Acteev Medical Introduction

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Ascend Performance Materials

Who we are?

- 70-year history in revolutionizing safety in everyday products
- Leading innovator in performance materials **made in the USA**
- **World's largest** fully integrated polyamide **6,6** resin manufacturer
- Currently generate $2.5 B in annual revenue
- **Pioneering** path for new standards in bacteria-, virus- and microbe-fighting technologies

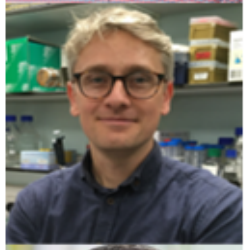
Acteev is supported by the medical board

Dr. Karoll Cortez, *Greater Baltimore Medical Center*
Interest | Expertise: regulatory, infectious disease, clinical trials

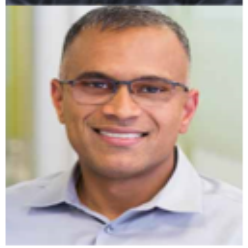
Dr. Athanasios (Tom) Harmantas, *St. Joseph's Health Centre*
Interest | Expertise: head & neck, endocrine

Professor Raina MacIntyre, *UNSW*
Interest | Expertise: infectious disease, clinical trials

Professor Christopher McDevitt, *University of Melbourne*
Interest | Expertise: microbiology



Professor AJ te Velthuis, *Princeton University*
Interest | Expertise: virology



Dr. Vikram Gopal, *Ascend Performance Materials*
Title: SVP & Chief Technology Officer

Who is Acteev, LLC?

Acteev is changing the way companies and consumers think about their everyday items. From textile, filtration to medical applications, Acteev's technology can be used across multiple industries to help create cleaner, microbe free products.

What is Acteev?

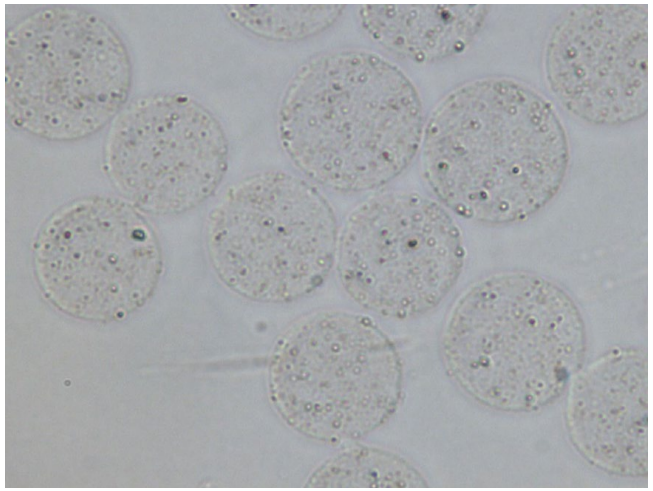
- Acteev is a nylon polymer with a **zinc ion technology** imbedded into the polymer matrix during the polymerization process
- The active zinc ion delivers **antimicrobial** properties throughout that advance wound care dressing application
- Acteev reduces **odor** causing bacteria
- The protection offered by Acteev is **non-cytotoxic, natural** and **permanent**
- Acteev will **not interfere with new cells** growth
- Acteev hasn't shown any signs of **bacteria resistance**

The Acteev Technology

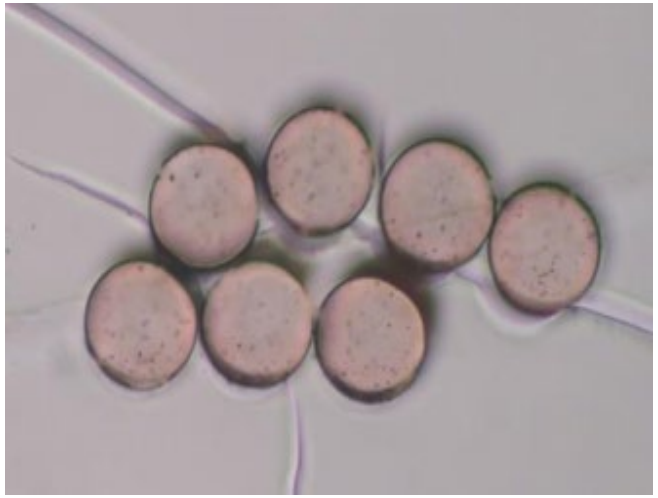
Acteev is a high-durability antimicrobial polymer that can be dyed finished and treated like standard polymers.

