CHAPTER 1

INTRODUCTION

1.1 GENERAL

Textile goods are excellent substrate for growing microorganisms. For the last fifty years, the prevention of microbial attack on textile materials has become increasingly important to consumers and textile producers. Several dangerous, infectious a blood borne bacteria and viruses, such as pseudomonas, caudidas, S. aureus and E. coli, are in attendance in hospital locations which are conductive for increase of the microorganisms. The textile materials such as socks and innerwear faced with smell from body perspiration. Currently there is also an interest in protecting health care workers from diseases that might be carried out by patients.

Especially for surgical gowns, drapes, masks, sheets, and pillowcases, there is an increasing need to care for medical staff from infection by blood borne pathogens such as HIV and HBV. Gowns should be able to avoid strike through or wetting out of the fabric, and so surgical gown materials should have not only antimicrobial properties but also blood barrier properties. In addition, the textile used in hotels, transportation and biological institution needs antimicrobial textiles. Textile materials with good opposing to antibacterial attack and cross infection by giving antibacterial and blood repellent finish. Textile materials with controlled release properties can release chemicals in a controlled way. Often there is a continuous slow release of the chemicals, but the release can also be envisaged upon a stimulus.

The controlled release of chemicals can find many applications, not only in the cosmetic area, where several products are already commercially available, but also in medical applications for controlled release of drugs. Nowadays, nonwoven fabrics are the most used textiles for surgical gowns, patient drapes, laboratory coats, coveralls, and other kinds of protective clothing.

There is currently a prominent trend toward increasing the level of hygienic necessities for materials used in both households and in different service sectors. The regulars need for protection from possible infection during stays in hotels and hospitals. Textiles materials are carriers of pathogenic micro flora, so that having fabric properties that prevent biological media (blood, wound secretions) from adhering to them and suppressing growth of microorganisms is of great attention. The creation of materials with antibacterial and antiadhesive properties for flax cation of bed linens and medical uniforms will reduce the risk work-related diseases in medical personnel and the spread of infections.

Fluoropolymers, most abundantly used as repellent agents in textile finishing, not only satisfy the demand for high water repellency but also impart oil and soil repellency is achieved by reducing the critical surface energy of fabrics.

Chitosan and fluoropolymers seem to be the most suitable finishing agents for providing surgical gown material with barriers against microorganisms and blood, but we have not found me earlier about finishing agents for surgical gowns using chitosan and fluoropolymers in combination. Thus, it would be very useful to identify the optimum concentrations of these agents to achieve blood repellency and antimicrobial activity.

Because many medical products including surgical gowns are used near human skin, the hand and air permeability of these materials are also very important. Thus, we evaluate that medical properties and air permeability of untreated and treated samples to assess the effect of chitosan and fluoropolymer treatment on the hand and breathability of the fabrics and we also study the surface of the samples.

Cotton muslin has been widely used for surgical gowns for many years and is still used in operating theatres. Recently, single – use gowns made from non- wove n's have gained in popularity because non-woven fabrics block fluids so well and single –use gowns are so reliable.

In this study, we have applied chitosan and fluoropolymers to cotton to develop dual function of surgical gown materials. The fabrics are 100% cotton cambric for reusable gowns. Each fabric is treated with chitosan and fluoropolymer's using Pad-Dry- Cure methods, respectively

Fluorochemical mostly used as repellent agents in textile finishing, which satisfy the demand for high water repellency and impart oil and soil repellency to textiles. Different antimicrobial agents have been applied to obtain antimicrobial properties to textile. Among them, the quaternary ammonium salts of cationic surfactants are widely used in antimicrobial finishing of textile. Quaternary ammonium salts exhibit marked antimicrobial activity against a wide range of bacteria, fungi, and viruses. One way for disease transmission from one person to another is using clothes by different people in hospitals.

Using of the disposable clothing products with antimicrobial finishing can provide a good protection against transmission of diseases for both the surgery team and patients. In this study acetyl trim ethyl ammonium bromide (CTAB) was used as an antimicrobial agent.

Chitosan, being a very abundant natural biopolymer, and because of its polycationic nature, finds various fields of applications such as water purification and drug delivery beads, apart from its application as a coating material in textiles. Chitosan-coated fabrics are well-known for their antibacterial and antifungal resistance. Some research on antimicrobial activity by varying parameters such as degree of deacetylation, molecular weight and chitosan concentration has been reported by various researchers. However, limited studies have been carried out on characterizing the fabric properties of chitosan-coated fabric.

Chitosan-coated fabrics exhibit different surface characteristics when compared with the uncoated fabrics. Studies on the surface characteristics of these fabrics will provide an insight into their suitability for apparel purposes. Fabric

friction is one of the important properties that characterize the surface behavior of fabrics.

A major source of cross infection is Bacteria-contaminated fabrics in hospitals. Among the most common Hospital acquired infection, Postoperative infections is a major component. Operating staff and patients are both sources of postoperative infection, since bacteria can find their way into an open wound and cause sepsis.

An antibiotic as an antimicrobial agent to impart antimicrobial properties to cotton. They found that fabrics treated with antibiotics retain excellent bacteriostatic activity. Points used a fluorochemical as a repellent finishing agent on woven fabrics. The surface tension of blood and body fluids ranges between 42 and 60 dyne/cm; to maintain blood repellency, the surface tension of fabrics has to be much lower than that of blood. In an operating room, a patient's blood can penetrate surgical gown material and possibly contaminate the surgeon's skin if not well protected.

Postoperative infections are the most common hospital-acquired infection. Operating staff and patients are both sources of postoperative infection since bacteria can, by a variety of routes, find their way into an open wound and cause sepsis. Postoperative wound infections develop in 2 to 5% of patients undergoing surgical procedures.

Surgeon gowns and drapes used surround the operative field acting as an effective aseptic barrier between the underclothes of the surgeon between the patient's bodies other than the prepared area. In the operating room, however, liquids such as blood, sweat, and saline solutions can carry bacteria with them.

If a liquid is wicked from a surgical gown to a non-sterile surface, one or both sides will become contaminated. Currently there is great interest in protecting health care workers from diseases that might be carried by patients.

Therefore, in order to protect patients from contamination by surgical staff during operations, and also to protect the surgical team from infectious blood and

other body fluids, surgical gown materials should have antimicrobial properties and blood repellency properties.

Chitosan, a polysaccharide comprising copolymers of glucosamine and N-acetyl-glucosamine, is obtained by alkaline deacetylation of the chitin derived from the exoskeletons of crustaceans and arthropods. It has attracted considerable interests due to their biological activities such as antimicrobial antitumor and immunoenhancing effects.

Chitosan is inexpensive, non-toxic, biodegradable and possesses reactive amino groups. It has been useful in many Carbohydrate Polymers. The areas of applications, such as wastewater treatment, food and textile industry and recently in drug industry and as a hydrating agent in cosmetics. In the last decade, the textile applications of chitosan have attracted many researchers. Cotton textiles have poor resistance to microorganisms, so the antimicrobial finishing of cotton fabrics is an economical way to prevent harm to the human body.

Several mechanisms were proposed for the antimicrobial activity by chitosan: Polycationic structure of chitosan which can be expected to interact with the predominantly anionic components (lipopoly-saccharides and proteins of microorganism surface) resulting in changes in permeability which causes death of the cell by inducing leakage of intracellular component.

The chitosan on the surface of the cell can form a polymer membrane which prevents nutrients from entering the cell. The chitosan of lower molecular weight enters the cell, binding to DNA and inhibits RNA and protein synthesis. Since chitosan could absorb the electronegative substance in the cell and flocculate them, it disturbs the physiological activities of the microorganism leading to death of the cells.

Chemical compounds are used as antimicrobial agents, but they also influence the natural flora of the human skin. Studies have shown in chitosan. A natural biopolymer is antibacterial, antifungal, antiviral, nontoxic, non – allergic and biocompatible.

Microencapsulation provides a mean of packaging separating and storing materials on a microscopic scale for triggered release under controlled conditions. Such as mechanical rupture. Electrical or chemical means or by leaching action in an appropriate liquid environment.

Antimicrobial textiles provide the benefits in hygiene, odour control and protection of the fabric from microbial attack, bacterial resistance to the biocides used and their toxic breakdown products in the household and environment have been concerns. Most biocides used on commercial textiles can induce bacterial resistance to these substances, which can lead to increased resistance to certain antibiotics in clinical use. With increasing demand for fresh and hygienic textiles, the consumption of anti-microbial is increasing day by day. To produce more and more textile products are necessary to have effective and safe environment. It is essential to have natural and inorganic sources with new technology to produce health and hygienic products. Biomaterials are more complex of different compounds, and it depends upon geographical location, age and extraction methods. But their eco-friendly nature and nontoxic properties facilitate for medical and health care textiles.

In recent research studies have revealed that chitosan is more effective in inhibiting the growth of bacteria than chitosan oligomers. Synthesized nano scale core–shell particles of poly (n-butyl acrylate) cores and chitosan shells applied them to cotton fabrics in a pad–dry–cure process. The antibacterial activities were maintained at over 90% reduction levels after 50 washes, to improve antimicrobial durability, chitosan has been cross linked to cotton using chemicals such as dimethyl dihydroxy ethylene urea (DMDHEU), citric acid, 1, 2, 3, 4-Butane tetra carboxylic acid (BTCA) or glutaric dialdehyde. These chemicals some of which are used in cotton durable press, crosslink chitosan to cotton through hydroxyl groups. Due to very small size of chitosan nanoparticles or structures, their surface areas are very high and processes involving nanoparticles or nanotechnology become much more efficient than the conventional ones. Nanotechnology also holds big promise for

textile related activities like smart and intelligent textiles, better finishing treatments and technical textiles. Due to the Antimicrobial action of the amino group at the C-2 position of the glucosamine residue, chitosan is also known to be an antimicrobial polysaccharide. The carboxylic groups in the chitosan structure were used as active sites for its fixation onto cotton fabrics. The ability of chitosan to immobilize microorganisms derives from its poly cationic character.

In case of discharged effluents, collected from desized, scoured, bleached and anti-microbial finished were treated with aerobic biological treatment *(*Lactobacillus acidophilus culture*).* Bacteria offers a cheaper and environment friendlier alternative for colour removal in textile effluents. Biological treatment has been effective in reducing dye house effluents and when used properly has a lower operating cost than other remediation process. The determination of the best conditions of preparation of a (tentatively) probiotic starter culture that might be suitable for cheese making composed solely of Bifidobacterium lactis Bo and Lactobacillus acidophilus Ki is critical if a consistently reliable acid production is to be achieved, especially because bifidobacterial have stringent requirements for growth.

Blood repellent finish is applied to the fabrics used for surgical gowns, bed linens and drapes to reduce surgical site infection. Blood and body fluids are considered as the carriers of several microorganisms and can be transferred through the barrier materials by wicking of fluid or pressure or learning on a flooded area of the product.

Blood Repellent agents' Various classes of chemicals have been introduced to impart water repellence to the fabrics. Out of them fluorochemical polymers are com- manly used as blood repellent finishing agent in industry and as well as in research. The surface tension of the fabric has to be much lower than that of blood and body fluids whose surface ten- Sion ranges in between 42 dynes/cm and 60 dynes/cm to produce water repellence. The sur- face tension of fluorocarbon water repellent agent is 10 dynes/cm which is lower than other com- manly used blood repellents. Fluro chemical mostly used as repellent agents in textile finishing, which

satisfy the de mend for high water repellence and impartoil and soil repellence to textiles. Teflon has surface tension lower than that of blood.

Weak interaction of C-F bonds and cotton decreases the surface tension and imparts blood repellence to the fabric.

1.2. Preparation of silane

Silane, also called Silicon Hydride, any of a series of covalently bonded compounds containing only the elements silicon and hydrogen, having the general formula SinH2n + 2, in which n equals 1, 2, 3, and so on. The silanes are structural analogues of the saturated hydrocarbons (alkanes) but are much less stable. The term silane is extended to include compounds in which any or all the hydrogen atoms have been replaced by other atoms or groups of atoms, as in tetra chlorosilane, SiCl4.

Silanes have been prepared by the reaction of magnesium silicide (Mg2Si) with acids or by the reduction of silicon chlorides with lithium aluminium hydride. All the silanes burn or explode upon contact with air, and they are decomposed by alkaline solutions with formation of hydrogen and hydrous silica. Upon heating, the silanes decompose into hydrogen and silicon; they react with the halogens or hydrogen halides to form halogenated silanes, and with olefins to form alkyl silanes.

