INFULENCE OF PULSE LASER ENERGY ON THE FORMATION OF GOLD NANOPARTICLES PREPARED BY LASER ABLATION IN LIQUID

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ABSTRACT

Gold Au nanoparticles (NPs) were synthesized by pulsed (Q-switched, 1064 doubled frequency-Nd: YAG). The laser ablation of Au metal plates has been performed by immersing Au metal plates in deionised water DDW. The pulsed laser ablation in liquids (PLAL) process preformed with different laser shots such as 15 and 30 pulses and laser pulse energy of(600-900) mJ and liquid depth is 8 mm. The formation efficiency of PLAL process was quantified in term of the absorption spectrum peaks. The absorption spectra Au shows a sharp and single peak around 512 nm indicates the production of pure and spherical Au NPs with an average size in the range of (5- 20) nm. There is a simultaneous possibility of on-line observation of the nanoparticles formation via measuring the variation in nanoparticles absorption at the peaks observed.

Keywords: gold nanoparticle,-laser ablation, laser shots ,noble metals nanoparticles.

INTRODUCTION

Naonosecond Nd:YAG laser was utilized as a part of the vast majority of tests achieved up today. Aside from the vitality of laser pulse energy, the aftereffects of laser removal in fluid stage rely on upon numerous other test parameters: laser wavelength, time of removal investigation, blending conditions and centering conditions. The Exact impact of a significant number of these components is not clear up today. In the event that most of the takes a shot at laser removal of fluid was performed in immaculate water (the fundamental inspiration for these works is SERS application or in watery arrangements, a few specialists made their trials in various natural solvents.

Laser ablation of bulk target immersed in liquid environment is a simple method, recently has attracted much attention for nanoparticles formation [4,5], and it is a hopeful method for the controlled production of nanomaterials via rapid reactive quenching of ablated species at the interface between the liquid and plasma. PLAL is a useful technique for preparing various types of nanoparticles (NPs) such as noble metals [6]. particles generated from laser ablation have a narrow particle size distribution with a variable primary particle size and shape.Noble Metals NPs are commonly 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 [7]. Gold have high surface area, easy fictionalization, high electric conductivity, high stability and corrosion resistance and their pronounced plasmon resonance band in the visible range as well as sensitivity to aggregation are amongst their most attractive features [8,9].

The characteristics of the gold nanoparticles synthesized and the ablation efficiency strongly depend upon many parameters such as the wavelength of the laser impacting the metallic target, the effective liquid medium and the number of laser shots[10]. This work aims to study the effect of the number of laser shots on some properties of gold nanoparticles.

Experimental Details

Au nanoparticles were set up by laser removal of a gold target. The objectives with 3mm thickness and a purity of 99.99 were washed with ethanol and deionized water to clear trademark blends in an ultrasonic cleaner. The cleaned target was made plans to the base of a glass vessel stacked with 50 cc of the strategy. Deionised water was used as the liquid environment for laser launch.

The sample surface was kept at 10 mm. In the midst of laser clearing, the specimen was rotated physically to ensure uniform expulsion and to keep up a basic segment from a Completing effect. Nd:YAG laser with a focal wavelength of 1064 nm and pulse length of 8ns was used in removal handle . The laser was working at frquance rate of 6 Hz. The Gaussian laser shaft was secured by a procedure of optical segments and gave at the standard scene to the surface of the target. After 5min of flight the UV-Vis annihilation spectra of Au colloid was in a flash measured by a spectrophotometer (Shimadzu UV-1650 PC). The surface morphology of the particles was examined by electron microscopy (INSPECT-550) and SPM AA3000 AFM supply by Angstrom co.

Result and Discussion

SEM images show the gold nanoparticles are spherical in shape. Since the media have similar dielectric functions, therefore, in this study the shift of the maximum of optical extinction is due to an increase in the size of the particles in the different environments. In addition, broadening of the extinction spectra in DDDW is related to the broad size distribution of the particles as confirmed by SEM images. It should be noted that the wavelength of maximum optical extinction was decreased with a decrease of the average size. Surface interaction between nanoparticles may result in a stable colloidal solution or control dispersion, aggregation, and precipitation. Nanoparticle–nanoparticle interaction also depends on all the attractive and repulsive force between them, such as attractive van der Waals forces that cause aggregation, and repulsive electrostatic forces due to the overlapping of electrical double layers .

