BUSINESS MODEL WHITEPAPER

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Market Overview and Existing Competitive Landscape

The wearables industry consists of a broad class of sensing and actuating technology that is incorporated into a user's accessories and clothes. Per a 2017 forecast by the International Data Corporation (IDC), the global market for wearable will increase to 237.5 million shipments by 2021. While accessory-based gadgets, such as the Apple Watch and the Fitbit, contributed to the initial awareness and adoption of wearable technology, functionalized clothing is expected to drive the future growth of the industry, with an expected annual growth rate of 76.6% between 2016 and 2021.

By incorporating technology directly into clothing, sensing and actuating capabilities can become more personalized and easier to use. Serving as a real-life analogue to a “super suit”, functionalized clothing can empower users with enhanced capabilities in an unobtrusive and aesthetic way. Some examples of emerging functionalized clothing include Google and Levi's joint Project Jacquard, a high-end commuter jacket woven with capacitive threads for remote control of a user's cell phone, and Athos' new clothing line, which incorporates electromyographic sensors directly into athletic wear. However, electronics-based clothing faces several setbacks toward widespread adoption. Particularly, microelectronics require a power source, as well as added design complexity and high costs.

Opportunity

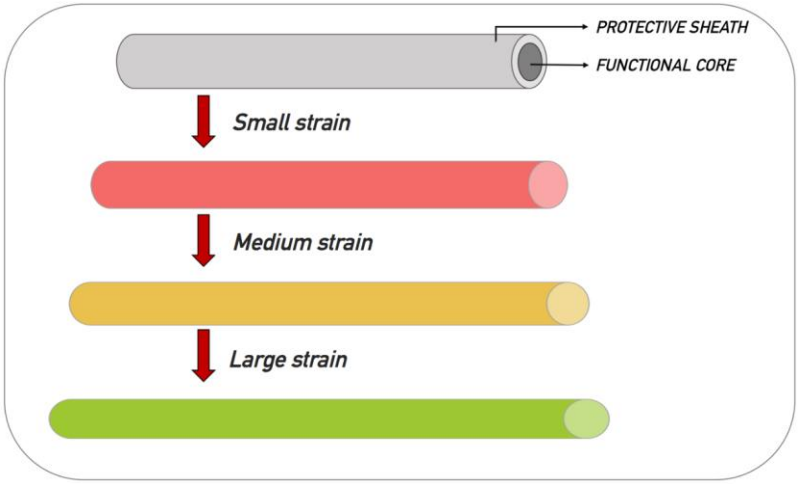
When considering future applications of functionalized fabrics, particularly in strain-sensing applications, such as a car-seat that can tell a parent whether they fastened their child securely, or yoga pants that tell a user whether she has the right technique, overly complex sensing mechanisms are not the best option, as they can overload the user with information and be prohibitively expensive.

Mechano-chromic sensing, or communicating changes in strain via color change, is an exciting avenue for functionalized fabric for several reasons. Color change is intuitive, aesthetic, and fun. For example, a car seat that changed from red when it was too loose, to green when it was appropriately taut, would provide a parent with real-time, easy to understand information. Chromic sensing can also be quantified when necessary. For example, a doctor could user chromic sensors in rehabilitative applications, and use a smart phoned based spectrometer, such as Consumer Physics’ new SCiO product, to precisely tune the amount of resistance provided by a sling or brace.

Based on the current market enthusiasm for functionalized fabrics, and the unrealized potential of mechano-chromic sensing for safety, rehabilitation, and sports/performance, we see an exciting opportunity for the development of a fiber-based mechano-chromic sensor.

Value Proposition

We have developed a design and fabrication process for a durable and flexible mechano-chromic sensor at the fiber-level. Our solution is an innovative new entrant to the wearables space, as it does not require a power source to operate, and it is highly modular and therefore can be seamlessly incorporated into an array of applications. Our design would enable fun and intuiting sensing, with a detection sensitivity as small as 10% strain. By realizing functionality at the fiber level, these sensors can be knitted into highly capable mechano-chromic textiles, with a sensing resolution of ~ 2 microns wide.



Cost Analysis

A summary of our cost analysis is included below. As can be seen, our fibers are approximately 10 times more expensive than an unfunctionalized fiber. However, these functionalized fibers eliminate the need for microelectronics or a power source, therefore its savings outweigh this premium.

We are using a fabrication process called electrospinning, which is a low-cost and highly tunable process in research settings, but manufacturing plants for electrospinning are limited, as this is an emerging process. Therefore, we expect variable costs for producing fibers to decline as this method gets more widely adopted. Our two top contractors for electrospinning including Fuidnatek and The Electrospinning Company.

MATERIAL COST	
Unfunctionalized fiber	$0.10 /gram
Functionalized sensing Fiber	$1.05 /gram
VARIABLE MANUFACTURING COST	
Traditional spinning	$0.15 /gram
Electrospinning	$0.50 → $0.05 /gram

Further costs would have to be assessed when we identify a partner and a product that will complement both our technological strengths and their design and brand expertise.

Strategy and Stakeholder Analysis

While we believe this technology is highly versatile, and will be able to find an array of mass-market applications, we have identified three high-value segments that would be potential early adopters.

The sports performance market is a go-to strategy for many emerging materials-related startups. For example, many composite materials find their first killer application in golf clubs and tennis rackets, as there is a high willingness to pay for status-oriented recreational sports that could provide some performance improvement to the game.

Rehabilitation is another attractive market. Because the healthcare industry sees such inflated treatment costs, any impact on recovery time can offer a large return on investment for insurance companies. This avenue would require testing, and potentially a partnership with the Penn Center for Physical Medline and Rehabilitation. If we could conduct a study, and quantify an improved recovery with back braces, slings, or physical therapy, when our color-changing strain sensors are used, we could provide a compelling and high-margin value proposition for insurance providers.

Finally, improved safety provides a key opportunity for us, as users are often willing to pay a premium for safety, particular in car seats. A similar adjacency is the military, fire, and police forces, which often have to use harnesses for a variety of missions. However, this market may be more challenging to break through to, as these purchase decisions are made on a wider-scale budgetary basis, rather than a person-by-person purchase.

Sports Performance	Rehabilitation	Improved Safety
• Technique-guiding yoga-pants • Instructive golf or tennis swing sensor • Stretching instruments for cross-training	• Resistance-based braces • Rehabilitative slings • Stroke-recovery physical therapy aid	• Car-seats • Recreation (e.g. climbing harness) • Construction harness • Straps and safety supports for military, fire, and police rescue

After assessing the prospective margins and length-to-entry for the above markets, we decided that sports-performance would be the best entry market for our technology, while the necessary studies can be performed for rehabilitation and safety, in order to break into those markets as a second-phase expansion strategy.

We also must consider the stakeholder landscape. As a materials innovation company, we sit at the top of the value chain. Because we achieve sensing functionality at the material level, we over-ride the need for additional electronics-based sensors, and thereby our impact extends into the intermediates realm as well. However, if we only operate at this end of the value chain, we will miss out on the potential high margins that can come from associating brand power to our aesthetic and fun sensing technology. Therefore, instead of pursuing customers and fulfilling a material-supplier role, we would instead pursue a partnership for a joint product design.

An example of such a partnership includes Google and Levi's Project Jacquard. Google brought the technical expertise, while Levi was able to bring the clothing design, distribution, and sales expertise. We plan to pursue companies such as LuLulemon, Adidas, and Under Armour. Because our design relies on a type of material and a fabrication process that would be outside of the realm of expertise of these companies, and with our planned intellectual property, we would be able to present an exciting and valuable partnership for these companies to design a joint product.