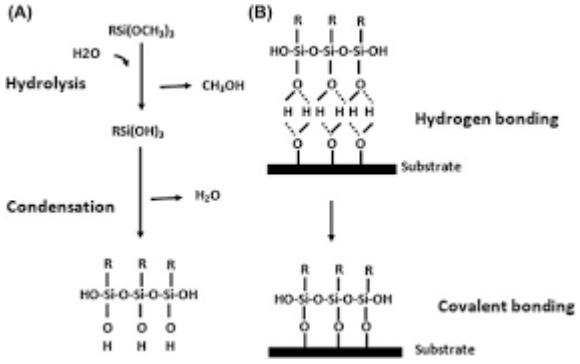


Fig.1.1. preparation of silane

The single-chain silicon-oxygen tetrahedral structure (SiO3) n of pyroxene minerals and the double-chain structure (Si4011) n of amphibole minerals are examples of inorganic polymers of silicon.

inorganic polymer: Silanes + HCl Silanes are compounds of silicon and hydrogen. Silicon forms a series of hydrides...

The simplest silane, monosilane (SiH4), is also the stablest; it is a colourless gas that liquefies at -112° C (-170° F) and freezes at -185° C (-301° F). It decomposes slowly at 250° C (482° F), rapidly at 500° C (932° F).

The instability of the silanes results from the reactivity of the silicon-hydrogen bond; derivatives in which all the hydrogen atoms have been replaced by organic groups, such as tetramethyl silane, Si (CH3)4, resemble the saturated hydrocarbons. The compound trimethylchlorosilane, (CH3)2SiCl2, is important as the starting material for the dimethylpolysiloxanes, members of the silicone family of polymers. Chlorotrimethylsilane and vinyl trichlorosilane are used to impart water repellence to numerous materials such as cloth, paper, and glass.

1.3. Extraction of silane

Natural halloysite nanotubes (HNTs) were modified with a silane coupling agent, *N*-β-aminoethyl-γ-aminopropyl trimethoxy silane (KH-792), to form a new adsorbent for Cr (VI) removal. The as-prepared product was characterized by FTIR spectroscopy, TGA, TEM, and specific surface analysis. The results showed that KH-792 was successfully grafted onto the halloysite surface. Modified HNTs exhibited a rapid adsorption rate for Cr (VI) and approached 95% of the maximum adsorption capacity within 5 min. The effects of initial Cr (VI) concentration, temperature, pH, and ionic strength on the adsorption capacity were investigated in batch experiments.

The results showed that low temperature was favourable to improve adsorption efficiency, and the adsorption capacity decreased significantly with the increase of pH and ionic strength. The optimum pH was found to be 3–5. The main adsorption mechanism was electrostatic interaction between protonated amino groups on the adsorbent surface and negatively charged Cr (VI). The results above

confirmed that modified HNTs had the potential to be utilized as a low-cost and relatively effective adsorbent for Cr (VI) removal.

1.3.1. Chemical formation of silane

Silane is an inorganic compound with chemical formula, SiH_4. It is a colourless, pyrophoric, toxic gas with a sharp, repulsive smell, somewhat similar to that of acetic acid. Silane is of practical interest as a precursor to elemental silicon. Silane with alkyl groups are effective water repellents for mineral surfaces such as concrete and masonry. Silanes with both organic and inorganic attachments are used as coupling agents.

Silane can be produced by several routes. Typically, it arises from the reaction of hydrogen chloride with magnesium silicide:

$$Mg_2Si + 4\ HCl \rightarrow 2\ MgCl_2 + SiH_4$$

It is also prepared from metallurgical grade silicon in a two-step process. First, silicon is treated with hydrogen chloride at about 300 °C to produce trichlorosilane, $HSiCl_3$, along with hydrogen gas, according to the chemical equation:

$$Si + 3\ HCl \rightarrow HSiCl_3 + H_2$$

The trichlorosilane is then converted to a mixture of silane and silicon tetrachloride. This redistribution reaction requires a catalyst:

$$4\ HSiCl_3 \rightarrow SiH_4 + 3\ SiCl_4$$

The most commonly used catalysts for this process are metal halides, particularly aluminium chloride. This is referred to as a redistribution reaction, which is a double displacement involving the same central element.

It may also be thought of as a disproportionation reaction even though there is no change in the oxidation number for silicon (Si has a nominal oxidation number IV in all three species). However, the utility of the oxidation number concept for a covalent molecule, even a polar covalent molecule, is ambiguous. The silicon atom

could be rationalized as having the highest formal oxidation state and partial positive charge in $SiCl_4$ and the lowest formal oxidation state in SiH_4 since Cl is far more electronegative than is H.

An alternative industrial process for the preparation of very high purity silane, suitable for use in the production of semiconductor grade silicon, starts with metallurgical grade silicon, hydrogen, and silicon tetrachloride and involves a complex series of redistribution reactions (producing by-products that are recycled in the process) and distillations. The reactions are summarized below:

$$Si + 2\ H_2 + 3\ SiCl_4 \rightarrow 4\ SiHCl_3$$

$$2\ SiHCl_3 \rightarrow SiH_2Cl_2 + SiCl_4$$

$$2\ SiH_2Cl_2 \rightarrow SiHCl_3 + SiH_3Cl$$

$$2\ SiH_3Cl \rightarrow SiH_4 + SiH_2Cl_2$$

The silane produced by this route can be thermally decomposed to produce high-purity silicon and hydrogen in a single pass.

Still other industrial routes to silane involve reduction of SiF_4 with sodium hydride (NaH) or reduction of $SiCl_4$ with lithium aluminium hydride ($LiAlH_4$).

Another commercial production of silane involves reduction of silicon dioxide (SiO_2) under Al and H_2 gas in a mixture of NaCl and aluminium chloride ($AlCl_3$) at high pressures:[7]

$$3\ SiO_2 + 6\ H_2 + 4\ Al \rightarrow 3\ SiH_4 + 2\ Al_2O_3$$

1.3.2. physical properties of silane

Silane is a colorless, flammable and poisonous gas, with a strong repulsive odor. It is easily ignited in air, reacts with oxidizing agents, is very toxic by inhalation, and is a strong irritant to skin, eyes and mucous membranes. Silane is

lighter than air. Under prolonged exposure to fire or heat the containers may rupture violently and rocket. It is used in the production of amorphous silicon.
CAMEO Chemicals

- Gas Vapor EPA Chemicals under the TSCA

Colorless, flammable and poisonous gas, with a strong repulsive odor; [CAMEO] Haz-Map, Information on Hazardous Chemicals and Occupational Diseases

- COLORLESS GAS WITH CHARACTERISTIC ODOUR. ILO International Chemical Safety Cards (ICSC)
- Colorless gas with a repulsive odor. Occupational Safety and Health Administration (OSHA); The National Institute for Occupational Safety

1.4. Properties of silane

Silane is the silicon analogue of methane. Because of the greater electronegativity of hydrogen in comparison to silicon, this Si–H bond polarity is the opposite of that in the C–H bonds of methane. One consequence of this reversed polarity is the greater tendency of silane to form complexes with transition metals. A second consequence is that silane is pyrophoric — it undergoes spontaneous combustion in air, without the need for external ignition.[11] However, the difficulties in explaining the available (often contradictory) combustion data are ascribed to the fact that silane itself is stable and that the natural formation of larger silanes during production, as well as the sensitivity of combustion to impurities such as moisture and to the catalytic effects of container surfaces causes its pyrophoricity. Above 420 °C, silane decomposes into silicon and hydrogen; it can therefore be used in the chemical vapor deposition of silicon.

The Si–H bond strength is around 384 kJ/mol, which is about 20% weaker than the H–H bond in H_2. Consequently, compounds containing Si–H bonds are much more reactive than is H_2. The strength of the Si–H bond is modestly affected

by other substituents: the Si–H bond strengths are: $SiHF_3$ 419 kJ/mol, $SiHCl_3$ 382 kJ/mol, and $SiHMe_3$ 398 kJ/mol

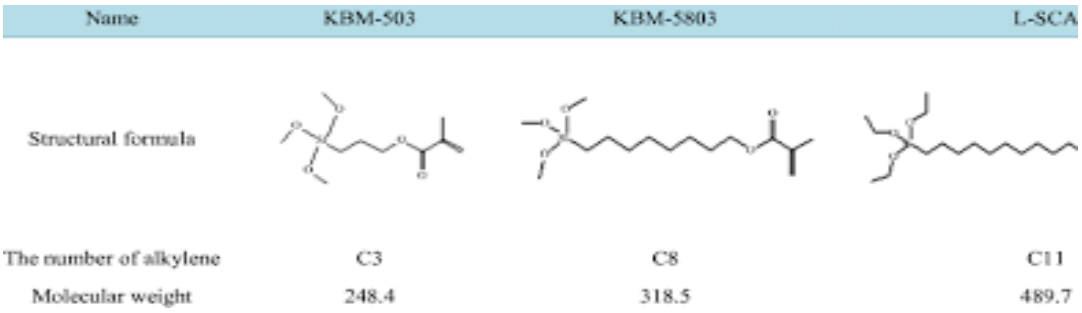


Fig 1.2. chemical formula for silane

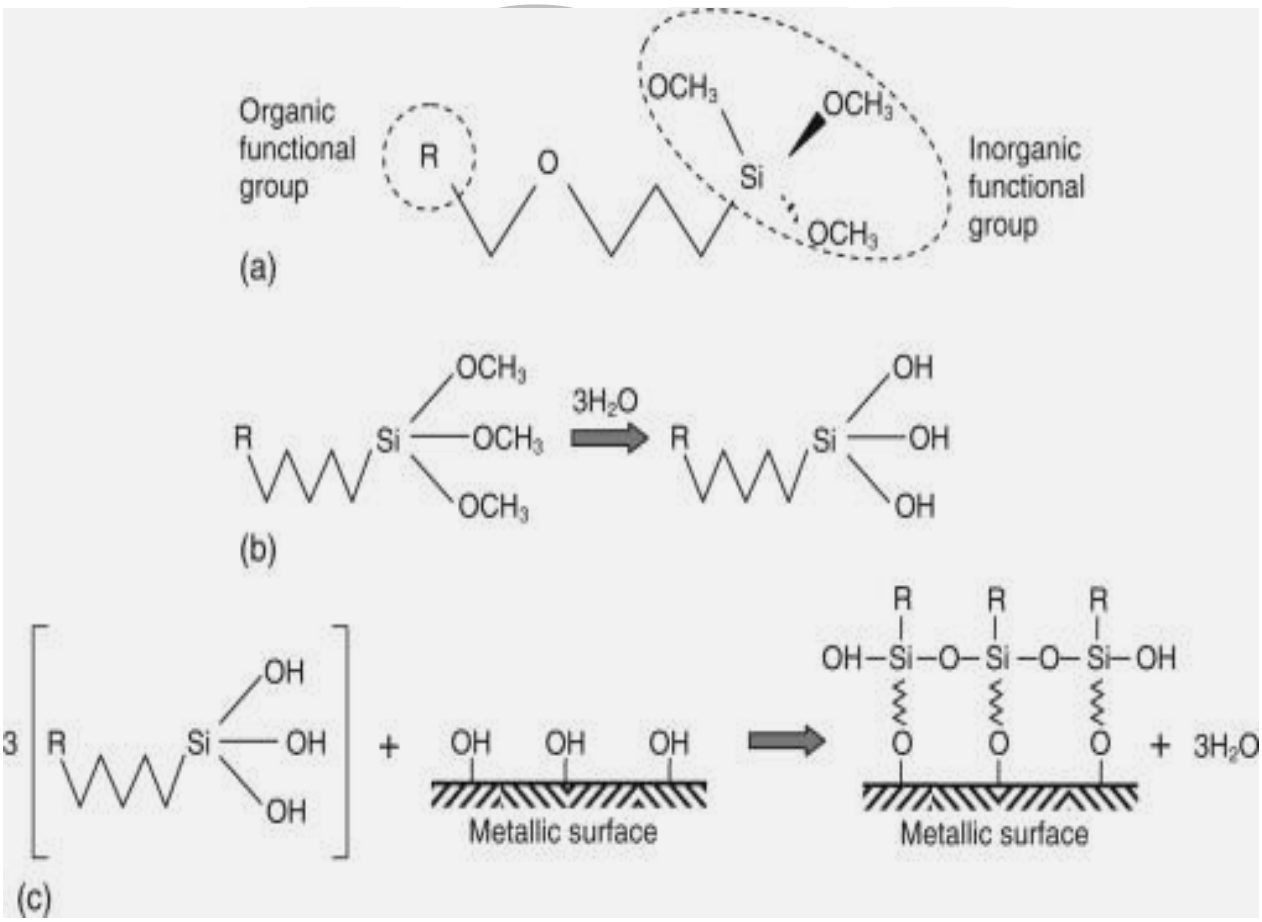


Fig 1.3. properties of silane

1.4.1. Application of silane

While diverse applications exist for organ silanes, silane itself has one dominant application, as a precursor to elemental silicon, particularly in the semiconductor industry. The higher silanes, such as di- and trispirane, are only of academic interest. About 300 metric tons per year of silane were consumed in the late 1990s. Low-cost solar photovoltaic module manufacturing has led to substantial consumption of silane for depositing (PECVD) hydrogenated amorphous silicon (a-Si:H) on glass and other substrates like metal and plastic. The PECVD process is relatively inefficient at materials utilization with approximately 85% of the silane being wasted. To reduce that waste and the ecological footprint of a-Si: H-based solar cells further several recycling efforts have been developed.

