research highlights

FUEL CELLS

Bio-inspired design

Angew. Chem. Int. Ed.

<http://doi.org/f3twg4> (2017)

Hydrogenases are enzymes that catalyse the reversible conversion of protons into H_2 . Therefore, they have provided inspiration for the design of new catalysts for production of H_2 from water and also for the reverse reaction, hydrogen oxidation, which occurs at the anode of a fuel cell. While hydrogenases themselves can be used in fuel cells, they are often expensive to produce and only work under limited conditions. Catalysts such as those based on nickel bis-diphosphine complexes, which are easier to produce and can operate under a wider variety of environments, are therefore being investigated as synthetic mimics. Now, Wendy Shaw, Vincent Artero, Alan Le Goff and colleagues at the Université Grenoble Alpes, France, and the Pacific Northwest National Laboratory, USA, demonstrate the immobilization and integration of such a catalyst into proton exchange membrane fuel cells and enzymatic fuel cells, achieving high power densities in both systems.

The researchers use electrostatic interactions to immobilize the catalyst on naphthoic acid-modified single-walled carbon nanotubes. The catalyst, once immobilized, maintains high activity for hydrogen oxidation across a wide pH range, with the turnover frequency going from 121 s^{-1} at pH 0.3 to 22 s^{-1} at pH 7. The behaviour of the immobilized catalyst is similar to that in solution, indicating that fixing it to the support does little to attenuate the structure or activity. Once integrated into a fuel cell that has an oxidase enzyme at the cathode, operating at $25\text{ }^\circ\text{C}$, the system achieves a maximum power density of 1.85 mW cm^{-2} at 0.60 V , higher than other precious-metal-free H_2 biofuel cells.

James Gallagher