Yarns coated with enzymes can act as filters

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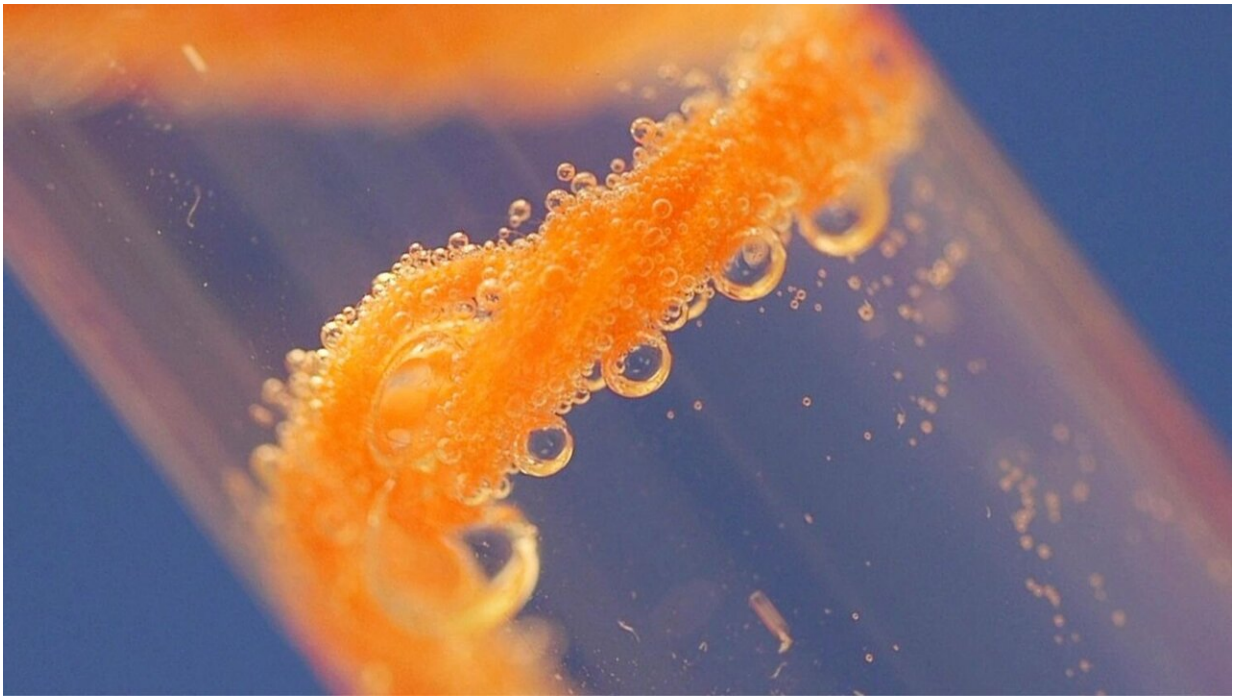

Orange biocatalytic yarn with oxygen bubbles. Credit: Lynn Doby, multimedia specialist, Textiles Creative and Technology Services, Wilson College of Textiles, NC State.

North Carolina State University researchers showed in a new study they could coat cotton yarns with enzymes, which are nature's tool for speeding chemical reactions, in order to change hydrogen peroxide into oxygen and water. The proof-of-concept study is a step toward the creation of a new generation of chemical filters.

Now, the researchers are studying whether they can design textile filters that could serve as a carbon capture technology. They are working on coating textiles with carbonic anhydrase, an enzyme that can turn carbon dioxide, a greenhouse gas, into water-soluble baking soda.

"The catalase system we described in the publication, although we can use it for real applications, mostly we were using it as a model to see if we could attach an enzyme to a textile, and show the reaction works," said the study's corresponding author Sonja Salmon, associate professor in textile engineering, chemistry and science at NC State. "We all know that carbon dioxide emissions are a big problem. What if we could make a filter for it like your body does when you breathe?"

The Abstract sat down with Salmon to talk about the study, which was reported in the journal *Advanced Materials Interfaces*, and the future of the research.

TA: What are enzymes?

Salmon: Enzymes are called nature's catalysts. They are proteins that are folded into a special shape that creates a site where chemical reactions can happen. Life as we know it would not exist without enzymes because many chemical reactions that are needed for life just wouldn't happen under ordinary conditions. Enzymes help chemicals meet up in the right way for reactions to happen.

TA: What is catalase, the enzyme you used in this study?

Salmon: Catalase is actually a very important enzyme in your body. It degrades hydrogen peroxide, which can form naturally. Your body makes catalase to destroy the peroxide before it can harm you.

In our study, catalase was our model system. We used a gel-like material called chitosan to stick the catalase to yarns, and then showed we could use them to change hydrogen peroxide into water and oxygen.

We chose catalase as the model because oxygen gas is released when the enzyme degrades peroxide, making bubbles in water. The bubbles let us know right away if the enzyme is working.

This study has implications for industrial processes. In the textile industry, peroxide is used to bleach cotton. If you wanted to reuse that same water for another process where the bleach would be damaging, you could use our biocatalytic textile as a filter to clean the peroxide out of the water.

TA: Why did you want to attach the enzymes to a textile?

Salmon: Many enzymes occur naturally as kind of dissolved materials. If you want to use them over and over again, one way to do it would be to attach them to a surface so that you can reuse them.

I'm interested in attaching enzymes to textiles specifically because textiles are very functional materials. You can make them in different shapes and sizes, they're flexible, and you can bend them. And—importantly for certain applications—they can transport water and liquids. Just imagine a dripping wet washcloth and you get the idea.

TA: What is the future application of attaching enzymes to textiles?

Salmon: The real target is to use an enzyme called carbonic anhydrase. This is another enzyme you have in your body. It helps you move carbon

dioxide out of your cells so you can exhale it.

What if we could make a filter with this enzyme to filter gas from a power plant? Carbon dioxide is a greenhouse gas, produced by burning fuel. To keep it from entering the atmosphere, we need to selectively pick out the carbon dioxide molecules from power plant emissions, and let other harmless gases go. These enzymes are very selective. They're only going to react with carbon dioxide to very quickly turn it into bicarbonate, which immediately dissolves in the process liquid. This captured carbon dioxide then would go to a separate process where bicarbonate is removed and the liquid is recycled. If you don't have a system to trap CO_2, it becomes very difficult to remove it from emissions. We're working to show that the technology we're developing could be a useful tool in the fight against climate change.

More information: Yue Yuan et al. Biocatalytic Yarn for Peroxide Decomposition with Controlled Liquid Transport, *Advanced Materials Interfaces* (2021). DOI: 10.1002/admi.202002104

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