



Antimicrobial Activity of Sds/Ag Treated Cotton Fabric

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Abstract

The antimicrobial cotton fabric has been prepared by coating it with Ag treated with SDS(Sodium dodecyl sulphate) nanocoating and its antimicrobial properties have been tested. It is observed in the present study, that the nanocoating coated cotton fabrics have good antimicrobial properties. The coated cotton fabric showed an antibacterial activity value of 5.86 against *Klebsiella pneumonia* ATCC 4352 and that of 4.89 against *Staphylococcus aureus* ATCC 6538 when tested according to the JIS L 1902-2015 method.



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The fabrics are made antibacterial by incorporating antimicrobial agents into them.¹⁻³ A cheap and practical alternative can be to prolong the efficacy of the fabric like PPEs by providing intrinsically antimicrobial properties directly onto the fiber materials. Recently, metal nanoparticles (NPs) as antimicrobial agents have increasingly been used in textile research due to their unique large surface-to-volume ratio, physico- chemical properties and biological multi-target mechanism of action, which may differ considerably from bulk material.^{4, 5} Zinc oxide nanoparticles (ZnO) that are considered nontoxic and biocompatible in low concentrations and have been applied in different therapeutic

applications as drug carriers and antimicrobial agent.^{6, 7} SDS is a sulfated surfactant that denatures membrane proteins of cells and pathogens. It thus has a dual action as a stabilizer and as an antimicrobial agent.⁸ Previous studies have demonstrated that in vitro SDS inhibited the infectivity of HSV-1 to Vero cells at quite low concentrations, suggesting that SDS could be a potential candidate for use as a topical microbicide.⁹ The development of these antimicrobial textiles that incorporate immobilized nanoparticles in SDS is a step beyond the current state-of-the-art. The interdisciplinary research field combining nanotechnology, biotechnology, and textile is still in its early stages. To our knowledge, the

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strategy proposed in the present work is unique and almost nothing is known about the properties and performance of such a system of silver nanoparticles and SDS which are complementary to each other in providing antimicrobial properties. In the present work, Ag treated with SDS nanocoatings were prepared and applied on cotton fabrics and their antimicrobial properties were studied.

Silver nitrate (AgNO_3) was used as a precursor while Tri Sodium citrate ($\text{C}_6\text{H}_5\text{O}_7\text{Na}_3$) and Ascorbic acid ($\text{C}_6\text{H}_8\text{O}_6$) were utilized as the reducing agent and surfactant, separately. To synthesize silver nanoparticles, initially, 80 ml of AgNO_3 was heated to 60°C and then 20 ml of $\text{C}_6\text{H}_5\text{O}_7\text{Na}_3$ and $\text{C}_6\text{H}_8\text{O}_6$ solutions, preheated to 60°C were added under stirring. The stirring of the above solution was continued for 20 minutes. After that, the solution was cooled to room temperature with continued stirring.¹⁰

Immediately after the synthesis to confirm the formation of Ag nanoparticles XRD characterization of the synthesized product has been carried out. The UV absorbance spectrum of the colloidal sample was also obtained in the range of 200–800 nm, using a UV–Vis spectrometer Shimadzu-UV 1800.

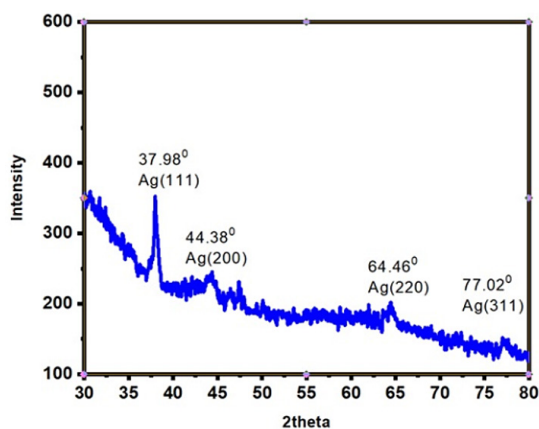


Fig. 1: XRD of silver nanoparticle

In the procedure for preparing the coated textile sample, 0.1 g of AgNP was added to 50 mL of the surfactant solutions with a concentration of 1 wt%. The dispersion was then ultrasonicated for 4 h and stirred for half an hour to get a homogenous solution. The cotton fabric was detergent washed; dried in the

