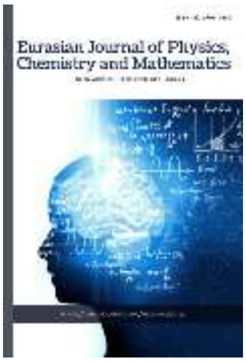

Pulsed Laser Targeting and Stirring for the Synthesis of (Au- Cu) Nano-Alloy from Monometallic Colloids

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ABSTRACT

The goal of this work has been to investigate the development of alloyed gold–copper nanoparticles (50%Au-50%Cu NPsunder simultaneous laser exposure and ultrasonic of colloids.(Au-Cu) compsit nanoparticle colloids by Laser ablation has been used as a feed for the dual method. The properties of produced particles are highly affected by experimental conditions such as churning and laser settings, including th e NPs size, form, content, and stability. A homogenous alloy and a core-shell structure of alloy nanoparticles containing (Au 50%: Cu 50%). To accomplish this, bulk targets were ablated with 1064 nm wavelength Nd: YAG laser in awater(DW) environment. Ultraviolet-visible optical absorption spectrometry, (TEM), (XRD) and FE-SEM and EDS

Keywords: Laser ablation; Alloyed Au-Cu nanoparticles; Dual procedure; Laser exposure; Mechanical mixing.

1. Introduction

Due to their use as catalysts, bimetallic nanoparticles (NPs) have gotten a lot of interest recently [1-3]. variations in surface plasma band energy and electro-optics [4-6], The experimental circumstances used to prepare them can have an impact on their size, shape, content, crystallinity, and structure [7]. To date, various physical approaches and combination strategies for the production of NPs have been described. Specific advantages of pulse laser ablation (PLA) are its ease of use and adaptability [8-9]. well-regulated exposure time [9] and the production of pure NPs from colloidal dispersions without the generation of by-products. Due to the fact that ion and reducing agent residues are often left behind in colloids created by chemical processes, their use in biological applications might be particularly problematic. NPs such as noble metals have also been prepared via PLA. Once the proper optical constants are applied to our theoretical approach, we can design the SPR of the colloidal NPs in accordance with the primary process parameters, including the Au-Cu mechanical mixture proportion and the average NP size. Evaporation-condensation, arc-discharge, and pulse laser ablation in liquid (PLAL) are three of the most promising physical techniques since they don't use solvents and can generate nanoparticles with a fairly even distribution. Pulse laser ablation of bulk target in liquid is a technique we investigated for the generation of nanoparticles using a nanosecond laser (PLAL) [10-12]. Laser-induced photochemical reduction is distinct from this process. Metallic bulk materials submerged in solution were fragmented to produce metal nanoparticles in this study [13-15].

2.Experimental work

2.1 Synthesis of Au alloy NPs

A pulsed Nd:YAG laser with a near infra-red wavelength of 1064 nm and operated at 1 Hz was used as the ablation source. Each pulse had duration of 10ns to ablate bulk targets normal to their surface. Gold and copper atcircular disk shaped tarand 99.99% purity were vigorously cleaned before the experiments. In the case of copper,Colloidal solutions of gold alloy nanoparticlesits (50%Au-50%cu) prepared using the liquid-pulsed laser method. The target was placed at the bottom of the glass flask immersed in distilled water, the volume of water used was 3ml, the energy was 660mj, and and the number of pulses before mixing is 800 pulse and The colloidal solution of gold nano particles and colloidal solution of copper nanoparticle was exposed to the laser beam againwith energy 660 mj , and 2000 pulse Then the colloidal solutions of gold nanoparticles and copper nanoparticles were mixed in volume proportions for each alloys of (50%Au-50%Cu) the solution is bombarded with with continuous stirring to get nano-alloys of Au and Cu and the purpose of eradication again is to reduce the size of the particles, Characteristics optical and structuralproperties of metalic NPs were recorded using UV-Vis spectrophotometer mega 2100 and XRD-6000SHIMADZU x-ray diffractometer .The nano particles samples were identified by the transmission electron microscope TEM ,and FE-SEM and EDS

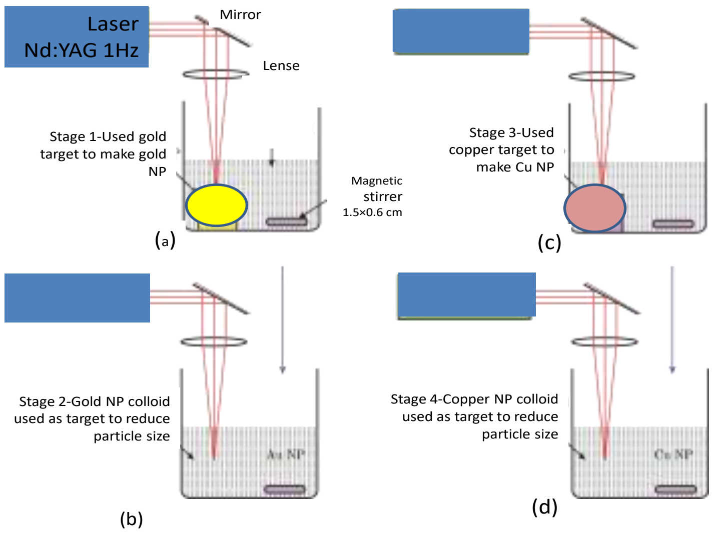
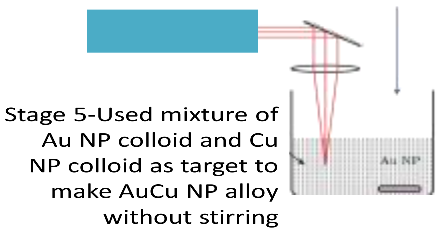