Due to weak bonds and hydrogen silane is a pyrophoric gas (capable of autoignition at temperatures below 54 °C /130 °F).

$$SiH_4 + 2\ O_2 \rightarrow SiO_2 + 2\ H_2O \text{ with } \Delta H = -1517 \text{ kJ/mol} = -47.23 \text{ kJ/g}$$

$$SiH_4 + O_2 \rightarrow SiO_2 + 2\ H_2$$

$$SiH_4 + O_2 \rightarrow SiH_2O + H_2O$$

$$2\ SiH_4 + O_2 \rightarrow 2\ SiH_2O + 2H_2$$

$$SiH_2O + O_2 \rightarrow SiO_2 + H_2O$$

1.4.2. Effect of silane

Five different silane coupling agents such as vinyltrimethoxysilane (VTMS), vinyltriethoxysilane (VTES), trimethoxysilylpropylmethacrylate (TSPM), glycidoxypropyltriethoxysilane (GPTES) and aminopropyltriethoxysilane (APTES) were used for the surface finishing of cotton fibres by condensation polymerization in ethanol/water medium. The finished cotton fibres showed improved textile properties like tensile strength, wear comfortless, moisture absorption and wrinkle recovery, but decreased swelling in aqueous solution. The finished cotton fibres were characterized by Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD) and Energy Dispersive X-ray

(EDX), thermogravimetric analysis (TGA) and derivative thermogravimetry (DTG). Attachment of silane coupling agents was confirmed and the finished cotton fibres showed increased thermal stability than the unfinished cotton. The finished cotton fibres showed higher reactive dye exhaustion due to silane coupling agent imparts new reactive sites for dye molecule on cotton fibres. The finished cotton fibres showed excellent fastness properties like washing, sunlight and chemical fastness properties. Improved textile properties of the silane finished cotton fibres with higher flexibility due to the presence of Si-O bond between the silane coupling agents and the cotton fibres, causes increased wear comfortless. Possible applications include use of the finished fibres as textile materials and garments.

1.5. CHITOSAN

Chitosan is an abundant biopolymer, consisting of poly [β-(1-4)-2-amio-2-deoxy-D- glucopyranose] - which is obtained after alkaline deacetylation of the chitin which is found in the exoskeletons of crustaceans, arthropods and mollusks, as well as the cell walls of certain fungi . Its production in nature has been estimated to be ca. 10^9-10^{10} ton/year.

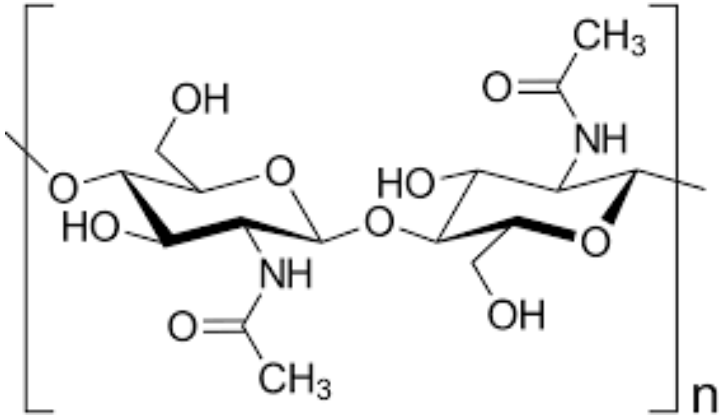


Fig 1.4. chitin

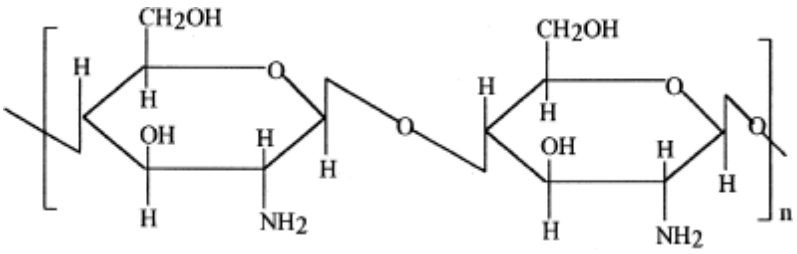
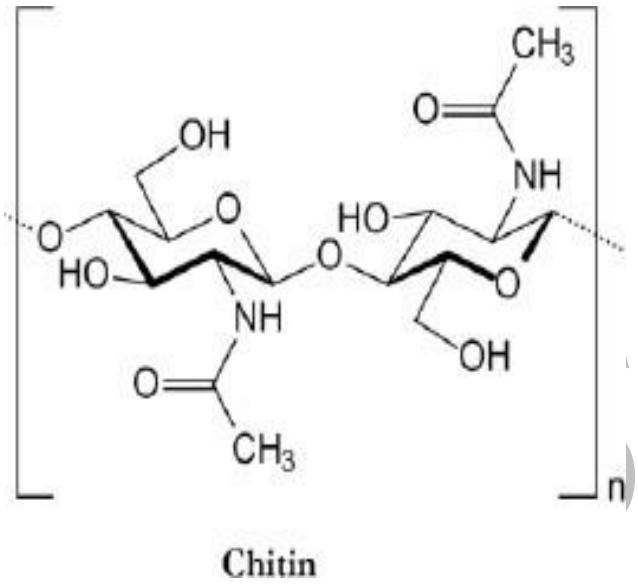


Fig 1.5. structure of chitosan



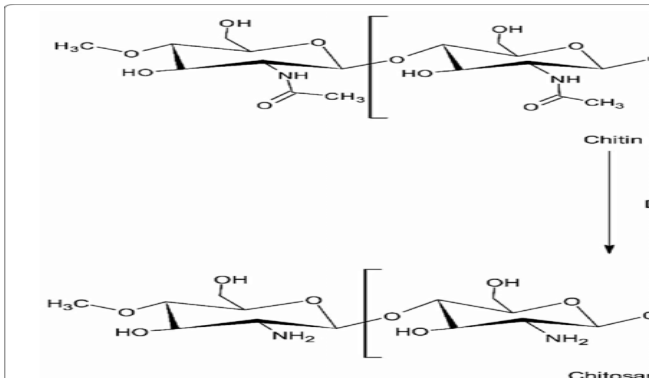


Fig 1.6 chemical formula for chitosan

1.6. Characteristics of chitosan

- Biocompatible
- Biodegradable
- Non – toxic
- Antimicrobial
- Ability to be functionalized
- Renewable

1.6.1. Preparation of chitosan

Chitosan is commonly prepared by deacetylating chitin using 40-50 % aqueous alkali at 100-160^{o}C for a few hours as described. The resulting chitosan has a degree of deacetylation (DD) up to 0.95. For complete deacetylation if needed, the alkaline treatmentcan be repeated but it is rarely achieved. The solubility in dilute aqueous acids is obtained at an extent of deacetylation of = 60 %.

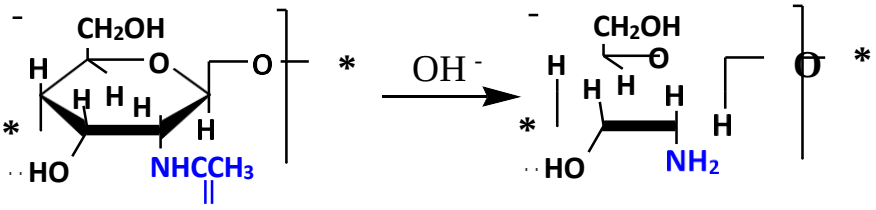


Fig 1.6.1 preparation of chitosan

1.6.2. Characterization of chitosan

Chitosan has two important structural parameters, which are degree of deacetylation (DD) and molecular weight (MW). Its performance in physics and chemistry is determined bythe influence of these two parameters on such things as solubility, enrichment ions, the mechanics of the chitosan membrane, flocculation, etc. In acidic solvents, the NH_2 group in chitosan

becomes a quaternary amino group and allows the chitosan to inhibit the growth of many bacteria, including gram-negative and gram-positive ones.

1.6.3. Degree of N-deacetylation

An important parameter to examine closely is the degree of N-acetylation in chitin, i.e., the ratio of 2-acetamido-2-deoxy-D-glucopyranose to 2-amino-2-deoxy-D-glucopyranose structural units. This ratio has a striking effect on solubility and solution properties. Chitin does not dissolve in dilute acetic acid, but if it is deacetylated to a certain degree, (approximately 60 % deacetylation) it becomes soluble in acid and it is referred as chitosan.

1.6.4. Chemical properties

The chemical properties of chitosan are as follows;

- Linear polyamine
- Reactive amino groups
- Reactive hydroxyl groups
- Chelates many transitional ions

1.7. Fourier transform infrared spectroscopy (FTIR)

Fourier transform infrared spectroscopy (FTIR) uses infrared radiation to determine the chemical functionalities present in a sample. When an infrared (IR) beam hits a sample, chemical bonds stretch, contract and bend, causing it to absorb IR radiation in a defined wavenumber.

In attenuated total reflectance (ATR) FTIR, the incident IR beam first passes through a ZnS, Ge, or diamond crystal, improving the surface sensitivity of the technique. The resulting plot is of absorbance (or transmittance) versus wavenumber. Sampling depth is dependent on the infrared transmitting crystal used to internally reflect the incident IR beam as well as the refractive index of the sample and is on the order of microns.

Although ATR-FTIR has a relatively deep sampling depth, it does not require ultra-high vacuum conditions, as do XPS and To FSIMS, and an analysis can therefore be conducted in less than ten minutes. ATR-FTIR can also be used to monitor migration of functional groups to thepolymer bulk.

1.8. Scanning electron microscopy (SEM)

When a sample is bombarded with electrons, it emits secondary electrons and X-rays. The intensity of the secondary electrons is detected to generate a high-resolution three-dimensional surface image. X-rays can be detected to conduct elemental analysis.

SEM is notas surface sensitive as other techniques, and non-conducting polymers must be sputter-coatedprior to analysis. Nevertheless, it is one of the more widely available tools in surface analysis, and it is thus often used to measure surface topography.

1.9. Chitosan and fluoropolymer:

In order to impart barrier properties against microorganisms and blood to 100% cotton fabrics and 55/45% wood pulp/polyester spun laced nonwoven fabrics, samples are treated with chitosan and fluoropolymers using the pad-dry-cure and pad-cure methods, respectively. Antimicrobial activity of the samples is analysed quantitatively by measuring the number of colonies of Staphylococcus aureus. Blood repellence is assessed with an impact penetration test using synthetic blood Samples treated only with chitosan show a high reduction rate in the number of colonies. Dual finished specimens treated with 1.1 % chitosan concentration also maintain over 90% reductions in the number of colonies. The blood repellence of dual finished nonwoven fabrics is superior to that of dual finished cotton.

1.10. Application of chitosan in surface modification of textile materials

Chitosan applied to the textile industry, as an antimicrobial finish, became popular dueto its ability to provide protection against allergies and infection diseases, coupled with moisture retention and wound healing capabilities.

