SILVADUR™ Antimicrobial

Durable, Effective Odor Control Technology for Textiles

SILVADUR™ Patented Technology: Winner of the Prestigious R&D 100 Award

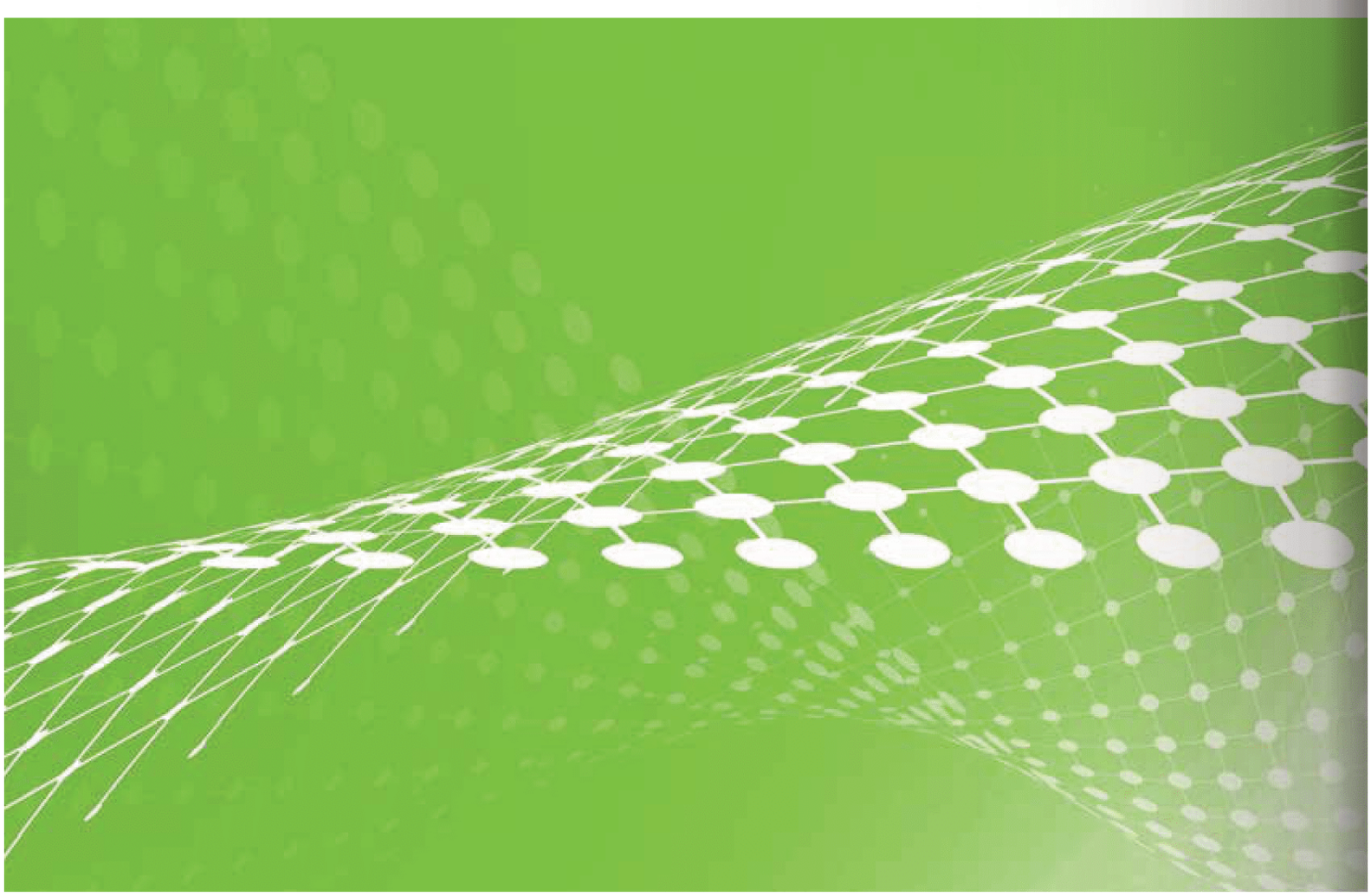
R&D Magazine recognizes SILVADUR™ Antimicrobial from DuPont as one of the top 100 most technologically significant products.

