International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

Preparation and Characterization of Cu nanoparticles by Laser Ablation in NaOH Aqueous Solution

Wasan Mubdir Khilkala[A], Ghaleb A. Al-Dahash[A*] and Sahib N. Abdul Wahid[B]

[A] Laser Physics Department, Babylon University, College of science for women, Hilla, IRAQ
[B]Physics Department, Kufa University, College of Education for girl, Kufa, IRAQ

Accepted 10 July 2014, Available online 01 Aug 2014, **Vol.4, No.4 (Aug 2014)**

Abstract

In the recent years, laser ablation in liquid has become an increasingly important technique for the fabrication of NPs . this paper reports our recent studies on the generation of Cu NPs by ablation of metal targets in aqueous environments using Q-switch Nd-YAG laser (λ=532nm) immersed in NaOH (0.1M) .solution of NPs is found stable in the colloidal form for a long time. The Surface topography studied by atomic force microscopy revealed wider size distributions, with particle sizes (98.43nm to 115.99nm)and shape were measured by using SEM shows spherical shape while the composing of the prepared nanoparticle were determined by X-ray ,UV-Visible spectroscopy has been employed for the optical properties .the UV-VIS spectrum of produced solution shows red shifted in the peak position .

Keywords: *Laser Ablation, Collide Nanoparticles, Aqueous solution, Cu nanoparticles*

1. Introduction

The properties and behavior of material at the nano-scale or level vary greatly when compared to micro levels. The properties of nanoparticles show great differences in electric, optical, magnetic and chemical properties from the bulk material of which they are made.(Piriyawong *et al*,2012).

Silver and gold nanoparticles have been extensively studied as they show a strong absorption band in the visible region, which is due to the excitation of the surface plasmon resonance.(Hodak *et al*,1998),(Robarti *et al*,1995),(Bae *et al*,2002),(Mafune *et al*,2001),(Perner *et al*,1997),(Asharoidi *et al*, 1996). Recently, attention has been focused on Cu nanoparticles due to their catalytic and electrocatalytic properties.(Shim *et al*,2002),(Huang *et al*,1997).

Laser ablation of solid target in liquids is simple and reliable method for generation of nanoparticles (NPs) of almost any metals and semiconductors. It is an alternative to chemical synthesis of NPs and is capable of producing NPs that are free of any surface-active substances and counter-ions. The properties of NPs generated by laser ablation in liquids depend on a number of experimental parameters. The specific feature of laser ablation in liquids is subsequent interaction of generated NPs with the laser beam via direct absorption of laser radiation.

So the final properties of NPs depend on such parameters as laser pulse duration, laser wavelength, laser fluence on the target, nature of surrounding liquid, number of laser shots, etc .(Shafeev,2008),(Yang,2007).

Generating of NPS through PLAL technique passes through three fundamental steps. Firstly plasma generates due to extreme heating during the interaction of laser with mater. Secondly the ultrasonic adiabatic plasma expands leads to quick cooling of the plume.

Finally after plasma extinguishing the formed nanoparticles clusters encounter and interact with the solvent and surfactant molecules in the surrounding solution .those processes involve the nucleation and phase transition of nanocrystals.(Swankar *et al*,2009),(Mafune *et al*,2002).

The aim of the work is to study the effects of the NaOH solution on the composed and the stability of prepared NPS since NaOH represents the base medium for many chemical reaction occur during nanoparticles formation and also the effects of laser energy on the concentration of the synthesis NPS.

2. Experimental methods

Fig.1 shows the schematic diagram of PLAL experimental setup for synthesis colloidal solution of Copper NPs. The laser used in this work is a nanosecond Q-switched Nd-YAG LASER .Its operates at 1064 nm and 532nm wavelength ,50 pulses number ,6Hz pulsed repetition rate and <10ns pulse duration at energy of (20,80,140,200,260) mj ,the laser beam is focused on the target surface with diameter of 1mm .Copper target(purity 99.99%) was plased at the bottom of the quarts cell and immersed at 8mm depth in the solution of NaOH (0.1M). indeed the colloidal was re-irradiation with (500pulse) by 532nm wavelength and 260mj.

The absorption spectra of the colloidal solutions was measured using UV-Visible, NPs size and surface morphology where examine using AFM, while the shape of NPs examined by SEM.

*Corresponding author: **Ghaleb A. Al-Dahash**

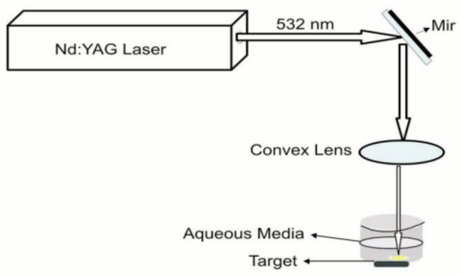


Fig. 1 Experimental arrangement

3. Results and Discussion

Fig.2 displays the absorption spectra of copper nanoparticle produced in NaOH medium and the color of the copper colloidal is light yellow .UV-Visible absorption spectrum of the synthesized colloidal solution of nanoparticles shows red shift in the position of absorption peak as appeared in Table (1), also absorbance shows an increase in the Plasmon peak with increasing the laser energy, indicating to the increase in the concentration of NPs.(Hisham *et al*,2012).

