



Preliminary Presentation: Bromodosis

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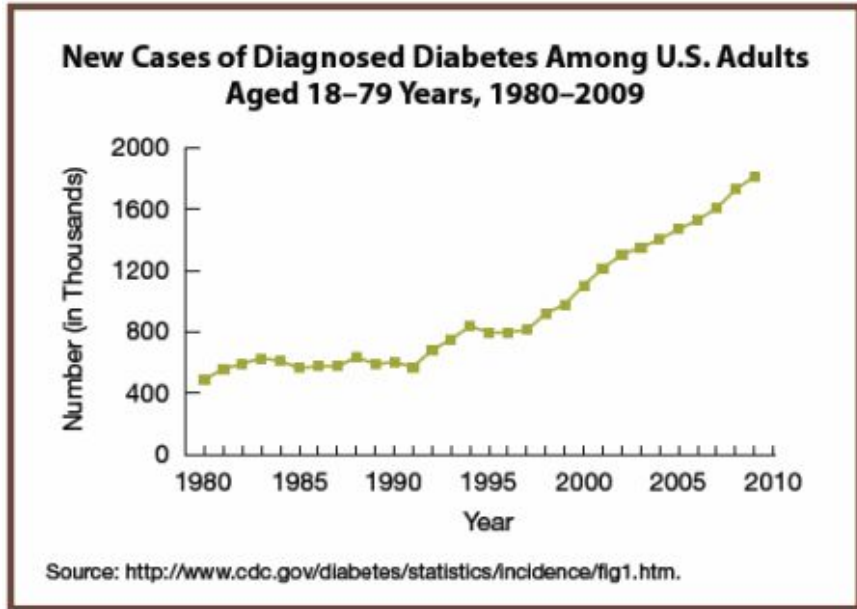
Client: Dr. Dan Moran

The foot sole's warm and wet environment is highly productive for bacteria and fungi

- Bromodosis: medical term for stinky feet
- 16% of the U.S. suffers from bromodosis in their lifetime
- 35 million people- point prevalence of athlete's foot in U.S



A rapidly growing U.S. diabetic population is further fueling the need for improved bromodosis solutions



- 100 million Americans have diabetes or prediabetes
- A simple, effective, and long-lasting treatment is needed for reliably eliminating foot fungus as well as foot and shoe odor in a diverse population not solely limited to athletes.

Project Scope



Product Goals	Novelty Features	Secondary Features
<ul style="list-style-type: none">• Deliver a verified and validated daily wearable item by April 1st, 2019• Eliminates existing foot microbial infections as well as foot and shoe odor• Prevents future infections by sterilizing the shoe environment	<ul style="list-style-type: none">• *High impact anti-microbial functionality that persists for an extended period• Reliability for a diverse user population• Minimized safety concerns for an appealing risk to benefit ratio• Cost effective	<ul style="list-style-type: none">• Maximal user comfort• Easy to use• High quality design and appearance

Necessary Design Specifications



Antimicrobial Efficacy	*Eliminates 99.9% of microbes on the toes and feet in 12 hours.
Diverse Sizing	Reliable for feet sized 4 through 12 men's and women's.
Long Functional Duration	*Antimicrobial effects remain functional for at least 6 months and withstand at least 50 washing and drying cycles.
User Safety	<p>Must not result in shocks or punctures after repeated loading during locomotion in any practical environment; if an electrical current is used, it must be less than 1 mA.</p> <p>Contact with product results in a <i>negative</i> skin test for allergens in 95% of the sampled population.</p> <p>*If metals are used, product is 100% compliant with relevant federal dermal exposure limits-even in product failure.</p>
Affordability	Must be competitively priced to alternate solutions; less than \$10 to produce.
Simple Operation	The product should be effective with minimal user effort. Less than 10 seconds should be required to turn on functionality (not including the time to put on the product).

Secondary Design Specifications



Comfortability	The final prototype should <u>not</u> have significantly worse comfortability Likert ratings than an ordinary sock of similar material in blind trials.
Quality Design and Appearance	A sleek design that seeks to hide/camouflage the functional components. At least 60% of a randomly polled sample should say they would buy the sock just based off the appearance.

Existing treatments for foot odor and infection are either preventive or reactive, but not both

Treatment	Description	Broad Examples	Commercial Brands	Cost Range*
Deodorants and Antiperspirants	Prevents sweating and masks odor	aluminum chloride, aluminum sesquichlorohydrate	Dr. Scholl's, Carpe	~ \$8 - 25
Moisture Elimination	Absorbs or wicks away moisture	active carbon inserts, zinc oxide powders, wicking socks	Zor pads, Remodeez, Foot Sense Powders,	~ \$4 - 20
Antimicrobial Gear	Antimicrobial materials in contact with the foot environment	Silver nanoparticle, silver, copper, and titanium thread socks	Rhone Silvertex, Balega, Tommie Copper, Tisoks	~ \$12 - 45
Antifungal Ointment	Potent antifungal agent to kill an existing infection	Butenafine hydrochloride, miconazole nitrate	Activis, Lotrimin, generics	~ \$2 - 10
Foot Washes	Disinfects the foot; home remedies	Vinegar baths, salt washes, tea baths	N/A	~ \$2 - 15

*Cost range estimated by list online pricing of commercial brands and competitors. Links to products are provided at the end of the presentation

Existing wearable antimicrobial footwear technology lacks a product that is convenient, highly potent and long-lasting

Technology	Advantages	Disadvantages
Active Carbon	Absorbs moisture	Limited longevity (60 wears ¹ , 1 month ²), Indirectly antimicrobial
Moisture Wicking Socks	Facilitates evaporation	Limited effectiveness, Indirectly antimicrobial
Silver Nanoparticle/Yarn Socks	Antimicrobial ³ , low concentration effectiveness ³	Rare allergy ³ , Wash sensitive ⁴
Copper Yarn Socks	Antimicrobial ⁵	Requires high concentration Cu for effectiveness ⁵
Titanium Yarn Socks	Antimicrobial under UV light ⁶	Requires UV radiation ⁶

¹ Zoropads, ² Remodeez, ³ Mijnenonckx, et. al, ⁴ Benn, et. al, ⁵ Vincent, et. al, ⁶ Itabashi, et. al.

