WATER ELECTROLYSIS

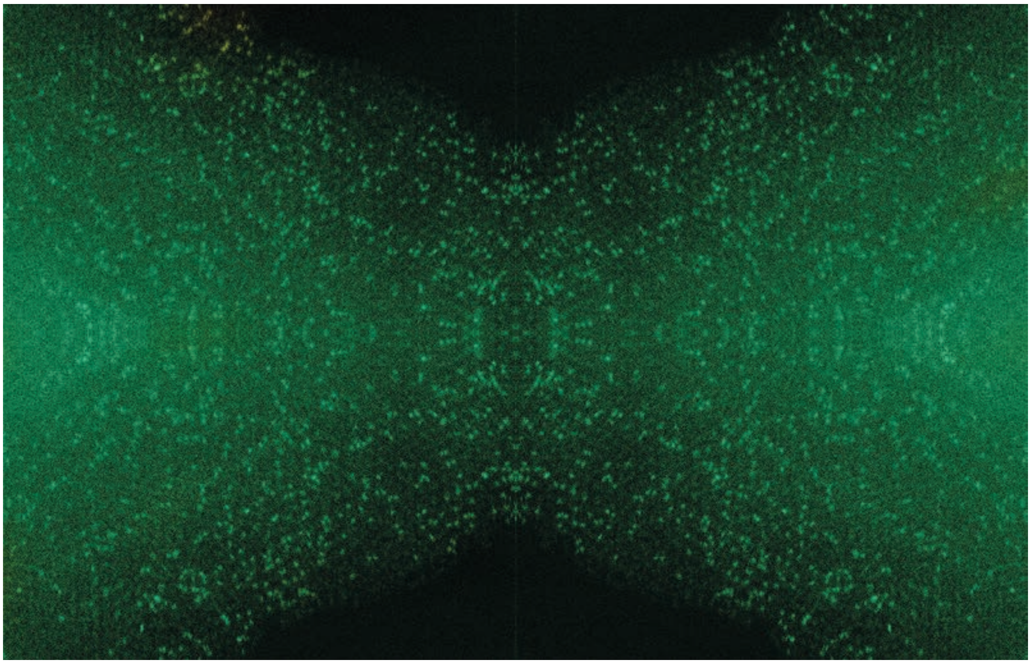
Making green hydrogen with much less iridium

Hydrogen can now be produced using far less of the rare metal iridium, thanks to a new catalyst

A new catalyst for producing green hydrogen that contains much lower levels of the rare metal iridium than previous catalysts has been developed by RIKEN researchers[1]. This could greatly enhance our ability to produce the environmentally friendly fuel.

Hydrogen is a renewable energy source, but it is not yet possible to extract hydrogen from water on a scale that can rival energy production based on fossil fuels.

The green way to extract hydrogen from water is an electrochemical reaction requiring a catalyst. The best catalysts for this reaction—the ones that yield the highest rate and the most stable hydrogen production—are rare metals, with iridium being the best of the best.



An electron diffraction pattern of the new catalyst for splitting water. It contains 95% less of the rare metal iridium compared with conventional catalysts, making it much more sustainable.

But iridium's scarcity is a major problem. "Iridium is so rare that scaling up global hydrogen production to the terawatt scale is estimated to require 40 years' worth of iridium," says Shuang Kong of the RIKEN Center for Sustainable Resource Science (CSRS).

A team led by Ryuhei Nakamura at CSRS is searching for other ways of producing high rates of hydrogen for long periods. They eventually hope to develop new catalysts based on abundant metals, which will be highly sustainable.

The team recently stabilized green hydrogen production at a relatively high level using a form of manganese oxide as a catalyst (see page 17). However, achieving industrial-level production in this manner is still years away.

"We need a way to bridge the gap between rare metal- and common metal-based electrolyzers, so that we can make a gradual transition over many years to completely sustainable green hydrogen," says Nakamura.

"The unexpected interaction between manganese oxide and iridium was key to our success."

The team has now realized that by combining manganese with iridium. They found that when they spread iridium atoms on a piece of manganese oxide so that they didn't touch each other, hydrogen production in a proton exchange membrane (PEM) electrolyzer was sustained at the same rate as when using iridium alone, but with 95% less iridium.

With the new catalyst, continuous hydrogen production was possible for more than 3,000 hours (about 4 months) at 82% efficiency without degradation.

"The unexpected interaction between manganese oxide and iridium was key to our success," says Ailong Li of CSRS. "This is because the iridium resulting from this interaction was in the rare and highly active +6 oxidation state."

The new catalyst has a lot of potential for immediate usefulness, Nakamura believes. "We expect our catalyst to be easily transferred to real-world applications, which will immediately increase the capacity of current PEM electrolyzers," he says.

In collaboration with industry partners, the team plans to deploy and test the new catalyst on an industrial scale in the near future. ●

Reference

1. Li, A., Kong, S., Adachi, K., Ooka, H., Fushimi, K., Jiang, Q., Ofuchi, H., Hamamoto, S., Oura, M., Higashi, K. *et al.* Atomically dispersed hexavalent iridium oxide from MnO_2 reduction for oxygen evolution catalysis. *Science* **384,** 666–670 (2024).