SILVADUR™

Advanced, Sustainable, Microbial Control

Antimicrobials have been available for years, but they lacked reliable efficacy and consistent durability against microbe derived odors on textiles. **SILVADUR™** antimicrobial delivers "intelligent" microbial control.

- Using a patented, controlled-release technology, **SILVADUR**™ delivers a low concentration of silver ions to fabric surfaces to control malodor-generating bacteria.
- The revolutionary technology contained in **SILVADUR**™ is the world's first and only aqueous-base-silver-polymer delivery system.
- Patented Smart Release delivery system requires less silver to eliminate bacteria, substantially reducing waste.



SILVADUR™ Provides Three Modes of Action to Control Odors:

Antimicrobial Odor Control

Smart Release controlled delivery system uses very low levels of silver (e.g. 30ppm silver ion) to control odor-causing microorganisms

Odor Absorption Control

Blocks select odorants via absorption

Controls Metabolic Enzymes

SILVADUR™ silver ion polymer quickly targets enzymes, preventing production of malodors like isovaleric acid (common component of foot and armpit odor)

SILVADUR™ Delivers Supply Chain Excellence

Performance at Every Step

SILVADUR™ performs intelligently at each stage of the supply chain. Textile manufacturers can create items that offer **unmatched antimicrobial protection at low dosages** and easy to use formulations

Brand owners and retailers can design products that feature truly intelligent freshness, enabling them to remain active for multiple washings. Consumers can feel confident knowing their garments provide intelligent freshness protection that won't harm them or the environment.

Ultimate Ease of Use

SILVADUR™ is the perfect alternative solution to traditional, often costly and problematic silver particle-based technologies and with its polymeric nature, low dosage profile and formulation composition, **SILVADUR™** is widely chosen for ease of use and to replace particles, ZPT, and Quat-based technologies.

SILVADUR™ Can Be Applied Easily Using Almost Any Method...

Application Versatility

Thermally Stable

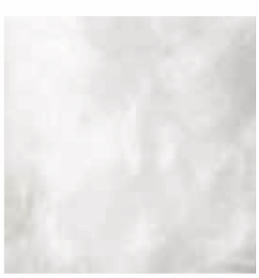
Applicable to Natural & Synthetic Fibers

Spray, Pad & Exhaustion Application

Fast & Efficient Exhaustion

...And At Any Step In The Process.

