Structural Characterization of Nanoparticles Prepared by laser Ablation of Gold target in water

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Abstract

This research has presented an alternative-novel ,easy, fast and no contamination. Noble metal gold Nps was prepared by pulsed (Q-switched , step method for preparation of pure and stable noble metal versatile Nanoparticles in a high ablation rate and size selected manner with a high concentration,long period of stability, less aggregation, non toxic and (1064 and 532) nm doubled frequency-Nd:YAG) laser ablation of gold metal plates immersed in double diand deionised water(DDDW). The optimum preparation parameters had been optimized for the best formation efficiency of pulsed laser ablation in liquid (PLAL) process, which are laser shots is 20 pulses laser energy in 600 mJ , liquid depth is (10) mm. TEM images and size distribution of Au particles obtained in distilled water at different wavelengths have been confirmed .

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الخلاصة:

في هدا البحث تم تقد يم طريقه تباديله جديدة سهله وسريعة وخاليه من الملوثات ، تم تحضير جسيمات نانوية من معدن الذهب النبيل باستخدام طريقة القشط بالليزر للحصول على معدن مستقر وجسيمات نانويه متنوعة باستخدام ليزر النديميوم- الياك النبضي ذو الطول ألموجي 1064 nm , 532nm وزمن نبضة 20 ns وطاقة 600 ملي جول بطريقة التبخر الانفجاري لقطعة معدنية فائقة النقاوة من الذهب مغمورة في ماء لاأيوني وثنائي التقطير يعرف ب DDDW. ، إن أفضل معالم تحضيريه كانت لاحسن كفاءة ليزر نبضي عندما تكون عدد النبضات 20 نبضه وطاقة الليزر 600 mJ وعمق السائل 10 mm.تم استخدام بتقنية (TEM) المجهر الالكتروني النافذ لدراسة التوزيع ألحجمي لجسيمات الذهب المغموره في الماء للأطوال الموجيه المختلفة كما تم أخذ صور مختلفة .

Introduction

Metallic nanoparticles (1–100 nm) are considered as one of the most important materials due to their unique optical, electronic and chemical properties compared to massive materials (Haberland 1993, Kreibig and Vollmer 1995) Moreover, they change their properties on depending their shape, size and surrounding medium and they can be used in many fields of advanced technology, particularly in the areas of biotechnology, medicine, optoelectronics, chemical catalysis, surface cleaning, etching and cutting (Kreibig and Vollmer 1995 ; Elghanian et al. 1997 ; El-Sayed et al. 2006; 1995) ; Fujimoto 2003; Jain et al. 2007; Che and Bennett 1989; Valden et al. 1998; Haruta 1997; Kruusing 2004a, b).

The laser ablation of metallic targets in liquids is without any contamination of chemical reagent and parasitic ions compared to the chemical ways to produce metallic nanoparticles in solution As for laser ablation in vacuum (Fuchs et al. 1989; Santos Aires et al. 1989; Cadete Santos Aires et al. 1993, 1994; Rousset et al. 2000a, b);Raheem.G,K. laser ablation in liquids is a quite easy method for the production of mono-, bi- and multi-metallic component nanoparticles that can replace chemical preparations. Bimetallic They are nanoparticles are of wide interest. They are particularly important in the field of catalysis since they often exhibit better catalytic properties than their monometallic counterparts (Sinfelt 1983; Sachtler 1984, Toshima and Wang 1993; Toshima et al. 1992) and varying their composition can be a way for modulating their optical properties (Papavassiliou 1976).

In this work, we present results concerning bimetallic nanoparticles prepared by laser ablation of targets in distilled water. The goal was to obtain colloids of bimetallic nanoparticles having a uniform and well- defined composition, if that of the target. We have elaborated bimetallic nanoparticles at wavelengths (1064 and 532)nm and have further possible studied by transmission electron microscopy (TEM).

Materials and methods:

Gold NPs were synthesized by pulsed laser ablation of high purity gold target in double distilled and deionized water DDDW at room temperature. The gold target (purity of 99.99%) was fixed at bottom of glass vessel containing of 1 ml of double distilled deionized water DDDW. The ablation was achieved using focused output of pulsed Nd: YAG laser (type HUAFEI) operating with a repetition rate of 1 Hz and pulse width of 20 ns. Ablation is carried out with laser operating at (1064 and 532) nm wavelengths at flounce set in 61 J/cm^2. The spot size of the laser beam on the surface of the metal plate was 1.20 mm in diameter. The distance between the focusing lens and the metal plate set at 10 cm. The pulse energy was (750 mJ). The liquid thickness over target was 7 mm. The number of laser shots applied for the metal target at 50 pulses. Size and shape measurements investigated by Transmitting electron microscope TEM (FEL Quanta 200, Netherlands). The absorbance spectra of the nanoparticles solution measured by UV-VIS double beam spectrophotometer (type CECIL C. 7200).

Laser Source and Measurements Device

Nd-YAG Laser

Q-switched Nd/YAG laser system type HUAFEI providing pulses of 1064nm and 532 nm(frequency doubled) wavelength with maximum energy per pulse of 1000 mJ, pulse width of 10 ns, repetition rate of 10 Hz and effective beam diameter of 12 mm, was used for laser ablation. The laser is applied with a lens with 110 mm focal length is used to achieve high laser fluence.

