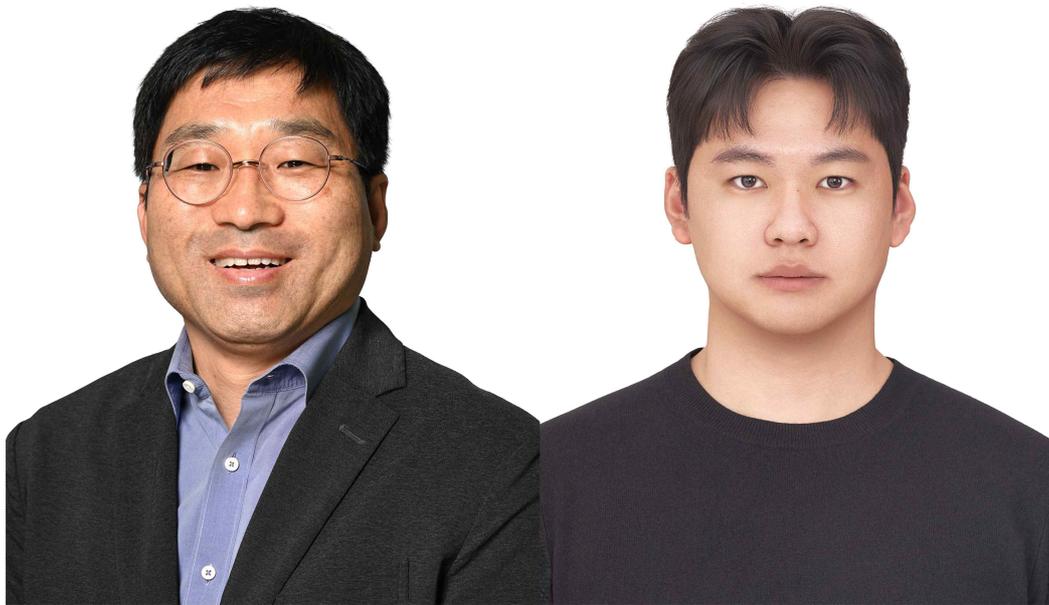


GIST develops hydrogen production electrode that lasts 1,000 hours while reducing rare metal iridium by 80%

- *Professor Chanho Pak's team from the Department of Chemistry achieves both performance and durability while significantly reducing the use of expensive iridium catalysts*
- *Presents potential for commercialization of 'PEM water electrolysis,' a core technology for next-generation green hydrogen production*
- *Published in the international journal **Advanced Science***



▲ (From left) Professor Chanho Pak of the Department of Chemistry at GIST, and master's student Ho Seong Yang

The Gwangju Institute of Science and Technology (GIST, President Kichul Lim) announced that a research team led by Professor Chanho Pak of the Department of Chemistry has developed a catalyst that operates stably while significantly reducing the amount of iridium (Ir), a key metal required for hydrogen production, and a high-performance electrode utilizing this catalyst.

"Water electrolysis," a representative eco-friendly technology for hydrogen production, involves splitting water into hydrogen (H₂) and oxygen (O₂) using electricity; it is attracting attention as a next-generation energy technology due to its near-zero carbon

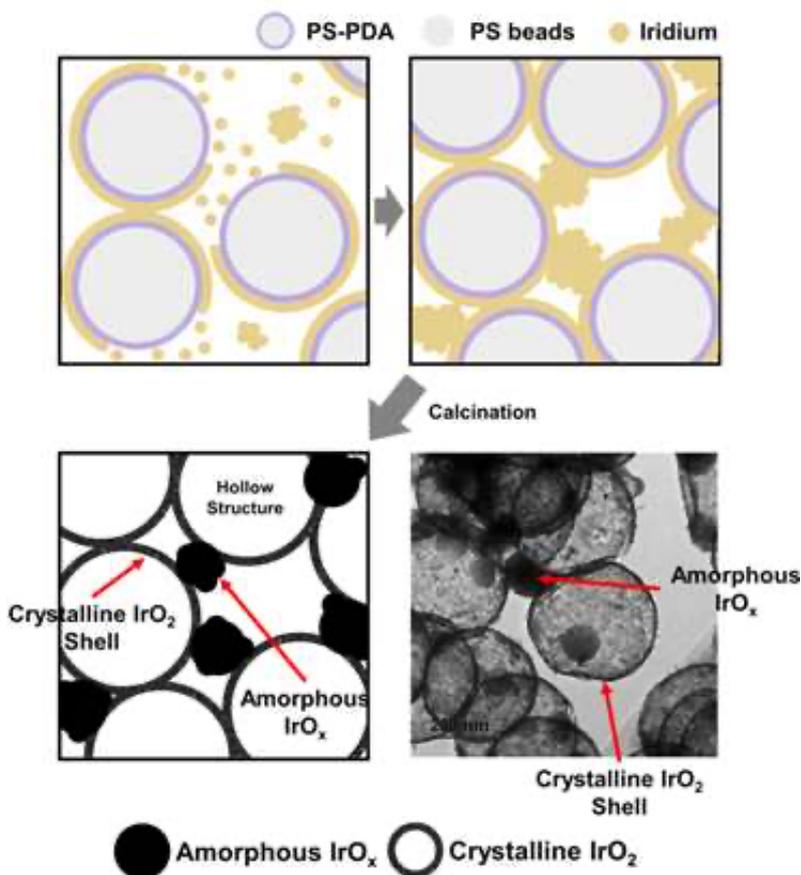
emissions.

In this process, iridium is used as a key catalyst to accelerate the reaction that produces oxygen from water. However, because it is expensive and rare, it is difficult to simultaneously secure both performance and lifespan (activity–durability trade-off*).