Fig. 1 Showing the experimental setup – stage 1: making gold nanoparticles; stage 2: reducing the size of AU NPs by laser treatment; stage 3: making copper nanoparticles; and stage 4: reducing Cu NPs colloid particle size.



Stage5 (Fig. 2) the NP colloids produced in stages 2 and 4 were mixed in equal volume and stirred for various durations while being irradiated by the same laser energy 660mj produce Au-Cu alloy NPs.

3. Result and discussion

3.1 XRD analysis of Au alloy NPs

The synthesized colloidal NPs were deposited on glass substrate by drop casting method the structure property of prepared NPs films was investigated by X-ray diffraction (XRD) was carried out to determine the crystal structure, crystalline size and some crystalline parameters of the Au-Cu samples prepared by laser extraction at energy (660 mJ) and wavelength. (1064 nm) and the number of pulses after mixing (2000 pulse) and after mixing the solutions, colliadal Figure (3) shows the XRDpatterns of alloys prepared from alloy of NPs with a fixed volume ratio (Au 50%): Cu 50%) the diagnostic peaks that were detected were shifted towards angles (2Ɵ)(38.21°) can be indexed to (111), (200), (220) and (311)planes, respectively of (Au-cu) alloy ((JCPDS 34-1302). to obtain an Au-Cu alloy with a cube crystal structure with a space group plane (Pm-3m no. 221),[16

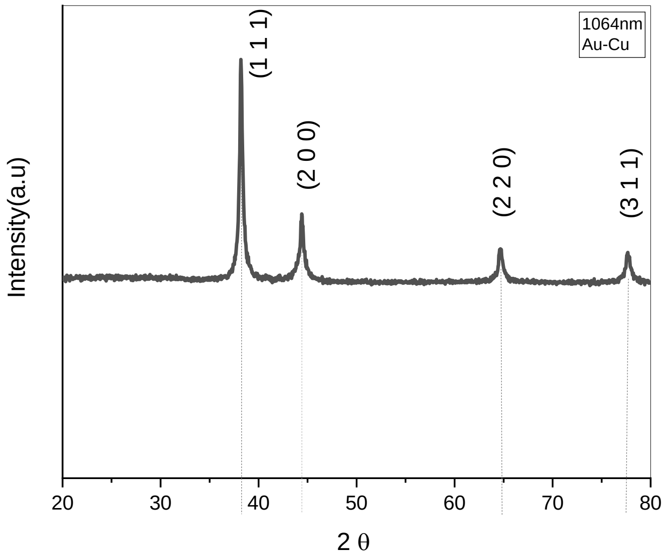


Figure (3): X-ray diffraction (XRD)patterns of gold-copper nano alloys (Au-: Cu)prepared using gold-copper alloys using laser ablation technique

Table (2) some crystalline parameters of gold-copper alloys prepared from t goldalloys collidal (Au-cu).

Sample	2Ɵ (deg) Practical	2Ɵ (deg) Standard	FWHM (deg)	Crystalline size (nm)	d_{hkl} (°A) Practical	d_{hkl} (°A) Standard	(hkl)
50%Au - 50%Cu	38.21	38.10	0.49368	15.2	2.3534	2.36	(111)

3.2 FE-SEM and EDS analysis for (50%Au-50%cu)

FE-SEM was used to examine(50%Au-50%Cu)) alloys nanoparticles colloidal solutions synthesized by PLAL technique using energy (660mj)and 2000 pulses are selected for,) alloy sample as shown in Figures (4) show images of the results of FE-SEM)) and average sizes ofAu50%-cu50%) nanoparticles at a frequency of 1 Hz for wavelength (1064 nm) Part a a scale of 200 nm with a magnification of (200 kx). (21.1nm)

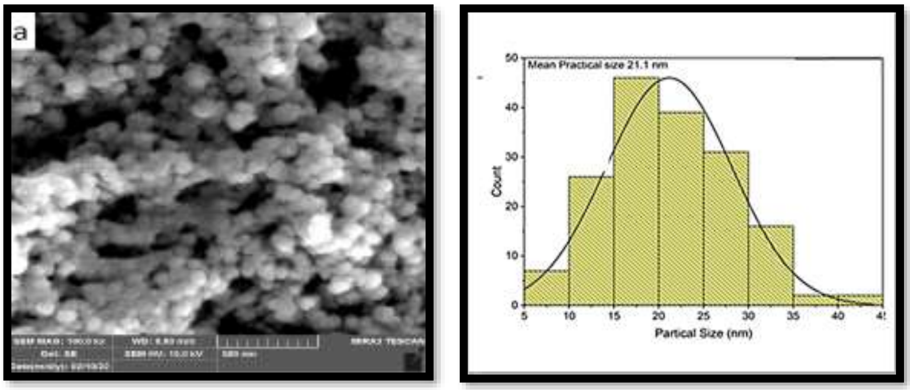


Figure (4): FE-SEM analysis of (50%Au-50%Cu) NPs alloy powder of wavelength 1064nm and energy of (660mj).