- The active ingredient is added in such a way as to be distributed throughout the polymer matrix. Is not a particle in the polymer.

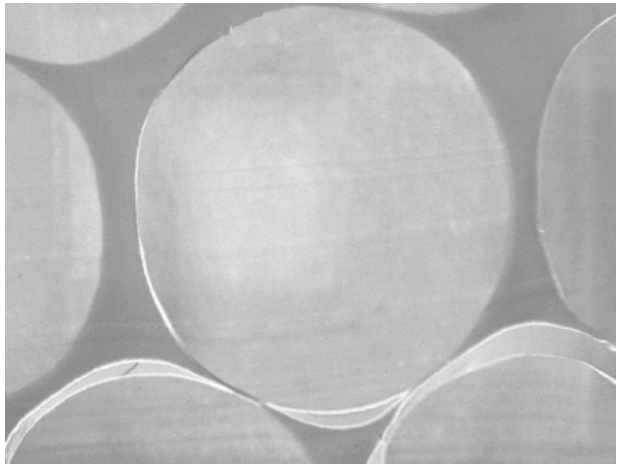
- Ingredients are added during the polymerization process, leaving them dispersed at the molecular level, providing a large reservoir of the active ingredient



Compounded



Silver Coated



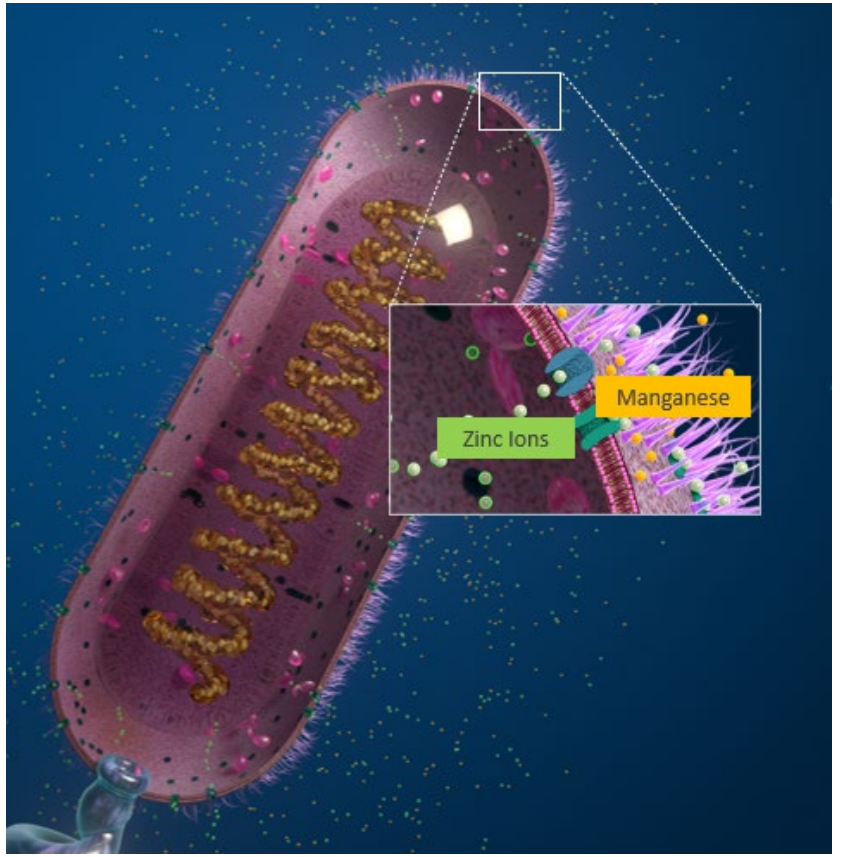
Polymerized

Different than other antimicrobials

How it Works

Bacteria are living creatures — and they need nutrients to survive. When bacteria contacts Acteev, the **active zinc ions block their ability to process essential nutrients.** Without these nutrients**, the bacteria "starve" and are unable to survive.**