The prime focus for chitosan as an antimicrobial treatment has been on cotton. Early work indicated that the antimicrobial effect was potent against a range of microbes, but the finishing was not durable. To improve durability, chitosan has been crosslinked to cottonusing chemicals such as dimethyloldihydroxyethyleneurea (DMDHEU), citric acid, 1,2,3,4- butane tetracarboxylic acid (BTCA) or glutaric dialdehyde. These chemicals, some of which are used in cotton durable press, crosslink chitosan to cotton through hydroxyl groups. Antimicrobial activity with a durability of up to 50 washes has been reported in some of thesestudies. Ye & al. synthesized nanoscale core–shell particles of poly (*n*-butyl acrylate) cores and chitosan shells and applied them to cotton fabrics in a pad–dry–cure process. The antibacterial activity was maintained at over 90 % reduction levels after 50 washes.

Mehta & al. reported that chitosan improves the dye coverage of immature fibers in cotton dyeing and that it could be successfully used as a thickener and binder in pigment printing of cotton.

Since cotton fibers contain large amounts of hydroxyl groups, they are highly hydrophilic. In addition, the fiber crystallization is low, so that when cotton fibers absorb water, the bonding force among cellulose molecules is reduced markedly, which causes swelling. Therefore, when cotton fabrics are twisted or rubbed when being washed or worn, the cellulose macromolecules shift and undergo plastic deformation. Consequently, the fabricshrinks and wrinkles. The primary method of minimizing creases in cotton fabrics when washed or worn is to use appropriate agents to cross-

link the cellulose molecules in the fiber. This prevents the relative displacement of the cellulose molecules in cotton fibers when washed or worn. Crease resistance results from increasing the elasticity of the fibers.

Koo-Shien Huang & al. used H_2O_2 to degrade chitosan to low molecular-weight chitosan (LWCS), which was then mixed with an anti-creasing agent (dimethyl dihydroxyl ethylene urea) to produce the finishing agent, and then applied in the anti-creasing treatment of cotton fabrics.

1.11. FLUOROPOLYMER

Fluoropolymer coatings are widely used in many industries, although the consumer and many engineers and scientists are only aware of their use as nonstick coatings for cookware. This chapter first introduces fluoropolymer finish technology and market developments. It is a greatly condensed summary of a previous book by this author. Starting with a summary of the fluoropolymers used in finishes and their properties, an overview of liquid and powder technology follows. This includes processing considerations. Next is a summary of the history of fluoropolymers in finishes. Some guidance on food contact end use requirements follows. The rest of the chapter shows several sample ends uses. Each end use summarizes what types of coatings were used and what properties of fluor finishes were required.

Fluoropolymer—Teflon AF

A per fluorinated polymer made by Chemours breaks down the crystallinity completely, hence its designation amorphous fluoropolymer (AF). It is a copolymer made from 2,2-bistrifluoromethyl-4,5-difluoro-1,3-dioxole (PPD) and TFE. The structure of Teflon AF·

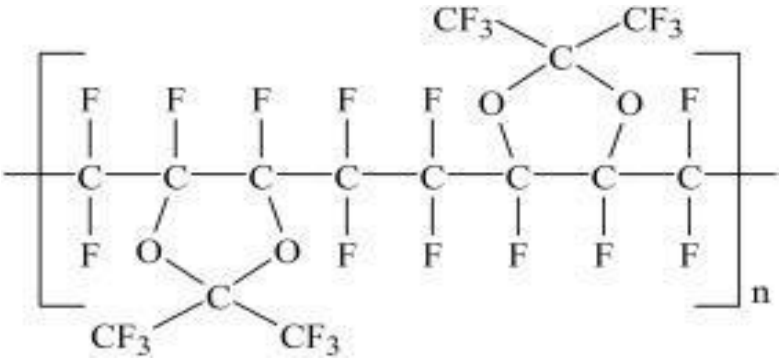


Fig 1.7 fluoropolymer

1.11.1 Preparation of fluoropolymer

A method for the preparation of a modified fluoropolymer powdered material is disclosed. A suspension of solid fluoropolymer particles together with PTFE particles in an aqueous carrier, is frozen and the frozen carrier is then removed by sublimation at sub-atmospheric pressure to produce a dry powder of modified fluoropolymer particles.

The present invention relates to a method for the preparation of Fluoropolymer powdered materials.

Fluoropolymers are long-chain polymers comprising mainly ethylenic linear repeating units in which some or all the hydrogen atoms are replaced with fluorine. Examples include Poly (tetrafluoroethylene), Perfluoro methyl vinyl ether (MFA), Fluoro ethylene propylene (FEP), Per Fluoro Alkoxy (PFA), Poly(chlorotrifluoroethylene) and Poly (vinyl fluoride). They are amongst the most chemically inert of all polymers and are characterised by an unusual resistance to acids, bases and solvents. They have unusually low frictional properties and can withstand extremes of temperature.

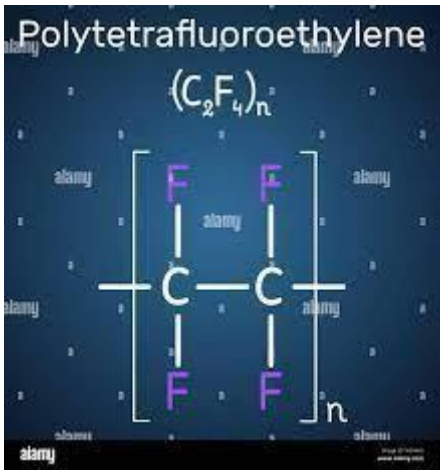


Fig 1.7.1 preparation of fluoropolymer

Accordingly, fluoropolymers are utilised in a wide variety of applications in which resistance to extreme environments is necessary. Current applications include the formation of tubing and packing materials within chemical plants, semiconductor equipment, automotive parts and structural cladding.

There are several applications which require the powdered form of the fluoropolymer. The fluoropolymer may be applied to a surface by electrostatic spraying of the powder. Uses would include the coating of household cookware to increase non-stick properties and abrasion resistance, and the coating of automotive parts to increase resistance to environmental weathering.

1.11.2. Extraction of fluoropolymer

AlN-doped fluoropolymer encapsulation layer was proposed for deep-ultraviolet light-emitting diodes. The proposed method can significantly enhance the light extraction from the chip-on-board packaging structure, which is attributed to the increased refractive index and light scattering ability of the encapsulant layer by the doping of AlN nanoparticles (NPs). When the AlN NPs content increases from 0.05 to 0.15 wt.%, the light output power enhancement increases from 10.1% to 16.4% at a driving current of 120 mA compared with pure fluoropolymer packaging structure. Furthermore, after aging tests at 100 °C for 600 h, the relative light output power of the 0.15 wt.% AlN-doped

fluoropolymer structure is only reduced by 5.3%, which is much lower than the pure fluoropolymer structure of 13% and the conventional silicone structure of 23.2%. The water- and oil-repellency of a cotton fabric treated with a fluorocarbon finish is shown to decrease with extended laundering. The nature of this diminishing performance is investigated by time-of-flight secondary-ion-mass spectrometry (ToF—SIMS) and X-ray photoelectron spectroscopy (XPS), which reveal an increase in the surfactants on the fibre surface and a decrease in the fluorocarbon coating as a result of laundering. The effect of heat-pressing on fabric repellence is also investigated by using XPS.

1.12. TEST METHOD OF ANTIBACTERIAL FINISH

A Chitosan nanoparticle (CNPs) is one of the alternatives that was investigated for its AM properties in textile applications, the nano form of chitosan is highly active due to very high surface area to volume ratio and expected to have desirable bioactivity even at very low concentration. Lauric acid (LA) is a crystalline fatty acid which has been shown to have AM effects towards Gram-positive bacteria and yeast. LA will be added to widen the spectrum activity of antibacterial mechanism towards Gram-positive and Gram-negative bacteria.

The main objective of this study is to develop antibacterial cotton fabric incorporated with chitosan nanoparticles (CNPs) and lauric acid to enhance physical and antibacterial properties of cotton fabric. The specific objectives of this study are:

- To investigate the effect of chitosan concentration on the formation of CNPs.
- To determine the effect of LA concentration on antibacterial properties.
- To characterize physical and antibacterial properties of treated cotton fabric.

CHAPTER 2

LITERATURE REVIEW

2.1. The Antimicrobial activity of cotton fabrics treated with different cross-linking agent and chitosan

In this paper, it is explained the cotton fabrics treated with two different cross-linking agents. In this presence of chitosan to provide the cotton fabrics a durable press finishing and antimicrobial properties by chemical linking of chitosan of the cellulose structure. Both type and concentration of finishing agent in the presence of chitosan as well as the treatment conditions significantly affected the performance properties and antimicrobial activity of treated cotton fabrics. The treated cotton fabrics with BTCA in the presence of chitosan strengthened the antimicrobial activity was more than the fabrics treated with Arco fix NEC. The maximum antimicrobial activity was obtained when the cotton fabrics were treated with 0.5-0.75% chitosan of molecular weight 1.5-5 kDa, and cured at 160°c for 2-3 min, Application of different material ions to cotton fabrics treated with finishing agent and chitosan showed a negligible effect on the antimicrobial activity.

2.2. Studies on frictional behavior of chitosan

In this research paper, study about the antimicrobial finishing has been an area of constant interest for processors. In this paper, we carried out studies into the frictional behavior of the chitosan concentration, a decrease in frictional constant values is observed. Test parameters such as normal load and area of contact are bound to affect the frictional values. With an increase in normal load, a decrease in frictional values is observed; and with an increase in the area of contact; a decrease in frictional values is observed.

CHAPTER-3

3.1 MATERIALS

3.1.1 Fabric preparation

Material – 100 % cotton fabric

Weave - Twill Weave

Count - 60s combed yarn

Ends Per Inch - 96

Picks Per Inch – 96

GSM - 86.3

3.1.2 Chemicals used

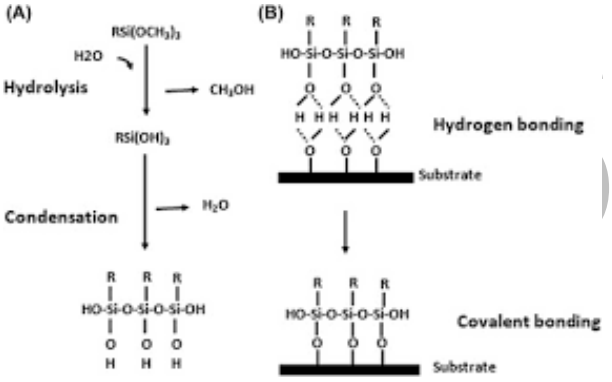
The basic chemicals used in the study for the following

- Chitosan
- Cross linked (eco finished CL)
- Fluoropolymer
- Silane

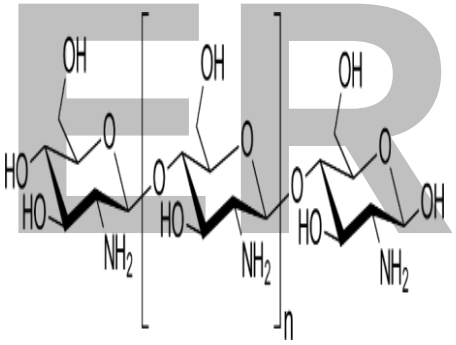
Table 3.1.2 Functional properties of chemical

S.NO	BOTANICAL NAME	OTHER NAME	FUNCTIONAL PROPERTIES
1	Chitosan	Deacetylated chitin biopolymer	Chitosan based films plasticized with different contents of glycerol were incorporated into chitosan solution to improve mechanical properties and all films obtained were flexible and transparent
2	Silane	Silicon hydride	A silane coupling agent acts as as sort of intermediary which bonds organic materials. It is this character tics that makes

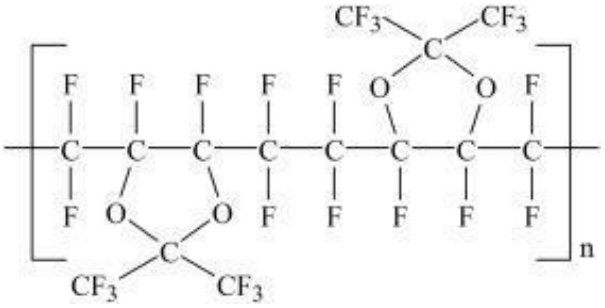
			silane coupling agent useful for improving the mechanical strength
3	Fluoropolymer	Fluorocarbon	It is characterized by high resistance to solvents acid and bases. The best-known fluoropolymer is poly tetra fluoroethylene under brand name TEFLON



silane



chitosan



fluoropolymer

Fig .3.1 Application of antibacterial finish on to fabrics

3.1.3. Application of Antibacterial Finish onto Fabrics

Silane was coated to the fabric by pad-dry-cure method. The fabric was padded with the takeout to attain a wet pick-up of 75%, dried and then cured at 100-120°C for 2 min. In order to fix the active silane substance on the fabric, a post treatment with 10 % citric acid was given, keeping material- to- liquor ratio of 1:20 at 50°C for 5 min. The treated fabric samples were then dried at 80°C and cured at 140° C for 2 min.

