

# Research examines how to apply conductive nanocoatings to textiles

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(PhysOrg.com) -- Imagine plugging a USB port into a sheet of paper, and turning it into a tablet computer. It might be a stretch, but ideas like this have researchers at North Carolina State University examining the use of conductive nanocoatings on simple textiles – like woven cotton or even a sheet of paper.

"Normally, conductive nanocoatings are applied to inorganic materials like silicon. If we can find a way to apply them to [textiles](#) – cheap, flexible materials with a contorted surface texture – it would represent a cost-effective approach and framework for improving current and future types of electronic devices," says Dr. Jesse Jur, assistant professor of textile engineering, chemistry and science, and lead author of a paper describing the research.

Using a technique called atomic layer deposition, coatings of inorganic materials, typically used in devices such as solar cells, sensors and microelectronics, were grown on the surface of textiles like woven cotton and nonwoven polypropylene – the same material that goes into reusable grocery store bags. "Imagine coating a textile fabric so that each fiber has the same nanoscale-thick coating that is thousands of times thinner than a human hair – that's what atomic layer deposition is capable of doing," Jur says. The research, done in collaboration with the laboratory of Dr. Gregory Parsons, NC State Alcoa Professor of Chemical and Biomolecular Engineering, shows that common textile materials can be used for complex electronic devices.

As part of their study, the researchers created a procedure to quantify effective electrical conductivity of conductive coatings on textile materials. The current standard of measuring conductivity uses a four-point probe that applies a current between two probes and senses a voltage between the other two probes. However, these probes were too small and would not give the most accurate reading for measurements on textiles. In the paper, researchers describe a new technique using larger probes that accurately measures the conductivity of the nanocoating. This new system gives researchers a better understanding of how to apply coatings on textiles to turn them into conductive devices.

"We're not expecting to make complex transistors with cotton, but there are simple electronic devices that could benefit by using the lightweight flexibility that some textile materials provide," Jur explains. "Research like this has potential health and monitoring applications since we could potentially create a uniform with cloth sensors embedded in the actual material that could track heart rate, body temperature, movement and more in real time. To do this now, you would need to stick a bunch of wires throughout the fabric – which would make it bulky and uncomfortable.

"In the world of electronics, smaller and more lightweight is always the ideal. If we can improve the process of how to apply and measure conductive coatings on textiles, we may move the needle in creating devices that have the requisite conductive properties, with all the benefits that using natural textile materials affords us," Jur says.

**More information:** “Atomic Layer Deposition of Conductive Coatings on Cotton, Paper, and Synthetic Fibers: Conductivity Analysis and Functional Chemical Sensing Using ‘All-Fiber’ Capacitors” - A paper describing the research is published in the June issue of *Advanced Functional Materials*.

## Abstract

Conductive coatings on complex fibrous systems are attracting interest for new electronic and other functional systems. Obtaining a quantitative conductivity value for complex surface coatings is often difficult. This work describes a procedure to quantify the effective electrical conductivity of conductive coatings on non-conductive fibrous networks. By applying a normal force orthogonal to the current and field direction, fiber/fiber contact is improved and consistent conductance values can be measured. Nylon fibers coated with an electroless silver plating shows effective conductivity up to  $1950 \text{ S cm}^{-1}$ , and quartz fibers coated with tungsten by atomic layer deposition (ALD) show values up to  $1150 \text{ S cm}^{-1}$ . Cotton fibers and paper coated with a range of ZnO film thicknesses by ALD show effective conductivity of up to  $24 \text{ S cm}^{-1}$  under applied normal force, and conductivity scaled as expected with film coating thickness. Furthermore, we use the conductive coatings to produce an “all-fiber” metal–insulator–metal capacitor that functions as a liquid chemical sensor. The ability to reliably analyze the effective conductivity of coatings on complex fiber systems will be important to design and improve performance of similar devices and other electronic textiles structures.

Provided by North Carolina State University

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