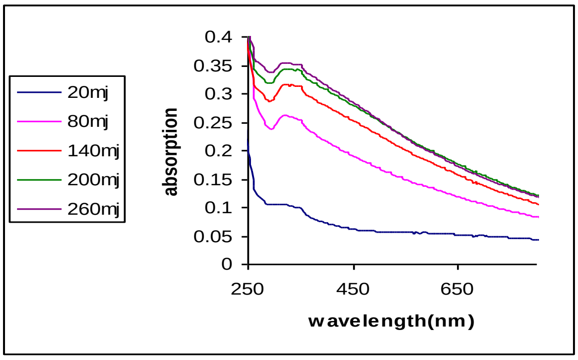
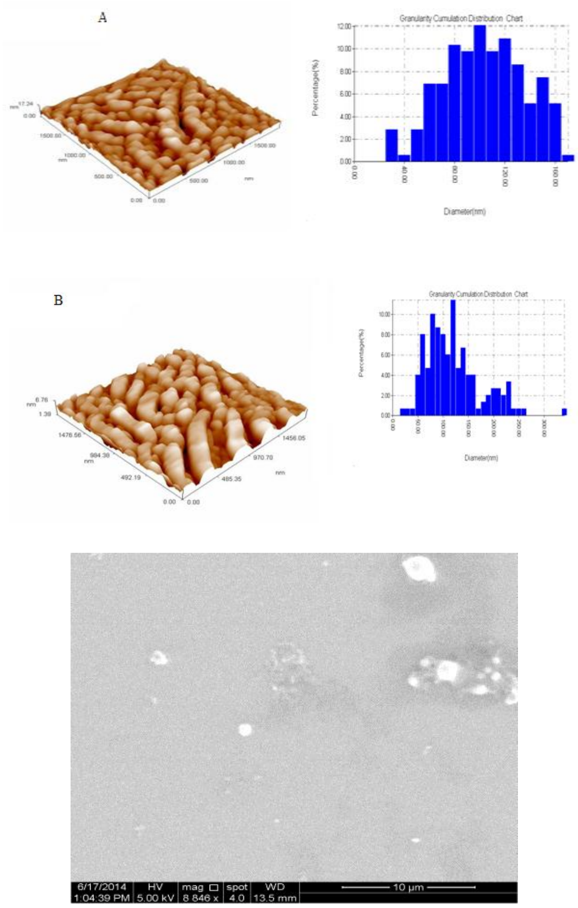


Fig. 2 Absorption spectrum of prepared CuO NPs

Table The peak position shows red shift with increasing of energy of ablation.

Energy of Ablation (mj)	Absorption peak position
20	289
80	301
140	304
200	310
260	313

Fig.3(A,B) shows AFM image of the Cu nanoparticles obtained in NaOH aqueous solution, The diameters of the particles were (98.43 nm) at 20mj and(115.99nm) at 260nm and this result shows as the energy of ablation increase the particle size increase , SEM measurements appeared that the formed particle is spherical in their shape Fig.3(C) .



(c)

Fig. 3 AFM and SEM of Cu nanoparticle in NaOH (A-at 20mj, B-at 260mj and C-SEM)

As shown in Fig.4 the prepared Cu colloidal is stable since the intensity of absorption peak is slightly drops after one month from preparation.

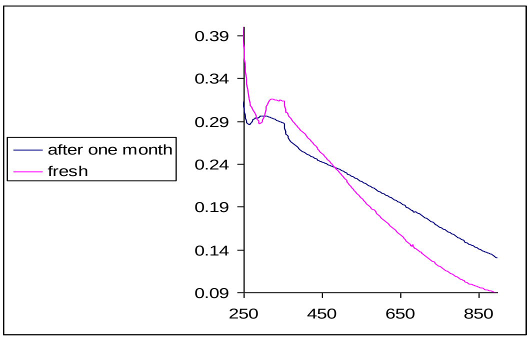


Fig Measuring the stability of the cu colloidal after one month

According to X-ray measurement the particle formed was CuO as revealing in Fig.5.

