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Editorial

A Study on Advances in Hydrogen Fuel Cells

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ABSTRACT

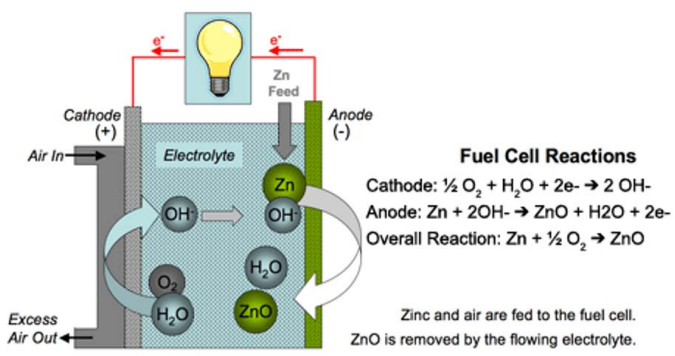
Hydrogen Fuel Cells are similar to batteries both generate electricity but batteries may run dead, on the other hand, a fuel cell will continuously provide electricity as long as hydrogen is provided. It is worth to take note that emissions of fuel cells are heat and water, there are normally no greenhouse gas emissions hydrogen Fuel Cells. There are many types of Hydrogen Fuel cells but most of them consist of anode, cathode and an electrolyte. This editorial paper contends about the generation of the hydrogen fuel cell, the novel catalyst for eco-friendly vehicles, turbocharging fuel cells, an economical and inexpensive fuel cell for power generation, water free and graphene powered fuel cells.

Keywords: *Hydrogen, Hydrogen fuel cells, Fuel cells, Clean energy, Graphene.*

INTRODUCTION

In hydrogen fuel cells, hydrogen and oxygen combine to generate electricity, heat, and water. It can be compared to batteries. Both convert chemical reaction to electric power. However, fuel cells will generate electricity as long as hydrogen is provided, never losing its charge. Hydrogen to generate electricity is a very important energy carrier. Renewable energy sources like sun, wind cannot generate energy all the time. Nonetheless, they could generate electric energy and hydrogen which can be stored until it's required. Hydrogen can be transported to locations where it is required. Major applications include transportation, portable uses, and stationary installations. Stationary hydrogen fuel cells are the largest and one of the powerful fuel cells. They are designed to provide clean, reliable source of on-site power to hospitals, banks, airports, military bases, schools, homes, and other applications.[1,2]

Figure 1. Illustrates an example of Zinc Fuel Cell.[3] Image Credit: Ovidiu Sandru



In this editorial of hydrogen fuel cells, recent developments of hydrogen fuels cells such novel catalysts to make hydrogen fuel cell economical for industrial and commercial usage are intended and also recent developments in the catalyst, applications and advantages of hydrogen fuel cells are exemplified.

NOVEL METHOD TO GENERATE HYDROGEN FUEL

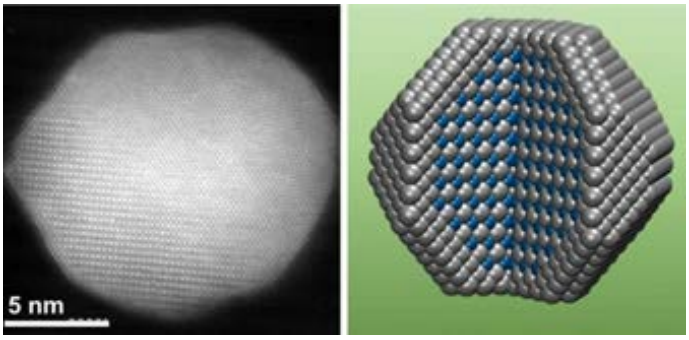
A team of experts from Ben-Gurion University of the Negev (BGU) and Technion Israel Institute of Technology have successfully discovered the fundamental chemical reaction that is present in solar power that can be formed the missing link to produce enough electricity to accomplish this process of generation of hydrogen fuel. It allows the process of human-made energy sources or precious metals to catalyze the reaction. One of the best part is that production of hydrogen does not emit greenhouse gases but until now, the process of generation required more energy than is generated. That resulted in limited commercial viability. Hydrogen production for fuel requires splitting water of water molecules (H_2O) into two hydrogen atoms and one oxygen atom. This study discloses breakthrough in comprehending the mechanism that takes place throughout the photochemical splitting of hydrogen peroxide (H_2O_2) over iron oxide photoelectrodes which includes splitting the photo-oxidation from linear to two sites.[4,5]