** activity–durability trade-off: This refers to a phenomenon where increasing the reaction rate (activity) of a catalyst leads to structural degradation and reduced lifespan, while conversely, increasing durability leads to a decrease in reactivity. This acts as a fundamental limitation in designing high-performance catalysts, making it difficult to simultaneously satisfy both performance and stability.*

The research team developed a ‘dual-phase’ iridium oxide catalyst that possesses both a rigid and regular ‘crystalline structure’ and a flexible and irregular ‘amorphous structure.’

In particular, the design features an amorphous structure filling the spaces between hollow, spherical crystal structures, thereby securing a continuous pathway for electrons to pass through.



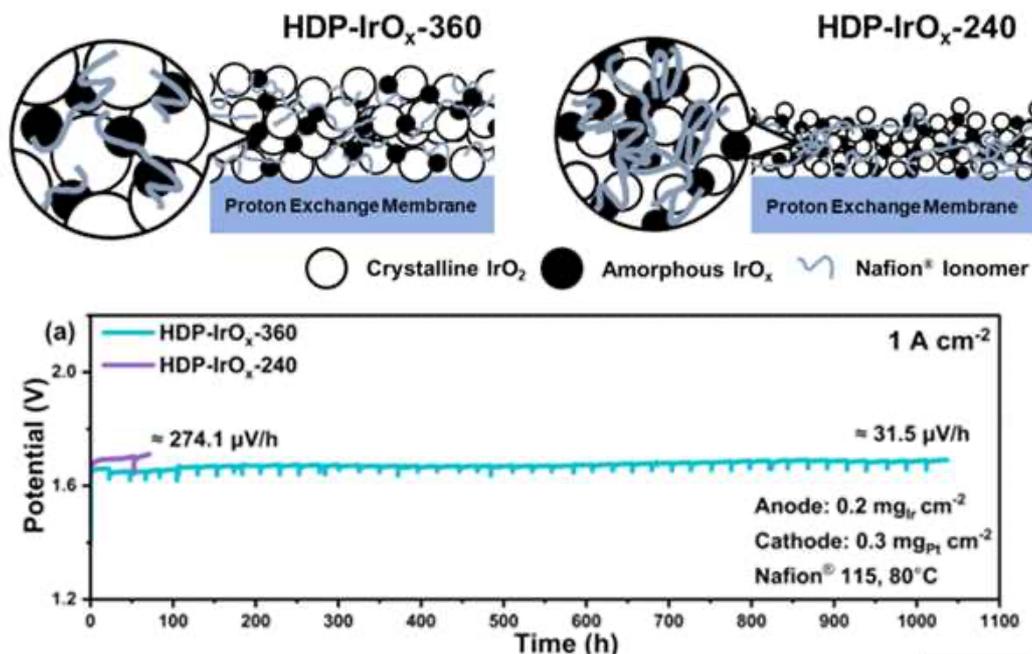
▲ *The process of forming iridium oxide containing two types of crystal structures. This illustrates the synthesis process using a spherical template to create iridium oxide where crystalline and amorphous structures coexist. During the heat treatment process, the structure rearranges to form hollow nanostructures; this expands the reaction surface area and secures pathways for efficient electron movement, thereby enhancing performance.*

The amorphous structure increases reactivity by providing numerous sites for catalytic reactions, while the crystalline structure serves as a conductive pathway and structural support. Through this "dual-phase" design, where two distinct structures interact within a single catalyst, both activity and stability were simultaneously achieved.

The research team verified the performance of the developed catalyst by applying it to a "membrane electrode assembly (MEA)," a core component of actual hydrogen production devices. As a result of conducting water splitting experiments for over 1,000 hours in an area of 1 cm by 1 cm while continuously flowing a high current (1 A (ampere)) at an industrial level, it was confirmed that hydrogen was produced stably without performance degradation.

In particular, even after more than 1,000 hours of continuous operation, the voltage increase was only 31.5 microvolts (μ V) per hour, demonstrating excellent durability by maintaining efficiency similar to that of initial operation with virtually no change.

This research is significant in that it has increased the potential for commercialization of Polymer Electrolyte Membrane (PEM) water electrolysis, a next-generation green hydrogen production technology, by realizing a water electrolysis cell that operates stably for a long time while reducing the use of iridium, an expensive rare metal, by more than 80% compared to existing commercial single cells.



▲ *Comparison of the structure and long-term operating performance of iridium oxide electrodes with different structures. As a result of comparing the structures of iridium oxide catalysts within water electrolysis units (MEAs), the HDP-IrO_x-360 model exhibited high hydrogen production efficiency and excellent durability due to the even formation of reaction channels.*

Professor Chanho Pak of the Department of Chemistry at GIST stated, "This is highly significant in that we have realized an electrode that operates stably for a long time while minimizing iridium usage, and secured an operating performance of over 1,000 hours based on a single cell." He added, "This will contribute to lowering the cost of polymer electrolyte membrane (PEM) water electrolysis units and accelerating large-scale green hydrogen production."

This research, led by Professor Chanho Pak of the Department of Chemistry at GIST and featuring Master's student Ho Seong Yang as the first author, was supported by the Green Hydrogen Technology Independence Project of the Ministry of Science and ICT and the National Research Foundation of Korea.

The research results — [Highly Robust Membrane Electrode Assembly Using Engineered Dual-Phase Iridium Oxide Catalysts Breaking the Activity–Durability Trade-Off in Proton Exchange Membrane Water Electrolysis](#) — were published online in the international journal *Advanced Science* on March 10, 2026.

Meanwhile, GIST stated that this research achievement takes into account both its academic significance and potential for industrial application, and that discussions regarding technology transfer can be conducted through the Technology Commercialization Center (hgmoon@gist.ac.kr).