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# Development of Self-Cleaning Socks using Nano-Finishing

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**Abstract -** *This work is to design and develop of self-cleaning socks using nano-particles technology. Socks of 100 % cotton are manufactured at SNQS International. Titanium dioxide $TiO_2$ nano-particles are proven to be good self-cleaning agent. So $TiO_2$ nano-particles of anatase form with photocatalytic property is taken for this project. This project mainly aims to avoid the use of or reduce laundering agents during washing and reduce the usage of water. Self-cleaning technology works on the presence of sun light and in presence of sun light $TiO_2$ acts as photo catalyst and removes stains, dirt etc. Then the finished socks are also tested to find out the anti-microbial property of socks.*

***Key Words*: *Socks, self-cleaning, $TiO_2$ nano-particles, photo catalyst, anti-microbial finishing.***

## 1. INTRODUCTION

Self-cleaning is done by technique of repelling the contaminants like dirt, toxic pollutants, and microbes from surface. Nano-particles play a vital role in the design of self-cleaning materials, especially textile materials. This work aims at development of cost effective, durable, stable self-cleaning surfaces. There are two types of TiO2 nanoparticles namely, anatase and rutile. The surface of nano particles have good photocatalytic activity which can be employed to self-cleaning technique. The technique of the self-cleaning technology is employed in socks and the properties are assessed to determine its self-cleaning ability and the main aspect to reduce the use of detergents during washing.

### 1.1 Objectives

To develop 100% cotton self-cleaning socks with Titanium Dioxide nano-particle finish and also evaluate antimicrobial property.

## 2. LITERATURE REVIEW

The main requirement of self-cleaning technique is to remove stain, dirt, microbes from the surface of the materials [1]. The self-cleaning ability of cotton were tested in four compositions as1%,3%,5% and 10% results shows cotton treated with $TiO_2$ shows good self-cleaning ability without affecting the comfort properties [3].Good self-cleaning efficiency is achieved with optimum temperature at 80C in 15 min optimum coating time [2,4]

Self-cleaning technique reduces labours and also avoids the use of detergent which helps to make environment sustainable [1,9] CA can be used both for disposable and non-disposable materials that require durability to laundering.CA also used as good anti-microbial agent [7]. The hydrophilic coating shows good self-cleaning efficiency with improved stability of the material [8].

## 3. MATERIALS AND METHODS

Socks were knitted from 100 % cotton $30^S$ Ne yarn at a socks manufacturing company. Bleached socks and finished with $TiO_2$ nano-particles.

### 3.1 Synthesis of Titanium Dioxide nano-particles

Titanium dioxide nano particles synthesized by the following proportion of chemicals as in the Table 1. This method is proven to get high productivity than the remaining methods.

**Table: 1** Proportion of Chemicals Added

| Compounds | Amount added |
|---|---|
| Titanium iso propoxide | 50 ml |
| water | 200 ml |
| urea | 1g |

Distilled water and urea were introduced into a beaker and the solution was stirred for five minutes. Titanium isopropoxide was added dropwise and stirred for 30 min. This suspension was introduced to a water bath at 90◦C for one hour. Then dried at 80◦C for 12 hours.

### 3.1 Cross linking of $TiO_2$ nano particles on socks

1 % $TiO_2$ Nano particles (on the weight of dry cellulose) were dispersed in cellulose solution by mechanical stirring at room temperature (27 – 30°C) and 2000 rpm for 120 mins.
1% Citric acid (on the weight of sample) is used as binder.
Few drops of wetting agent is added to the solution.
The fabric is soaked in the solution for 30 min
The coated fabrics were dried at 60°C for 30 min.

