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EFFECT OF LASER WAVELENGTH ON THE FABRICATION OF GOLD NANOPARTICLES BY LASER ABLATION

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ABSTRACT

In this work gold nanoparticles has been prepared via ablation of pure Au metal target in doubled distilled water was accomplished using Q-switched Nd: YAG pulse width 10 ns energy was 700 mJ number of shots was 90 shot at different laser wavelength(532 nm and 1064 nm) The effect of laser wavelength on the optical and surface morphology have been studied the result showed decrease in particle size when the wavelength of laser increase and UV-Visible result show a blue shift in the absorption spectra when the wavelength is increase.

KEYWORDS: Gold Nanoparticle, Laser Ablation, Laser Wavelength, Noble Metals Nanoparticles & Size

INTRODUCTION

Gold Silver Mercury Platinum Iridium Palladium Osmium Rhodium and Ruthenium are known as noble metals and show high resistivity to oxidation and corrosion even at high temperatures and these features make them precious metals These metals show distinctive physical and chemical properties different from the most base metals and lead to use noble metals as a “nanoparticles” in nanotechnology[1] NMNPs like gold are widely used and applicable in nanotechnology due to the existence of localized plasmonic modes in the visible–near infrared interval the easy surface functionalization and the chemical and physical stability [2].

A number of techniques can be used for NMNPs preparation Some examples are chemical reduction [3] photo-reduction [4] flame metal combustion [5] electrochemical reduction [6] solvothermal [7] electrolysis [8] and laser ablation Laser ablation is the operation of the removal of some of the material small volume of solids (or occasionally liquid) surface by irradiating it with a laser beam[9] Laser ablation in vacuum or in a background gas has been widely used for manufacturing of various nanopowders in gas phase and laser ablation in solution which has become a favorable method for the production of metal and metal alloy nanoparticles and some network structures [10] Laser ablation in liquids (LAL) has been accepted to be an effective and general trajectory to synthesize nanocrystals and fabricate.

To modify the particle properties by changing experimental parameters; e g laser fluence wavelength pulse duration pressure number of pulses etc [11 12] All laser parameters are important in laser ablation process but the wavelength of laser has a special importance Different wavelengths get absorbed differently in a particular material Thus the ablation process will be affected by the choice of wavelength.

EXPERIMENTAL

The gold nanoparticles is fabricated by pulsed laser ablation of the corresponding gold metal plate (99 99%) of 0 5 mm thickness using the Nd:YAG laser with pulse width of 10 ns and 6 Hz repetition rate at two laser wavelength (532 nm and 1064 nm) The gold target was placed on the bottom of a 1 mL quartz vessel filled with doubled distilled water The surface of the gold plate was polished before the experiment The depth of the doubled distilled water layer above the target was 9 mm The optical properties of gold nanoparticles were studied by optical absorption measurements of liquids that contained gold nanoparticles Due to fast growth and aggregation of nanoparticles all measurements were performed immediately after ablation and production of nanoparticles in water gold nanoparticles in DDW show a pink color and stability without sedimentation Also the shape and size of gold nanoparticles studied by SEM and AFM.

RESULTS AND DISCUSSIONS

Colloidal of gold nanoparticles was produced by pulsed laser ablation of a piece of gold plate placed on the bottom of quartz vessel containing 1ml of DDW focused energy was 700mJ /pulse and the number of applied pulses 90 pulses and At different wavelength 1064 nm and 532 nm.

Figure 1 shows UV–VIS absorption spectra of Au nanoparticles The spectra exhibit a characteristic peak around 522nm However it was found that the absorption peaks of samples produced at 532 nm laser wavelengths is lower than that produced at 1064 nm as shown in Fig 1 Therefore it suggests that the particle densities of samples prepared at 1064 nm laser wavelength are an optimum It may be concluded that laser wavelength of 532 nm is less efficient in fabricating nanoparticles in water.

