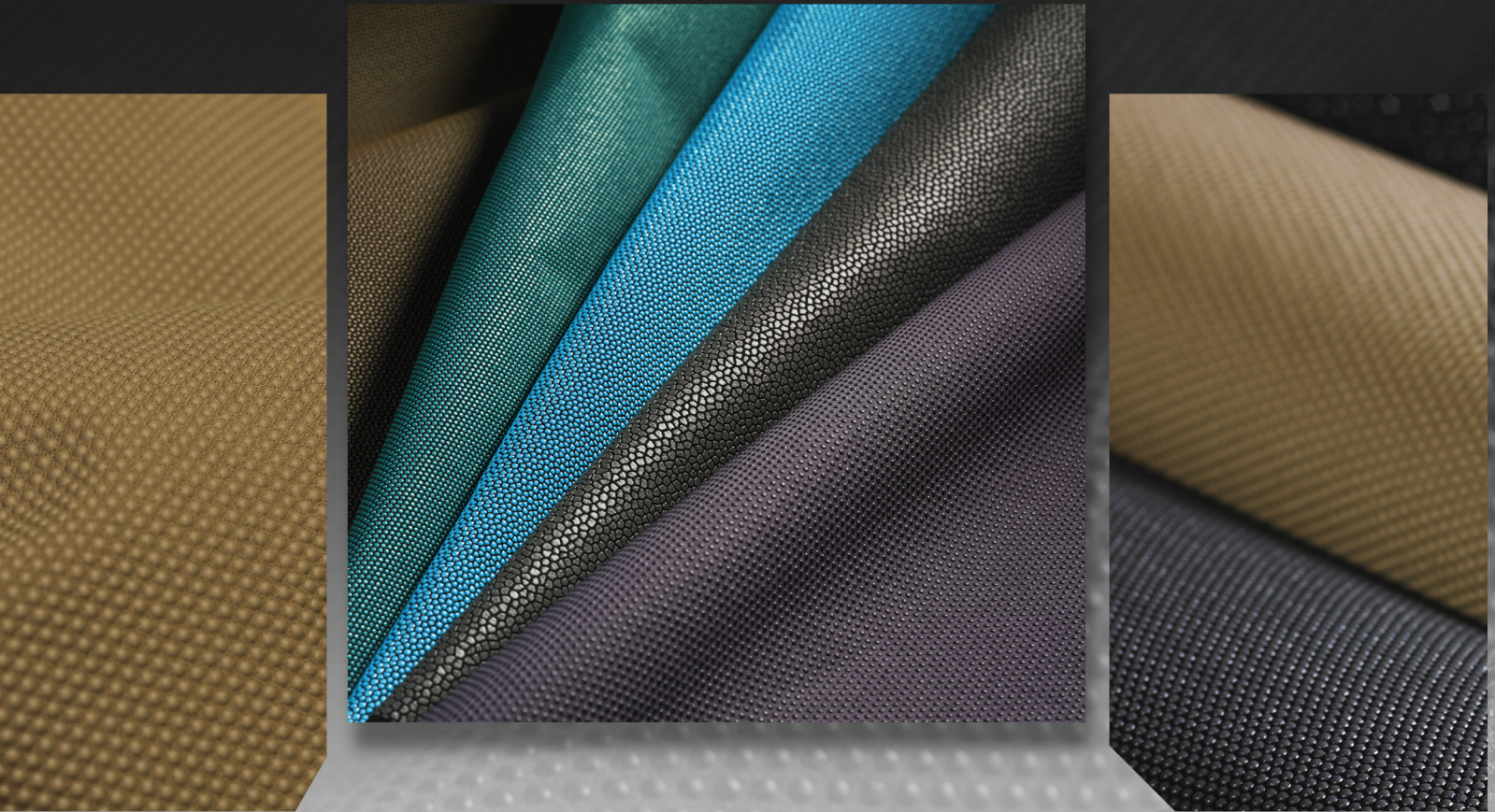


AmFr™

Antimicrobial, Flame Resistant SuperFabric®



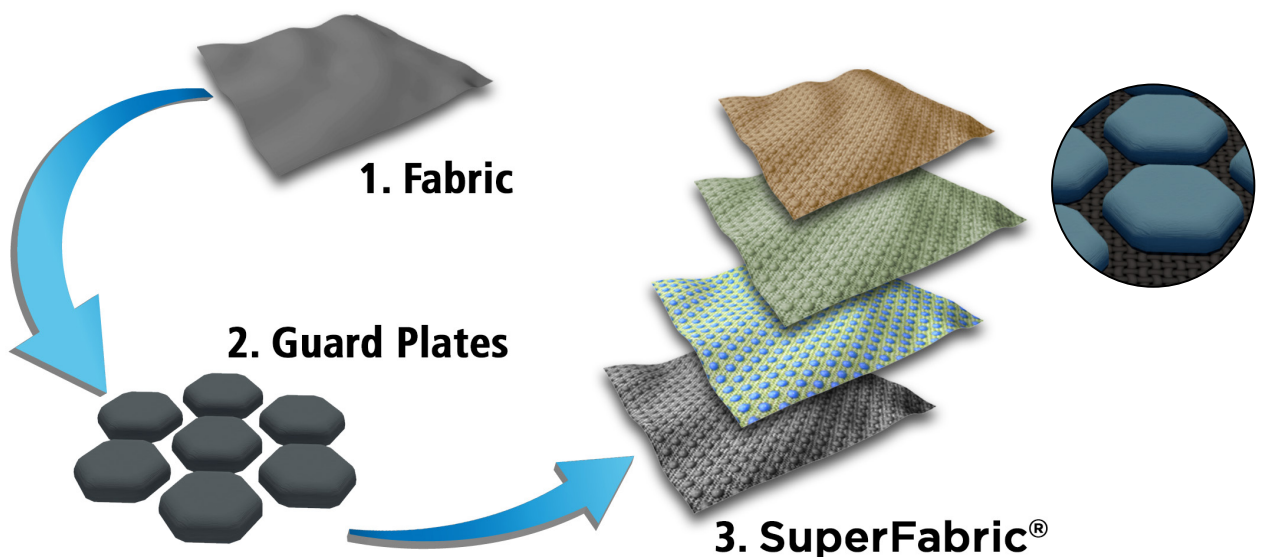
 SuperFabric®

Introduction to SuperFabric®

SuperFabric® technology starts with a fabric and overlays it with tiny, hard plates (“guard plates”) in a specific arrangement. The gaps between guard plates allow complete flexibility. The geometry, thickness, and size of the guard plates, as well as the fabric, can be varied depending on the desired attributes. SuperFabric® materials are designed to deliver a range of performance features such as abrasion resistance, stain resistance, quick drying, breathability and can be customized for many applications.



Step 1, (below) starts with a common fabric such as polyester, a stretch fabric, or even a fire/flame resistant fabric. Step 2, takes an array of small guard plates and embeds them into the fabric to create a SuperFabric® material (Step 3). These plates can have many different colors, patterns, thicknesses, and other attributes that creates a range of tough, durable, fabrics.



