

Medical textiles : Finishes for personal protective clothing

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ABSTRACT

In the last few months, the transmission of pandemic infectious pathogens from a patient to healthcare personnel has been increasing and this has led to increase in demand of Personal Protective Equipment/Clothing (PPE). This is crucial, because using PPE is the only way that will protect the health personnel's like doctors, nurses, patients etc. from being infected. Understanding the gravity of the situation Sarex has developed a range of anti-microbial agents and Fluorocarbons which can be various textile substrates that are used in manufacturing of Surgical gowns, face mask, gloves etc. This article highlights the results of antimicrobial and repellent finishes on cotton, polyester and polyamide woven fabric which are used for various medical applications. For anti-microbial finish a Quaternary Silane compound i.e. Saraguard-5700 and a cationic polymeric compound which is Saraguard-FL was used. and for repellent finish Careguard-66 (NEW) and Careguard-LTH which are based on C6 fluorocarbons were used, while the treated fabric showed excellent resistance to Gram positive and Gram Negative bacteria's and also showed alcohol and blood repellency. These finishes will also work on nonwoven fabrics.

Keywords- Alcohol repellency, blood repellency, anti-bacterial activity, Medical gowns, face mask.

Introduction

HOSPITAL acquired infections (HAI) are a global crisis. Particularly in a hospital environment, there is increasing concern over exposure to various microorganisms that can be easily transmitted from environment to man causing different diseases. In hospital environment there are very many variables that affect the occurrence of infection of humans, no matter that hospital protocol is executed according to protocol. Therefore, there is still necessary to create innovative textile products which can act as effective barrier to reduce risk of infection which is very dangerous for people with impaired immune systems.

Medical textiles is also known as Healthcare Textiles. It is one of the most rapidly expanding sectors in the technical textile market. Recently, with the global improvement in the level of living, consumers are now showing the trend to seek healthcare or health protective products. There is an increase in the people's interest for protection against epidemic diseases like human coronavirus, H1N1, SARS etc has been noted. It has been found that infectious pathogens can be transferred to healthcare personnel also due to their over exposure to the patients, through their respiratory organs and dermis via air and liquids (water, blood etc.), and through mucus membranes (eyes etc) also the transfer of infection can take place, due to travelling in overcrowded trains, buses etc.

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Thus, respiratory, dermal and mucus membrane protection are essential for healthcare personnel.

Around the world, there are more than 53 million people working in the healthcare field. Personal protective equipment – known as 'PPE' is a critical component in the hierarchy to protect these health care workers from infectious hazards. PPE includes gowns, respirators, face masks, gloves, eye protection, face shields, and head and shoe coverings.

Face mask, surgical gowns are identified as the most used piece of PPE, followed by gloves, in the healthcare industry. Surgical gowns address a dual function of preventing transfer of microorganism and body fluids from operating staff to the patient and also from patient to operating staff. Disposable surgical gowns offer several advantages over reusable's, but they are expensive and pose a risk of contamination outside of the hospital setting. Reusable gowns are generally made from woven fabrics and often contain cotton, polyester or a blend of these two fibres. The reusable surgical gowns are laundered and sterilized after every use in order to remove stains and kill bacteria. The greater advantage with reusable surgical gowns include less solid waste from limited disposal and more comfort to the wearer because of their better water vapor transmission. However they lose durability and barrier protection after repeated washing.

Nowadays, nonwoven fabrics are the most commonly used textiles for surgical gowns, patient drapes, laboratory coats, coveralls, and other kinds of protective clothing.