CATALYST FOR FUEL CELL FOR ECOFRIENDLY VEHICLES

One of the major factors that is holding back the widespread use of eco-friendly hydrogen fuel cells in vehicles like cars, truck and others is the price of the platinum catalyst that makes these cells work. One method can be to use less precious platinum is to combine it with other

economical metals, but those alloys catalyst incline to degrade quickly in fuel cells. But now, a scientist from Brown University have created a novel method; a new alloy catalyst that both shrinks usage of platinum and holds up good in fuel testing. This catalyst was made from alloying platinum with cobalt in nanoparticles. This problem was addressed by Li and his colleagues, they created alloy nanoparticles with specialized structure. These particles have a pure platinum outer shell neighboring a core made from alternating layers of platinum and cobalt atoms. This coated core arrangement is vital for the catalyst's reactivity and durability. Initial testing indicated that catalyst accomplished well in the laboratory setting and outperforming more traditional platinum alloy catalyst. New catalyst maintained its activity after 30,000 voltage cycles, whereas the performance of traditional catalyst dropped off significantly. Testing indicated that catalyst knocks targets set by the Department of Energy (DOE) for both initial activity and long term durability. Department of Energy has given a task to researchers to create a catalyst with an initial activity of 0.44 amps per milligram of platinum and an activity of at least 0.26 amps per milligram after 30,000 voltage cycles (roughly equivalent to five years of use in a fuel cell vehicle). Testing of the new catalyst indicated that it had an initial activity of 0.56 amps per milligram and an activity after 30,000 cycles of 0.45 amps.[6,7]

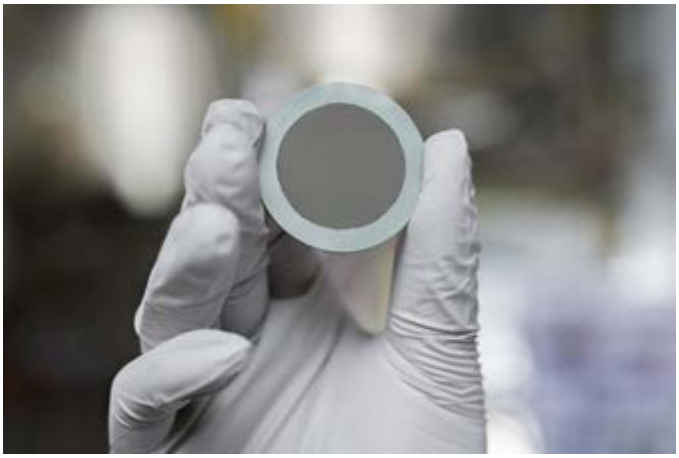
Figure 2. Illustrates the ordering in the core tightens the lattice of the shell, which increases durability. Image Credit: Sun lab / Brown University[7]



TURBO CHARGING FUEL CELLS

Powering clean and efficient cars is just only one-way fuel cell technology could speed up into a sustainable energy future, but technology has been a little slow. Now, engineers can turbocharge fuel cells with a new type of catalyst. The slowness comes from a chemical bottleneck, the rate of processing oxygen – a vital ingredient that aids fuel cells that are related to nanotechnology material. It speeds up oxygen processing and it is the subject of a new study. This technology was discovered by Georgia Institute of Technology. To accommodate partly oxygen's restrictions, fuel cells usually require pure hydrogen fuel, which reacts with the oxygen taken from the air, but the costs of producing hydrogen have been prohibitive. This new innovative catalyst is a prospective game changer. This catalyst is 8 times as fast as traditional ones. It achieves its efficiency by rushing oxygen through the fuel cell's system. There are few types of fuel cells, but scientist worked to improve solid oxide fuel cells which are found in some prototypical fuel cell cars. This comprehension of this study can also aid in enhancing supercapacitors and technology paired with solar panels, thus advancing supportable energy beyond the new catalyst's immediate potential to enhance fuel cells. The catalyst is activated - in this nano oxygen rush, the steep coating is applied about two dozen nanometers thick and is consist of two connected nanotechnology solutions that break both oxygen bottlenecks. First, nanoparticles are highly attractive to an oxygen molecule and it lets inflowing electrons quickly jump onto it, splitting into two separate oxygen ions (each one an O2-). The sequence of chemical holes called electron vacancies that are assembled into the nanoparticles structures pull up the oxygen ions like chains of vacuum cleaners passing the ions to the second phase of the catalytic process. The second phase is a coating that is full of oxygen vacancies that can pass the O2- even more rapidly toward its final destination. The ions meet to make water which exits the fuel cell. In the case of methane fuel, pure CO2 is also discharged which can be captured and recycled back into the fuel.[8,9,10]

