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Study the Effect of Laser Ablation on the Size and Shell Thickness of the Ag_{core}: Pt_{shell} Nanoparticlesin Water by Using Nd-YAG Laser Pulse

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Abstract: The paper study the effect of the laser pulse on the size and thickness of the Pt_{shell} nanoparticles prepared by laser ablation in water in different pulses 100, 150, 200 and 250. The structural properties of the prepared samples were analyzed by using a transmission electron microscopy (TEM) and UV-visible spectrometer. The results showed they are a possibility of preparing the Pt_{shell} with different sizes and thickness surrounding Ag_{core}, where shell thickness ranging from 8.3-20.1 nm and the Uv-vis shown the peak absorption of the Ag_{core}: Pt_{shell} is shifted from 410-388 nm according to increase the number of laser pulses on the platinum target on the collided Ag NPs, indicating that the Pt_{Shell} effect will have an influence more than the Ag NPs core.

Keywords: Nanoparticles, laser pulses, spectrometer, water, core, shell thickness

INTRODUCTION

Pulsed laser ablation in liquid (PLAL) is very efficient method for production of the nanoparticles. PLAL approach provides pure nanoparticle (NPs) colloidswith low contaminations and without chemical precursors (Mafune *et al*., 2001; Sasaki *et al*., 2006; Sajti *et al*., 2010; Singh and Soni, 2013). The PLAL is a single step process valid to varied metals and alloys, ceramics and semiconductor in different liquids (Zeng *et al*., 2012; Chen *et al*., 2004; Chen *et al*., 2004; Yang, 2007). Synthesize nanoparticles and fabricate nanostructuresin a single experiment can be done by Nd -YAGlaser pulses ablation in aqueous environment and this method is a well-known top down process to synthesize nanoparticles (Amendola and Meneghetti, 2013; Podagatlapalli *et al*., 2012).

The preparation of clusters alloy is of great importance as it can benefit from mass electromagnetic reactions. These allows mixing the properties of individual nanoparticles by interactions with the properties of adjacent nanoparticles that can lead to new properties that difference from those of the original components (Yan *et al*., 2010).

In recent years many reports using laser plus ablation to synthesized core: Shell from many metals, such as (Au@C) (Xu *et al*., 2018), Ag, Au and Cu core shell NPs (Vinod and Gopchandran, 2015), Ag/Pd core-shell NPs (Mottaghi *et al*., 2014), Ag/ZnO core/shell (Zhao *et al*., 2015), Au/Pd(II) core-shell (Sheykhifard *et al*., 2015), Pt/Pd NPs on graphene (Censabella *et al*., 2019), etc.

In these reports they study how to perpetration the core shell for metals using plus laser ablation and applied it's for many applications but they don't indicates to the effect plus laser on the thickness of shell on the core, so in this study, they studied the influence of laser pulse on the shell thickness and size of the platinum nanoparticles produced by laser ablation inside the colloidal Ag nanoparticle.

Materials: Pure silver foil, thickness 2.0 mm, 99.9% trace metals basis (Sigma Aldrich) and platinum foil, thickness 1.0 mm, 99.99% trace metals basis (Sigma Aldrich) and using as the received.

Laser ablation system: Laser (Q-Switch Nd-YAG) at wavelength (1064) nm and energy (240) mJ and the ablation process is performed at a repetition rate of 10 Hz and with pulse duration of 15 ns.

Preparation (core-shell) of (Ag-Pt): Preparation of nanoparticles colloids Ag_{core}: Pt_{Shell} nanoparticlesby PLA of the pure silver and platinum metal in aqueous solution from double distilled and deionized water (DWDDW). In dilates, the four samples of silver nanoparticles colloids were produced by laser ablation (E = 250 mJ and 50 plus) of the silver target placed on the bottom of quartz vessel with 2 mL of pure (DWDDW). Then, platinum piece putted inside each sample of the silver nanoparticles colloids and using PLA with different pulses 100, 150, 200 and 250 produced Ag_{core}:Pt_{shell} nanoparticles. The samples market as Ag_{core} 50: Pt_{shell} 100, Ag_{core} 50: Pt_{shell} 150, Ag_{core} 50: Pt_{shell} 200, Ag_{core} 50: Pt_{shell} 250, respectively.

The absorbance spectra of the NPs were measured by the UV-Visible CE-7200 (UV-Visible) spectrometer and the thickness of the shell for NPs was measured using transmission electron microscopy (TEM) (Model: LEO) 912 AB) (Germany).

