Antimicrobial Protection for Public Building Applications

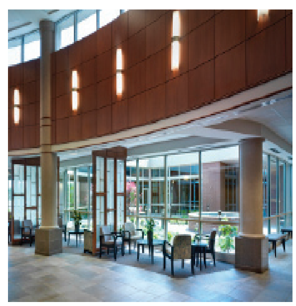
Antimicrobial Protection Infused into 70% Kynar 500® Fluorosurfactant Free PVDF Resin-Based Coatings for Public Building Applications[1]

Consumers around the world are recognizing a growing need for microbial control in paints and coatings used in public buildings. Microbes or microorganisms are living cells that are only able to be detected by the naked eye once they have multiplied to the millions. Types of microorganisms include bacteria, algae, fungi and mold. (See sidebar for more detail.)

The need for microbial control stems from the fact that there are an estimated 4.5 million bacterial and fungal species throughout the planet, many of which travel and migrate via the constant ebb and flow of human foot traffic through an ever-changing population of people visiting public buildings. Under the right conditions, some microbes can double in number every 30 minutes or faster.

Office buildings, hotels, schools and universities, retail establishments, hospitals, apartment buildings and senior living facilities include a myriad of fixed, painted or coated surfaces on which microorganisms may survive. Examples include:

- Interior, aluminum handrails in government buildings
- Patient room and intensive care units (ICU) entrances of hospitals and medical facilities
- Classroom window frame surfaces in schools and universities
- Entranceways of retail stores and shopping malls
- Column covers in hotels
- Light shelves in office buildings
- Interior frames of window units for historic renovations



Most surfaces within public buildings should be cleaned on a regular basis to help prevent the growth of bacteria, mold and mildew that can cause stains and odors on the surface of a product. However, cleaning alone may not remove the microbes. Usually not seen until they are concentrated on a surface, microbes multiply, break down these surfaces and paints, and cause a loss of coating or paint integrity. This growth is perceived as a stain and will continue to expand, using the surface itself as a food source and releasing unpleasant odors, until the microbial population is removed.

To augment cleaning programs, coating technologies containing antimicrobial compounds have been developed to provide an additional level of protection for the coating. Antimicrobial compounds can help prevent growth of stain

[1] Antimicrobial action is limited to protection of the coating surface and is not designed to protect users against disease-causing microorganisms, nor is it a substitute for normal cleaning.

and odor causing bacteria to help maintain the paint or coating integrity. These coatings may be used on a wide range of products in high-traffic public buildings including door knobs, faucet handles, bedrails in hospital and senior living facilities, and window frames.

This paper describes the development of antimicrobial compounds and their use in product finishes and coatings; how they are tested to prove effectiveness at protecting the paint or coating; and the advantages these coatings provide to owners and operators of public buildings, and the people who use, work and live in them.

How Does an Antimicrobial Work?

An antimicrobial agent in a coating is designed to inhibit the growth of odor causing bacteria and help prevent product deterioration of the coating from mold and mildew. It does not replace normal cleaning practices nor is it intended to protect users from disease causing micro-organisms. Microbes that land on surfaces treated with antimicrobial coatings are not killed; rather, the silver based particles emit ions that interfere with the microorganism's metabolism, reducing its ability to reproduce.

Coupled with regularly scheduled cleanings, antimicrobial-based coatings create an inhospitable environment for microbial growth by damaging the microbes' cell walls. In addition, this interferes with the conversion of nutrients into energy, inhibiting reproduction. The microbes die off and are not replaced within the population.

Antimicrobial treatments in solid products are largely surface treatment effects. For most, efficacy is related to controlled diffusion at the surface. Limited or no migration out of the surface provides durability as the incorporated active ingredient is not used up. The benefits of antimicrobial coatings on surfaces include odor control, reduced staining and surface discoloration from bacteria, mold and mildew. However, products and surfaces that have been treated with antimicrobial coatings do not disinfect their surroundings or contents. For example, the water in a treated cup is not sterilized, nor is growth in the water inhibited.

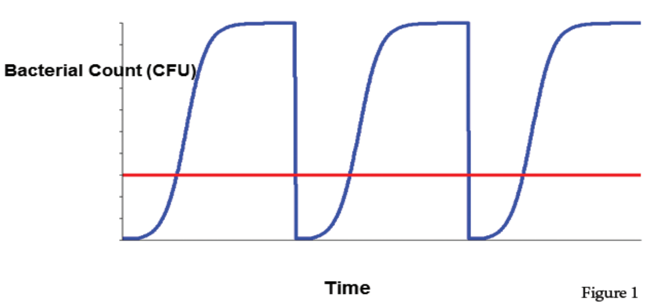


Figure 1

Figure 1 - A single uninhibited organism, doubling every 30 minutes for a day is equal to 2^{48} (2 to the power of 48) – approximately 10^{14} (10 to the 14th power) -- 281,474,976,710,656.