Fig. 1 shows the XRD analysis of powder silver nanoparticles. The presence of peaks at different 2θ values such as 37.98° , 44.38° , 64.46° and 77.02° correspond to (111), (200), (220), (311) planes of silver, respectively.¹¹ The peaks in the XRD pattern can be readily indexed to a face-centered cubic structure of the synthesized silver as per the literature (JCPDS, File No. 4-0783).¹² The lattice constant calculated from the XRD pattern was found to be $a = 0.4132$ nm, which is almost close to the standard value, $a = 0.4086$ nm. The crystallite size (L) of the silver nanoparticles thin film has been evaluated by Scherrer's formula in which λ is the wavelength (0.15418 \AA) of X-rays, β is the broadening of diffraction line measured at half of its maximum intensity in radian unit, and θ is the diffraction angle in degrees. The crystallite size of the newly synthesized silver nanoparticles has been found to be 14.17 nm.

$$D = K\lambda / \beta \cos\theta$$

Fig.2: shows UV-Vis spectra of silver nanoparticles showed an absorption peak of silver nanoparticles at about 409 nm, which confirms the formation of silver nanoparticles

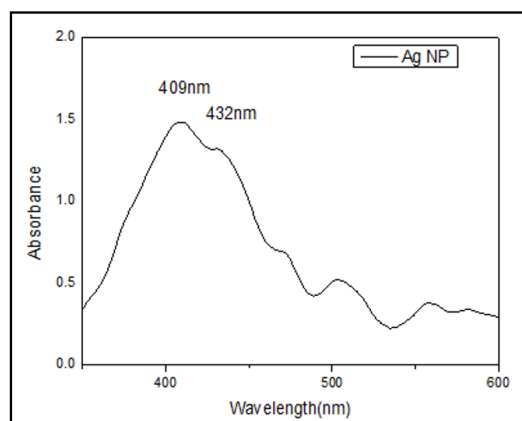


Fig. 2: UV-Vis spectra of silver nanoparticle

air before use. The cotton textile (3x3cm) was dipped in the above solution for one day. After that, the textile was air-dried. The add-on % of the coated fabric was about 20%. The coated cotton fabric was tested at BTRA, Mumbai. The coated cotton fabric was tested at BTRA, Mumbai. for antibacterial activity value

against *Klebsiella pneumoniae* by ATCC 4352 and against *Staphylococcus aureus* by ATCC 6538 when tested as per JIS L 1902-2015 Method.

The sample was kept under observation in contact with individual test organisms for 18-24 hrs shows results as given in Table 1

Table 1: Antibacterial activity value of coated textile

Sample	Test organism	Growth Value on Control Specimen	Growth Value on Test Specimen	Antibacterial Activity Value (A Value)
Coated cotton fabric	<i>Staphylococcus aureus</i> ATCC 6538	2.05	-3.81	5.86
	<i>Klebsiella pneumoniae</i> ATCC 4352	1.20	-3.69	4.89

Sample	<i>Staphylococcus aureus</i> ATCC 6538			<i>Klebsiella pneumoniae</i> ATCC 4352		
	Growth under specimen	Zone of inhibition	Zone of inhibition in mm	Growth under specimen	Zone of inhibition	Zone of inhibition in mm
Coated cotton fabric	Absent	Absent	-	Absent	Absent	-

The antimicrobial test shows, the growth value on the control specimen as 2.05 against *Staphylococcus aureus* by ATCC 4352 and 1.20 against *Klebsiella pneumoniae* by ATCC 6538. The corresponding values for the coated textile samples are -3.81 and -3.69 as shown in Table 1. Ag nanocoating coated cotton fabric showed an Antibacterial Activity value of 5.86 against *Klebsiella pneumoniae* ATCC 4352 and that of 4.89 *Staphylococcus aureus* ATCC 6538 when

tested according to the JIS L 1902 – 2015 method. The value of Antibacterial activity (A) obtained by this standard testing method shall not be less than 2.0 for the antimicrobial products. The coated textile sample shows a very good antibacterial activity value of more than 2.0. Further study will be carried out to assess the chemical interaction of Ag nanoparticles with SDS and its application in other types of textile materials.

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