Antimicrobial Coatings and Printing Applications

The COVID-19 pandemic has resulted in many ramifications affecting every-day activities and the search for solutions to combat the virus has caused a renewed interest in several approaches to combat it including antimicrobial coatings. Antimicrobial coatings have been used for many years and their popularity has seen resurgence due to SARS CoV-2, the virus that causes COVID-19.

What is an Antimicrobial Coating?

Microbes or microorganisms can be living things such as bacteria, protozoa, fungi such as mold and mildew, or non-living things such as a virus. Microbes that are harmful are referred to as pathogens. In the battle against pathogens, one of the approaches is to protect surfaces from microbes. Almost all surfaces including equipment, counters, walls, textiles, and food can be susceptible to microbes, which can ultimately find their way to human beings.

Antimicrobials are substances used to destroy or suppress the growth of harmful microorganisms on objects and surfaces. Antimicrobial coatings incorporate approaches and chemicals to inhibit the growth of germs and bacteria on a variety of surfaces.

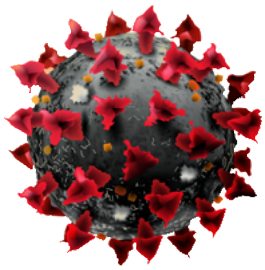
Where Are Antimicrobial Coatings Used?

Antimicrobial surface coatings are used in healthcare, consumer, and industrial applications. They are commonly applied to counters, walls, switches, doorknobs and handles, and other high-touch areas. In some cases, they are sprayed onto textiles, masks, gloves, and carpeting. Paint manufacturers are applying them to their wall paint and primer products to inhibit the growth of pathogens in facilities. In healthcare settings they are being applied to medical devices, electronics, medical instruments, trays, etc.

They are also used in maintaining indoor air quality with air handling systems, such as ventilation, heating, air-conditioning, ceilings and fans. They can be effective in combating mold growth and regrowth on various surfaces like automotive components, walls, ceiling pipes, etc.

Their application is also being used in restaurants for menus and other surfaces, hotels and lodging, assisted living centers, transportation including airlines, cruise lines, and trains, schools including books, packaging, and food processing units, dairy, large-scale production, and utensils and containers. In the textile sector, they also help provide durability, freshness, and stain resistance to fabrics.

How Do Antimicrobial Coatings Work?



Obtaining a surface that can hinder the growth of microbes can be attained through two approaches:

The first is a physical modification, which comprises material alteration and surface roughness to create structured surfaces to interrupt the lifecycle processes of microbes or damage the cell membrane. This approach essentially either traps the microbe and prevents it from spreading or reproducing. Examples of these coatings include graphene materials, dendrimers, and polymer brushes.

The second involves chemicals that kill or deactivate microbes. These chemical changes include grafting of polymers, using superhydrophobic surfaces, nanomaterials and other chemical agents. These types of coatings can include self-cleaning coatings and coatings with antimicrobial additives. Common chemicals include silver/silver nanoparticles, copper, brass, bronze, copper-nickel-zinc and cupronickel, titanium dioxide, and polycationic hydrogels.

Are All Antimicrobials the Same?

No, there is a hierarchy of application and effectiveness. There are nonpublic health products vs. public health products. The nonpublic health products protecting things such as paints, fuels, carpet, textiles, etc. and the public health products protect people. Public health products are regulated by the United States Environmental Protection Agency (USEPA) and divided into three categories:

- Sterilizers (Sporicides) – They eliminate all bacteria, fungi, spores, and viruses.
- Disinfectants – They destroy or inactivate microorganisms (bacteria, fungi, viruses,) but may not act as sporicides as those are the most difficult forms of microbes to destroy. Based on effectiveness, EPA will classify a disinfectant as limited, general/broad spectrum, or as a hospital disinfectant.
- Sanitizers - They reduce the number of microorganisms but may not kill all of them.

How Are Antimicrobial Coatings Tested?

