



## Moving Cotton Textiles into the 21<sup>st</sup> Century Through Technology



# *Argaman's Corporate Goal*

*We seek to dominate the specialty textile industry by producing superior and proprietary textiles by introducing low cost, environmentally compatible finishing processes at fiber level entry into textiles and master batch entry into polymers. Our fabrics change textiles from being passive to becoming active.*

# *What We Do and How We Do It*

Argaman has 3 platform technologies that specifically apply to space travel needs. Each category covers a variety of products as will be shown

- I. Ultrasonic Cavitation which is branded as CottonX
- II. Polymer additives which are branded as Feelament
- III. Temperature Control textiles which are branded as CoreBody

**Every textile product can be made using one of our technologies with no noticeable change to the product.**

Only a few examples of each technology are presented here.



# CottonX - Ultra Sonic Cavitation



# What is Ultrasonic Cavitation?

Applying high-intensity ultrasound to water introduces enormous mechanical strains. These are powerful enough to actually rupture (“tear apart”) the liquid, leaving small cavities in the water.

These cavitation bubbles rapidly collapse, releasing tremendous amounts of energy as **heat** and **intense shockwaves**.

This energy is transferred to the chemistry which propels it like a bullet into the individual fibers.

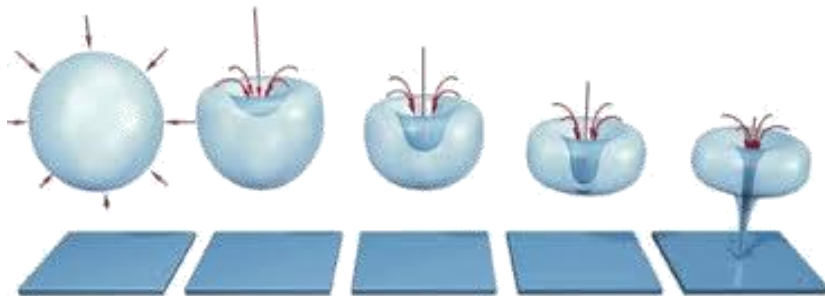
# Our Ultrasonic Magic

Cavitation bubbles collapse at 2,000 atmospheres and 5,000C, causing extraordinarily powerful **shockwaves**.

Using the clean **energy** of ultrasound, we simply **blast** our chemistry into fibers.

The high-speed chemical particles embed into fibers like **arrows shot into a tree**.

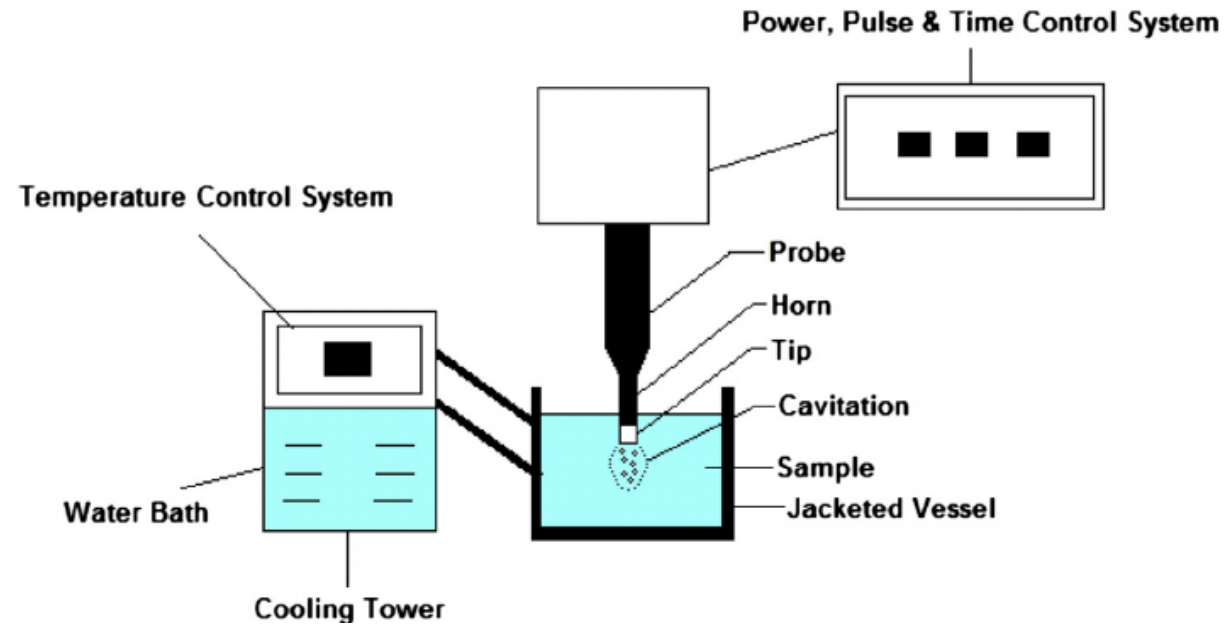
Our fibers now have unique and value-added properties .



