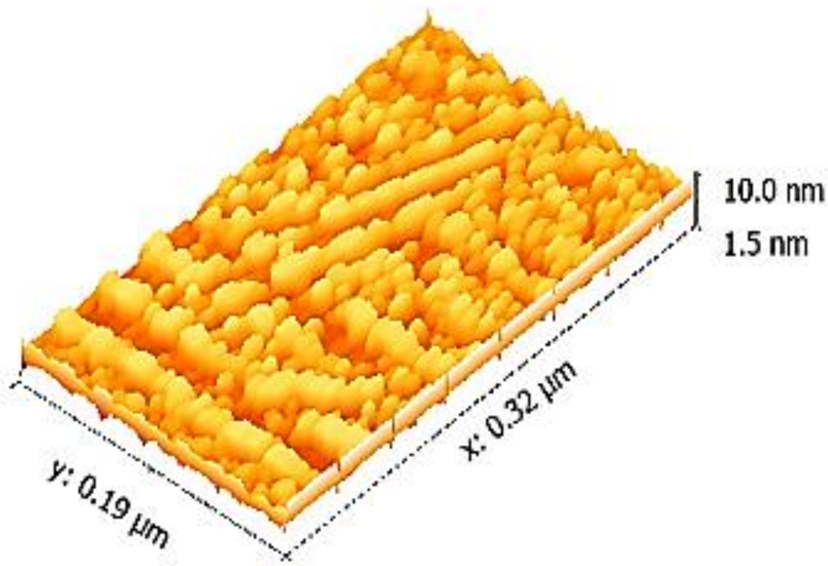
The surface morphology and size of the silver nanoparticles of incubation were studied by AFM. The two- and three-dimensional images of the nanoparticles are shown in Fig. 6a, b. From the 2D view, well-separated spherical particles are seen. The 3D view revealed that the growth direction of all the particles was almost same confirming the single crystalline nature of the cubic phase of Ag nanoparticles.

**Table 2.** Peak indexing. of nanosilver Colloid.

| $2\theta$ | hkl |
|---|---|
| 31.8842 | [111] |
| 36.85 | [200] |
| 42.5 | [200] |
| 57 | [220] |
| 68.38 | [311] |

