

Antimicrobial and antiviral agent for healthcare and hygiene textiles

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Introduction

HEALTH care-associated infection (HAI) is an infection that is acquired in a hospital or any health care facility, including hospitals, ambulatory surgical centres, nursing home, rehabilitation facility, outpatient clinic, diagnostic laboratory or other clinical settings. Healthcare associated infections continue to trouble the healthcare industry. Unfortunately for hospitals, they are a great breeding ground for infections. *Clostridium difficile*, *Staphylococcus aureus*, *Escherichia coli*, fungi, viruses, or other, less common pathogens are responsible for HAIs. These unanticipated infections develop during the course of health care treatment which may results in significant patient illnesses and deaths. The infection can originate from the outside environment, another infected patient, staff that may be infected, or in some cases, the source of the infection cannot be determined.

Healthcare personnel comes in contact with patients infected with pandemic diseases like SARS (Severe Acute Respiratory Syndrome), AIDS (Acquired Immune Deficiency Syndrome), avian influenza (bird flu), H1N1 (swine flu), Corona virus and multidrug-resistant tuberculosis. It is necessary for healthcare personnel to wear Personal Protective Equipment (PPE) to limit morbidity and mortality of patients in their care, as well as themselves, their family members, and other members of the community to prevent a pandemic's larger societal progression. It has been found that infectious pathogens can be transferred to healthcare personnel through their respiratory organs, body fluids and through mucus membranes. Personal protective equipment (PPE) refers to physical barriers that are used alone or in combination, to protect mucous membranes, airways, skin and clothing from contact with infectious agents. Surgical gowns, gloves, masks, aprons, Boots or shoe covers, Cap or hair cover and related items used in operating rooms along with blankets, sheets, pillow covers, furniture covers and other products throughout the hospital and health care facilities also fall into this category. Commonly used PPE

include medical masks, respirators, gloves, gowns and eye protectors. Some other types of PPE, such as face shields, are also occasionally used by healthcare workers. Among these, respiratory (medical masks, respirators etc.) and dermal (gloves, gowns etc.) protective equipment are primarily textile-based and used regularly by healthcare workers.

Nearly all textile materials that are being utilized in the hospitals viz., Healthcare workers' (HCWs) uniforms and PPE gets contaminated with bacteria and are conducive to cross infection or transmission of diseases originated by bacteria, fungi, viruses, pathogens. The existence and progression of microorganisms can be a source of health problems, odours and of course the weakening of the fabrics. Recently the outbreak of coronavirus throughout the globe has produced large stress for protecting the personals with functional clothing and materials. Antimicrobial property has thus become an important function to be incorporated in the uniforms and PPE as a means of reducing this contamination. Sarex is therefore introducing a product Saraguard-5700 which is highly effective, durable, non leaching antimicrobial and antiviral agent suitable for all substrates and effective against pathogens, viruses and bacteria's.

