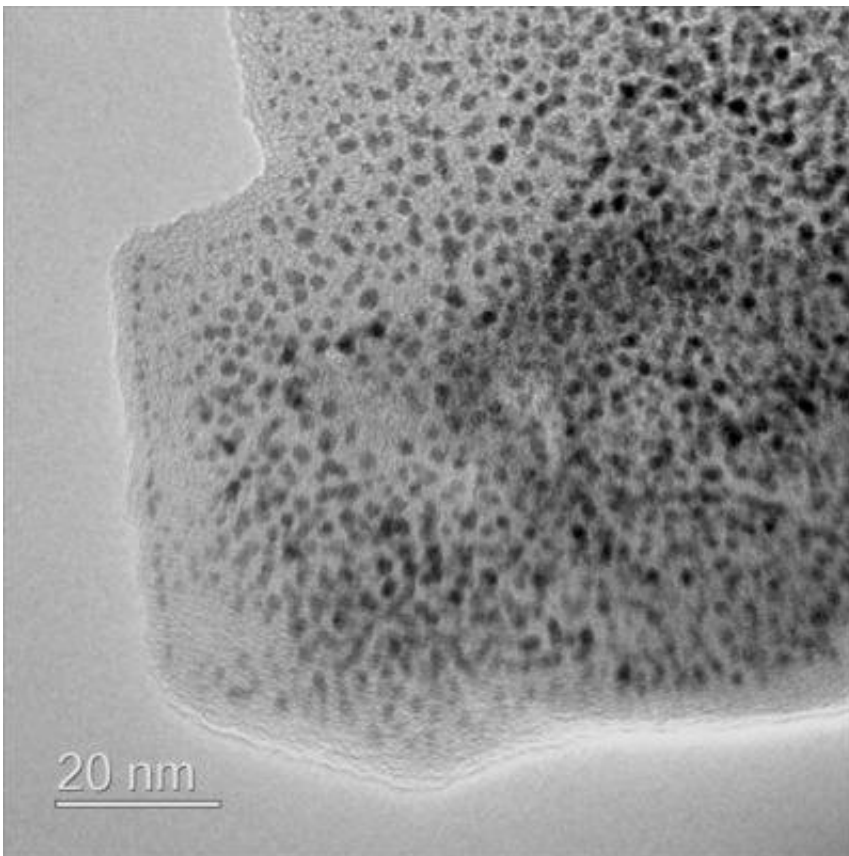


Scientists develop new material for longer-lasting fuel cells

July 23 2020



Transmission Electron Micrograph of graphene decorated with platinum nanoparticles. The dark spots are the platinum nanoparticles and the grey sheet they lie on is the graphene support material. Credit: Patrick Cullen / Gyen Ming Angel

New research suggests that graphene—made in a specific way- could be

used to make more durable hydrogen fuel cells for cars.

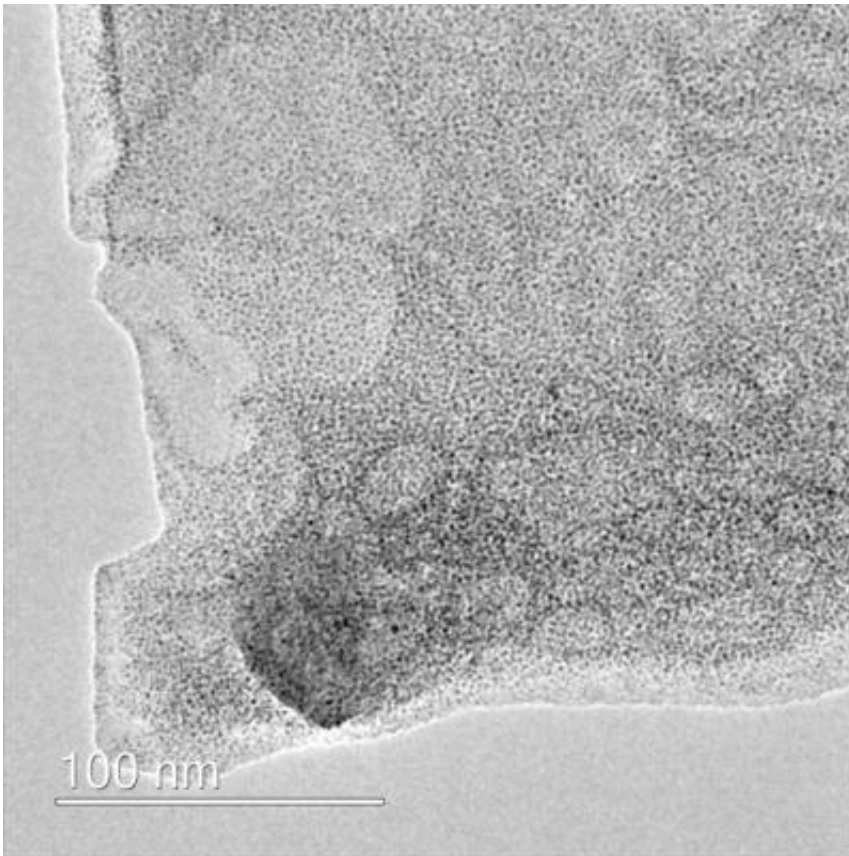
In the study, published today in the journal *Nanoscale*, scientists produced [graphene](#) via a special, scalable technique and used it to develop hydrogen [fuel cell](#) catalysts. The research team, involving scientists from Queen Mary University of London and University College London (UCL), showed that this new type of graphene-based catalyst was more durable than commercially available catalysts and matched their performance.