**Shockwave!**

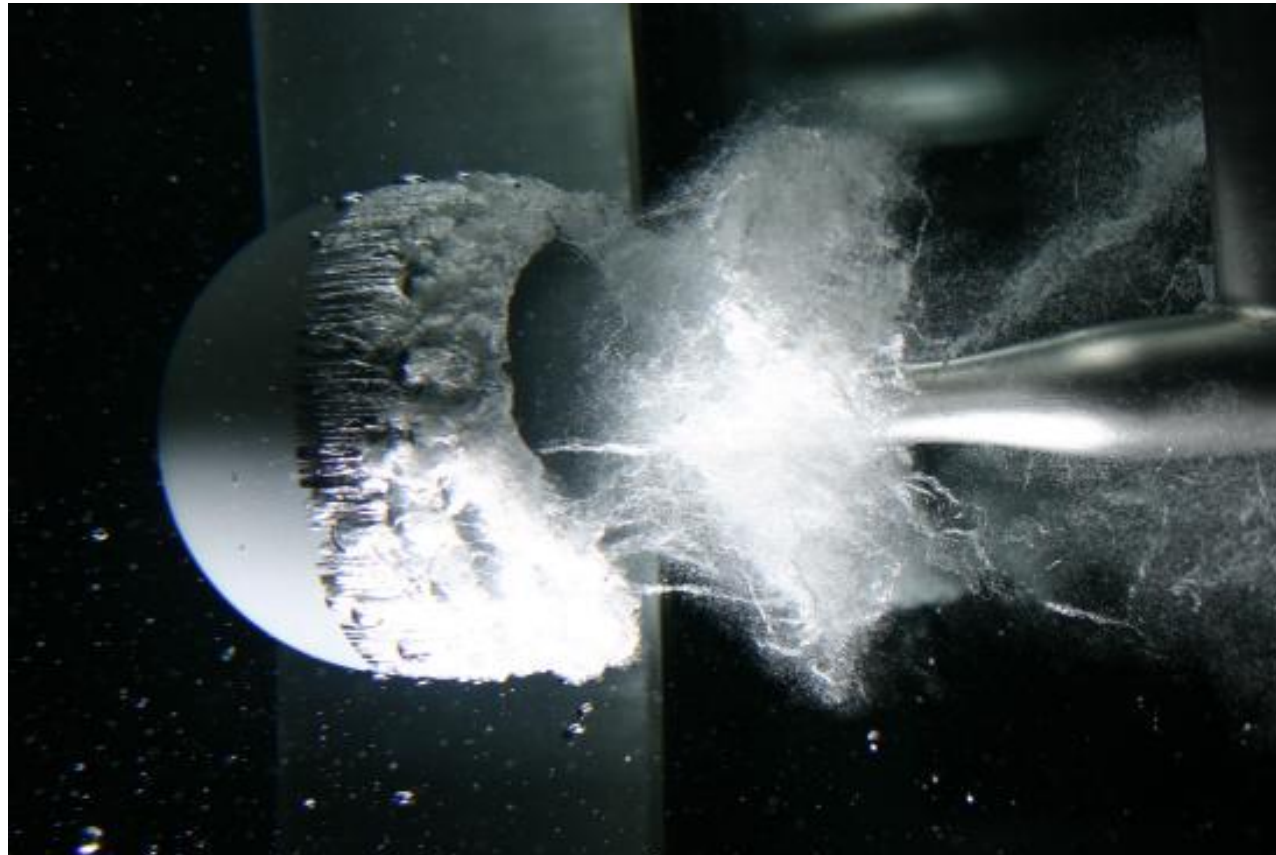


# How It's Done





# An Electron Microscope Photo of an Imploding Micro-Bubble





# *What Can We Do with Cavitation?*

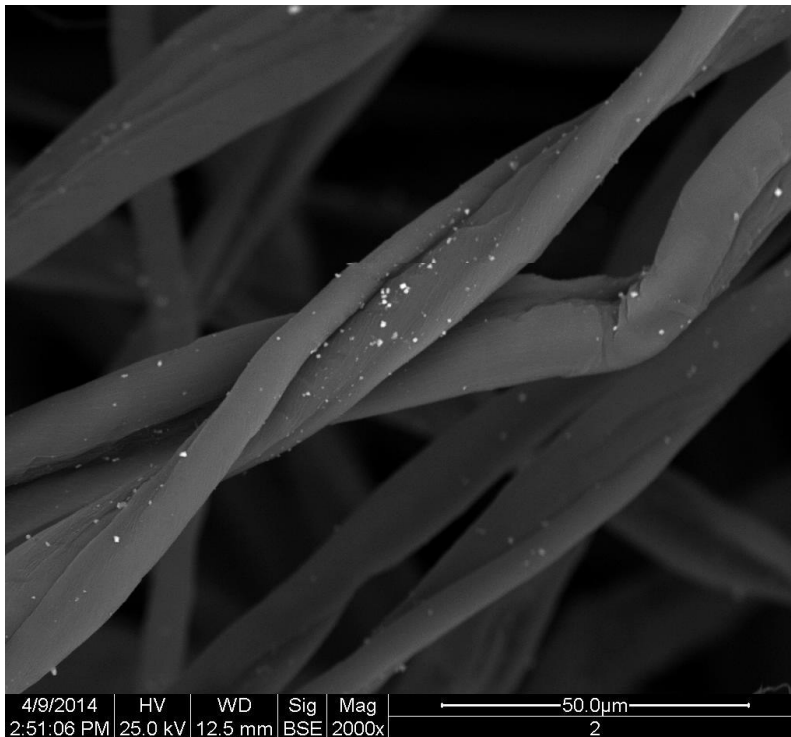
1. Self-sterilizing fabrics to control HAIs - A recently completed CDC study has proven a 50% reduction in MDROs and a 25% reduction in HAIs
2. Wound healing products – gauze and diabetic socks
3. Fabrics that reduce facial wrinkles and treat acne
4. Cotton that doesn't ignite – ever!
5. Wash less – use more products/always fresh
6. Cotton that shields against radiation and conducts electricity

There's more – lots more.

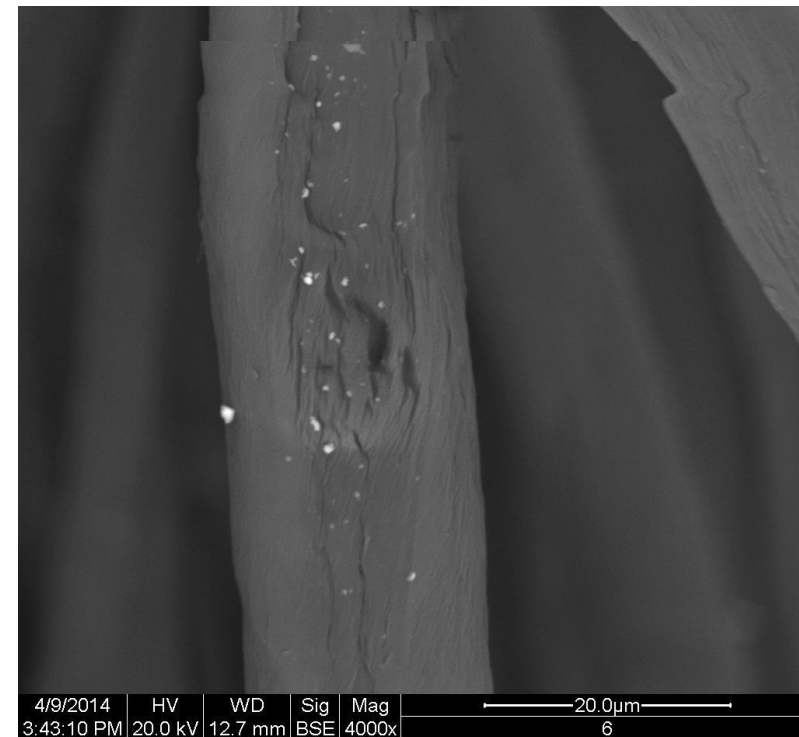


# What a Cavitated Fiber Looks like under an Electron Microscope

**After 20 abrasive washings**



**Internal examination of fiber**



# Self-sterilizing/disinfecting Vs. **Antimicrobial**

- An **antimicrobial** is an agent that kills microorganisms or stops their growth but not necessarily for any length of time.
- **Sterilization and disinfection are** absolute terms, i.e. the article must be microbe free all the time under all circumstances.
- CDC sponsored clinical trial demonstrated a reduction in MDROs by 25% when only beddings and gowns changed. Evidence Based Data.



# CDC Sponsored Test Results

University of Pennsylvania Medical School Hospital

Randomized Controlled Study

## Results:

- 25% in Hospital Acquired Infections
  - 50% reduction in MDROs in ward
- 
- January 12, 2016 through July 31, 2016
  - 1,021 patients in Medical and Surgical ICUs
  - Change of beddings and patient gowns (only)
  - Evidence Based Medical Proof





# A Randomized Controlled Trial of the Effect of Accelerated Copper Textiles on Healthcare-Associated Infections and Multidrug-Resistant Organisms: The “Investigating Microbial Pathogen Activity of Copper Textiles” (IMPACT) Study

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## Background

- Healthcare-associated infections (HAIs) occur in as many as 10% of hospitalized patients and up to 75% are due to resistant organisms.
- Environmental surfaces are frequent reservoirs for pathogens causing HAIs including multidrug-resistant organisms (MDROs).
- Considerable variability in cleaning methods across institutions
- <50% of surfaces decontaminated by terminal room cleaning
- Copper is an essential trace element with antimicrobial properties
- Recent studies noted significantly lower concentrations of micro-organisms (including MDROs) on copper containing environmental hard surfaces (e.g., door handles) compared to control surfaces
- Few data on impact of copper on clinical outcomes (HAIs, MDROs)
- Results of past studies have conflicted. Some have noted reductions in MDROs with use of copper products while others have not.
- Past studies limited by focusing on unique populations; failure to control for differences in study groups; and limited analyses.
- Studies have also varied considerably with regard to definitions of outcomes as well as whether MDROs were assessed as outcomes

## Objective

- We conducted a randomized controlled trial (RCT) in medical and surgical ICU populations to determine the impact of use of CottonX™ accelerated copper textiles (CTs) on HAIs and MDROs.