What is **AmFr™**?

AmFr™ is part of our **SuperFabric®** line of products. In addition to the standard features of SuperFabric® materials, **AmFr™** adds antimicrobial and fire-resistant properties.

Key Features of **AmFr™**

- 1 ▶ **Antimicrobial**
- 2 ▶ **Fire/Flame Resistant**
- 3 ▶ **Abrasion Resistant**
- 4 ▶ **Stain Resistant**
- 5 ▶ **Environmentally Friendly**

1) **ANTIMICROBIAL**

- **Kills viruses, bacteria, and other microbes on its surface.**
- **Will not wash out or leach out into the environment.**
- **Uses IONPURE, instead of silver or copper nanoparticles, as a highly effective antimicrobial.**
- **Is encapsulated into the guard plates for durable, long lasting effectiveness.**
- **TUV-SUD lab tested as a highly effective antimicrobial fabric.**

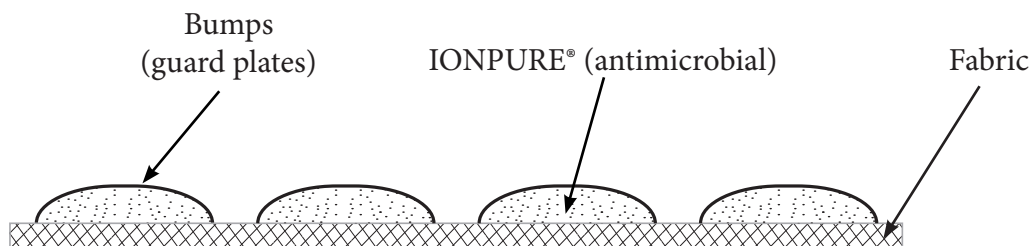
Problems with conventional antimicrobial fabric