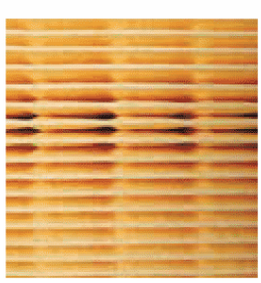
Yarn Production



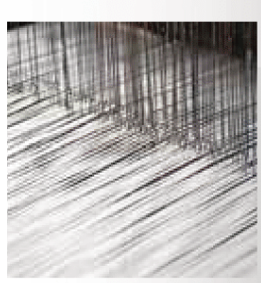
Nonwovens

Fabric Finishing

Garment Production



Fiber & Fiber Fill Production

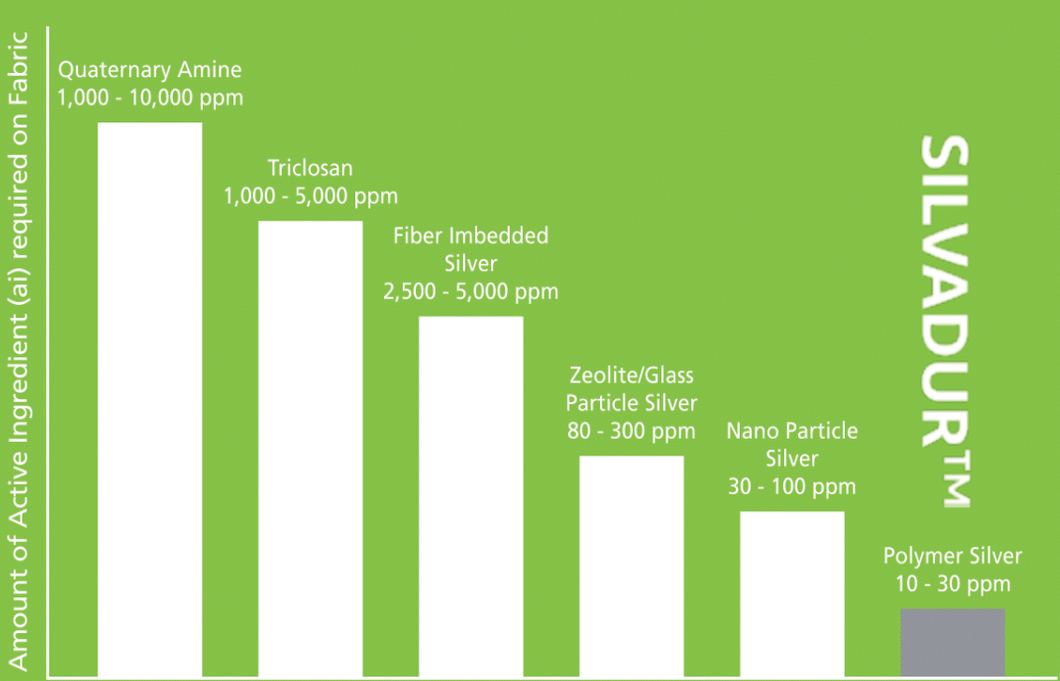


Fabric Production

SILVADUR™ Delivers Unmatched

Efficacy & Durability

SILVADUR™ Optimizes Antimicrobial Efficacy and Delivery for Reliable and Durable Performance...



...And Demonstrates Significant Bacterial Reduction.

Test Method: AATCC 100; 1:20 NB in sterile distilled water + 0.05% Triton X-100 wetting agent; 24 hour contact, 1.0 g sample; 1000ul inoculum; 10ml D/E neutralizing broth; EMB agar; Mannitol Salts agar

Test Organisms	*Staphylococcus aureus* (ATCC 6538) *Klebsiella pneumoniae* (ATCC 4352)	
Concentration of inoculum (cells/ml)	*S. aureus*	*K. pneumoniae*
	1.88E+05	1.99E+05
Method Used to Measure Living Bacteria	Pour plate method	
Sample Material	100% Polyester	

	S. aureus Percent Reduction from Supplied Control		*K. pneumoniae* Percent Reduction from Supplied Control	
	Initial	50x	Initial	50x
UNTREATED	–	–	–	–
SILVADUR™ TREATED	>99.9%	99.9%	>99.9%	>99.9%

Conclusions: The samples were washed using AATCC 61-2A method to simulate 50 home launderings. The treated sample demonstrated significant bacterial reduction compared to the supplied control before and after washing. This treated sample passes Tier 1 screening for determining durable antimicrobial activity of treated articles.

SILVADUR™ is the Optimal Choice in Antimicrobial Quality, Efficiency and Value

SILVADUR's unique delivery system is the only credible and reliable alternative to traditional, and often costly, commercially available antimicrobial solutions in the marketplace today.

Superior Silver Ion Technology

SILVADUR™ vs. Silver Nanotechnology

- **SILVADUR**'s fully-soluble polymer system delivers silver ion–not metallic silver–to the treated fabric surface for a uniform coating.
- **SILVADUR**'s Smart Release system allows the use of very low levels of silver ion, thereby reducing silver waste potential.
- Nanoparticle-based silver products rely on silver metal particles that do not easily dissolve in water, providing a less-than uniform finish.