RESULTS AND DISCUSSION

Figure 1 shows the absorption spectra of the Ag_{core}: Pt_{shell} nanoparticles at energy 240 mJ and the number of Pulse of Ag_{core} (50) pulse and Pt_{shell} 100, 150, 200 and

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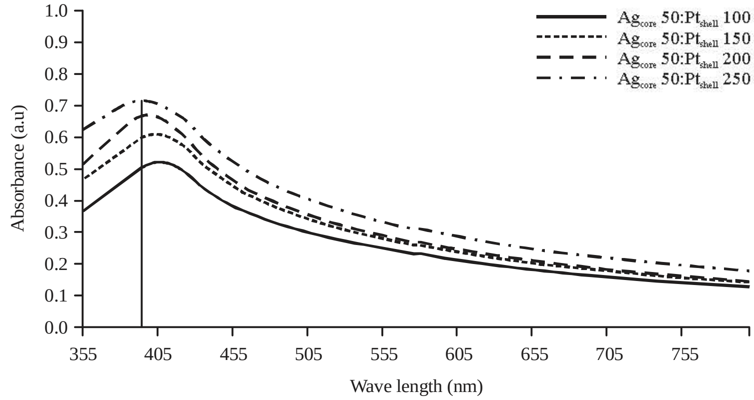

Fig. 1: Absorption spectra of Ag_{core}: Pt_{shell} nanoparticles in water

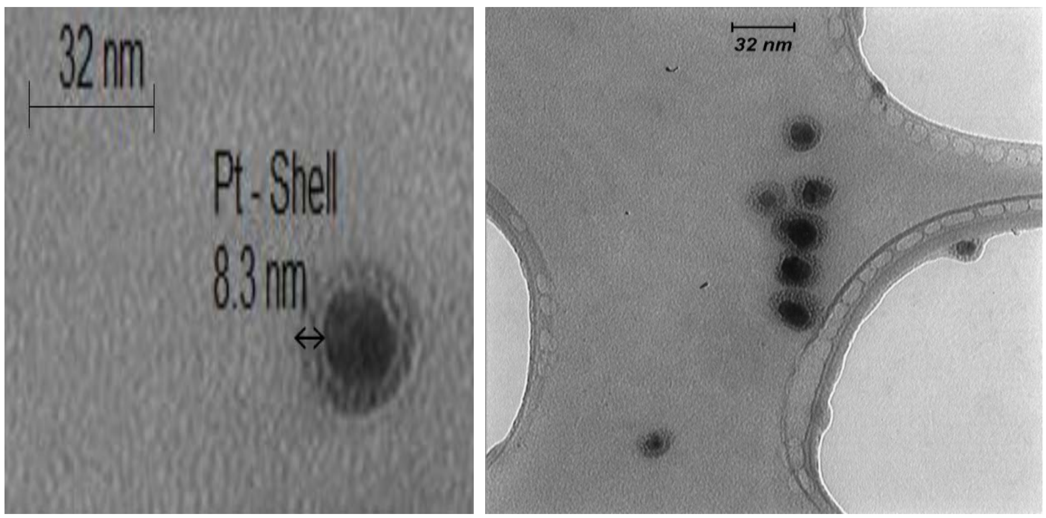

Fig. 2: TEM images of Ag_{core} 50: Pt_{shell} 100 NPs, in set shows particle size and shell thickness

Table 1: Values of both the absorption intensity and the wavelength of the absorption (λ peak) by increasing the number of shell pulses

λ_{peak}	Absorbance intensity	Number pulse of shell
410	0.39	100
405	0.48	150
394	0.52	200
388	0.66	250

Table 2: Relationship between the numbers of laser pulses of the Pt particles platinum ablation in colloid solution of Ag and the shell thickness

Shell thickness (Pt_{shell})	Number pulse of laser
8.3	100
12.4	150
16.5	200
20.1	250

250 Pulse. The absorption peak contains NPs for silver and platinum and also note that increase the pulses number of Pt_{shell}, the absorption peak of the nanocomposite of Ag_{core}: Pt_{shell} shift towards to the wavelength short (blue Shift), indicating that the Pt_{shell} effect will have influence more than the core (Table 1).

Figure 2 illustrates the TEM image of Ag_{core} 50: Pt_{shell} 100 NPs.They can note from this figure that the particle size is 32 nm and the shell thickness Pt_{shell} is 8.3 nm.

Figure 3 illustrates the TEM images of Ag_{core} 50: Pt_{shell} 150 NPs. They can note from the figure that the particle size is 50 nm and the shell thickness Pt_{shell} is 12.4 nm.

Figure 4 illustrates the TEM images of Ag_{core} 50: Pt_{shell} 200 NPs. They can note from the figure that the particle size is 50 nm and the shell thickness Pt_{shell} is 16.5 nm.

Figure 5 illustrates the TEM images of Ag_{core} 50: Pt_{shell} 250 NPs. Note from the figure that the particle size is 80 nm and the shell thickness Pt_{shell} is 20.1 nm.

We observe from Fig. 2-5 that the number increases of laser pulses of the Pt_{shell} this lead to increase thickness of the shell. This indicates that the thickness of the shell can be controlled by controlling the number of pulses (Table 2).

