Comparison between the gold nanoparticles prepared by chemically and laser ablation method

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Abstract

Noble metal gold nanoparticles were prepared by two methods. The first method gold nanoparticles (AuNPS) synthesised by the reduction of chloroauric acid (HAuCl4) with a solution for sodium borohydride. The second method the gold mineral plates were ablation by pulsed laser when it was immersed in filtered H2O. The synthesized nanoparticles are characterized by using UV–Visible absorption spectroscopy, X-ray diffraction and transmission electron microscopy (TEM). The Ultraviolet-Visible absorption spectra in the visible regions of the gold nanoparticles appear intense absorptions a result of surface plasmon resonance (spr) vibrations in noble mineral nanoparticles. From X-ray diffraction and TEM tests the particle size for the laser ablation method calculated was found to be lie between (15-20 nm) and for chemical method approximately lie between (13-16 nm).

Keyword: Gold; Noble; Plasmon; Resonance;

Introduction:

Gold nanoparticles have pulled in expanding consideration because of their one of kind properties in multidisciplinary applications in the industry [1]. Noble mineral nanoparticles have been to a great extent considered in these last years on account of their size and shape subordinate optical properties just as their light confinement impacts at the nanoscale. [2]. The ablation of mineral solids in the fluid medium by the pulsed laser that it utilizing to the creation of nanoparticles has inalienable favourable circumstances
The surface plasmon resonance properties of gold nanoparticles make them quite useful in the fields of biomedical and bioimaging therapeutics, and as biodiagnostic tools [4]. One of the most significant attributes of the gold colloids is to make a surface plasmon band to empower their potential applications in biosynthesis, catalysis and sensors [5].

A devolution from the reigning chemical methods to synthesize nanoparticles into Laser ablation to synthesize nanoparticles in liquid phase has throughout the years been watched owing mostly to its nonhazardous, contamination-free, and. Among different nanoparticles which are generally accessible, gold nanoparticles wide scope of uses, for example, sensors that it draws specific consideration among researchers owing [6].

We still lack the ability to synthesis gold nanoparticles with stable good and a large amount of quality. The existence synthesis processes of gold nanoparticles are certain shortboards. Therefore a stable, convenient and efficient process for the synthesis of gold nanoparticles is of importance. The development of a complete production route is a challenge. A different generation of gold nanoparticles was reported for and explored. The Citrate decrease technique is one of the greatest procedures. Anyway, the items' dispersity and strength are regularly constrained the gold nanoparticles mainstream and advantageous. the item gold nanoparticles In ongoing years was created to control the procedure by altering the response conditions to presents improved outcomes a superior size control and with higher monodispersity [7].

**Experimental Section**

1. **Synthesize of gold nanoparticles by chemical method**

   The materials used in this method are (chloroauric acid (HAuCl4)), sodium borohydride (NaBH4) and the citrate acted only as a stabilizing agent. Preparation of AuNPs can be described by the following.

   Three solutions will be available by dissolving (0.12 mg) of HAuCl4, dissolving (0.6 mg) of NaBH4 and dissolving (0.5 mg) of the citrate in 5ml distilled and deionised water. Pouring out 5 ml of (NaBH4) solution by utilizing a graduated cylinder for 50 ml beaker, put the beaker in a snow bath. To reach the solution for temperature 5 C° let it cool for 20 minutes. Begin the centre of the group on the magnetic plate and put a magnetic bar in the beaker and start the stirring. Pour 3ml of the citrate solution in the beaker. Put 3ml of the citrate solution into the (NaBH4) solution in the beaker and add...
the HAuCl4 solution drop by drop about one drop per second, even the mixture changing light red.

The solution should be a medium, darker red when increase adds the chloroauric acid solution. Stop the mixing when the chloroauric acid solution is added and take out the magnetic bar. If the mixing continues as soon as the solution mixture turns to dark red colour, the aggregation is probably going to happen. The AuNPs were prepared by chemical method reduction of gold salt (chloroauric acid (HAuCl4)) solution and used a sodium borohydride (NaBH4) as a reducing agent. The AuNPs were stable for a long period when they prepared with correct ratio and placed in dark or brown glass containers for preventing exposure to light and affecting ion charge.