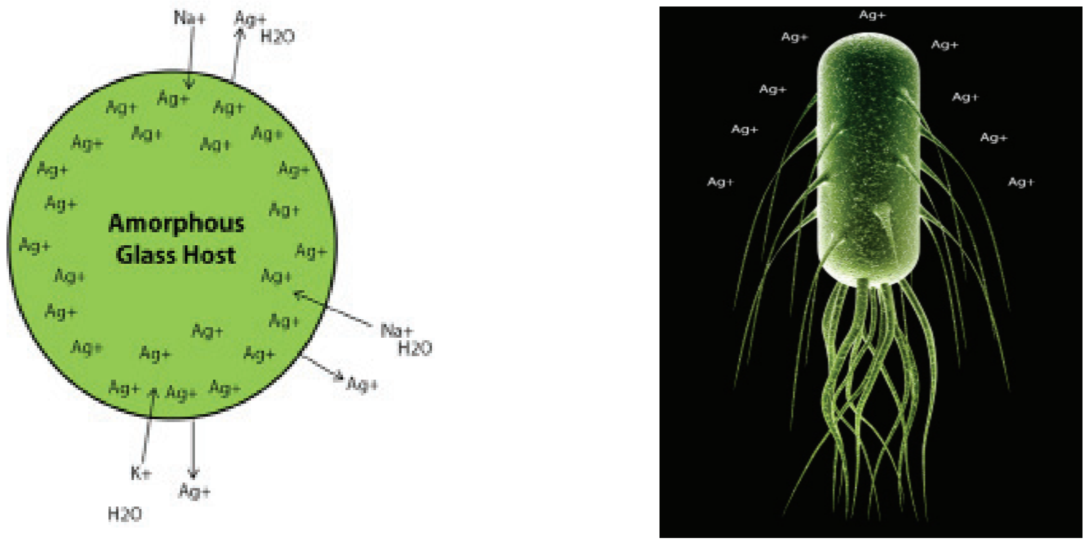
Assuming continuous environmental inoculation, one would see a lower average population with continuous inhibition through a treated surface (red) rather than an untreated surface with periodic disinfection (blue). The blue line represents the untreated surface, where, very quickly (doubling every 30 minutes), the microbial population increases to a maximum level before it is cleaned and disinfected, and the population drops near zero. The process continues to repeat itself as new microorganisms are introduced as some die out (a low steady state level). A combination of disinfecting and cleaning a treated surface provides the lowest average microbial population since the organism count would go down to zero and then never rise above the red line.

Three-Coat Finishing Process Meets Most Stringent AAMA Specification

An antimicrobial coating technology can provide an added level of protection for the coated surface. Through research and testing, SHER-NAR® 5000 Premium Performance Architectural Coating System with antimicrobial protection has been developed to coat interior and exterior aluminum surface architectural products to inhibit the growth of stain- and odor-causing bacteria. SHER-NAR® 5000 is based upon 70% Kynar 500® FSF® resin-based system. When moisture is present, the Microban® technology activates the ion exchange mechanism and small amounts of silver cations (positively charged ions) are released into aqueous environments. The release rate is highly regulated by the unique amorphous glass structure giving extraordinary longevity. The released silver acts on odor-causing bacteria by disrupting metabolism and reproduction (FIGURE 2). The resin used in the coating is fluorosurfactant-free, as fluorosurfactants have recently come under scrutiny by various regulatory agencies.

The SHER-NAR coating consists of a three-coat finishing process designed to meet the requirements of the American Architectural Manufacturers Association's specification standard, AAMA 2605-13 – the most stringent, high-performance specification for architectural coatings offered by AAMA.

The coating's antimicrobial protection safeguards the coated product's surface throughout its useful lifetime. Incorporated during the SHER-NAR manufacturing process, the antimicrobial additives operate on the cellular



When moisture is present, the ion exchange mechanism is activated and silver cations are released. The released silver acts on bacteria by disrupting metabolism, transport mechanisms and reproduction.

FIGURE 2

level to continuously disrupt and prevent uncontrolled growth of the microorganism.

Where's the Proof?

The antimicrobial technology helps to prevent the growth of stain and odor causing bacteria on the coating itself, while the coating protects the substrate. As microbes come into contact with the coating, the antimicrobial agent in the coating penetrates the microorganism's cell wall, disrupting its ability to grow and reproduce. The enhanced coating does not replace traditional cleaning methods, but works to keep the surface cleaner longer by inhibiting microbial growth.

All Microban® technologies used in Sherwin-Williams products are registered and approved by the US EPA for their specific use in the product in which they are incorporated. They have a history of safe use in consumer, industrial and medical product applications around the world. All applications must follow guidelines set by the EPA, including the language used to market products with antimicrobial protection. The EPA regulates built-in antimicrobial claims under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), which limits claims to protection of the treated product and prohibits public health claims.