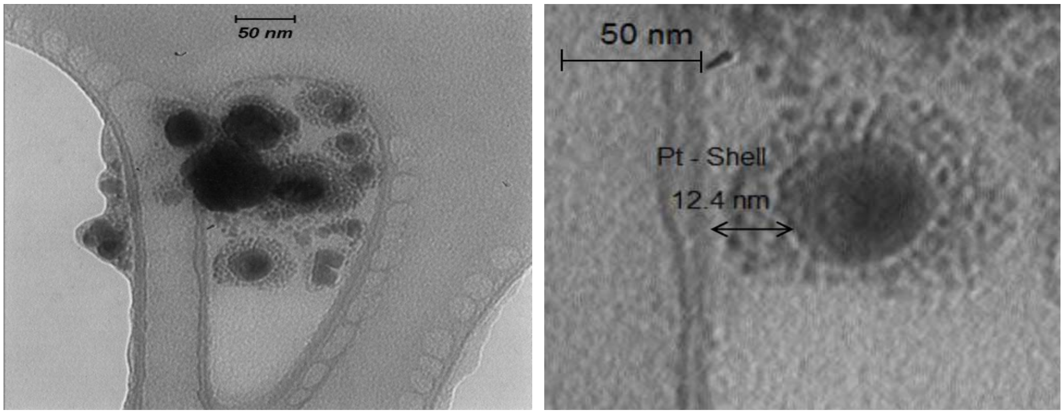

Fig. 3: TEM image of Ag_{core} 50: Pt_{shell} 1150 NPs, inset shows particle size and shell thickness

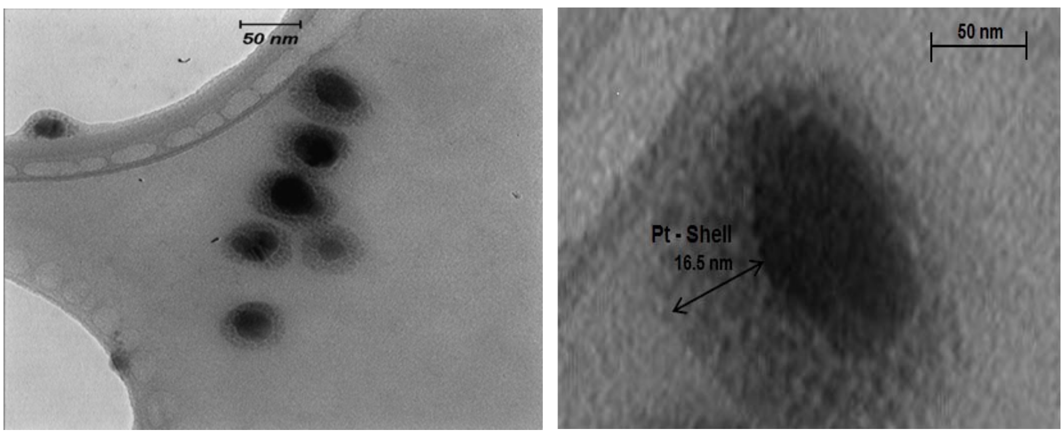

Fig. 4: TEM images of Ag_{core} 50: Pt_{shell} 200 NPs, inset shows particle size and shell thickness

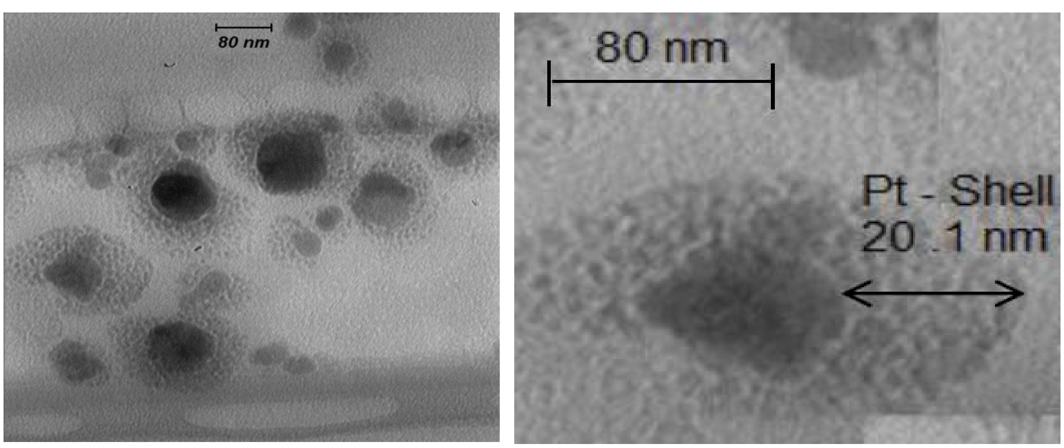

Fig. 5: TEM image of Ag_{core} 50: Pt_{shell} 250 NPs, inset shows particle size and shell thickness

CONCLUSION

The laser ablation method that using different pulses on the Pt target submerged in silver collided given different thickness increases with an increasing pulse laser, as the TEM reinforce these results. The Uv-Vis shown that the absorption peeks have blue shift as the increasing the laser pulses increasing on the Pt and that mean the Pt_{shell} increase on the Ag_{core} and control the size of the nanoparticles of Ag_{core}: Pt_{shell} by controlling the number of laser pulses falling on the metal (Pt_{shell}) in colloid solution of Ag_{core}.

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