Semiconductor Laser

Diode laser type IIIB laser product- 21CFR, Taiwan, was used. Its wavelength is 532nm and 1064nm; maximum output power is 10 mW. The beam diameter and divergence angle were experimentally measured about 2 mm and 3 mRad, respectively.

Transmission Electron Microscope

Samples of nanoparticles were identified by the transmission electron microscope TEM type CM10 pw6020, Philips-Germany (electronic microscope centre-collage of medicine/ Al-Nahrien University). The test samples were prepared by placing a drop of suspension of interest on a copper mesh coated with an amorphous carbon film. The drop was dried with an infrared lamp (Philips, 100 W) until all the solvent had evaporated. This process was repeated three to four times. The TEM carbon grids were loaded into the sample. The images were obtained at an accelerating voltage of 60 KV, with maximum magnification of 25000x-450000x. The diameter of produced was calculated from the following equation (taken from CM10 TEM sheet).

$$D = \frac{d}{M} \times \frac{3}{4} \quad \text{(nm)} \quad \text{.....................................(1)}$$

Where; D, d and M are: nanoparticle diameter, real diameter on image, and magnification of TEM respectively.(Kreibig and Vollmer 1995).

Results and discussions

TEM images and size distribution of Au particles obtained in distilled water at different wavelengths(532 and 1064)nm are shown in Fig. 1.
gold nanoparticles produced by laser ablation of gold Plate immersed in 1 ml of DDDW,. The nanoparticles thus produced were calculated to have the average and 13 nm and 22 nm at (532 and 1064)nm wavelength respectively. The result shows that the average diameter increases with an increase of the laser wavelength. However, laser irradiation of the nanoparticles can stimulate further change of their morphology or can change the rate of their aggregation.

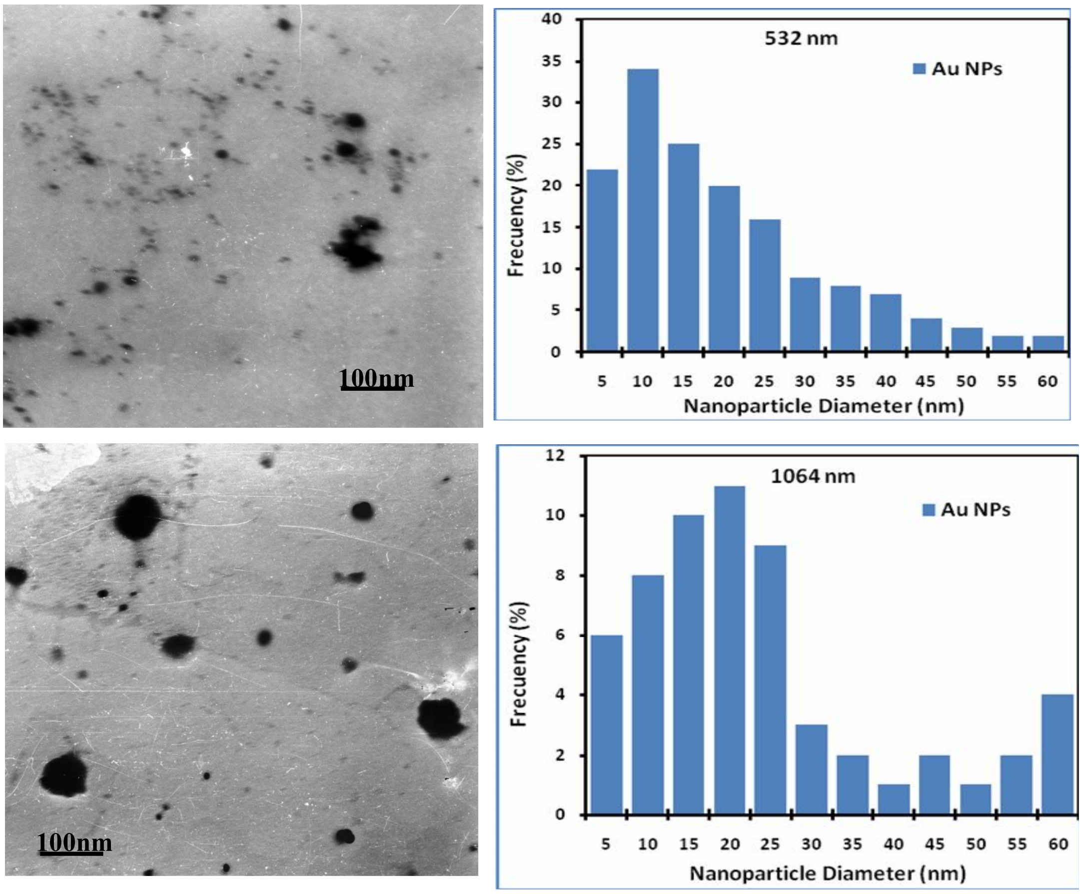

Fig. 1: TEM images and size distribution of gold nanoparticles produced by (1064 and 532) nm laser ablation (E=600 mJ/pulse) of gold plate immersed in 1ml of DDDW. The laser shots set of 20 pulses .

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