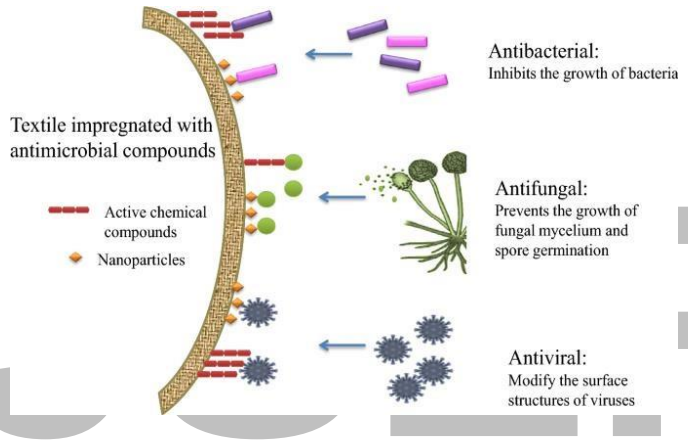


Fig .3.2. Application of blood repellent finish

3.1.4 Application of Blood Repellent Finish

In this work, dual finishes of antibacterial and blood repellency were imparted to the woven cotton fabrics. The antibacterial finished materials were post treated with fluoropolymer independently by the following methods.

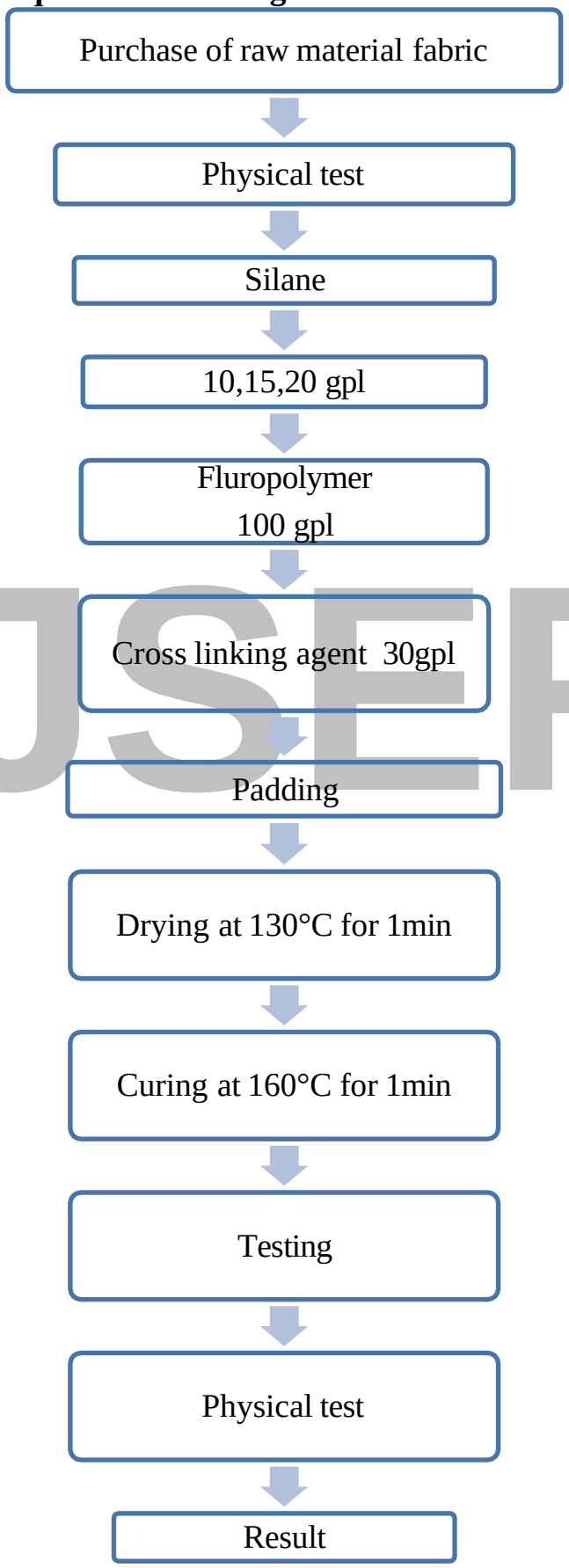
3.2. PROCESS PARAMETERS

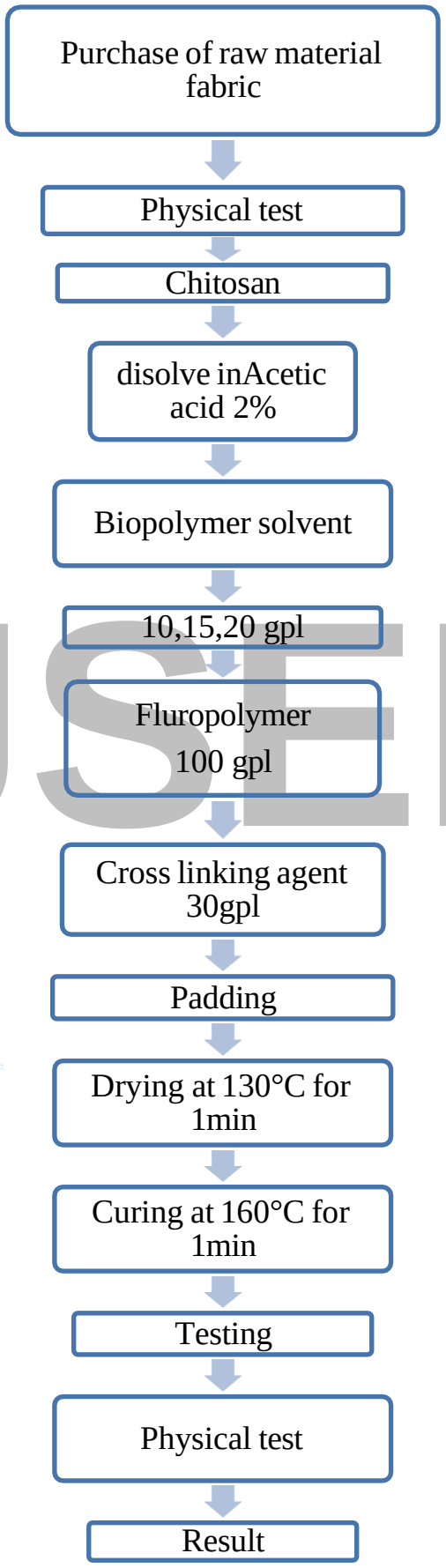
3.2.1 Process parameters

The process parameters that are used in the study are given below

- ML (material to licker) ratio – 1:20
- Temperature
- Time – As per requirement

3.2.2 The process sequence of finishing




Purchase of raw material fabric
Physical test
Chitosan
disolve inAcetic acid 2%
Biopolymer solvent
10,15,20 gpl
Fluropolymer 100 gpl
Cross linking agent 30gpl
Padding
Drying at 130°C for 1min
Curing at 160°C for 1min
Testing
Physical test
Result

3.3 PRE- TREATMENT OF FABRIC (SCOURING AND BLEACHING ON 100% COTTON FABRIC)

3.3.1 Scouring (Recipe)

Caustic soda	-	2%
Soda ash	-	2%
Wetting agent	-	1%
Time	-	2-3 hrs
Temperature	-	Boiling temperature

3.3.2 Procedure for scouring

- Take known weight of sample.
- Take the weight of chemical and water on the basis of sample weight in beaker.
- Sodium Hydroxide, soda ash, detergent and water taken as per M:L ratio.
- These solutions are treated for 15 minutes and stir it continuously at 45^{o}C temperature.
- Then dip the sample in the solution and raises the temperature of the solution up to 45^{o}C temperature.
- Now the sample is treated for further 60 min. while slowly raising the temperature up to 70^{o}C.
- Now the fabric is treated at 90^{o}C temperature for 3hour.
- After required time, the sample is taken out, washed and dried.

3.3.3 Bleaching (Recipe)

Sodium hypochlorite – 4%

Sodium carbonate - 1%

M; L - 1;20

Temperature - Room Temperature

Time - 60 min

3.3.4 Procedure for Bleaching

- Take known weight of sample.
- Also take the weight of chemical and water on the basis of sample weight in beaker
- Sodium hypochlorite, sodium carbonate was taken and water as per M:L ratio had been taken.
- These solutions are treated for 15 min and stir it continuously at room temperature.
- Then dip the sample in the solution and raises the temperature of the solution up to room temperature.
- Now the sample is treated for further 60 min.
- Now the fabric is treated at room temperature.
- The sample is taken out & sample dip in the 1 drop of HCl acid solution.
- Again, sample is washed and dried.

3.3.5 Fabric is treated under Pad -Dry- cure method

Table 3.3.5 Recipe CBR (chitosan / blood repellent)

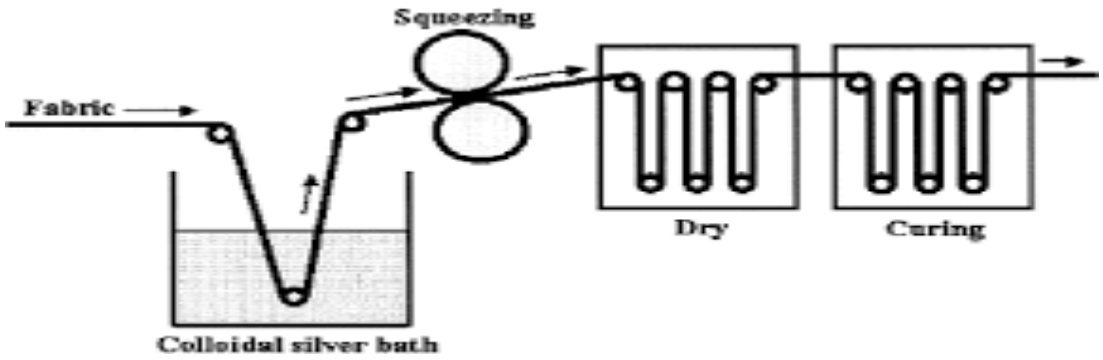
CBR (CHITOSAN / BLOOD REPELENT)			
Sample	SK 1	SK 2	SK 3
Chitosan	10gpl	15gpl	20gpl
cross linking agent (eco finish cl)	30gpl	30gpl	30gpl
Fluropolymer	100gpl	100gpl	100gpl

Table 3.3.6 Recipe SBR (Silane/ blood repellent)

SBR (SILANE / BLOOD REPELENT)			
Sample	SK 1	SK 2	SK 3
Silane	10gpl	15gpl	20gpl
cross linking agent (eco finish cl)	30gpl	30gpl	30gpl
Fluoropolymer	100gpl	100gpl	100gpl

The most common application method for easy-care and durable press finishes is a pad–dry–cure procedure. In this process, the crosslinking reactant, catalyst, softener, and other components are dried on the fabric prior to the crosslinking reaction that takes place during the curing step.

The fabrics were treated separately with 10,15 and 20 gpl fluoropolymer using the above recipe by pad- dry-cure method to attain a wet pick-up of 75%, dried at 130°C and cured at 150-160°C for 2 min.