SILVADUR™ vs. Silver Chloride and Particle Based Systems

- Traditional silver-based antimicrobials deliver silver particles to the fabric surface and rely on silver particle leaching or slow dissolution of poorly-soluble silver salts to control bacteria.
- Silver particulate size and the indiscriminate release of silver can cause discoloration and reduced antimicrobial performance over time. In addition, the particulates can cause a non-uniform antimicrobial finish during the manufacturing process, leading to higher cost-to-treat and poor quality.

SILVADUR™ vs. Polymeric Quat Systems (Quat Silanes)

- Fabrics treated with **SILVADUR**™ require less heat and less time without extra binders or added steps during the application process.
- Quat Silanes can be difficult to control, requiring careful dilution, formulation and processing conditions.
- Quat Silane treated fabrics can become water repellant which requires more chemicals and costs to control hydrophobicity for customers requiring moisture management capabilities.

Unmatched Antimicrobial Protection

The SILVADUR™ Advantage vs. Traditional Antimicrobial Technologies

	SILVADUR™	Other Silver Particle Based Technologies	Quat Silanes	Zinc Pyrithione (ZPT)
Delivery System	An organic polymer-based system utilizing a patented release technology	Inorganic supported system that releases silver laced particles in the presence of water and ions	Application can be difficult to control	Dispersion or powder. Sometimes requires equipment clean-up after textile processing.
Wash Durability of Finish	Excellent durability as organic polymer system adheres to fiber	• Low to medium durability • Inorganic matrix has no attraction for the fiber surface • Needs binder to increase durability	• Antimicrobial performance lost upon use • Surface changes are neutralized upon washing • May require binders	• Requires binders on cotton • Does not have broad antimicrobial performance at concentrations below 1000 ppm typically • *Pseudomonas* can survive
Effects on Fabric Look and Feel	No effect or slight increase in hydrophilicity	Might change feel of fabric due to binder system	Makes fabric hydrophobic due to the presence of long carbon chains	May cause loss of color in synthetic fibers and fabrics
Color Stability	Colorfastness maintained	• Depending upon use level, yellowing or discoloration of white fabrics sometimes observed • Shade shift occurs with overtreatment • Potential interferences with ionic dye systems	• Depending upon use level, yellowing or discoloration of white fabrics sometimes observed • Shade shift occurs with overtreatment • Potential interferences with ionic dye systems	Depending upon use level, yellowing or discoloration of white fabrics sometimes observed

Optimal Silver Ion Delivery

SILVADUR™ technology's fully soluable polymer system delivers silver ion to the treated fabric surface for a uniform coating unlike silver and zinc pyrithione particle technologies, which leave voids in protection and accumulate between fibers. **SILVADUR™** uses less silver and generates less waste without compromising performance across the treated article.

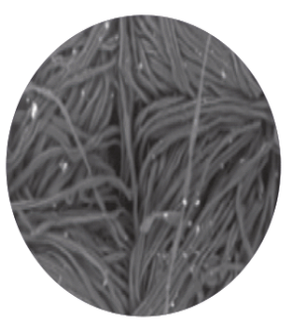
Complete Protection

Silver ion-polymer complex creates a uniform treatment on the fabric surface

DuPont Analytical Sciences

Uniform Application

Typical particle technologies deliver non-uniform treatment on fabric surfaces, thus leaving voids in treatment and protection



Fibers Text. East. Eur. 2008, 16 ,5, 101.