Table 1:			
Units: mg/L: milligrams/liter nm: nanometers			
Silver Particles in Water (mg/L)	Silver Particle Size (nm)	Mass of Silver Ions	Fraction of Wasted Silver
30	5	3.2361	0.89213
30	10	0.3236	0.98921
30	20	0.1079	0.99640
(Source: Reviewed article 'Environmental Science: Nano. The Royal Society of Chemistry 2017)			

Table 1 shows if the size of silver nanoparticles is 5 nanometers, then 89.213% of silver particles added to water is wasted. If the size of silver particles is 10 nanometers, 98.9213% of the silver added to water is wasted and at 20 nanometers, 99.640% is wasted. This means that only a very small fraction of silver nanoparticles added to water is used to kills microbes and the rest is wasted. This is a serious problem with conventional antimicrobial fabrics. Silver is a precious metal that is used for many technical markets such as electronics and needs to be conserved when possible.

AmFr™ delivers antimicrobial functionality in a much better way compared to conventional antimicrobial fabrics.

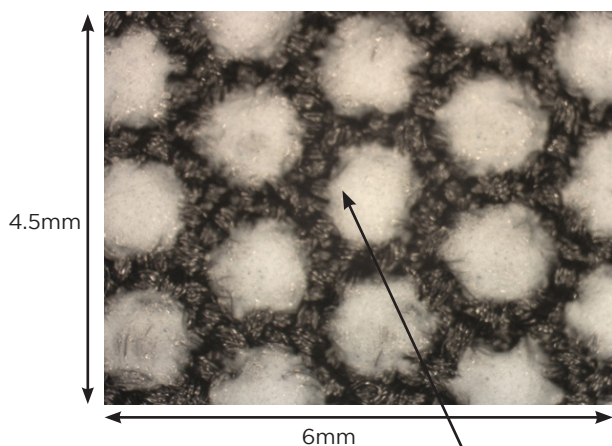
AmFr™ uses IONPURE particles, a very efficient generator of silver ions (Ag^+), which are uniformly embedded in the body of the guard plates. The agent releases silver ion atoms through their interaction with small concentrations of water molecules present in the material of the guard plates. The released silver ion atoms and their counterpart negative ions diffuse through thermal motion to the surface of the guard plates and kill viruses and bacteria they encounter. Gaps between two neighboring guard plates is less than 1 mm. Thus, silver ion atoms released from guard plates travel a shorter distance to encounter viruses and other microbes. Besides, **AmFr™** does not contain silver as a metal. **AmFr™** generates silver ion atoms very efficiently without wasting a huge amount of silver metals. See **Appendix A** for more details of antimicrobial functionality of **AmFr™**.



The difference between AmFr™ and traditional yarn based antimicrobial fabrics

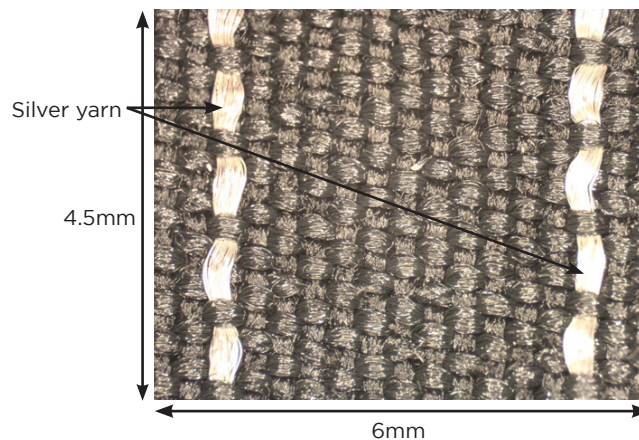
Conventional antimicrobial fabrics often times use silver yarns that are sparsely woven into the fabric. The average gap (distance) between two neighboring silver yarns is about 4 mm. Therefore silver ions released from silver yarn must travel, through thermal motions, about 2 mm in average, to kill a bacterium that is sitting at the middle of a gap between two neighboring silver yarns. The distance of 2mm is a very long distance for extremely small silver ion atoms. Also, one cannot interweave silver yarns more densely, since silver is expensive and the fabric becomes stiff.

