Researchers create a protein 'mat' that can soak up pollution

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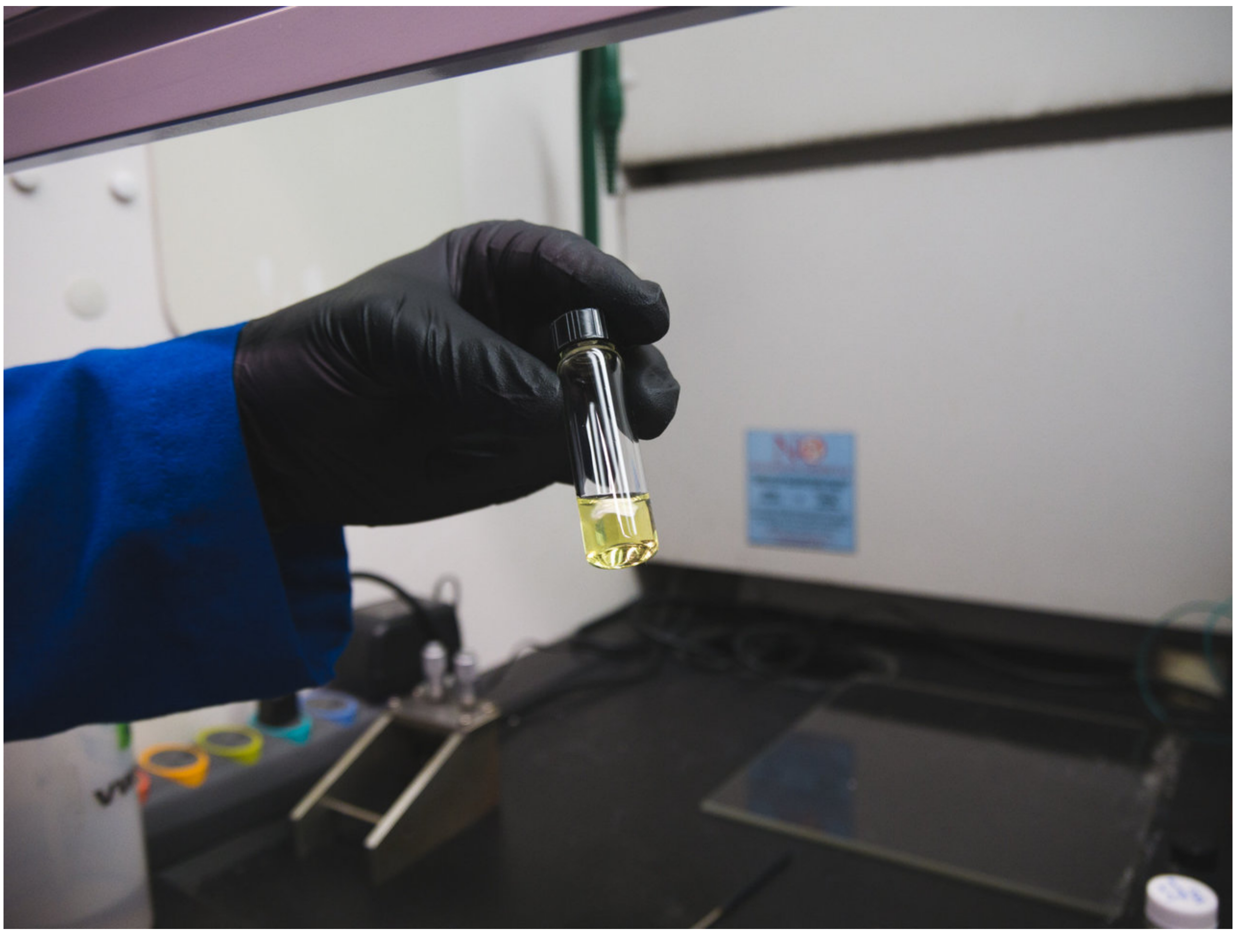


The researchers used the random heteropolymers to stabilize organophosphorus hydrolase and then made fiber mats from the polymers. The researchers submersed the mats in a well-known insecticide and found that the mats degraded an amount of insecticide weighing approximately one-tenth of the total fiber mat in just a few minutes. Credit: Christopher DelRe and Charley Huang.

In a breakthrough that could lead to a new class of materials with functions found only in living systems, scientists at the University of California, Berkeley, have figured out a way to keep certain proteins active outside of the cell. The researchers used this technology to create mats that can soak up and trap chemical pollution.

Despite years of effort to stabilize proteins outside of their native environments, scientists have made limited progress in combining proteins with synthetic components without compromising protein activity. The new study shows a path toward exploiting the power of proteins outside of the cell by demonstrating a unique way to keep proteins active in synthetic environments. The materials presented in the study could enable on-demand biochemical reactions where they were once not feasible.

"We think we've cracked the code for interfacing natural and synthetic systems," said study author Ting Xu, a Berkeley professor in the Department of Materials Science and Engineering and the Department of Chemistry, whose lab led the work.