Performs on Synthetics

Uneven distribution of ZPT on polyester

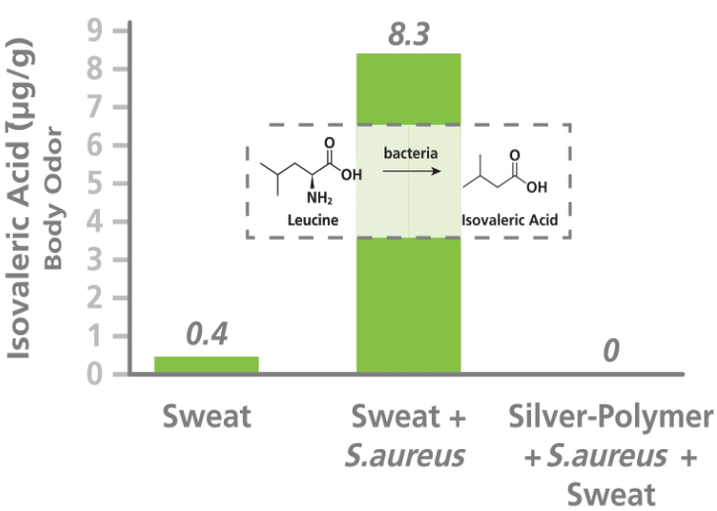
DuPont Analytical Sciences

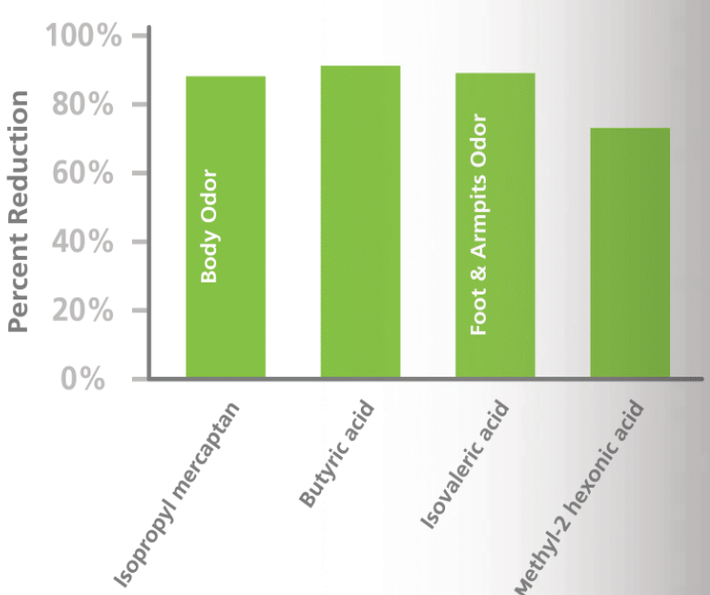
The Future of Freshness is Here

SILVADUR™ Delivers Effective & Reliable Odor Control in Textiles

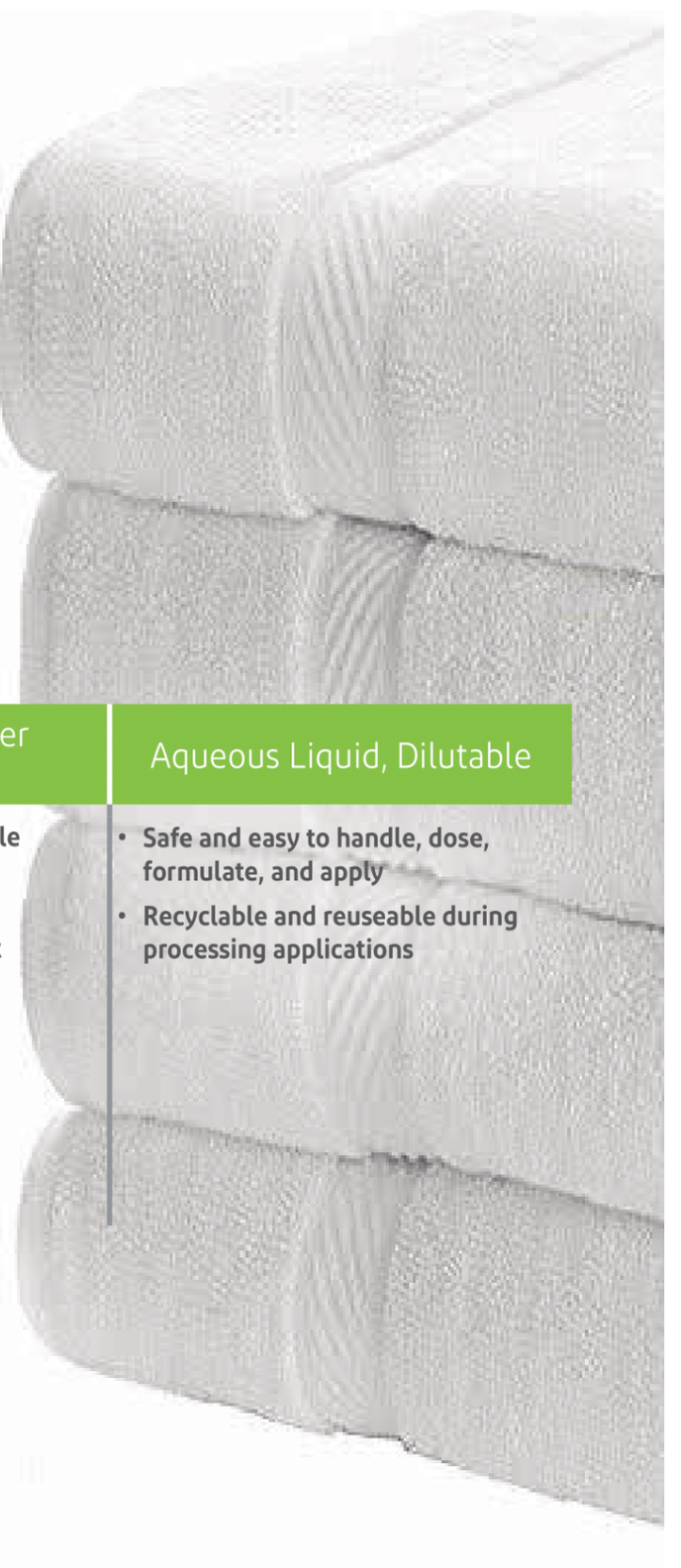
Odor is a growing concern in apparel and textile applications due to laundering limitations managing odor causing microorganisms and the odorants they produce. Key contributors to textile odor include combinations of microorganisms, human sweat, and urine.

SILVADUR™ Reduces Common & Problematic Malodors In Textiles





SILVADUR™ Advanced Polymeric Silver Ion Delivery



Complexed Silver Ion	Proprietary Polymer Delivery System	Aqueous Liquid, Dilutable
• Broad spectrum protection against microbes and mal-odorants • Can use a low silver ion dose to provide microbial and odor control	• Superior long-lasting durable performance • Patented Smart Release Technology with a feedback mechanism • Efficient pad and exhaust application • Drives uniform distribution on textiles • Heat and light stability	• Safe and easy to handle, dose, formulate, and apply • Recyclable and reuseable during processing applications

SILVADUR™: Approved by Leading Ecological Certification Programs

International OEKO-TEX® Association

SILVADUR™ is recognized and listed as an Active Chemical Product (with biological activity) by the International OEKO-TEX® Association as a formulation that has been assessed to be harmless to human health, provided it is used as indicated and designated.

A bluesign® System Partner

SILVADUR™ is committed to applying the bluesign® system by:

- Being a responsibly acting party of the textile supply chain
- Continuously improving environmental performance
- Focusing on a sustainable future

A bluesign® Approved Chemical Product

- Complies with the strict ecological and toxicological requirements of the bluesign® criteria
- Properly applied it allows production with a minimum impact on people and the environment
- Basis for bluesign® approved textiles and accessories

OEKO-TEX®
CONFIDENCE IN TEXTILES

bluesign®
SYSTEM PARTNER

bluesign®
APPROVED

Advanced, Sustainable Antimicrobial Technology

Efficient, Effective, Ecological Odor Control

Highly effective

Extensive testing proves **SILVADUR**™ is highly effective in protecting fabrics from odor-causing and other nuisance microorganisms.