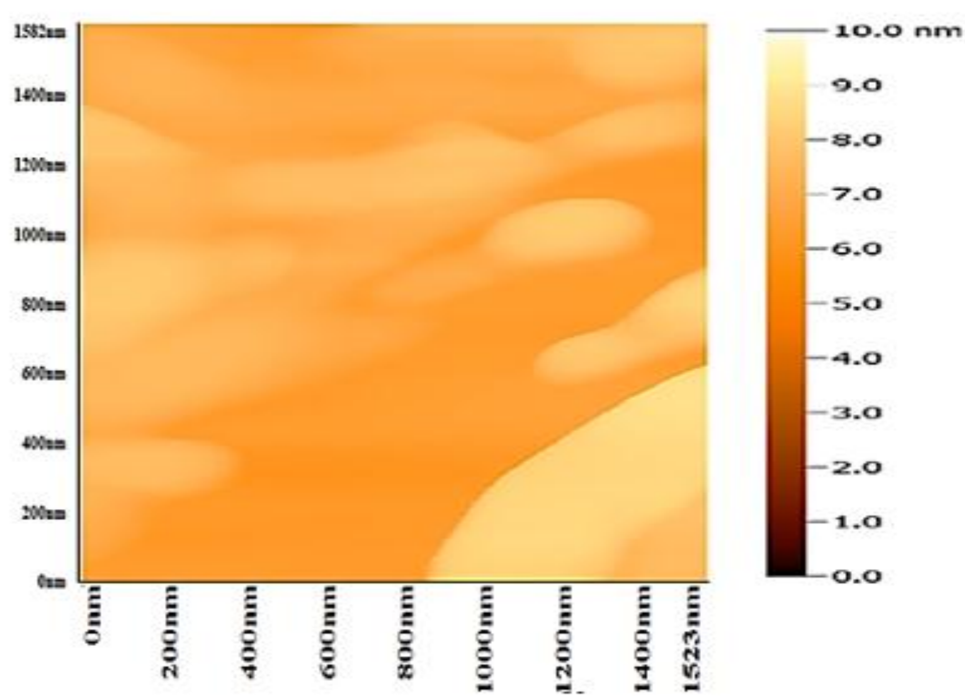



**A) 2D**

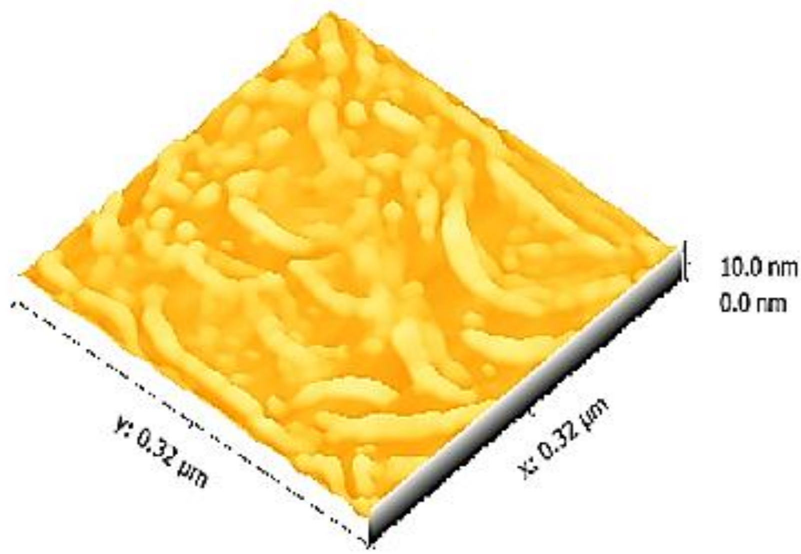



**B) 3D**

**At low time of radiation**




**A) 2D**

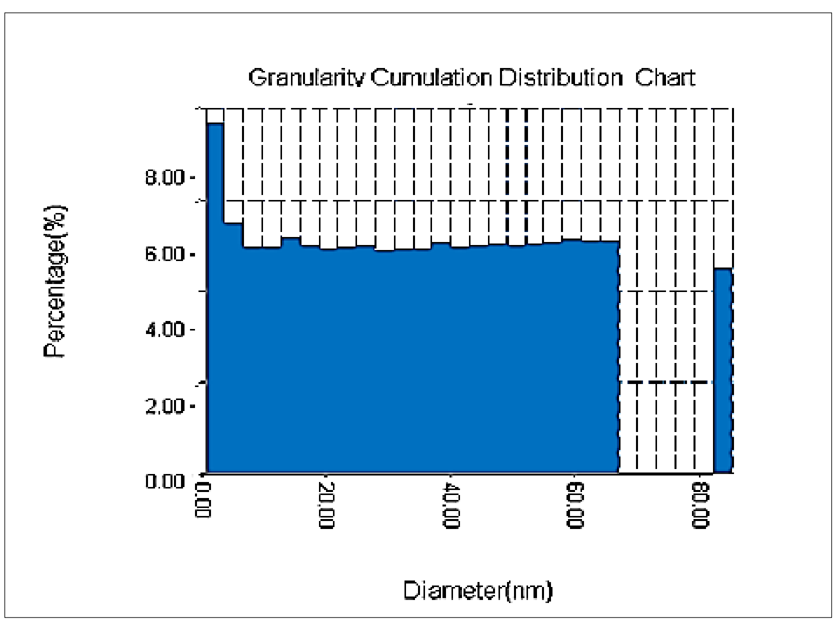



**B) 3D**

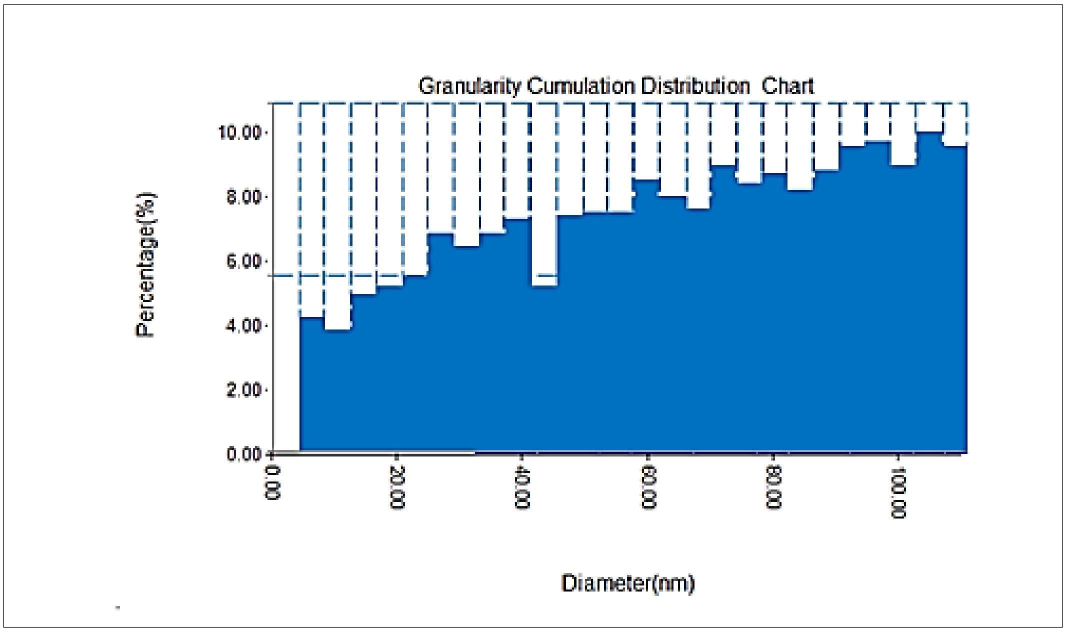
**At 45sec. of radiation time**

**Fig. 6.** A) show the atomic force microscope results for AgNPs, B) corresponding 3D view.

Figure (7) show particle size distribution for silver nanoparticle. where results showed the range of the particle diameter between (1-120nm) but the average the particle size variated from 33.988 to 93.175.nm and it is so difficult to controlling the grain size so it is a global problem but the particle size still in the nanoparticle range.




