Gwangju Institute of Science and Technology
Official Press Release — https://www.gist.ac.kr

Section of Public Relations	Hyo Jung Kim Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Jaeyoung Lee School of Earth Sciences and Environmental Engineering 062-715-2579	
Release Date	2021.01.11	

Professor Jaeyoung Lee's joint research team expects high-efficiency hydrogen production by developing a three-layered barnacle-shaped active catalyst to replace expensive precious metal catalysts

□ GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Earth Sciences and Environmental Engineering Professor Jaeyoung Lee and Pohang University of Science and Technology Professor Kangwoo Cho succeeded in developing a catalyst for oxygen-producing reactions (equivalent reactions of hydrogen-producing reactions) in a new crystal structure that determines the efficiency of water electrolysis technology* that produces hydrogen by supplying electricity.

* water electrolysis technology: Water electrolysis technology that electrochemically decomposes water has a big advantage in that it can be free from fossil fuels and carbon dioxide emissions through a combination with renewable energy in producing high-purity hydrogen.

◦ Technology that uses hydrogen as an alternative energy source for petroleum and coal to reduce the emission of carbon dioxide, which is the main component of greenhouse gas, is drawing attention. However, more than 97% of the current hydrogen production is produced through

thermochemical refinement of fossil fuels such as coal, which is still highly dependent on fossil fuels.

- The research team developed a cobalt metal-based catalyst that does not use expensive platinum-based metals, but has a barnacle structure with a large surface area and a titanium dioxide (TiO_2) structure that is easy to convert to an active point in three layers. Due to the extended active point during the reaction and the improved adsorption ability with the reactants, the developed catalyst showed excellent activity (100 mV lower overvoltage than the existing cobalt metal catalyst) in the oxygen generation reaction, which is the reaction to determine the efficiency of water electrolysis.

- Through a real-time radiation accelerator-based X-ray analysis, the research team observed that the density of the active point in the catalyst increased due to the non-reversible oxidation reaction during the oxygen generation reaction in the developed catalyst.

  - In addition, depleted oxygen in the catalyst structure increases the oxophilicity* of cobalt metal, overcoming the limitation of cobalt metal, which is slow to be adsorbed with reactants, and improving the rate of oxygen generation reaction to cause an increase in catalytic activity. As a result, the energy efficiency of water electrolysis has improved by 13% compared to previous ones, increasing the amount of hydrogen production compared to the amount of electricity.

    * oxophilicity: the degree to which a compound changes into an oxide or reacts with an oxygen atom

- Professor Jaeyoung Lee and Professor Kangwoo Cho said, "By proposing a new catalytic structure shaped like a three-layered barnacle and identifying the reaction mechanism, the candidate group for a catalyst structure for high-efficiency oxygen-generating reactions has been expanded. It is expected that this will greatly contribute to the hydrogen economy by advancing the path of low energy and eco-friendly hydrogen production."

▫ This research was led by GIST School of Earth Sciences and Environmental Engineering Professor Jaeyoung Lee (corresponding author) and Pohang University of Science and Technology Professor Kangwoo Cho (corresponding author) and was conducted by GIST Ph.D. student Kahyun Ham (co-first author) and POSTECH Ph.D. student Sukhwa Hong (co-first author) with support from the National Research Foundation of Korea and the GIST Research institute and was published online on January 4, 2021, in *ACS Energy Letters* (2019 Impact Index: 19.003 / Physical Chemistry (6/159, top 3.7%), a world-renowned academic journal in the field of electrochemistry.

GIST
Since 1993