

**Section of
Public Relations**Hyo Jung Kim
Section Chief
(+82) 62-715-2061Nayeong Lee
Senior Administrator
(+82) 62-715-2062**Contact Person
for this Article**Professor Chang Hyuck Choi
School of Materials Science and Engineering
062-715-2317**Release Date**

2020.08.05

Professor Chang Hyuck Choi's research team identifies the cause of reduced durability of catalysts for hydrogen fuel cells

- GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Materials Science and Engineering Professor Chang Hyuck Choi's research team has identified the cause of reduced durability of non-precious metal catalysts for hydrogen fuel cells, and this is expected to further energize the commercialization of hydrogen fuel cells.
 - Hydrogen fuel cells that produce electricity by reacting hydrogen with oxygen in the air need a catalyst to help them react. Existing hydrogen fuel cells mainly use platinum as a catalyst, but the scarcity and high price of platinum have hindered commercialization. Therefore, research on inexpensive iron, nitrogen, and carbon-based monoatomic catalysts that can replace platinum is actively underway.
- However, iron-based single-atomic catalysts are highly unstable in acidic environments, which is the operating condition of hydrogen fuel cells. For long-term stable power production, it is necessary to ensure durability during their operation.
 - Hydrogen peroxide, a byproduct of the oxygen reduction reaction* created at the anode, is considered one of the main causes for instability, but it is difficult to improve durability because the exact reaction mechanism between is unknown.

* oxygen reduction reaction: A reaction that takes place at the anode of a hydrogen fuel cell where oxygen reacts with electrons and protons to produce water.

- The research team artificially exposed the catalyst to hydrogen peroxide and confirmed with experiments that unstable reactive oxygen species* generated under acidic conditions with sufficiently strong alkaline electrolytes are the main cause of catalyst degradation.

* reactive oxygen species: chemically reactive molecules containing oxygen atoms, which includes hydrogen peroxide and hydroxyl radicals

- In working with acidity from a range of 0 to 14, the researchers discovered that the degree of degradation from oxygen reduction reaction was affected by the acidity of the electrolyte.
- The team also confirmed through electron spin resonance spectroscopy* that the degree of reactive oxygen species produced and the degree of catalyst degradation were proportional. Because unstable reactive oxygen species created under acidic conditions are the main cause of catalyst deactivation, their control is necessary to ensure the durability of the catalyst in hydrogen fuel cells.

* electron spin resonance spectroscopy: A method for studying materials with unpaired electrons that is similar to nuclear magnetic resonance (NMR), but it uses electron spin instead of the spin of atomic nuclei. It is particularly useful for studying metals or organic radicals.

- GIST Professor Chang Hyuck Choi said, "The greatest significance for this research achievement is that it established a strategy to improve the durability of a hydrogen fuel cell by using an inexpensive iron-based monoatomic catalyst and demonstrated this through direct experiments. It is hoped that this will contribute to the revitalization of the future hydrogen economy through the development of oxygen reduction catalysts with high activity and durability."
- This research was supported by the Technology Development Program to Solve Climate Changes and by the Creative Materials Discovery Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT and was published on July 20, 2020, in *ACS Catalysis*, an international academic journal published by the American Chemical Society.

