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Review: A comparative study on the synthesis of gold and silver nanoparticles using pulsed Laser ablation, extraction plants and plasma methods

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Abstract

Nanoparticles have very important and unique properties and qualities that make them important and distinctive in all fields , and they are used in different applications , and on this basis i conducted this study .this review focuses on the progress in the laser ablation , biological and plasma synthesis processes for Au and Ag NP generation, especially in their fabrication fundamentals and potential applications. First, the fundamentals of the laser ablation method are critically reviewed, including the laser ablation mechanism for Au and Ag NPs and the controlling of their size and shape during fabrication using laser ablation. Second, the fundamentals of the biological method are comprehensively discussed, involving the synthesis principle and the process of controlling the size and shape and preparing Au and Ag NPs using biological methods. Biological route of nanoparticle synthesis , it is an environmentally friendly , low cost and very effective method , Biosynthesis route by extracting plants possesses great ability to synthesize various size and shape of metallic nanoparticles Of these biomaterials ,this study focuses on the synthesis of nanoparticles by plant extracts , The biomolecules present in the plants such as terpenoids, flavones, ketones , amino acids aldehydes, proteins , vitamins, alkaloids , tannins, phenolics, saponins, and polysaccharides play a vital role in reduction of metals. Third, the synthesis of Au and Ag NPs using plasma route.the plasma method , which is a method consisting of sending a sufficient pulse of electric current through an electrical wire for materials that conduct electricity , and the wire is thin , and when heated , the wire evaporates , which leads to an explosive shock wave , and this method is a good method for producing metal nanoparticles with good specifications for use in many applications .many of the techniques used to describe these nanoparticles have been discussed , and this review highlights the applications of nanoparticles in various fields such as agriculture , medicine , food , and cosmetics . Thus, this article reviews the achievements and current status of synthesis of nanoparticles by pulsed laser ablation, extraction of plants and plasma routs, and hopes to provide insights into this exciting research frontier.

Keywords: synthesis, gold and silver nanoparticles

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1. Introduction

The application of nanostructures and materials is an emerging field in nano science and nanotechnology , where nanoparticles have been used in different fields due to their antimicrobial properties and due to their localized surface Plasmon resonance properties [1]. the size of nanoparticles ranges from (1-100)Nanometers , which gives them unique electrical . optical and thermal properties [2] . this is what encouraged the use of these nanoparticles for diagnosing diseases , drug delivery , and biological treatment of cancer cells in the body , and in bio imaging

[3] .nanoparticles of noble metals such as palladium , gold , silver and iron are being studied on a large scale in research in the current era [4] . the size of the NPS plays an important and major role in nano – biotechnology , as its small size makes it more productive for all biological applications [5] . and that noble metals are very rare and valuable , and they have made a great revolution in the fields of medicine and biological fields in the modern era compared to the rest of the other materials [6] . the unique physical properties that gold possesses , such as its high resistance to corrosion , made it very important and compatible for medical applications , as it is considered a very suitable element for dealing with many diseases such as cancer , skin sores , smallpox , measles and AIDS [7] . AgNPS were also used antibacterial materials and rheumatoid arthritis [8] . due to its relative chemical stability , which makes it less dangerous and easier to prepare [9] . silver has also been widely used as an antimicrobial and antiviral , as silver metal is of high value in healing many diseases [10] .in the electronic [11]. The silver nanoparticles were prepared in several ways , including the use of plant extracts , which is called the

green method [12] [13] . and method of using laser [14] . and plasma method [15] . and many other methods , as well as gold metal , gold nanoparticles have been prepared in many ways , such as the green method [16] . and use the ND-YAG Laser method [17] . and the Plasmon method [18] . however , in this study we focus on these three important methods .

2. Synthesis of AgNPS and AuNPS :

In this method , nanoparticles were manufactured by laser excision of bulk metal materials in a solution of [19] . and this method has many advantages we compared it to other traditional methods for preparing mineral colloids in the lack of chemical regents in the solutions , and thus pure colloids can be produced very necessary in many of the applications [20] . in this method , colloidal solutions of silver nanoparticles and gold nanoparticles are prepared by pulsed laser ablation in the liquid [21] . this method has many advantaged compared to other methods , including that the produced nanoparticles are pure and the size of these particles can be controlled by controlling the laser parameters and the surrounding medium [22] . and high purity silver metal is used , as it is placed at the bottom of glass container immersed in distilled water at a height of 3 ml , and the silver target is bombarded by a ND-YAG laser , which is a wavelength of 1064 nm [23] . the laser beam appears on the surface of the solid target material inside surrounding medium , the temperature of the irradiated material increases rapidly , and this leads to evaporation of the material , and the medium it must be chosen carefully , because all generated molecules interact with the surrounding particles from complexes , for example , are oxides and other types that are undesirable , as in fig1 b and1 c. the coagulation phenomenon must also be controlled because the particles generated by the laser have a very clean surface , as for the entrained particles , they harm the properties of the generated particles , as shown in fig 2 [24] . the wavelength for laser is a key factor which determines the absorption competence of the target , and wavelength of the laser