Micrograph of an antimicrobial AmFr™ at 20X magnification

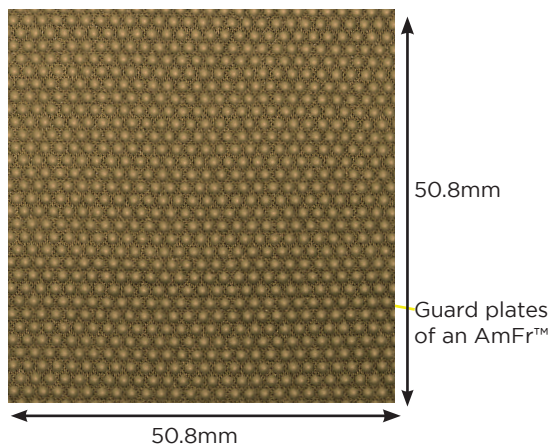


A guard plate of an AmFr™ that contains IONPURE

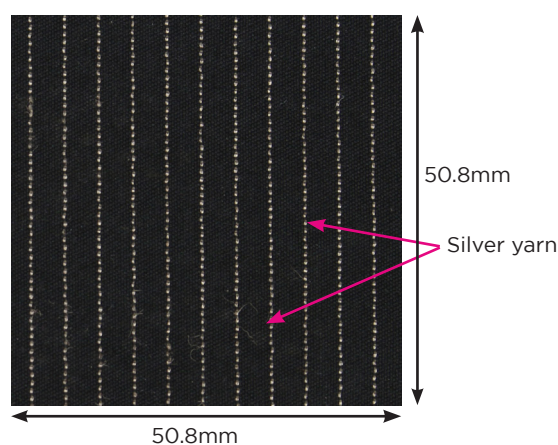
Micrograph of a typical silver-yarn based antimicrobial fabric at 20X magnification