There is not a single specific test to prove the efficacy of antimicrobial coating. However, several test methods have been developed by different organizations to meet industry standards. Some of these tests have been developed by:

- American Society for Testing and Materials (ASTM)
- American Association of Textile Chemists and Colorists (AATCC)
- Japanese Industrial Standard (JIS)
- International Organization for Standardization (ISO)

The tests provide insight into the performance of an antimicrobial coating in combatting the growth and survival of microbes. The tests do have limitations as they are designed for specific applications, material, or antimicrobial technology. Therefore, choosing one specific method can be difficult.

However, an example of standards is ISO 22196 (JIS Z 2001) for antibacterial coating by manufacturers. Antifungal test methods are ASTM G21 or AATCC Method 30, Part III. Similarly, ASTM E2149 is used to detect antimicrobial activity after one hour exposure, and ASTM E2180 is used to detect the antimicrobial activity after 24 hours of exposure on textiles. Also, ASTM G21 is used to determine resistance against black mold and fungus.

How are Antimicrobial Coatings Regulated?

The USEPA regulates antimicrobial pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). There are a set of regulations that have been created that govern how the coatings are defined and allowed to be used in commerce. While similar in outcomes, hand sanitizers are considered drugs and thus are regulated by the Food and Drug Administration.

Antimicrobial agents are considered pesticides when they are intended to protect public health. Under FIFRA, USEPA's primary responsibility is to review the toxicity of the ingredients and the potential for exposure to ensure the materials can be used safely. USEPA requires antimicrobial producers to demonstrate the effectiveness of their products with research. If EPA determines that no adverse effects are expected to occur when the product is used according to the label directions, they grant product registration.

Registering a product as a pesticide allows claims about its antimicrobial properties. The drawback to this is that registering a pesticide can take years and hundreds of thousands of dollars. Any change in formulation for a registered coating requires re-registration.

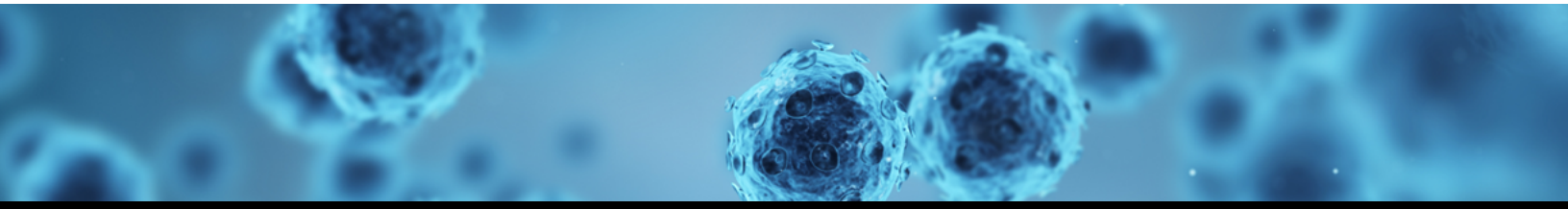
Compared to surface disinfectants, antimicrobial coatings need to have an extended period of action against microbes. EPA-registered surface disinfectants will kill microbes at the time they are used, but if new microbes later come into contact with the surface, a previously applied disinfectant will not protect against them.

There are some EPA-registered products with residual efficacy against bacteria. Such products will continue to work against bacteria for hours, months or even years after application (i.e. "residual" or "long-lasting" efficacy claims). However, there are currently no publicly available EPA-registered products with residual efficacy against SARS CoV-2 or other viruses.

Due to the length of time required and expense associated with getting a coating registered, very few coatings have been approved. EPA has issued some emergency allowances for coatings and other ones are pending due to the COVID-19 pandemic, but these have limitations regarding their geographical use and expiration dates and can only last a year. After that additional action will be required to allow for its continued use.

Alternative to Registration

An alternative to the registration process is to use "the treated article exemption." In most instances, this is the approach that is used by many businesses using antimicrobial coatings. According to USEPA's Pesticide Registration Notice #2000-1, there are exemptions from FIFRA in certain cases where a product is treated with antimicrobial chemicals. If the antimicrobial agent is registered with EPA and the product claims describe protection of the product, not people, the product does not need to be registered as a pesticide with the USEPA.