## Methods

- This randomized controlled trial (RCT) was conducted at the Hospital of the University of Pennsylvania, a 725-bed quaternary care center.
- Subjects enrolled in the Medical ICU (MICU), and Surgical ICU (SICU).
- The primary intervention was use of copper textiles (CTs) (CottonX™ accelerated copper linens, Argaman Technologies, Ltd.) in patient room.
- 4 products: 1) fitted sheet; 2) flat sheet; 3) pillowcase cover; 4) gown.
- Primary outcome of interest: development of a new HAI and/or MDRO.
- Any HAI or MDRO occurring between day three of the ICU stay through two days after ICU discharge was included
- All new MDROs were identified based on clinical cultures obtained as part of routine clinical care. MDROs were defined as one of the following: 1) methicillin-resistant Staphylococcus aureus (MRSA); 2) vancomycin-resistant enterococcus (VRE); 3) extended spectrum (third or fourth generation) cephalosporin-resistant Enterobacteriaceae (ESCR-EB); and 4) carbapenem-resistant Enterobacteriaceae (CRE).
- A subject could have more than one outcome during ICU stay.
- A subject could be included for distinct stays (or “episodes”) in the ICU.
- Data included baseline variables and variables during follow up.
- Primary outcome was number of new HAIs and MDROs per 1000 patient days. Poisson regression model used to compare rates of events in the two study groups

## Results

- Subjects enrolled from January 12, 2016 through July 31, 2016
- The 1,021 subjects accounted for 1,205 study episodes
- 351 (29%) were in CT rooms, 854 (71%) were in non-CT rooms

**Table 1.** Baseline Variables in Copper Textile (CT) and non-CT Rooms

Variable	Copper (n = 351 ) No (%)	Non-Copper (n = 854) No (%)
Age, median years (IQR)	62 (18.5)	61 (21)
Female sex, no. (%)	157 (45)	364 (43)
Non-White race, no. (%)	106 (33)	285 (36)
Length of stay prior to ICU, median days (IQR)	1 (5)	1 (4)
Recent antibiotic use <sup>a</sup> , no. (%)	290 (83)	727 (85)
Presence of surgical wound (f. no. (%) <sup>b</sup>	127 (36)	262 (31)
Presence of open surgical wound, no. (%) <sup>b</sup>	27 (7.7)	43 (5)
Presence of sacral decubitus ulcer, no. (%) <sup>b</sup>	12 (3.4)	32 (3.7)
Presence of urinary catheter, no. (%) <sup>b</sup>	237 (68)	551 (65)
Presence of central venous catheter, no. (%) <sup>b</sup>	104 (30)	276 (32)
Presence of feeding tube, no. (%) <sup>b,c</sup>	53 (15)	146 (17)
Presence of ventilator use or trach, no. (%) <sup>b</sup>	119 (34)	329 (39)
Hepatic dysfunction, no. (%) <sup>b</sup>	54 (15)	157 (18)
Diabetes mellitus, no. (%) <sup>b</sup>	107 (31)	253 (30)
Renal dysfunction, no. (%) <sup>b</sup>	58 (17)	148 (17)
Malignancy, no. (%) <sup>b</sup>	126 (36)	292 (34)
Prior organ transplantation, no. (%) <sup>b</sup>	39 (11)	121 (14)
HIV, no. (%) <sup>b</sup>	2 (0.6)	9 (1)
APACHE II score, median score (IQR) <sup>a,b,d</sup>	22 (13)	23 (14)

**Table 2.** Longitudinal Variables in Copper Textile (CT) and non-CT Rooms

Variable	Copper (n = 351) No (%)	Non-Copper (n = 854) No (%)
<b>Comorbidities</b>		
Surgical wound: open and closed (yes/no), no. (%)	127 (36)	262 (31)
Open surgical wound (yes/no), no. (%)	27 (7.7)	43 (5)
Fecal incontinence (yes/no), no. (%)	81 (23)	242 (28)
Urinary incontinence (yes/no), no. (%)	56 (16)	117 (14)
Diarrhea (yes/no), no. (%)	92 (26)	225 (26)
CHG bath (yes/no), no. (%)	263 (75)	624 (73)
Sacral decubitus ulcer (yes/no), no. (%)	12 (3.4)	32 (3.7)
Urinary catheter (yes/no), no. (%)	247 (70)	598 (70)
Central venous catheter (yes/no), no. (%)	115 (33)	319 (37)
Ventilator use or trach (yes/no), no. (%)	134 (38)	363 (43)
Feeding tube (yes/no), no. (%) <sup>a</sup>	71 (20)	177 (21)
Rectal tube (yes/no), no. (%)	68 (19)	172 (20)
Antibiotic use (yes/no), no. (%)	276 (79)	670 (79)
Anti-CDI antibiotic use (yes/no), no. (%)	64 (18)	136 (16)
Immunosuppressive use (yes/no), no. (%)	125 (36)	289 (34)

- In the 1,205 study episodes, there were 108 outcomes.
- 78 events that qualified as HAIs and 43 that qualified as MDROs
- Overall (HAI + MDRO)** rates of outcome per 1000 patient days in the CT and non-CT groups were 11.7 and 15.4, respectively,  
**IRR (95%CI) = 0.76 (0.46, 1.19); p=0.22.**
- When including only the **HAI outcome**, the rates of HAIs/1000 patient days in the CT and non-CT groups were 10.3 and 10.4, respectively  
**IRR (95%CI) = 0.99 (0.57, 1.64); p=0.97**
- When including only **MDRO outcome**, rates of MDROs/1000 patient days in the CT and non-CT groups were 3.7 and 6.5, respectively  
**IRR (95%CI) = 0.57 (0.23, 1.26); p=0.15**
- Secondary analyses showed similar results: 1) MICU v SICU; 2) Each subject only included once; 3) only the first outcome included

## Conclusions

- Rates of the composite outcome (HAIs and/or MDROs) were ~25% lower with use of CTs, although difference not statistically significant.
- The lower composite rates in the CT group driven in large part by the incidence of new MDROs, which were over 40% lower in CT group.
- Findings were consistent among the various secondary analyses
- Future work in larger studies should further investigate the role of copper textiles in prevention of HAIs and particularly MDROs.

## Limitations

- The study was underpowered to demonstrate significant differences.
- Overall event rates lower than originally projected
- Intervention not blinded; while knowledge of room status could affect clinical practice, longitudinal variables which could reflect practice (e.g., antibiotic use, indwelling devices) were similar across groups.

## Disclosure

Authors of this presentation have nothing to disclose concerning possible financial or personal conflicts of interest. This study has been approved by the Institutional Review Board of the University of Pennsylvania.

## Acknowledgements

This work was supported by the CDC Cooperative Agreement FOA#CK000163 Epicenters for the Prevention of Healthcare Associated Infections (E.L.). Additional support was provided by the NIH grants K24-AI080942 (E.L.) and K01-AI103028 (J.H.H.). Argaman Technologies Ltd provided copper textile products for this study.

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*Hospital Acquired Infections*  
*The #1 Cause of Death in Hospitals*  
*Anecdotal Evidence Test performed in Israel*

100,000 deaths a years in the USA alone

10,000 deaths a year in the UK

	2010-2011	2011-2012	Percent Decrease	P value
Total # of HIA Infections	73	49	25%	<0.05
# of times patients given Antibiotics	53	37	30%	<0.05
Total Days of Antibiotics	762	497	34.8%	<0.0001
Fever >38.5°C	58	18	70%	<0.0001

