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Behavior of Localized Surface Plasmon Resonance with Shape, Size, Liquid Medium and Magnetic Field in Au:Ag Alloy

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Abstract: In this research study the behavior of the subject of the oscillation resonance Surface Plasmon (SPR) and the size and shape of nanoparticles for alloy Au_{50}: Ag_{50} prepared in a manner laser ablation in pure water and Sodium Dodecyl Sulphate (SDS) solution and at three different concentrations 0.25, 0.09, 0.01 molar. Where showed SEM pictures of colloidal nanoparticles for Au_{50}:Ag_{50} alloy composition of two types of forms of nanoparticles, one cube-shaped in the case of energy use 730 mJ and the other on a spherical shape when energy use 430 mJ in a (SDS) solution and at wavelength 1064 nm. Laser ablation for the alloy under the influence of magnetic field led to increase the concentration and size of nanoparticles which led to the removal of the top of the subject of the oscillation resonance surface plasmon towards larger wavelengths, X-Ray Diffraction (XRD) spectra of colloidal nanoparticles of alloy prepared in water it showed when to shed the magnetic field during laser ablation process plays an important role in improving the optical properties of the NPs.

Key words: Nanoparticles, nano-collide, laser ablation, surface plasmon resonance, water, magnetic field

INTRODUCTION

Nanoscience is intended that science that deals with the study and characterization of nano-materials and the appointment of the chemical and physical properties with the study of phenomena associated arising from decrease sizes and nanotechnology refers to 10^{-9} m (Kittel, 2004). Perhaps not received any previous interest technology and anticipation like that enjoyed by nanotechnology (Nano Technology) which is the magic key to progress in science and knowledge (Huang and El-Sayed 2010).

That the term plasmon used to refer to plasma oscillations in metals such as collective oscillation of the conduction electrons by light. The term resonance refers to aplasma oscillationsexcited by electromagnetic waves and the term surface use because the polarization of the surface is the original inplasma oscillation (Huang and El-Sayed 2010; Darroudi *et al*., 2011). The Surface Plasma oscillation (SPR) in the metal nanoparticles absorb or dissipate the the photon oscillation of a certain wavelength.

And for (Alloy clusters) the great importance because of the advantage of collective electromagnetic interactions we used gold and silver alloy and went by (Au_{50}:Ag_{50}) which can attend by (Direct solution growth) or (Self-assembly) method (Yan *et al*., 2010). This allows combining the individual nanoparticles properties by interactions with the nearby nanoparticles properties that could lead to new properties different from those of the original components (Yin *et al*., 2012). In other advantage to the use of noble delivery of heat and electricity they are superior to all other metals (Kim *et al*., 2012; Khilkhal *et al*., 2014). The weight atomic of silver is (107.868) and silver fused at a temperature 962°C. Either the gold is a chemical metal element and has a gold color yellow brilliant, atomic number (79) and atomic weight (196.967), melts at a temperature 1064°C and boils at 2856°C and the gold good conductor of heat and electricity is not affected by air or heat and humidity does not melt in concentrated acids such as hydrochloric acid and sulfuric but dissolved in aqua regia (a mixture of hydrochloric acid and Alnterec Center).

MATERIALS AND METHODS

Practical part: Nanoparticles prepared (NPs) of Au_{50}:Ag_{50} alloy by laser ablation of a piece ofhigh-purity alloyin different solvents such as Double Distilled and Deionized Water (DDDW) and Sodium Dodecyl Sulphate (SDS) with different concentrations (0.25, 0.09, 0.01) molara using

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basic wavelength 1064 nm of laser (YAG:Nd) with energy 730, 610, 520, 430 mJ and a width of a pulse (Mubdir *et al*., 2014) nanoseconds and the rate of recurrence (Kim *et al*., 2012). Hzand the number of pulses (100) pulse. Was used baker glass and a situation where the solution then a piece where the dimensions of the alloy piece (1×1) cm^2 and the height ofthe liquid level in baker 4 mm, used the lens to the nation to focus the laser beam with afocal length 15 cm.

Used magnetic flux system during the laser ablation process of the Au_{50}:Ag_{50} metal alloy type (Nivs technologies Pvt., Ltd., India) which generates a variant magnetic flux of from 5 m teslato 1000 mT.