Polyethylene terephthalate is a preferred textile fiber in many durable applications of nonwoven for its ease of sterilization and compatibility with other fibers. Although Polyester has excellent mechanical strength and good stability but end use capacity is limited due to difficult to do functional finishing because of lack of polar groups on the surface and poor wet ability

Need for functional finishing on PPE-Clothing

The textile materials used in PPE are frequently subjected to the human blood which consist of various pathogens and causes cross infection. Blood and body fluids are considered as the carriers of the several microorganisms and can be transferred though barrier material like surgical fabrics, drapes, bed linens by wicking of fluids, pressure or leaning on flooded area. In order to protect the patients, hospital personnel and surgical team from such cross infection, it is a primary requirement that the fabric for these applications should be waterproof and breathable (water vapor permeable) in order to provide better protection and comfort for healthcare personnel. Along with these functionality requirements, it is also necessary that the fabric used should not promote the growth of any trapped infectious microorganisms. The above finishes will also help to protect the fabrics aesthetic, physical and biological properties.

a.) Anti-bacterial finish on PPE-clothing

To provide such functionality to fabrics, Sarex has developed highly effective and economical antimicrobial agents like Saraguard-5700 and Saraguard-FL which are suitable for all substrates and are highly durable and effective against pathogens, viruses and bacteria's.

Saraguard-5700 is a Quaternary Silane, methanol free, non-leaching antimicrobial agent

Saraguard-FL is a non-leaching antimicrobial agent

Both the antimicrobial agents can be used for finishing of all types of textile substrate and can be applied by padding, exhaust, soaking and spraying methods. They are effective against broad spectrum of microbes, pathogens and viruses. It passes AATCC 100, JIS L 1902 test methods.

Saraguard-FL and Saraguard-5700 provides a barrier shield and ensures protection of the treated textile, passively protecting the user. They also impart freshness, comfort and ensure material protection. The concept behind this shielding

technology is to reduce and prevent the colonization and multiplication of bacteria, pathogens and viruses.

b.) Fluorocarbon finish on PPE-clothing

Understanding the above requirement of manufacturing environmentally friendly fluorocarbons which are suitable for application in medical textiles, and keeping in mind the requirements of PPE clothing, Sarex has developed two fluorocarbons which can provide effective protection against blood, alcohol and body fluids.

Careguard-66(NEW) is a new generation water and oil repellent fluorocarbon based on C6 Chemistry. It is a dispersion of fluoropolymer which imparts durable alcohol and blood repellency on polyester, cotton, and their blends.

Careguard-LTH is also a C6 based, non ionic, oil and water repellent which also gives alcohol and blood repellency. Careguard-LTH is more suitable for non-woven fabrics made of synthetic fibres.

Sarex fluorocarbons are Bluesign certified and meets the stringiest ecological parameters which are required for application on medical textiles.

Materials & Methods

Application of anti-microbial agents

A 100% Cotton, Polyester and polyamide fabric were treated with Saraguard-FL and Saraguard-5700 at required concentrations, with 65% pick-up. The pH of 5.5 was maintained and the fabrics were dried at 150oC for 2 min.

Application of Ffluorocarbons

A 100% Cotton, Polyester and Polyamide fabric were treated with Careguard-66 (NEW) and Careguard-LTH at required concentrations, with 65% pick-up. The pH of the application bath was maintained 5.5 using 0.5gpl Acetic Acid, 5gpl IPA was also added to increase the pick-up. Fabric was finished with padding application and dried at 130oC for 2 min and cured at 160 oC for cotton and 170oC for 100% Polyester and Polyamide fabric.

Test Method for testing Blood and Alcohol Repellency

The blood repellency of the sample was assessed by using Impact Penetration Test and Spray test, AATCC 22. The synthetic blood was prepared by using distilled water, a

surfactant (Acrysol G 110, Rohm and Hass Co) and red dye (direct red 081) according to ASTM F 23.40.01 for testing the resistance of clothing to synthetic blood. Alcohol resistance was tested as per AATCC 193.

Impact penetration test

According to AATCC 42-2000A of impact penetration test, a volume of water/synthetic blood was allowed to spray against a taut surface of the test specimen backed by a weighted blotter. The blotter was then reweighed to determine water penetration and the specimen is classified accordingly. The specimen 178 x 330 and the blotting paper were conditioned in an atmosphere of 65+2% RH and 21°C temperature for at least 4 hours before testing.

