



Green Synthesis of Gold Nanoparticles

HAMID REZA GHORBANI*

Department of Chemical Engineering, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran.

*Corresponding author: hamidghorbani6@gmail.com

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ABSTRACT

There is an increased interest in understanding the toxicity and rational design of gold nanoparticles for biomedical applications in recent years. In this study gold nanoparticles were synthesized using dextrose as a reducing agent. The gold nanoparticles displayed characteristic Surface Plasmon Resonance peak at around 550 nm having a mean particle size of 75 ± 30 nm. In order to identify and analyze nanoparticles, UV-Vis spectroscopy, Scanning electron microscopy (SEM), and dynamic light scattering (DLS) were used.

Key words: Gold Nanoparticles, Green Synthesis, Dextrose.

INTRODUCTION

Nanotechnology has emerged as the interdisciplinary science conjugating the basic concept of engineering with the application of biology, chemistry, physics and medical science¹. Research in the field of synthesis of nanoparticles has been growing dramatically over the last few decades due to their unusual and highly interesting properties with wide potential applications like antifungal activity, antibacterial effect, skin cancer therapy etc.^{2,3}. Nanomaterials have potential applications in electronics and photonics, catalysis, information storage, chemical sensing and imaging, environmental remediation, drug delivery and biological labelling⁴⁻⁶. In particular, gold

nanoparticles have many important applications that include: optical devices, electronics, biotechnologies and catalysis⁴.

To obtain gold nanoparticles, various wet chemical methods employing various polar and nonpolar solvents have been used. The most common method is the reduction of tetrachloroauric acid (HAuCl_4) by excess sodium borohydride (NaBH_4) or sodium citrate in the presence of stabilizing/ capping ligands such as citrate, thiolates, amines, phosphanes, carbonyls, dendrimers, and surfactants^{7, 8}. Size control in the small size range by UV irradiation is a simple, clean, reproducible and fast technique with very few control parameters that Sau *et al.* reported it⁹. In

another work, uniform gold nanoparticles with low size polydispersity was synthesized from the chloroauric acid precursor at high concentration (2.5 mM) by the citrate reduction method via combined temperature and pH controls¹⁰.

In another study, to synthesize gold nanoparticles, the reduction reaction between tetrachloroauric acid and sodium citrate was used. It was found that initial gold salt concentration and trisodium citrate concentrations and mixing rate are very important variables in the colloid nanoparticle synthesis¹¹. In 2014, Verma et al. reported the synthesis of gold nanoparticles by trisodium citrate. Their work was carried out to investigate the synthesis and characterization of gold nanoparticles and the effect of various parameters (temperature, gold salt concentration trisodium citrate concentrations, mixing rate and pH) on its size and size distribution¹².

This paper presents the synthesis of gold nanoparticles by simple and green route. In this work, we employed H₂AuCl₄ as an initial reagent, dextrose as reducing agent, and polyvinyl pyrrolidone (pvp) as a stabilizer.

MATERIALS AND METHODS

Materials

Hydrochloroauric acid trihydrate as the precursor, dextrose as the reducing agent and polyvinyl pyrrolidone (PVP) as the stabilizing agent to synthesize gold nanoparticles were purchased from Sigma-Aldrich.

Preparation

1 ml of aqueous solution of dextrose (3 g/100 ml) and 1 ml polyvinylpyrrolidone (20 g/l) were added to 100 ml aqueous solution of H₂AuCl₄ (0.01 M). The reaction between this solution and Au³⁺ ions were carried out for about 15 min. After 15 min, the color of the reaction solution changed to vivid ruby red. This color change indicates a possibility of gold nanoparticles production.

Characterization of gold nanoparticles

Uv-vis spectroscopy was used to prove the existence of nanoparticles. The morphology and size was determined by the scanning electron

microscopy (SEM), and Dynamic light scattering (DLS) analysis.

RESULTS

For analytical study of the prepared sample, the amount of absorption within wave length of 500–650 nm was observed by uv-vis spectroscopy. It is known that an absorption band at about 520-580 nm due to surface plasmon resonance in gold nanoparticles¹³. Fig. 1 shows the UV-Vis spectra of Nano-gold Colloidal Solution recorded between 500 and 650 nm. As illustrated the SPR band cantered 550 nm confirms the formation of gold nanoparticles in the solution^{12, 13}.

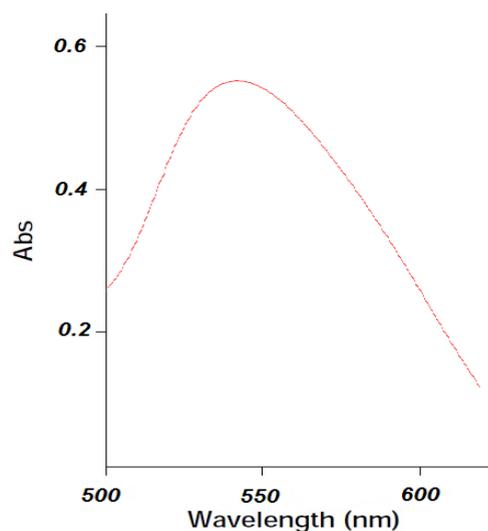


Fig.1: UV-vis spectra of gold nanoparticles solution

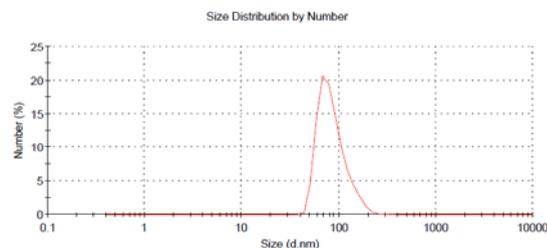


Fig. 2: The size distribution of gold nanoparticles by number

It is well known that gold can be reduced from Au³⁺ to Au⁰ by dextrose. Dynamic light scattering is a widely used technique for the

determination of particle size in colloidal solution. As is seen in figure 2, average size of nanoparticle synthesized is 75 nm. The distribution of gold nanoparticles is about 30 nm which indicates moderate distribution of the nanoparticles. SEM

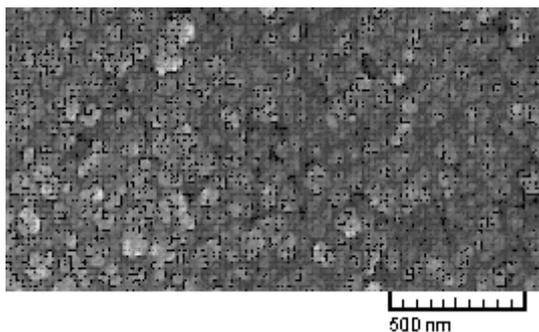


Fig. 3: SEM micrograph of gold nanoparticles produced by dextrose

analysis was carried out to understand the topology of gold nanoparticles. At the end, gold nanoparticles were studied by scanning electron microscopy (SEM). Fig. 3 confirms gold nanoparticles formation at nano size.

CONCLUSIONS

This is an environment friendly one-step method for synthesis of gold nanoparticles. The dextrose acted as a reducing agent of HAuCl_4 and polyvinylpyrrolidone (pvp) as a capping material. Nanoparticles in the range of ~ 75 nm are synthesized by dextrose when it is added to HAuCl_4 . It seems this method is a fast and green method to form gold nanoparticles. The gold nanoparticles were characterized by UV-visible, TEM and DLS analysis.

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