

Increased expectations for antimicrobial textiles

Application-specific testing adds value to these important products.

Features | **June 4, 2025** | By: Timo Hammer, Ph.D.

Antimicrobial fabrics and commodities continue to expand their applications in various sectors, **driven by the increasing awareness of hygiene and infection control. The importance of antimicrobial materials has grown in parallel with media reports on global infectious diseases**, including emerging viral threats such as COVID-19, antibiotic-resistant bacteria like MRSA and VRE, and other pathogens like EHEC and SARS-CoV-2.



Controlled testing, such as that done in Hohenstein's lab environment, helps to evaluate the effectiveness of antimicrobial treatments in textiles. Photo: Hohenstein Institute.

The practical application of antimicrobial textiles and commodities remains a focus of scientific and regulatory discussion, especially as textiles are increasingly recognized as potential sources of infection transmission. Consequently, antimicrobial products are viewed as valuable tools to interrupt infection chains and provide active protection for users.

Expanding specific uses

Modern antimicrobial textiles can contribute to breaking infection chains by reducing microbial load on surfaces and fabrics, thereby lowering transmission risk. For example, antimicrobial textiles used in healthcare settings can limit the spread of pathogenic bacteria and viruses, including multidrug-resistant strains.

Antimicrobial textiles are also increasingly used in sportswear and activewear to mitigate odor **caused by microbial activity on sweat**. Microorganisms metabolize sweat components, producing malodorous substances. Extensive wear trials demonstrate that antimicrobial fabrics can effectively reduce odor formation by inhibiting microbial growth within the textile matrix, rather than affecting the skin microbiome directly. This passive mechanism involves binding sweat and microbes into the fabric, preventing the production of odorous compounds.

With the increase in applications and environments, **the role of antimicrobial materials in infection prophylaxis and prevention has gained new significance**. While first-generation antimicrobial textiles primarily aimed to protect the material itself from environmental degradation, current generations are expected to deliver effective antimicrobial, antifungal and antiviral activity tailored to specific medical and hygienic applications.

These advanced textiles must demonstrate efficacy and safety according to their intended use, necessitating appropriate testing and validation methods. As new fiber technologies and application possibilities emerge, the demand for standardized, reliable testing systems to evaluate antimicrobial efficacy and safety has increased accordingly.

Compliance in the U.S.

In the U.S., biocidal products are regulated by the Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). This regulation ensures that biocidal products are safe, effective and properly labeled to be marketed in the U.S.

Before a textile treated with silver can be sold in the U.S., the active ingredient silver (or silver ions) must be registered as a biocidal active ingredient with the EPA. This registration requires a comprehensive assessment of safety, efficacy and environmental impact. Data on toxicological properties, environmental persistence and potential risks to humans and ecosystems must be submitted.

After the active ingredient is registered, the final product—i.e., the silver-treated textile—must also be registered with the EPA if it qualifies as a biocidal product. This involves providing evidence of efficacy against target organisms and safety data. Clear labeling and instructions for use are also required to inform consumers and retailers about proper application and safety precautions.

The efficacy of the silver-treated textile must be demonstrated through appropriate testing that complies with EPA guidelines. Safety evaluations are necessary to minimize potential risks to users and the environment. The EPA places particular emphasis on avoiding silver accumulation, which could be toxic, and on preventing adverse effects such as allergic reactions.

Only products that meet all regulatory requirements are permitted for sale in the U.S. Manufacturers must ensure their products are properly registered and that all labeling regulations are followed; non-compliance can result in fines, product recalls or other legal actions.

The European Union

The use of antimicrobial agents in textiles and commodities is strictly regulated within the European Union under the Biocidal Products Regulation (EU) No 528/2012. This regulation aims to ensure that biocidal products are safe for human health, the environment and consumers, while also maintaining a high level of efficacy. Before a biocidal product can be placed on the market or used in the EU, it must undergo a comprehensive authorization process, which includes a detailed assessment of active substances, product efficacy and safety data.

An essential step in compliance is the approval of active substances used in biocidal products. These substances must be evaluated and approved at the EU level through the European Chemicals Agency (ECHA). Once approved, biocidal products containing these active substances can be authorized for specific uses and applications, such as textiles with antimicrobial finishes.