- Effective against Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Candida auris, Candida albicans



Safety First

Unlike the few bacteria-killing, chemical coatings currently available, zinc active is safe and all-natural

- Acteev's active ingredient zinc is labeled GRAS, or Generally Regarded as Safe by the U.S. Food and Drug Administration
  - Non cytotoxic
  - Bacterial static

Backed by science – Bacteria and Fungus

Acteev MED

Independent laboratories have tested Acteev technology against common bacterial and fungal strains.

Microbe	Test Method
Staphylococcus aureus	ISO 20743
Klebsiella pneumoniae	ISO 20743
Escherichia coli	ASTM E3160
Candida auris	ASTM E3160
Candida albicans	ASTM E3160
Aspergillus brasiliensis Penicillium funiculosum Chaetomium globosum Trichoderma virens Aureobasidium pullulans	ASTM G21

Acteev's antimicrobial technology is embedded to protect the product. The product does not protect users or others against disease-causing bacteria, viruses, germs or other organisms. *Bioefficacy data (including antibacterial and antifungal) cannot be used on marketing materials, packaging or digital content in association with Acteev Protect even when referencing Acteev Technology. Regulations in other countries may differ. This presentation is for discussion purposes only. Consumer-facing literature and claims need to follow the appropriate regulatory and legal validation and review process.*

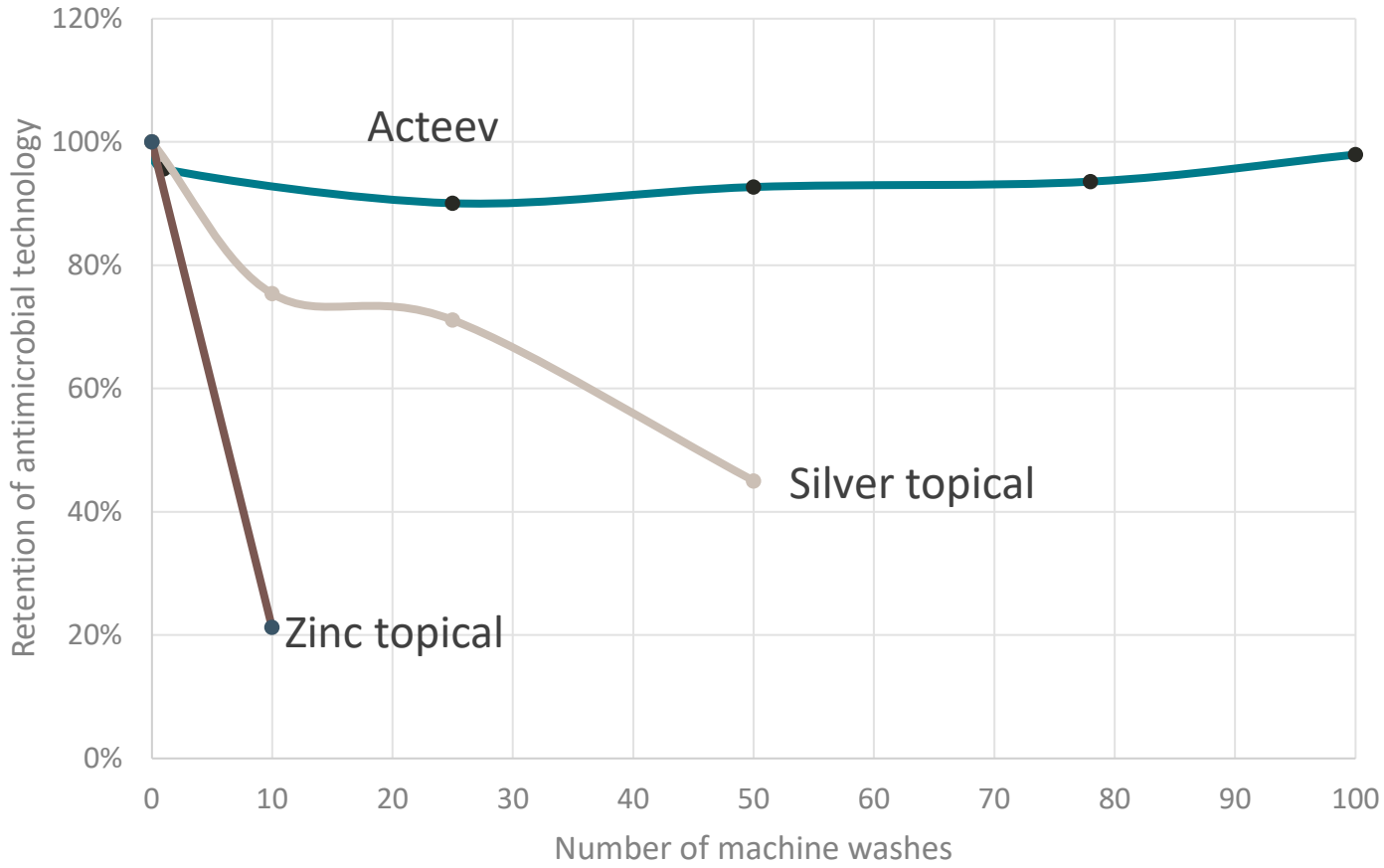
Testing conducted on various end forms. Please refer to technical data sheet for data on specific products.