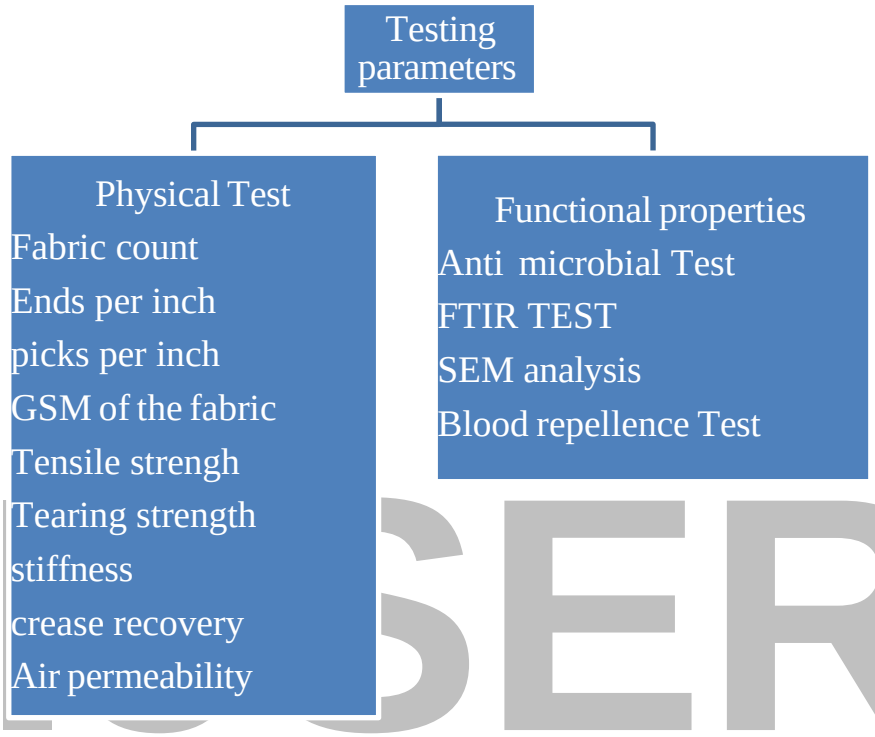
Laboratory Pad- Dry Machine

Fig 3.3. Padding process

CHAPTER 4

TEST RESULT AND DISCUSSION

4.1. TESTING PARAMETERS



4.1.1. Physical Test Before Treatment

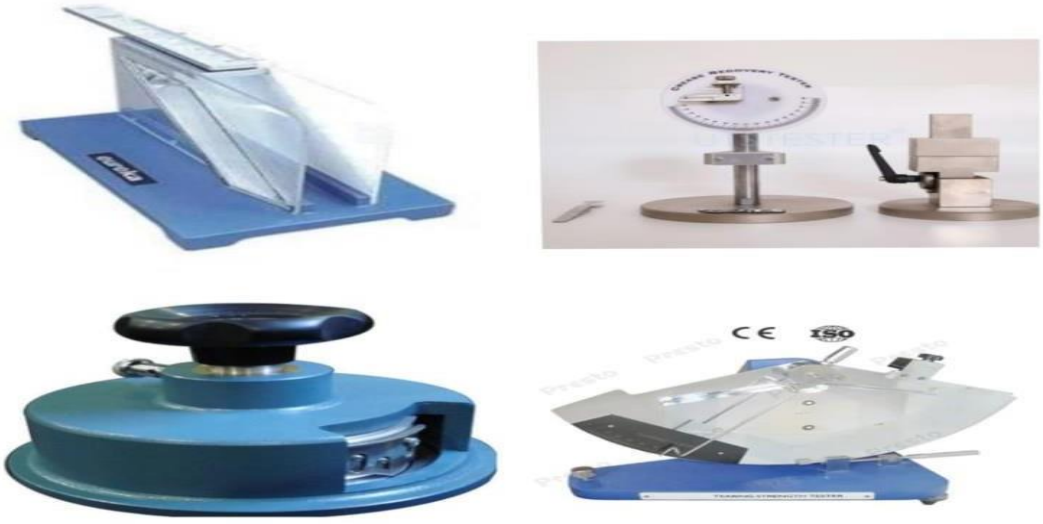


Fig 4.1 physical properties

Fabric properties for cotton woven fabric

Table 4.1.1 physical test before treatment

Fabric properties	Warp way	Weft way
Count	60s Ne	60s Ne
Inch	EPI- 96	PPI-96
End/Dent	2 ends/ dent	
GSM of the fabric	86.3g/m. sq.	86.3g/m. sq.
Tensile strength	Elongation = 15%	Elongation =17.5%
Tearing strength	1200gms	832gms
Stiffness	2.15 kg/sq.cm	2.32 kg/sq.cm
Crease recovery	78 degrees	76 degrees
Air permeability	376.8 cc/sec/sq.cm	376.8 cc/sec/sq. cmZ

4.2 TEST METHODS FOR ACCESSING THE ANTIMICROBIAL FINISH

In this work, the qualitative agar diffusion test and quantitative bacteria reduction through. AATCC100-2004 test was used to access the antimicrobial activity of the fabrics.

The antibacterial effect of the different concentrated silane and fluoropolymer treated sample were determined qualitative by agar diffusion plate test using EN ISO 20645:2004 method against staphylococcus aureus ATCC 6538 and Escherichia coli ATCC 10229.

When effective antibacterial activity was determined against the used bacterial pathogens, AATCC 100-2004 test method was used to analyse reduction in bacterial counts for quantitative determination.

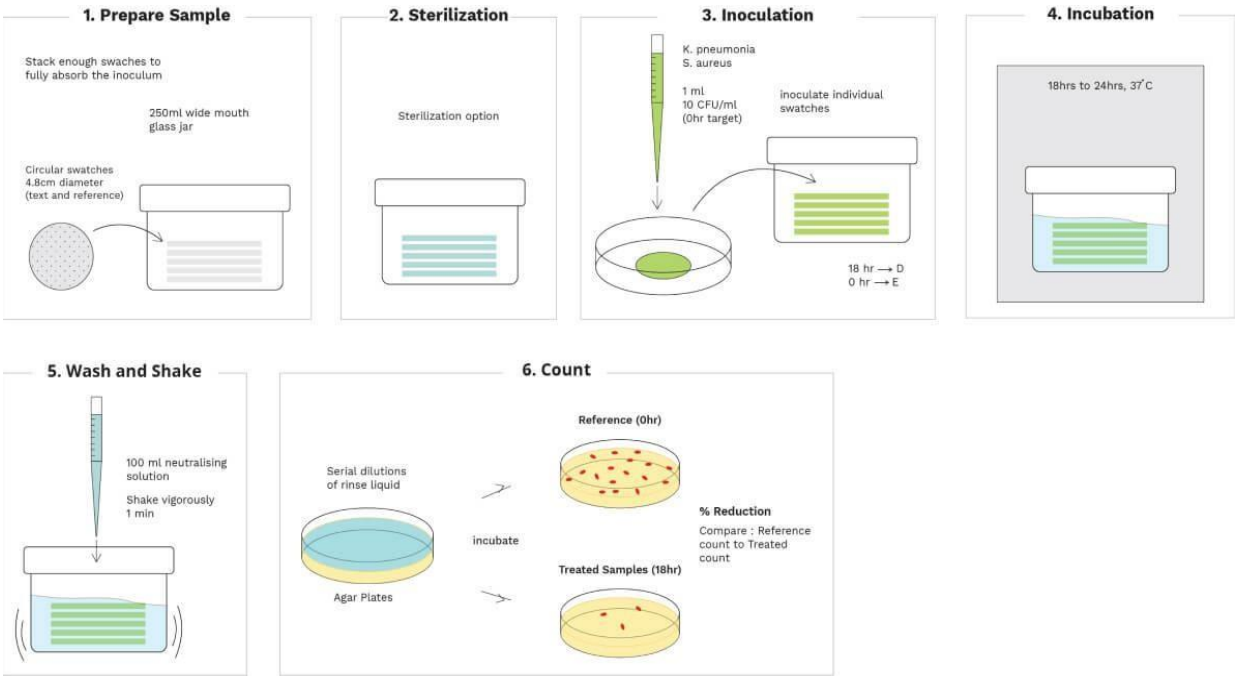


Fig 4.2 Test methods for accessing the antimicrobial finish

4.2.1. Agar diffusion method (EN ISO 20645)

Qualitative antimicrobial determination by EN ISO 20645:2004 method employs a two layered agar plate. The lower layer has sterile culture medium and the upper layer of agar was inoculated with individual test bacteria (1X108 cells). Test specimens were imprinted onto the inoculated agar using sterile forceps. Agar plates were incubated for 18-24 h at 37ºC. Assessment of antibacterial activity was determined by the extent of bacterial growth in the contact zone between the agar and the specimen.

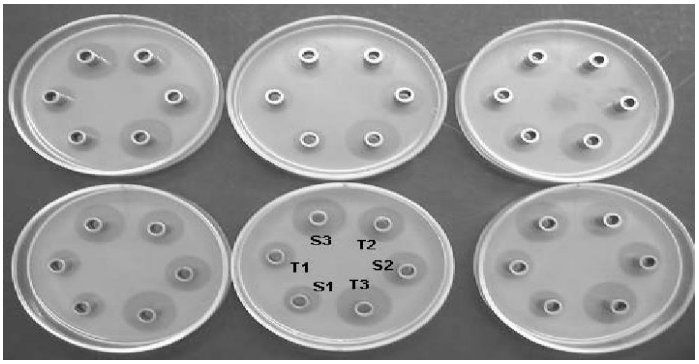


Fig 4.3 Agar diffusion method

4.2.2. Antibacterial quantitatively method (AATCC 100-2004)

The antimicrobial activity was quantitatively evaluated using AATCC 100-2004 test method against the standard bacterial strain which gets effectively inhibited by EN ISO 20654:2004 method. The treated samples were inoculated with bacterial inoculums (1X105 cells/ml). After incubation sterilized distilled water was added for serially dilution. From every dilution 1ml of diluted solution was plated on agar medium and incubated for 24 h at 37 ± 2°C.

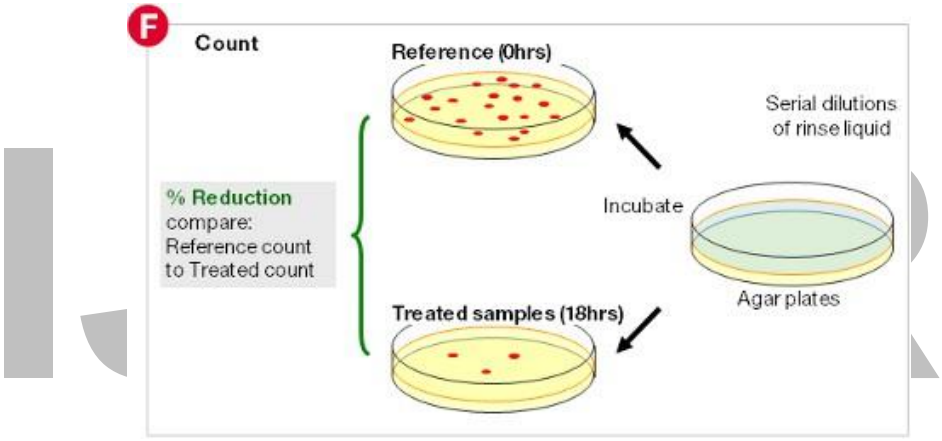


Fig 4.4. Antibacterial quantitatively method

4.3. TEST METHODS FOR ASSESSING BLOOD REPELLENT FINISH

The blood repellency of the sample was assessed using impact penetration and spray test. The synthetic blood was prepared using distilled water, a surfactant (Acrysol G110, Rohm and Hass Co) and red dye (Direct Red 081) according to ASTMF 23.40.01(draft) for testing the resistance of protective clothing material to synthetic blood.

Impact Penetration Test (AATCC 42 -2000)

A volume of water/synthetic blood was allowed to spray against a taut surface of the test specimen backed by a weighed blotter. The blotter was then reweighed to determine water penetration and the specimen is classified

accordingly. The specimen 178× 330mm and the blotting paper were conditioned in an atmosphere of 65± 2 % RH and 2 1 °C temperature for at least 4 h before testing.

The increase in mass of the blotter in grams was calculated and the average result of the three test specimens was reported.

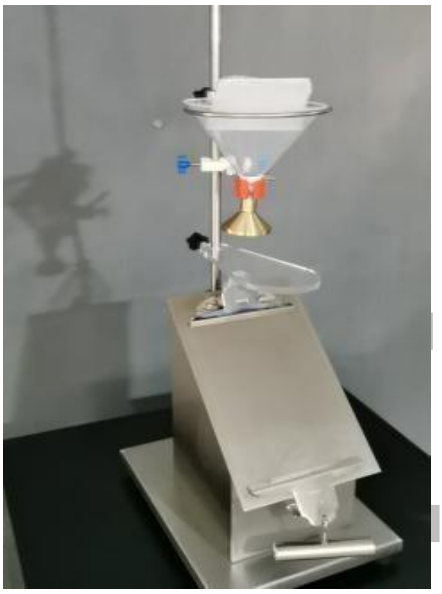


Fig 4.5 Impact penetration test

ASTM F1670 Significance and Use This test method is based on Test Method F 903 for measuring resistance of chemical protective clothing materials to penetration by liquids. This test method is normally used to evaluate specimens from individual finished items of protective clothing and individual samples of materials that are candidates for items of protective clothing. Finished items of protective clothing include gloves, arm shields, aprons, gowns, coveralls, hoods, and boots. The phrase “specimens from finished items” encompasses seamed and other discontinuous regions as well as the usual continuous regions of protective clothing items. Medical protective clothing materials are intended to be a barrier to blood, body fluids, and other potentially infectious materials. Many factors can affect the wetting and penetration characteristics of body fluids, such as surface

tension, viscosity, and polarity of the fluid, as well as the structure and relative hydrophobicity or hydrophobicity of the materials.