Structure properties and size of nanoparticles, the shape and morphology of the samples deposition were analyzed by using X-Ray Diffraction (X-Ray) and Scan Electron Microscope (SEM) and Transmission Electron Microscope (TEM) where the absorption spectra measured of NPs solution by (UV-visible) spectrum.

RESULTS AND DISCUSSION

Laser ablation of Au_{50}:Ag_{50} alloy in the water: Figure 1 absorption peak of Au_{50}:Ag_{50} NPs about 430 nm in water (DDDW) using a wavelength 1064 nm. When increasing the laser energy of 730-430 mJ, the focus of NPs will increase and this leads to absorbance increased and when it hits laser pulses metal surface submerged in 2 mL of water (DDDW) it will be generated with the wave of a strong vibration spreading cloud in all directions within the impact area. This cloud sends light and noise, the problem of invisible cloud of metal particles which adsorbs outside surface of the metal and dispersed in all directions within the liquid. Shown that the color of the solution changes when the increased laser energy where they lead to concentration increasing of nanoparticles and thus increased sharpen the solution color (Al-Dahash, 2016).

The absorbance of nanoparticles of the alloy at using high laser energies, produced NPs be with a high concentration and the large nano-size and this is due to a surface plasmon resonance Package Display Decrease (SPR) to increase energy (Table 1).

Figure 1 and 2 shows the image of Scanning Electron Microscope (SEM) and the EDX scheme of the colloidal solution for alloy Au_{50}:Ag_{50} prepared in water, using a wavelength of 1064 nm and at energy 610 mJ, Fig. 1 shows turned out to be a kind of spherical forms for granules nanoparticles and the rate of volume of granular 37 nm and EDX scheme refers to the purity of the components of the alloy of gold and silver (Al-Dahash, 2013).

Table 1: For the value highest of the absorbance spectrum of nanoparticles of the alloy in the water and at the wavelength 1064 nm as a function of laser energy

Energy (mJ)	Absorbance	Wavelength (nm)
730	0.26	430
610	0.21	427
520	0.20	415
430	0.12	415

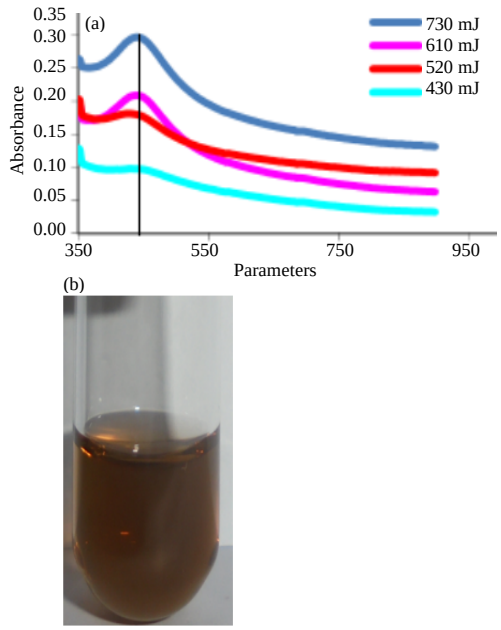

Fig. 1a, b: The absorbances pectrum of the NPs colloidal solution of the Au_{50}:Ag_{50} alloy in the water (DDDW) when using the following parameters (λ = 1064 nm) (P = 100 pulse), (f = 6 HZ)

Figure 3 shows the TEM image and distribution statistical of Au_{50}:Ag_{50} alloy solution colloidal in the water and at the wavelength the main 1064 nm of laser (Nd: YAG) and when the ablation energy of 610 mJ, see from figure forming spherical nanoparticles with the rate of volume of granular 37 nm and also note the beginning of the network forming or in advanced cases of growth (nano wire) due to increased energy to 610 mJ, thereby increasing the likelihood for re-docking and extended nanoparticles (coalescences) which leads to an opportunity to be some large-grained and as is evident in the statistical distribution facility for the image (Al-Kinany *et al*., 2014).

