



## Bacterial and Fungal Inhibition in Fibers & Textiles

### Introduction

Textiles, nonwovens, carpets and fibers provide bacterial and fungal pathogens an environment conducive to survival and growth. Studies conducted on medical textiles, sheets and garments; indicate survival duration of weeks and sometimes even longer. Among the bacteria studied were common nosocomial infection-causing bacteria, those that cause hospital infections, includes antibiotic and drug-resistant strains such as MRSA. With the diminishing ability to control these drug-resistant strains, and rapid mutation around existing antibiotics, textiles and fibers are viewed as an opportunity to reduce the spread of pathogenic bacteria and fungi, and thus infections. Textiles in the hospital and home settings are candidates for protection via reduction of pathogenic organism survival. Odor-control in the textiles is a side benefit of such protection.

Several “high priority” textiles come to mind in the hospital:

- Towels facecloths and bathmats in the bathroom.
- Sheets, pillowcases and blankets on the bed, the surface fabrics of the mattress.
- Patient gowns, isolation gowns, scrubs.



- Isolation drapes, upholstery and wall coverings and carpeting in the room or waiting areas.



By preventing bacteria and fungi from thriving in/on fibers and textile products, the risk of patient-to-patient or patient-to-staff transmission of infection can be reduced. Antibacterial and antimicrobial textile treatments are now possible and cost-effective. Extended wash durability is also possible.

### Historical range of antimicrobial solutions

This is a complex area with many variables and objectives, however, historically, a range of antimicrobial treatments and chemistries have been utilized on textiles and these are mentioned briefly below:

- Quats or Quaternary amines offer temporary performance and are not broad-spectrum.
- Silanes require constant physical motion to be effective and then physically “load up”.
- Tin-based compounds as not viewed as particularly safe or medically acceptable.
- Triclosan and some other synthetic materials can degrade into undesirable compounds.

- Many materials can bioaccumulate, often in fatty tissues and can show up in breast milk.
- N-Halamines with chlorine are viewed as overly reactive and harsh and the process can be environmentally “dirty”.
- Traditional biocides often leach out and into adjacent materials; or skin. In-fact, the traditional test was as leaching test with a zone of inhibition (AATCC 147) which was popular when leaching was considered beneficial and desirable.
- Additionally, many alternatives are not broadly effective against the full range of typical pathogens, especially things a basic and gram positive plus gram negative bacteria.
- Chitosan, bamboo fibers and other natural materials offer a very low level of performance.
- Silver has become the standout product.

### Silver – Technology of Preference

Despite the long list of prior and partial solutions, silver in a controlled release ionic format has gained acceptance as the “technology of preference”. There are complications and challenges however. Silver exists in many forms from elemental to nano, compounds, complexes, colloidal, etc. Metallic silver is marginally useful as it must be presented in an ionic format to become effective and a dosing system or delivery system must be present. Silver is photo-reactive and color change or even skin staining can occur with many systems. It is a challenge to develop and select an optimized formulation or blend of formulations and even more challenging to optimize the performance vs. price vs. manufacturing complexity curve. Biovation specializes in silver formulations that address and overcome the above limitations.

Here are some of the attributes of a modern silver antimicrobial:

- Silver is recognized as safe and effective by both EPA and FDA when used as an infection-control and odor-control “active”. It is used in many FDA medical devices including dressings.
- Silver is a broad-spectrum biocide as it functions well against gram-negative and gram-positive bacteria plus fungi. Note that fungal performance may require a higher concentration.

- Silver is effective at low levels, often 20-50 ppm of available silver imparts robust end-use performance. The MIC or minimum inhibitory concentration as low as 2-5 µg/l or ppm range with most bacteria.
- Silver is generally thought to enter the bacterial cell-wall prevent from reproduction, thus preventing the “mildew” smell on wet fibers and the toxins and odors often generated by bacteria. Bacteria simply do not thrive or reproduce in the presence of silver ions.
- Silver, when properly formulated, is durable and is effective for years, generally good for the life of the article.
- When placed in a “controlled release” structure, silver ions are released in response to local conditions and provide a reactive or demand-release situation in which concentration equilibrium is maintained and protection is constant.
- Silver does not degrade into harmful byproducts like some other agents.
- Excessive release of silver or ionic silver is precluded via a controlled-release mechanism.
- Silver is completely non-toxic to mammals and has not been shown to promote bacterial resistance like antibiotics do.
- Silver is not highly acidic or basic and does not contain salts like some other antimicrobial agents. It is safe for extended skin contact and if eaten is harmless. The hand or feel is not affected.