There are some factors that can be attributing to the changes in PLAL efficiency between the two wavelengths First it may be contributing to light absorption properties of the target materials The Au target have the capability to absorb the long wavelength (specifically1064 nm) laser energy as efficiently as at 532 nm At wavelength 532 nm the value of the abortion coefficient k of bulk noble metals (silver or gold) is less than that at wavelength 1064 nm[13] Another factor is that at green wavelength the absorbance by metal hydrosol is substantially higher than that at the 1064 nm Although the visible wavelength exhibits a lower ablation threshold than that of the infrared one [14].

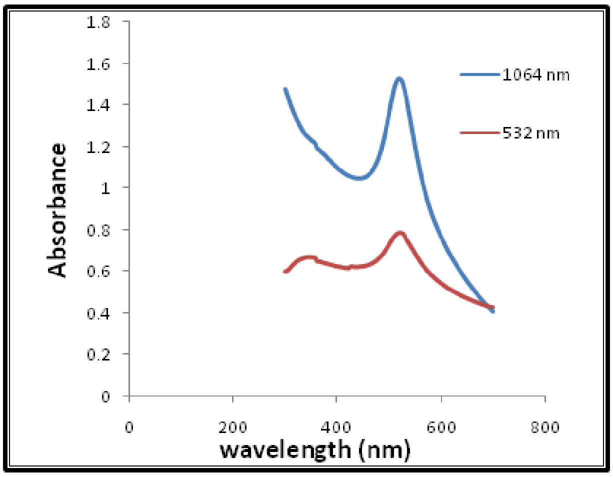
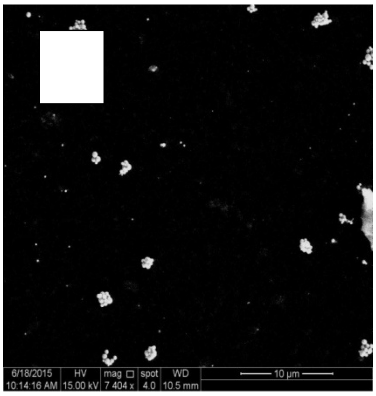


Figure 1: The Absorbance Spectra of the Plasmon Band of Au Nps Obtained By Λ=1064 Nm And 532 Nm

Table 1: Maximum Values of Absorbance Spectrum as a Function of Different Wavelength

Wavelength (Nm)	λ Abs(Nm)	Absorption
1064	518	1 529
532	522	0 785

Figure 2shows SEM images and size distributions of gold nanoparticles produced by laser ablation of metal plates immersed in DDW; the laser energy was 900 mJ and 90 pulse the laser wavelength is 1064 nm and 532 respectively the particles distributions of 1064 are more homogenous than 532 and the average size of GNPs prepared at 1064 nm is smaller than that prepared at 532 nm The average sizes increases with decrease in the laser wavelength.



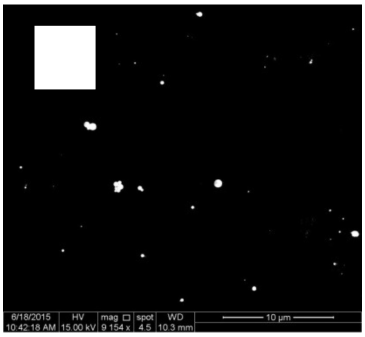
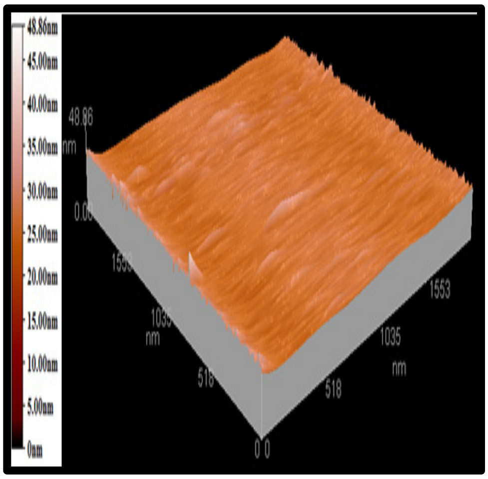