Figure 4 shows The TEM image and statistical distribution of nanoparticles size for Au_{50}:Ag_{50} alloy in water (DDDW) and at (100) pulse and a wavelength 1064 nm and energy 430 mJ and note that when you use a little energy led NPs to the production of nano-size and small volumetric rate of 20 nm which shows that the use of the few energies leads to reduce the chance for

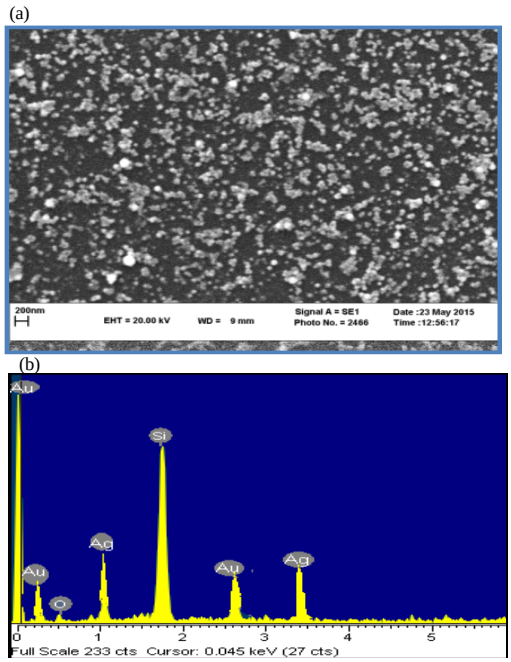

Fig. 2: The SEM images and EDX scheme of nanoparticles of Au_{50}:Ag_{50} alloy colloidal in water (DDDW) and at using parameters (λ = 1064 nm), (E = 610 mJ), (pulse = 100)

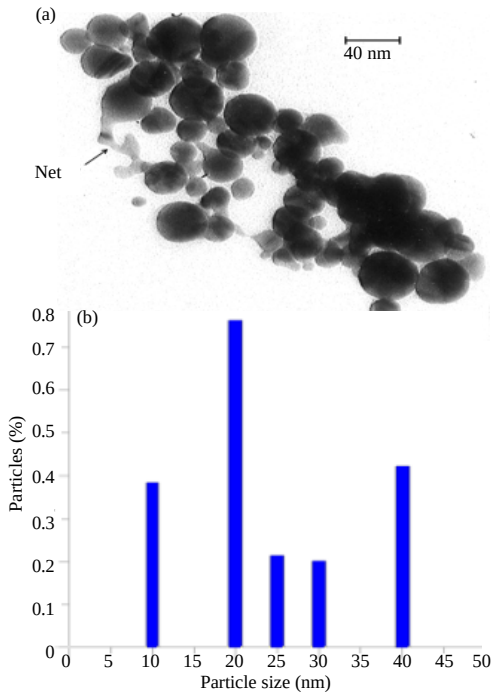

Fig. 3: The TEM image and distribution statistical of nanoparticles of Au_{50}:Ag_{50} alloy colloidal in pure water and at using parameters (λ = 1064 nm), (E = 610 mJ), (pulse = 100) (f = 6 Hz)

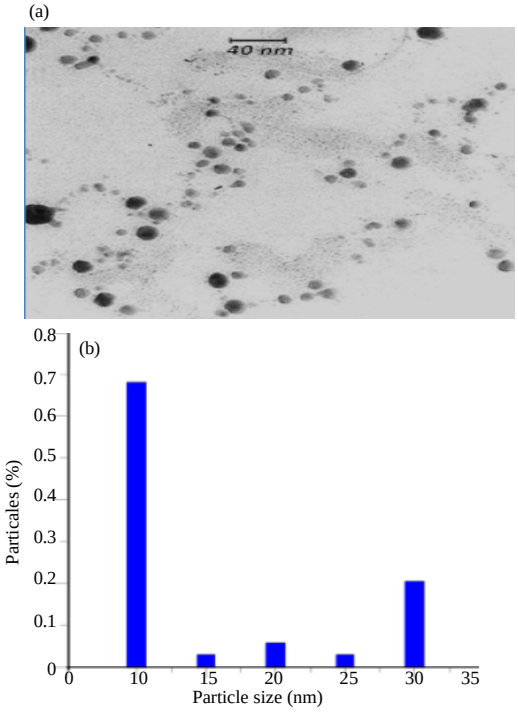

Fig. 4: The TEM image and distribution statistical of nanoparticles of Au_{50}:Ag_{50} alloy colloidal in pure water and at using parameters (λ = 1064 nm), (E = 430 mJ), (pulse = 100) (f = 6 HZ)

(coalescences) and be small spherical granules and as is clear from the statistical distribution facility for the image.