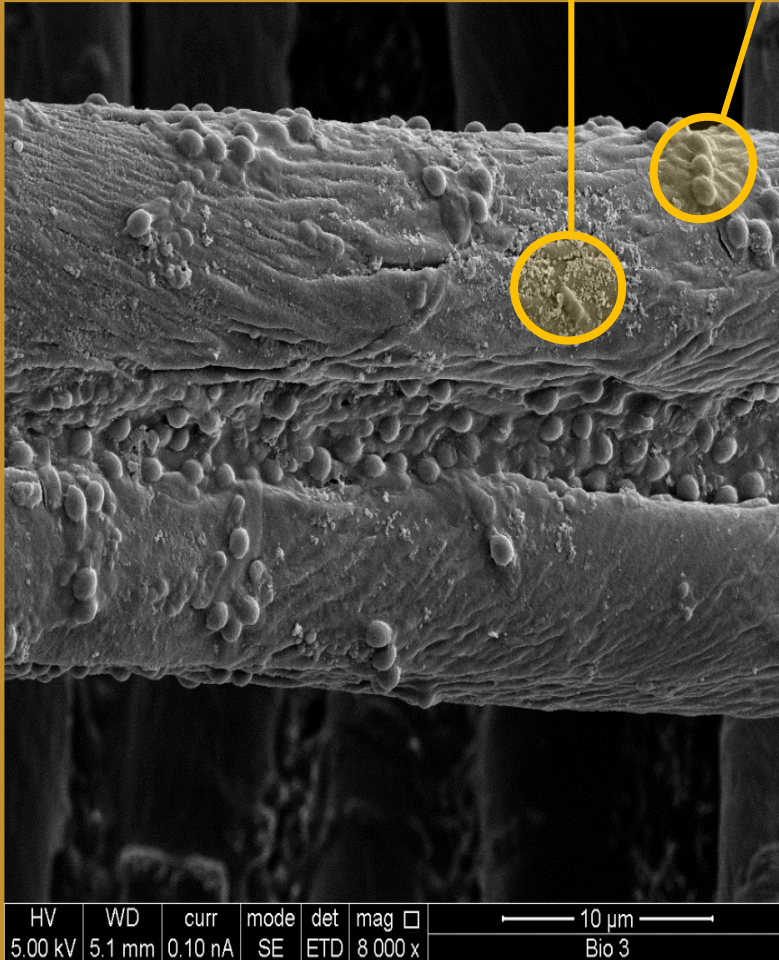




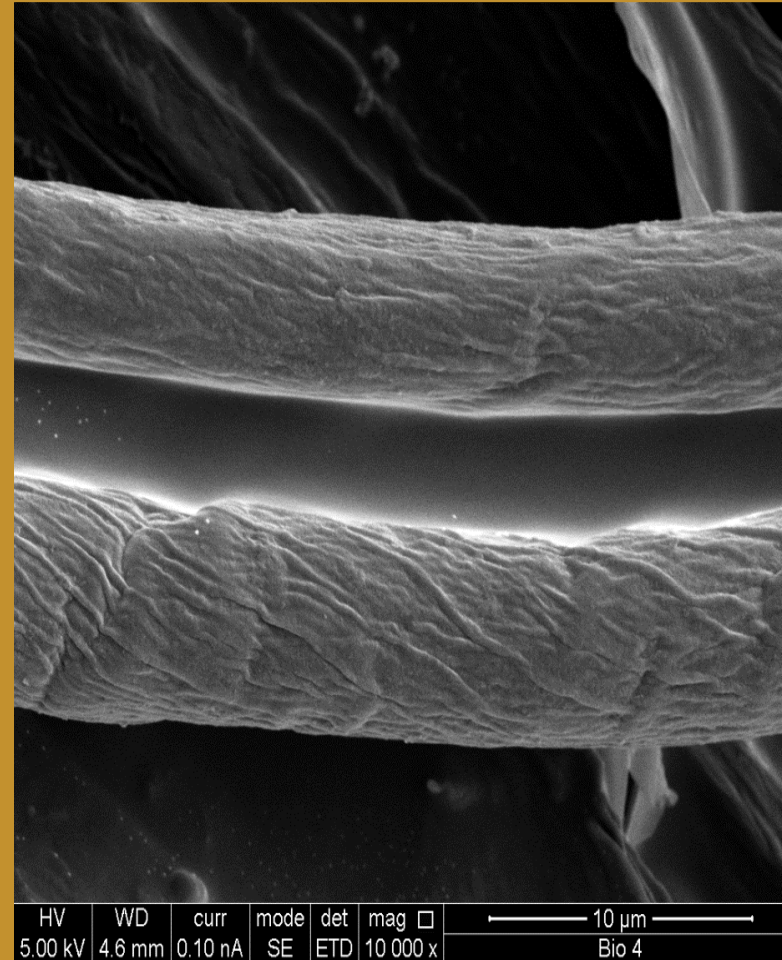
E.coli

Streptococcus

Bio-inhibiting  
Cavitated Cotton Fibers



Cotton Fiber



Treated Cotton Fiber



Wound  
Dressing

**Argaman's Quality Dressing**





A TRUE DIABETIC PRODUCT – CAN BE  
MADE USING EITHER COTTONX OR A  
BLEND OF FEELAMENT TECHNOLOGIES

**Argaman's SOUND technology**

# Wound Healing Mechanism

**Compared to control and silver there was a statistically significant heal rate ( $p < 0.01$ )**

*(Borkow, Gabbay, Zatcoff. Could chronic wounds not heal due to too low local copper levels? Medical Hypotheses 2008; 70:610-3)*

- 6X increase in integrins (binding proteins of extracellular matrix proteins)
- 22X increase in placental growth factor (PLGF)
- 100X increase in TGF-1, TGF-2, TGF-3 proteins (which stimulate collagen formation)

*(Borkow, Gabbay, Dardik, et al. Molecular mechanisms of enhanced wound healing by copper oxide-impregnated dressings. Wound Repair Regen. 2010; 18: 266-75)*



# Wound Healing

62 YO WF Diabetic



Sep 9



Oct 7



Sept 30



Oct 7



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Published Evidence of the effect of Copper Oxide on Diabetic Ulcers  
Note: Reduced scar tissue indicating cell regeneration rather than cell repair

#3423, 55 YO Diabetic  
Started Cupron 04-19-2006

Start  
treatment



2 Weeks  
of  
treatment



4 Months  
of  
treatment



#1875 71 YO diabetic,

Start  
treatment



2 Weeks  
of  
treatment



4 Weeks  
of  
treatment



10 Weeks  
of  
treatment



# What Happens When the Wound Healing Technology is Applied to Healthy Skin?

## Skin Enhancement

### Permitted claims:

- Reduction of wrinkles
  - Increased hydration of the skin
  - Increased elasticity of the skin
  - Reduction of mottled hyper-pigmentation
  - Overall improvement of skin appearance
- 
- Acne treatment pillowcase (as an OTC FDA approved product – in development)



## The Cosmetic Effect

Wrinkle Reducing Textiles –  
Just from sleeping on a  
pillowcase!

Left - day 0

Right - day 28



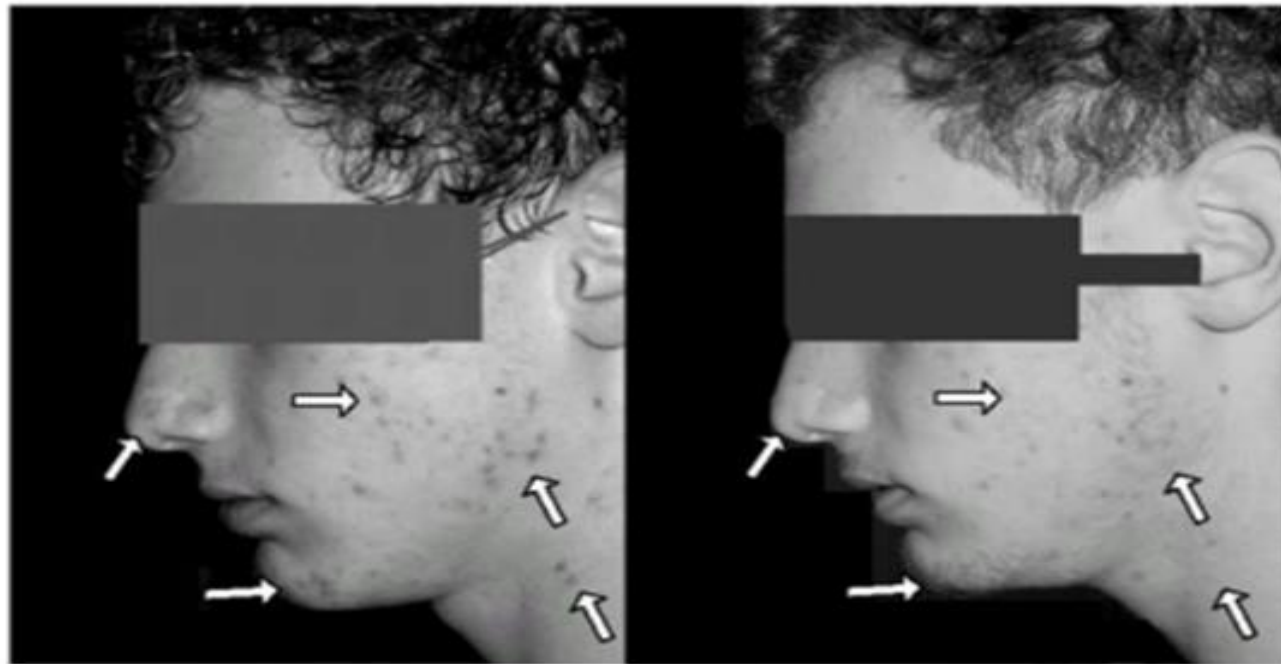
FTC Compliance testing  
slated to be completed end  
June, 2019 which will allow  
all products using this  
technology to make skin  
enhancement/wrinkle  
reduction claims.