Hydrogen [fuel](#) cells convert [chemical energy](#) into electrical power by combining hydrogen and oxygen with the aid of catalysts. As the only by-product of the reaction is water, they provide an efficient and environmentally friendly power source.

Platinum is the most widely used catalyst for these fuel cells, but its high cost is a big problem for the commercialisation of hydrogen fuel cells. To address this issue, commercial catalysts are typically made by decorating tiny nanoparticles of platinum onto a cheaper carbon support, however the poor durability of the material greatly reduces the lifetime of current fuel cells.

Previous research has suggested graphene could be an ideal support material for fuel cells due to its corrosion resistance, high surface area and high conductivity. However, the graphene used in the majority of experiments to-date contains many defects, meaning that the predicted improved resistance has not yet been achieved.

The technique described in the study produces high-quality graphene decorated with platinum nanoparticles in a one-pot synthesis. This process could be scaled up for mass production, opening up the use of graphene-based catalysts for widespread energy applications.



Transmission Electron Micrograph of graphene decorated with platinum nanoparticles. The dark spots are the platinum nanoparticles and the grey sheet they lie on is the graphene support material. Credit: Patrick Cullen / Gyen Ming Angel

Professor Dan Brett, Professor of Electrochemical Engineering at UCL, said: "Satisfying global energy demands without damaging the environment is one of the great modern challenges. Hydrogen fuel cells can provide cleaner energy and are already used in some cars as an alternative to petrol or diesel. However, a big barrier to their widespread commercialisation is the ability for catalysts to withstand extensive cycling required for their use in energy applications. We've shown that by using graphene instead of the typical amorphous carbon as a support

material we can create ultra-durable catalysts."

The researchers confirmed the durability of the graphene-based catalyst using a type of test based on those recommended by the US Department of Energy (DoE), known as accelerated stress tests. Accelerated stress tests deliberately stress the catalyst rapidly over many cycles in a short space of time, allowing scientists to assess the stability of new materials without having to use them in an operational fuel cell over a period of months or years.

Using these tests, the scientists showed that loss in activity over the same testing period was around 30 per cent lower in the newly developed graphene-based catalyst, compared with commercial catalysts.

Gyen Ming Angel, Ph.D. student and lead author of the study, from UCL, said: "The DoE sets tests and targets for fuel cell durability, with one accelerated stress test to simulate normal operating conditions and one to simulate the high voltages experienced when starting up and shutting down the fuel cell. Most research studies in the graphene space only evaluate using one of the recommended tests. However, since we have high-quality graphene in our material, we have managed to achieve high durability in both tests and under long testing periods, which is important for the future commercialisation of these materials. We look forward to incorporating our new catalyst into commercial technology and realising the advantages of longer-life fuel cells."

Graphene is made from a single layer of carbon atoms arranged in a hexagonal lattice. Despite its relatively simple structure, graphene is thought to have remarkable properties including high electrical conductivity, high transparency and high flexibility.

Dr. Patrick Cullen, Lecturer in Renewable Energy from Queen Mary University of London, said: "Over the years, there's been a lot of hype

around graphene and the vast number of promising applications for this material. However, the research community is still waiting for its full potential to be realised, and this has led to some negativity around this proposed 'wonder material'. This view isn't helped by the fact that many research studies on graphene use defective versions of graphene. We hope that this paper can restore faith in graphene and show that this material holds great potential for improving technology, like fuel [cells](#), now and in the future."

More information: Gyen Ming Anthony Angel et al. Realising the Electrochemical Stability of Graphene: Scalable Synthesis of Ultra-durable Platinum Catalyst for the Oxygen Reduction Reaction, *Nanoscale* (2020). [DOI: 10.1039/D0NR03326J](https://doi.org/10.1039/D0NR03326J)

Provided by Queen Mary, University of London

Citation: Scientists develop new material for longer-lasting fuel cells (2020, July 23) retrieved 24 April 2024 from <https://phys.org/news/2020-07-scientists-material-longer-lasting-fuel-cells.html>

<p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p>
--