Collaborative Research Advances Shape-change 'Robotic' Textiles. By Kathlyn Swantko

Tech for Fit & Function

"Powered only by body heat, our shape-changing textiles create new opportunities for interaction with the clothes we wear every day," explains Dr. Brad Holschuh, co-leader of the project and assistant professor, apparel design and co-director of the University of Minnesota Wearable Technology Lab. "This capability has the potential to radically change garment design that initially benefits the user with loose, easy-to put-on apparel. But once on the body, the garment can then physically transform itself into more snug-fitting clothing."

Two research groups are collaborating on the project: the Wearable Technology Lab (WTL) in the College of Design, and the Design of Active Materials and Structures lab (DAMSL) in the Department of Mechanical Engineering, under the direction of Dr. Julianna Abel, Benjamin Mayhugh Assistant Professor.

The project, slated to continue through 2021, is led by Professors Abel and Holschuh, along with two U of M graduate students, Kevin Eschen and Rachael Granberry, and is an explicit partnership with NASA, via a space technology research fellowship. The program also involves industry partners; Fort Wayne Metals develops the advanced materials required to create the shape-changing textiles.

The effort simultaneously solves two significant problems in the creation of robotic textiles for on-body applications: 1) how to create usable actuation, or movement,

SMA knits have demonstrated they react to the heat generated passively by the human body, and these textiles can be engineered to both tighten and adjust the topography to conform to complex body geometries. Photo Credit: University of Minnesota Design of Active Materials and Structures Lab and Wearable Technology Lab.

without requiring significant power or heat; and 2) how to conform textiles or a garment to parts of the body that are irregularly shaped.

While resembling typical knits, the textiles used are created from a special category of active materials known as SMAs (shape memory alloy materials), a combination of metals that change shape when heated. The knit-based SMA systems have customizable actuation qualities, which can be tailored both at the material level and the system/architectural level. Recent advancements in the engineering of SMAs have made it possible to manufacture SMAs with precisely targeted actuation temperature ranges.

Program Goals

The team's short-term goal is to refine the technology for compression garment applications. They have partnered with NASA to develop the technology for astronauts as they return to earth. (Currently, astronauts wear compression garments to sustain blood pressure as they transition from zero gravity to earth gravity.)

"Over the long term, we want to translate this technology to a variety of global applications — medical garments, behavioral garments, and even everyday clothing to create a new paradigm of dynamic clothing," says Holschuh. For instance, compression stockings, which would be easy to put on, but tighten around the wearer's foot and leg when in place to provide the required medical or therapeutic compression. The technology could also translate to any garment that ultimately needs to fit the user tightly (e.g. corsets, belts, shoes, etc.).

The team is also investigating blended fibers, combining SMAs with traditional fibers to create active textiles with more typical surface finishes and textures. The textiles are evaluated and validated using both 2D mechanical testing and 3D garment motion testing on mannequins and humans.

"Thinking more broadly, textiles with variable mechanical properties can be deployed to create variable stiffness for knee braces, variable-loading casts and other orthotics, dynamic-squeeze garments for circulatory therapy for diabetics, or for behavioral therapy for those with SPD (Sensory Integration Dysfunction)/autism. And, the application for space actuatable textiles is enormous!" states Holschuh.

Everything produced in the lab can be created using industry-standard knitting techniques, explains Holschuh. ●

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