# Highly Durable and Active Fuel Cell Electro-Catalyst Designed with Hybrid Support

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## SUMMARY

UCLA researchers in the Department of Materials Science and Engineering have demonstrated an innovative electrocatalyst design with a hybrid support for fuel cells that can dramatically increase the lifetime of the catalyst, as well as its activity.

## BACKGROUND

Precious metal group (PMG) nanocrystals (NCs) (e.g. Pt, Pd, and Au) have shown great potential as cathode electrocatalysts in proton exchange membrane (PEM) fuel cells. To synthesize highly active PMG nanocatalysts in a cost-effective manner, PMG NCs are usually loaded on high surface area supporting materials, such as carbon-based materials. Graphene, or reduced graphene oxide (RGO), stands out as an excellent electrocatalyst support because of its good conductivity, high surface area, and high mechanical strength. However, the stacking effect between RGO sheets blocks a substantial amount of catalytic sites on NCs and sets a higher resistance for the diffusion of reactant molecules, which in turn retards the catalytic reaction. There have been reports of retarded oxygen reduction rates at a certain potential range and slowed oxygen diffusion using RGO as a catalyst support for the oxygen reduction reaction (ORR) occurring at the fuel cell cathode. Additionally, RGO sheets obtained by wet chemical synthesis usually contain more defects, which reduce the electron transfer rate in the graphene sheet and across the NC RGO interface as well. Therefore, further improvement of the design is necessary for mitigating or preventing the stacking of RGO sheets as the electrocatalyst support.

## INNOVATION

Researchers at UCLA have designed a system incorporating a highly active and durable ORR catalyst supported by an hybrid composite material that is prepared by loading Pt NCs on a primary support RGO, which is then composited with a secondary high surface area carbon black (CB) support. With the insertion of CB particles between the Pt RGO sheets, stacking of RGO is effectively prevented, promoting diffusion of oxygen molecules through the RGO sheets and enhancing the ORR electrocatalytic activity. The resulting hybrid structure also exhibits improved durability, with >95% retainment of Pt's electrochemical surface area after 20,000 operation cycles as measured by the accelerated durability test.

## APPLICATIONS

- Broadly applicable to both cathode and anode catalysts in hydrogen fuel cells, direct methanol fuel cells, and metal fuel cells.

## ADVANTAGES

- Minimized stacking of RGO
- Enhanced electrocatalytic activity
- Improved durability

## STATE OF DEVELOPMENT

Successfully tested in the lab and further testing is underway for scale up and mass production.

## RELATED MATERIALS

- Li, Y., Li, Y., Zhu, E., McLouth, T., Chiu, C.Y., Huang, X., and Huang, Y. Stabilization of high-performance oxygen reduction reaction Pt electrocatalyst supported on reduced graphene oxide/carbon black composite, Journal of the American Chemical Society, 2012.

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## INVENTORS

- Huang, Yu

## OTHER INFORMATION

### KEYWORDS

Electrocatalyst, catalyst, Proton exchange membrane (PEM) fuel cell, fuel cell, precious metal group (PMG), nanocrystals (NCs), PMG nanocatalysts, reduced graphene oxide (RGO), oxygen reduction reaction (ORR)

### CATEGORIZED AS

- **Energy**
  - Hydrogen
- **Materials & Chemicals**
  - Composites
  - Nanomaterials
- **Nanotechnology**
  - Materials
- **Engineering**
  - Other

### RELATED CASES

2012-559-0

## PATENT STATUS

| Country | Type | Number | Dated | Case |
|---|---|---|---|---|
| United States Of America | Issued Patent | 9,680,158 | 06/13/2017 | 2012-559 |

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- High Performance Platinum-Based Catalyst Combined with Carbon Support Engineering



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