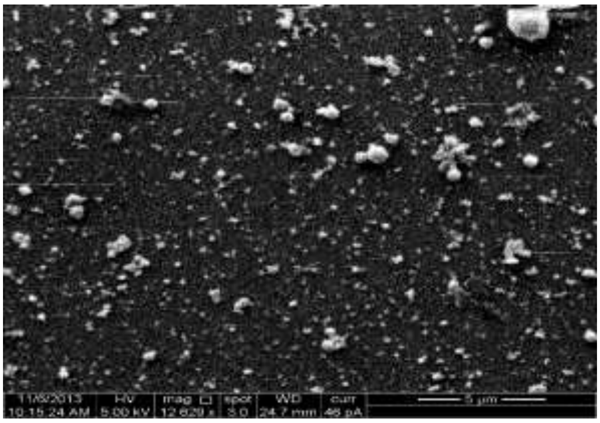

Fig. 1 : SEM image of AuNP on silicon substrate

Plume–nanoparticle interaction depends on all attractive and repulsive forces between plume species and the nanoparticles, such as attractive van der Waals forces that cause growth and/or aggregation, and repulsive electrostatic forces due to the overlapping of electrical double layers [30]. The growth rate of nanoparticles depends on the number of nanoparticles which were formed in the first stage, and the molecular polarity of the liquid environment. The polarizability of a molecule and the permittivity of the liquid medium can be very important in terms of electrostatic interaction. Figure 2 shows the UV-Vis spectrum of citrate stabilized gold nanoparticles. The plasmon band observed for the wine-red colloidal gold at 518 nm (Figure 1) is the characteristic of gold nanoparticles..

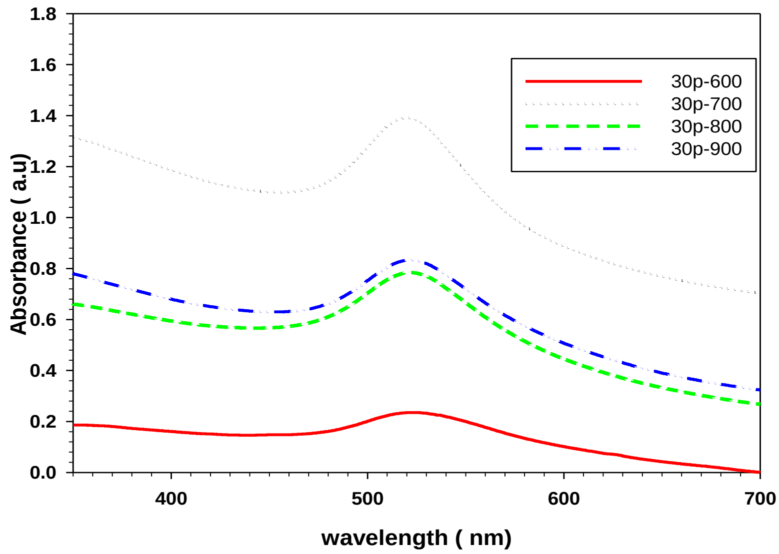

Figure 2: UV-Visible of Au nanoparticles as a function of laser power energy.

Figure 2 shows the absorption spectra of gold nanoparticles solutions, synthesized by pulsed laser ablation of a piece of silver plate placed on ultra pure DDDW. When the laser pulse reaches to the gold surface submerged in water; establish cloud spark with a strong shock wave are spread in all directions. The spark emitted light and noise consists invisible cloud of discrete nanoparticles of gold surface and spread out in all directions within the water. Liquid color changes to red and the evidence of the spread of gold nanoparticles inside the liquid and the increases in the absorption intensity of the red color it is evidence of increased density of nanoparticles and increase their numbers within the liquid.