Real scale photo of an antimicrobial AmFr™



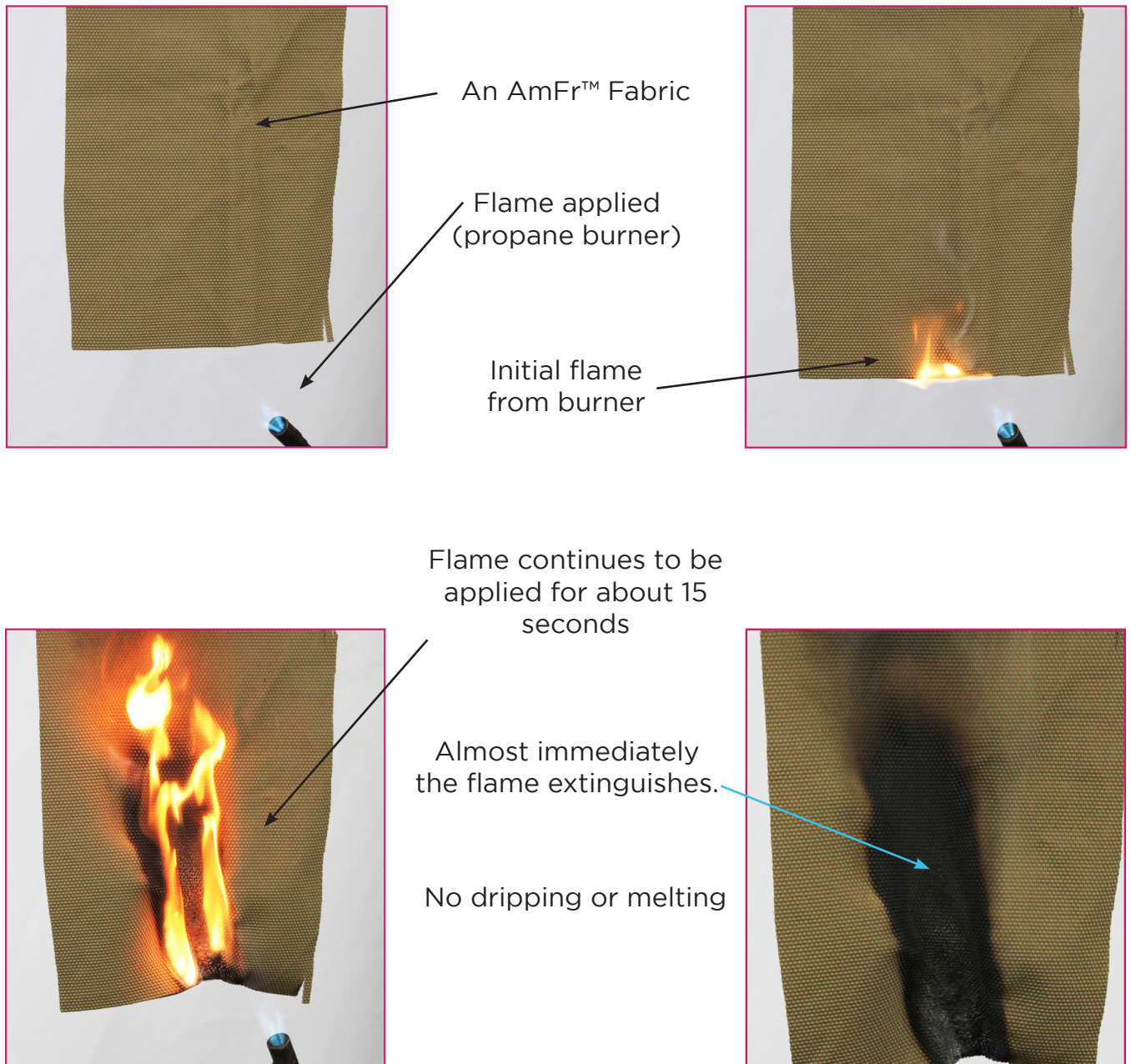
Real scale photo of a typical silver-yarn based antimicrobial fabric



2) FIRE/FLAME RESISTANT

AmFr™ fabrics are highly flame/fire resistant. The guard plates are specially formulated against fire/flame, and are coupled with a strong fire resistant fabric to create a highly durable material.

Here an **AmFr™** sample undergoes an intense flame test with a propane burner. When the flame is removed, it goes out quickly.



AmFr™ passes the Vertical Flame Test (AMST D6413-12)

The Vertical flame test is the standard test method for flame resistance of textiles. The purpose of this test is to determine whether the fabric will continue to burn after the source of ignition (flame) is removed, as well as to determine if dripping or melting occurs. The test is performed by having a 12" swatch of the material enclosed and secured in a chamber. The bottom of the fabric is exposed to a controlled flame for 12 seconds and then the flame is extinguished. All SuperFabric® **AmFr™** fabrics undergo this stringent vertical flame test.

3) ABRASION RESISTANCE

SuperFabric® technology adds small, hard guard plates to fabric. The Taber abrader is used to test the abrasion resistance of the fabric. Here, the fabric without any guard plates is tested against the same fabric with guard plates.

More than 5 Times the Abrasion Resistance

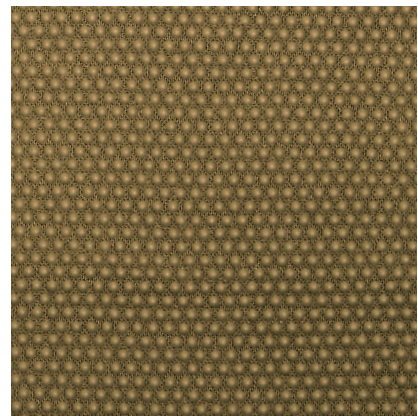
This particular **AmFr™** material (701505-065) has more than 5 times the abrasion resistance than just the fabric without guard plates. This demonstrates the durability and abrasion resistance that SuperFabric® technology adds.



