International Journal of Applied Engineering and Technology ISSN: 2277-212X (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jet.htm
2015 Vol. 5 (3) July-September, pp.63-75/Gokarneshan et al.
Review Article

NANO FINISHING OF COTTON FABRICS

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ABSTRACT
Nano textile finishing has gained interest during the past decade. A number of nano materials have been used effectively in imparting the desired functional properties to fabrics. A wide range of fabrics including cotton, silk, wool, and polyester have been treated with nano materials with interesting results. This chapter exclusively highlights the nano finishing of cotton fabrics. Various materials such as silver oxide, titanium dioxide, silicon oxide, and zinc oxides have been applied on to textile materials with interesting results. The nano finishes compare well with their conventional counterparts with regard to properties and durability.

Keywords: *Cotton, Functional Properties, Metal Oxides, Nano Materials, Nano Finishes*

INTRODUCTION

During the past two decades, the small particle research has become quite popular in various fields of chemistry and physics. The small particles now we call nano structured materials are having interesting properties. Metallic nano particles represent a class of materials that are increasingly receiving attention as important starting points for the generation of micro and nano structures. These particles are under active research because they possess interesting physical properties differing considerably from that of the bulk phase. It has small sizes and high surface/volume ratio (Chattopadhyay, 2006). A number of nano finishes on textile materials have been evolved during the recent years. The application of nano particles to textile materials has been the object of several studies, aimed at producing finished fabrics with different functional performances. For example, nano silver has been used for imparting antibacterial properties (Kwon *et al.,* 2002; Lee *et al.,* 2003), nano titanium dioxide for UV blocking and self cleaning properties (Dura'n *et al.,* 2007; Xin *et al.,* 2004; Fei *et al.,* 2006), and zinc oxide nanoparticles for antibacterial and UV blocking properties (Vigneswaran *et al.,* 2006; Qi *et al.,* 2007; Baglioni *et al.,* 2003). Conventional textile finishing methods used to impart different properties, such as water repellency and stain repellency, to the fabrics often do not lead to permanent effects, and lose their functions, after laundering or use. Nano particles can provide high durability for treated fabrics as they possess large surface area and high surface energy that ensure better affinity for fabrics and lead to an increase in durability of the desire textile functions (Wong *et al.,* 2006). Thus decreasing the size of particles to nano scale dimensions fundamentally changes the properties of the material. By virtue of its small size and high surface energy, nano particles are bound to the fabric surface by vander vaal's forces which give a reasonable wash fastness. In general, as wash fastness is a particular requirement for textiles, it is strongly it is strongly correlated with the nano particles adhesion to the fibres. In order to increase the wash fastness, nano particles can be applied by dipping the fabrics in a solution containing a specific binder (Vigneswaran *et al.,* 2006; Qi *et al.,* 2007; Baglioni *et al.,* 2003). Wash fastness can be further improved with the formation of covalent bonding between nano particles and the fabrics surface. In these cases the excellent properties are still maintained after about 55 home launderings (Daoud and Xin, 2004).

Influence of Silver Nano Particles

Silver nano particles have received considerable attention due to their attractive physical and chemical properties. Metallic silver colloids were prepared more than a century ago. Silver nano particles can be synthesized using various methods, such as chemical, electrochemical, gamma radiation, photo chemical, laser ablation, etc., (Yakutik *et al.,* 2004). The most popular preparation of Ag colloid is chemical reduction of silver salts by sodium borohydride or sodium citrate. This preparation is simple, but the great care must be exercised to make stable and reproducible colloid. The purity of water and reagents, cleanliness of glassware are critical parameters. Solution temperature, concentrations of metal salt, reducing agents and reaction times influence particle size. Controlling size and shape of metal nano particles remains a challenge. The size – induced properties of nano particles enable the development of new application or the addition of flexibility to existing systems in many areas such as catalysis, optics, microelectronics and textiles.

Silver nano is a trademark name of an antibacterial technology which uses silver nano particles in washing machines, refrigerators, air conditioners, air purifiers and vacuum cleaners. Antibacterial effect of silver nano particles as textiles has already been shown by various researchers (Patel *et al.*, 2005; Razafimahefa *et al.*, 2008; Radetic *et al.*, 2008; Lala *et al.*, 2007). But the effect of Ag nano treatment on other physical and chemical properties of textiles is hardly found in the literatures. In the present work, Ag nano particles have been synthesized by the reduction silver salt ($AgSO_4$) with sodium boro hydride in the presence of tri sodium citrate and characterized by particle size analyzer, scanning electron microscope (SEM) and atomic force microscope. Prepared silver nano colloids have been applied to the textiles and the effect on various properties, like tensile, creasing, stiffness, dyeing and bacterial resistance are examined by standard methods. Silver nano colloids have been applied on scoured and bleached cotton fabrics.