# Sleeping on a Pillowcase Designed for This Treatment

## Acne Treatment

Before

1 week



# A New Class of Industrial Textiles

## Fabrics which are completely non-ignitable, not fire retardant

Will replace synthetic products that exist in the market already

Equal performance, far greater comfort

Non-toxic, No melt, no drip

No smoke, no flame, no off-gassing

Environmentally sustainable

## Fabrics which conduct and store electricity

Radiation shielding

Medical monitoring

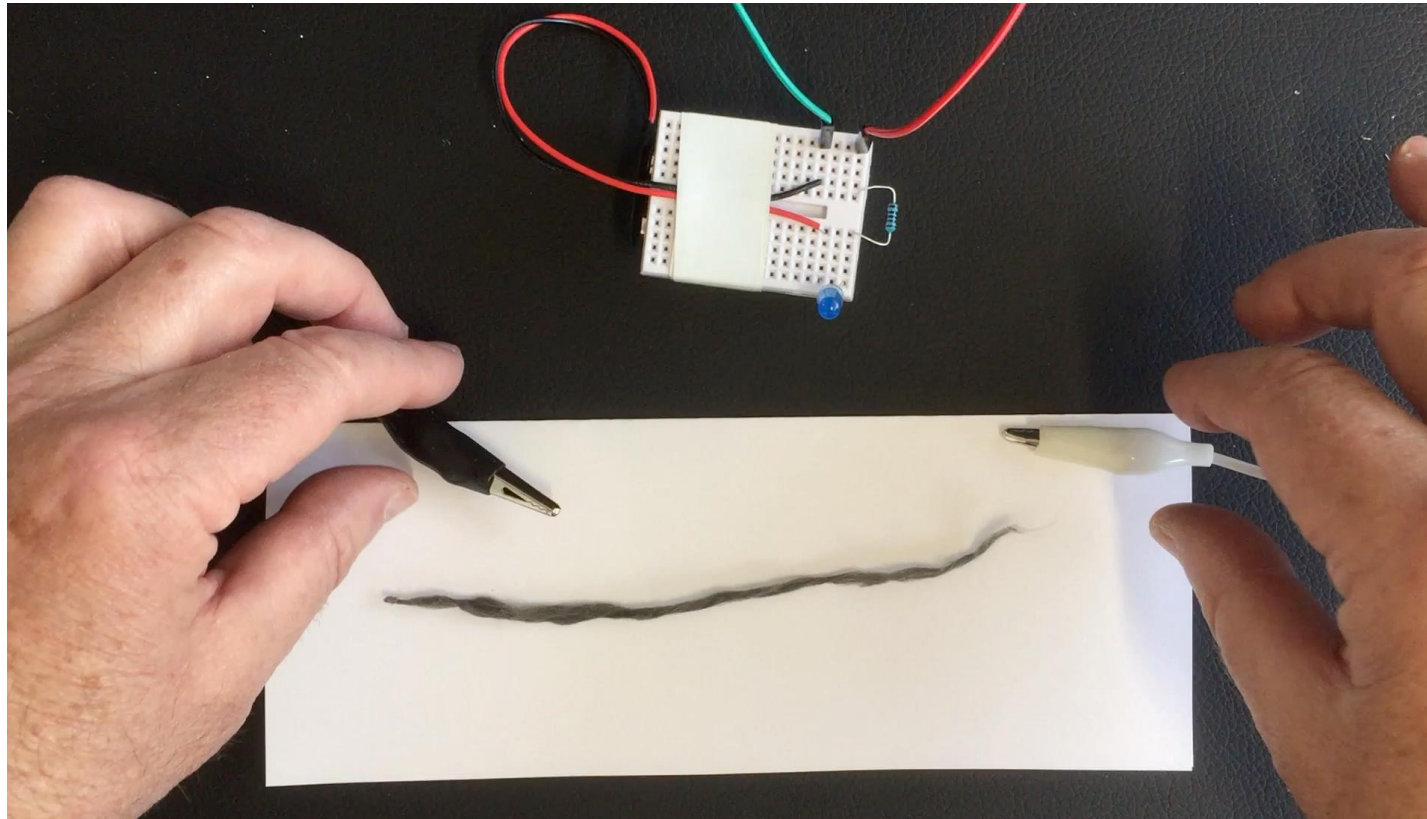
Military camouflage



COTTON THAT NEVER BURNS



# COTTON THAT CONDUCTS ELECTRICITY



# Market Opportunities

## Cross-Technology Products

	CONSUMER		INDUSTRIAL		HEALTHCARE	
						
<b>Product Examples</b>	<ul style="list-style-type: none"> <li>• Bedding</li> <li>• Clothing</li> <li>• Footwear</li> </ul>	<ul style="list-style-type: none"> <li>• Athletic Wear</li> <li>• Mattress Covers</li> <li>• Bath</li> </ul>	<ul style="list-style-type: none"> <li>• Airline Fabrics</li> <li>• Clothing (military)</li> </ul>	<ul style="list-style-type: none"> <li>• Carpeting</li> <li>• Personal Protective Equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Garments</li> <li>• Wound Dressings</li> </ul>	<ul style="list-style-type: none"> <li>• Diabetic Socks</li> <li>• Bed Linens</li> </ul>
<b>Estimated Market Size</b>	> \$5 Billion		> \$5 Billion		> \$2 Billion	

# Competitive Advantages of CottonX™ Platform

- No use of chemical binders
- No pollution issues
- Scaled for mass production
- No change to standard textile manufacturing process
- Durable to washings
- Safe for the people involved in the process
- Safe for the people using the product
- Ecologically friendly – chemistry and water are recycled
- **ENVIRONMENTALLY SUSTAINABLE!!!**



# Feelament – Polymeric Applications



# Master Batch Products

- Accelerated Metal Oxides
  - Microbial inhibition HAIs soft surface control
  - Personal hygiene (socks, underwear)
  - Wound healing (gauze, diabetic socks)
  - Cosmetics (creams, ointments)
  - Application to films for HAI hard surfaces control
  - Food packaging for extended shelf life
  - White Copper (accelerated and white in color)

# WHITE COPPER

A completely new development that will change the industry:

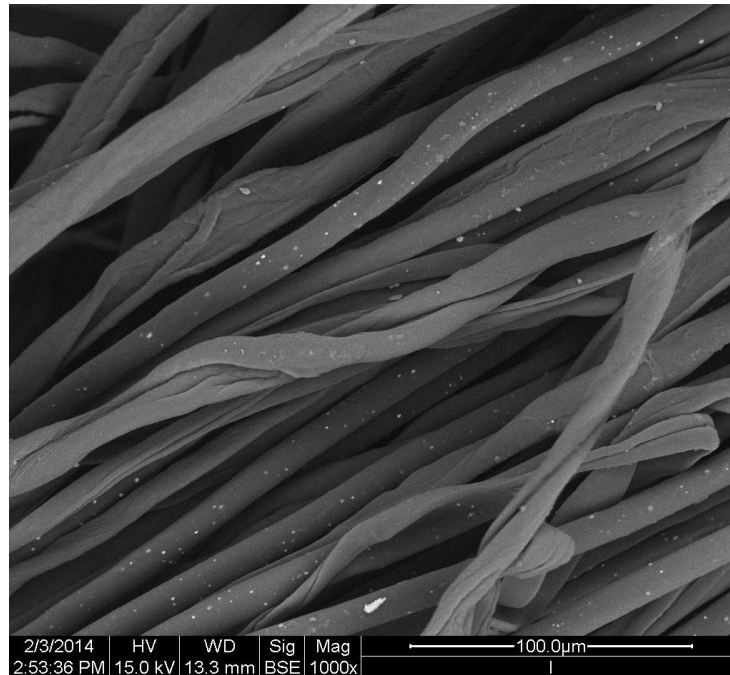
Copper oxide is the safest most effective bacterio-cidal material being used today.