Laser ablation Au_{50}:Ag_{50} alloy in SDS solution: Figure 5 shows the absorbance spectra of the NPs of Au_{50}:Ag_{50} alloy which owns the absorption peaks at 463, 427, 424 nm where the ablation of alloy metal submerged in 2 mL of the SDS solution and at three different concentrations are 0.25, 0.09, 0.01 molar, respectively and at the wavelength 1064 nm and four different energies and figure we can see that the intensity of the top absorbance for NPS colloidal be at the lower concentration (0.01) molar and this result is interpreted that the highest absorbency of NPs Au:Ag be at the least concentration, this shows that the NPs be more stabilizing than the rest of concentrations due to a case of (hybridization) for (SPR) between gold and silver and the emergence of the Localized Surface Plasmon Resonance (LSPR). And over the possibility of the case of hybridization occurring (LSPR) is equal to the lattice constants of both gold andsilver almostmaking it easier coalescences process and homogeneity of network installation for both of them (Ghaleb and Nagham 2016).

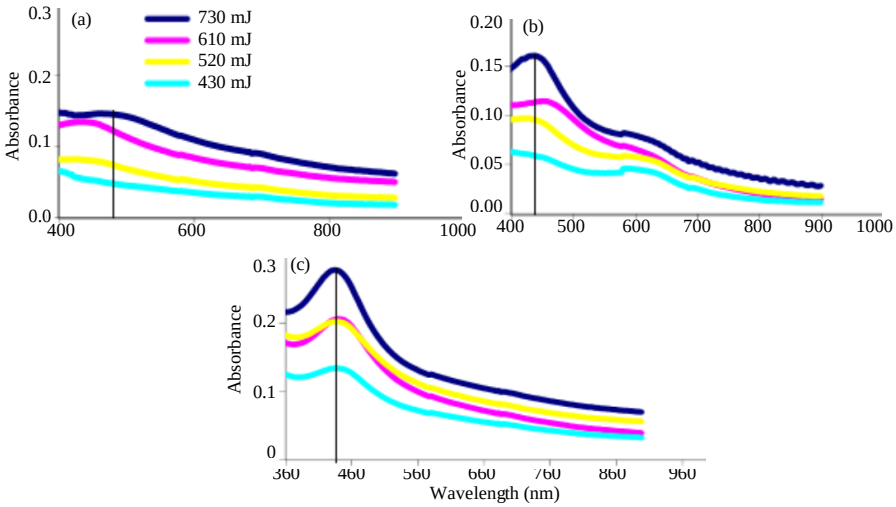

Fig. 5: Absorbance spectrum of nanoparticles of Au_{50}:Ag_{50} alloy colloidalin SDS solution and at three concentrations 0.25, 0.09, 0.01 molar and at λ= 1064 nm, pulse = 100 and in four different energies