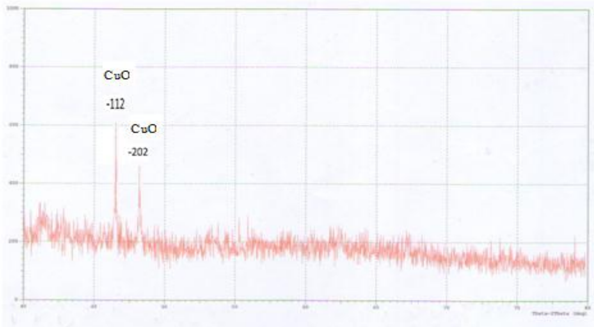


Fig.5 X-ray of prepared colloidal of cuO in NaOH solution

also Fig.6 show by further irradiation of the prepared colloidal result in increases the absorption intensity which indicating increase of NPs concentration in the solution[14].

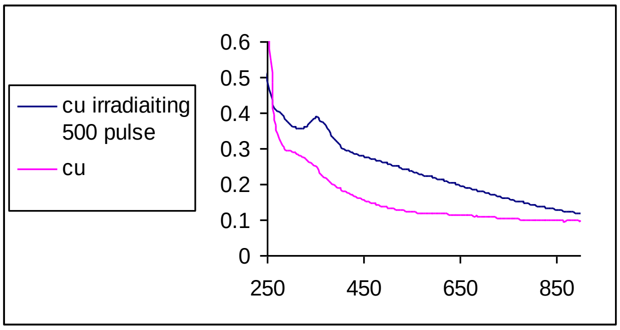


Fig. after re-irradiating with 500 pulses the peak intensity increase

Conclusions

In summary, this research work has successfully produced spherical CuO nanoparticles by using a simple method of nanosecond pulsed laser ablation in NaOH. No additives, such as solvents, surfactants or reducing agents, are needed in the procedure. Optical measurements of colloidal CuO NPs exhibit single maximum optical extinction. The solution of colloidal is stable for more than one month, and by re- irradiation of the colloidal CuO NPs solution the concentration of NPs ,as well as by increasing the ablation energy the concentration of NPs and the particle size increase .

Reference

V.Piriyawong , V.Thongpool , P.Asanithi ,P.Limsuwan, (2012)Effect of Laser Pulse Energy on the Formation of Alumina Nanoparticles Synthesized by Laser Ablation in Water,*Surface Science Direct*,32,1107-1112.

Hodak, J. K.; Martini, I.; Hatland, G. V.(1998) Spectroscopy and Dynamics of Nanometer-Sized Noble Metal Particles *J. Phys. Chem.* B ,102, 6958.

Robarti, T. W.; Smith, B. A.; Zhang, J. Z.(1995) Ultrafast electron dynamics at the liquid–metal interface: Femtosecond studies using surface plasmons in aqueous silver colloid *J. Chem. Phys.* ,102, 3860.

Bae, C. H.; Nam, S. H.; Park, S. M.(2002) Formation of silver nanoparticles by laser ablation of a silver target in NaCl solution *Appl. Surf. Sci.*, 198, 628.

Mafune, F.; Kohno, J.; Takeda, Y.; Kondow, T.; Sawake H., (2001) Formation of Gold Nanoparticles by Laser Ablation in Aqueous Solution of Surfactant , *J. Phys. Chem. B*, 105, 5114.

Perner, M.; Bost, P.; Plessen, G.; Foldman, J.; Becker, U.; Menning, M.; Schmidt, M. (1997) *Phys. Rev. Lett.*, 78, 2192.

Asharoidi, T. S.; Logunov, S. L.; El-Sayed, M. A. (1996), Picosecond Dynamics of Colloidal Gold Nanoparticles, *J. Phys. Chem*., 100, 8053.

Shim, I.-W.; Noh, W.-T.; Kwon, J.; Cho, J. Y.; Kim, K.-S.; Kang, D. H. (2002), *Bull. Kor. Chem. Soc.*, 23, 563.

Huang, H. H.; Yan, F. Q.; Kek, Y. M.; Chew, C. H.; Xu, G. Q.; Ji, W.; Oh, P. S.; Tang, S.(1997) *H. Langmuir* , 13, 172.

G.A. Shafeev, (2008) Laser-based formation of nanoparticles, in: Lasers in Chemistry, Volume 2: Influencing matter. *Edited by M. Lackner, Wiley VCH, Wienheim*, , 713 – 741.

G.W. Yang, (2007) *Progress in Materials Science*, 52, 648–698.

R.K.Swankar,S.C.Singh and R.Gopal, (2009).optical Characterizations of Copper Oxide Nanomaterial *,International Conference on Optics and Photonics,Chandigarh,India*,30Oct.-1 Nov.

F.Mafune,J.Kohno,Y.Takeda,T.Kondow,(2002)Full Physical Preparation of Size-Sellected Gold Nanoparticles inSolution :Laser Ablation and laser-Induced Size *Control Journal Physics Chimistry* B,106,7575-7577.

Hisham Imam1, Khaled Elsayed2, Mohamed A. Ahmed2, Rania Ramdan2,(2012) Effect of Experimental Parameters on the Fabrication of Gold Nanoparticles via Laser Ablation, *Optics and Photonics Journal*, 2, 73-84.