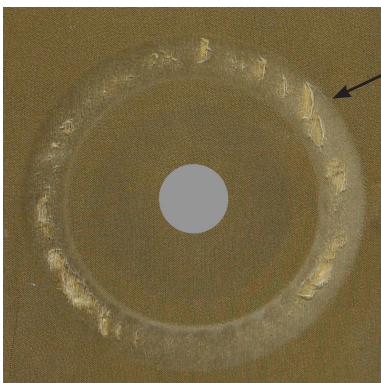
Sample undergoing Taber abrasion test



Fabric (no guard plates)

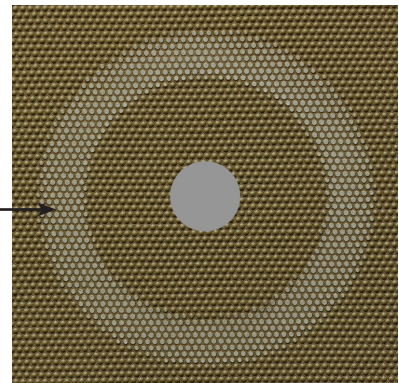


Fabric with guard plates



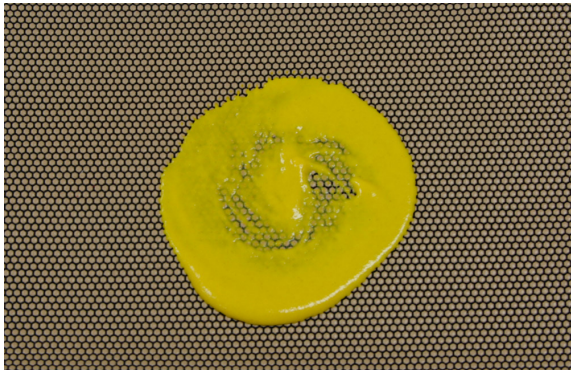
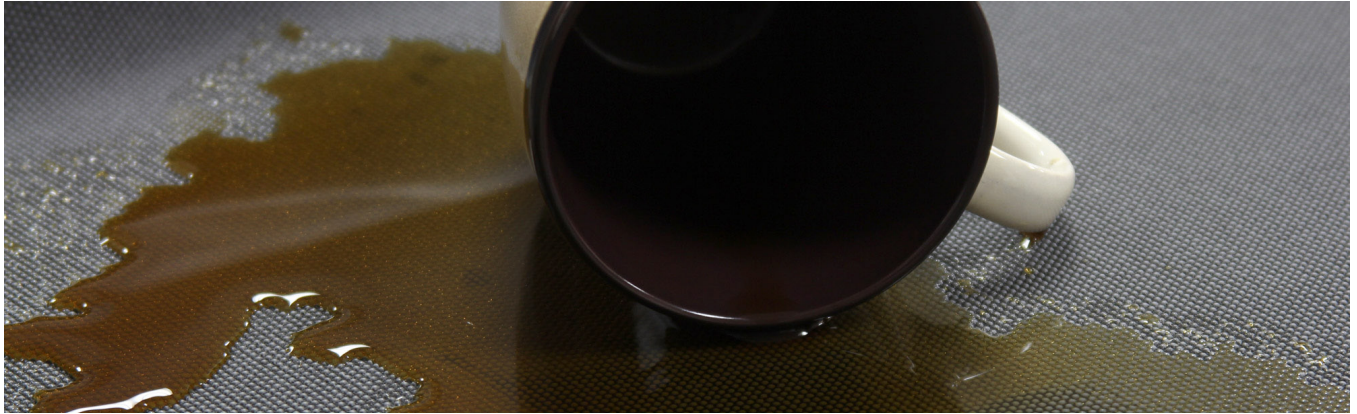
After 250 cycles the fabric alone (no plates) has failed (worn through).

After 250 cycles the AmFr™ sample shows only minor scuffing.

