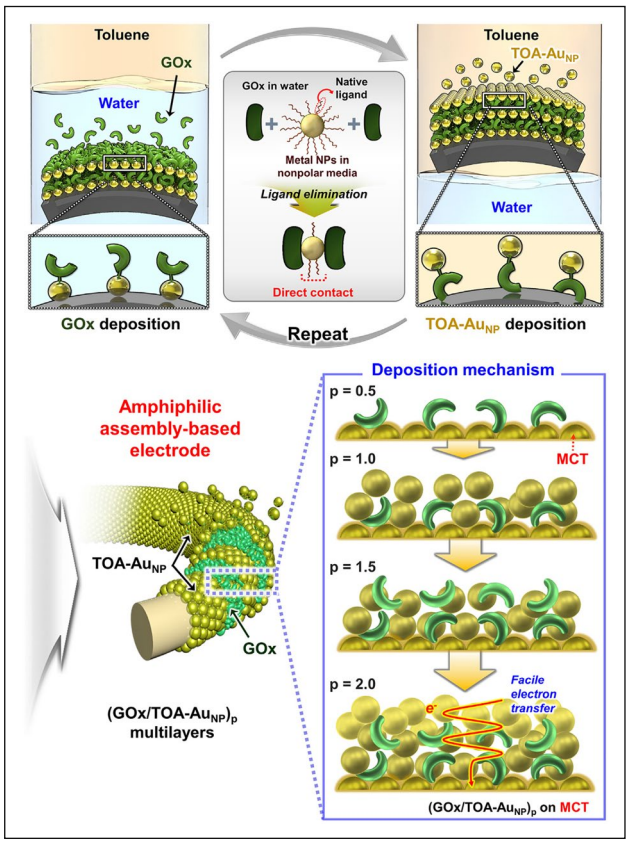
Amphiphilic assembly enhances performance of biofuel cells

Enzyme electrodes are useful in a range of applications, including biofuel cells (BFCs) that convert biochemical energy into electricity under mild biological conditions. However, most BFCs provide low power output and short-term operational stability due to their poor electron transfer between enzymes and electrodes and between neighboring enzymes. Now, an international research team from Korea and the United States address these shortcomings through an amphiphilic assembly designed to prepare high-performance BFCs.



Amphiphilic assembly enhances performance of biofuel cells. GOx is glucose oxidase; TOA is tetraoctylammonium bromide; NP is nanoparticle; and MCT is metallic cotton textile. Credit: AIP Publishing.

As reported in a recent issue of *Applied Physics Reviews* (https://doi.org/10.1063/5.0084917), amphiphilic-assembled multilayers composed of glucose oxidases (GOx) in aqueous media and hydrophobic/conductive nanoparticles in nonpolar media were deposited onto cotton fiber/textile to form the anode, which has notably increased electron transfer efficiency and immobilization stability. The cathode was formed by sputtering platinum onto the gold nanoparticle-coated cotton fibrils to improve the efficiency of the oxygen reduction reaction.

"Our novel electrode design using an amphiphilic assembly, which breaks with the common perspective of enzyme immobilization, can maximize the electron transfer at the enzyme/enzyme and enzyme/electrode interfaces as well as realize high operational stability, inducing the formation of a perfect and nanoblended enzyme layer," says first author Cheong Hoon Kwon of Korea University.

The method induced favorable interfacial interactions between electrocatalysts and improved electron transfer kinetics of electrodes. According to the researchers, it achieved unprecedented mass loading of hydrophilic enzyme and hydrophobic/conductive metal nanoparticles and greatly increased electron transfer efficiency and current density.

The researchers wrote in their article, "The assembled [three-dimensional] porous textile- and fiber-based hybrid BFCs exhibit high power outputs (1.5 mW cm^2 for textile BFCs and 7.3 mW cm^2 for fiber BFCs) without using redox mediators."

Co-author Jinhan Cho, a professor in the Department of Chemical and Biological Engineering at Korea University, says, "Our results could be of significant interest to various researchers and engineers working in the areas of self-assembly, energy conversion, and electrochemical sensors, in addition to BFCs."

Source: AIP Publishing