A battery of third-party clinical studies was performed on fabric treated with **SILVADUR**™ These studies were used to evaluate the potential for **SILVADUR**™ to cause skin irritation or skin sensitization in humans. These evaluations found no evidence that **SILVADUR**™ when applied to fabrics at up to 10 times higher than recommended levels either irritates or causes sensitization in humans.

Safe and non-sensitizing

SILVADUR™ treated articles are non-sensitizing and non-irritating to humans.

21-Day Cumulative Irritation Patch Tests of **SILVADUR**™ on Cotton and Polyester Fabrics demonstrate no evidence of skin irritation among the participants of the cotton and polyester tests at any observation period.

Ecologically friendly

SILVADUR™ is recyclable and reusable during processing applications due to its inherent light stability and water solubility.

Saves resources

SILVADUR™ helps processing plants reduce their overall raw material purchases and usage of energy and water.

Long lasting odor protection

Less laundry saves consumers time, energy, water and money.

SILVADUR™ technology provides durable, sustainable odor control solutions for textiles

Consumers want odor control features and are WILLING TO PAY MORE for them*

A comprehensive, global consumer study confirmed that odors are a universal problem and consumers are looking for odor prevention solutions in textiles.*:

Odors are a global problem. Nine out of ten consumers indicate that body odor (sweat) in fabrics is a "major" problem. Other problematic odors include:

- Musty smell
- In the hamper - after wear and before laundering
- During wear or use

74% of consumers want apparel and home fabrics manufactured with odor control/ protection.

89% of consumers would prefer items treated with INTELLIFRESH,™ powered by SILVADUR,™ odor protection for items they purchase often.

consumers are willing to PAY up to **30%** MORE for odor control depending on the item

*DuPont Global Consumer Online Survey of 5,040 consumers ages 18 to 70, in China, US, Japan, India, Germany and France conducted in 2019

Backed by The DuPont Company

DuPont combines the power of science and technology to passionately innovate technologies and processes that are essential to human progress. Our employees connect chemistry and innovation with the principles of sustainability to provide our customers and consumers with solutions that make lives better.

DUPONT™

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PRODUCTS OF LIMING GROUP / BEN TECH CHEMICAL

WARP SIZING

- Modified Starch
- Tapioca Starch
- PVA
- CMS
- Acrylic Size
- Compound Size
- One Shot Size
- Sizing Wax
- After Wax
- After Oil
- Filament Size
- Anti-static Agent

DYESTUFFS

- Disperse Dyes
- Reactive Dyes
- Direct Dyes
- Acid Dyes
- Basic Dyes
- Sulphur Dyes
- Indigo Dyes
- Optical Brightening Agent

GARMENTS WASH

- De-sizing Enzyme
- Anti-Back Staining Agent
- Nutral Biopolish Enzyme
- Acid Biopolish Enzyme
- Stone-free Enzyme

DYEING AUXILIARIES

1 PRE-TREATMENT

- De-sizing Enzyme
- Scouring Agent
- Sequestering Agent
- Wetting Agent
- Mercerizing Agent
- Stabilizer for H2O2
- Killer of H2O2
- Three-in-one Agent

2 DYEING PROCESS

- Levelling Agent
- Dispersing Agent
- Wetting Agent
- Anti-crease Agent
- Soaping Agent
- Retarding Agent
- Anti Yellowing Agent
- Defoamer
- Anti-migration Agent
- Reduction Cleaning Agent
- Fixing Agent

3 FINISHING PROCESS

- Non-ionic Softener
- Cationic Softener
- Silicone Softener
- Hydrophilic Softener
- PE-wax Emulsion
- Water Repellent Agent
- Cross-lingking Agent
- Raising Agent
- Anti-pilling Agent

BASIC CHEMICALS

- Glacial Acetic Acid (GAA)
- Organic Acid
- Paraformaldehyde 92%, 96%
- Paraffin Wax
- Melamine Powder
- 1,4 - BDO

WASTE WATER TREATMENT

- De-coloring Agent
- Polymer (Polyelectrolyte)
- Poly Aluminium Chloride (PAC)

NOTE

NOTE

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