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Core – Shell Properties of $Au_{@}Ag$ and $Ag_{@}Au$ Colloidal system Prepared by Laser Ablation

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Abstract : In this research was prepared Core-shell nanocolloid system of Au-Ag by using pulses of Nd–YA Glaser with (1064nm) wavelength and (40) mJ energy, in (DDDW). Structural and spectral Properties were studied by using Transmission electron microscope (TEM) and UV-Visbl. Spectrophotometer, where TEM images showed formation of Core-Shell clearly. As well as TEM images showed nanoparticles of the gold colloidal with configure the nano-sized particles less than 10 nm. As well as the (UV - visible) Spectrum showed formation (Au_{Core}-Ag_{Shell}) and (Ag_{Core}- Au_{Shell}) in both cases shifted (SPR) peaks to (450) nm, and to 470 nm, respectively, this confirms formation surface overlap of (SPR), between (Core) and (Shell).
Keywords: Core – Shell, $Au_{@}Ag$, $Ag_{@}Au$ Colloidal system, Laser Ablation.

Introduction:

Production of nanoparticles by laser ablation of solid materials in gas or in vacuum has been explored extensively over the past two decades. The method of laser Ablation has received considerable attention as a new technique to produce nanoparticles. Which represents the phenomenon of laser interaction with the material, as the amount of mass removed depends on the laser parameters (such as pulse duration, number of pulses, energy, wavelength, the properties of the target and surrounding[1,2] As a result of scientific progress, the methods of the preparation of nanoparticles has developed and became advantages of each method and the methods implemented to serve their purpose, which is used for them[3].

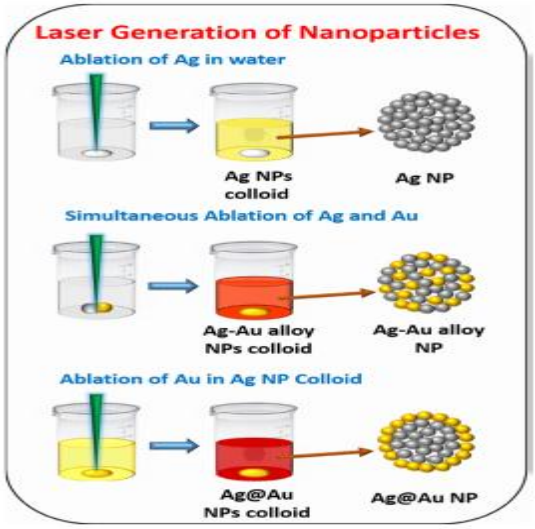
Method of (Laser Ablation) is applied of a laser pulse with a high-energy on a solid target, then at very short time , formation nanoparticles and deposited on substrate and composed of thin-film, this method has been used for the first time in 1960[3].
This way (PLAL) has much attention as a new way for production of nanoparticles (NP_S). In general, this method has the ability to produce different kinds of nanoparticles such as metals[4-6] and noble metals[7,8] semiconductor[9] alloy[10,11] and oxides[12].

The preparation of the elements (Alloy Clusters) are of great importance where utilized from the collective electromagnetic interactions, this allows combining the properties of individual nanoparticles by interactions with neighboring properties of nanoparticles, which can lead to new properties different from those of the original components.

Experimental Part

The nanocolloidal system(Core – Shell)(Ag - Au) is a way to the laser ablated metal inside of metal nanocolloidal solution of the other metal. That means ablation of silver metal (core) in the nanocolloidal of gold (shell) solution or ablation of gold metal (core) in the nanocolloidal of sliver (shell) solution. By using (Nd -

YAG) Laser with wavelength (1064 nm), (40) mj energy in Double Distilled and Deionized Water (DDDW), as shown in Figure (1).The figure shows the stages of (Core - Shell)preparation in distilled water twice and deionized Double Distilled and Deionized Water (DDDW).