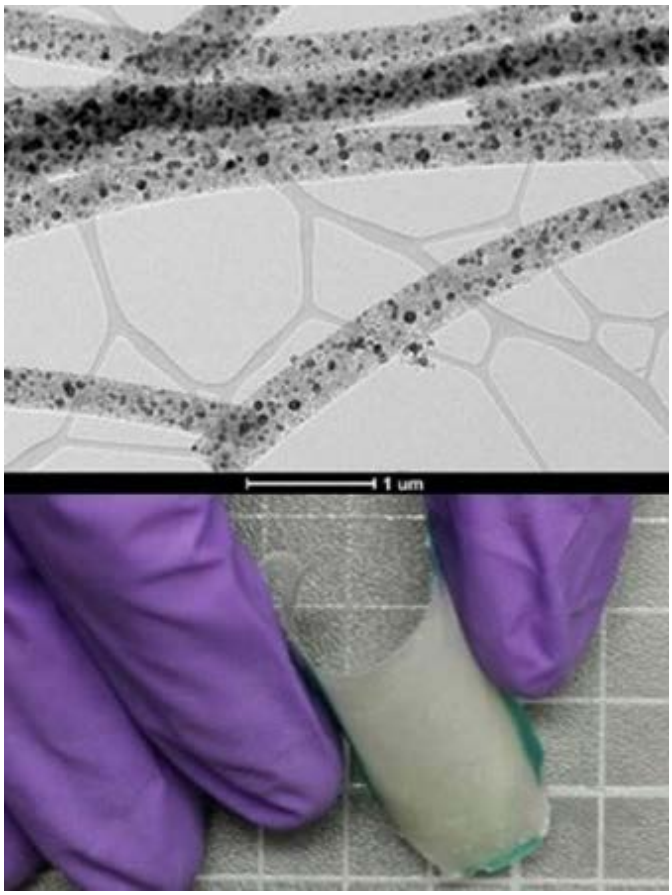
Figure 3. Illustrates a new boost to fuel cell technology from Georgia Tech: A nanoparticle coating on this disc turbocharges the processing of oxygen on the cathode end of solid oxide fuel cells, increasing eightfold current best performance. Image Credit: Georgia Tech / Christopher Moore[9]



ECONOMICAL AND AN INEXPENSIVE FUEL CELLS

Fuel Cells have significant potential to be a clean and efficient way to run cars, computers and power stations but the cost of production is so high that it is limiting their use. But a scientist at the University of California, Riverside, explained the development of inexpensive and efficient catalyst material for a type of fuel cell called polymer electrolyte membrane fuel cell (PEMFC) which turns the chemical energy of hydrogen into electricity and is among the most favorable fuel cell types to power cars and electronics. This catalyst was created at University of California – Riverside, made of porous carbon nanofibers embedded with a compound made from abundant metal, for instance, cobalt which more than 100 times less expensive than platinum. Many of the hydrogen fuel cells are already used by some of the carmakers, offer advantages over traditional combustion technologies including higher efficiency, quitter operation, and lower emissions. Like batteries, fuel cells are also electrochemical devices that consist of positive and negative electrode sandwiching an electrolyte. When a node is injected with hydrogen fuel, catalyst splits the hydrogen molecules into positively charged particles called protons and negatively charged particles called electrons. These electrons are focused through an outward circuit where they power an electric motor before rejoining the positively charged hydrogen ions oxygen to form water.

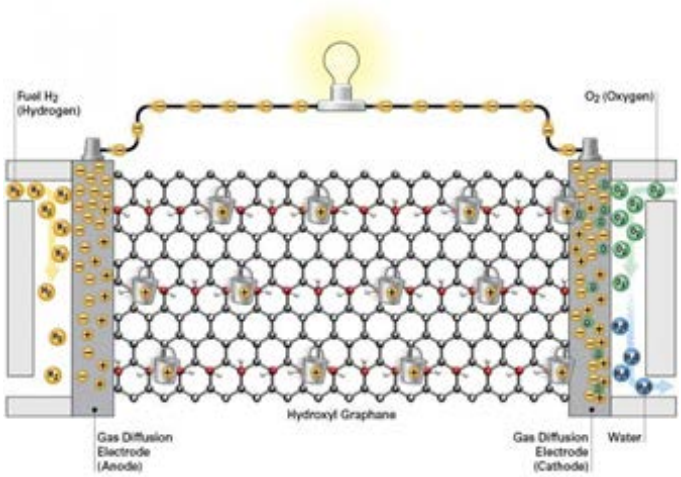
Figure 4. Illustrates engineered carbon fibers embedded with active nanoparticles (top) can be fabricated into structural materials that are lightweight and flexible (bottom). Image Credit: UC Riverside[11]



GRAPHENE CAN BE EFFICIENT AND WATER FREE HYDROGEN FUEL CELLS

Scientists at University of Pittsburg found a rare and unique features properties of graphene – a two dimensional polymer of carbon and hydrogen that can form a type of anhydrous "bucket brigade" that carries protons without the necessity or requirement for water, significantly leading to advancement of more efficient and effective hydrogen fuel cells for vehicles and other systems that require energy. At the core of the fuel cell is a Proton Exchange Membrane (PEM). These films mostly rely on water to assist in the conduction of protons across the membranes. This mechanism works well unless the temperature gets too high or humidity drops, which depletes the film of water and stops protons from migrating across the film. Their team is concentrated on graphene because when functionalized with hydroxyl groups it creates more stable and insulating membrane conduct protons.[12,13]

Figure 4. Illustrates In computer simulations at Pitt, graphene provides a water-free "bucket brigade" to rapidly conduct protons across the membrane and electrons across the circuit. Image Credit: A. Bagusetty/University of Pittsburgh; Rick Henkel[13]



CONCLUSION

To conclude the survey of new methods and novel catalyst for the hydrogen fuel cell to make it economical and eco-friendly for commercial and industrial usage are reviewed in this paper.

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CONFLICTS OF INTEREST

There is no conflicts of interest as per the Author's point of view.

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