If the proper ratio of chloroauric acid to sodium borohydride was not used, the nanoparticles could aggregate, although this can be avoided by capping the nanoparticles with some stabilizing agent such as polyvinyl alcohol. The AuNPs nanoparticles could aggregate if the off chance that the correct proportion of chloroauric acid to sodium borohydride was not utilized, even though this can be kept away from by capping the AuNPs nanoparticles with some stabilizing operator, for example, polyvinyl alcohol.

2. Synthesize of gold nanoparticles by laser method

Nd-YAG pulsed laser was used to prepare the gold nanoparticles (AuNPs) through ablation of a specimen of the gold metal plate (pure: 99%) immersed in quartz vessel containing 1-10 ml of pure double distilled and deionized water. The changing a distance between the mineral plate and the focusing lens for the laser beam it causes the spot volume of the laser beam on the face of the gold mineral plate was shifted in the scope of 0.5-2.30 mm in diameter. The pulse energy has differed in the scope (50-1000 mJ). The laser fluence was varied in the range from 478 to 13.6 J/cm2. The number of laser shots guided for the mineral objective ranged from 5 to 120 pulses. The colour AuNPs solution was turned from colourless to very light red or faint pink in colour.

Results and Discussion:

1. UV-VIS spectrometry AuNPs were prepared by chemical method

The electronic absorption spectra for gold nanoparticles synthesised by the reduction of HAuCl4 solution with the sodium borohydride solution was illuminated in figure (1). The surface plasmon resonance (spr) is plainly unmistakable as a peak intensity and narrower spectrum and its maximum are located at shorter wavelengths the plasmon peak position of AuNPs was around 512 nm. For little particles, this peak is extinction because of the decreased mean freeway of the electrons.
The SPE band of Au NPs prepared by chemical method reduction of gold salt (chloroaauric acid (HAuCl4)) solution and used a sodium borohydride (NaBH4) as a reducing agent in spectrum (Figure 2) is more intense and narrower than in the SPE band of Au NPs synthesised through pulsed laser for Nd-YAG ablation of a piece of gold metal plate in spectrum (Figure 1), and its maximum is located at shorter wavelengths the plasmon peak location of AuNPs was about 512 nm. That attributed to the mobility of generated nanoparticles which are much lower in solution than in gas [8,9].

![Figure 1](image)

Figure (1) UV-visible spectra of AuNPs were prepared by chemical method reduction of gold salt (chloroaauric acid (HAuCl4)) solution and used a sodium borohydride (NaBH4) as a reducing agent.

2. UV-VIS spectrometry AuNPs were prepared by laser method

The plasmon peak position that shows in figure (2) for AuNPs was around 518–520 nm indicating the formation of particles with dimensions of 5–30 nm in the solution for laser energy used in the experiment. The formation of the gold nanoparticles in the solution was also verified by the TEM results, which are discussed below. The existence of the monocular surface plasmon peak estimated that the produced nanoparticles were about spherical in either case the absorption spectrum have twain plasmon peaks the particles were ellipsoidal [9,10]. The laser shots were observed to be the effect upon the width and the tallness of the surface plasmon resonance peaks. The gold nanoparticles, was faint pink in colour, due to plasmon absorption [11].
Figure (2) UV-visible spectra of AuNPs were synthesized by pulsed laser for Nd-YAG ablation of a piece of the gold metal plate.

3. X-RAY Diffraction analyses for AuNPs were prepared by laser method

The x-ray diffraction that shows in figure (3) for Au NPs prepared by pulsed laser for Nd-YAG ablation of a specimen, of the gold mineral plate, immersed in quartz vessel containing 5-10 ml of pure double distilled and deionised water and the XRD style in the 2θ extent from 30° to 70°. The XRD pattern exhibit three peaks because of diffraction as the following (111), (200) and (220) planes of metal gold (JCPDS No. 04-0784). The forming of crystalline AuNPs with face-centred cubic (fcc) structure proposes through an XRD pattern. The samples are nanocrystalline in nature that plainly demonstrates from broadening of XRD peaks. The particle volume (d) was determined from XRD line widening information, the crystallite size of the AuNPs calculated using Scherrer formula as follows:

\[ d = \frac{k\lambda}{\beta\cos\theta} \]  