Method of Application

Silver nano particles have been applied on cotton, wool, and silk fabric samples by dipping them in the dispersion for 10 minutes and then padded on an automatic padding mangle machine 2-dip-2-nip padding sequence at 70% expression. The padded substrates were air dried and finally cured at 120^0C for 20 minutes in a preheated curing oven (Raja and Thilagavathi, 2010).

Influence on Dyeing Behaviour

Cotton, wool, and silk fabrics treated with silver nano colloid particles, have been dyed with three types of direct dyes. The treated fabrics so dyed have been compared with the untreated fabrics. The color strength values of the nano treated fabrics are higher than the untreated ones. The optimum results have been observed in the treated fabrics dyed with CI direct green 6 dye. The color strength values of the treated fabrics have shown that the presence of nano metal particles improves the dye affinity towards the textile material. The silver nano particles in the fabric thus act as a mordant (Raja and Thilagavathi, 2010). The negatively charged dye anions get attracted towards the fibre probably due the polarity developed in the metal particles by induction which results in better bonding between the dye and the fibre. The improvement in the colour fastness properties also indicates the better coupling of the dye and the fibre. Therefore fabrics treated with silver nano colloids not only improve the colour strength but also the colour fastness, which is observed to be a major setback with direct dyes.

Influence on Microbial Resistance

Treated as well as untreated fabrics of cotton, wool and silk have been tested for bacterial resistance by measurement of loss in breaking load due to soil burial test. The test results show that the loss in breaking load is reduced in all the fabrics tested. It only proves that the fabrics (cotton, wool and silk) treated with nano silver colloid particles exhibit improvement in the bacterial resistance. The reason behind is that the metallic ions and metallic compounds exhibit a specific amount of sterilizing effect. The oxygen present in atmosphere is partially converted to active oxygen due to catalysis with the metallic ion, and thus dissolves the organic substance to produce a sterilizing effect. The antibacterial effect is greatly improved on account of the very large relative surface area, and increasing their contact with bacteria or fungi. Nano silver has been found to be highly reactive with proteins (Raja and Thilagavathi, 2010). It therefore interferes with cell growth by seriously affecting cellular metabolism, through its contact with bacteria or fungus. Moreover, the respiration, basal metabolism of the electron system, and transport of substrate in the microbial cell membrane get suppressed by the nano silver particles. They also prevent the growth and division of bacteria and fungi that cause infection, odour, itchiness and sores.

Influence on Physical Properties

Silver nano colloids have been applied to textile materials and the effect on various properties such as tensile, creasing; stiffness, dyeing and bacterial resistance have been evaluated by standard methods

(Chattopadhyay and Patel, 2009). Silver nano particles have been applied on bleached and scoured cotton, wool and silk fabrics. The research has been focused on the influence of the silver nano particles on the physical, dyeing, and microbial properties of fabrics so treated. Under physical properties, the tensile strength, crease recovery and bending length have been considered. The introduction of nano particles into the fibre structure causes an improvement in its load bearing capacity. The treatment has improved the breaking load of cotton fabric by 8%. The enhancement in the load bearing capacity of the textile material could probably be attributed to the fact that the silver nano particles owing to their small size are able to penetrate between the polymer molecules and thereby act as filler or cross linking agent. The incorporation of silver nano particles with regard to improvement in crease recovery angle is found to give better result in comparison with the cross linking method as in the latter case the crease recovery is improved at the expense of increasing the fabric rigidity. The nano particles that penetrate between the polymer chain molecules do not interfere much with the flexibility of the polymer system and thereby render the treatment to be considerably less harsher than the cross linking treatment. In another research work reported, the physical properties of cotton fabrics treated with meso silver and SILPURE (silver chloride compound) nano particles have been investigated for deteriorating effects, and these are found to be suitable for apparel applications (Ghosh *et al.*, 2010). Meso silver is pure silver sub-nanometer sized particles suspended in de-ionized water. Ultra fresh SILPURE is a formulation of a silver compound, a polymer (polyvinyl derivative) and formaldehyde in aqueous solution. No significant deterioration in breaking load or strain has been observed (Ghosh *et al.*, 2010; Gokarneshan *et al.*, 2012). The strength of the SILPURE treated fabric increases with a slight reduction in strain value, which could be attributed to the presence of a polymer (Polyvinyl derivative) in the SILPURE solution, as it forms a thin layer that substantially increases the fabric thickness and provides further fabric integrity under strain. These results have not been observed in the case of meso silver treated fabric. The treated as well as untreated fabrics show very high pilling. However, SILPURE treated fabrics showed some improvement in pill appearance, probably due to the presence of over coating. Both treated fabrics did not show weight loss due to abrasion. Also, the treated fabrics did not show change in the comfort characteristics, namely, thermal resistance and evaporative resistance.

