Synthesis Conditions Of Au Core® Ag Shell System by Laser Ablation in Distilled Water By Using Different Wavelengths “(1064, 532,355)”nm

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Abstract. In this study, an easy and a rapid method has been used to prepare nanoparticles employing the laser ablation technique in Double Distilled Deionized Water (DDDW). Lasers with three different have been used. The laser ablation of a (Au core @ Ag shell) system shows the best ablation at wavelengths of 1064 and 355 nm in DDDW solution with resulting Grain size less than (20 nm). This is the best result for obtaining the size near Quantum Dot (Q.D.) of the Ag @ Au NPS system. The TEM, AFM and statistical distribution of Grain size have been used to analysis morphological properties. The absorption peak shows IR shift for Au @ Ag system, that leads to growth large grains. This indicates that Ag-shell more effective than Au-core at (532,355) nm wavelengths. Some of the optical parameters, such as refractive index (n) and extinction coefficient (k), have been calculated for the prepared nanoparticles collide. TEM shows the formation (Core -Shell) clearly, and the form of NPs can almost have a spherical shape with size < 20 nm. The gold (Au-shell) is more effective than Ag-core. The colloidal nanoparticles have been used as in biological applications to kill or inhibit E. coli and Staph bacteria.

Keyword: Nanotechnology, Laser ablation, Colloidal nanoparticles, core-shell

1. Introduction

for nanotechnology is the use of polymer nanomaterial for vascular and central nervous system surgeries. It is also used in the treatment of wounds, burns and Intervention in cosmetics[1]. Laser ablation is an effective technique for producing nanoparticle solutions Nanotechnology is the 21st century innovation. Without a doubt, this innovation has started to economically attack a few fields and applications, and there are no restrictions to potential applications at present being tried. Therapeutic has represented the a lot of nanotechnology applications and we are experiencing the time of medicinal nanotechnology.[1] For instance, the medication will convey inside the human body with bearers of nanoscale sizes that can target diverse cells in the body. This method can likewise effortlessly picture the cells of the body and control and shape in various structures. Different kinds of lysosomal nanoparticles are currently being produced to convey hostile to malignant growth properties and immunizations. Gold-covered nanoparticles are additionally used to devastate malignant growth cells. These nanotubes are around 120 nanometers in length and are littler than the extent of the malignant growth cell by multiple times[2].

One of the most promising medical applications for metals, oxides, and even organic metals. Much effort has been made to assess the effect of laser parameters and thermal properties of the liquid on the size and composition of nanoparticles[3-8].

A key feature of metals is the presence of resonant surface plasmons, which their location depends on the nature of the metal, the shape, size, and structure of the nanoparticles. Thus, the exact location of the plasmonic surface of the resonance spectroscopy over a spectral display using a single metal is
precisely determined. As for the metal-core system, its results are promising, since the optical properties of metals depend on the size of the core and the shell thickness. For example, the resonant surface plasma of the Au / Ag nanoparticle can be adjusted over a wide spectrum.

The core@ shell can be introduced by depositing silver on the surface of nanoparticles of gold. The simplest method is to produce a single metal surface material, where they will be formed in a stable manner with jackets or polymers [8]. Neodymium YAG laser model (Huafei Tongda)

Technology-DIAMOND-288 pattern EPLS) with (1064, 532,355) nm wavelength, 7 ns pulse width and repetition frequency 1-6 Hz, has been used for ablation. Results showed the best efficiency at wave length (355,1064)nm and Grain size less than (20) nm has been obtained because of the possibility of coalescence in water. The aim of the work was to preparation core shell system and used this system to treatment of bacterial growth type (E. coli and Staph).

2. Experimental Work

The nanocolloidal system (Core @ Shell) (Au@ Ag) is a way to the laser ablated metal inside of metal nanocolloidal solution of the other metal. That ablation of gold metal (core) in the nanocolloidal of silver (shell) solution or ablation of sliver metal (core) in the nanocolloidal of gold (shell) solution (Ag @ Au). By using (Nd-YAG) Laser with wavelengths (1064, 532,355) nm, (80@60) mJ energy in water with pulses (150@ 50) have been used in the laser ablation as shown in Figure (1). (Q- switched Nd:YAG laser) having maximum energy of (1000mJ) per pulse, with pulse of width (7ns) and (6Hz) repetition rat, the laser beam diameter (2mm) that has been used for laser ablation as shown in Figure (3).The absorption spectra of the colloidal solutions have been measured using A double –beam UV- Visible spectrophotometer (CECIL 2700) in the range (190-1100) nm. NPs size and surface morphology have been examined using TEM, while the surface topography of NPs examined by AFM.

![Figure 1. Experimental set-up for colloid preparation by laser ablation (Nd:YAG Laser λ= 1064, 532, 355)nm](image-url)
Figure 2. planned for the process of Ablation of silver and gold metal by (Nd- YAG)Laser.

Figure 3. (Q-Switch Nd: YAG (λ= 1064, 532, 355)nm system.
3- Results and Discussion

3.1. UV-Visible Spectrophotometer

Figure (4a) shows the NPS absorption spectra of Au core @ Ag shell prepared in distilled water (DDDW) using (1064,532,355) nm wavelengths, (60 @ 80) mJ energy and (150 @ 50) pulses. The color of the solution for wavelengths (1064,532,355) nm is shown in Fig.(4b). We observed from Fig.(4a) two peaks (400,535) nm and 397,532 and 397,532 for Au core @ Ag shell wavelength (1064,532,355) nm. The Au core @ Ag shell colloidal solution contains pure NPS for gold and silver. Absorption peaks are shifted towards the higher red (IR) wavelengths. This indicates that the effect of gold (Au-shell) is more effective than Ag-core, and this confirms the clear evidence that the effect of the Au-shell influencing the dominant Ag-core. This shift in absorption peaks is related to the collective nature of the SPR of Au and NPS Ag, which is consistent with the source[9,10,11].
3.2. Transmission Electron Microscopy (TEM)

Transmission electron microscopy (TEM) was used to examine the morphology and structure of stabilized core-shell nanoparticles. Figures (5),(6) show a TEM image and size distribution of NPs of (Au core-Ag shell), prepared by laser ablation, where the laser wavelengths (1064, 355) nm and Energy (60 @ 80) m J, in Ethanol, shows formation (Core -Shell) clearly, and note that the form of NPs can be almost as a spherical shape with size < 20 nm.