The primary problem with its use is that it's dark brown and can't be disguised.

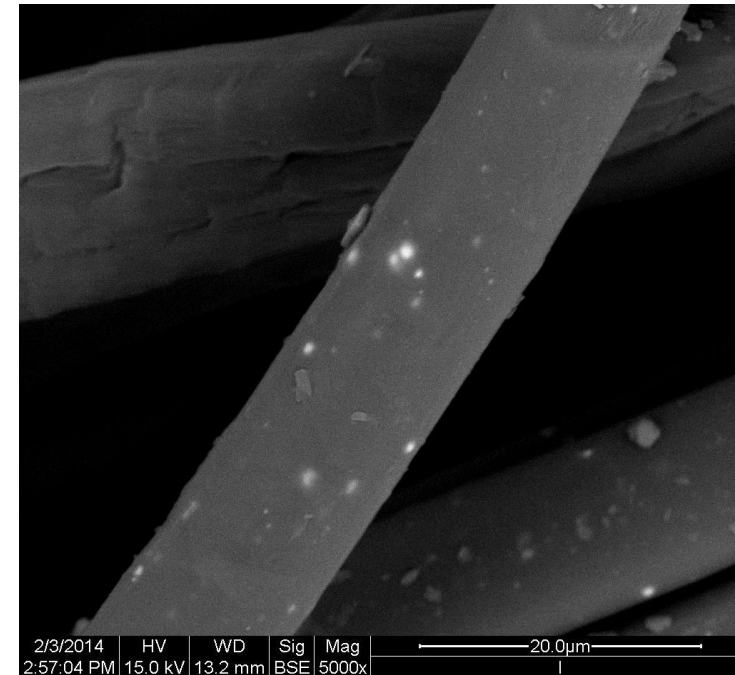
**NOW IT'S AVAILABLE IN WHITE!**

# Accelerated Metal Oxide Extruded in a Fiber – Self-Sterilizing based on polyester

**Cotton/Polyester Blend Yarn**



**Single Polyester Fiber**





# A Simple Protective Aid Against Microbes

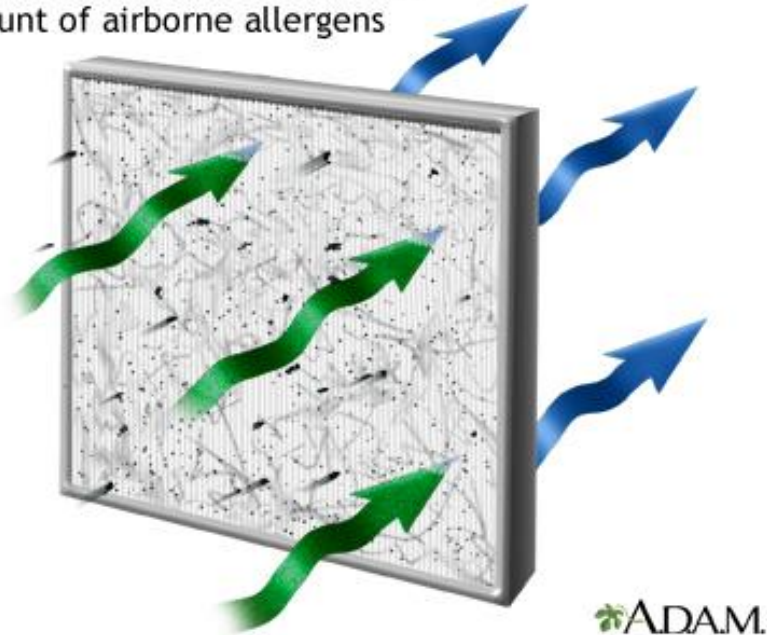
Washable/Reusable and Disposable  
Viral/Bacterial Deactivation Masks



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# Microbial deactivation materials in the air circulation system which destroys bacteria and viruses

A HEPA air filter can reduce the amount of airborne allergens



# Sample Product Line

## Introduction of Accelerated Copper into:

Polymer Fibers		Cotton Fibers			Raw Polymers	
Treated Polymer Fibers		Treated Copper Fibers			Treated Master Batch	
						
Antiviral Respirators	Antibacterial Surgical Masks	Antifungal Socks	Anti-mite Mattress Covers	Antibacterial Bedding	Packaging	Biofilm Reduction
Hospitals, military, epidemics, airports, first responders		Athlete's foot, diabetics	Dust mite allergies	Hospitals (HAIs)	Food/agri-cultural industry	Catheters



CoreBody™




COOLING AND WARMING TECHNOLOGIES

**Argaman's SOUND technology**

# *Bi-component Fabrics*




*The Original Fabric was Developed for NASA by Jeff Gabbay in Two Variations*

Performance attributes of our fabrics

-  *Reduction of heartbeat rate in exercise regimen*
-  *Removal of exudates from wounds through moisture movement*
-  *Instantaneous heating (scuba suit concept)*

*Our garments are in use in the International Space Station by the NASA crew.*

*Additional fabric and garment combinations we are now producing*

-  *Accelerated Bio-inhibition*
-  *Fire Retardant with and without Bio-inhibitor*
-  *Weltings for bullet proof vests*