The absorption spectrum in a solution of gold nanoparticles quasi-symmetrically around the 512 nm. These changes imply that the nano seeds in the growth solution rearranged, and the formation of spherical nano seeds occurred during this period. It can be seen from Figure 2 that the increases of the pulse energy to 700 mj lead to increase of absorbance intensity which is an evidence of increases of the density of nanoparticles inside the liquid. However the increase in the laser pulse energy above 700 mj (800 and 900 mj) lead to decreases the obsorbance intensity of Au nanoparticles due to

The fact that the laser beam works to uproot higher and larger amount of microparticles in each pulse energy. The explanation for this when you increase the ability of the laser beam make it able to eradicate Micro particles and not nano particles. The position and number of the peaks is related to the size, shape and material type of the nanoparticles. For spherical shaped particles a single peak of extinction spectra appears. Broadening of the optical absorption spectrum related to the size distribution and aggregation of the nanoparticles

Figures 3 show TEM images of Au nanoparticles. The average size of Au nanoparticles was found to be in the range of 5-10 nm. The sizes and morphology of Nano-Au was analyzed by utilizing a transmission electron magnifying instrument (TEM). The outcomes demonstrate that the Nano-Au was in a round shape and has a normal size of 10 nm (Fig. 2). Fig.2 demonstrates AFM pictures of Au NPs. An expansion in the development rate brings about a more extensive size appropriation with a more noteworthy normal size of nano-molecule which is around 10 nm. Consequently, no total and precipitation happen and the colloidal arrangement is steady.

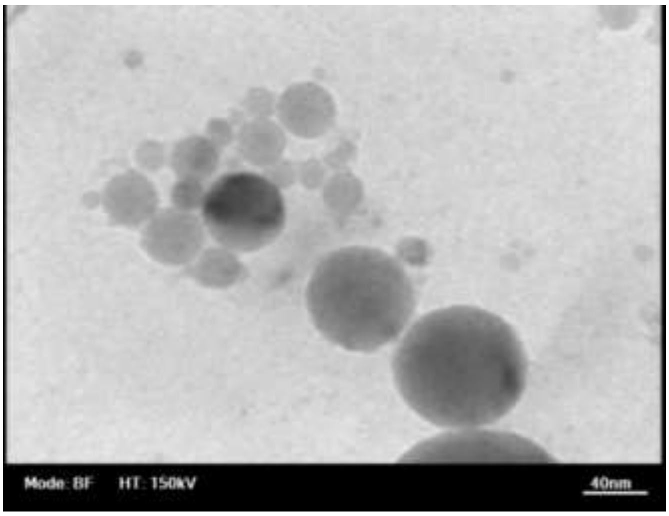

Figure 3 : TEM image of Gold nanoparticles prepared by Nd-Yag laser pulse

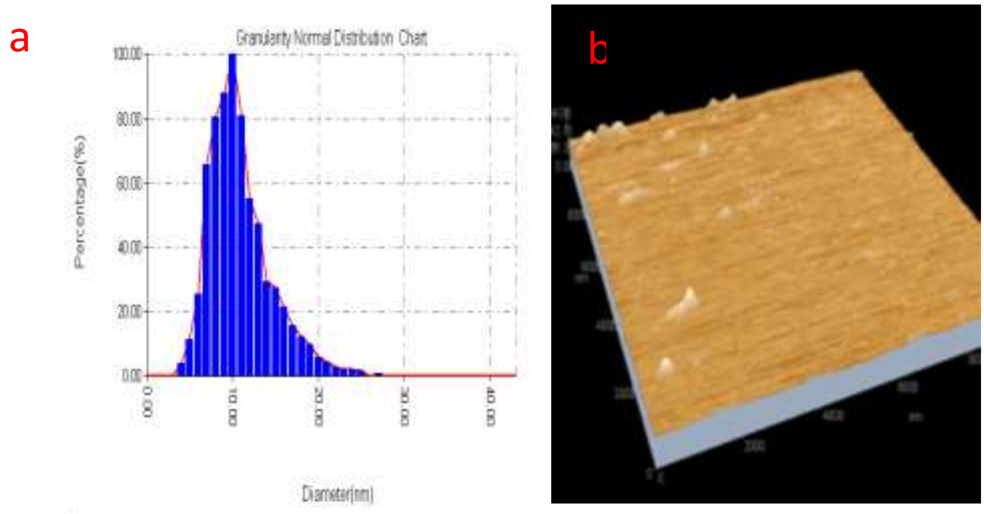

Figure 4 : AFM images of Au NPs(a) volume percentage (b) 3D image of AuNPs

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