Journal of Materials Science and Nanomaterials

Extended Abstract Open Access

Silver and Copper Nanoparticles by the Pulsed Plasma in Liquid and Their Antibacterial Properties

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Keywords: Nanoparticles, antibacterial property, magnetic nanoparticles, nanometer, and Polyvinylpyrrolidone

Abstract:

One of the most important properties of silver nanoparticles is their antimicrobial action against several bacteria, fungi, and viruses. Surprisingly, nano Ag is healthy and non-toxic to low concentrations of human and animal cells, since the possible toxicity of silver nanoparticles to the atmosphere is considered extremely low compared to other materials. Silver and copper nanoparticles were prepared by using pulsed plasma in liquid method. This is a low voltage pulsed spark discharge in a dielectric liquid. The electrodes of about 2 mm in diameter and about 10 mm in length made of pure silver rods were submerged in a 50 ml pyrex beaker filled with deionized water and plasma (200 V, 50 A (peak), 10 μs) was generated between the silver electrodes for about 15 min. Polyvinylpyrrolidone (PVP), Cetyl trimethylammonium bromide (CTAB), Sodium n-Dodecyl Sulphate (SDS) were used as a stabilizing agents. The XRD spectra of the prepared samples indicated the face-centered cubic crystalline structure of metallic silver nanoparticles. Spherically shaped silver nanoparticles of diameter 2.2 ± 0.8 nm were synthesized by the pulsed plasma in aqueous solution with PVP surfactant. Similarly, silver nanoparticles of diameter 1.9 ± 0.4 nm size were obtained with SDS surfactant. In vitro antibacterial properties of all the synthesized silver nanoparticles against the Gram-negative bacteria Escherichia coli were examined by Kirby–Bauer disk diffusion susceptibility method. It was noticed that the stabilized with SDS silver nanoparticles demonstrated a better antibacterial activity against bacterial strains as compared to the silver nanoparticles stabilized with PVP, CTAB.

The group of nanoparticles which can be affected by gradients of the magnetic field is called Magnetic nanoparticles. In general, these particles consist of magnetic elements such as nickel, iron, cobalt, and their chemical compounds. The diameters of nanoparticles are smaller than 1 micrometer, and the diameter of the larger microbeads varies from 0.5-500 micrometer. Several individual magnetic nanoparticles together form a cluster of magnetic nanoparticles whose diameter ranges from 50-200 nanometers is called magnetic nano beads. Nanoscale materials have a high volume-to-volume ratio and special chemical and physical properties that make antimicrobial agents promising. NPs are produced and used in a wide range of commercial products, e.g. in electronics, bio-sensing, clothing, food production, cosmetics, and medicine. Silver nanoparticles, copper nanoparticles, and silver-copper nanoparticles complex (AgCuNPs) are used very commonly in different science studies. In addition, these nanoparticles' colloids are widely available commercially, and cost-friendly. The physical and chemical processes used to synthesize metal nanoparticles are expensive and potentially environmentally harmful. These methods have many drawbacks including the use of toxic solvents, hazardous by-product generation and high energy consumption. There is, therefore, a need to develop environmentally benign procedures for metal nanoparticles synthesis. Copper is an essential element for the metabolism of animal and plant cells. Its antimicrobial activity is internationally recognized and has recently been identified as the first solid by the United States Environmental Protection Agency Antimicrobial compound. Laboratory and clinical studies have been conducted to demonstrate its effectiveness. In recent years, copper has been used as a building material for hospitals and medical centers as its antimicrobial properties proved useful in the fight against infections. The synthesis or extraction of compounds such as nanoparticles with antimicrobial properties is significant and has potentially promising applications to counter the growing number of pathogens resistant to antimicrobials that are currently accessible. Copper has bactericidal activity, primarily due to its ability in a continuous cycle to give and accept electrons. It creates a radical hydroxyl, which may be involved in a variety of adverse reactions to cellular macromolecules such as protein and lipid oxidation. They are formed from different materials, either metallic or polymeric, and are often radically different from larger particles in their active surface area, chemical reactivity and biological activity. Together with modern antibiotics, it is proposed that bacteria are much less likely to develop resistance to metal nanoparticles. Exposing bacteria to surfaces of copper causes the cells to undergo significant damage to the membranes within minutes. The antimicrobial properties of silver and copper have gained the greatest attention as regards nanoparticles. The two were integrated into various materials including polymethylmethacrylate (PMMA) and hydroglasses. Nanoparticles' bacterial susceptibility depends on several factors such as the bacterial strain, the type and size of nanoparticles, the nature of the initial growth media, and the concentration of cells. The use of nanoparticles as oral antimicrobials to control various infections, their biocidal properties and their anti-adhesive capacity against biofilms is becoming increasingly important. CuO is a composite semiconductor with a monoclinical structure and is the most simple member of the copper compound family. This has a number of useful properties such as superconductivity to high temperatures, electron correlation effects, and dynamic rotation. One potential explanation for their toxicity may be traditional physical and chemical methods of synthesizing metal nanoparticles.

This Syntheticisation of nanoparticles from biological sources will solve the problem. Copper nanoparticles have major drawbacks including the rapid oxidation of exposure to sunlight. Throughout preparation and storage, copper is oxidized to CuO and Cu2O, and then Cu2+, making it impossible to synthesize copper nanoparticles in a natural environment. Nanostructures are new materials that are obtained by dispersing a small amount of nano-sized filler into a biopolymer matrix while preserving the biodegradability and non-toxicity of the material. These may exhibit improved mechanical, optical, chemical, and barrier properties, and biological reactivity compared to pure biopolymers, depending on the dispersion and size of the inorganic filler portion in nanostructures. Because of their dispersion by nanometer, biopolymer-clay nanocomposites show great advances in mechanical and physical properties compared to pure biopolymers Nanonomaterial load, form of drug, size and shape of nanoparticles, functional surface groups and concentration of crystallinity are important factors for their antibacterial impact. Given the benefits, its toxicity and protection are obstacles that restrict its effective and safe usage Because of low cost, copper-based nanoparticles are preferred to gold or silver nanoparticles; high surface area; good thermal, mechanical stability, antimicrobial activity and UV light barrier properties; high performance conductive content in various applications; and use in photovoltaic applications.