Figure(1-1) : planned for the process of Ablation of silver and gold metal by(Nd-YAG)Laser(13).

Results and discussion

1 – 1Nanocolloidal solution of (Au_{Core} - Ag_{Shell}) system:

Figure **(1-2a)** shows the absorbance spectrum of nanoparticles of(Au, Ag, Au_{core}-Ag_{shell}) prepared in the water, and when the wavelength (1064) nm and (40) mJ energy, we noted three peaks (450, 540 410) nm for (Au_{core}- Ag_{shell}, Au, Ag) respectively. Where Au_{Core}- Ag_{shell} NP_S contain gold and silver, peak (540) shifted toward (blue wave length). Figure**(1 - 2 b)** showed the color of the colloidal solutions of nanoparticles for (Au, Ag, Au_{core}- Ag_{Shell}) respectively.

We note that the absorption peak of the (Au_{Core}) is (540) nm, and when formation of the (Core - Shell), the peak of absorption shifted towards shorter wavelengths (Blue Shift). The effect of (Ag - Shell) will be more influence than the (Au - Core), and thus the value of (SPR) absorption will be shifted from 540 nm to 450 nm, and so by the silver shell effect, this confirms clear evidence of shell than Core.

(a) **(b)**

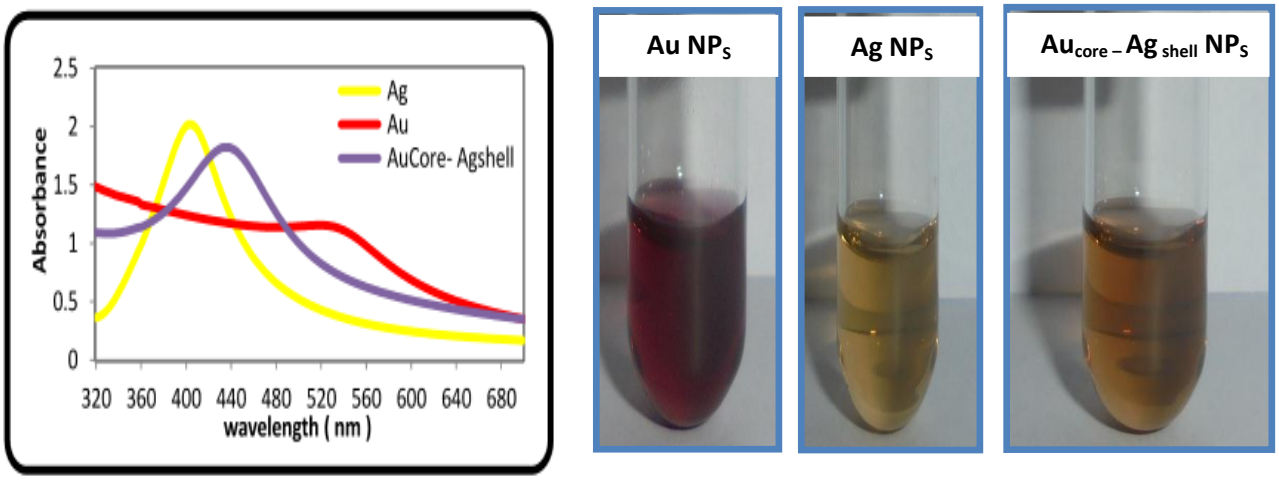
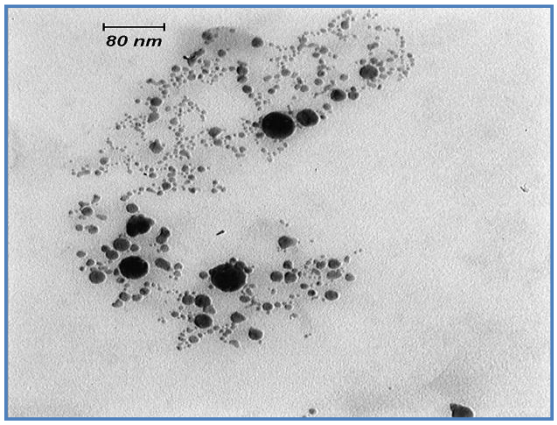
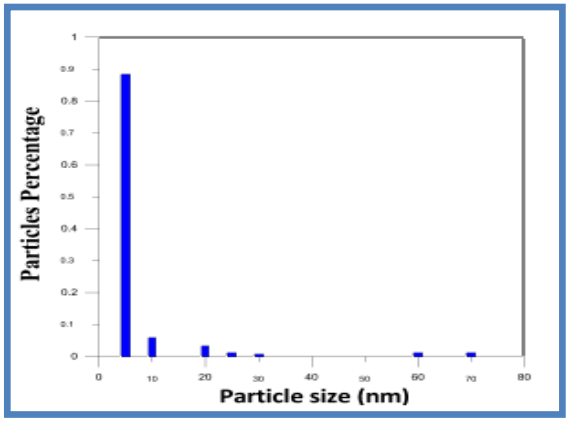