Influence of Zinc Oxide Nano Particles

Zinc oxide nano particles have been used for imparting anti bacterial and UV blocking properties (Vigneshwaran *et al.*, 2006; Qi *et al.*, 2007; Baglioni *et al.*, 2003). It has the advantage of cost effectiveness in comparison with nano silver oxide, non toxic and chemically stable under exposure to high temperature and also capable of photo catalytic oxidation. Zinc oxide is widely used in different areas because of its unique photo catalytic, electrical, electronic, optical, and dermatological and anti bacterial properties (Pan *et al.*, 2001; Arnold *et al.*, 2003; Sawai, 2003; Xiong *et al.*, 2003; Behnajady *et al.*, 2006; Tang *et al.*, 2006). For these applications, the nano particle need to be dispersed homogeneously in the different matrices and a number of new synthetic strategies have been developed in order to prevent particle agglomeration and to increase the stability of ZnO nano particle dispersions (Tang *et al.*, 2006; Guo *et al.*, 200; Kathirvelu and Bhaarathi, 2009). The wide range of applications is possible as ZnO has three key advantages. First, it is a semi conductor with a direct band gap of 3.37eV and a large excitation binding energy of 60 meV. It is an important functional oxide, exhibiting excellent photo-catalytic activity. Secondly, because of its non central symmetry, ZnO is a piezoelectric, which is a key property in building electro mechanical coupled sensors and transducers. Finally, ZnO is bio safe, bio compatible and can be used for bio medical applications without coating. With these three unique characteristics, ZnO could be one of the most important nano materials in future research and applications.

Method of Application

Four types of fabric samples (Cotton and 45:55 Polyester / Cotton) having both woven and knitted structures were used. These fabrics were made by using 100 % cotton yarns and 100% sensura polyester yarns by weaving and knitting. The fabric construction details for Cotton and 45:55 Polyester / Cotton fabrics are given below:

i) Woven fabric – plain weave, 48" width, 130 g/m^2 mass, 1/40s Ne yarn count (warp & weft), 98 EPI (cotton), 92 EPI (Polyester / Cotton), 72 PPI (cotton) and 78 PPI (Polyester / Cotton) and
ii) Knitted fabric – Pique structure, 130 g/m^2 mass, 34Ne count and 26 gauge, 26 inch.

The two kinds of woven and knitted fabric with different compositions were then dyed using reactive blue dye under identical conditions. The yarn count and construction were chosen so as to have uniform mass 130 gsm (Gambichler *et al.,* 2001). The construction and weight of the fabrics were chosen so as to keep the fabrics for shirting category.

The fabric samples were conditioned at 21^0C and 65% RH. Cotton and 45:55 Polyester / Cotton blend samples (10cm x 10cm) were soaked in 2-proponal dispersion of ZnO nano particles for 10 min under gentle magnetic stirring. The fabrics were then squeezed on a padding mangle to 70% expression to remove the excess dispersion and dried in a oven at 130^0C for 15 min under atmospheric pressure (dry hest). In order to evaluate the nano particle adhesion to the textile fibres, the treated fabrics were washed five times as per the standard method (UNI EN ISO 26330:1996). Electrolux automatic laundry machine (internal drum diameter 51.5cm, internal drum depth 33.5 cm and heating capacity 5.4 kW) was used, and the washing cycles were performed at 30^0C with reference detergent without optical brighteners. The drying step was carried out on a horizontal flat surface. The fabric specimens were tested before and after the washing cycles using TEM and UV spectro photometry.

Influence on UV Properties

Zinc oxide nano particles have been applied on polyester cotton woven and knits, which have been reactive dyed. Infrared spectroscopy and X ray investigations have revealed that the morphology and size of the nano particles are greatly influenced by the experimental conditions. Interestingly, the increase in the reaction temperature from 90^0C in water to 150^0C in 1,2- ethanediol has reduced the nano particle size from 20nm to 9nm (Gambichler *et al.,* 2001). SEM studies on nano treated fabrics show that the ZnO nano particles are well distributed on the fabric surface. The extent of nano particle adhesion to the fibre surface is primarily determined by particle size. The larger nano particles get removed from the fabric surface by washing, while the smaller ones penetrate deeper and strongly adhere to the fabric matrix as revealed through SEM. The average size of the nano particles obtained through one method of synthesis are found to be 20 ± 5 nm and another method of synthesis has been found to be 10 ± 1 nm. The UV spectra for nano treated as well as untreated fabrics have been measured with regard to absorption, transmission and reflection. The spectra have revealed that untreated cotton doesn't absorb UV radiation while treated cotton strongly absorbs UV radiation in the region between 200nm-300nm (Gambichler *et al.,* 2002; Behnajady *et al.,* 2006). Nano treated cotton as well as polyester cotton blend fabrics have shown increase in UV absorption over the entire range that has been investigated.

The results indicate higher protection from UV radiation for treated cotton fabrics. Moreover, woven fabrics show better UV shielding properties in comparison with knits. Also P/C blends show better UV absorption in comparison with 100% cotton, owing to the better absorption properties of polyester component in the blend. The results agree with the findings of earlier researchers. The improvement in UV absorption of the fabric treated with ZnO nano particles opens up the possibilities of protecting the human body against solar radiation and also for other technological applications. The nano finishing with ZnO improves the UV absorption, and also enhances the anti bacterial activity, and self cleaning properties of the fabrics so treated. It thus opens up the possibility of multi functional finishing of textile materials with single treatment.