Antimicrobial testing

Evaluation of the finished fabrics for antimicrobial activity was performed by AATCC-100 test method against Staphylococcus aureus, Escherichia coli and Klebsiella pneumoniae also they were subjected to 25 home launderings by AATCC 135A test method.

Results and discussion

It is evident from Table 1, 2 and 3 that treated fabrics showed excellent antimicrobial activity, while on the unfinished fabric there was heavy growth of bacteria. This is because fabrics finished with Saraguard-FL and Saraguard-5700 will bind with microorganisms to their cell membrane and disrupt the lipo-polysaccharide structure resulting in the breakdown of

Table 2: Antimicrobial activity on Polyester fabric

Recipe	Antimicrobial activity					
	(Initial)			After 25 HL		
	S. aureus (%)	E.coli (%)	K. pneumoniae (%)	S. aureus (%)	E.coli (%)	K. pneumoniae (%)
Unfinished	0.0	0.0	0.0	0.0	0.0	0.0
40g/l Saraguard-5700	99.95	99.85	99.23	99.90	98.80	99.11
50g/l Saraguard FL	100	100	100	99.93	98.34	95.50

Table 3: Antimicrobial activity on Polyamide fabric

Recipe	Antimicrobial activity					
	(Initial)			After 25 HL		
	S. aureus (%)	E.coli (%)	K. pneumoniae (%)	S. aureus (%)	E.coli (%)	K. pneumoniae (%)
Unfinished	0.0	0.0	0.0	0.0	0.0	0.0
40g/l Saraguard-5700	99.85	99.20	99.72	99.00	99.02	99.37
50g/l Saraguard FL	100	100	100	100	99.96	99.84

Table 4: Blood and Alcohol repellency on various substrates

Finishing agent	Blood repellency test			Alcohol repellency test			Spray Test		
	100% Cotton	100% Polyester	100% Polyamide	100% Cotton	100% Polyester	100% Polyamide	100% Cotton	100% Polyester	100% Polyamide
	Unfinished	Fail	Fail	Fail	Fail	Fail	Fail	0	0
50g/l Careguard-66 New	Pass	Pass	Pass	Pass	Pass	Pass	100	100	100
60g/l Careguard-LTH	Pass	Pass	Pass	Pass	Pass	Pass	90	100	100

Table 1: Antimicrobial activity on 100% Cotton fabric

Recipe	Antimicrobial activity					
	(Initial)			After 25 HL		
	S. aureus (%)	E.coli (%)	K. pneumoniae (%)	S. aureus (%)	E.coli (%)	K. pneumoniae (%)
Unfinished	0.0	0.0	0.0	0.0	0.0	0.0
40g/l Saraguard-5700	99.93	99.75	99.21	99.75	98.19	97.38
50g/l Saraguard-FL	100	100	93.11	90.08	81.53	93.54

the cell, thus providing antimicrobial effect. Also because of the binding capacity of the antimicrobial agents, the fabrics will show durability against home laundering. Also in addition to the below results, Saraguard-5700 will also provide protection against wide range of Gram positive and Gram negative bacteria, fungi, algae, viruses.

Table 4 shows the results of Blood repellency, Alcohol repellency and Spray test on 100% Cotton, 100% Polyester and 100% Polyamide fabric. The treated fabric shows excellent repellency for all the above three parameters and passes the test method.

Conclusion

Healthcare-associated infections (HAIs) have been part of health care delivery since antiquity and are major causes of morbidity and mortality. In the current fight against Corona virus we believe that PPE will be at forefront in protecting our healthcare personnel's. The PPE-clothing like gowns, face mask, gloves etc. treated with Sarex fluorocarbons and anti-microbial is believed to protect the wearer from getting

infected. The bacterial and blood barrier properties of treated and untreated fabrics have been assessed and it strongly implies for the development of bacterial and blood barrier materials for PPE clothing. Also the fabrics which are treated with both, the fluorocarbon and anti-microbial will meet the requirement of ISO 16603 and ISO 16604 Class 3 which are also required for medical application, we will be discussing more on this test method in the forthcoming articles. ■