[1] Testing conducted on Acteev Protect fabric made with 70 denier/68 filament yarn and filaments.

Permanency of Acteev Technology

- Purchased commercial samples of different technologies
- Measured active ingredients of each sample and Acteev sample
- Washed samples for a prescribed number of times per AATCC protocol
- Remeasured active ingredients to determine loss

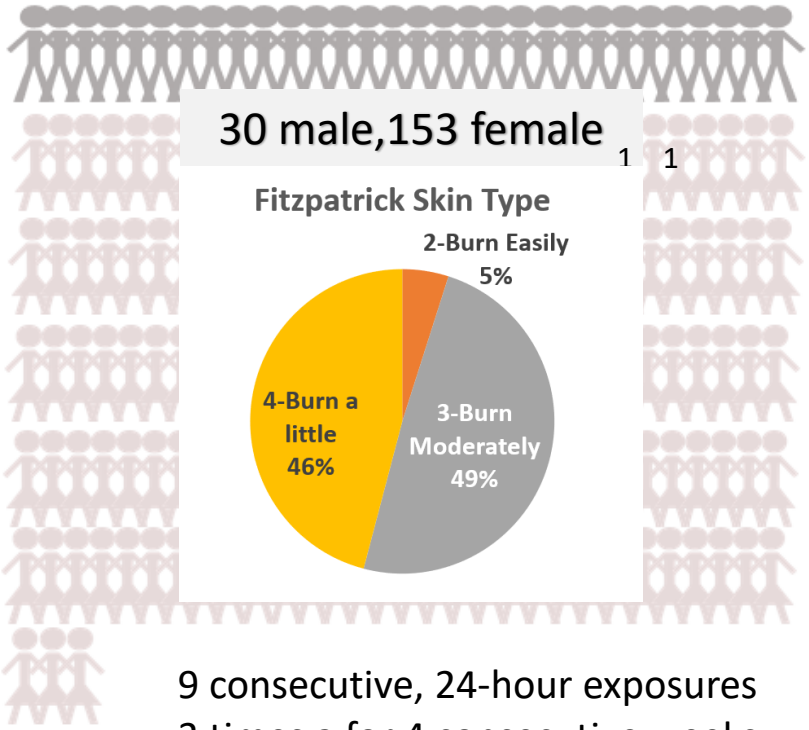
Acteev samples washed by ATTCC protocol with other commercial technologies resulting in a superior efficacy over time.