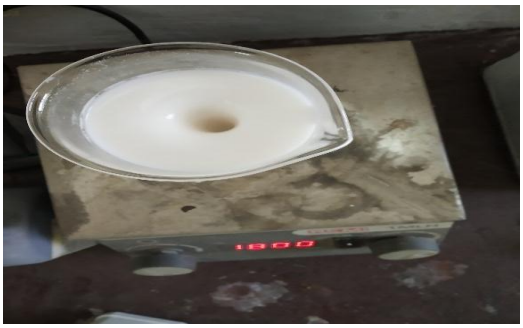

**Fig -1**: nano particle solution

## 4. Results and Discussion

### 4.1 FTIR of Treated and Untreated Socks

Fourier Transform Infrared Spectroscopy (FTIR) is tested for both the treated and untreated sample. The samples are tested in the laboratory and the results were discussed below,

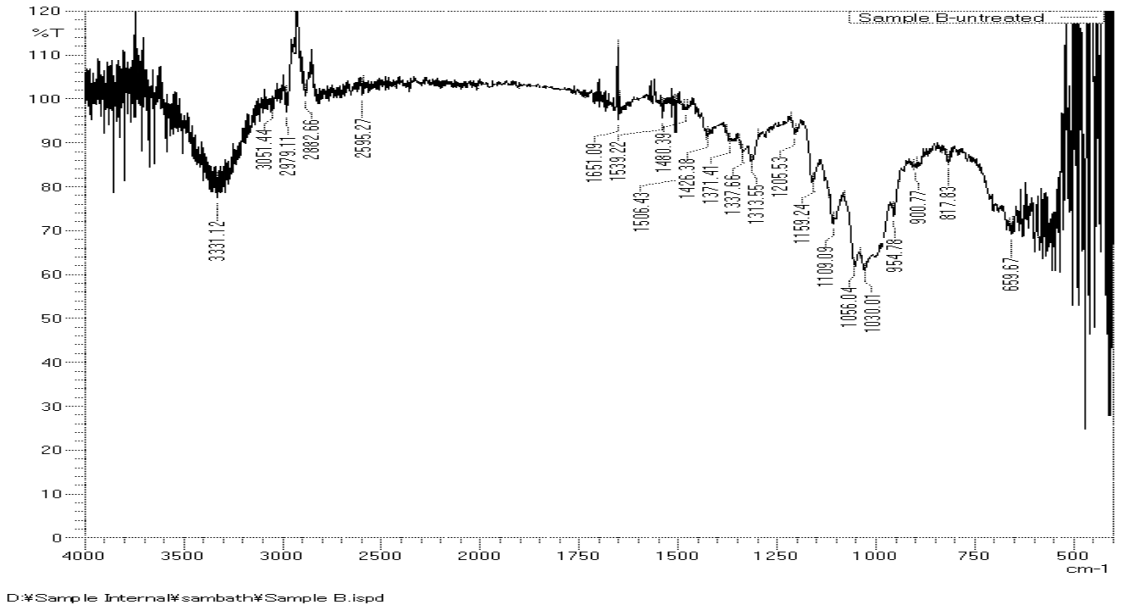


**Fig-4.1** FTIR of untreated sample

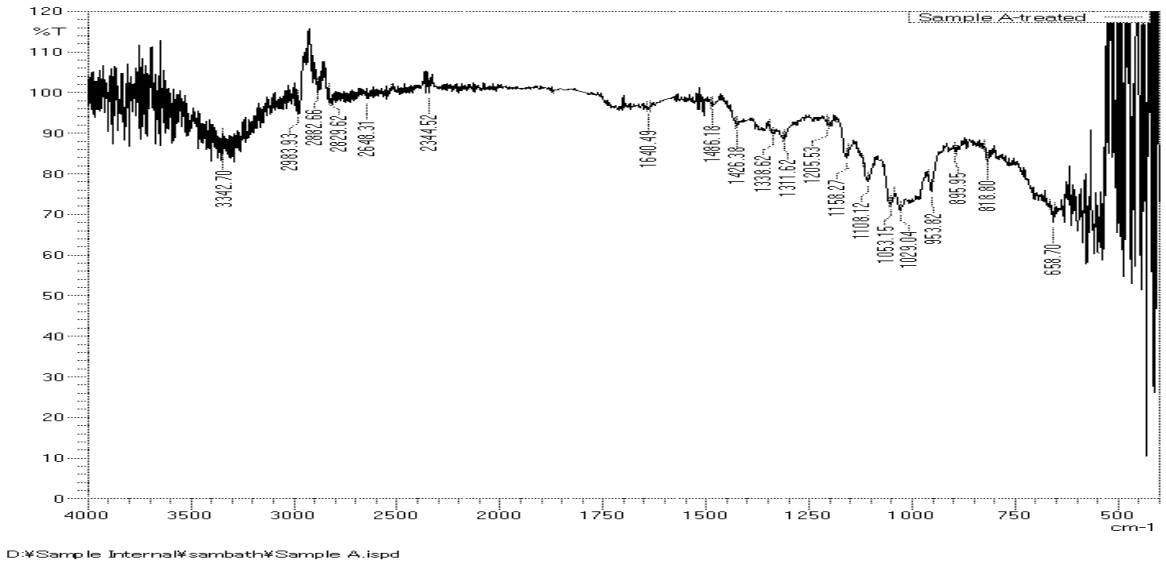


**Fig-4.1** FTIR of treated sample

### 4.2 Findings in FTIR

Peak at 550 of the treated shows the presence of $TiO_2$ nanoparticles which is not present in the untreated fabric.

### 4.3 TEM Analysis of Nanoparticles

TEM is a microscopy technique which is done to determine the purity and size of nano particles and the result is shown below,

**Titanium Dioxide Nano Powder 99.9% Purity**

| Test Item | Composition |
|---|---|
| Color | White |
| Particle size | 30-50nm |
| Crystal Form | Anatase |
| Surface Specific Area | 30-50 m2/g |
| Density | 3.8g/cm3 |
| Cl | 600ppm |
| Co | 10ppm |
| Cu | 30ppm |
| Fe | 60ppm |
| K | 200ppm |
| Ni | 100ppm |

