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Some Significant Trends in Antibacterial Nano Textile Finishes

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Abstract

The article highlights some insights of some recent researches in nano textile finishes. Effort has been taken to impart antimicrobial finishing to the cellulosic fabric using nano silver solution at different concentrations and an eco-friendly cross linking agent through exhaustion method. The curing conditions have been varied maintaining specified temperatures and time durations. In another study, the extracellular synthesis of highly stable silver particles for the development of nanosafe textile using the extracts of yellow papaya peel has been attempted.

Keywords: Antimicrobial; Nano silver; Cotton; Nanosafe textile

Introduction

Recently the market for antimicrobial textiles has witnessed considerable improvement. This growth has been fuelled by the increased need of consumers for fresh, clean and hygienic clothing. Extensive research is taking place to develop new antimicrobial finishes. The mechanism of antimicrobial activity and the principles of antimicrobial finishing of textiles has been highlighted. Antimicrobial finishes add value to textiles and garments by providing protection in different ways. There are different types of fungicides or bactericides such as metal salts, aldehyde amines, urea, phenols and antibiotics, which have the ability to interrupt the usual metabolism of microorganism and inhibit their growth thereby imparting antibacterial and antifungal activity to cellulosic fibres. Since antibacterial method to textiles is the chemical method, antibacterial finishing via nanotechnology is used instead [1].

Bio-nano technology has emerged as integration of biotechnology and nano technology for developing nano technology for developing biological and environmentally benign technology for synthesis of nanoparticles. The most widely studied nano particles in the recent past are those made from the noble metals such as silver, gold and platinum. There is an increasing commercial demand for nano particles due to their wide applicability in various areas, such as electronics, catalysis, chemistry, energy and medicine [2]. Also, in the textile sector, nano technology is expected to hold considerable potential for the development of new materials.

Nano silver finish on cotton

Nanoscale particles provide a narrow size distribution which is required to obtain a uniform material response. Materials such as paints, pigments, electronic inks, and ferrofluids as well as ann advanced functional and structural ceramics, require that the particles be uniform in size and stable against agglomeration. Fine particles, particularly nanoscale particles with significant surface areas, often agglomerate to minimize the total surface or interfacial energy of the system. Although the process of using solution chemistry can be a practical route for the synthesis of both submicrometer and nano scale particles of many materials issues such as the size, distribution of particles, morphology, crystallinity, particle agglomeration during and after synthesis and separation of these particles from the reactant need further investigation. Druids used silver to preserve food. American settlers put silver dollars in milk to stop spoilage. Silver leaf was used during World War I to combat infections in wounds. Human skin has many surface bacteria present at any time, which is not a bad thing [3].

Antimicrobial activity of silver

The antimicrobial activity of silver has been recognized by clinicians for over 100 years. However, it is only in the last few decades that the mode of action of silver as an antimicrobial agent has been studied with any rigour. Metallic silver is relatively unreactive. However, when exposed to aqueous environments, some ionic silver is released. Certain salts like silver nitrate are readily soluble in water and have been exploited as antiseptic agents for many decades. The generation of silver ions can also be achieved through ion exchange using complexes of silver with other inorganic materials like silver zeolite complexes silver nanoparticles have also been demonstrated to exhibit antimicroibial properties against both bacteria and viruses with close attachment to the microbial cell/virus particles being demonstrated with activity being size dependent. Despite this, the principle activity of silver is as a result of silver ions within an aqueous matrix. This therefore implies that for silver to have an antimicrobial effect, free water must be present. Silver ions interact with a number of components of both bacterial, protozoal and fungal cells. Toxicity to microbial cells is exhibited at very low concentrations with masses within the range of a few fg- cell-1s being associated with bactericidal activity. The kinetics of kill vary depending on the source of the silver ions with silver derived from ion exchange processes demonstrating delayed activity compared with that derived from soluble salts. Activity appears to increase with temperature and pH. Studies have demonstrated that silver ions interact with sulfydryl (-SH) groups of proteins as well as the bases of DNA leading either to the inhibition of respiratory processes or DNA unwinding. Inhibition of cell division and damage to bacterial cell envelopes are also recorded, and interaction with hydrogen bonding processes has been demonstrated to occur. Interruption of cell wall synthesis resulting in the loss of essential nutrients has been shown to occur in yeasts and may well occur in other fungi.