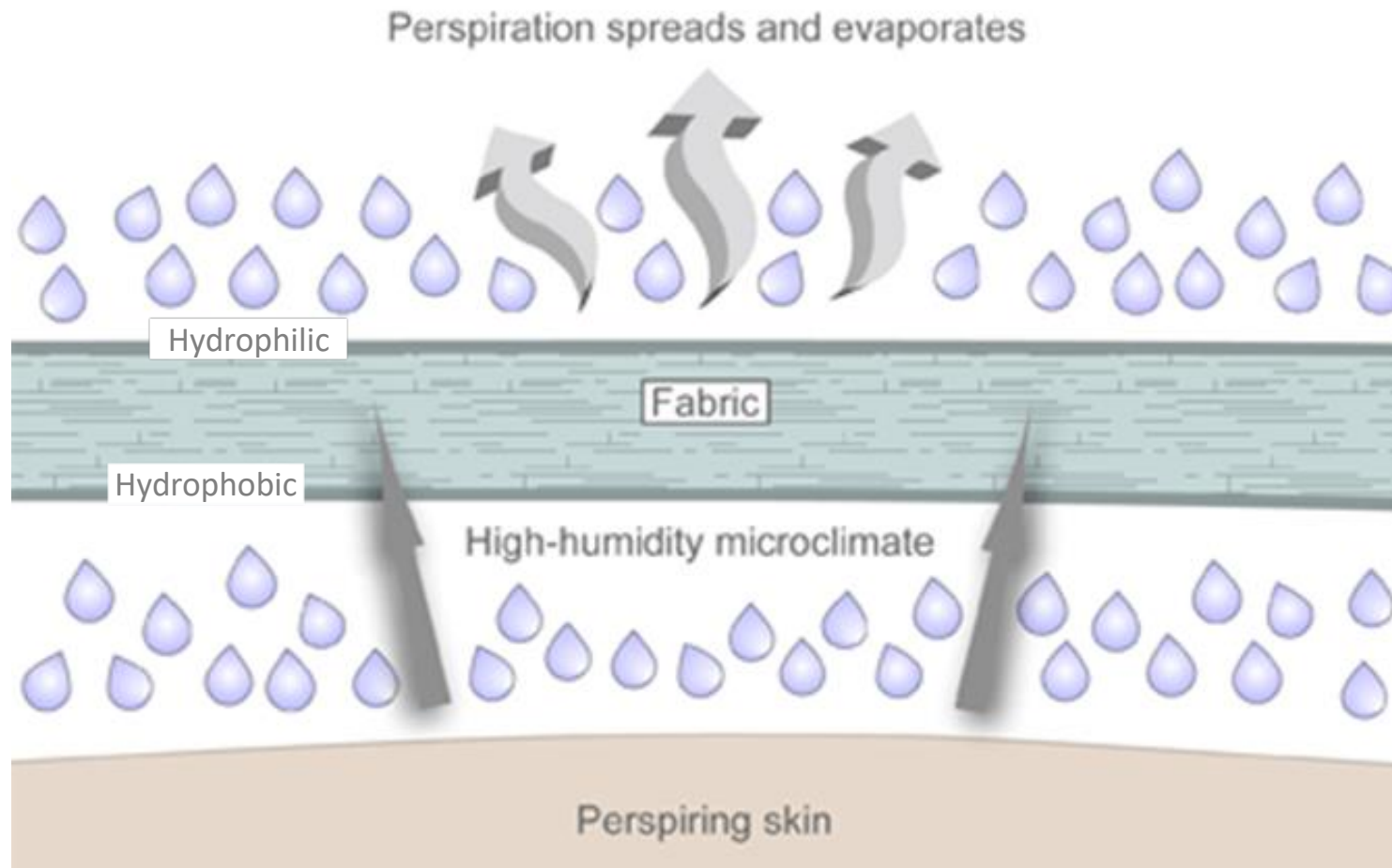
# Our Cooling Technology

## HOW DOES IT WORK?

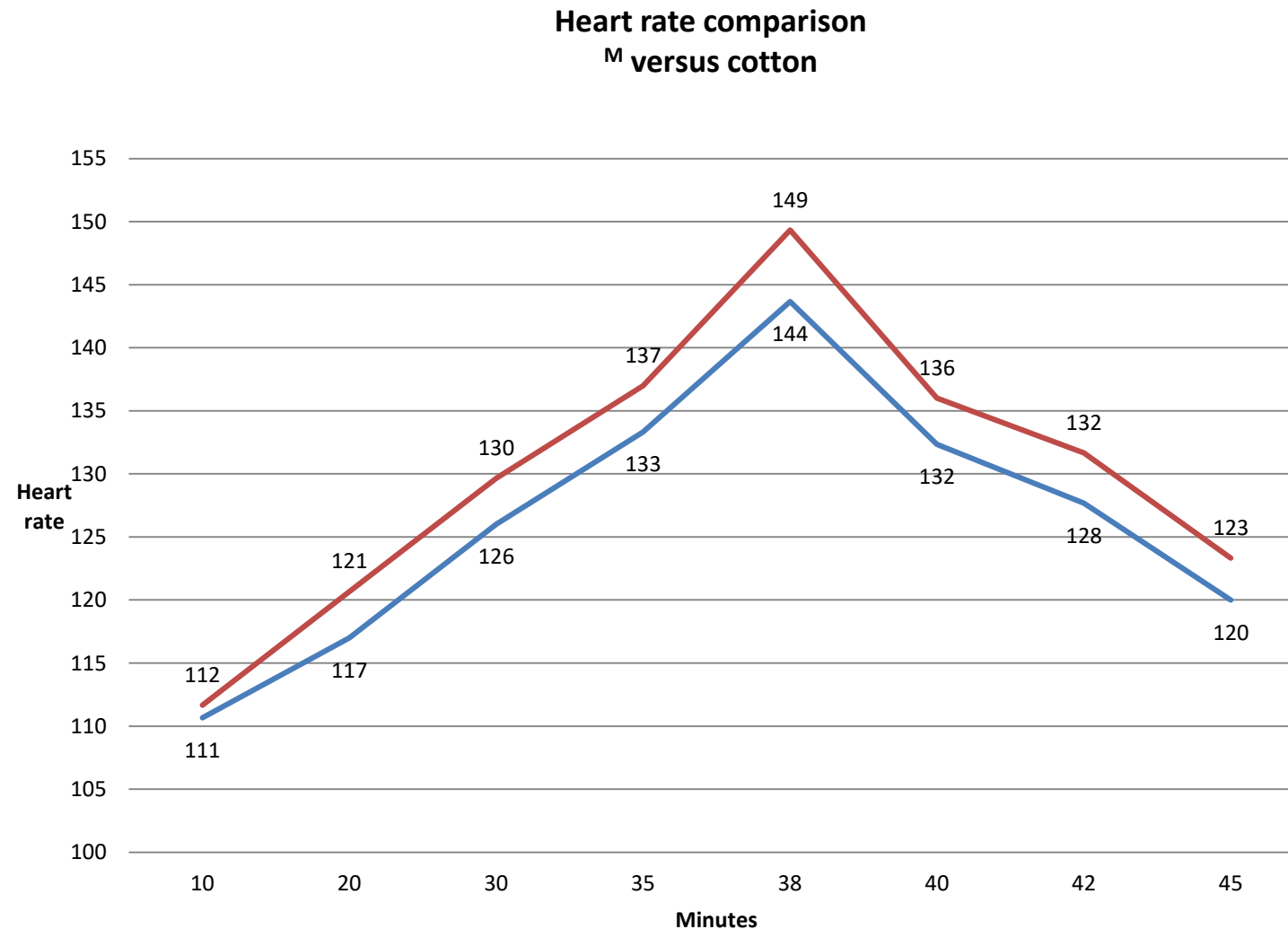
- When the hydrostatic pressure of the water drop overcomes the hydrophobicity of the fiber, there is a cascade effect of movement of complete moisture movement from one side of the fabric to the other side. This keeps the inside of the fabric and the person wearing the garment dry.
- This is NOT a wicking effect which leaves the moisture in the fabric.
- Knit into the outer layer of the fabric are yarns with massive surface area which captures and spreads the water drop over a large surface area. The large surface area spreads the moisture and maximizes evaporation and cooling.

*Accelerated moisture transport and evaporation lead to **faster** and **better** body **cooling**, resulting in **better performance** for longer periods of time.*