Having listed these positives, it is easy for one to think this is the perfect situation. However, one has to be cognizant of the below parameters when designing a silver based formulation:

- The silver must be delivered in an ionic format for greatest effectiveness. Compounds, salts, complexes, and the many formats silver can be found in are far from ideal antimicrobial solutions.
- Silver discolors as it photo oxidizes to the traditional sepia/brown color from old black & white photos, the silver halide color.
- Silver can be delivered in a nano format and as such, is of great concern from a safety perspective as nano particles can too easily cross cell-walls or bodily protective membrane.

- Silver is non-migratory and remains in-place. It therefore must be positioned appropriately for maximum efficacy.
- Silver can be incorporated into polymers, fibers and films; however, if not exposed to a surface, can be effectively trapped and wasted, a costly problem.
- Silver readily complexes with sulfur, chlorides and rapidly forms insoluble compounds although still technically antimicrobial. Washing rapidly diminished the effectiveness of many silver formulations.

To design an optimized solution, with a good cost/performance ratio, one must analyze many factors including:

- The end-use, cost limitations, conditions of use and the performance objectives.
- The manufacturing process and how it can be adapted or modified, if required.
- Claims language as allowed by regulatory constrains.
- Advertizing and documentation within regulatory boundaries.
- EPA and/or FDA oversight and compliance issues.

### Biovation's Silver Formulation

Biovation has optimized its textile offerings and offers the following benefits via it BioArmour™ technology and product platform:

- Each application is studied to ascertain the requirements and options. Both durable topical and polymer additive options are available.
- Great efforts are taken to optimize formulations that are low-cost yet perform.
- When silver is chosen as the “active” it is delivered from an ionic-release system.
- In textiles, our silver is tightly bound and complexed into a delivery system structure. The silver remains in-place and is non-migratory fir greatest performance. Nano-silver technology is rarely used although highly evolved formulations are available for specific end uses.
- Unique optically clear formulations are available and prevent color shifting.
- Additional features can be added and generally include:

- o Enhanced fungal performance.
- o Oxidizer functionality.
- o Odor scavenging technology (although the effective life of these systems is limited).
- In most applications, concentration determines the speed of kill with versions ranging from effective consumer odor control to robust FDA medical-grade pathogen control.

*The net result is a clear, flexible and durable surface coating on each fiber or polymer additive within the fibers. These systems emit low-levels of silver ions for extended periods and thus maintain equilibrium on the fiber surface with the potency to prevent bacteria growth. Biovation BioArmour™ formulations for fabrics and textiles result in a deep reservoir of silver-ions for years of protection.*

### Biovation Expertise

Biovation is chemical technology agnostic; meaning, Biovation does not limit itself to any particular set of antimicrobial platforms available in the commercial market. Rather, based on decades of research and development of formulations, it compounds and formulates customized and unique solutions for targeted specific applications. Hence, as part of chemical platforms available to Biovation, we can consider metals (for example, there are commercially available silver releasing powders that have obtained FDA and EPA approvals), metal compounds, surface active agents, surfactants, quaternary ammonium compounds, organic acids, inorganic acids, biopolymers, antioxidants, oxygen scavengers, carbon dioxide emitters and others provided in any combination and concentration. The combination and concentration of the various elements depends on the several factors such as the specific textile type, type of targeted end-use, the nature of the microbes to be controlled and hindered and other synergistic affects with the conditions present in the application environment.

## Contact Us

Biovation's expertise is in infection control formulations and we look forward to partnering up with you. We invite you to contact us [solutions@biovation.com](mailto:solutions@biovation.com) to discuss how Biovation can help you with our portfolio of technologies and solutions.

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## Biovation LLC

55 Industrial Park Road  
Boothbay, ME 04537 USA

Ph: 207-633-0616

Fax: 207-633-0614

[www.biovation.com](http://www.biovation.com)