

New catalyst efficiently produces hydrogen from seawater

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Zhifeng Ren, director of the Texas Center for Superconductivity at UH and M.D. Anderson Chair Professor of physics, said the new catalyst allows researchers to avoid many of the obstacles that have stymied the widespread use of seawater to produce hydrogen. Credit: University of Houston

Seawater is one of the most abundant resources on earth, offering



promise both as a source of hydrogen—desirable as a source of clean energy—and of drinking water in arid climates. But even as watersplitting technologies capable of producing hydrogen from freshwater have become more effective, seawater has remained a challenge.

Researchers from the University of Houston have reported a significant breakthrough with a new oxygen evolution reaction <u>catalyst</u> that, combined with a <u>hydrogen</u> evolution reaction catalyst, achieved current densities capable of supporting industrial demands while requiring relatively low <u>voltage</u> to start <u>seawater</u> electrolysis.

Researchers say the device, composed of inexpensive non-noble metal nitrides, manages to avoid many of the obstacles that have limited earlier attempts to inexpensively produce hydrogen or safe drinking water from seawater. The work is described in *Nature Communications*.

Zhifeng Ren, director of the Texas Center for Superconductivity at UH and a corresponding author for the paper, said a major obstacle has been the lack of a catalyst that can effectively split seawater to produce hydrogen without also setting free ions of sodium, chlorine, calcium and other components of seawater, which once freed can settle on the catalyst and render it inactive. Chlorine ions are especially problematic, in part because chlorine requires just slightly higher voltage to free than is needed to free hydrogen.

The researchers tested the catalysts with seawater drawn from Galveston Bay off the Texas coast. Ren, M.D. Anderson Chair Professor of physics at UH, said it also would work with wastewater, providing another source of hydrogen from water that is otherwise unusable without costly treatment.

"Most people use clean freshwater to produce hydrogen by water splitting," he said. "But the availability of clean freshwater is limited."



To address the challenges, the researchers designed and synthesized a three-dimensional core-shell oxygen evolution reaction catalyst using transition metal-nitride, with nanoparticles made of a nickel-iron-nitride compound and nickel-molybdenum-nitride nanorods on porous nickel foam.

First author Luo Yu, a postdoctoral researcher at UH who is also affiliated with Central China Normal University, said the new oxygen evolution reaction catalyst was paired with a previously reported hydrogen <u>evolution</u> reaction catalyst of nickel-molybdenum-nitride nanorods.

The catalysts were integrated into a two-electrode alkaline electrolyzer, which can be powered by <u>waste heat</u> via a thermoelectric device or by an AA battery.

Cell voltages required to produce a current density of 100 milliamperes per square centimeter (a measure of current density, or mA cm⁻²) ranged from 1.564 V to 1.581 V.

The voltage is significant, Yu said, because while a voltage of at least 1.23 V is required to produce hydrogen, chlorine is produced at a voltage of 1.73 V, meaning the device had to be able to produce meaningful levels of <u>current density</u> with a voltage between the two levels.

More information: Luo Yu et al. Non-noble metal-nitride based electrocatalysts for high-performance alkaline seawater electrolysis, *Nature Communications* (2019). DOI: 10.1038/s41467-019-13092-7

Provided by University of Houston



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