The following figures also show the (EDS) diagrams of gold alloys after mixing and being exposed to laser radiation again at a rate of 2000 Pulse and a power of 660mj The EDX spectra of (Au-cu) alloy nanoparticles as shown clearly in Figures 5)

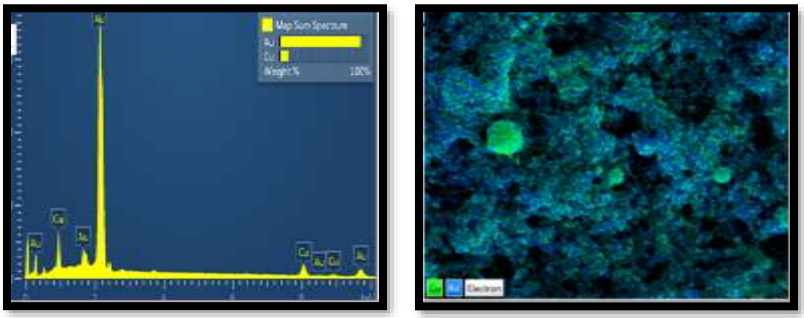


Figure (5): EDS dispersal spectroscopy of (Au-Cu) NPs alloy powder of wavelength 1064nm and energy of (660mj).

Table (2): Percentage of Au-Cu NPs s for wavelength 1064nm.

Element	Line Type	Wt%	Atomic%
50%Au-50%Cu	M.series	88.93	**72.16**
	L.series	11.07	**27.84**

3.3 TEM analysis

Shown Fig 6 shows the TEM images of as-synthesized gold and cupper nanoparticles were confirmed the 50:50 volume ratio by majority of copper nanoparticles than gold nanoparticles as optimized. The histograms in Figures 6(indicating the average particles size of. Both samples consisted of particles[17] with a similar spherical shape and average size of Au NPs as it was (20.1 nm)

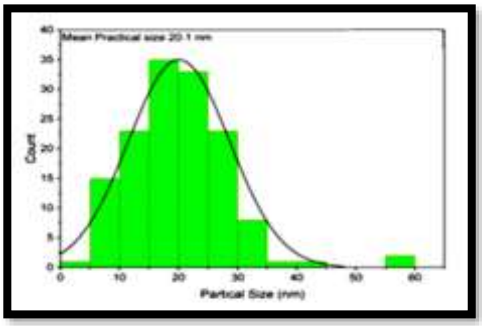


Figure (6): show the (Au50%-cu50%) alloys particles prepared by the pulsed laser ablation method at (2000pulse) and with an energy of (660m J) they were spherical shape

The surface Plasmon resonance was investigated by UV-Vis absorption spectra forAlloy nanoparticles with various volume ratio of Au and cu) are prepared by mixed as-synthesizeNPs (50%Au-50%Cu) as shows in Fig7 The strong SPR absorption band of Au and cu colloids at ~521 nm [18] . It also indicates that the shapes of the particles are semi-spherical due to the color instability of the colloidal solutions after mixing and during exposure to the laser. A change in the sizes of nanoparticles occurs and because of the speed of oxidation of copper and its interaction with dissolved oxygen in distilled water, [19].

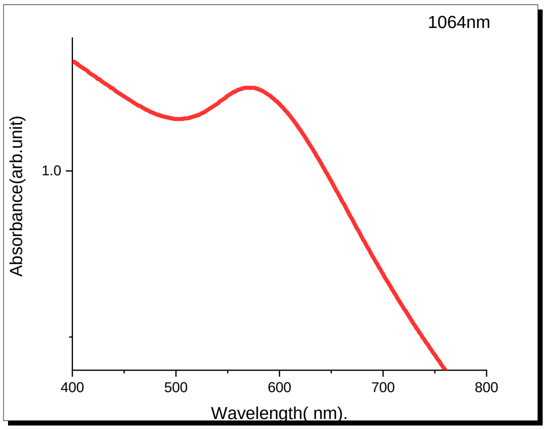


Figure (7): diagram of (50%Au-50%Cu) alloy with a wavelength of 1064nm, an energy of 660Mj, and a number of 2000pulse

4. Conclusion

In this study, successes to investigate the development of alloyed gold–copper nanoparticles (Au-Cu NPs) under simultaneous laser exposure and mechanical stirring of mixed monometallic colloids. Laser ablation of Au and Cu nanoparticle colloids has been used as a feed for the dual method. The properties of produced particles are highly affected by experimental conditions such as churning and laser settings, including the NPs size, form, content, and stability. A homogenous alloy and a core-shell structure of alloy nanoparticles containing (Au 50%: Cu 50%)

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