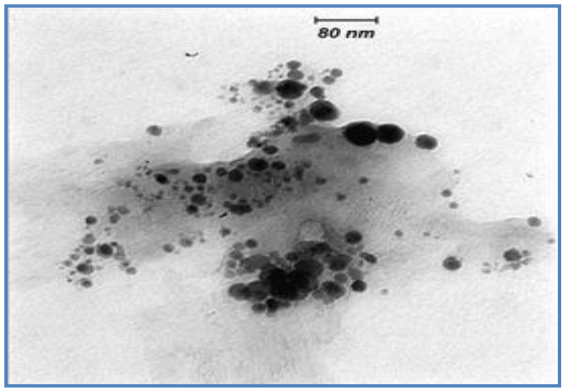
Figure (1 - 2): (a)absorbance spectra of (Au, Ag, Au_{core} - Ag_{shell}) NP_S in water, at (λ = 1064 nm), (E = 40 mJ),, (pulse of Au = 50 P), (pulse of Ag = 100 P) ,(b) Photos of NP_S collide.

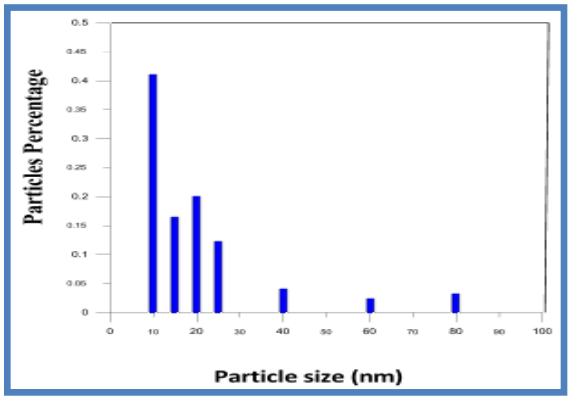
Figure**(1-3)** shows TEM images and size distribution of NPS of(Au, Ag, Au_{core}- Ag_{shell}) prepared by laser ablation, where the wavelength (1064) nm and Energy (40)mJ, in the water (DDDW). Figure**(1 -3a)**shows formation of particles with size of less than 10 nm nanometer (Quantum dot), for Au NP_S colloidal, Figure**(1-3c)** shows the effect of (Core - Shell) clearly and as described below.



