Fuel cells for hydrogen vehicles are becoming longer lasting

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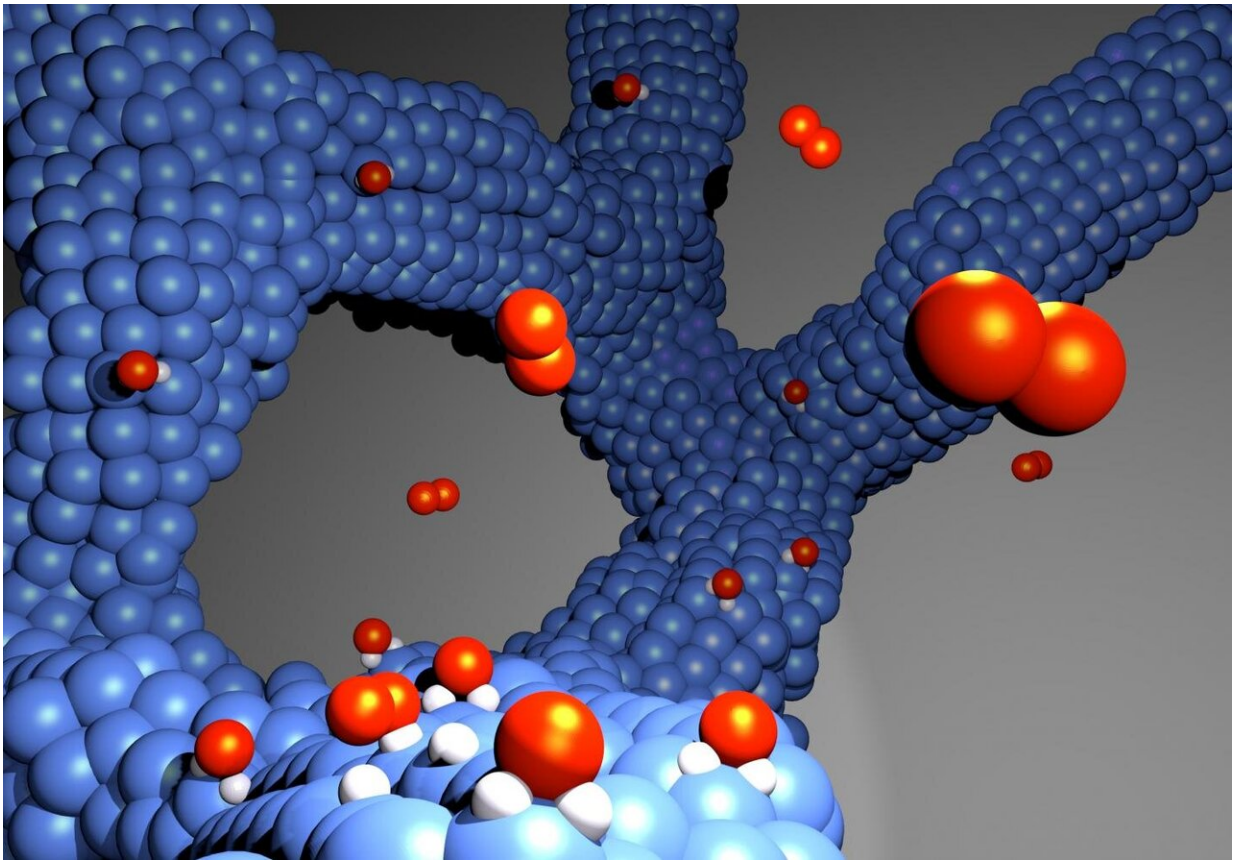

The new electrocatalyst for hydrogen fuel cells consists of a thin platinum-cobalt alloy network and, unlike the catalysts commonly used today, does not require a carbon carrier. Credit: Gustav Sievers

Roughly 1 billion cars and trucks zoom about the world's roadways. Only

a few run on hydrogen. This could change after a breakthrough achieved by researchers at the University of Copenhagen. The breakthrough? A new catalyst that can be used to produce cheaper and far more sustainable hydrogen powered vehicles.

Hydrogen vehicles are a rare sight. This is partly because they rely on a large amount of platinum to serve as a catalyst in their fuel cells—about 50 grams. Typically, vehicles only need about five grams of this rare and precious material. Indeed, only 100 tons of platinum are mined annually, in South Africa.

Now, researchers at the University of Copenhagen's Department of Chemistry have developed a catalyst that doesn't require such a large quantity of platinum.

"We have developed a catalyst which, in the laboratory, only needs a fraction of the amount of platinum that current hydrogen fuel cells for cars do. We are approaching the same amount of platinum as needed for a conventional vehicle. At the same time, the new catalyst is much more stable than the catalysts deployed in today's hydrogen powered vehicles," explains Professor Matthias Arenz from the Department of Chemistry.

A paradigm shift for hydrogen vehicles

Sustainable technologies are often challenged by the limited availability of the rare materials that make them possible, which in turn, limits scalability. Due to this current limitation, it is impossible to simply replace the world's vehicles with hydrogen models overnight. As such, the new technology a game-changer.

"The new catalyst can make it possible to roll out hydrogen vehicles on a vastly greater scale than could have ever been achieved in the past," states Professor Jan Rossmeisl, center leader of the Center for High

Entropy Alloy Catalysis at UCPH's Department of Chemistry.

The new catalyst improves fuel cells significantly, by making it possible to produce more horsepower per gram of platinum. This in turn, makes the production of hydrogen fuel cell vehicles more sustainable.

More durable, less platinum

Because only the surface of a catalyst is active, as many platinum atoms as possible are needed to coat it. A catalyst must also be durable. Herein lies the conflict. To gain as much surface area as possible, today's catalysts are based on platinum-nano-particles which are coated over carbon. Unfortunately, carbon makes catalysts unstable. The new catalyst is distinguished by being carbon-free. Instead of nano-particles, the researchers have developed a network of nanowires characterized an abundance of surface area and high durability.

"With this breakthrough, the notion of hydrogen vehicles becoming commonplace has become more realistic. It allows them to become cheaper, more sustainable and more durable," says Jan Rossmeisl.

Dialogue with the automotive industry

The next step for the researchers is to scale up their results so that the technology can be implemented in hydrogen vehicles.

"We are in talks with the automotive industry about how this breakthrough can be rolled out in practice. So, things look quite promising," says Professor Matthias Arenz.

The research results have just been published in *Nature Materials*, one of the leading scientific journals for materials research. It is the first article

in which every researcher at the basic research center, "Center for High Entropy Alloy Catalysis (CHEAC)", has collaborated. The center is a so-called Center of Excellence, supported by the Danish National Research Foundation.

"At the center, we develop new catalyst materials to create sustainable chemicals and fuels that help society make the chemical industry greener. That it is now possible to scale up the production of hydrogen vehicles, and in a sustainable way, is a major step forward," says center leader Jan Rossmeisl.

More information: Self-supported Pt–CoO networks combining high specific activity with high surface area for oxygen reduction, *Nature Materials* (2020). DOI: 10.1038/s41563-020-0775-8 , www.nature.com/articles/s41563-020-0775-8

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