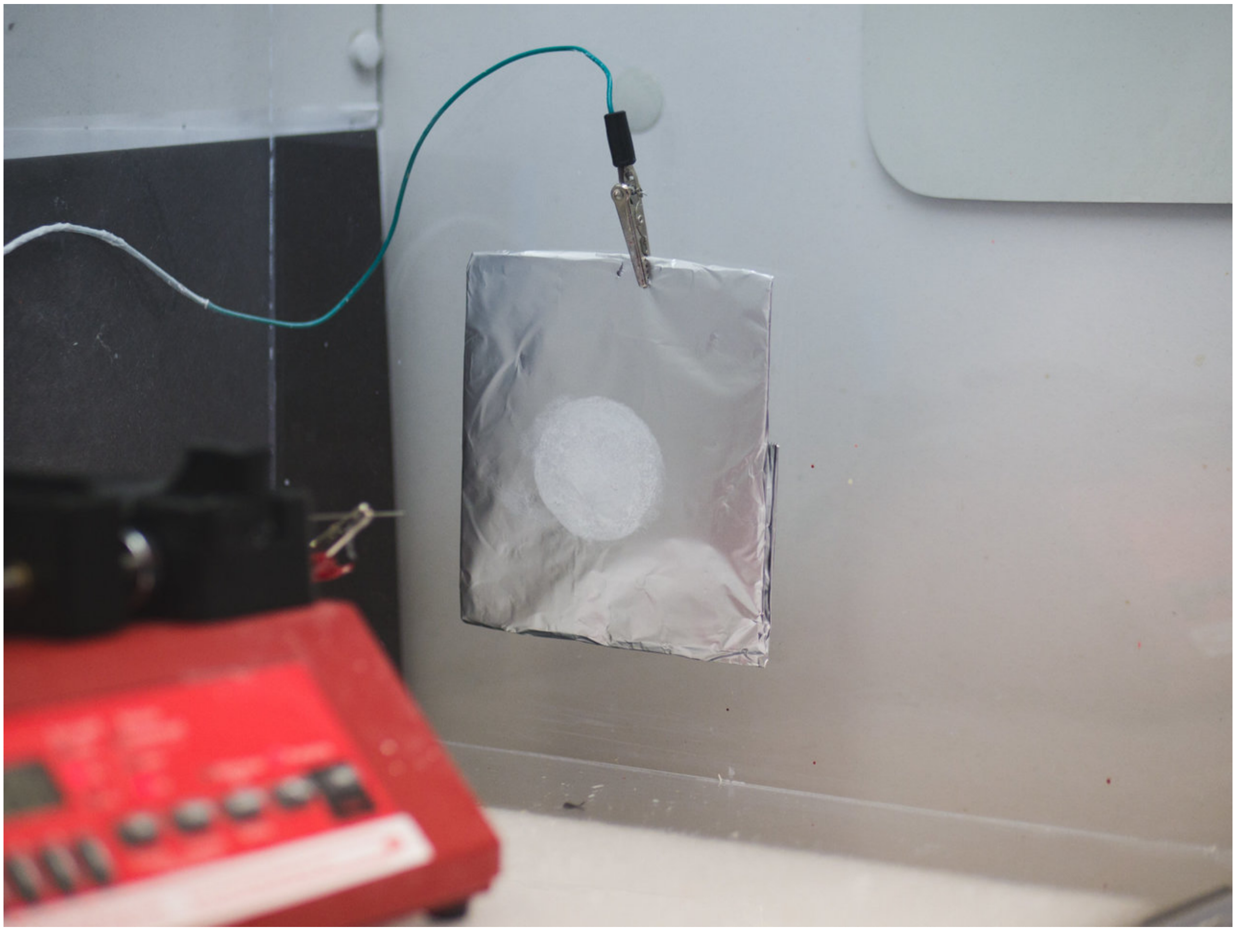
The study will be published in the March 16 issue of the journal *Science*. The research was supported by grants from the U.S. Department of Defense. Collaborators at Northwestern University were supported by the Department of Energy and the Sherman Fairchild Foundation. Collaborators at the University of Lyon and the Air Force Laboratory received support from the Fulbright program and the Miller institute.

The problem with proteins is that they are finicky. Remove them from their native environments and they will likely fall apart. To function properly, proteins must fold into a specific structure, often with the help of other proteins. To overcome this challenge, Xu's lab analyzed trends in protein sequences and surfaces to see if they could develop a synthetic polymer that provides all the things that a protein would need to keep its structure and function.

"Proteins have very well-defined statistical pattern, so if you can mimic that pattern, then you can marry the synthetic and natural systems, which allows us to make these materials," Xu said.

Xu's lab then created random heteropolymers, which they call RHPs. RHPs are composed of four types of monomer subunits, each with chemical properties designed to interact with chemical patches on the surface of proteins of interest. The monomers are connected to mimic a natural protein to maximize the flexibility of their interactions with protein surfaces. The RHPs act as unstructured proteins, commonly seen inside cells. They increased membrane protein folding in water during protein translation and preserved water-soluble protein activity in organic solvents.

The researchers at Northwestern University ran extensive molecular simulations to show that the RHP would interact favorably with protein surfaces, wrap around protein surfaces in organic solvents and weakly in water, leading to correct protein folding and stability in a non-native environment.



The white fiber mat containing an enzyme, seen here in white, was created via a process called electrospinning. Credit: Christopher DelRe and Charley Huang.

The researchers then tested whether they can use an RHP to create protein-based materials for bioremediation of toxic chemicals, which they were funded to do by the Department of Defense. The researchers mixed RHP with a protein called organophosphorus hydrolase (OPH), which degrades the toxic organophosphates found in insecticides and chemical warfare agents.

The researchers used the RHP/OPH combination to make fiber mats, submersed the mats in a well-known insecticide and found that the mats degraded an amount of insecticide weighing approximately one-tenth of the total fiber mat in just a few minutes. This opens the door to the creation of larger mats that could soak up toxic chemicals in places like war zones.

"Our study indicated that the approach should be applicable to other enzymes," Xu said. "This may make it possible to have a portable chemistry lab in different materials."

More information: "Random heteropolymers preserve protein function in foreign environments" *Science* (2018). science.sciencemag.org/cgi/doi … 1126/science.aao0335

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