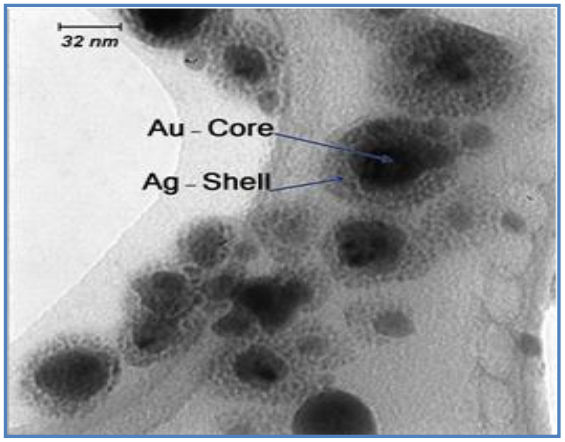


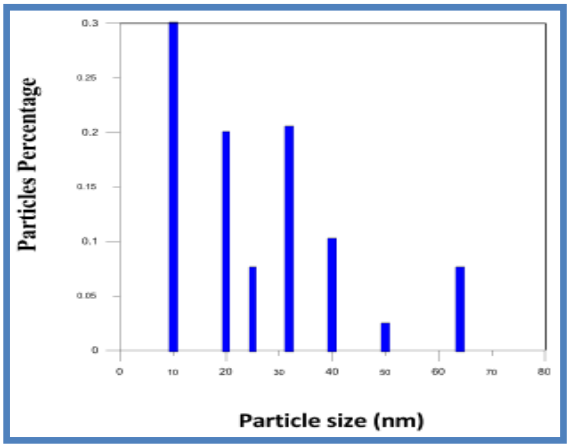
(a) Au NP_S





(b) Ag NP_S





(c) Au_{Core} – Ag_{Shell} NP_S

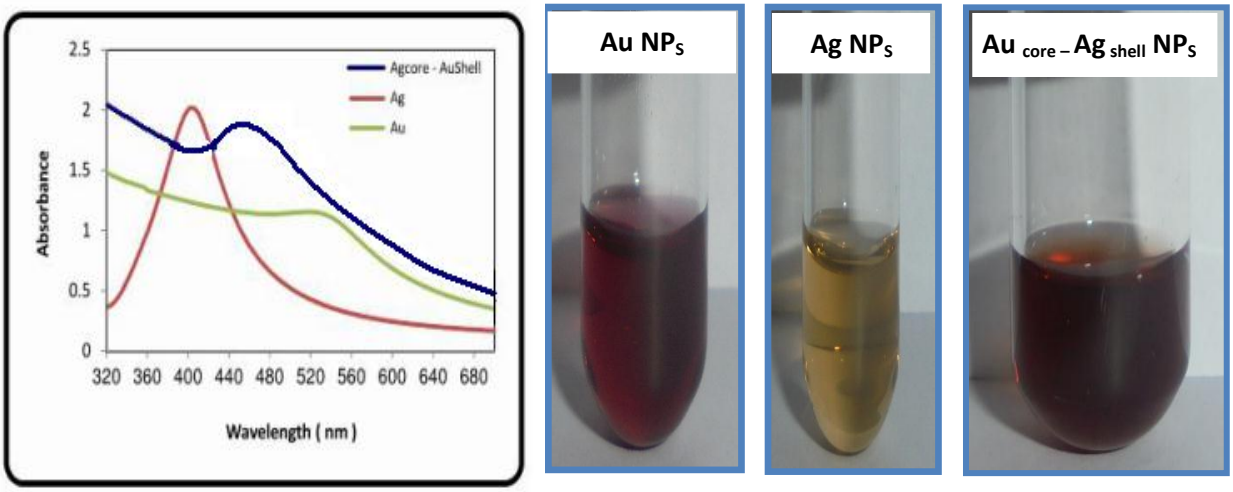
Figure(1-3): The TEM image and Statistical Distribution of nanoparticles (Au, Ag, Au_{core} - Ag_{shell}), in water with (λ = 1064 nm), (E = 40 mJ), (pulse of Au_{Core} = 50 P), (pulse of Ag_{Shell} = 100 P) (f = 6 HZ).

