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Synthesis and Characterization of Colloidal Gold Nanoparticles Suspension using Liquid Soaps

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Abstract

In this communication, we represent a versatile and effective technique to synthesize stable aqueous dispersions of gold nanoparticles using chemicals presents in the liquid soaps. Auric tetra chloride ($HAuCl_4$) was used as precursors for synthesis of the gold nanoparticles. The reduction of the gold precursor was carried out using citric acid, Glycerin and other reducing agents present in the liquid soap. Sodium sulphate, sodium chloride present in the liquid soap acts as stabilizing agents. The sources of these precursors in this case were liquid soaps like Pril Perfect (lime), Dettol (Hand Wash), Palmolive, Nomarks (Face Wash), Lakme fruit Burst (Face Wash), Clean & Clear (Face Wash), and Himalaya Neem (Face Wash).By using different process like thermal reduction, microwave, solvothermal and photo catalytic reduction process the above reaction was accomplished. UV-visible spectroscopy, scanning tunneling microscopy (STM) was used to ascertain the formation of gold nanoparticles. The color of the gold nanoparticles suspension varies from red to blue depending upon the shape and size of the particles

Keywords: Green technology, microwave irradiation, photo catalytic, Autoclave, solvothermal, spectroscopy and microscopy.

1. Introduction

Gold nanoparticles are the most stable metal nanoparticles; during the past decades colloidal gold nanoparticles have received significant research attention, both due to their unique physical and chemical properties, and promising applications [1,2,3]. Synthesis of gold nanoparticles and using as nanostructure materials become an exciting area of interdisciplinary research various techniques have been developed to synthesis colloidal gold nanoparticles. The recent interest of gold nanoparticles is propelled by both the advancement in our scientific understanding of their synthesis and physical properties as well as their possibilities of potential applications in the field of chemical and biological sensing [4,5,6], cancer treatment [7], catalysts [8,9,10], drug delivery [11], electronics and optoelectronic devices [12], colloidal dispersion of gold particles with small diameter appear ruby red color while with larger diameter appear bluish, this difference in color is due to larger particle size and when light interact with matter its optical properties change i.e. the size dependence color of colloidal gold is simply a consequence of how light interact with matter [13].Optical properties and applications of these nanoparticles have been highlighted in many reviews and other research works [14,15,16,17]. Colloidal gold nanoparticles are generally produces by the reduction of gold salt such as auric tetrachloride ($HAuCl_4$) in an appropriate solvent, usually stabilizing agent is also added to prevent the particles from agglomeration, most frequently thiols modified ligands are used as a stablishing agent for the formation of AuNPs which bind to the surface and form Au-sulfur bond [18].As concerned the preparation of colloidal gold nanoparticles various chemical routs has been proposed including aqueous and non aqueous solvent, electrochemical method [19,20,21], radiolytic and photochemical method [22], have been widely studies for different purpose of synthesis methods of AuNPs and Several mechanisms have been proposed to explain the dependence of the morphology and geometry of AuNPs on the growth conditions, based on the experimental conditions and additives synthesis of various shape and sized NPs achieved. Citrate reduction method is quite effective method, during our study we have found that liquid soap contains many such chemicals that we generally use for materials synthesis, although chemical method with various reductances are convenient and they are dependent on solution containing there for it is extremely difficult to produced particle size with same mean diameter under similar conditions. Some of the chemical reducing reactions can be carried out at room temperature. But most of them need elevated temperatures for a higher reaction rate recently it has been demonstrated that thermal factor affect the size and uniformity of nanoparticles [23] so by controlling the temperature we can prevent the growth of nanoparticle. Herein, four different techniques have been used for the synthesis of nanoparticles of silver and gold, these are thermal reduction process [24], microwave irradiation [25], photo catalytic reduction process [26] and solvothermal reduction process [27].

2. Experimental

The colloidal gold particles with different sizes were prepared in aqueous solution system containing: Auric tetra chloride ($HAuCl_4$) 15 ml of 1mM, 1 ml of liquid soap solution.

Synthesis: The synthesis has been done by four methods. There are four methods in which reactions takes place at elevated temperature.

Method 1– Photo catalytic reduction (PC), UV short (280 nm – 100 nm) for 30 min.

Method 2- Solvothermal reduction process (ST), at 15 psi and 121^0C for 15 min.

Method 3- Microwave irradiation (MW), medium cycle (2450 MHz; 700 W) for 5 min.

Method 4 - Thermal heating (TR), at 80^0 C (Magnetic stirrer) for 15 min.

In a typical experimental procedure double distilled water was used throughout the experiment. All glassware used in the experiment was scrupulously cleaned with acetone solution and rinsed in turn with double distilled water. 15 ml of 1 mM metal salt is mixed with 1 ml of liquid soap solution of different liquid soaps (Himalaya Neem, Lakme, Clean & Clear, Pril, Dettol, Palmolive, Nomarks) having different reducing agents Himalaya neem (Nimba, Sodium, Potassium), Lakme (Glycerin, Sodium FragariaVesca (Strawberry) Fruit Extract), Clean $ Clear (Glycerin, Methyl Cellulose), Palmolive (Sodium, Magnesium, Ammonium), Pril (Citric Acid) Nomarks (Citrus Limon, Aloevera, Neem), Dettol (Potassium, Glycol). It is then subject to the reduction process using each of the four processes mentioned above.

3.Characterization

Gold Nanoparticles synthesized by the various methods were characterized using UV – VIS Spectroscopy (Thermo Scientific UV-10) and Scanning Tunneling Microscope (Nano Surf Easy Scan 2). Following are the graph obtained through characterization process.

