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A study of methods of Synthesis of silver nanoparticles

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Abstract

As a result of its vast variety of applications, nanotechnology is a fast-growing area of study. Nanomedicine is a branch of medicine that investigates how nanotechnology may be used to prevent, cure, diagnose, and control illness in humans. Due to their wide spectrum of antibacterial, anticancer, wound healing, and other therapeutic capabilities, silver nanoparticles with a diameter ranging from 1 to 100 nm are regarded as the most essential in this respect. They are also the most cost-effective to produce.

Key words: Synthesis, Silver, Nanoparticles, Chemical, Properties etc.

Introduction

With its high conductivity, chemical stability, catalytic and antibacterial properties, silver nanoparticles (AgNPs) emerged as a beneficial product from nanotechnology. Biological nanoparticles, particularly those made from plant extracts, are becoming more popular because of their low toxicity, low cost, and environmental friendliness. Alfalfa, Aloe vera, Cinnamomum camphora, Emblica officianalis, Carica papaya, Eucalyptus hybrid, Capsicum annuum, and tamarind are among the plants whose gold and silver nanoparticles have been found. Silver nanoparticles may be synthesised from the leaves of Acacia melanoxylon. Byproducts of the human body's purine metabolism include the primary nitrogenous component in urine, uric acid (UA). Its higher levels have been linked to a wide range of clinical conditions. Hyperuricemia (also known as Lesch-Nyhan syndrome) is associated with a variety of health issues, including gout, renal, and heart disease. Dopamine (DA) is a critical neurotransmitter that has been implicated in several epidemiological studies as a risk factor for cardiovascular disease. The concentration of UA in brain fluids ranges from 1-50 nM, while the concentration of dopamine is on the order of 100 nM. Consequently, a simple, precise and reliable technique for determining uric acid in the presence of interference became a need. Comparing classical spectroscopy, chemiluminescence, chromatography, spectrofluorometry, colorimetry, and electrophoresis procedures, electrochemical assays were widely acknowledged as the quickest available.

Synthesis of silver NPs

- **Physical methods**

“The most significant physical techniques are evaporation-condensation and laser ablation. Physical synthesis techniques have many benefits over chemical synthesis, the most notable of which are the uniformity of NP distribution and the lack of solvent contamination in the created thin films. Some drawbacks of employing a tube furnace at atmospheric pressure for the synthesis of silver nanoparticles are that it takes a long time and a lot of energy to raise the ambient temperature surrounding the source material. A typical tube furnace consumes several kilowatts of electricity and needs a preheating period of several minutes to attain a steady working temperature, which is a significant drawback. A tiny ceramic heater with a specific heating area was used to manufacture silver NPs. The evaporation of the raw ingredients was facilitated by a tiny ceramic heater. Because the temperature gradient at the heater surface is much steeper than in a tube furnace, the evaporated vapour may cool extremely quickly.

- **Chemical methods**

When producing silver NPs, chemical reduction is the most frequent method of production. Silver ions (Ag+) in aqueous or non-aqueous solutions can be reduced using a variety of reducing agents, including sodium citrate, ascorbate, sodium borohydride (NaBH4), elemental hydrogen, the polyol process, the Tollens reagent, N, N-dimethylformamide (DMF), and poly (ethylene glycol)-block copolymers. Ag+ is reduced to metallic silver (Ag0) by these reducing agents, which then aggregate into oligomeric clusters. Metallic silver colloidal particles are formed as a result of these clusters. Metal nanoparticle preparation requires the employment of protective chemicals to stabilise dispersive NPs and protect NPs that may be absorbed or bound onto nanoparticle surfaces from agglomeration, thereby preventing the formation of clusters. Stabilizing the development of particles and preventing them from becoming agglomerated or losing their surface qualities may be achieved by using surfactants with functionalities (e.g. thiols, amines, acids, and alcohols).

Microemulsion techniques

Using microemulsion methods, it is possible to produce silver NPs that are both uniform and controlled in size. First, metal precursor and reducing agent are separated in two separate, immiscible phases in two-phase organic systems, which is the basis for the formation of nanoparticles. As the quaternary alkyl-ammonium salt mediates interphase transport between two phases, it affects the rate at which metal precursors and reducing agents interact with one other. In the non-polar aqueous medium, metal clusters generated at the interface are stabilised because their surfaces are covered with stabiliser molecules and transmitted to the organic medium via the interphase transporter. The usage of very toxic chemical solvents is one of the main drawbacks.