# Our Cooling Technology



# Demonstration of Reduced Cardiac Activity in an Aerobic Regimen







**Thermal  
garments**

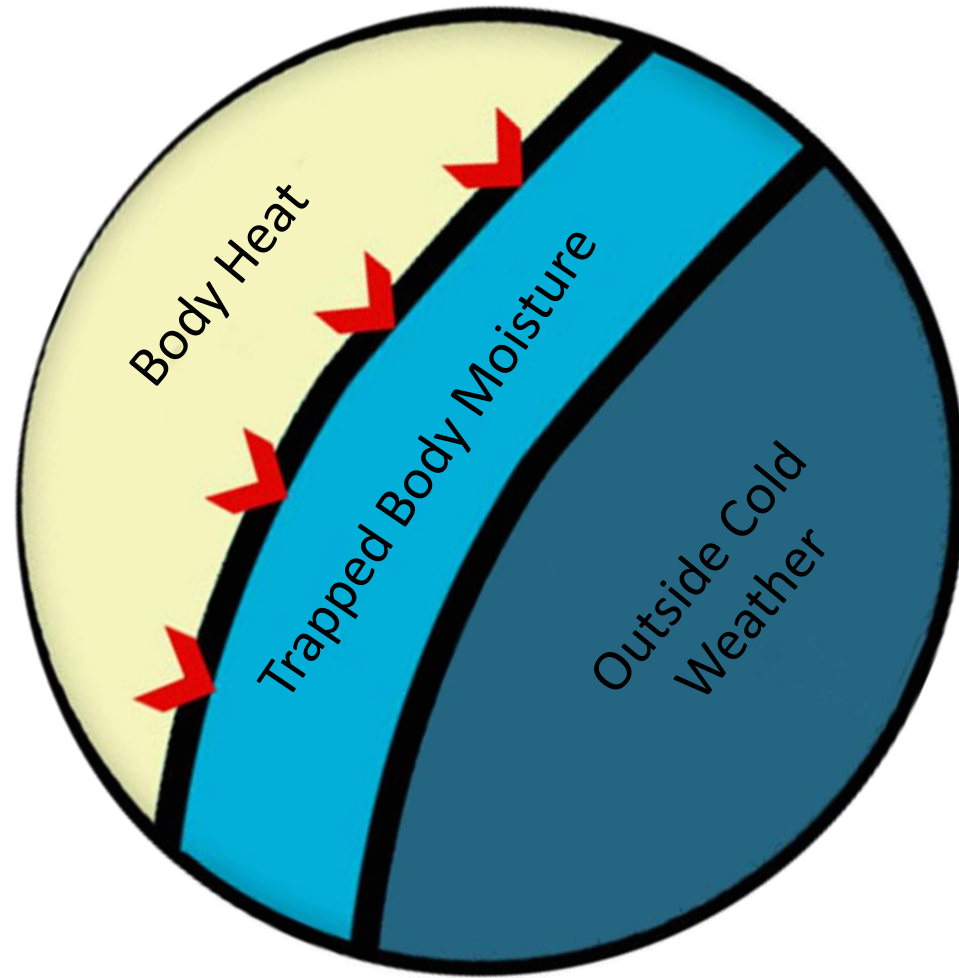
**Temperature Control Apparel**

# Our Thermal Technology

## HOW DOES IT WORK?

- The outer layer is a superb, **superlight thermal insulator**. Warmth Without Weight.
- The body's natural moisture gets trapped in the inner absorbing layer. The trapped water is then warmed by the body - much **like a wet suit!**
- Compared to other thermals, Argaman's patent-pending combination fabric gives **the best thermal insulation possible for a given weight**.
- Increased **comfort** as well – soft to the touch, and with good draping quality.

## Our Thermal Technology



## Thermal Materials Compared

		Argaman Technologies	Polyester (PET)	Cotton
THERMAL	Warmth	Excellent	Average	Only if heavy
	Light weight	30% less	Average	Heavy
MOISTURE MANAGEMENT	Wet-suit action	Excellent	None	None
RESISTANCE TO DAMAGE	Stain resistance	High	Low	Low

# Back to the Future

These slides, which were taken from a presentation made to the European Space Commission in May, 2019, discuss specific problems that can only be solved through cavitation of fibres.

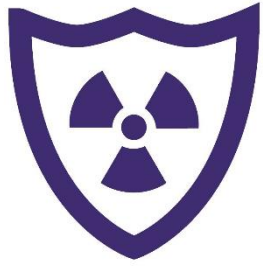
The issues addressed in these slides, while at present having only limited commercial use, represent a potential direction for the future of high tech fibres/yarns/garments which are likely to respond to future needs.

In light of the recent discovery of antibiotic resistant strains of bacteria in the space capsules this is particularly relevant since we do not know the origin of the microbes or how they obtained their mutative state. Bacteria have demonstrated mutative ability when exposed to radiation in outer space.

# *Space Travel Issues Addressed Specifically by Ultrasonic Cavitation*

1. Self-sterilizing fabrics to control bacterial bio-burden
2. MDRO control in space capsule to prevent self-infection
3. Complete odour control
4. Wound healing gauze and socks
5. Hydration of skin
6. Non-ignitable
7. Super absorbent cotton
8. No wash fabrics – self cleaning/ always fresh
9. Protection against exposure to radiation
10. On-sight determination of temperature
11. On sight determination of light waves source
12. Easily incinerated to carbon powder for off-jetting
13. Power storage in garment

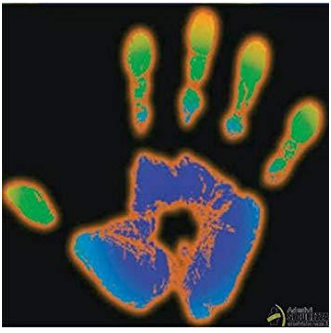




# Radiation Shielding

- Materials that offer radiation shielding and reflectance can be cavitated into cotton fibers
- Experimentation and proof of concept exist using Single Walled Nano-Carbon Tubes
- Radiation Shielding can be increased or enhanced by adding BTTN to the cavitation formula
- The thickness of the fabric will determine the radiation shielding capacity of the fabric but if done on cotton the fabrics are likely to be very light and comfortable.



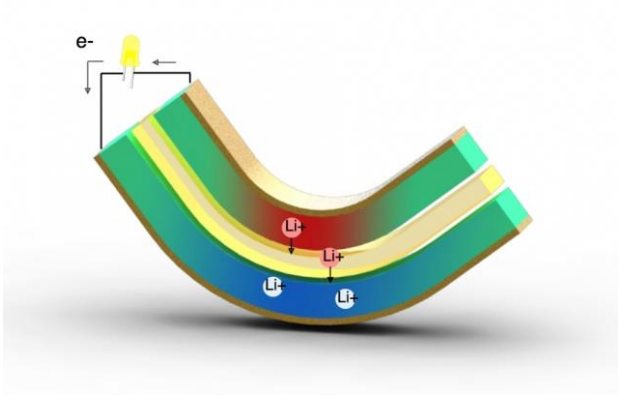


# Thermo-chromatic Textiles

- Thermo-chromatic treated fabrics for visual temperature monitoring
- Determination of temperature parameters
- Determination of speed of change
- Determination of different types of light both in and outside the human visual spectrum (UV, IR, SWIR, etc.)



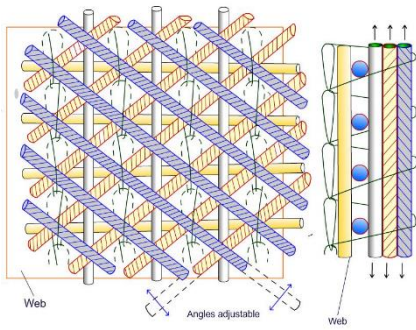




# Power Storage in Textiles

- Anode chemistry / Diode Chemistry in two different layers laminated with an electrolyte
- Proof of concept exists
- Rechargeable
- Sensors can be added to the garment for monitoring
- Based on cotton





# Self Repairing Textiles

- Yarns that can be placed back in their matrix
- Specific different knit configurations with elastane yarns
- More than one technology can be added to these fabrics
- Soft to the touch
- Self-cleaning finish can be added to the fabrics
- Wound healing chemistry can be added to the fabrics



# Where We Are Today

- Basic research on cavitation at the fiber level is complete.
- A default group of products now exists.
- We are at the advanced planning stage of mass production machinery.
- Letter of Intent from VF Industries (Lee, Wrangler, Rider jeans)
- Under due diligence by L'Oreal and Victoria's Secret.
- Have completed a proof of concept anecdotal hospital test successfully and are planning a final test.
- In negotiation with Zorlu of Turkey (largest textile manufacturer in Europe) concerning cooperation.
- In negotiation with Parkdale, Inc. of the USA (largest processor of cotton in the world) concerning cooperation for the USA market.
- Have successfully produced and sent samples to Cintas, Inc. (the largest commercial laundry in the USA).
- Have completed the EPA registration, FDA registration, and FTC Cosmetic Claims (Truth in Advertising) tests successfully.
- White Copper™ is fully developed and is in the process of EPA registration.

# Antimicrobial Textiles for Long Duration Space Flight



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