Influence on Stain Elimination Properties

Zinc oxide is widely used in different areas because of its unique photocatalytic, electrical, electronic, optical, dermatological, and antibacterial properties (Arnold *et al.,* 2003; Dodd *et al.,* 2006). They have been applied on cotton and polyester/cotton fabrics, so as to assess their stain elimination function. A setback with the ZnO is that it is very ineffective in utilizing the energy from the sun, and as a consequence the fabrics so treated require more time to breakdown the stains. It acts as a catalyst by breaking down the dirt molecules and generates electrons that ionize the oxygen present in the air. The ZnO nano particles release the electrons by means of the photoelectric effect. In the solar spectrum, only

3% is being utilized by the high energy blue and UV light (Gambichler *et al.*, 2001). Hence a very small portion of the solar spectrum is available for the ZnO nano particles in order to breakdown the stains. The cleaning process commences with the excitation of electrons to the conduction band. The electrons so excited should react with the oxygen atoms in the air, which in turn should react with the dirt particles. The amount of electrons freed from ZnO nano particles, and also their accessibility, influence the reactions that take place. In the case of big stains, a great deal of energy is required in order to enable the fabric to completely break it down. The ability of the stain eliminating fabrics to break down the organic compounds is restricted by a number of factors. Sunlight provides the best means for the stain elimination process. A deeply stained garment should be exposed for a complete day so as to remove the stain. However, the stain elimination garment would be ideally suited for military applications, wherein the garment exposure to sun is for long periods.

The test results indicate that in the case of untreated cotton knit, the stain release effect is poorest, as it is bulkier than the woven fabric. In the case of untreated cotton woven fabric and untreated p/c knit, the stain release effect is found to be the same as is indicated by the ratings. The untreated p/c woven fabric rates the best among all the untreated fabrics so studied. The blended fabrics exhibit better stain release effect in comparison with their cotton counterpart, due to the hydrophobic nature of the polyester component in the blend. The stain release rating shows a considerable increase from 3 – 7 with regard to untreated as well as treated cotton wovens. A similar trend is observed in the case of untreated and treated cotton knits, wherein the rating increases from 2 – 6. Similar trend is also observed in the case of p/c woven's where the ratings increased from 4 – 8, and in the case of p/c knits (untreated and treated) the same trend is again observed (3- 7). The results ultimately indicate that the improvement in stain release effect is same in cotton and p/c fabrics and so also woven and knits. The studies ultimately point out that the application of ZnO nano particles improves the stain release effect on fabrics so treated, irrespective of the type of material and the fabric structure. However, the method of synthesis of nano particles influences the extent of stain release. The method of synthesis causes change in the size of the nano particles, which in turn changes the surface area of contact (Kwon *et al.,* 2002). In the case of fabric treated with smaller nano particle size, the surface area of contact is increased, which increases the photo catalytic activity and there by improves the stain release effect.

Influence on Antibacterial Properties

In a recent study, nano-ZnO particles have been coated on cotton so as to impart functional properties. The interesting revelation from this study showed that the treated fabrics exhibited better antibacterial activity than bulk treated fabrics in comparison with untreated ones. Higher antibacterial activity has been observed against *S.Aureus* than *E.Coli* both in qualitative as well as quantitative tests (Gambichler *et al.*, 2001). The nano particle size and concentration can be manipulated to get improved wash durability. In order to get improved antimicrobial effects on cotton fabrics, the padding conditions and the particle size of ZnO needs to be optimized. The method could be extended to polyester, silk and other fabrics. It is widely applicable to health and hygiene textile sectors. The finding also throws open the room for other areas to be concentrated for further research in order to answer a number of questions to arrive at a proper conclusion.

Influence of Nano Silicones

Silocone finishes are widely recognized as the best materials for increasing the softness of fabrics, enhancing their aesthetic feel and imparting an excellent hand (Talebpour and Home, 2006). Silicones have been responsible for giving super softness to fabrics over the years, and the quest to produce the optimum handle for apparel fabrics with suitable comfort properties has presented an interesting challenge. Silicones and their modifications, such as dimethyl silicone, methyl hydrogen silicone, amino silicone, polyether modified silicone, epoxy, carboxyl and amide, give varying softness with different comfort properties. Amino silicones are known to impart extremely soft handle. At present amino-functional silicon Elastomers are the most efficient softeners in the field of textile finishing**.** During the application, generally done in the acidic conditions, these amino groups are quaternized to cationic species which have a stronger attraction for the negatively charged fabric. This is particularly true for cotton based fabrics, which develops a negatively charged surface in aqueous bath. This improves deposition, performance and durability of the softener coating. These polysiloxane softeners are best delivered to the textile surface in the form of an emulsion. There is sufficient information available on the effect of conventional silicone emulsion application on the properties of textile fibres (Tzanov, 1998; Jang and Yeh, 1993; Robati, 2007; Chi–Young and Obendorf, 1998). But very little information on the effect of silicone nano emulsion on the properties of cotton fabrics has been found in the literature.