2 - Nanocolloidal solution of (Ag_{core}–Au_{Shell})system :

Figure (1 - 4 a) shows the absorbance spectrum of nanoparticles of (Au, Ag, Ag_{Core}- Au_{shell}) colloidal prepared in water ,with (1064) nm wavelength and energy (40) mJ, we noted three peaks (470, 540 ,410) nm for (Ag_{core}-Au_{shell}, Au, Ag) respectively .where Ag_{Core}- Au_{shell} colloidal contains pure NP_S for gold and silver. Can we see the color of each of the colloidal nanoparticles (Au, Ag, Ag_{core} - Au_{Shell}) as in Figure (1 - 4b).

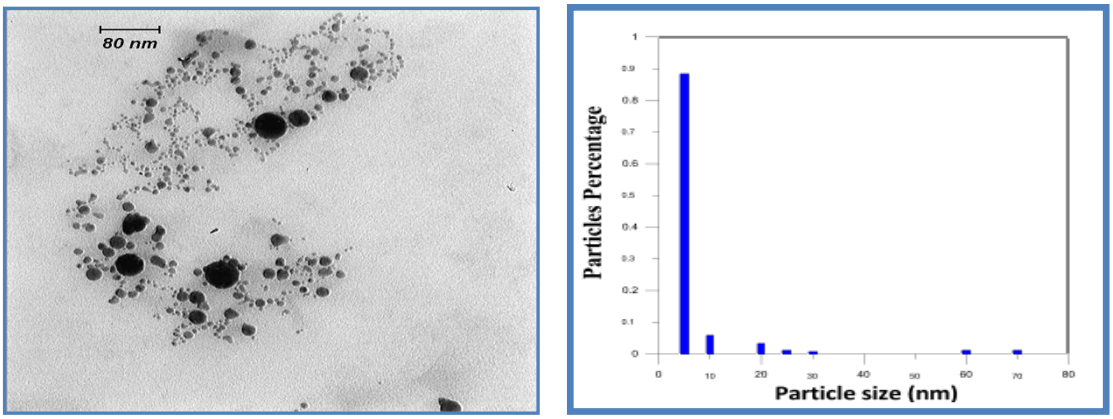
We noted that the absorption peak of (Ag_{core}) was (410) nm, and when you configure the installation of the (Core - Shell), the absorption peak shifted to larger wavelengths (red shift). The effect of (Au - Shell) was more effective than the core(Ag - Core), and thus the value of the SPR absorption will be shifted from 410 nm to (470) nm, and so by the golden shell effect (Au - Shell), and this confirms clear evidence that the effect of the (shell) influential, which dominates the effect of (Core) ,when comparison between (1 - 4 a) and (2 - 4 a) note in both cases installation (Au_{Core}-Ag_{Shell}), or (Ag_{Core}- Au_{Shell}) will be pushed (SPR) peak to (450) nm, and (470) nm, respectively, and this supports the case for a superficial overlap of (SPR), between (Core) and (Shell).