also affects the depth of absorption and the focus area , pulsed ND-YAG laser is widely used in laser ablation and different wavelengths and energies have been used in the method of preparing laser nanoparticles as in [25] . lasers wavelengths of 355 , 532 , nm and energy of 500 , 600 ml were applied as in figure 1d . and by using different number of pulses 500 , 600 , 700 , 800 , 900 pulsed for each wavelength . the samples were analyzed structurally and optically , and gold nanoparticles were prepared using a metallic objective of pure gold in distilled

water with a wavelength of 1064 nm , and the number of energies 480 , 680 , mj and its optical properties were studied . it was noted that the average size of gold nanoparticles decreases with increasing laser energy , used because the ablation process was accompanied by melting of the target surface with led evaporation and spontaneous absorption of the incident laser photon by the nanoparticles , which leads to the formation of smaller particles due to larger particles disintegrate [26] .

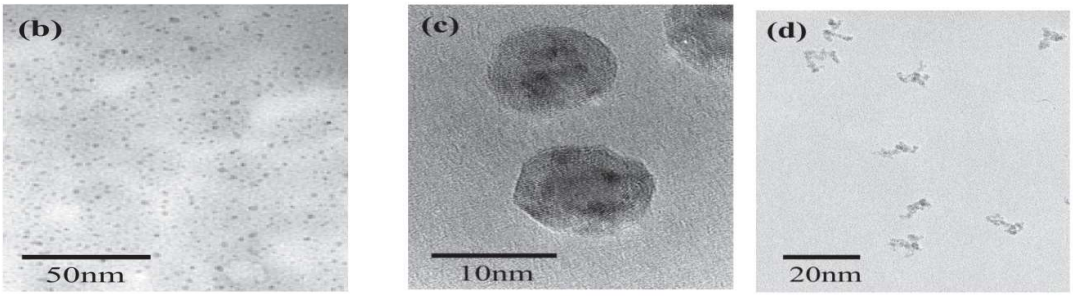

fig 1 (b) typical transmission of laser ablation generated carbon (c) oxidized nickel nanoparticles on the surface (d) aggregates of nickel nanoparticles as a result of necking and coagulation

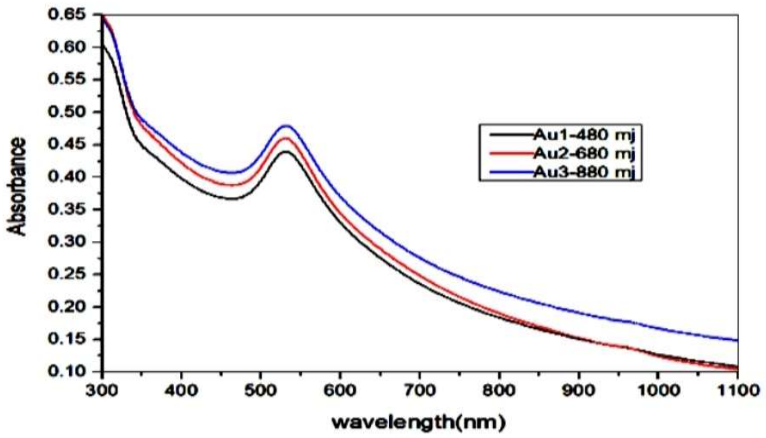

Fig (2) absorbance spectrum as a function of a wavelength of Au nanoparticles prepared at different pulse laser energies

it was also observed through the work that increasing the value of the average surface roughness increases the energy of the laser pulse , because increasing the energy of the laser pulse allows the small granules to gather , so the coalescence process occurs , which leads to the production of large granules, and this leads to surface roughness , and this means that the increases in energy led to reduce the size of the gold nanoparticles , and the granules became of different sizes [27] .

