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Synthesis and applications on sensing technique of silver nanoparticle

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Abstract
Medical diagnostics and medical gadgets, such as metal nanoparticles with diameters under 100 nm, have had a significant influence on customised healthcare during the last several decades. “Antimicrobial agents, biomedical device coatings, drug-delivery carriers, imaging probes, and diagnostic and optoelectronic platforms may all benefit from silver nanoparticles (AgNP) because of their unique physical and optical features and biochemical activity. In this study, we focused on the key synthesis methods for AgNPs, including physical, chemical, and biological synthesis processes, as well as the distinct physiochemical features of AgNPs. Molecular processes underpinning their plasmonic effects on mono- and bimetallic structures, as well as cytotoxicity to cells and microbes, are also discussed. Finally, we summarise the existing uses of AgNPs in nanoscience and nanomedicine and explore their prospects for the future in these fields.

key words: Synthesis, Silver, Nanoparticle, Applications, Antimicrobial etc**.**

Introduction

Many different sectors have found use for metal nanoparticles. A wide range of applications for nanoscale materials technology may be found in sectors as diverse as chemistry and medicine due to the strong correlation between the physical, chemical, and optical characteristics of metallic nanoparticles. AgNPs have recently been the subject of extensive research due to their superior physical, chemical, and biological properties. The superiority of AgNPs over bulk silver comes in large part as a result of the nanoparticles' superiority in size, shape, composition, crystallinity, and structural design. Many efforts have been undertaken to discover and make use of their useful qualities, including anti-bacterial and anti-cancer treatments, diagnostics and optical electronics, water disinfection, and other medical and pharmaceutical uses. Silver is a natural resource with intriguing material characteristics, but the usage of silver-based nanomaterials has been restricted owing to their instability, such as the oxidation in an oxygen-containing fluid. As a result, gold nanoparticles have an untapped potential compared to AgNPs (AuNPs). The size, distribution, morphological form, and surface characteristics of AgNPs have been found to have a substantial impact on their physical, optical, and catalytic capabilities in previous studies. These factors may be altered using a variety of synthetic techniques, reducing agents, and stabilisers. When it comes to medication delivery, for example, AgNPs are often larger than 100 nm in order to handle the larger doses that need to be given. Shapes such as rods, triangles, circles, octahedrons, and polyhedra may be achieved by altering the surface characteristics of AgNPs. The antibacterial properties of Ag^+ ions have been shown in antimicrobial applications using AgNPs. In the disciplines of nanomedicine, pharmaceutics, biosensing, and biotechnological engineering, these outstanding AgNP capabilities have made them useful.

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Applications of Silver Nanoparticles

Health

- **Antimicrobial Activity.**

Using silver metal as an antiseptic for wound healing lead researchers to discover the function of Ag NPs as antimicrobial agents against both fungus and bacteria. Due to Ag NPs' antibacterial action differing for various species, their resistance against multidrug-resistant bacteria and fungi is likewise variable. Methicillin-resistant Gram-positive Staphylococcus aureus and methicillin-resistant Staphylococcus epidermidis and Streptococcus pyogenes have the most strong antibacterial action. Antimicrobial activity against Gram-negative strains of Salmonella typhi and Klebsiella pneumoniae was rather modest; this might have been owing to the plasmolysis of the bacteria's cell walls by Ag NPs. Due to the variations in cell wall structure and quantity of functional groups on the cell surface of the two bacteria, the chitosan-Ag colloid is more effective against Escherichia coli than C. albicans. Pullulan-mediated Ag nanoparticles with greater negative zeta potential are more stable owing to repulsion among the particles and demonstrate significant antibacterial action against Gram-positive bacteria because of this.

- **Sensing and Therapeutic Application.**

Medical gadgets that are portable and wearable may be a preferable option for patient monitoring. Stretchable sensors benefit from the high conductivity of Ag NPs. A variety of carbon-based nanomaterials, including as graphene sponges, multi-walled carbon nanotubes, and carbon black, are coated or dispersed with Ag NPs to create these sensors. In order to demonstrate their outstanding temperature-sensing capabilities, the sensors were employed to generate electrocardiograms.