Method of Application

Desized, scoured and bleached cotton fabric with the following specifications was used: plain weave; areal density 120 gsm; EPI 142; and PPI 40. Amino polysiloxane silicone softener was collected in two forms, viz nano emulsion and conventional emulsion softeners. Acetic acid was used for adjusting pH of the finish bath. Carbon powder was used as artificial soil (Belmin and Carole, 2003; Chattopadhyay and Vyas, 2010). Both the forms of emulsion were applied from a pad bath containing silicone softener at a pH 5. The concentrations of conventional and nano emulsion softeners were 20gpl and 10 gpl respectively. The padded fabric was dried and cured at 150oC for 3 min.

Influence on Whiteness and Yellowing

A problem associated with the silicone finish is that the amino group in the silicone, though imparting a number of special properties, is susceptible to yellowing tendency in the fabrics. This
occurs during drying or curing of the treated fabrics (Salamone, 1996). The influence of curing time on yellowing has been compared for both conventional as well as nano silicone emulsion treated fabrics The results reveal that an increase in curing time at constant temperature increases the yellowing of the treated samples in both the cases. But interestingly, the increase in time of curing shows a much milder effect in case of nano silicone emulsion applied fabrics, so far as yellowness is concerned.

Influence on Soiling

The influence of soiling on the finished fabric has been evaluated (Salamone, 1996). The extent of soiling has been measured in terms of change in whiteness of the fabrics. The results reveal that the whiteness of fabrics treated with silicone nano emulsion softener is better than those treated with conventional silicone emulsion. Thus the fabrics treated with silicone nano emulsion softener shows higher soil resistance compared to its conventional counterpart and exhibits better whiteness properties. This could be attributed to the better coverage of the fabric by nano emulsion, which left little space to accommodate soil particles during subsequent soiling treatment.

Influence on Absorbency and Feel

Besides imparting soft feel to fabrics, nano silicone finishes also impart water resistance characteristics. This could be attributed to the methyl groups which are oriented and attached to the fibre surface by silicone links. Comparative studies on fabrics treated with conventional and nano silicone finish have revealed that nano form of the emulsion makes the fabric more water repellent compared to its conventional counterpart (Salamone, 1996). Also comparative objective evaluations of the hand feel of the fabric have shown that nano silicone treated fabric gives a better feel. Nano emulsion softener covers each fibre and reduces the friction between them which subsequently increases their mobility that results in better softness.

Influence on Mechanical Properties

Silicone finishes have gained popularity for enhancing softness properties of textile materials and thereby improving the aesthetic feel and resulting in excellent hand. Very recently, some research has been done by comparing the nano silicone emulsion with their counterpart in respect of properties such as softness, feel, wrinkle recovery, absorbency, soiling and tensile properties. Investigations have been carried out on desized, scoured and bleached cotton fabrics, with nano as well as conventional silicone emulsion, and also involving the use of carbon powder used as artificial soil.

The effect of conventional and nano silicone emulsion have been investigated with regard to bending length, crease recovery and tensile properties. The application of silicone softener reduces the bending length and increases the crease recovery angle of cotton fabrics. The softness of textile material results from the binding action of the silicone emulsion between the fibres in the yarn and yarns in the fabric.

The softening ability of silicone arises due to the flexibility of siloxane, which forms the backbone and provides freedom of rotation of Si-O bond, and thereby results in the unique flexibility of the siloxane molecules (Schueller and Romanowski, 1999; Wang *et al.,* 2004). Though both conventional and nano silicone finishes improve the crease recovery angle of fabrics, the nano silicone gives an even better crease recovery angle as compared with its conventional counterpart. This is due to the small droplet size of nano emulsion that could penetrate better into fabric structure in comparison with the droplets of conventional macro silicone emulsion.

The application of emulsion softener also results in loss of breaking load with increased elongation at break (Salamone, 1996). It reduces the friction between the fibres and between the yarns in the fabric, ultimately resulting in reduction of load bearing capacity with increased elongation on load. The nano emulsion gives significant results with respect to loss in breaking load and an increase in elongation at break, due to its better penetration and higher surface area coverage.

Influence of Titanium Dioxide Nano Particles

Nano technology deals with the science and technology at dimensions of roughly 1 to 100 nanometers (1 Billion nanometers = 1 Meter) although 100 nanometers presently is the practically attainable dimensions for the textile products and applications (Yadav *et al.,* 2006). The technology can be used in engineering desired textile attributes, such as fabric softness, durability, breathability and in developing advanced performance characteristics, namely, water repellency, fire retardancy, antimicrobial resistance etc., in fibers, yarns and fabrics (Wong *et al.,* 2006). With the advent of nano technology, a new area has developed in the realm of textile finishing. Nano coating on the surface of textiles and clothing enhance the material for UV blocking, anti microbial and self cleaning properties (Hoon, 2005). The inherent properties of textile fibers provide room for the growth of micro organisms. Besides, the structure of substrate and chemical process may induce the growth of microbes. Humid and warm environment still aggravate the problem. Infestation of microbes cause cross infection by pathogens and development odor where the fabric is worn next to skin. In addition, the staining and loss of performance properties of textile substrates are the results of microbial attack.