Mechanism of action

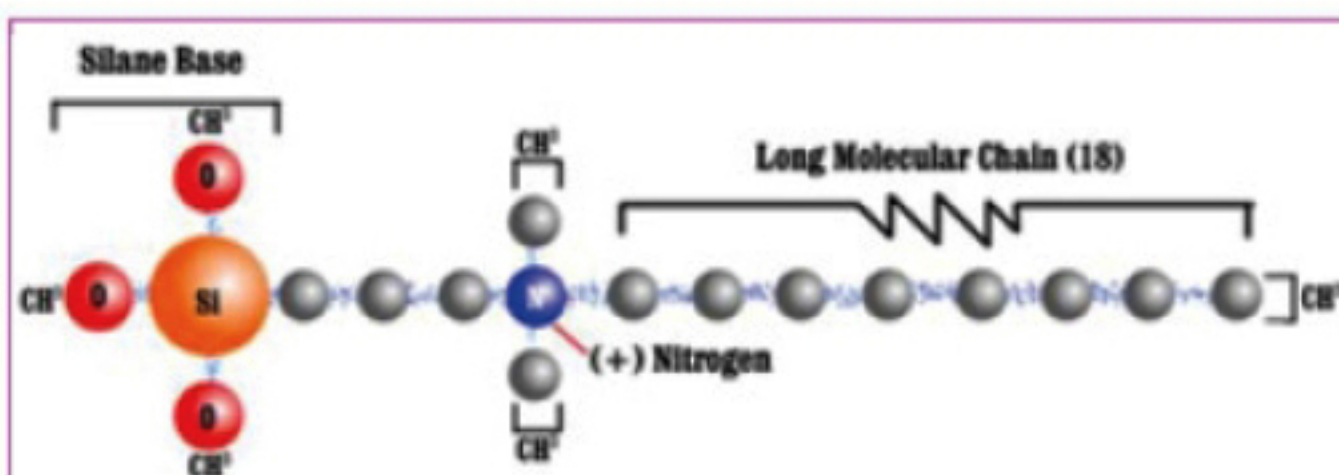
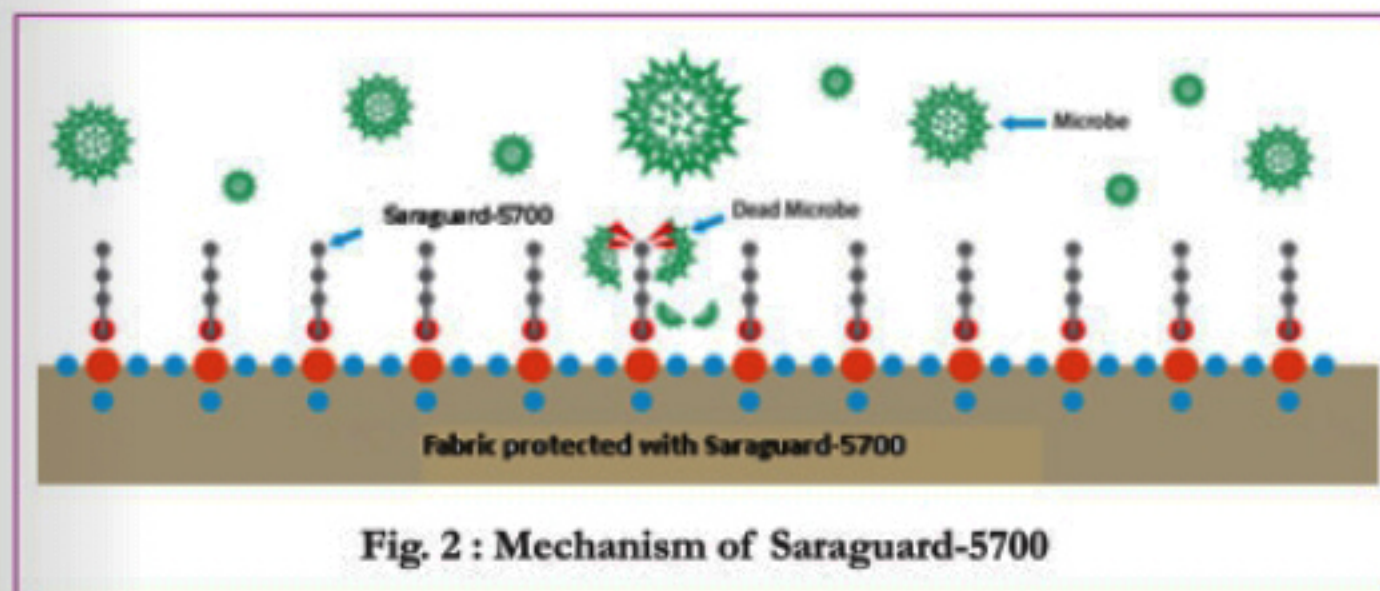


Fig. 1: Silane Quaternary Ammonium Compound in Saraguard-5700

The silanol (hydrolyzed silane) of Saraguard-5700 covalently bonds to fabric surfaces. This bonding becomes more durable by the silanol functionality, which homo-

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polymerizes i.e. forms chemical bonds with each other. After the molecule has homo-polymerized, it becomes an integral and permanent part of the fabric thereby imparting durable antimicrobial activity to the finished fabric.

When a microbe contacts the positively charged organo-functional silane treated fabric surface, the cell membrane is physically ruptured by a sword like action as shown in Fig. 1 and then electrocuted by a positively charged nitrogen molecule as shown in Fig. 2. Antimicrobial activity will be effective as long as the surface of the treated substrate remains intact. Since it is not consumed and does not leach-out, the antimicrobial activity is not depleted and continues to control microbial growth.

Unique key features

- Methanol free, Silane based, Non-leaching Anti-microbial agent.
- Effective against broad spectrum of microbes, pathogens, bacteria, viruses, algae, mold, yeast.
- It is highly suitable in medical textiles, healthcare and hygiene textiles and Personal protective equipments (PPE). PPE refers to protective clothing, helmets, gloves, face shields, goggles, facemasks and/or respirators or other equipment designed to protect the wearer from injury or the spread of infection or illness.
- Applicable on all types of textile substrates including woven, non-woven and composites. It is also applicable on non-textile substrates viz., glass, table top, flooring, cartons etc.
- Can be applied by padding, exhaust, soaking and spraying methods.
- Durable to multiple home launderings.