Environment

- **Sensors**

Heavy metal ions such as Ni, Co, and Hg (II) and sulphide anions may be detected using Ag NPs' colorimetric sensing capability. A greater anisotropy and lightning rod effect may be achieved by using silver nanoplates with triangular sections. It has been shown that these ions may be detected in solutions using plasmon sensors, which show an increasing blue shift when Hg2+ ions are present. Films of Ag NPs coated with tris(4,7-diphenyl-1,10-phenanthroline)ruthenium(II), dichloride complex (Ru(dpp)3Cl2) enclosed in plasticized polymethyl methacrylate (PMMA) have been utilised to construct the sensors, which detect dissolved oxygen in aqueous solutions via ratiometric sensing. ' Ag NPs has created an electrochemical sensor that can detect the herbicide atrazine (Atz). It is possible to swiftly collect and identify malachite green residues using SERS sensors based on the in situ development of Ag NPs on polydopamine- (PDA-) templated filter sheets (FP).

- **Pollution Degradation.**

Ag NPs' catalytic activity is dependent on the size, shape, and surface structure, as well as the bulk and surface composition, of the reducing agent (electron donor) and dye (electron acceptor) with which they are exchanged. Smaller Ag NPs in tubular nanocomposite catalysts

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resulted in better catalytic activity than larger ones. It doesn't matter whether kind or location of substituents are present in the nitroarene series; Ag NPs are excellent catalysts. By using sodium borohydride to degrade 4-nitrophenol, the biosynthesized Ag NPs demonstrated an extremely high chemocatalytic activity, resulting in the complete degradation of 4-nitrophenol into 4-aminophenol, 4-methyl orange (MeO), and Methylene Blue (MB). Organic dyes may be bleached at room temperature using potassium peroxodisulphate in an aqueous solution containing silver-bearing nanoparticles. When the amount of Ag NPs utilised as a catalyst increased, the rate constant rose. While Ag NPs have been shown to breakdown dye in wastewater/effluents, they also exhibit unique features for carbon dioxide electrolysis that play an important role in the conversion of CO2 into CO. In the reduction of halogenated organic pollutants by BH4, Ag NPs serve as a heterogeneous catalyst".

- **Water Treatment**

Biosynthesized Ag NPs were impregnated into nitrocellulose membrane filters at a concentration of 1 mg/L and showed complete inhibition of the microbial community of E.coli, Enterococcus, Pseudomonas, and S. aureus suspension, as well as inactivation and removal of E. coli up to 6 and 5.2 orders of magnitude, respectively, in the water purification process of the bactericidal membrane. Additionally, the polyimide (PI) membrane was enhanced by the addition of zwitterionic sulfobetaine methacrylate (SBMA), which was grafted onto the membrane. In an actual water sample, the Ag NPs may be readily separated from the beads and prevent the development of bacteria. Incorporating multiwall carbon nanotubes (MWCNTs) with embedded iron oxide and silver nanoparticles provides powerful antibacterial properties. Pathogenic bacteria are stored on the surface of polyacrylonitrile (PAN) sorbent, which is utilised in water treatment. Using Ag NPs, however, no biofilm growth was seen on the surface of the substrates. Water that has been polluted by microorganisms may be treated in an emergency by passing through Ag NPs-coated paper.

Conclusions

Researchers have been intrigued by the adjustable features of Ag NPs for a long time. Ascorbate, citrate, and sodium borohydride are often used to reduce silver salts to nanoparticles. Biochemical metabolites from biological sources are also commonly used to produce the nanoparticles. Its antibacterial characteristics make Ag NPs desirable for managing infectious illnesses, removing germs from water, and killing plants. But more study is required before the particles may be used outside the laboratory. Nanoparticle production is always a challenge since there is no one synthesis process that works well. Silver nanoparticles' influence on the environment and human health may also be a concern if they are widely used, thus further research into how Ag NPs accumulate and behave within the human body is needed.

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