Basically, with the view to protect the wearer and textile substrate itself antimicrobial finish is applied to the textile materials (Sang *et al.,* 2004). It is well known fact that the growth of bacteria and microorganism in food or water is prevented when stored in silver vessels due to its antibacterial properties. Metallic ions and Metallic compounds display a certain degree of sterilizing effect. It is consider that the part of the oxygen in the air or water is turned into active oxygen by means of photo catalysis with the metallic ions, thereby dissolving the organic substance to create the sterilizing effect. With the use of nano sized particles, the number of particles per unit area is increased, and thus anti-bacterial effects can be maximized (Xin *et al.,* 2003). Nano TiO_2 sol and finishing agent was prepared by sol-gel method, during tetrabutyl titanate was used as a precursor and ethanol was used as solvent. The agent was penetrated into polyester fabric by padding method, the anti ultra violet performance of fabric was analyzed and the external morphology was carefully studied afterwards (Haixia *et al.,* 2009).

The spacer are attached on the cotton by the formation of an ester-bond. The TiO_2 binds to the cotton by chemical means and the textiles present self-cleaning properties. The deposition of TiO_2 on the cotton textile surface is non-homogeneous due to the irregular surface of the cotton fabrics used (Meilert *et al.,* 2005). Li *et al.,* (2008) has done the research about the treatment of cotton fabric using the nano meter Titanim Dioxide improving the performance of anti-ultraviolet property. Durable anti bacterial cellulose and its blend fabrics were prepared by incorporating a zinc peroxide polymer (Vigo and Benjaminson, 1981). Anti bacterial properties can be attained by either physically or chemically incorporating antibacterial agents into fibers and fabrics. The antibacterial agents can be antibiotics, formaldehyde, heavy metal ions (Silver & Copper), quaternary ammonium salts with long hydrocarbon chains (Sun and Worley, 2005).

Method of Application

The woven and knitted fabric of 100% cotton and 45/55 % of polyester were applied with titanium dioxide nano particles by spraying by using spray gun and also pad-dry-cure method. Nano particles were applied on the face side of the with concentration 1%, Material to liquor ratio 1: 20, Acrylic binder 1%. 100% cotton and 45/55 % of polyester woven and knitted fabris were cut to the size of 30 X 30 cm (Parthasarathi and Thilagavathi, 2009). These fabrics were coated with titanium dioxide nano particles by using spray gun. A dispersion of nano particle was filled in the hand spray gun. The fabric substrate was fixed on a vertical board. The nano particle solution was evenly sprayed over the by fabric maintaining a constant distance between the fabric and the spray gun nozzle. The excess solution was squeezed using a padding mangle which was running at a speed of 15m/min with the pressure of 15kg/cm^2 after padding the fabrics was dried naturally and then cured for 3 minutes at 150°C

Treated Fabric Appearance under SEM

Titanium dioxide has been applied on to polyester cotton fabrics (Parthasarathi and Thilagavathi, 2009). The treated fabrics have been observed under scanning electron microscope (Figures 1 – 4). The antimicrobial activity of the treated fabrics has also been studied.

The surfaces of the treated fabrics were observed by SEM microscopy. This SEM micrograph show the nano scaled titanium dioxide particles by urea medium on 45/55% polyester/ cotton samples. The nano particles are well dispersed on the fiber surface in both cases, although some aggregated nano particles are still visible. The particle size plays a primary role in determining their adhesion to the fibers. It is reasonable to expect that the largest particles agglomerates will be easily removed from the fiber surface, while the smaller particles will penetrate deeper and adhere strongly into the fabric matrix.

