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Team reports a high performance nanoparticle electrocatalyst

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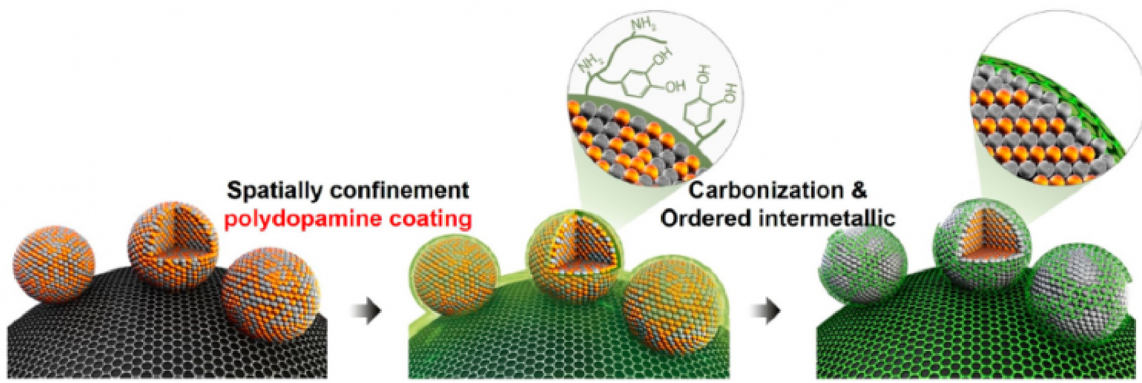

Figure A Synthesis of ordered intermetallic fct PtFe/C. Schematic synthesis diagram of carbon-supported and N-doped carbon-coated ordered fct-PtFe NPs

Scientists operating out of IBS' Center for Nanoparticle Research have reported highly durable and active intermetallic platinum-iron (PtFe) nanoparticles (NPs) coated with nitrogen (N) doped carbon shell. Precision sized face centered tetragonal (fct) PtFe NPs, only a few nanometers thick, are formed by thermal annealing at 700oC, resulting in a carbon outer layer which protects the NPs from detachment and dissolution throughout the harsh fuel cell operating conditions. The N-doped carbon shell not only prevents the amalgamation of the NPs during a thermal annealing process to keep their sizes as small as 6.5 nm but also protects them under the harsh operating condition.

Nanoparticles are microscopic particles between 1 and 100 nanometers (nm) in size. To put that into perspective, the greatest particle size that can pass through a surgical mask is 100 nm. In 1959, physicist Richard Feynman proposed that one day humankind could create machines composed of several individually manipulated molecules or atoms, and these machines could be constructed by tools that were only slightly larger -an inventive and, for the time, perplexing thought.

Rejuvenated Nano Research

Now, some 40 years later, nanoparticle research has seen something of a renaissance and is an area of intense scientific research, due to a wide variety of potential applications in biomedical, optical, and electronic fields. Published reports have increased exponentially since 2000 and there's little evidence to assume this trend will cease.

Demand for a practical synthetic approach to the high performance electrocatalyst is rapidly increasing for fuel cell commercialization. An electrocatalyst is an electrical current that acts as a catalyst. A fuel cell is a device that converts chemical energy from a fuel into electricity through an electrochemical reaction of positively charged hydrogen ions with oxygen or another oxidizing agent - an oxidizing agent or an oxidizer is a chemical species that transfers electronegative atoms, usually oxygen, to a substrate.

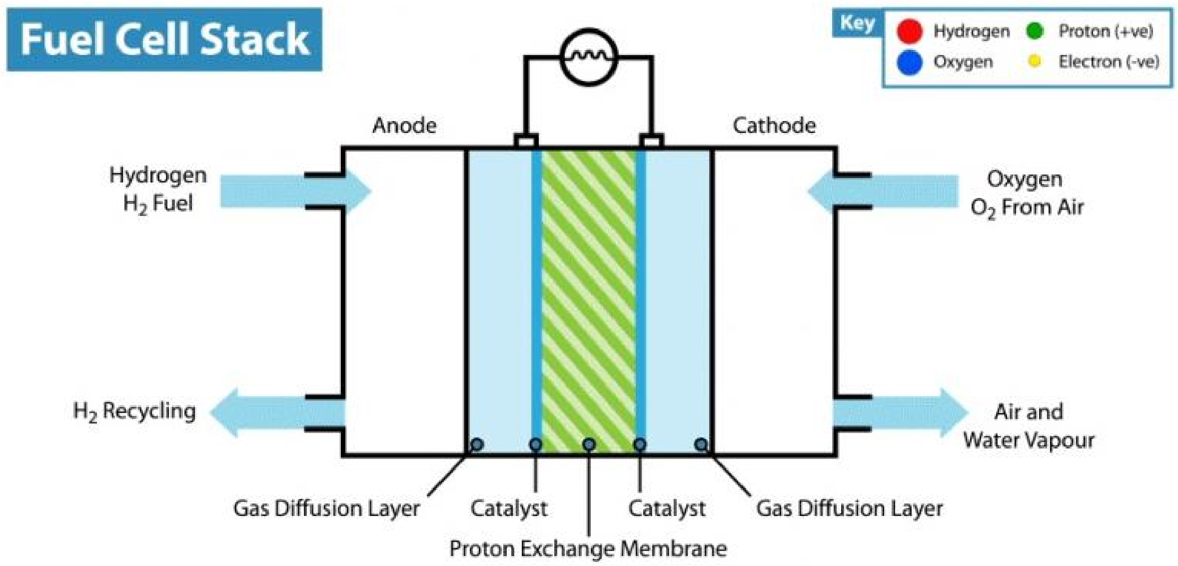

Figure B Operational Fuel Cell

These devices are incredibly popular due to their ability to generate electricity by reacting oxygen and hydrogen without emitting CO2. Fuel cells are commonly found in all types of equipment and vehicles, the most common types are found in cars, airplanes, boats and military equipment like submarines and weaponry. There are however limitations to fuel cells: they require platinum which is expensive and found in limited deposits on Earth.

Fuel Cells in Ordinary Life

Nanoparticle-based electrocatalysts have been intensively investigated for fuel cell applications over the past decade, mainly motivated by their high mass activity. Great effort has been exhausted to utilize the high activity and surface area of NPs in order to make a breakthrough for fuel cell commercialization. The team's paper, published in the *Journal* *of the American Chemical Society*, stated that a practical use of nanomaterials for fuel cell electrocatalyst is impeded by their low physical and chemical stability. Under the standard fuel cell operating conditions, NPs are often oxidized, dissolved, or detached from the support and clustered into larger particles, losing their electrochemical catalytic activity during cycling. Therefore, ordered intermetallic NPs are considered as one of the most promising candidates to achieve both high activity and stability in practical fuel cell applications.

The resulting ordered tetragonal-PtFe/ C nanocatalyst coated with an N-doped carbon shell shows the higher performance and durability compared to disordered face centered cubic (fcc)-PtFe/C and commercial Pt/C. According to the team's paper, their approach 'can open a new possibility for the development of high performance and cost effective fuel cell catalysts.'

More information: Dong Young Chung et al. Highly Durable and Active PtFe Nanocatalyst for Electrochemical Oxygen Reduction Reaction, *Journal of the American Chemical Society* (2015). DOI: 10.1021/jacs.5b09653

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