The surface tension range for blood and body fluids (excluding saliva) is approximately 0.042 to 0.060 N/m (1). To help simulate the wetting characteristics of blood and body fluids, the surface tension of the synthetic blood is adjusted to approximate the lower end of this surface tension range. The resulting surface tension of the synthetic blood is approximately 0.042 ± 0.002 N/m. The synthetic blood mixture is prepared with a red dye to aid in visual detection and a thickening agent to simulate the flow characteristics of blood. Part of the protocol in Procedure for exposing the protective clothing material specimens with synthetic blood involves pressurization of the test cell to 13.8 kPa. This hydrostatic pressure has been documented to discriminate between protective clothing material performance and correlate with visual penetration results that are obtained with a human factors validation. Some studies, however, suggest that mechanical pressures exceeding 345 kPa can occur during clinical use. Therefore, it is important to understand that this test method does not simulate all the physical stresses and pressures that are exerted on protective clothing garments during actual use. This test method is offered to identify those protective clothing materials that warrant further evaluation with a microbiological challenge.

Spray Test (AATCC 22 -1996)

Water sprayed against the taut surface of a test specimen under control conditions produces wetted pattern whose size depends on the relative repellency of the fabric. Specimen of 18×18cm size was conditioned at 65± 2 RH and 21° ± 1°C.

Evaluation is accomplished by comparing the wetted pattern with the observations as mentioned in the following standard rating The spray rating is

determined by comparing the appearance of the tested specimen with descriptive standards and photographs. The AATCC Spray Test Rating Chart is available for this purpose.

Fig 4.6 Spray test

How to Order

1. 901-302 SPRAY RATING TESTER – MODEL 513 ACCESSORIES
2. 510-315 Spare Spray Nozzle
3. 393-253 Spare Specimen Holder
4. 766-456 AATCC Spray Test Rating Chart
5. 201-513 ISO Certificate of Calibration

Standard Observation rating

1. 100 (ISO-5) Sticking or wetting of upper surface
2. 90 (ISO-4) Slight random sticking or wetting of upper surface
3. 80(ISO-3) Wetting of upper surface of spray points
4. 70(ISO-2) Partial wetting of whole of the upper surface
5. 50(ISO-1) Complete wetting of whole of upper surface

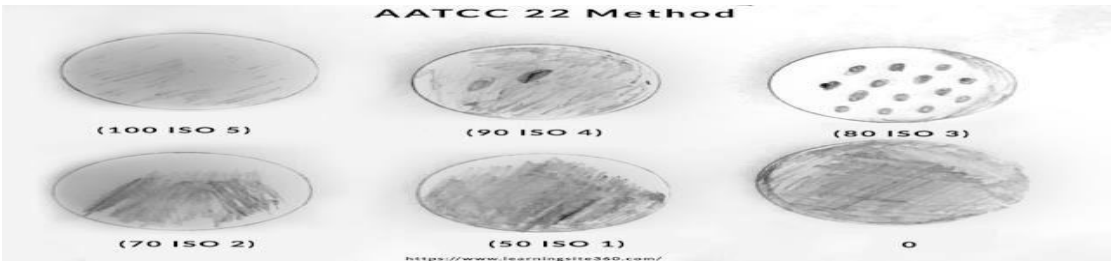


Fig 4.7 standard observation rating

4.4. ANTIMICROBIAL FINISH

4.4.1. Chitosan using Antimicrobial Finish

E. COLI **Staphylococcus**

Fig 4.8 Chitosan using Antimicrobial Finish

Table 4.4.1 Chitosan using Antimicrobial Finish

Antimicrobial Activity	**SK 1**	**SK 2**	**SK 3**
Staphylococcus	**18mm**	**25mm**	**31mm**
E. COLI	**20mm**	**26mm**	**30mm**

4.4.2. Silane using Antimicrobial Finish

E. COLI **Staphylococcus**

Fig 4.9 Silane using Antimicrobial Finish

Table 4.4.2 Silane using Antimicrobial Finish

Antimicrobial Activity	**SK 1**	**SK 2**	**SK 3**
Staphylococcus	**17 mm**	**23 mm**	**28 mm**
E. COLI	**20 mm**	**26 mm**	**30 mm**

4.4.3. Antibacterial Efficacy of Silane, chitosan Treated Fluoropolymer Finished Fabrics

- The cotton woven fabrics treated with the silane, chitosan shows very good resistance to both gram positive and gram-negative bacteria and durability also good.
- The result of agar diffusion test for antimicrobial effectiveness against Staphylococcus aureus and E. coli cultures.

- Specimen represents Silane, Chitosan treated fluoropolymer finished sample. The antibacterial activity of the silane treated fluoropolymer finished samples at 6 different concentrations of fluoropolymer deposited samples based on agar diffusion and the method is given in It can be inferred that the antimicrobial efficacy reduces apparently with the increase in fluoropolymer concentration. This may be due to the increase in add-on of fluoropolymer; especially the higher concentration makes the fabric surface highly hydrophobic and considerably restricts the release of antimicrobials.

- In antimicrobial test the result shows that the woven fabrics treated with silane. Chitosan and fluoropolymers have an excellent activity and at the same time the blood repellency effect has an excellent. If the concentration increases the antimicrobial activity increases. These results are achieved. The result showed in above slide both qualitative and quantitative methods.

4.5. FTIR Test

The FTIR instrument sends infrared radiation of about 10,000 to 100 cm^{1} through a sample, with some radiation absorbed and some passed through. The absorbed radiation is converted into rotational and/or vibrational energy by the sample molecules. The resulting signal at the detector presents as a spectrum, typically from 4000 cm^{-1} to 400cm^{-1}, representing a molecular fingerprint of the sample. Each molecule or chemical structure will produce a unique spectral fingerprint, making FTIR analysis a great tool for chemical identification.

4.5.1. SILANE FLUOROPOLYMER FTIR TEST

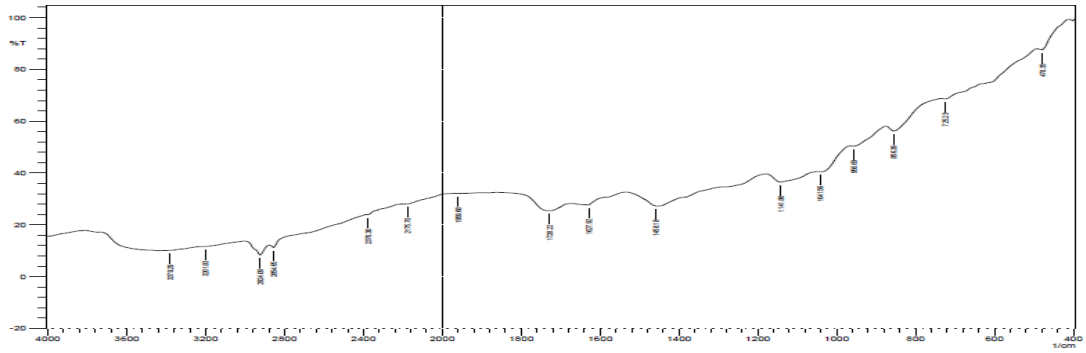


Fig 4.10 silane fluoropolymer FTIR test

Table 4.4.3 silane fluoropolymer FTIR test

S.NO	FREQUENCY	FUNCTIONAL GROUP
1.	3700-3100	Water OH stretch
2.	3600-3200	Alcohol OH stretch
3.	3500-3350	N-H Stretch
4.	3300	=C-H Stretch
5.	3100-3000	=C-H Stretch
6.	2950-2840	-C-H stretch
7.	2900-2800	-C-H aldehydic
8.	2250	C=N Stretch
9.	1740-1720	C=O aldehyde
10.	1680-1600	C=C alkaline

4.5.2. CHITOSAN FLUOROPOLYMER FTIR TEST

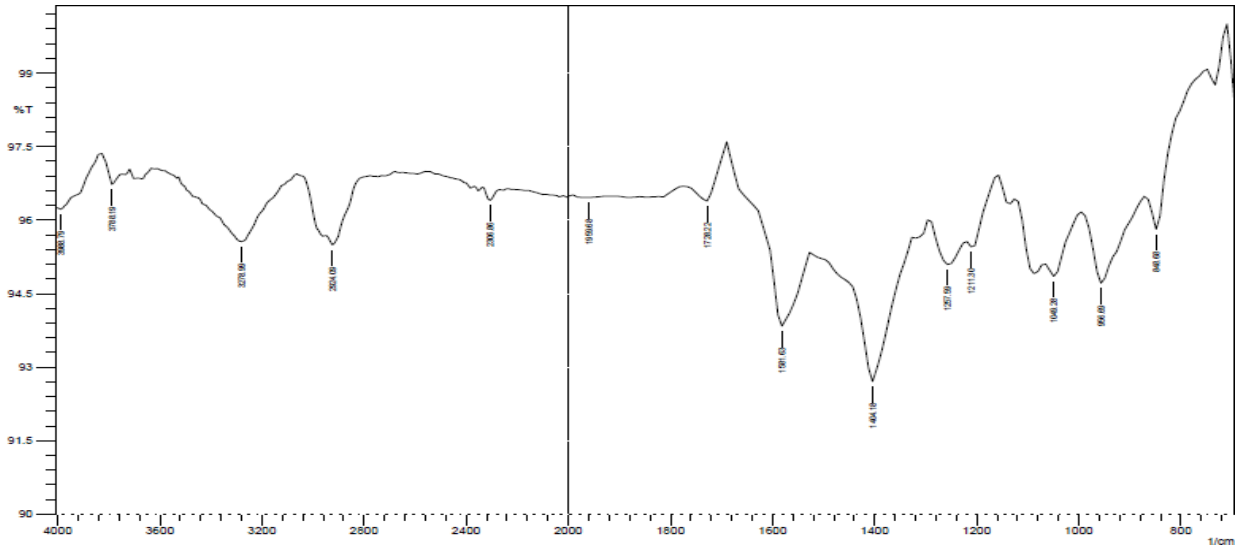


Fig 4.11 chitosan fluoropolymer FTIR test

Table 4.4.4 chitosan fluoropolymer FTIR test

S.NO	FREQUENCY	FUNCTIONAL GROUP
1.	3027.97	-OH, Stretching of the hydroxyl group
2.	2917.15-2207.92	C-H Stretching
3.	2011.61	C=C
4.	1419.53	C-F Stretching
5.	1090.24 – 1036.41	C=O Stretching
6.	871.77	C=H bending of aromatics
7.	602.64	C-X, where X is a halogen

4.6. SEM Analysis

scanning electron microscopy (SEM) were conducted as previously described. Briefly, *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC29213 were cultured overnight, 10^7 CFU ml^{-1} bacteria were incubated with 1 × MIC of CHAP or diluents of the same volume at 37 °C for 30 min. All the samples were fixed and proceeded for the SEM respectively.