Where:
- \(\lambda\) = wavelength of the radiation,
- \(\beta\) = full width at half maximum
- \(d\) = crystallite size
- \(\theta\) = Bragg's angle
- \(k\) is a constant and is equivalent to 0.9 [11]. From figure (3) the particle volume determined was found to be ~20 nm.
4. X-RAY Diffraction analyses for AuNPs were prepared by chemical method

Figure (4) demonstrates the XRD pattern in the 2θ extent from 20° to 80° for AuNPs synthesized by chemical method reduction of gold salt (chloroauric acid (HAuCl4)) solution and used a sodium borohydride (NaBH4) as a reducing agent. The prepared gold nanoparticles were determined the crystal structure by XRD analysis. The XRD measurement of AuNPs has appeared in figure (4) results showed that four obvious Bragg reflection peaks showed up at positions 38.23°, 44.45°, 64.62°, 77.64° that could be ordered to (111), (200), (220), (311) lattice planes of face-centred cubic gold sequences (JCPDS file 04-0784). As clear from the watched model, the most important peak is centred at 2θ = 38.23°, that is originated from the face-centred cubic gold. The top crystal plane of the prepared nanoparticles must be the (111) plane which this outcome plainly appears. The most reactive face is the face (111) because of the rising atomic density for the face. comparable diffraction examples have been formerly reported for AuNPs utilizing plant extractor as capping agents and reducing [12,13].

The average crystal size of these particles was determined from full-width half-maximum (FWHM) of the diffraction peaks and utilizing Scherrer's equation (1) given above: The volume (d) of (AuNPs) for the specimen were determined to be approximately 16 nm. XRD peaks for (AuNPs) prepared under differing tow method, showed that AuNPs prepared by chemical method show (small size) had a wider peak sample figure (3) than their prepared with the laser method show figure (4).
Figure (4) X-RAY Diffraction analyses for AuNPs were prepared by chemical method reduction of gold salt (chboroauric acid (H\text{Au}Cl\text{4})) solution and used a sodium borohydride (NaBH\text{4}) as a reducing agent.

5. Transmission electron microscopy for AuNPs was prepared by chemical and laser methods

Figure (5) shows transmission electron microscopy (TEM) pictures and size distributions for (AuNPs), generated by pulsed laser for Nd-YAG ablation of a segment of the gold metal plate.

The gold nanoparticles thus generated were determined to have the rate diameters extent of the nanoparticle lie between 15-20 nm. Figure (6) demonstrates TEM volume and pictures distribution for (AuNPs), generated by chemical method reduction method for gold salt (chloroauric acid (H\text{Au}Cl\text{4})) solution and used a sodium borohydride (NaBH\text{4}) as a reducing agent. The gold nanoparticles thus generated were determined to have the rate diameters extent of the nanoparticle lie between 13-16 nm.

The gold nanoparticles were created by a chemical technique characterized by the size distribution widens and average particles smaller sizes compared with the gold nanoparticles created by laser technique. In the case of high energy by laser methods, the surface morphology of irregular molecules can be explained by the thermally induced pressure pulses that are absorbed by defects and cause cracking [13,14]. Increasing laser shots increase the average diameter of nanoparticles. However, their rate of aggregation may alter or stimulate laser irradiation of nanoparticles a further change of their morphology [9,15].
Figure (5) TEM images and size distributions of gold nanoparticles, produced by chemical method reduction of gold salt (chloroauric acid (HAuCl4)) solution and used a sodium borohydride (NaBH4) as a reducing agent.

Figure (6) TEM images and size distributions of (AuNPs), generated by pulsed laser for Nd-YAG ablation of a segment of gold metal platelet.

**Conclusions:**

From XRD peaks and TEM test for (AuNPs) prepared according to differing two methods, showed that AuNPs prepared by chemical method extract (little volume) had a wider peak pattern than prepared by the laser method. A devolution from the reigning chemical methods to synthesize nanoparticles into Laser ablation to synthesize nanoparticles in the liquid phase has over the years been monitored owing predominantly to its nonhazardous and non-polluting materials.

The pulsed laser ablation of solids in fluid medium utilizing to the creation of nanoparticles has intrinsic favourable circumstances contrasted to the chemical method and this strategy has been demonstrated to give a productive way to deal with getting synthesizing different nanoscale materials.
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