Figure 2: SEM Images Gold Nanoparticles Produced by Laser Ablation Obtained by Laser Wavelength is (A) 1064 Nm and (B) 532 nm

Figure 3 shows AFM images and the corresponding size distributions of gold nanoparticles The laser wavelength is 1064 nm and 532 nm The nanoparticles thus produced were calculated to have the average diameters of 15 nm for 1064 nm wavelength and 21nm for 532 nm wavelength The result shows that the average diameter and size distribution increase with the decrease of wavelength. The average sizes increases and the distribution broadens with decrease of wavelength[8] because the temperature of induced plasma by 1064 nm higher than the 532 nm laser mainly due to the wavelength-dependent inverse Bremsstrahlung (IB) process (such that the IB absorption coefficient is proportional to the cube or square of the wavelength) reaction rate to heat the induced plasma And the plasma at 1064 nm is more energetic compared to that generated by the 532 nm laser we found the dispersion of nanoparticles at short wavelength is better it was in range (8-14) nm.



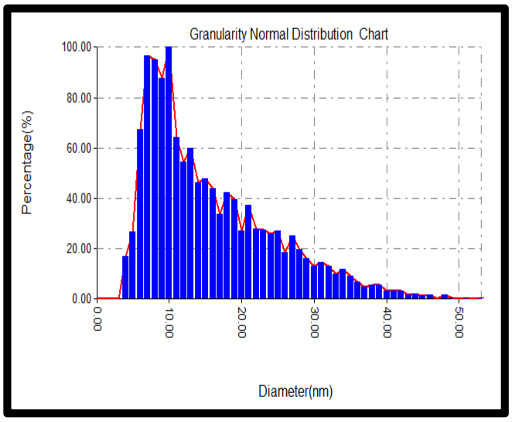
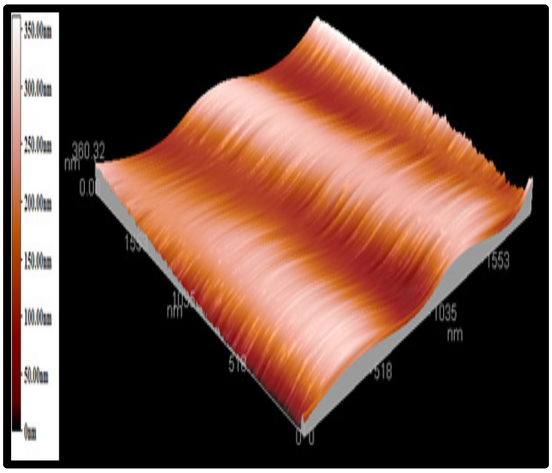


Figure 3: (A) AFM Images and Size Distributions of the Gold Nanoparticles Produced By Laser Ablation the Laser Wavelength is1064nm



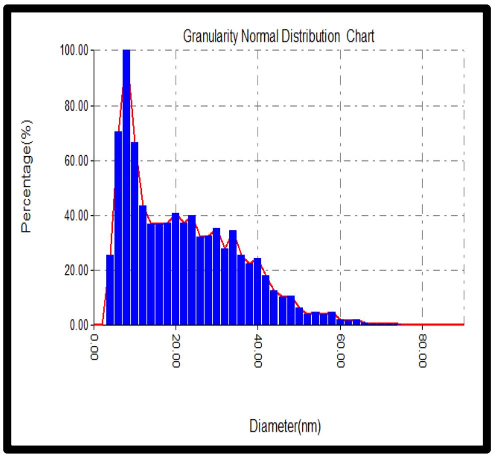


Figure 3(B): AFM Images and Size Distributions of the Gold Nanoparticles Produced by Laser Ablation the Laser Wavelength is 532 nm

CONCLUSIONS

Gold nanoparticles were successfully prepared by laser ablation in double distilled water at various laser wavelengths. Metals nanoparticles can be produced at laser wavelength of 1064-nm laser energy more efficiently than at 532 nm becouse the contributing to light absorption properties of the target materials that the average diameter and size distribution increase with the decrease of wavelength.

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