- **UV-initiated photoreduction**

The manufacture of silver NPs in the presence of citrate, polyvinylpyrrolidone, poly (acrylic acid), and collagen has been reported to use a simple and successful approach, UV-initiated photoreduction. When Huang and Yang used silver nitrate as a stabilising agent to prevent NP aggregates from forming, they were able to create silver NPs through photoreduction in layers of inorganic laponite clay suspensions. UV irradiation period was used to determine the NPs' characteristics. When exposed to UV light for three hours, silver nanoparticles with a bimodal size distribution and rather large sizes were produced. This process of further irradiation reduced the size and dispersion of silver nanoparticles to a more consistent level. Silver nanoparticles (nanospheres, nanowires, and dendrites) were synthesised using poly (vinylalcohol) and UV irradiation photoreduction at ambient temperature (as protecting and stabilising agent). The formation of nanorods and dendrites was greatly aided by high concentrations of poly (vinylalcohol) and silver nitrate.

- **Photoinduced reduction**

A number of photoinduced or photocatalytic reduction processes may be used to make silver NPs. In addition to its excellent spatial resolution, ease of usage, and considerable adaptability, photochemical synthesis is a clean method. One may create the nanoparticles in a wide range of media, including cells, emulsion, polymer films (such as surfactant micelles), and glasses. With the aid of photoinduced reduction, microreactors were used to create nano-sized silver particles with an average diameter of 8 nm. It was also shown that the photoinduced approach may be utilised to transform silver nanospheres into triangle nanocrystals (nanoprisms) with appropriate edge lengths between 30 and 120 nm. Dual-beam lighting of NPs was used to regulate the particle development process. For stability, citrate and poly (Styrene sulfonate) were utilised.. When hydrogen was withdrawn from an an aliphatic amine, the excited triplet state of 2-substituted thioxanthones formed -aminoalkyl radicals, which reduced Ag+ extremely quickly. Previous reactions were calibrated to regulate the conversion of silver ion to silver metal by substituent influence on thioxanthones (Ag0).

- **Electrochemical synthetic method**

Silver nanoparticles may be produced electrochemically. Particle size may be controlled by electrolysis settings, and silver NP homogeneity can be improved via electrolytic solution composition. Electrochemical reduction at the liquid/liquid interface resulted in the formation of polyphenylpyrrole-coated silver nanospheroids (3-20 nm in diameter). When the silver metal ion was transferred from an aqueous solution to an organic solution, the reaction was carried out with the pyrrole monomer. Electrochemical reduction within or outside zeolite crystals was used to generate monodisperse silver nanospheroids (1-18 nm) according to the silver exchange degree of compact zeolite film modified electrodes in another investigation. Electrochemically, silver nanoparticles (10-20nm) with narrow size distributions were easily produced in water. The silver clusters in this work were stabilised using poly N-vinylpyrrolidone. NPs are well-protected against agglomeration by Poly N-vinylpyrrolidone, which also lowers the rate of silver deposition while promoting the nucleation and production of silver particles. In order to prevent the formation of flocculates near the cathode and assure particle monodispersity, the use of a spinning platinum cathode has been shown to be an effective technical solution. Improved particle size and dispersion of silver NPs were achieved by adding sodium dodecyl benzene sulfonate to the electrolyte.

Conclusion

Laser ablation, gamma radiation, electron radiation, chemical reduction, and photochemical techniques, along with microwave processing and the thermal decomposition of silver oxalate in water or ethylene glycol as well as biological syntheses are just some of the methods used to create various sizes and shapes of silver nanoparticles. Natural reducing and stabilising chemicals may be used to readily synthesise NPs using biosynthetic techniques. Biosynthesis of metal and semiconductor NPs utilising organisms has been proposed as an ecologically and economically acceptable alternative to chemical and physical techniques". Particle size and shape are critical to the assessment of NPs production. As a result, it's imperative that researchers look at ways to better manage NP shape and monodispersity. It is necessary to improve the reaction conditions. Well-characterized NPs may be synthesised at rates that are faster or comparable to chemical and physical techniques by utilising selected organisms with high production capacity and carefully managing reaction conditions. In addition to medicines, cosmetics, foods, and medical uses, this approach might be applied in a variety of other industries.

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