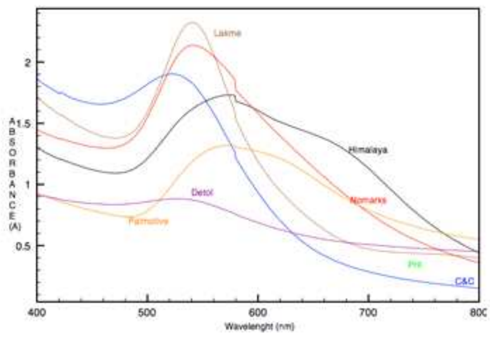

Fig: 1 Evolution of UV-vis spectra of GNPs with thermal reduction method

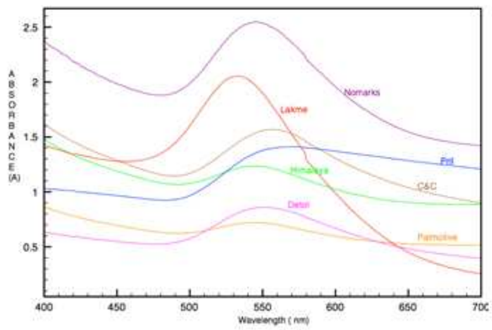

Fig: 2 Evolution of UV-vis spectra of GNPs with photo catalytic reduction method

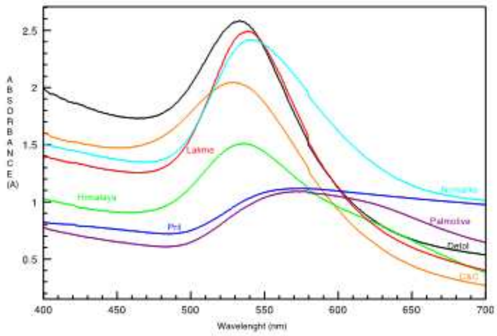

Fig: 3 Evolution of UV-vis spectra of GNPs with Solvothermal reduction method

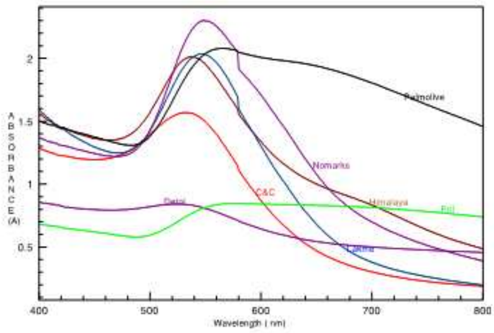

Fig: 4 Evolution of UV-vis spectra of GNPs with microwave irradiation method

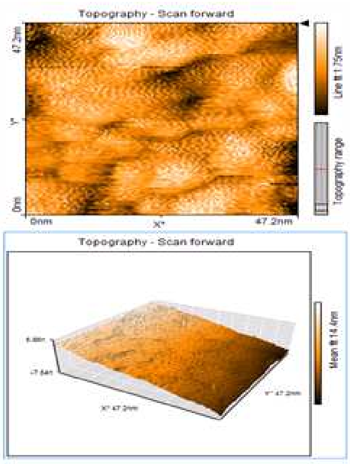

Fig 5. STM Image of AuNPs with 3D views

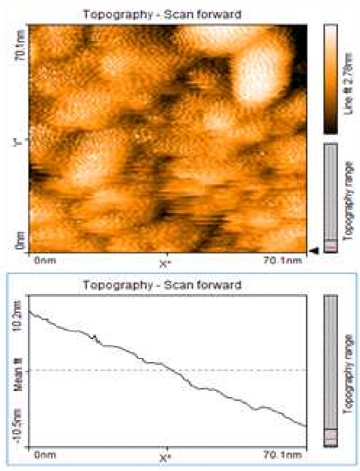

Fig 6. STM Image of AuNPs with line graph

4. RESULTS AND DISCUSSION

As mentioned above colloidal gold particles are prepared by four different methods. The reaction mechanism is the reduction of aqueous metal ion with reducing agent present in the liquid soap and the formation of gold nanoparticles is confirmed by using uv-vis spectroscopy. Color changes appear after the completion of the reaction. It is well known that gold nanoparticles exhibit dark purple or red wine color based on the shape and size of the colloidal nanoparticles of gold. Under uv-vis spectroscopy gold nanoparticles shows surface Plasmon absorption in the range of 530-570 nm. The induction period of forming gold nanoparticles in the presence of different surfactant is different; Broadening peak indicates the particles are poly dispersed. Surface Plasmon resonance in nanoparticles is strongly depends on the shape, size and dielectric constant. Noble metal particles specially silver and gold exhibit a strong absorption band in the visible region and giving specific color to the solution. Some graph shows broadening peak i.e. due to larger particles size. Sharpe peak indicates that the particle sizes are uniform. Based on the color observation we can say that the particles size range is from 10 to 20 nm [28]. Fig 5 and Fig 6 shows the surface morphology of gold nanoparticles. After investigation of images it is clear that the particles are in cluster form. From the figure shown above it is clear that nanoparticles are in cluster form. STM images for AuNPs show Surface morphology at the distance of 40-70 nanometer. Basically STM Shows the lattice structure i.e. arrangement of atoms, of any nanoparticles in this case these are AuNPs The line graph for both silver and gold nanoparticles is almost straight this indicates the preparation of tip, sample and approach were done successfully and it also indicates towards good tunneling contact. It is more difficult to obtain good image of AuNPs, atomic structure are difficult to observe because the electrons are distributed homogeneously on the surface [29].

5. Conclusion

The comparative study of green synthesis of AuNPs exploiting four physical techniques – Photo catalytic, Thermal, Solvothermal and Microwave, gave the change in Plasmon Resonance. The results obtained by characterization of synthesized materials are compared and the study shows the change in physical techniques in Green synthesis indirectly speculates on the orientation and nucleation of nanoparticles

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