(a) **(b)**

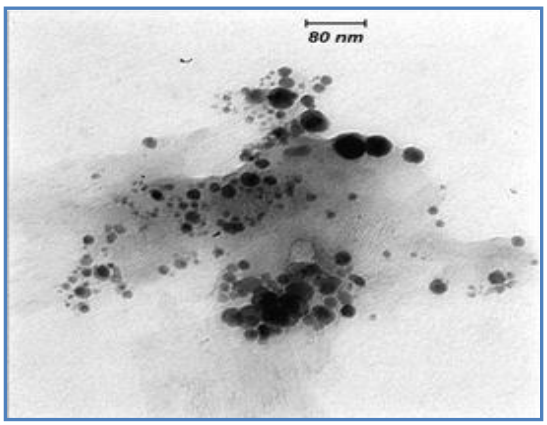


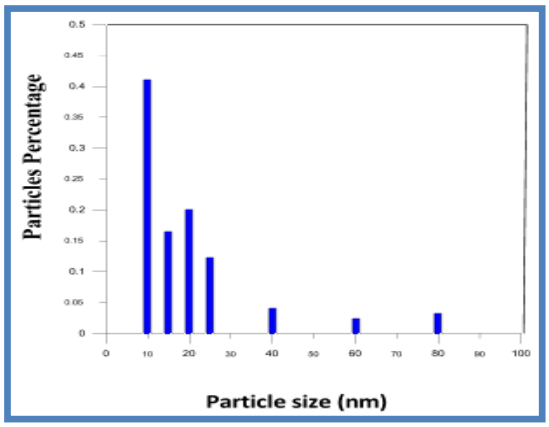
Form (1– 4): (a)absorbance spectra for NP_S of (Au, Ag, Au_{core} - Ag_{shell}), in pure water, at use a (λ = 1064 nm), (E = 40 mJ), (pulse of Au = 100 P), (pulse of Ag = 50 P), (b) Photos of NP_S.

Figure **(1-5)** shows image TEM and size distribution of NP_S of (Au, Ag, Ag_{core} - Au_{shell}), prepared by ablation laser, where the wavelength (1064) nm and Energy (40) mJ, in the water Figure (1-5c) shows formation (Core - Shell) clearly, and note that the form of NPS can be almost spherical.

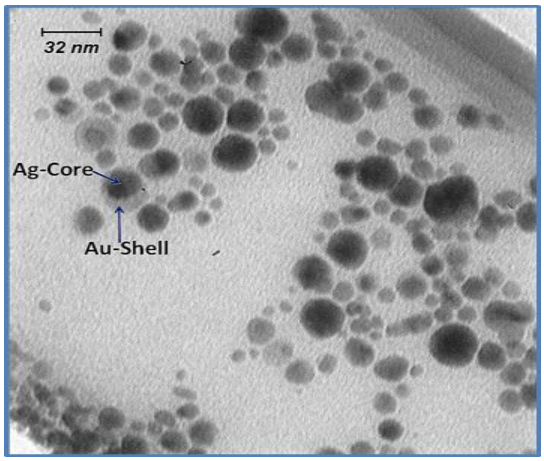


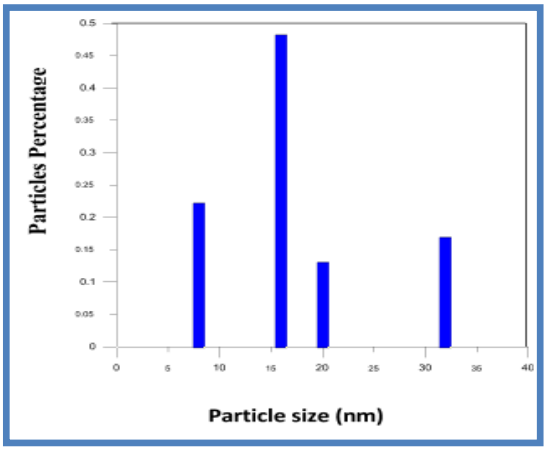
(a) Au NP_S





(b) Ag NP_S





(c) Ag_{Core}– Au_{Shell} NP_S

Figure (1-5): TEMimage and Statistical Distribution of (Au, Ag, Ag_{Core}-Au_{Shell}), in the water with (λ = 1064 nm), (E = 40 mJ),, (pulse of Ag_{Core} = 50 P), (pulse of Au_{Shell}= 100 P) (f = 6 HZ).

Conclusions

1. TEMimages showing the formation of the Core - Shellsystem clearly. As well as showed TEM images of nanoparticles as gold colloidal, withnano-sized particles less than 10 nm.
2. Formation of (Au_{Core}-Ag_{Shell}) and (Ag_{Core}- Au_{Shell}) in both cases lead to shift(SPR) peak to (450) nm, and 470 nm, respectively, and this confirms for the case of superficial overlap of (SPR) , between (Core) and (Shell).
3. We can control the thickness of the shell layer by the number of laser pulses to eradicate Metal Control (Shell).

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