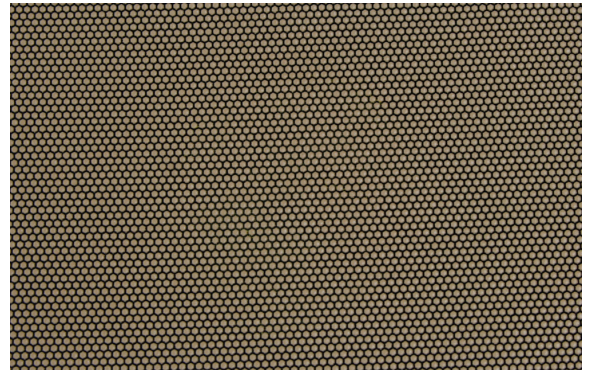


4) STAIN RESISTANCE

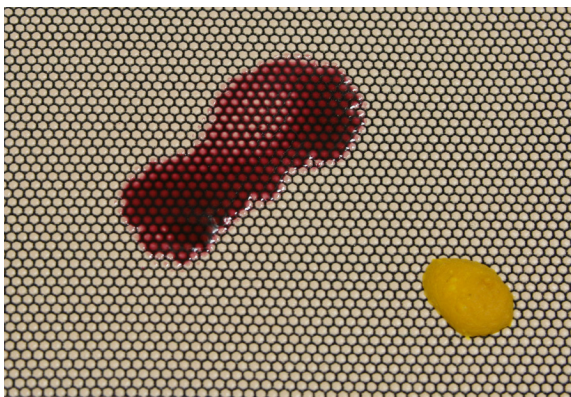
AmFr™ materials, like all SuperFabric® materials, are very resistant against a variety of staining agents. Typically, only a gentle rinse and/or mild detergent are all that is needed to clean SuperFabric®.



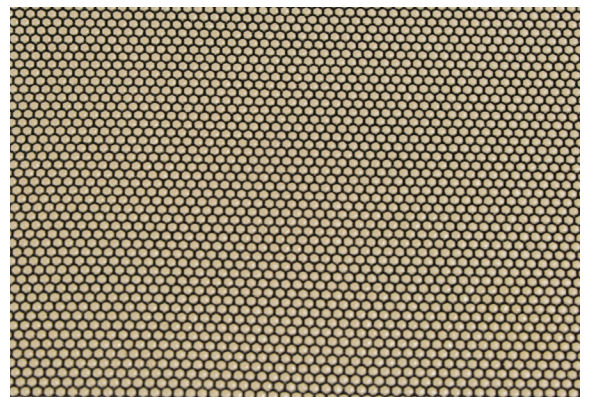
Mustard smeared into sample



Completely gone with simple water/
soap clean



Grape juice and mustard



Completely gone with simple water/
soap clean

Visit www.SuperFabric.com to see stain resistance videos

5) ENVIRONMENTALLY FRIENDLY

AmFr™ does not use silver or copper nanoparticles

AmFr™ uses IONPURE which emits silver ions that appear to be safe to the environment. Traditional antimicrobial fabrics saturate the fabric with much higher concentrations of silver to make it antimicrobial. The agent used in **AmFr™** to achieve antimicrobial functionality has ZERO nanoparticles and is able to use much less silver.

AmFr™ is much more durable

A durable material produces less waste for waterways and landfills as it doesn't get disposed of nearly as often as would cheap, low cost materials. It represents one of the highest forms of environmental friendliness (prevention/minimization).

BILLIONS of pounds of textile waste are created each year. This waste ends up in landfills, oceans, lakes, and even water supplies. We must consider not only the end product itself, but the manufacturing and disposal of such product.



APPENDIX A

Evidence that AmFr™ Is Effective Against Microbes Including Corona Viruses

In 2016, 2019 and 2021, *Am99™ samples were tested by TÜV SÜD using the JIS Z 2801:2012 standard. TÜV SÜD Certificates of Test show that Am99™ has excellent capability to inhibit the growth of microorganisms or to kill them. TÜV SÜD is an international testing organization that is US Environmental Protection Agency (US EPA) and US Food and Drug Administration (US FDA) Good Laboratory Practice (GLP) compliant. It is internationally recognized for its extensive testing and certification services. The JIS Z 2801:2012 method is very sensitive to antimicrobial activity and has become the industry standard for antimicrobial performance. The JIS Z 2801:2012 procedure has been adopted as an International Organization for Standardization (ISO) procedure, ISO 22196.

The JIS Z 2801:2012 procedure does not test efficacy against viruses, but the antimicrobial agent in Am99™, namely silver ion (Ag⁺), has been shown by independent researchers to be effective against viruses including corona viruses. Corona Virus is the family of viruses that includes the SARS-CoV-2 virus that caused the COVID-19 pandemic. Silver ion acts against viruses including human corona virus in multiple ways.