Human Skin Testing

Acteev Substrates including Knits and Nonwoven containing Acteev were "dermatologically tested and under the conditions of this study there was no indication of a potential elicit dermal irritation or sensitization (no contact allergy) noted.*"

METHODS:



9 consecutive, 24-hour exposures
3 times a for 4 consecutive weeks

RESULTS:

According to the International Contact Dermatitis Research Group scoring scale[2],

100% of the subjects scored
0 = Negative or
No reaction

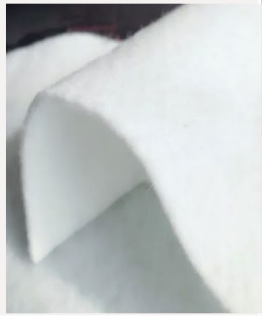
* 34gsm Acteev MED spunbond/natural Acteev knit used for testing conducted at independent laboratory

[1] Agache P, et.al. Measuring the skin, Springer-Verlag Berlin Heidelberg, 2004, p473
[2] Rietschel, R.L, et.al. Fisher's Contact Dermatitis 4th ed. Baltimore, Williams & Wilkins, 1995

Moisture and Pressure Management Capabilities

Acteev MED

Acteev is available in multiple form factors and versatile enough to meet any product design requirements.

	Material	Wicking	Bulk Absorption	Transfer	Pressure Management
	Textile Fabric: 100% Acteev	●			
	Textile Fabric: Acteev & Spandex	●			●
	Needle Punch: 100% Acteev				●
	Needle Punch: Acteev blend 70/30	●	●		●
	Spunlace: 100% Acteev			●	
	Spunlace: Acteev blend 70/30	●			
	Spunbond			●	

Versatility of Value Chain

Through our different level of partners and business models, we can be a supplier throughout the value chain and provide a variety of form factors.

Pressure Ulcers

- The global pressure ulcers treatment market was worth around USD 4.50 billion in 2021
- Estimated to grow to about USD 6.41 billion by 2028, with a compound annual growth rate (CAGR) of approximately 6.10 over the forecast period.
- The pressure ulcers treatment market was valued at USD 4,493.75 million in 2021,
- Expected to reach USD 6,375.58 million by 2027, registering a CAGR of 6.24% during the period of 2022-2027.

