
Safe Space: Improving the "Clean" Methanol Fuel Cells Using a Protective Carbon Shell

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Scientists encapsulate catalyst in a protective molecular sieve that selectively prevents undesired reactions in methanol fuel cells.

Because of the many 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 added cost, making this process challenging with current technology. In contrast, methanol (CH_3OH), a type of alcohol, does not require cold storage, has a higher energy density, and is easier and safer to transport. Thus, a transition into 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, so far, 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.



If successfully commercialized, direct methanol fuel cells could replace the ubiquitous lithium-ion batteries in portable electronics thanks to their higher energy density.

Fortunately, in a recent study published in [ACS Applied Materials & Interfaces](#), a team of scientists from Korea has come up with 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 various types of 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.

Prof 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 remarks.

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.

Read the [original article](#) on Incheon National University.