How Is It Tested?

Surfaces labeled to be antimicrobial to resist odors and stains that can adversely affect the coating must be effective against multiple bacterial species as confirmed by approved test methodologies. There are international standard setting bodies that are responsible for producing and validating antimicrobial test methodologies that are unbiased and provide an accurate representation of the efficacy against bacterial species. The standard setting bodies include the International Standards Organization (ISO), American Society for Testing and Material (ASTM) and Japanese Industrial Society (JIS). The most common methodologies are the ISO 22196, JIS Z 2801, and ASTM E2180; a comparison of these methods can be found in Table 1.

	ISO 22196	JIS Z 2801	ASTM E 2180
Bacteria	Staphylococcus aureus Escherichia coli	Staphylococcus aureus	Escherichia coli
Carrier	Low nutritive, aqueous	Low nutritive, aqueous	Non-nutritive visous carrier
Comparison to controls	Must have unprotected control samples	Must have unprotected control samples	Must have unprotected control samples

Table 1

Testing of antimicrobial treated hard surfaces is similar, regardless of the standard setting body. Testing is conducted by placing organisms onto the protected surface and in parallel on an unprotected surface. The samples are incubated for a specified amount of time at an optimal temperature for bacterial growth. After the incubation, microbiologists remove the organisms and count them. The amount of bacteria remaining on the unprotected surface is compared with that on the protected surface resulting in a percent reduction or a log reduction. Because the bacteria are counted, this quantitative test is the gold standard of antimicrobial testing to determine if the product is effective at resisting the growth on the coating of mold, stains and odor causing bacteria.

In addition to quantitative testing, samples can also be tested using qualitative test methods (e.g., Kirby Bauer). These methods are visually assessed for bacterial inhibition as shown in Figure 3. If bacteria grow to the edge of a sample, the underlying substrate becomes opaque. If a sample is sufficiently protected, there will be a clear zone around the sample where bacteria cannot grow; this is referred to as a zone of inhibition. The type of test utilized for a specific antimicrobial compound will depend on the antimicrobial being utilized and the matrix being treated.

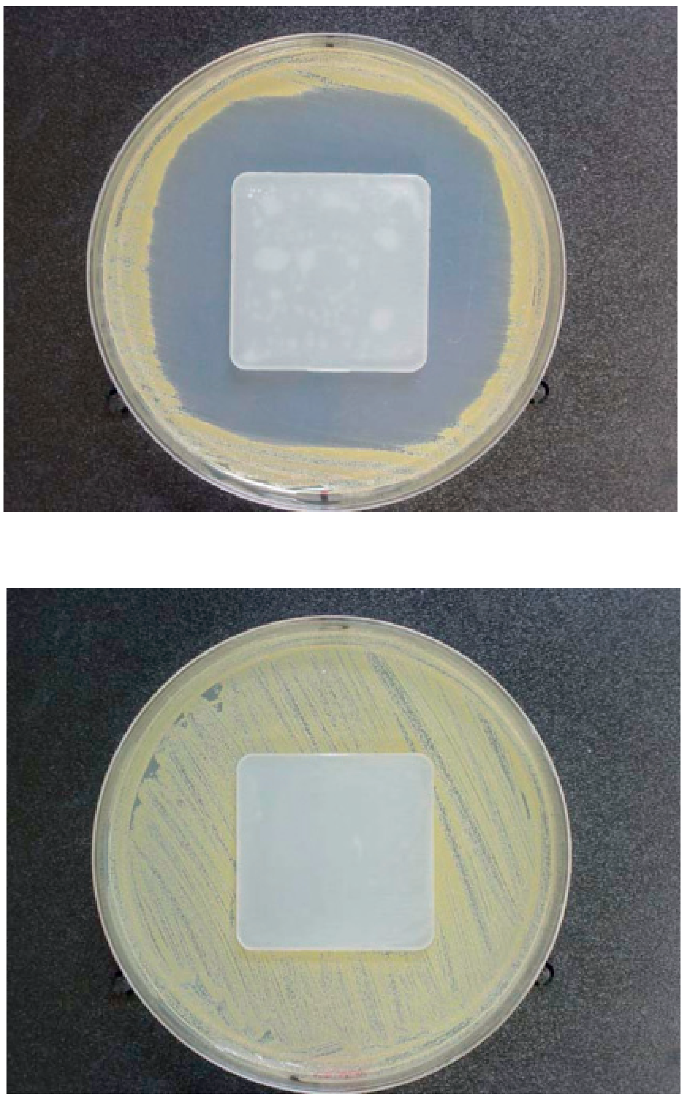


Figure 3

These are all relatively complicated and involved test procedures and, for this reason, it is suggested that a well-accredited microbiology lab, that tests coatings and maintains alignment with developmental bodies (ISO, ASTM, AATCC), be employed. Additionally, labs can be accredited by ISO to ensure that there is no variation from accepted methodologies. The Microban® microbiology lab has actively participated in ISO, ASTM and AATCC method development and round robins. Finally, Microban® often partners with third party labs to verify internal efficacy results.