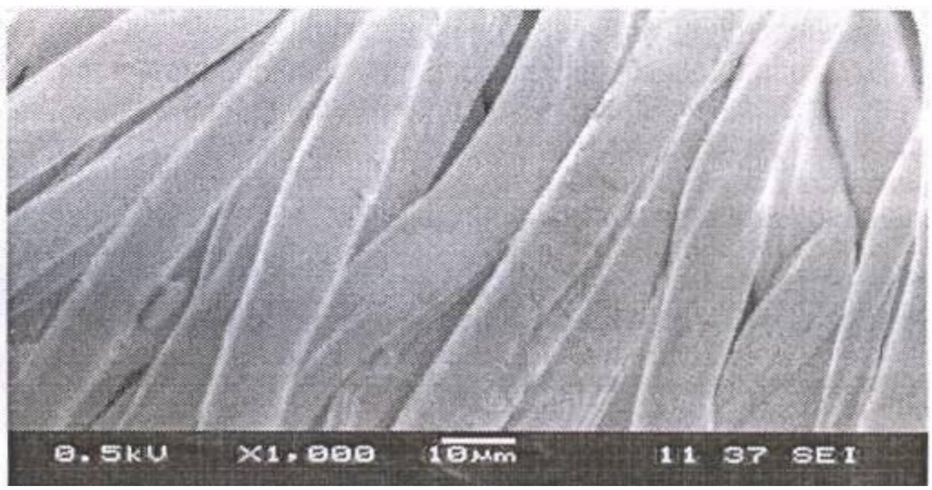

Figure 1: Untreated 100% Knitted Fabrics

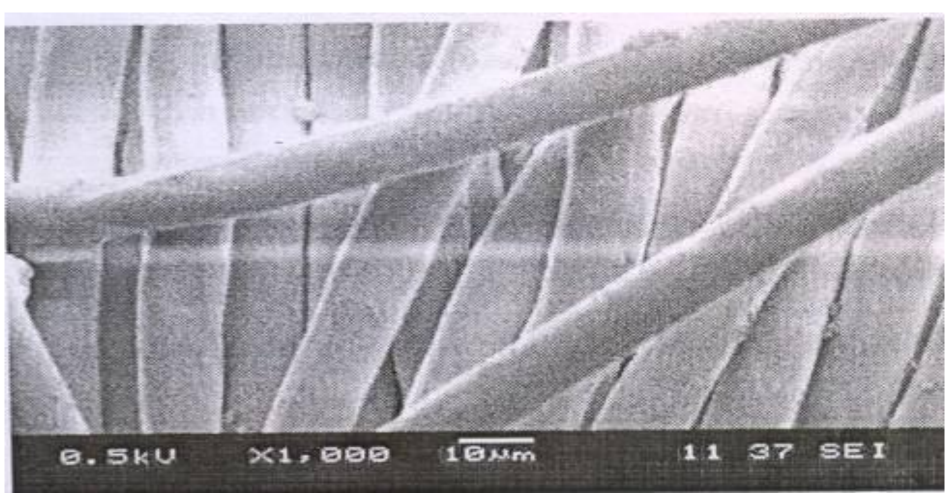

Figure 2: 100 % cotton knitted fabric treated with 1% titanium dioxide nano particles

