BIOFUEL CELLS

Doubly protected

Nat. Commun. **9**, 3675 (2018)

Enzymatic biofuel cells convert fuels, such as H_2 or glucose, directly into electricity, making use of naturally derived components to drive the catalytic processes that occur at the electrodes. For example, in H_2-powered biofuel cells, hydrogenase enzymes are often used at the anode to oxidize H_2 to protons. Although hydrogenases are efficient catalysts for this reaction, they are typically sensitive to high potentials and to O_2, limiting their stability. Now, Adrian Ruff, Wolfgang Schuhmann and colleagues in Portugal and Germany design a hydrogenase-based bioanode that is protected from these stresses using a multi-layered architecture.

The device designed by the researchers makes use of a particularly O_2-sensitive hydrogenase that is embedded in a redox-active viologen-modified polymer. This polymer wires the hydrogenase to the electrode and functions as a buffer to protect against high-potential deactivation. On top of this is a second polymer layer that is not redox-active but houses two different enzymes: catalase and glucose oxidase. These enzymes work together in a cascade to protect the O_2-sensitive hydrogenase by reacting glucose sacrificially with O_2 and, in the process, creating anaerobic conditions. Simultaneously, via a different enzymatic cascade, glucose also acts as a reactant to generate peroxide, which is the oxidant for the system, in situ at the cathode. In chronoamperometric experiments in the presence of O_2, after 6 h the H_2 oxidation current of the unprotected bioanode decreases to approximately 15% of its starting value, and the protected bioanode maintains about 70% of its current over the same time period.

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Published online: 9 October 2018
https://doi.org/10.1038/s41560-018-0271-4