Companies that want to use this alternative must be careful not to make any claims regarding public health. Thus, no claims can be made regarding protection from COVID-19 or other disease-causing microbes. Any claims need to be narrow and specific about performance or product protection from microbe-related problems like odors and material degradation. Acceptable claims include statements such as "This surface is protected from damaging microbes by XYZ's antimicrobial coating" or "Provides continuous protection against odor- and staining-causing bacteria, mold and mildew on the product" or "provides continuous protection to fight the growth of bacteria, mold and mildew that can cause stains, odors and deterioration of the product".

An **unacceptable** claim would be "XYZ's antimicrobial coating kills disease-causing bacteria and viruses." or "XYZ's antimicrobial reduces risk associated with cross contamination from bacteria".

Enforcement by USEPA

USEPA has been very aggressive in enforcing its regulations and the requirements under FIFRA. USEPA is authorized to issue a Stop Sale, Use, or Removal Order to any person with a pesticide or device in their ownership, custody, or control whenever there is reason to believe that such pesticide or device is in violation of any provision of FIFRA, or that such pesticide or device has been, or is intended to be, distributed or sold in violation of any provision of the Act. USEPA has issued two "Stop Sale" directives to an online retailer that covers over 100 products. USEPA can also levy heavy fines and seek criminal prosecutions for violations and have won convictions resulting in probation and jail terms for individuals and companies.

EPA has received a plethora of tips and complaints regarding potentially false or misleading pesticidal claims during the COVID-19 pandemic. The Agency has prioritized enforcement action against bogus COVID-19 efficacy claims made by companies and individuals attempting to take advantage of the pandemic crisis. For example, a person in Georgia was indicted for allegedly selling an unregistered pesticide in the form of lanyards claiming to protect wearers from viral infections including COVID-19.

Using Antimicrobial Coatings

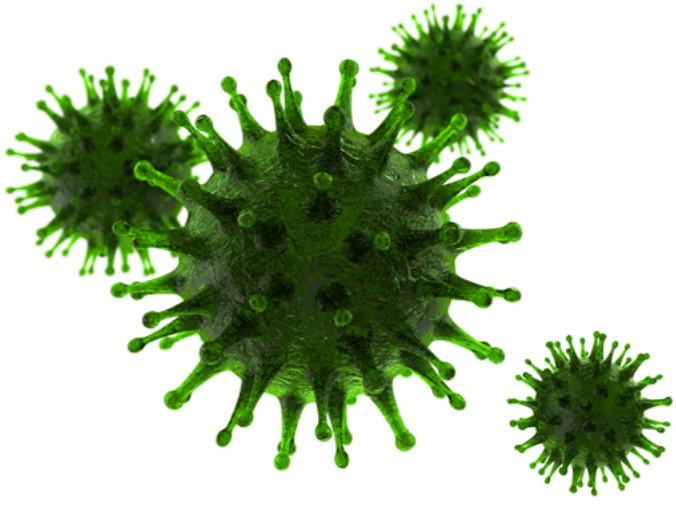
Since the coatings are highly regulated and USEPA is being very aggressive in its enforcement of claims, any printing operation that wants to use a coating needs to do its homework to avoid penalties and embarrassment. Companies that want to use antimicrobial coatings need to be aware of how USEPA regulates these restricted "treated product" claims to product protection for currently registered antimicrobials. EPA also has strict labelling requirements for products claiming antimicrobial action. Therefore, any claims that will be made about a product need to be carefully worded and consistent with the claims being provided by the supplier of the coatings. This will require diligence to ensure that the products you are interested in has complaint labelling. In addition, the supplier cannot reference testing to specific organisms. This makes it challenging to determine the validity of claims.

Summary and Conclusion

The COVID-19 pandemic has brought renewed attention to antimicrobial coatings and their growth from a printing application perspective has grown accordingly. They are being used on a variety of printed products ranging from menus and books to textiles and face masks. Even though antimicrobial coatings have been used in some form or another for quite some time, their use and application is poised for continued growth. Many organizations will employ the use of antimicrobial coating as a method of keeping germs away and maintaining a healthy environment for their people and this presents an excellent business opportunity for print providers.

For More Information

For more information, please contact Marci Kinter, Vice President of Government & Regulatory Affairs at mkinter@printing.org or Gary Jones, Director EHS Affairs, at gjones@printing.org.



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