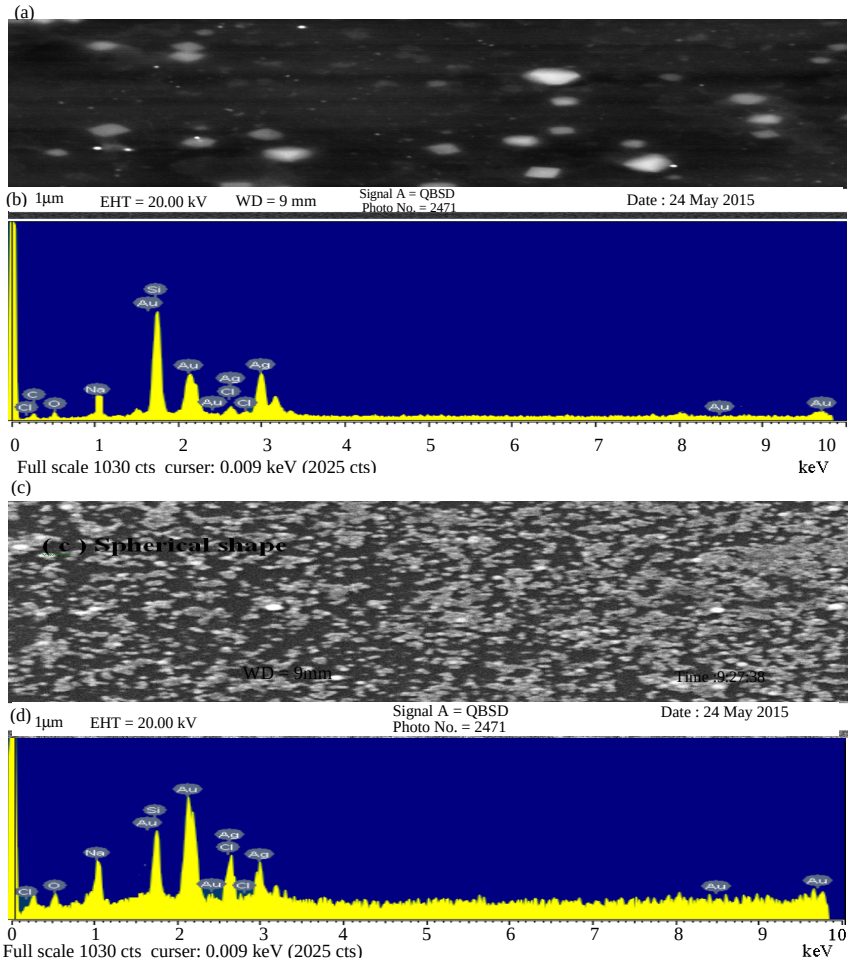

Fig. 6: a) The SEM images and EDX scheme of nanoparticles of Au_{50}:Ag_{50} alloy colloidal; b) In (SDS 0.25) solution and at energy 730 mJ; c) In the (SDS 0 .01) solution and d) At energy (430 mJ) and at using (λ = 1064 nm), (pulse = 100)

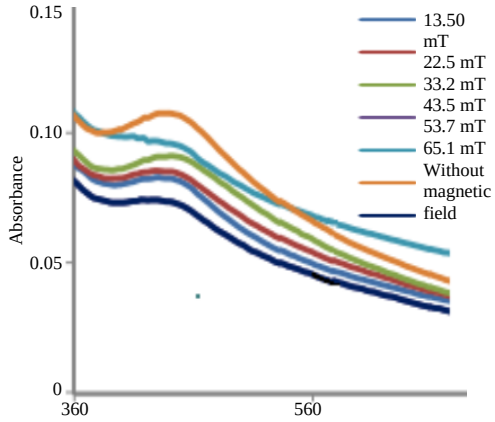

Fig. 7 : The absorbance spectra of nanoparticles for Au_{50}:Ag_{50} alloy colloidalin water (DDDW) and at (λ = 1064 nm), (E = 430 mJ), (pulse = 100), the magnetic fluxintensity ranging from (10 -65.1) mT

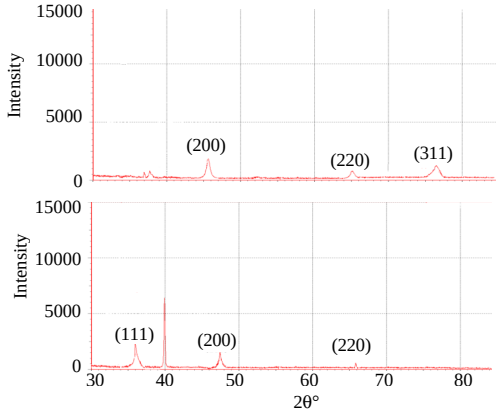

Fig. 8: The X-Ray Diffraction spectra (XRD) of Au:Ag NPS prepared in water, the presenceand the absence of the effect (MF) and when (λ = 1064nm), (E = 430 mJ) and at the magnetic flux intensity (65 0.1) mT