3. Preparation of nanoparticles by the green method

This method is considered one of the best ways to prepare nanoparticles [28]. This method id done using different plants , as a sample is collected from the used plant and washed with distilled water grams of the plant are taken from it with 50 ml of distilled water at a temperature of 90 for an hour , and then a sample is taken 5 ml of silver nitrate at a concentration of 1 mm , and then 50 ml of silver nitrate solution was mixed with 7.5 ml of aqueous extract After which it was observed that the color of the used solution changed , and by changing the color the nanoparticles are characterized using UV , XRD and other measurements [29] . different plants are used , as silver nanoparticles were prepared using *Laureola Skimmia* leaf extract at room temperature , and the prepared nanoparticles showed a Plasmon resonance surface at 640 nm , and particles with spherical and hexagonal shapes were obtained , crystalline , it Was also prepared by using the waste extract of crocus sativus . particles were obtained with a spherical shape and a size between 12 and 20 nm [30] . parkia speciosa leaf extract was also used , the effect of various factors such as (temperature , acidity , time and concentration) on the preparation process was studied , so the prepared particles gave photo catalytic activities a against methylene blue dye , and antimicrobial activity , gold nanoparticles were also prepared using four different plants as reducing agents , *Namely Lippia citriodora* , *Solvia Officinalis* , *Gravelens Pelargonium* and *Puniea Granatum* As 15 ml of fruit leaves were washed with distilled water , and nanoparticles prepared by mixing 10 ml of ionic gold solution with 0.75 ml of plant extracts , and the color of the mixture changed to a dark red color , so the color change of the mixture was due to the formation of gold particles the nanoparticles were verified using UV measurement , as they were absorbed at a wavelength of 530 nm . FTIR spectra it was received from the extract and the colloidal solutions , so similar spectra were obtained for the two stages that checked , and this great similarities between the extract and colloidal solutions indicates the presence of the same compounds in the two media , and it was found that most of the particles were small in size , that is in the range of 30-70 nm .

4. Plasma method

In this method , an effective device for exploding wires is used to produce quantities of nanoparticles , and this electrical explosion of wires is done in a container with a capacity of 500 ml specially prepared to receive the electrodes and the medium , and in study [31] . silver wires with diameters of 0.2 , 0.3 mm on the effects of wire diameter , in length , and liquid type were studied , and the structural features of all the samples were studied by XRD , and the surface coarser and terrain of the precipitated thin films were studied by TEM measurement , and SEM to be sure the shape and size of nanoparticles , liquid medium is an important measure that affects the properties of nanoparticles , and in the study [32] .the effects of the blasting medium on the size and optical properties of gold nanoparticles that were synthesized by the method of electro explosive wires were studied , as a gold wire with a diameter of 0.2 mm was detonated in a liquid to produce nanoparticles , and the suspension was collected for analysis , and the shape and size of gold nanoparticles were observed by means of TEM , and the image showed TEM that the nanoparticles are spherical in shape , but they appear to be connected and form a network , the average particle size was 10 nm , and according to UV measurement , the nanoparticles are spherical , and the optical absorption spectra of AuNPS were shown in the range of 300-800 nm , all gold particles showed nanoparticles in many different liquids have one peak at 530 nm [33] . it has shown the comment obtained in the TW20 better stability .

5. Characterization of AgNPS and Au NPS and their properties

To understand the methods of nanoparticle preparation , applications and control , this is obtained through the use of SEM , TEM , FESEM , RTIR infrared spectroscopy measurements are also used , energy dispersive X-ray

spectroscopy EDX was used , XRD diffraction measurement , and ultraviolet spectroscopy is used to confirm the formation of silver nanoparticles , XRD is used to determine the crystallinity , in the UV-

Vis measurement of Ag NPS , optical absorption peak appears because the surface Plasmon resonance , and no impurities were observed besides oxygen and carbon , which confirm that were used reagents did not remain , and final product can be separated very easily from the mixture [34] . the study of [35] . when conducting the XRD measurement , it was found that size of the AgNPS decreased under conditions of rapid explosion and high viscosity of the media , as the high viscosity led to a reduction in molecular size and increased dispersion stability because of little expansion in the size of the plasma , and in the UV study also the visible absorption spectrum of ultraviolet rays was found the visible peaks correspond the surface Plasmon resonance of Ag nanoparticles obtained from explosive silver wires with a diameter of 0.2 , 0.3 , and 0.4 mm , which indicates that solution contains a lot of aggregated particles , and this is consistent with the measurement of the TEM , colloidal silver nanoparticles exhibit absorption at wavelengths of 420-390 nm [36] . also the TEM measurement , SEM enables us to obtain a deeper insight into the morphology and size distribution of the nanoparticles , and in study [37] . TEM image of the gold nanoparticles shows that the gold nanoparticles depend on the surrounding environment , the study [38] . showed that close examination by SEM showed that many nanoparticles are surrounded by a halo , and therefore it may be larger than its actual size of the particles , and particles less than 10 nm not easily noticed by a halo , SEM , and that images represent only a specific part of the particles , and the contrast between background , and organic matter in the SEM measurement is less important than the contrast between Au and background , and there was a special approach to assess the size distribution of nanoparticles through SEM images , average (d) diameter of the nanoparticles was calculated however , smaller particles cannot be observed ,it is expected that cluster will appear larger density dispersion properties , and there are points to note that SEM pictures are a limited part of the particles community[38] .

6. Factors affecting particle size

(1)- The size of the silver nanoparticles

The size of the silver nanoparticles was obtained by TEM and measure the diameter distribution , and the diameter of the majority of particles ranges from less than 10 nm (99.2%) [39] . like its small size , so particles with a diameter of 10 nanometer or lower percentages can be obtained under different conditions .

