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Professor Chang Hyuck Choi's research team develops original technology for performance evaluation of catalysts for hydrogen fuel cells

- GIST (Gwangju Institute of Science and Technology) School of Materials Science and Engineering Professor Chang Hyuck Choi's research team has developed original technology for the performance evaluation of non-precious metal catalysts for hydrogen fuel cells, providing an opportunity to take a step closer to commercialization of hydrogen fuel cells.

  - A hydrogen fuel cell that generates electricity by reacting hydrogen with oxygen in the air needs a catalyst to help these reactions. Existing hydrogen fuel cells mainly use the precious metal platinum as a catalyst, but the scarcity and high price of platinum are a major obstacle for commercialization. Therefore, in recent years, there has been research on cheap catalysts that can replace platinum.

- Among them, the monoatomic iron-based catalyst composed of iron, nitrogen and carbon is attracting attention as an efficient oxygen reduction catalyst*. However, due to the lack of technology for diagnosing the performance of monoatomic catalysts, it is difficult to identify active point density** and conversion frequency***, which are major determinants of catalyst performance.

* oxygen reduction catalyst: a reaction that occurs at the anode of a hydrogen fuel cell where oxygen reacts with electrons and protons to reduce water

** active point density: e density of the area on which the reactant is catalyzed on the catalyst surface

*** conversion frequency: the number of molecules that react per unit hour per active point of the catalyst

- The research team devised a technology to measure the active point density and conversion frequency, which are determinants of catalyst performance, by realizing that cyanide ions (CN-) can be irreversibly adsorbed to iron-based monoatomic catalysts.

  - Cyanide ions were irreversibly adsorbed on iron-based monoatomic catalysts using a specially designed reactor. The amount of cyanide ions adsorbed was quantified by ultraviolet-visible (UV-Vis) spectroscopy. At the same time, the reduction in oxygen reduction reactivity of the catalyst irreversibly adsorbing cyanide ions was measured. This allowed the active point density and conversion frequency of the catalyst to be successfully derived.

  - Furthermore, the versatility of the developed diagnostic technology was demonstrated by deriving the performance determinants of other transition metals* and noble metal-based monoatomic catalysts and platinum catalysts that are widely used commercially.

    * transition metals: a metal element of 4 to 7 periods and 3 to 11 groups located on the periodic table

- GIST Professor Chang Hyuck Choi said, "This research achievement has the greatest significance in securing the core technology for performance evaluation of iron-based monoatomic catalysts that are close to commercialization. In the future, it is expected that this technology can be utilized to contribute to the activation of the hydrogen economy through the development of oxygen reduction catalysts with high activity."

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