Figure 6 shows Scanning Electron Microscope (SEM) Image and the of EDX scheme forming the two type from forms of nanoparticles, one cube-shaped in the case of laser ablation when the energy is 730 mJ and in the (SDS 0:25) solution and the other on the spherical shape in the case of laser ablation when the energy is 430 mJ and in the (SDS 0.01) solution and both are using the wavelength (1064) nm and attributed the cause to configure these shapes (spherical and cube) because the spherical shape needs to less Potential Energy (PE) compared with the cubeshape this will lead to prevent caking at least concentration, compared to the high concentration (SDS 0.25). Therefore, the absorption peak for nanoparticles for the cube shape be unclear peak (un-sharp peak) and this is confirmed by the Fig. 5 a this shows that the surface plasmon impact for nanoparticles be the less at the top concentration (SDS 0.25) at energy 730 mJ and this leads to the (aggregation) lead to the formation cube shape as shown in Fig. 6a. While the absorption peak of nanoparticles for spherical shape be sharp and very clear and this is because of the influence of surface Plasmon be high in the formation of nanoparticles, leading to the appearance of absorption peak as shown in Fig. 5c this leads to the formation of spherical shape as it is shown in Fig. 6c. The case of non-spherical shapes are unusual obtained (rare) in the method of laser ablation where forms are often spherical therefore, considered the emergence of cubic forms of new state (Nikolov *et al*., 2011).

The magnetic field effect of Au_{50}:Ag_{50} alloy in water (DDDW): Figure 7 shows the absorbance spectra of the Au: Ag Nps colloidalat the wavelength 1064 nm and notes when they areeffecta magnetic field during laser ablation to the alloy, the absorbance Peak shift about 460 nm and that explain the increased size of the NPS and also noted that the increase absorbance when the Magnetic Flux intensity increasing (MF) which refers to the increase in the concentration of the alloy NPS.

Table 2:The magnetic field effecton the average sizeof NPS

The effect	2 θ°	hkl	Full Width at Half Maximum (FWHM)	NPS size(nm)	NPS average size (nm)
The magnetic	38.0	111	0.16	64.0	31.8
field absence	45.0	200	o.62	17.3	
	65.0	220	o.65	14.2	
The magnetic	37.5	111	0.64	15.0	49
field presence	45.5	200	0.29	32.0	
	66.0	220	0.11	100.0	

Figure 8b shows the X-Ray Diffraction spectra (XRD) of Au: Ag NPs colloidal prepared in the water, under the influence of magnetic field and the lack of impact where noted when you do not effect (MF), the deviation peak (111) be sub visible while the notes when effect a magnetic field during laser ablation process for alloy metal and at magnetic flux intensity (65.1) mT has become a clear and grown in three directions (hkl) and also notes that there are clear deviation peaks when you do not effect the magnetic field while becoming a quasi-visible or hidden when it is effect the magnetic field during the laser ablation process. It is therefore concluded that the influence of Magnetic Field (MF) during the laser ablation process plays an important role in improving the crystalline properties of the NPs. Table 2 shows the effect of the magnetic field effect an average particle size of the NPs and the note from the table that the average particle size of the NPS during magnetic field effect during the

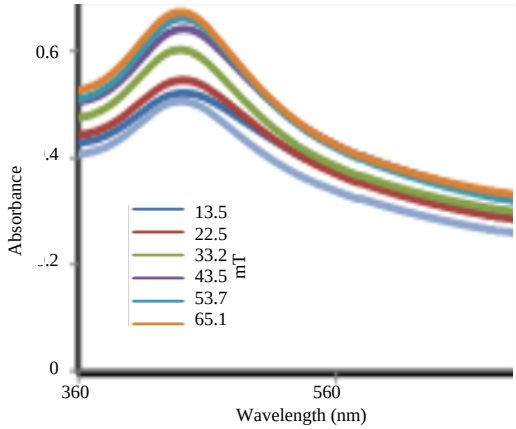

Fig. 9: The absorbance spectra of Au:Ag NPs colloidalin SDS solution and the concentration of 0.25 moralar and at (λ = 1064 nm), (E = 430 mJ) (Pilse = 100), the magnetic flux intensity (65.1-10) mT