(2)- Effect of dispersants on silver nanoparticles

Plays PVP necessary role in surface formation of silver nanoparticles (AgNPS) as it is used as a dispersant that protects the nanoparticles when preparing them due to covers its surface in order to have a stable colloid , and this is very necessary in industry , and the amount of PVP has a significant impact on the size of the silver nanoparticles , so using only a small amount of it causes agglomeration and the appropriate weight ratio for $AgNO_3$ / PVP should be optimal to produce small particles , the surface of the nanoparticles is completely covered with PVP , but nevertheless the size of the particles increases when an excess of PVP is added , and this means that the excess PVP does not reduce size of the material [40] . infrared absorption spectroscopy shows that the silver nanoparticles coordinate with N or O in PVP , which generates a cover on the particles surface , this class can block the silver nanoparticles from the agglomeration , and from producing colloidal spherical particles.

(3)- The effect of temperature

In this study [41] . the reaction was carried out at 50 degrees Celsius , so the mixture turned brown , and the TEM pictures of the AgNPS were formed and that they are not spherical , and this confirms that the rate of reaction has increased significantly , which led to formation) of large moleculars and the occurrence of .reaction it is not desirable at high temperatures , but when temperatures were low , at 10 degrees Celsius , we find that the reaction was slow , and color of the solution changed after 3 hours , and there are many processes in which the generation of nanoparticles tends to generate heat , as in high temperature in laser ablation , wire blasting method [42] . and that the rapid cooling process resolves the process to obtain the size and entangled shape of the nanoparticles .

(4)- Surface concentration

The total free energy is the sum of the free energy of the mass and the surface of the nanoparticles [43] . as the free energy in the surface contributes greatly to the reduction of the size , and there is a tendency for the nanoparticles to form aggregates larger than the basic size at the beginning , so all properties must be determined by concentration , and there are many researches that emphasize the variation of shape dependent properties according to the Nano scale [44] .

7. Applications of (AgNPS and AuNPS)

Nanoparticles are among the most important and attractive materials in applications , they have been(used in a wide range of fields , as antibacterial agents [45] . and in the disinfection of medical and household appliances and water treatment [46] . and they have been used as antibacterial agents for Escherichia coli [47] . and in the production of flexible electronic circuits at a low cost [48] . and the silver nanoparticles prepared with a size of 15 nanometers showed inhibition of Gram positive and Gram negative bacterial strains [49] . and showed toxic effects on colon cancer cells [50] . in another study , the prepared silver nanoparticles gives significant photo catalytic activities against the methylene glue formula [51] . and against human stomach cancer cells MNK45 [52] . gold nanoparticles were also used in many applications , as they were used in the treatment of cancer , antibacterial and immunodeficiency virus , in humans , AuNPS have had an important place in many applications such as drug delivery , bio imaging therapy , treatment of tumor sites [53] , and compound green AuNPS act activity against coryne bacterium pseudopodia , which causes serious bacterial infection found in sheep [54] . and it also showed an effective effect on toxic on mammalian cells , and act as drug carries , and mixing them with antibiotics leads to antibacterial effects , and AuNPS were designed and synthesized with multiple functions , so they worked as a vaccine for cancer [55] . and some studies showed that AuNPS spherical particles are suitable for medical applications [56] . and were used in cosmetics , microchip technology , home appliances , textile materials , nutrition products , and biological imaging [57] . nanoparticles have also been used to increase the effectiveness of antiviral drugs for prevention , photo thermal therapeutic diagnosis , photo acoustic imaging , and in laser therapy [58] .

8. Conclusions and outline

The nobel nano metals such as silver and gold nanoparticles have played an important role in the different scientific area like biology tests , medical optics , envirnomental treatment and so on. these nanometals can be

used in drug delivery , antibacterial , anti corrosion and in variouse field in life in industrial , medical, gemotrical and biological fields to get more friendly synthesis results , thats means there is no side effect on the environment , should use friendly technique to synthesis nanometals such as pulsed-laser ablation and biosynthesis. The aim of the present review study is focusing on the developments in the synthesis of noble nanometals techniques and various their applications. like pulsed laser , extraction of plants and plasma techniques . The current study addressed several importants sections: the firsit section dealt with the synthesis of gold and silver nanoparticles in three different techniques: the pulsed laser technique, the plant extracts technique and plasma technique.The second section dealts with studying the properties of silver nanoparticles and gold nanoparticles, and these properties include the structural, morphological and optical properties of pre-products nanomaterials.Finally, the current review study included the important applications of siver nanoparticles and gold nanoparticles, some of which are used as adsorption materials in the treatment of pollutantsin water as well as in anti bacterial and anti corrosion for some materials and so on.

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