Effective against following microbes': Bacteria, Fungi, Yeast, Mold, Algae, Viruses

Bacteria		Fungi	Yeast	Algae	Mold	Viruses
Gram positive	Gram negative					
<ul style="list-style-type: none"> ▪ <i>Staphylococcus aureus</i> ▪ <i>Bacillus subtilis</i> ▪ <i>Streptococcus faecalis</i> 	<ul style="list-style-type: none"> ▪ <i>Escherichia coli</i> ▪ <i>Klebsiella pneumonia</i> ▪ <i>Samonella typhosa</i> ▪ <i>Mycobacterium tuberculosis</i> 	<ul style="list-style-type: none"> ▪ <i>Aspergillus niger</i> ▪ <i>Aspergillus terreus</i> ▪ <i>Aspergillus flares</i> ▪ <i>Chaetonium globosum</i> 	<ul style="list-style-type: none"> ▪ <i>Saccharomyces cerevisiae</i> ▪ <i>Candida albicans</i> 	<ul style="list-style-type: none"> ▪ <i>Cyanophyta oscillatoria</i> ▪ <i>Cyanophyta anabaena</i> ▪ <i>Chlorophyta selenastrum gracile</i> 	<ul style="list-style-type: none"> ▪ <i>Black mold</i> 	<ul style="list-style-type: none"> ▪ <i>Influenza A2</i> ▪ <i>Influenza B</i> ▪ <i>Adenovirus</i>

End application includes:

- ✓ Surgeon Gowns
- ✓ Caps
- ✓ Faces Mask
- ✓ Gloves
- ✓ Bandages
- ✓ Bed Linens
- ✓ Patient Drapes
- ✓ Cover Cloths
- ✓ Ambulance Blankets
- ✓ Stretchers
- ✓ Filter Materials
- ✓ Diapers
- ✓ Bedding
- ✓ Blankets
- ✓ Pillow Cases
- ✓ Hospital Uniforms
- ✓ Incontinence Diapers
- ✓ Wipes
- ✓ Surgical Hosiery etc.

Application method

100% Cotton, Polyester and Polyamide fabrics were treated with 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.

Evaluation

The finished fabrics were taken further to study their antimicrobial activity. Following test methods were followed to study the efficacy of product.

1. Assessment of antibacterial finishes on textile materials: AATCC 100
2. Assessment of Antifungal activity on textile materials : AATCC 30
3. Durability Study: AATCC 135
4. Assessment of antiviral treatment using AATCC 100-2012 (Modified for viruses)

Antiviral property of 100% Polyester fabric treated with 40gpl Saraguard-5700 was also carried out from outside laboratory (Biotech testing services). The antiviral property was determined by AATCC Test Method 100-2012 (modified) using MS2 Bacteriophage (MS2), an RNA virus of the family Leviviridae. Escherichia coli 15597 are the hosts for

bacteriophages. Due to its environmental resistance, MS2 bacteriophages are used as a surrogate virus particularly in place of Picocornaviruses such as Poliovirus and human Norovirus in water quality and antimicrobial studies.