Ag⁺ ion reacts strongly with the sulfur in the cysteine amino acids in the spike protein of corona virus, and with both cysteine and methionine amino acids in the lipid envelope that protects the virus. This mechanism can deactivate a virus in a relatively short period of time. Ag⁺ used in inert carriers which are used in Am99™ can reduce human coronavirus by 2/3 after 1 hour, 95% after 4 hours, and 99% after 24 hr. [Kelly R. Bright, Enue E. Sicairos-Ruelas, Patricia M. Gundy, and Charles P. Gerba, Food and Environmental Virology 1(1):37 (2009).]

Finally, Ag⁺ ions inhibit viral replication by reducing extracellular DNA formation [R.L. Hu, S.R. Li, R.J. Hou et al; Genetics and Molecular Research, 2014; 13(3):7022-7028.].

Ag⁺ ions act as an inhibitor of viral entry inhibiting virion binding, fusion, and infectivity, thereby acting as an effective virucidal agent against cell-free virus and cell-associated virus [P. Orłowski, E. Tomaszewska, M. Gniadek et al; PLOS ONE, 2014; 9:1-15.]. Once treated with silver ions, the virus acts as a “dead body” and is no longer able to infect a cell. Ag⁺ ions prevent the spread of coronavirus by its action on neuraminidase [Y.A. Shtyrya, L.V. Mochalova, N.V. Bovin; ACTA NATURAE, 2009; 1 (2):26]. Ag⁺ ions induced viral neuraminidase deactivation suppresses virus growth and virus destruction occurs.

All of the actions of silver ions on viruses that either kill the virus or inhibit its spread cannot be used unless the silver ion can be delivered to the virus in a manner that will protect people such as in textiles or on various other surfaces. Am99™ uses IONPURE as a highly effective way to deliver Ag⁺ to viruses in textiles and other surfaces.

In an experimental study of the inactivation of SARS coronavirus, Craig Feied, MD, found that silver ions delivered by antimicrobial powders such as silver glass or silver zeolite can deactivate or dramatically reduce the survival time of coronavirus on treated surfaces [C. Feied, Novel Antimicrobial Surface Coatings And The Potential For Reduced Fomite Transmission Of SARS and Other Pathogens, doi 10.1.1.736.9295, 2004.]

DISPOSITION OF SILVER IONS AND COUNTER IONS

Silver ions are such a potent antimicrobial that only a small amount is required in Am99™. Silver ions are slowly released from IONPURE together with hydroxide ions, sodium ions, and phosphate ions. The silver ions and the sodium ions are positively charged and those positive charges are balanced by the negative charges on the phosphate ions and the hydroxide ions.

Human Safety: The safety of these materials to the human body is evident by the silver glass being approved by the US Environmental Protection Agency and the US Food and Drug Administration for food contact, water contact, and human skin contact. The sodium ion is common in many foodstuffs that contain salt. The phosphate ion is a natural human blood buffer and is plentiful in food such as eggs. The small amount of hydroxide ions are tied up by the phosphate ion, and the small amount of silver ions are acting as the antimicrobial. It is not harmful to human cells in the concentrations in which it is present.

Environmental Safety: Silver ions that enter the environment quickly react with chloride ions and sulfide ions both of which are plentiful in ground water sources. Those reactions result in insoluble compounds that do not dissolve in water. Phosphate ions promote cell growth of aquatic plants and help produce food for waterfowl, fish, and other animals. A drastic excess of phosphate ion, such as that produced from fertilizer runoff, can cause eutrophication of water ways, but the total amount from silver glass is minuscule compared to fertilizer runoff and other sources.

*Note: AmFr™ fabrics uses the same antimicrobial agents and manufacturing as Am99™ fabrics, but adds fire/flame resistance.



CONTACT US

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AmFr™ is formulated with antimicrobial properties to protect the SuperFabric® itself from stains, odors, and damage caused by bacteria and other microbes. Antimicrobial protection is limited to the SuperFabric® material. Higher Dimension Materials makes no direct or implied claims to protecting users or providing other health benefits.

This revolutionary textile uses IONPURE antimicrobial agent (EPA Registration Numbers 73148-1 through 73148-3 and 73148-5 through 73148-8) embedded into its guard plates, resulting in a durable treatment that does not wash off under normal laundering conditions, does not leach and is highly resistant to being abraded off.



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