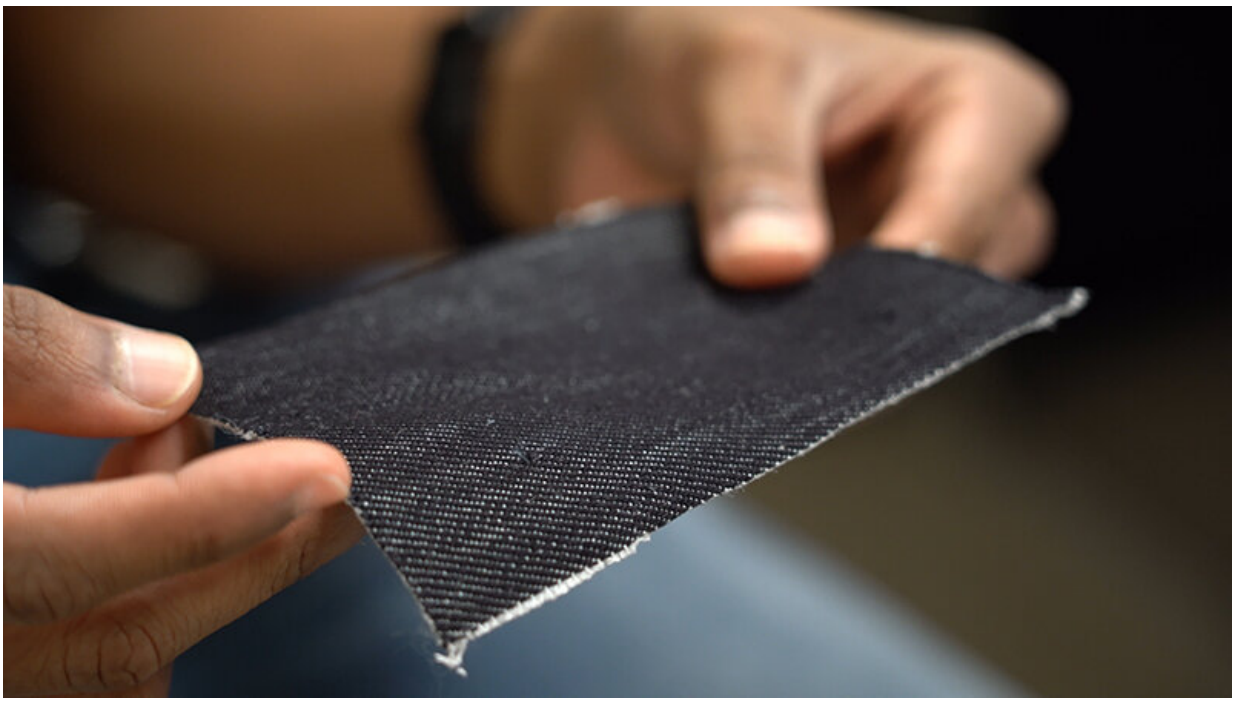
Hiking gear fabric has cooling effect that may make your next smartwatch more comfortable

May 21 2021, by Jared Pike



Researchers have discovered that a commercial fabric typically used for hiking gear has the heat-conducting properties of stainless steel, allowing the material to dissipate heat more effectively than other fabrics. Credit: Purdue University photo/Jared Pike

As smartwatches become more powerful, they will generate more heat.

To prevent burns or rashes, what if a material touching the skin could feel as cool as metal, but also be flexible enough to be worn on the wrist?

A team of Purdue University engineers has discovered that a type of fabric typically used for hiking gear has remarkable heat-conducting properties on par with stainless steel, potentially leading to wearable electronics that successfully cool both the device and the wearer's skin.

The material is made of ultra-high molecular weight polyethylene fibers, which are sold commercially under the brand name Dyneema. These polymer-based fabrics are marketed for their high strength, durability and abrasion resistance, and are often used to create body armor, specialty sports gear, ropes and nets.

Purdue heat transfer researchers recently investigated other uses for the fabric, namely as a cooling interface between human skin and wearable electronics (see a video about this research on YouTube). Their research is published in *Scientific Reports*.

"This fabric has great flexibility and thermal properties. If you stitch it differently, weave it differently or start blending the polymers with different materials, you could tailor the fabric's properties to different applications," said Justin Weibel, a research associate professor in Purdue's School of Mechanical Engineering.

If a material has a high thermal conductivity, that means heat dissipates through the material more easily. There are many heat-dissipation methods for fabrics, from the simple (moisture-wicking); to the intricate (conventional fabrics with heat-conducting strands woven in); to the very complex (liquid-cooled garments worn by astronauts).

"Your next smartwatch or virtual reality headset could be more powerful than your current smartphone, so we need to dissipate heat away from

the electronic components to keep the wearer comfortable," said Aaditya Candadai, who recently completed his Ph.D. at Purdue doing research on this project. "These polymer fabrics have amazing thermal properties that can keep these devices cooler and avoid low-degree skin burns."

The team discovered these properties by benchmarking Dyneema against conventional cotton fabrics, as well as polyethylene sheets in rigid non-woven form. They obtained several different commercially manufactured fabric samples and even wove their own samples from raw Dyneema fibers.

The researchers tested the fabric samples at the Birck Nanotechnology Center in Purdue's Discovery Park. The samples went into a small vacuum chamber, with a metal wire laid across the surface as a heat source.

Using an infrared microscope, they could generate detailed data about how much heat was being conducted through the fabric's surface, and in which direction. They found that the Dyneema fabric has 20-30 times higher thermal conductivity than other fabrics, comparable with steel.

The team also tested the fabric's flexibility, which is important for wearable electronics.

"There's a balance; we don't want to make thermally conductive materials that are so stiff, people won't be comfortable wearing them," Candadai said. "These polymer fabrics are in that sweet spot of having good conductivity and good flexibility."

The fabric naturally has these properties with no additional circuity or other equipment, but the researchers also have plans to test how weaving in different materials affects the fabric.

"We could integrate other types of fibers—carbon fibers, metal fibers—to achieve different combinations of properties," said Amy Marconnet, an associate professor of mechanical engineering.

More information: Aaditya A. Candadai et al, Thermal Conductivity of Ultrahigh Molecular Weight Polyethylene: From Fibers to Fabrics, *ACS Applied Polymer Materials* (2019). DOI: 10.1021/acsapm.9b00900

Aaditya A. Candadai et al, Thermal and mechanical characterization of high performance polymer fabrics for applications in wearable devices, *Scientific Reports* (2021). DOI: 10.1038/s41598-021-87957-7

Provided by Purdue University