Pressure Ulcers

Cause

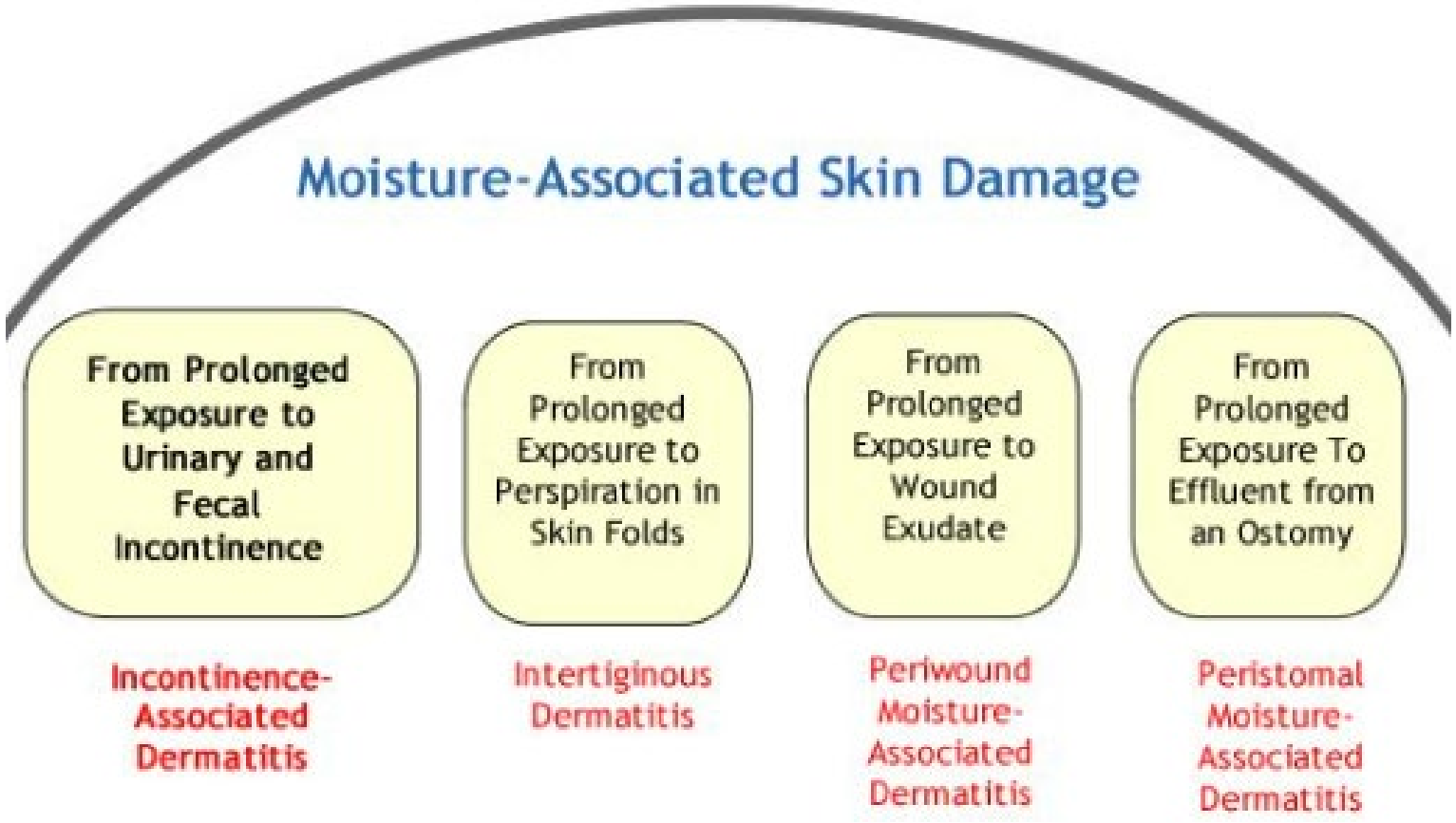
1.External (interface) pressure applied over an area of the body, especially over the bony prominences can result in obstruction of the blood capillaries, which deprives tissues of oxygen and nutrients, causing ischemia, hypoxia, edema, inflammation, and, finally, necrosis and ulcer formation. Ulcers due to external pressure occur over the sacrum and coccyx, followed by the trochanter and the calcaneus (heel).

2.Friction is damaging to the superficial blood vessels directly under the skin. It occurs when two surfaces rub against each other. The skin over the elbows can be injured due to friction. The back can also be injured when patients are pulled or slid over bed sheets while being moved up in bed or transferred onto a stretcher.

3.Shearing is a separation of the skin from underlying tissues. When a patient is partially sitting up in bed, skin may stick to the sheet, making the skin susceptible to shearing in case underlying tissues move downward with the body toward the foot of the bed. This may also be possible on a patient who slides down while sitting in a chair.

4.Moisture is also a common pressure ulcer culprit. Sweat, urine, feces, or excessive wound drainage can further exacerbate the damage done by pressure, friction, and shear. It can contribute to maceration of surrounding skin thus potentially expanding the deleterious effects of pressure ulcers.

