

Precise embroidered circuits bring next-gen smart clothing closer to reality



By embedding numerous interlocking geometric shapes, a wearable broadband antenna can be created (Credit: Jo McCulty/ Ohio State University) [View gallery \(3 images\)](#)

From [sweat-sensing wristbands](#) to [electrode-embedded workout suits](#), new innovations in smart clothing are coming thick and fast. Now, Ohio State University researchers have made another big breakthrough, managing to create embroidered circuits using metallic thread that's just 0.1 mm thick. By embedding different patterns, the tech could be used to create everything from a t-shirt that boosts your cellphone signal, to a hat that tracks brain activity.

Embroidery is not likely something that you'd associate with cutting edge technology, but a new breed of functional textiles, known as "e-textiles" are set to challenge that perception. The concept makes use of sewing machines capable of embroidering thread into fabric automatically based on a pattern sent to it from a computer. But rather than traditional thread, fine metal wires are used.



The Ohio State researchers have been working to refine the process for a couple of years, and have made significant progress in that time. At the start of the project, the team was working with silver-coated polymer thread measuring about 0.5 mm (0.02 in) across and made up of 600 fine filaments twisted together.

They've since moved to a much thinner alternative that's only made up of seven filaments, each with a copper center and enameled with pure silver. The new thread is thinner, but thanks to its materials, maintains high conductivity. Because it's so thin, at just 0.1 mm, the resulting fabric feels just the same as if traditional thread had been used, with none of the rigidity you might initially expect.

So, how does that embedded metal wiring translate to functional use? Well, it's all in the shape. Depending on the pattern that's embroidered, it's possible to create many different useful products. For example, a broadband antenna can be created by embedding numerous interlocking geometric shapes that together form a circular pattern measuring a few inches across. The wiring required to produce that antenna only costs around 30 cents, and the embroidery process reportedly takes just 15 minutes to complete.

The researchers have also used the embroidery technique to embed an RFID chip in rubber – a part of a project undertaken in partnership with a tire manufacturer.



Looking forward, the team intends to continue its work on smart clothing, and there are plans to license the technology out, meaning that these sci-fi-sounding products might just become a purchasable reality somewhere down the line.

"A revolution is happening in the textile industry," said director of the Ohio State University laboratory John Volakis. "We believe that functional textiles are an enabling technology for communications and sensing – and one day even medical applications like imaging and monitoring."

The research has been published online in the journal [IEEE Antennas and Wireless Propagation Letters](http://www.ieee.org/publications_standards/publications_standards_home).