Antiviral activity of silver ions has been recorded, and the reaction with –SH groups has been implicated in the mode of action. The association of silver nano particles with the envelope of certain viruses has been suggested to prevent them from being infective. Much of the research into the mechanism of action of silver ions has been associated with its use as a therapeutic agent especially as a topical dressing on burns. The concentration employed in and released from treated articles is significantly lower than in these applications. Under such conditions, it has been suggested that in many cases, the concentration of silver ions available following hydration of the surface of a treated article is too low to produce antimicrobial activity associated with many of the mechanisms described above. However, silver ions have been demonstrated to interact with the proteins and possibly phospholipids associated with the proton pump of bacterial membranes. This results in a collapse of the membrane proton gradient causing a disruption of many of the mechanisms of cellular metabolism and hence cell death. Silver ions clearly do not possess a single mode of action. They interact with a wide range of molecular processes within microorganisms resulting in a range of effects from the growth of effects from the inhibition of growth loss of infectivity to cell death. The mechanism depends on both the concentration of silver ions present and the sensitivity of the microbial species to silver. Contact time, temperature, pH and the presence of free water all impact on both the rate and extent of antimicrobial activity [4-17].

The results of both fabrics applied to determine the silver content in fabrics for microbiological estimation of bactericidal efficacy show that silver nano particles are well coupled with the fabric, indicating the long lasting of such a finish against washing [18]. The results obtained with the SEM image of cotton fabrics, and the results derived before and after finishing demonstrate that both fabrics are protected from *Eschirichia coli*. The silver nano particles used in this work were well dispersed in the finishing bath nano particles, even in very small amounts, can provide the final product with bacteriostatic properties due to the fact that nanoscaled materials have a high surface area-to-volume ratio.

Application of papaya peels derived silver nano particles on cotton

Apart from improving their functionality, the use of nanotechnology could lead to the production of textiles with completely novel properties or the combination of various functions [9]. These multifunctional textiles can be antistatic textiles, reinforced textiles, antibacterial, self cleaning textiles, bleaching textiles, etc, and can open the way for the use of its products in other fields outside traditional industries [19-21]. Among all nano particles, silver nano particles are of particular interest due to their strong and wide spectrum antimicrobial activities. For protection against microbial contamination, silver has been incorporated into various forms of plastics e.g., catheters, dental material, medical devices, implants, and burn dressings. These nano particles have also been used for durable finish on fabrics. As bactericides, the silver nano particles may help in solving the serious antibiotic resistance problem.

Several strategies are employed for the synthesis of silver nano particles including chemical techniques, physical techniques and recently via biological techniques [22]. Biological techniques have received much attention as a viable alternative for the development of metal nanoparticles [23]. Many bacterial as well as fungal species have been used for silver nano particles synthesis [24,25]. But most of them are reported to accumulate silver nano particles intracellularly. On the contrary, plant extract mediated synthesis i.e., green synthesis always takes place extracellularly, and the reaction times remain very short as compared to microbial synthesis.

Extracts of several plants such as Pelargonium, graveolens, Medicago sativa, Azadirachta indica, Lemongrass, Aloe vera, Cinnamomum, Camphora, Emblica officinalis, Capsicum annuum, Dyospyros kaki, Carica papaya, Coriandrum, Boswellia ovaliofoliolata, Tridas Procumbens, Jatropa curcas, Solanum melongena, Datura metel, Citrus aurantium, and many weeds have shown the potential of reducing silver nitrate for the formation of silver nanoparticles without any chemical ingredients [26,27].

Carica papaya (papaya) is a native of northern India and has been cultivated and naturalized over the mediterarian region since ancient times. It is a medicinal plant. Different parts of this plant including flower and fruits are used for the synthesis of silver nano particles. Main edible portion of the plant is fruit, peel of which is generally discarded. Fewer reports related to the synthesis of silver nano particles using peel extracts are available. It has been explored for the first time the potential of the peels of yellow papaya as non toxic biological systems for the biosynthesis of green nano silver particles.

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Among the different methods of nanoparticles synthesis, green synthesis method has advantage in controlling particle size and morphology effectively [28]. This method is also convenient and fast as compared to other conventional methods. Due to their potent antibacterial activity, papaya peel derived silver derived nanoparticles can be incorporated into fabrics and the manufacturers can make textiles free from spoilage by microorganisms. The significant reduction in reaction time with fruit peel extract is an important result and will enable nanoparticle biosynthesis methods to compete with other routes for the formation of nanoparticles that are currently much more rapid and reproducible.

Conclusion

Nano silver particles have been applied on cotton fabrics. In order to evaluate the quality of the finished fabric, various properties such as washing fastness and zone of inhibition have been studied. The bacteria *E.Coli* has been used to investigate the zones of inhibition for determination of the antibacterial activity of the fabric. SEM has been used to study the surface characteristics of these fabrics. The findings reveal good and durable bacteriostatic efficacy of silver nano particles applied during the finishing of cotton and viscose. In another study dip and dry technique has been used to treat fabric with silver nano particles so as to study the influence of antibacterial activity. The synthesized nano particles are also characterized and quantified. Due to their potent antibacterial activity, papaya peels derived silver nanoparticles can be incorporated into fabrics and the manufacturers can make textiles free from spoilage by micro-organisms.

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