Moisture Associated Dermatitis



- Textiles used for moisture and friction management are specialty medical fabrics designed to help manage and prevent skin complications associated with excess moisture and friction in areas such as folds in the skin (>$100M US market)

Potential Collaboration Opportunities

Opportunity	Problem to be Addressed
Moisture Wicking Antibacterial Material	• Cutting of the material • Cytotoxicty • Silver acceptance in a global market

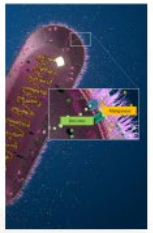
Application of Zinc Ion Embedded Nylon Antimicrobial Technology for Design Flexibility of Wound Dressings

Dr. Kyoung Woo Kim, Keh Dema, Victor Kholodkov, Dr. Kevin Urman, Dr. Rajib Mondal
Ascend Performance Materials, Texas, United States

Introduction

Wound healing is a dynamic and complex process that follows several phases of healing.1 Advanced wound dressings are specifically designed to promote these phases and/or a particular pathological condition. Most wound dressings are composite products with a combination of materials to incorporate various features, including antimicrobial properties. Incorporating the antimicrobial technology in the dressing typically involves additional manufacturing steps and is sometimes not feasible for certain components due to material processing limitations. A novel polymer based on high performance nylon which incorporates and maintains zinc in its ionic form was developed. It was converted into multiple forms with different features without any additional coating, chemicals, or textile processing to offer design flexibility of modern wound dressings.

Zinc–Effective, Yet Safe and All-natural Antimicrobial Option



- Zinc has proven therapeutic benefits and is commonly applied to soothe the skin.
- Zn^{2+} induces Mn^{2+} starvation, resulting in bactericidal behavior[2]
- Active Zinc ingredient is labeled GRAS, or Generally Regarded as Safe, by the U.S. Food and Drug Administration
- Various end-forms demonstrated effective antibacterial and antifungal properties while tested to be non-cytotoxic while exposed to exposing the extract fluid to mouse fibroblast cells.

Independent laboratories have tested various end forms for efficacy against common bacterial and fungal strains

Microbe	Efficacy	Test Method
Staphylococcus aureus	>99.99%[i]	ISO 20743
Klebsiella pneumoniae	>99.99%[i]	ISO 20743
Escherichia coli	>99.99%[i]	ASTM E3160
Candida albicans	99.3%[ii]	ASTM E3160
Candida auris	99.3%[ii]	ASTM E3160
Aspergillus brasiliensis *Penicillium funiculosum* *Chaetomium globosum* *Trichoderma viens* *Aureobasidium pullulans*	No Growth	ASTM G21

[i] Testing conducted on Acteev Protect fabric made with 70 denier/68 filament yarn and filaments. [ii] Testing conducted on Acteev Protect 34 gsm spunbond material.

Design Flexibility of Wound Dressings

- Wound dressings are composed of various layers of materials, having different moisture and pressure management properties.
- Desired antimicrobial properties in these layers are typically imparted by topical treatment or by using electroplated fibers/textiles

Electroplated Fibers and Textiles	Limits dyeability and physical properties: Wicking, absorption, abrasion.
Topical Treatment	Applied after dyeing through dye bath, pad, plasma treatment, foams, and spray coating. Limited to some end-forms.
Novel Zinc Embedded Polymer	Zinc added during the polymerization process, leaving Zinc ions dispersed at the molecular level. Maintains nylon properties: dyeability, wicking, absorption, conformability.

Example of Simplified Antimicrobial Wound Pad Manufacturing Process

Zinc ion embedded Nylon 66 → **Staple Fiber** (1.7 dpf, 38 mm) → **Needle Punch Nonwoven** (Soft, moisture wicking, highly absorptive, anti-odor, anti-microbial)

Variable physical properties of different end-forms made with Zinc Ion Embedded Nylon

Form Factor	Basis Weight	Thickness	Apparent Density	Air Permeability	Wicking	Bulk Absorption
	gsm ASTM D3776	mm Min press. 0.1 kPa	g/cc	cfm ASTM D737	mm Ref. # 2	g/g (%) Ref. # 2
Circular Knit	125	0.51	0.245	276	83	278%
Warp Knit	285	0.65	0.439	39	3	145%
Spunbond-1	10	0.11	0.091	>1500	1	916%
Spunbond-2	34	0.26	0.131	1065	2	462%
Spunlace-1	60	0.76	0.079	529	42	770%
Spunlace-2	110	0.74	0.149	258	67	487%
Needlepunch-1	120	2.19	0.055	445	18	1543%
Needlepunch-2	300	3.51	0.085	180	38	1100%
Needlepunch-3	650	5.57	0.117	40	70	800%