The authorization process involves demonstrating the product's efficacy, safety for users and consumers, and minimal environmental impact, in accordance with the criteria outlined in the guidance documents. Note that the biocide-treated fabric is not regarded as a biocidal product itself, but a "treated article." There is an important difference.

The efficacy of biocidal products must be substantiated through appropriate testing, which should be aligned with the latest standards and guidance. The ECHA guidance emphasizes that efficacy claims must be supported by scientifically valid data, including laboratory tests and, where applicable, field studies. Safety assessments include evaluating potential risks to

humans, especially for products intended for skin contact, and to the environment, considering factors such as leaching, persistence and ecotoxicity.

Products containing biocidal active substances must be correctly labeled according to the regulation, providing clear information on their intended use, safety precautions and efficacy claims. Certain substances or formulations may be restricted or require specific handling procedures to prevent misuse or unintended environmental release.

The regulation also mandates the assessment of environmental risks, including the potential release of biocidal substances during washing or disposal. Effect-based eco-toxicological tests are recommended to evaluate the impact on aquatic and terrestrial ecosystems, ensuring that antimicrobial textiles do not pose undue risks to environmental health.

A tiered testing approach

When testing the effectiveness of biocide-treated products, such as textiles treated with silver, it is mandatory to evaluate their performance in real-world applications. This practical approach ensures that the product works as intended in everyday use. In Europe, this method is even legally required under the EU Biocide Regulation, which emphasizes the importance of demonstrating real-life efficacy for biocide-treated products. By adopting this tiered approach—a systematic test procedure that is structured in several stages—manufacturers and users can be confident that the biocide treatment provides the desired protection and performance in practical settings.

The tiered approach begins with an initial, basic evaluation of product performance in controlled laboratory tests to demonstrate efficacy against the target organisms. If the results are positive, a second stage follows in which efficacy is tested under conditions that more closely approximate the actual conditions of use, for example in real environments or on the products themselves, and in some cases, in a third stage efficacy is confirmed in a practical, real-world environment to ensure that the product works reliably under actual conditions of use.

This multi-stage process makes it possible to prove the effectiveness of a product in a scientifically sound and reproducible way without conducting unnecessary tests. It helps to ensure the safety and efficacy of biocidal products while minimizing the burden on manufacturers and testing institutes. ECHA emphasizes that this approach is an important part of the regulatory requirements to ensure the effectiveness of biocidal products in practice.

Adjusting for use

Different applications require different performance criteria. For example, an antibacterial cleaning cloth must prevent the spread of environmental microorganisms during cleaning, whereas a barrier material in a hospital setting must effectively prevent pathogen transmission via contact with nosocomial germs.

Despite these differences, many textiles are currently tested under uniform conditions using standard test strains, typically according to DIN EN ISO 20743. This standard provides a basis for product comparability and quality assurance but is not designed to evaluate the specific practical applications of antimicrobial textiles comprehensively. It primarily offers a quantitative measure of efficacy against test bacteria such as *Klebsiella pneumoniae* and *Staphylococcus aureus*.

However, the standard can be adapted for more application-specific testing by incorporating modifications, enabling evaluation of antimicrobial textiles for diverse uses such as odor control, infection prevention in healthcare and food sectors, or household hygiene.

Feasible modifications of DIN EN ISO 20743 include:

- **Use of application-relevant microorganisms.** Replacing standard strains with pathogens or microbes pertinent to the specific application, including fungi and viruses, to better simulate real-world conditions.
- **Methodological variations.** Extending testing to monofilaments, fibers, porous fabrics, sponges, hydrophobic textiles and non-textile materials like plastics, ceramics or metals. Additionally, efficacy kinetics can be assessed by varying contact times according to application needs.

These adaptations allow for more precise optimization of textiles and commodities for their intended environments, from household to clinical settings.

Dr. Timo Hammer is CEO Life Science & Care at Hohenstein. He has also been a Research Project Manager and Head of Research for the Hohenstein Life Science Institute.