**Figure 5.** TEM image and statistical distribution of Au150 - Ag50 NPS in pure water and using parameters (λ = 1064 nm), E = (60 @ 80 mJ), (pulse = 150 @ 50) (f = 6 HZ).

**Figure 6.** TEM image and statistical distribution of Au150 - Ag50 NPS in pure water and using parameters (λ = 355 nm), E = (60 @ 80 mJ), (pulse = 150 @ 50) (f = 6 HZ).
3.3. Atomic Force Microscopy (AFM)

Figure (7a and b): shows an AFM image of the NPS Au150 @ Ag50 system in distilled water (DDDW) at energies (60 @ 80) mJ and prepared by using wavelengths of (1064,355) nm, respectively. At 1064 nm, the concentration of nanoparticles is minimal, so the chances of collisions between particles are small, resulting in small particles as in fig. 7a. At wavelength (355 nm) the concentration Nanoparticles are large. As the matter in nature tends to stabilize, the movement of collisions between particles leads to the fusion of some of them and the acquisition of the coalescences phenomenon, and then to the formation of large nanoparticle, leading to increased surface roughness and increased surface area as we observe in Fig (7b).

\( (a) \lambda = 1064 \text{ nm} \)

\( (b) \lambda = 355 \text{ nm} \)

Figure 7. AFM (3D) image of NPS for Au150 @ Ag50 in distilled water (DDDW) of a, b, when using the following parameters (\( \lambda = 1064, 355 \text{ nm} \)\( P = 150 @ 50 \text{ pulse} \), \( f = 6 \text{ HZ} \), \( E = 60 @ 80 \)) mJ.

3.4. Optical Properties of Au core @ Ag shell

The discussion of optical properties constants cover refractive index and the absorption coefficient of the Au @ Ag in distilled water. At different wavelengths, we observed the refractive index of NPs Au @ Ag in distilled water as that in fig. (8) and (9). The slope
increases in the direction of the red shift and increases with the wavelength because the increase leads to an increase in the concentration of NPS.

This leads to an increase in the refractive index, where the refractive index depends on the density. For the NPS Au @ Ag absorption coefficient in the distilled water, we noticed the wavelength increases, which increases absorption as shown in the fig. (8), (9) and [12,13].

Figure 8. Shows the relationship between the refractive index as a function of wavelength of Au @ Ag NPS and when using the following parameters (λ = 1064, 532, 355) nm, (E = 60 @ 80) mJ, pulse = (150 @ 50) in the distilled water (DDDW) (a, b, c).
Figure 9. Shows the relationship between the extinction coefficient as a function of wavelength of Au @ Ag NPS and when using the following parameters (λ = 1064, 532, 355) nm, (E = 60 @ 80) mJ, pulse = (150 @ 50) in distilled water (DDDW) (a, b, c).

3.5. Applications of nanoparticles
Nanoparticles (Au, Ag and Au-core@Ag-shell) are prepared in distilled water (DDDW), laser excision card (60, 80, 80 @ 60) mJ and wavelength (1064). Two types of harmful bacteria are inhibited in the human body (E. Coli, Staph). Fig. 10 shows the absorbance spectra of NPS Au, Ag, Au @ Ag, and the color of the colloidal nanoparticles of each metal. Note that the absorption
peaks are around 529, 394, 400 @ 541) nm for NPS (Au, Ag, Au core @ Ag shell), respectively.

a) Au

![Graph showing absorbance vs. wavelength for Au NPS in pure water]

b) Ag

![Graph showing absorbance vs. wavelength for Ag NPS in pure water]
Figure 10. Absorption spectra and photos of NPS for Au, Ag, Au @ Ag in distilled water (DDDW), at (λ = 1064 nm), (E = 60, 80, 60 @ 80) mJ.

Figure (11): shows the photographs of the effect of nanoparticles of gold and silver and Au @ Ag on two types of bacteria (E. coli, Staph).

Bacteria have been kept for incubation at 37 °C for 24 h. The used medium is Muller Hinton Agar and the bacterial hole capacity was 0.5 mm. The colloidal nanoparticle of gold and silver and Au @ Ag were added by (0.2) ml in the bacterial hole and the best bacteria were inhibited where the nanoparticle is Staph bacteria.
Figure 11. Photographs of the effect of nanoparticles on silver and gold and Au @ Ag on two strains of bacteria (Staph, E. coli).

4- Conclusions

1- The particle size and stability of the nanoparticles can be controlled by appropriate laser parameters (wavelength and energy). In addition to the concentration of the solution used.
2- The quality and morphology of the shell can be controlled using different laser energies.
3- The laser ablation of Au @ Ag in distilled water shows the best efficiency at wavelength (355, 1064) nm. and Grain size less than (20) nm have been obtained because of the possibility of coalescence in water because water is of polar matter.
4- The process of employing colloidal nanoparticles of (Au @Ag , Ag, Au), dissolved in distilled water, at a wavelength of 1064 nm, and a card of (60 @ 80) mJ in an applied field to kill two types of (E. coli, Staph) where successfully managed to kill bacteria.

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