Methods

1. During polymerization of nylon 66, active Zinc was introduced.
2. Zinc polymer was utilized to create various forms, such as spunbond, spunlace (hydroentanglement), needle-punch non-woven, warp-knit, and circular knit textiles.
3. Basis weight, air permeability, moisture wicking, bulk absorption were measured as per ASTM methods. Dyeability, cytotoxicity were tested.
4. Retention of Zinc was determined by before and after laundering analysis after 100 washes as per AATCC protocol.
5. Antimicrobial efficacy against gram-positive and gram-negative bacterial strains using industry standard ISO20743 as a testing framework was conducted.

Results and Discussion

Simplified and streamlined manufacturing process commonly used for fibers, was adopted without any manufacturing challenges to produce various antimicrobial substrates with zinc embedded nylon technology. The versatility in performances was demonstrated. Apparent densities of 0.1 g/cc to 0.2 g/cc were achieved. Vertical wicking was tuned from 0 mm to 100 mm. Bulk absorptions of these forms were also varied from 2 to 15 times of its initial weight. Laundering 100 times does not impact the concentration of the active ingredient in the polymer with zinc retention over 90%. All these forms showed very good antibacterial properties, up to 5-7 log reduction, while tested against S. aureus and K. pneumonia.

Conclusion

Modern wound dressing are composite products with various layers providing specific moisture and pressure management characteristics along with antimicrobial properties. This novel polymer technology demonstrated the capability of achieving variable properties, while maintaining good antibacterial efficacy. A simplified manufacturing process is now possible that can be incorporated to design modern antimicrobial wound dressings. Performance against skin and wounds would need to be studied.

References:

1. Wallace HA, Basehore BM, Zito PM. Wound Healing Phases. [Updated 2022 Aug 25]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470443/
2. McDevitt CA, Ogunniyi AD, Valkov E, Lawrence MC, Kobe B, McEwan AG, Paton JC. A molecular mechanism for bacterial susceptibility to zinc. PLoS Pathog. 2011 Nov;7(11):e1002357.
3. Cruz J, Leitão A, Silveira D, Pichandi S, Pinto M, Fangueiro R. Study of moisture absorption characteristics of cotton terry towel fabrics. Procedia Engineering, 2017, vol. 200, p389-398.

ACTEEV SPUNLACE | APM22309

General Information	
Description	SPUNLACE, MADE WITH 1.7 DENIER, 38 mm STAPLE FIBER, NYLON and 1.5 DENIER, 38 mm STAPLE FIBER, LYOCELL
Application	Traditional Wound Care, Advanced Wound Care, Compression, Patient Positioning, Moisture Transfer
Product Functionality	Product is protected by a zinc based antimicrobial agent to inhibit the growth of bacteria and fungi caused by unwanted odors. The product has also been tested and showed no skin irritation or sensitization.

Product Properties

Property	Typical Values	Units	Testing Method
Fabric Weight	123	gsm	ASTM D646
Thickness	0.72	mm	Min. Pressure 0.1 kPa
Air Permeability	138	cfm/ft²	ASTM D737
Wicking	100	mm	Ref*
Bulk Absorption	575	g/g (%)	Ref*
Breaking Strength and Elongation	Machine Dir 67/45% Cross machine 60/61%	lbf/%	ASTM 5034

*Cruz J, Leitão A, Silveira D, Pichandi S, Pinto M, Fangueiro R. Study of moisture absorption characteristics of cotton terry towel fabrics. Procedia Engineering, **2017**, vol. 200, p389-398.

Current applications

Acteev MED

Traditional Wound Care

Advance Wound Care

Sutures

Compression

Sport Braces