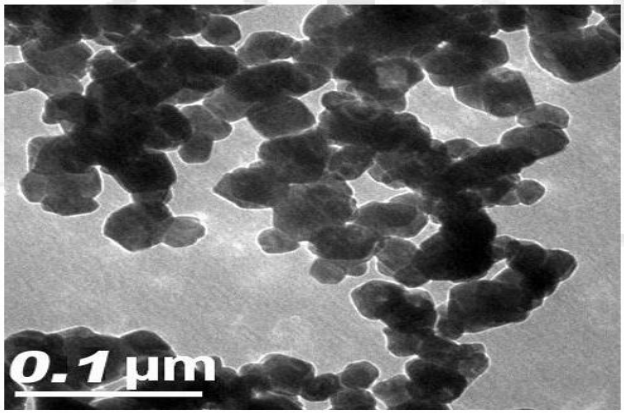


**Fig-4.3** TEM Analysis

### 4.4 Efficiency of Cleaning

$TiO_2$ nano-particle treated and untreated socks were worn and used for 5 hours and then both the samples are removed and dried in sunlight for 3 hours and then both the samples are rated by grey scale testing method and the results are tabulated.

**Table- 4.4** Change in stain

| S.No | Material | Parameter | Grey scale Rating for change in stain |
|---|---|---|---|
| 1 | Untreated socks | Change in stain | 1.5 |
| 2 | Treated socks | Change in stain | 3 |

Treated fabric after drying in sunlight shows in stain which the stain is lesser than the untreated fabric due to the action of nanoparticles in the presence of sunlight change.

## 5. Conclusion

The socks coated with $TiO_2$ nano particles has shown good cleaning efficiency in the grey change in color scale staining method. The untreated socks has stain rating nearly up to 3 in grey scale rating but in treated socks it is nearly 1.5 and also good visible difference is seen in stain variation.

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