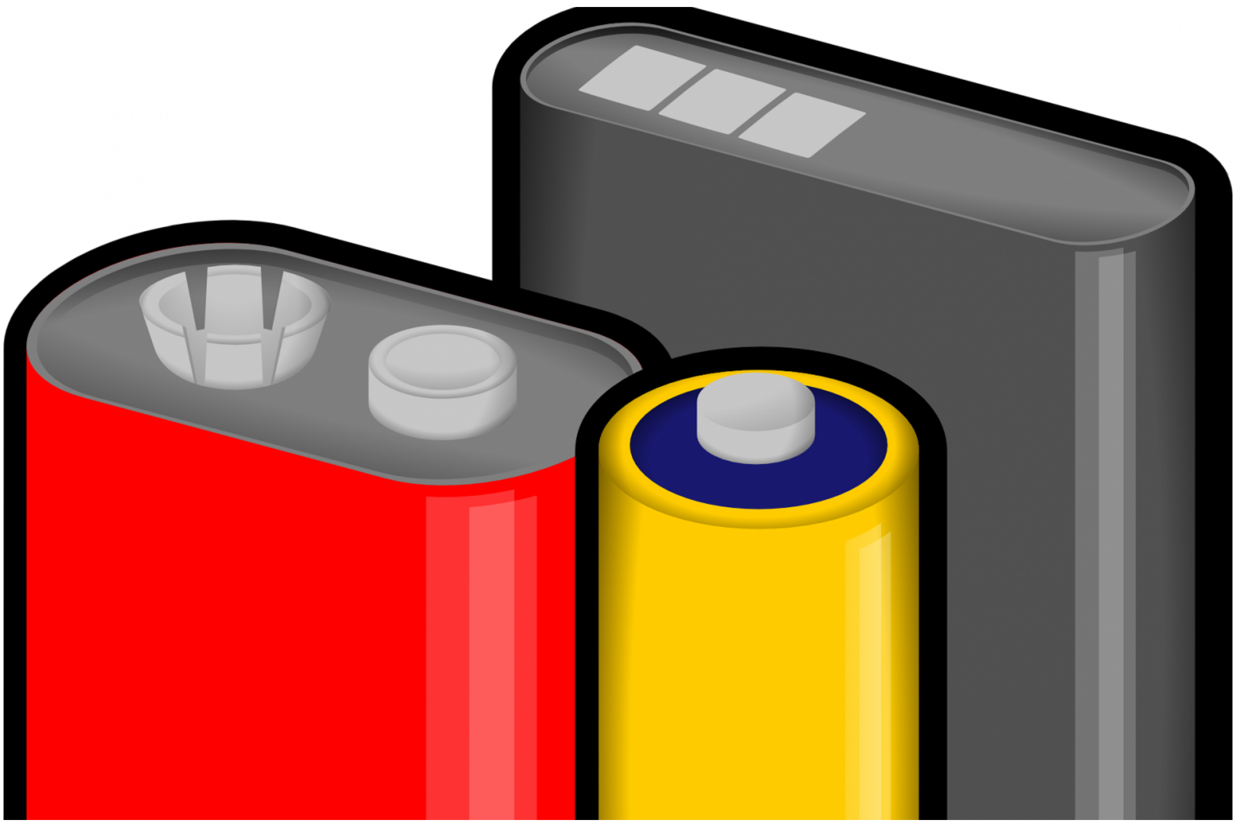
Safe space: Improving 'clean' methanol fuel cells using a protective carbon shell

December 7 2020



Credit: CC0 Public Domain

Because of environmental problems caused by the use of fossil fuels, many scientists worldwide are focused on finding efficient alternatives. Though high hopes have been placed on hydrogen fuel cells, the reality is that transporting, storing and using pure hydrogen comes with a huge cost, making this process challenging with current technology. In contrast, methanol (CH_3O_3), a type of alcohol, does not require cold storage, has a higher energy density and is easier and safer to transport. Thus, a transition to a methanol-based economy is a more realistic goal.

However, producing electricity from methanol at room temperature requires a direct methanol fuel cell (DMFC), a device that currently offers subpar performance. One of the main problems in DMFCs is the undesired methanol oxidation reaction, which occurs during methanol crossover, that is, when it passes from the anode to the cathode. This reaction results in the degradation of the platinum (Pt) catalyst that is essential for the cell's operation. Although certain strategies to mitigate this problem have been proposed, so far, none has been good enough owing to cost or stability issues.

In a recent study published in *ACS Applied Materials & Interfaces*, a team of scientists from Korea reports a creative and effective solution. They fabricated—through a relatively simple procedure—a catalyst made of Pt nanoparticles encapsulated within a carbon shell. This shell forms an almost impenetrable carbon network with small openings caused by nitrogen defects. While oxygen, one of the main reactants in DMFCs, can reach the Pt catalyst through these "holes," methanol molecules are too big to pass through. "The carbon shell acts as a molecular sieve and provides selectivity toward the desired reactants, which can actually reach the catalyst sites. This prevents the undesirable reaction of the Pt cores," explains Professor Oh Joong Kwon from Incheon National University, Korea, who led the study.

The scientists conducted experiments to characterize the overall structure and composition of the prepared catalyst and proved that oxygen could make it through the carbon shell and methanol could not. They also found a straightforward way to tune the number of defects in the shell by simply changing the temperature during a heat treatment step. In subsequent experimental comparisons, their novel shelled catalyst outperformed commercial Pt catalysts and also offered much higher stability.

Professor Kwon has been working on improving fuel cell catalysts for the past 10 years, motivated by the many ways in which this technology could find its way into our daily lives. "DMFCs have a higher energy density than lithium-ion batteries and could therefore become alternative power sources for portable devices, such as laptops and smartphones," he says.

With the future of our planet on the line, switching to alternative fuels should be one of humanity's top goals, and this study is a remarkable step in the right direction.

More information: Dohyeon Lee et al, Methanol Tolerant Pt–C Core–Shell Cathode Catalyst for Direct Methanol Fuel Cells, *ACS Applied Materials & Interfaces* (2020). DOI: 10.1021/acsami.0c07812

Provided by Incheon National University

Citation: Safe space: Improving 'clean' methanol fuel cells using a protective carbon shell (2020, December 7) retrieved 18 April 2024 from https://techxplore.com/news/2020-12-safe-space-methanol-fuel-cells.html