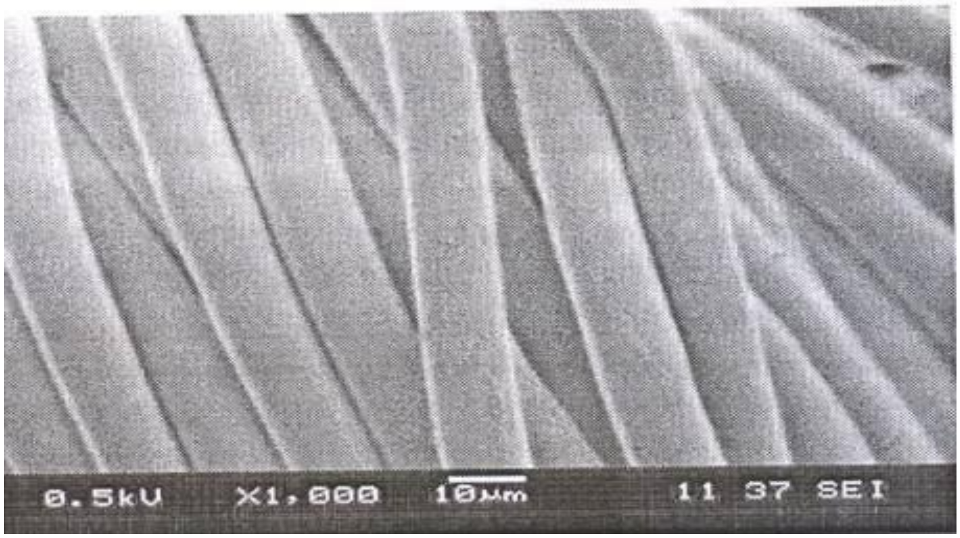

Figure 3: The untreated 45/55% Polyester/Cotton woven fabric

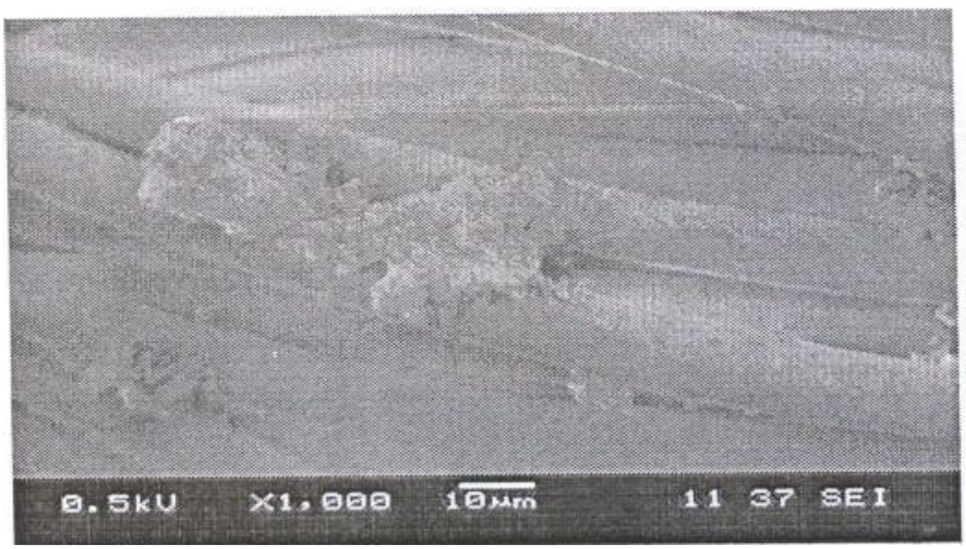

Figure 4: 45/55% Polyester/cotton woven fabric treated with 1% of titanium dioxide nano particles

Influence on Anti Bacterial Activity

Titanium dioxide is preferable to other inorganic forms of titanium because of its higher efficiency in preventing infection. In the control fabric the growth of both *Staphylococcus Aureus* and *Klebseilla Pneunomiae* was found on the fabric as well as surrounding the fabric (Parthasarathi and Thilagavathi, 2009). In Titanium dioxide treated fabric there was no bacterial growth on the fabric, but it was found surrounding the fabric. The woven fabrics treated with titanium dioxide exhibit better reduction than the knitted fabrics because of their construction. Among thecomposition 45/55% polyester/cotton blend shows better reduction than the 100% cotton because of the resistance property of polyester.

CONCLUSION

The influence of various types of nano finishes on the properties of cotton fabrics have been discussed herein. Silver nano colloids have been applied on cotton, wool and cotton fabrics and have been investigated for dyeing behavior, antimicrobial properties and physical properties. The color strength and color fastness have shown improvement in the case of direct dyes, where these were inherent set backs.

The microbial resistance improves due to the sterilizing effect of the metallic ions and metallic compounds in silver. The physical properties tested include tensile strength, creasing, and bending stiffness. The breaking load of cotton fabric has improved by 8% due to introduction of nano material in fibre structure. The crease recovery is also found to be better when compared with the cross linking method. The physical properties of cotton fabrics treated with meso silver and SILPURE (silver chloride compound) nano particles have been investigated for deteriorating effects, and these are found to be suitable for apparel applications. No significant deterioration in breaking load or strain has been observed. The strength of the SILPURE treated fabric increases with a slight reduction in strain value, which could be attributed to the presence of a polymer (Polyvinyl derivative) in the SILPURE solution, as it forms a thin layer that substantially increases the fabric thickness and provides further fabric integrity under strain. These results have not been observed in the case of meso silver treated fabric. The treated as well as untreated fabrics show very high pilling. However, SILPURE treated fabrics showed some improvement in pill appearance, probably due to the presence of over coating. Both treated fabrics did not show weight loss due to abrasion. Also, the treated fabrics did not show change in the comfort characteristics, namely, thermal resistance and evaporative resistance. Zinc oxide nano particles have been used for imparting anti bacterial and UV blocking properties. The studies conducted on cotton and polyester cotton blend fabrics indicate higher protection from UV radiation for treated cotton fabrics. Moreover, woven fabrics show better UV shielding properties in comparison with knits. Also P/C blends show better UV absorption in comparison with 100% cotton, owing to the better absorption properties of polyester component in the blend. Zinc oxide is widely used in different areas because of its unique photocatalytic, electrical, electronic, optical, dermatological, and antibacterial properties. They have been applied on cotton and polyester/cotton fabrics, so as to assess their stain elimination function. The studies on stain release indicate that in the case of untreated cotton knit, the stain release effect is poorest, as it is bulkier than the woven fabric. In the case of untreated cotton woven fabric and untreated p/c knit, the stain release effect is found to be the same as is indicated by the ratings. The untreated p/c woven fabric rates the best among all the untreated fabrics so studied. The blended fabrics exhibit better stain release effect in comparison with their cotton counterpart, due to the hydrophobic nature of the polyester component in the blend. In a recent study, nano-ZnO particles have been coated on cotton so as to impart functional properties. The interesting revelation from this study showed that the treated fabrics exhibited better antibacterial activity than bulk treated fabrics in comparison with untreated ones. Higher antibacterial activity has been observed against *S.Aureus* than *E.Coli* both in qualitative as well as quantitative tests. Nano silicones have been applied on cotton woven fabrics to study effect on whiteness and yellowing, soiling, absorbency and feel and mechanical properties. There has been an overall improvement in these properties tested. Titanium dioxide nano particles have been applied onto knitted cotton and polyester cotton fabrics and the effects on fabric appearance and antibacterial activity studied. All the types of nano particles show an overall improvement in the various properties investigated.

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