Results & discussions

Representation of Antimicrobial Activity

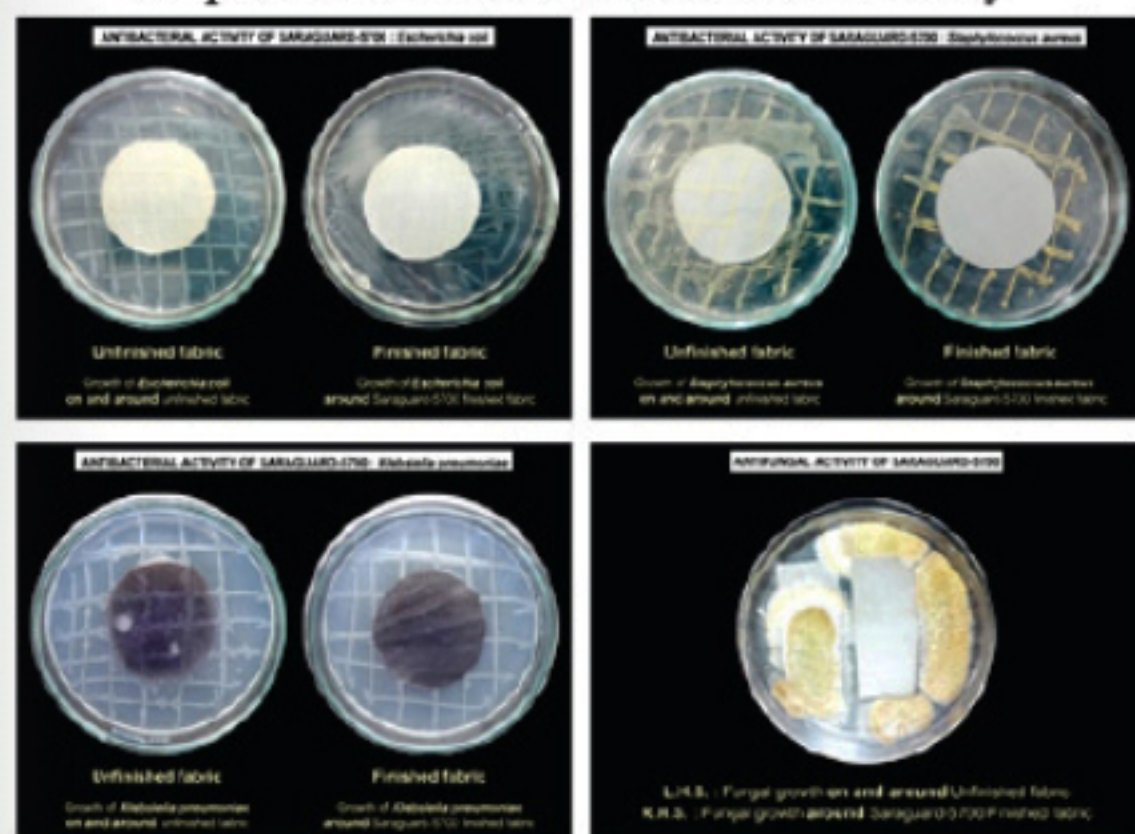


Table 1 : Antibacterial Activity on various fabrics – 25 HL 40 gpl

40 gpl Saraguard-5700	Reduction in Bacteria (%)					
	100% Cotton fabric		100% Polyester fabric		100% Polyamide fabric	
	Initial	25 HL	Initial	25 HL	Initial	25 HL
<i>Staphylococcus aureus</i>	99.93	99.75	99.95	99.90	99.85	99.00
<i>Klebsiella pneumoniae</i>	99.21	97.38	99.23	99.11	99.72	99.37
<i>Escherichia coli</i>	99.75	98.19	99.85	98.80	99.20	99.02
<i>Methicillin-resistant Staphylococcus aureus (MRSA)</i>	99.96	90.13	99.99	87.33	98.19	89.33
HL : Home Laundering						

From the photograph of the antimicrobial activity and the results tabulated in Table 1, Saraguard-5700 proved its efficacy as an effective antimicrobial agent. Also the silanol (hydrolyzed silane) of Saraguard-5700 covalently bonds to the fabric

Table 2 : Antiviral property on 100% Polyester fabric - MS2 Bacteriophage

Test Organism	Samples	% Reduction of Virus	
		At 2 hours	At 24 hours
MS2 Bacteriophage	40 g/l Saraguard-5700	>99.98	>99.98
	Untreated	0.00	0.00

surfaces and also homo-polymerizes i.e. forms chemical bonds with each other thereby imparting durable antimicrobial activity to the finished fabric.

The antiviral property of Saraguard-5700 is also justified from our recent study of Saraguard-5700 as an Antiviral agent, Table 2. Saraguard-5700 shows > 99% reduction of virus (MS2 Bacteriophage) at 2 hr and 24 hrs. Further elaborative study is being carried out to evaluate the efficacy of Saraguard-5700 on various fabrics which will be reported in future articles. Also other researchers have reported that Silane Quaternary Ammonium Compound like Saraguard-5700 can also work against broad spectrum of viruses like Adenovirus Type II & IV, Influenza A2, Influenza B, Reovirus Type I, etc. 1,2,3

References

1. I-Fu Tsao, Henry Wang, "Removal and Inactivation of Viruses by a Surface Bonded Quaternary Ammonium Chloride", ACS Symp.Ser.1990, Volume Date 1988, 419, pp. 250--67. Reaction with Lipophilic Viruses.
2. M. Klein, A. DeForest, "Principles of Viral Inactivation", Disinfection, Sterilization and Preservation. 3rd Ed., S. Block, Ed., (Lea & Febiger, Philadelphia, PA) 1983, pp.422-434.
3. M. Abbaszadegan, et. al., "Evaluation of Proprietary Treated Zeolite in Point of Use Devices for Removal of Microorganisms", NSF Water Quality Center, Arizona State University, Tempe, AZ 85257; 12/03. W. Peterson & R. Berman, U.S. Pat. Pending, 60/472,429 (7/2003).