How Is It Specified?

Linetec recognizes the need for high-performance coatings with Microban® protection for use in public buildings to help prevent the growth of stain and odor causing bacteria, mold and mildew. Specifiers, owners and architects can realize the benefit of SHER-NAR® as a reliable coating that meets the AAMA 2605-13 specification that is based upon a 70% Kynar 500® FSF® resin-based system.

These may be specified as:
PVDF-based, AAMA 2605-13, fluoropolymer finish containing minimum 70% Kynar 500® FSF® resin, three-coat system with Microban® antimicrobial protection, [paint code].

What Are the Additional Advantages?

SHER-NAR® coatings include solar reflective pigments designed for monumental builds – high-performance applications – and will maintain normal durability even with the addition of the antimicrobial agent, based on AAMA 2605-13 specification.

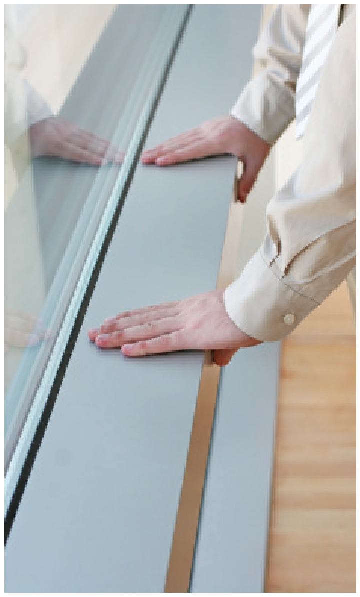
The normal color range for coatings that meet AAMA 2605-13 specification are those available in the SHER-NAR® coating. Due to the strict color change requirements within the specification, which includes a 10-year South Florida exposure test in which the coating must lose no more than 5ΔEs of color, certain bright colors are not available. Color choices are typical to what would be found in other PVDF technologies. Per the specification, the finish must retain a minimum of 50% of the original gloss value.

Please remember: Normal cleaning practices must be maintained. This coating is not designed to replace normal cleaning practices. The Microban® protection that is built into the SHER-NAR® coatings during the manufacturing process works continuously for the useful lifetime of the coating.

SIDEBAR

Types of Microbes

Bacteria



Billions of years ago, bacteria – single celled organisms -- were among the earliest forms of life on Earth. Bacteria are microscopic, single cell-organisms that are divided into two main groups by virtue of cell wall constitution – Gram-positive, such as *Staphylococcus*, MRSA and Gram-negative, such as *E. coli, Pseudomonas* and *Salmonella*. There is no escaping the presence of bacteria; in fact, the majority of the bacteria encountered are beneficial to the environment by helping return nutrients to the soil through decomposition of organic waste, or beneficial even to the human body (probiotics) through the digestion of food. However, some bacteria cause stains, odors and product surface deterioration as their metabolisms produce acidic materials and sulfur-based compounds. These bacteria can adversely affect the everyday surfaces.

Most bacterial test protocols require the testing of two organisms, one Gram-positive and the other Gram-negative due to the differences in the cell wall structure. Some antimicrobials are more effective against one or the other of these groups. Others are broad spectrum with good efficacy measured against both.

Fungus

Early fossil records suggest that fungi have been on Earth for more than 550 million years; some experts estimate that today more than 1.5 million fungus species exist. Common fungi include mushrooms, puffballs, truffles, yeasts and most mildews.

Unlike bacteria, fungi are multi-cellular organisms that contain membrane-bound organelles, and a “true nucleus”. Fungal cells are encompassed by a strong but flexible nitrogen-containing polysaccharide called “chitin.” The chitin protects the fungus and, depending on the mode of action, can reduce or eliminate the effectiveness of many antimicrobials.

The most common means of fungal reproduction is by the formation of spores. This occurs in fungi such as *Aspergillus niger* (black shower mold), *Penicillium pinophilum* (bread mold) and *Trichophyton mentagrophytes* (Athlete’s Foot).

Mold spores are present everywhere in our indoor and outdoor environment, and many of the products found in buildings provide rich nutrient sources. The most common defense is prevention: control moisture in the building to avoid high humidity levels and look for products with antimicrobial protection to resist the growth of mold.

LINETEC

888-717-1472
www.linetec.com
sales@linetec.com

* Kynar 500® and FSF® are registered trademarks belonging to Arkema Inc.