A) **Avg. Diameter:** 33.988 **nm**




B) **Avg. Diameter:** 93.17 **nm**

**Fig. 7.** Particle size distribution for nano silver.

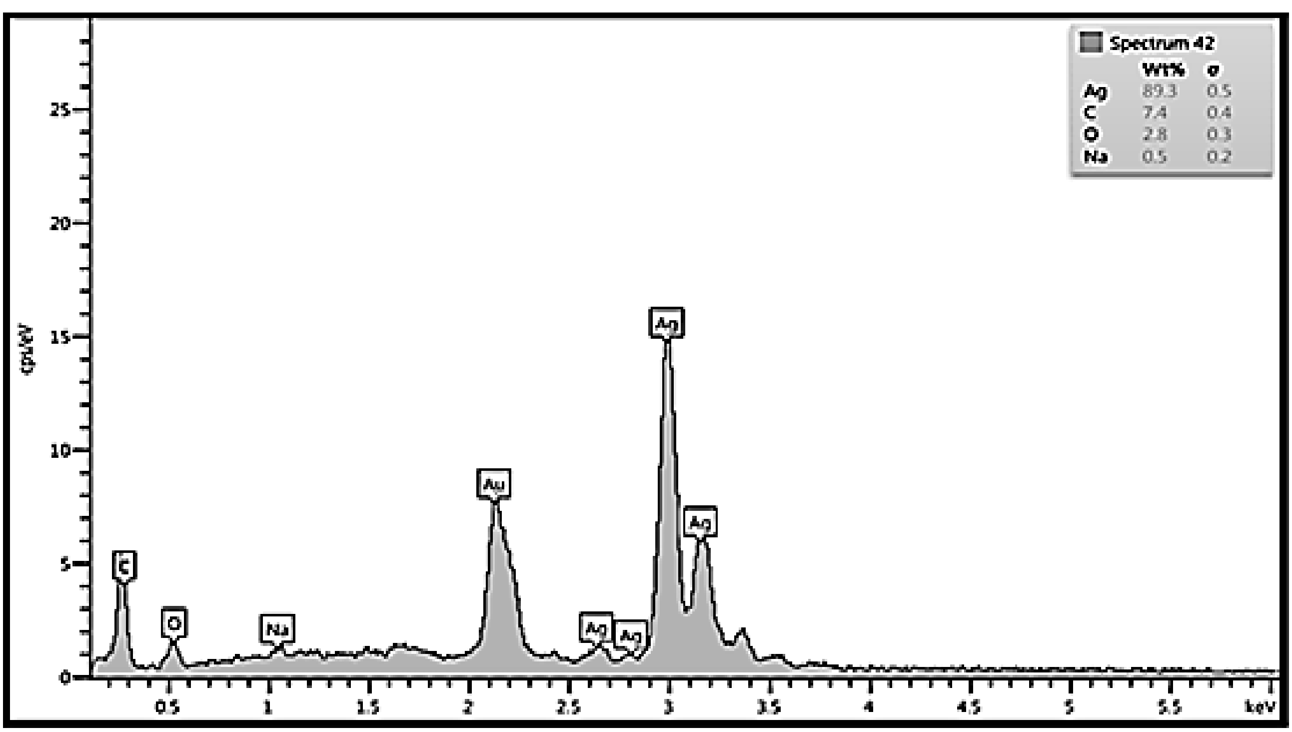



**Fig. 8.** The spot EDX spectra of Ag-nanostructured on thin film samples.

While Figure 8 show The spot EDX spectra of nanosilver, from EDX spectra measurements results gave indication about the elemental analysis of Glass coated with nano Ag shows that the peaks observed at 3.0, 3.2, and 3.4 keV correspond to the binding energies of Ag Lα, Ag Lβ, and Ag Lβ2 respectively

## 4. CONCLUSIONS

The synthesis method which consider as low cost, environmental friendly and can be prepared in simple laboratory equipment in ambient condition. In addition to prepared minimum particle size for silver nanoparticles was variated from 33.988 to 93.175 nm, and it is so difficult to controlling the grain size.

So it is a global problem but the particle size still in the nanoparticle range. Where the morphologies of the Ag-NP were also significantly dependent on pH and ionic strength. The increase in irradiation time increased the intensity of the absorption solutions also increase the pH. Also the colloid colors changed from colorless and the yellowish brown color, this indicating that the formation of Ag-NP was more effective.

## References

[1] Jia, H. J. Zeng, W. Song, J. An, B. Zhao, Preparation of silver nanoparticles by photo-reduction for surface-enhanced Raman scattering, *Thin Solid Films*, 496, 281-287, 2006.

[2] H.I. Dambus, W.A. Mahdi, S.J. Benden, R.I. Atiyah, H.A. Ahmad, A.G. Nagee, F.A. Mubder, Coating Silicon and Glass Substrate with Colloidal Silver Nanoparticles Using Thermal Spray Pyrolysis and Studying Electrical Properties, *Diyala Journal for Pure Sciences*, 8(3), 256-259, July 2012.

[3] Logar, M., Suvorov, D., Jancar, B., Kostanjsek, R., In Situ Synthesis of Ag Nanoparticles in Polyelectrolyte Multilayers. *Nanotechnology*, 18, 1-7, 2007.

[4] Sujuan Yu and Jingfu Liu, Silver nanoparticles in the environments, Springer Verlage Berlin Heidelberg, 2015 .

[5] O.L.A. Monti, J.T. Fourkas, D.J. Nesbitt, Diffraction-Limited Photogeneration and Characterization of Silver Nanoparticles, *J. Phys. Chem. B.* 108, 1604-1612 , 2004 .

[6] Jes Ærøe Hyllested, Marta Espina Palanco, Nicolai Hagen, Klaus Bo Mogensen and Katrin Kneipp , Green Preparation and Spectroscopic Characterization of Plasmonic Silver Nanoparticles Using Fruits as Reducing agents. *Beilstein J. Nanotechnol.* 6 (2015) 293-299.

[7] Rohini Dhandapani, Senthil Kumar Kandasamy, Fabrication of Polymer Schottky Diode using PANI/Ag Nanocomposite, *International Journal of Research in engineering and Technology* 3(7), May 2014 .

[8] J. Fang , K. L. Stokes, J. A. Wiemann, W. L. Zhou, Jianbiao Dai, Feng Chen, Charles J. O'Connor, "Microemulsion-processed bismuth nanoparticles", *Mat. Sci. Eng*. 83, 254-257, 2001.

[9] Foliatini1,2, Yoki Yulizar1 & Mas Ayu Elita Hafizah3 , The Synthesis of Alginate-Capped Silver Nanoparticles under Microwave Irradiation, *J. Math. Fund. Sci.* Vol. 47, No. 1, 31-50, 2015.

[10] Tabassum Bashir, Muhammad Zahid Qureshi, Photosynthesis of Silver Nanoparticles Using E. Camaldulensis Leaf Extract and Their Characterization, *J. Chil. Chem. Soc.* 60(1), 2015.

( Received 14 January 2016; accepted 27 January 2016 )