Engineer uses metal-oxide nanomaterials deposited on cloth to wipe out microbes

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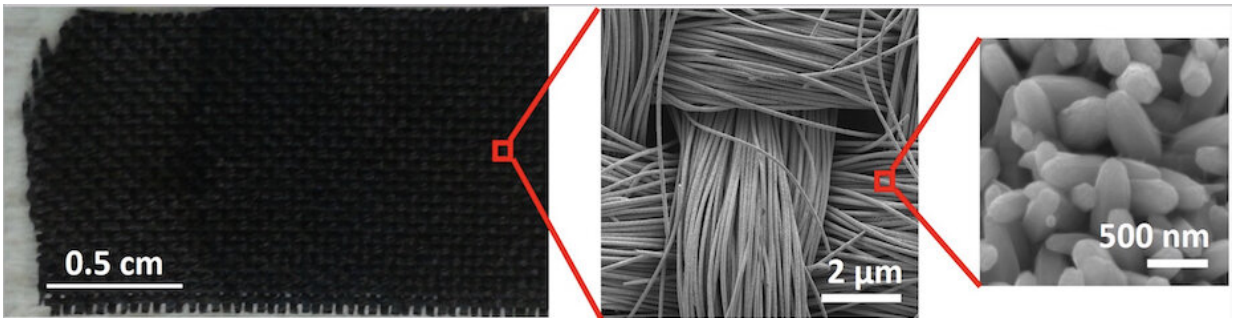

Here's a sample from Sonal Padalkar's lab: a carbon cloth coated with zinc oxide nanomaterials that are just billionths of a meter in size. Padalkar says the shape, size and density of the zinc oxide can be fine-tuned on the cloth. Credit: Sonal Padalkar

In an effort to make highly sensitive sensors to measure sugar and other vital signs of human health, Iowa State University's Sonal Padalkar figured out how to deposit nanomaterials on cloth and paper.

Feedback from a peer-reviewed paper published by *ACS Sustainable Chemistry and Engineering* describing her new fabrication technology mentioned the metal-oxide nanomaterials the assistant professor of mechanical engineering was working with—including zinc oxide, cerium oxide and copper oxide, all at scales down to billionths of a meter—also have antimicrobial properties.

"I might as well see if I can do something else with this technology," Padalkar said. "And that's how I started studying antimicrobial uses."

It turns out nanomaterials are rough on microbes such as bacteria. They actually puncture the cell walls of the single-cell microbes, causing leaks and ultimately death.

Put that on a cloth and you could have an effective, chemical-free disinfecting wipe.

"The implications of our present antimicrobial studies are enormous," Padalkar said. "We can find applications in wide areas, including our everyday life to many very specific applications, like surgical units in hospitals."

But does it work on tiny viruses, too?

More study is needed, Padalkar said. But, the mechanism would be the same—puncturing the protein coats of viruses to damage and kill the microbes.

Nanomaterials on a thread

Padalkar said she's been studying metal-oxide nanomaterials as antimicrobial agents for about eight months. Since 2018, she's studied the materials for use in various biosensors.

The key contribution from her lab has been figuring out how to grow nanostructures of metal oxides on cheap, lightweight, flexible cloth and paper. Padalkar's fabrication techniques are based on electrochemical deposition—applying electricity to the cloth or paper while also applying a solution containing precursors to the metal oxides.

Tests show the resulting nanostructures are consistent, stable and robust. She said the technology could be scaled up for larger surfaces and scaled all the way down to a single thread.

She has also worked with Carmen Gomes, an associate professor of mechanical engineering at Iowa State, to study the electrochemical sensing of bacteria using zinc-oxide nanomaterials deposited on glass. So far, she said the preliminary data look very positive. The project will be extended to study antimicrobial activity.

Applications all over

As with most research projects, there are still questions to study and answer.

"What shape, size, density of the nanomaterial will be ideal for this work?" Padalkar said. "What surface charge will be optimal on the nanomaterial so that bacterial interaction is possible? What will be the shelf life of such nanomaterials as antimicrobial agents?"

So far, Padalkar's faculty startup funds are supporting her search for answers. She's now writing a research proposal for external funding for her project.

In these days of hand-washing, social distancing and searching for hand sanitizer, there's certainly a need for all kinds of antimicrobial products. Padalkar said the antimicrobial cloth and paper products made possible by her fabrication technology could be useful in homes, in hospitals and clinics, at workplaces and schools and around farms.

"We do not plan to wrap up this work soon," she said. "The need for antimicrobial products is urgent and understanding the details of the mechanism and material parameters is paramount for the success of

these new materials."

More information: Ahmad Fallatah et al. Cerium Oxide Based Glucose Biosensors: Influence of Morphology and Underlying Substrate on Biosensor Performance, *ACS Sustainable Chemistry & Engineering* (2019). DOI: 10.1021/acssuschemeng.8b02286

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