Note: A full product list with links is included in Existing Product Links

Patented wearable footwear technologies do not protect electrical methods of continuous antimicrobial metal ion delivery

- Active Carbon
 - Seal against outside moisture for footwear¹
- Silver-Containing Wearables*
 - Ion release using nanoparticles and partially water-soluble chemicals
 - Textiles with antimicrobial silver threading and related processes²
- Copper-Containing Wearables
 - Pending applications for mixed elastic/copper fibers for bandages³



Team Organization



Matt Heiken	Logan Groneck	Ashton Naumann
<ul style="list-style-type: none">• Materials Research• Design Specification Supervisor• Prototype Development Outreach• Prototype Cosmetics & Marketability	<ul style="list-style-type: none">• Existing Solutions Research• Existing Product Outreach• Client Communications• Prototype Construction & Safety Consideration	<ul style="list-style-type: none">• Antimicrobial Delivery Methods Research• Clinical Outreach• Engineering Communication Center Contact for Technical Documents• Ensure All Deadlines Met

References



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- Mijnendonckx, Kristel, et al. "Antimicrobial Silver: Uses, Toxicity and Potential for Resistance." *BioMetals*, vol. 26, no. 4, Aug. 2013, pp. 609–621., <https://link.springer.com/article/10.1007%2Fs10534-013-9645-z>.
- "National Foot Health Assessment 2012." *Foot Odor* | *Institute for Preventive Foothealth (IPFH)*, Institute for Preventive Foot Health, June 2012, www.ipfh.org/resources/surveys/national-foot-health-assessment-2012.

References cont.



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Vincent, M., et al. “Contact Killing and Antimicrobial Properties of Copper.” *Journal of Applied Microbiology*, vol. 124, 20 Dec. 2017, pp. 1032–1046., <https://onlinelibrary.wiley.com/doi/epdf/10.1111/jam.13681>.

Patent References



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Dehn, Michael. (US20090203275A1) *Self-Closing Ventilation Insert and Method of Producing it*. 13 December 2016.

Dudaa, Marcus. (US20130178779A1) *Sock for treatment of foot and leg wounds, methods of use and manufacture*. 29 December 2015.

Ehlenz, Peter, and Lutz Irgel. (US451730A) *Method of Producing a Sorptive Body, Particularly for Eliminating Odors, Air Freshening, Etc. and the Resultant Product*. 14 May 1985.

Gabbay, Jeffrey. (US20150209386A1) *Copper Containing Materials for Treating Wounds, Burns and Other Skin Conditions*. 24 October 2014. *Application Only

Knight, Mc, and Guldalian, J. (US3800792A) *Laminated collagen film dressing*. 2 April 1974.

Pole, Robert. (WO2001097867A2) *Perspiration absorbing items*. 16 June 2000 *Application Only

Reymonet, Jean-Louis. (US6277179B1) *Agglomerates based on active charcoal, their process of preparation and their use as adsorption agents*. 21 August 2001.

Song, Edward, and Wilmink, Michael. (WO2018160589A1) *Antimicrobial elastic support bandages*. 28 February 2017.

Vickers, Thomas W. (US5678247A) *Odor-Absorbing Clothing Article*. 21 Oct. 1997.

Yamauchi, Akira. (US4206514A) *Sanitary footwear articles*. 10 June 1980.

Yan, Jixiong, and Cheng, Jiachong. (US6979491B2) *Antimicrobial yarn having nanosilver particles and methods of manufacturing the same*. 27 December 2005.

Yoshimi, Hiroyuki, and Itoh, Yoshio. (US4151660A) *Socks for use with footwear*. 1 May 1979.

Existing Product Links

Product	Link
Dr. Scholl's Odor X Spray	https://www.drscholls.com/products/comfort-and-energy/odor-x-odor-fighting-spray/
Carpe Foot Lotion	https://www.carpelotion.com/index.html
Zor pads - Active Charcoal Insert	http://www.zor pads.com/
Remodeez - Active Charcoal	https://www.remodeez.com/
Foot Sense All Natural Foot and Shoe Powder	https://www.amazon.com/gp/product/B00O2DQO4C/?tag=menshealth-auto-20&ascsubtag=%5bartid 2139.a.19538343%5bsrcj%5bchj
Rhone - Silvertch socks	https://www.rhone.com/collections/running-socks-for-men
Balega - Silver	https://balega-socks.implus.com/products/silver-running-socks/
Balega - Moisture wicking	https://balega-socks.implus.com/products/hidden-running-socks/
Tommie Copper	https://www.tommiecopper.com/men/compression-sock
Tisoks	https://www.amazon.com/Tisoks-Titanium-Antifungal-Antibacterial-Athletes/dp/B078GBZBHX/ref=sr_1_13?ie=UTF8&qid=1538337716&sr=8-13&keywords=antimicrobial+socks
Lotrimin	https://www.lotrimin.com/our-products/athlete-antifungal-cream.php
Activis	https://www.healthwarehouse.com/miconazole-nitrate-2-cream-actavis-1-5-oz.html?qclid=Cj0KCQjw0dHdBRDEARIsAHjZYYCGWxlclbTn0AMaBdd5acKb5_AECMiUHnA1JUq0Oj5ot3L2GApzFxaAmphEALw_wcB