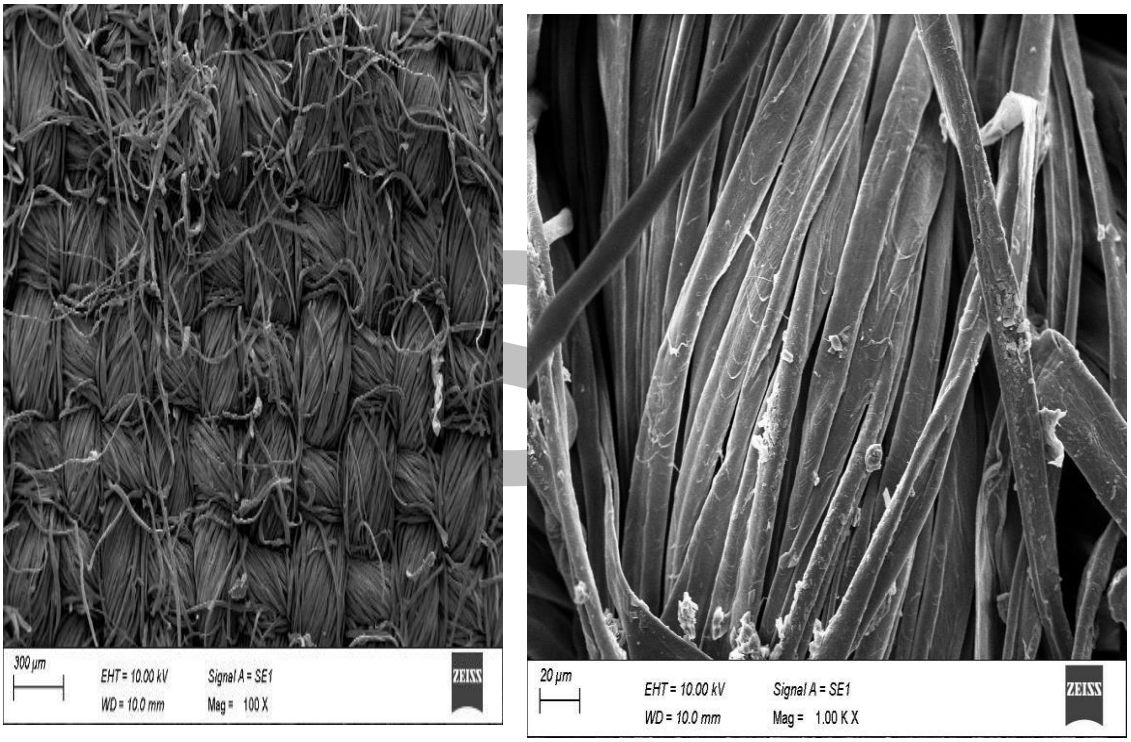


Fig 4.12 SEM Analysis

Scanning electron microscopy images of the antibacterial effect of the F3d fraction (200 μg/ml) against the MRSA N315 strain at different times. A: negative control (2 h without antibiotic); B: F3d (30 min); C: F3d (2 h); D: F3d (4 h). When the bacteria were incubated with the F3d fraction for 2 and 4 h, morphological alterations were observed. No morphological cellular alterations were observed with 30 min incubation.

4.7. Effect of Fluoropolymer Treatment on Blood Repellency

It is observed that the amount of synthetic blood penetrating the sample is reduced with the increase in fluoropolymer concentration. The spraying rate also improves with the increase in fluorocarbon concentration. It may be concluded that the result concentration of fluoropolymer is increased then the blood repellence also increased.

4.7.1. Spray Test:

Standard Observation rating

I. 100 (ISO-5) Sticking or wetting of upper surface
II. 90 (ISO-4) Slight random sticking or wetting of upper surface
III. 80(ISO-3) Wetting of upper surface of spray points
IV. 70(ISO-2) Partial wetting of whole of the upper surface
V. 50(ISO-1) Complete wetting of whole of upper surface

In the spray test woven and non-woven fabrics has been taken these fabrics are treated with fluoropolymers under six concentrations of 10 gpl,15 gpl, 20 gpl in that the blood repellency effect is 90 in (4% &5%) and above 90 in (6% &7%). The observation of 90 is slight random sticking (or) wetting of upper surface. Above 90 is sticking or wetting in upper surface.

4.7.2. Penetration Test:

- In the penetration test the untreated woven has been taken in that blood penetration takes place so its failure. The woven and non-woven fabrics treated with fluoropolymers under six concentrations. The result is pass in both the fabrics if the concentration increases the blood repellency effect is also increases.

4.7.3. Drop Test

In the drop test the untreated woven has the spreading effect of drops of blood that shows in fig. In the figure shows the treated woven fabrics with fluoropolymer the drops of blood do not spreads on the fabrics.

Fig 4.13 Drop Test

4.8. Blood Repellence Test

4.8.1. SILANE BLOOD REPELLENCE

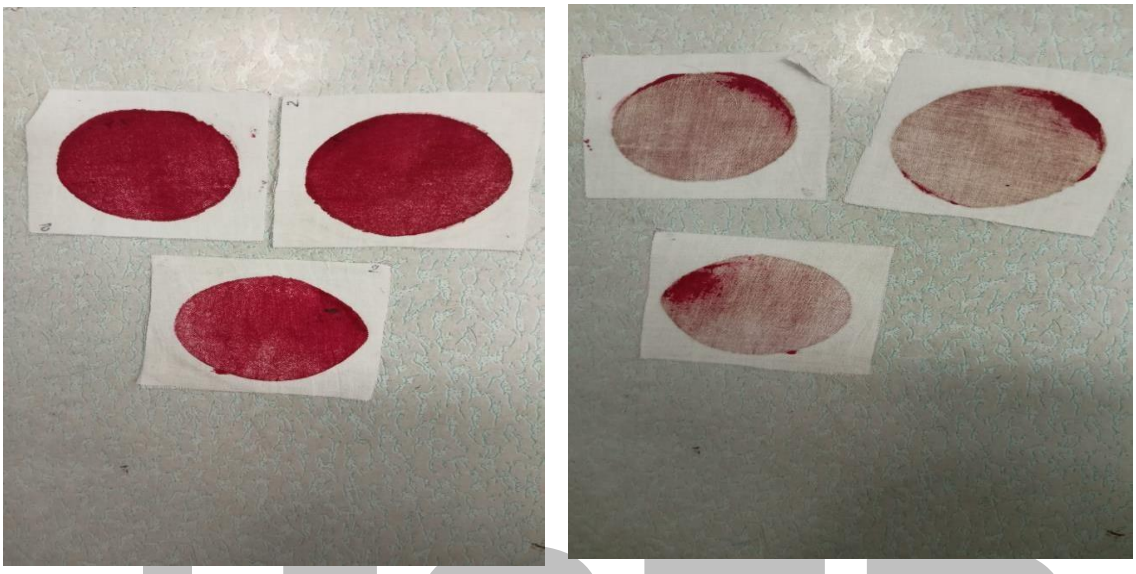


Fig 4.14 silane blood repellence

Table 4.8.1 silane blood repellence test

Pressure	Time (min)	Fabric 1	Fabric 2	Fabric 3
0	5	1/3rd partially penetrated	Minimum amount of blood only penetrated	Minimum amount of blood only penetrated
13.8	1	-	-	-
0	4	-	-	-
Thickness of the fabric	-	0.29	0.29	0.28
Weight/sq. Met(g)	-	48.24	48.72	48.63
Location of the specimen	-	Right	Middle	Left

4.8.2. CHITOSAN BLOOD REPELLENCE

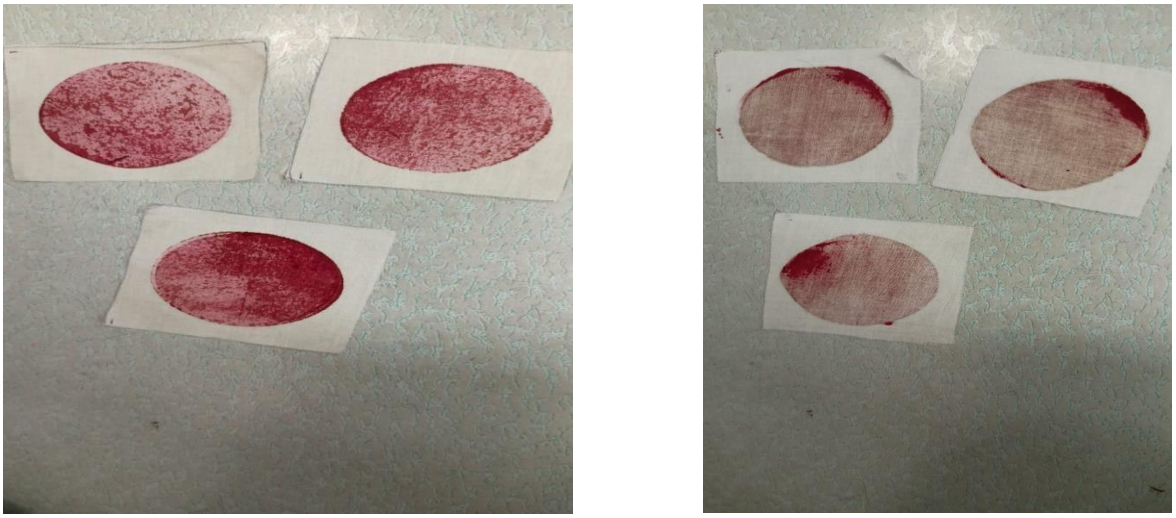


Fig 4.15 Chitosan blood repellence

Table 4.8.2 Chitosan blood repellence test

Pressure	Time (min)	Fabric 1	Fabric 2	Fabric 3
0	5	1/3rd partially penetrated	1/3rd partially penetrated	Minimum amount of blood only penetrated
13.8	1	-	-	-
0	4	-	-	-
Thickness of the fabric	-	0.29	0.29	0.30
Weight/sq. Met(g)	-	48.63	48.26	48.28
Location of the specimen	-	Right	Middle	Left

It is observed that the amount of synthetic blood penetrating the sample is reduced with the increase in fluoropolymer concentration. The spraying rate also improves with the increase in fluorocarbon concentration.

It may be concluded that the result concentration of fluoropolymer is increased then the blood repellence also increased.

4.8.3. Fabric properties for cotton woven fabric After treatment using silane

Fabric properties	Warp way	Weft way
Count	60s Ne	60s Ne
Inch	EPI- 96	PPI-96
End/Dent	2 ends/ dent	
GSM of the fabric	48.39g/m. sq.	48.39g/m. sq.
Tensile strength	Elongation = 1.6%	Elongation = 1.6%
Tearing strength	1280gms	1216gms
Stiffness	2.05 kg/sq.cm	2.125 kg/sq.cm
Crease recovery	96 degrees	96 degrees
Air permeability	302.5 cc/sec/sq.cm	300.5 cc/sec/sq. cm

4.8.4. Fabric properties for cotton woven fabric After treatment using chitosan

Fabric properties	Warp way	Weft way
Count	60s Ne	60s Ne
Inch	EPI- 96	PPI-96
End/Dent	2 ends/ dent	
GSM of the fabric	48.39g/m. sq.	48.39g/m. sq.
Tensile strength	Elongation = 1.4%	Elongation = 1.4%
Tearing strength	1440gms	1536gms
Stiffness	2.1625 kg/sq.cm	2.225 kg/sq.cm
Crease recovery	95 degrees	94 degrees
Air permeability	320.6 cc/sec/sq.	310.5cc/sec/sq. cm

CHAPTER 5

CONCLUSION

In this project work, when fluoropolymer concentration increases the blood repellence increases and same time antimicrobial activity will be increased. Antibacterial and blood repellent cotton woven fabric were prepared by directly incorporating of silane, chitosan and fluoropolymer on the fabrics. An interesting observation is the clear zone of inhibition and excellent bacteria growth. 2% of silane and 5% of chitosan is enough for producing an excellent protective both woven fabrics. Then the 4% of fluoropolymer give optimum result when increases the concentration of fluoropolymer and it is given excellent blood repellency.

The antimicrobial efficiency of the silane, chitosan based treated fabric reduces with the increase in both blood and antimicrobial finish increase.

Simultaneously antimicrobial and blood repellent finish protect from microbes, and blood repellent finish gives standard spray ratings.

To optimize process concentration of antimicrobial and blood repellent finish during the process.

To Protection from Micro-organism textile materials and clothing are known to be susceptible to microbial attack, to make product blood repellent and antimicrobial finished gown.

In order to protect patients, hospital personnel and surgical team for cross infections through textile materials through infectious blood and other body fluids, it is extremely important to produce textile materials against cross infection by giving blood repellent and antimicrobial finish. Various classes of chemicals have been used to impart blood repellence to the fabrics. Out of them fluorochemical polymers are most prominently used as blood repellent finish.

6. SCOPE FOR FUTURE WORK

- Functional finishes to surgical fabrics for blood repellence and anti-microbial action boost the protection level for doctors in a hospital, Sterilized gowns do not offer a permanent solution in hospitals.

- The sterilization process must be carried out repeatedly without which microorganisms may harm doctors and paramedics.

- Functional finishes, applied to cover the inherent weaknesses of cotton and polyester, may be an alternative to overcome this problem. As the comfort level of surgical gowns depends on the fabrics, the fabric variety assumes key importance.

- Textile products offer a conducive environment for bacterial growth, which may cause health problems and inconvenience due to odour and fabric disorientation. As microbes often attack the additives applied to the textiles, it leads to discoloration and loss of its functional properties, like elasticity.

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