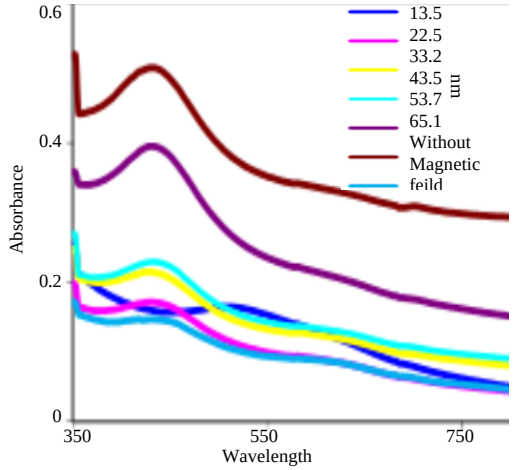

Fig. 10: The absorbancespectra of Au: Ag NPs colloidalin SDS solution and theconcentration of (0.09) Molar andat (λ = 1064 nm), (E = 430 mJ), (Pulse = 100), the magnetic fluxintensity 65.1-10 mT

removal process is greater than the average particle size of the NPs without field effect and this indicates that NPs be great because confinement that occurs for plasma during effect the magnetic field which increases the chance of nanoparticles jowl with each other and thus, the production of large size NPs (Duggal and Tech, 2006).

The magnetic field effect of Au_{50}:Ag_{50} alloy in SDS solution: Figure 9 shows the absorbance spectra of Au: Ag NPs colloidalin SDS solutionand the concentration of (0.25) molar andatthe wavelength 1064 nm.Note fromthe figure, the absorbance increases when increasing the Magnetic Flux intensity (MF) which refers to the increase in the concentration of the alloy NPs. and absorbency peak higher appear at 65.1 mT.

Figure 10 shows the absorbance spectra of the Au: Ag NPs colloidalin SDS solution and the concentration of (0.09) molary andat the wavelength 1064 nm it is noted that the absorbance increases when increasing the Magnetic Flux intensity (MF) which refers to the increasein the concentration of NPs of the alloy as well as the absorbance peak shift about 500 nm, at the magnetic flux intensity 43.5 mT in addition to that noted an increase of the magnetic field, the display absorption package (FWHM) will decrease significantly indicating increased plasma confinement and lack of breadth, leading to increase the intensity of ions and particles and leading to an particles union opportunity which indicates an increase in the size of the NPs.

Figure 11 shows the absorbance spectra of the Au:Ag NPs colloidalin SDS solutionand the

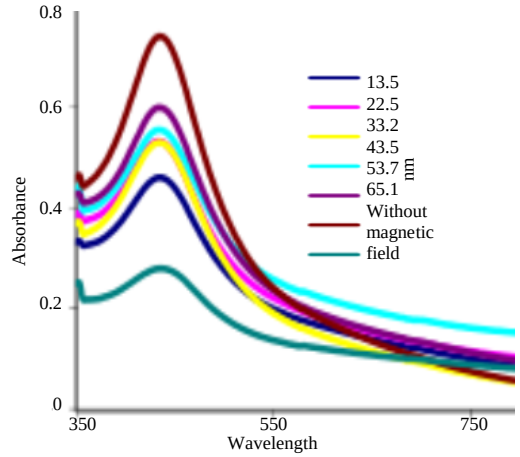

Fig. 11: The absorbance spectra of Au:Ag NPs colloidali n SDS solution and the concentration of (0.01) molara and at (λ = 1064 nm), (E = 430 mJ), (pulse = 100), the magnetic flux intensity (65.1-10) mT

concentration of (0.01) molar andat the wavelength 1064 nm note from figure that the increases absorbance when increasing the Magnetic Flux intensity (MF), the density Plasmon increases due to confinement increased or packing but in this lowest concentration (0.01) molar we note that there is nodisplacement as happened in the highest concentration and that the lack of concentration of chloride ions which help to increase the proportion of the size of the aggregation and hence the increased field intensity lead to an increase in the concentration of NPS (Chen and Chen, 2002).

CONCLUSION

Laser ablation of (gold-silver) alloy metal in the SDS solution and at the wavelength 1064 nm, led to the formation of two types of forms of colloidal nanoparticles depending on the used energy. At energy 730 mJ got a cubic shape and this is rarely obtained at using the method of laser ablation in liquids. But at the energy is 430 mJ got a spherical shape.

The magnetic field effect during laser ablation process led to the removal of the top position of the surface Plasmon resonant oscillation toward larger wavelengths due to confinement increased and there by the granular size increasing of nanoparticles.

The magnetic field effect during laser ablation process led to the improvement of the optical properties of nanoparticles to colloidal Au_{50}:Ag_{50} alloy.

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