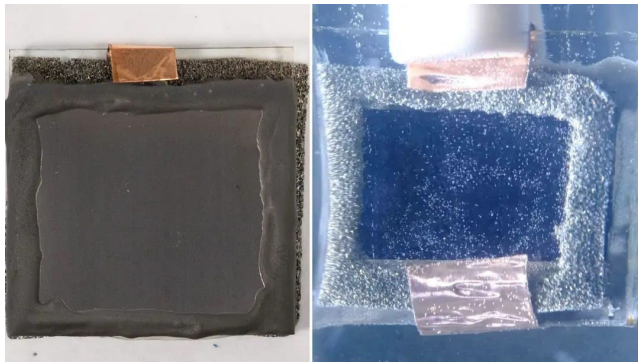


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Singapore device turns seawater into hydrogen

Researchers at Nanyang Technological University developed a solar-powered device that produces hydrogen from seawater while simultaneously breaking down toxic hydrazine.



Scientists at Nanyang Technological University in Singapore have engineered a solar-powered apparatus capable of generating hydrogen directly from seawater. The system concurrently decomposes hydrazine, a highly toxic industrial pollutant, functioning as a dual-purpose solution for clean fuel production and wastewater treatment. By harnessing sunlight to drive the necessary chemical reactions, the device operates without requiring an external power source.

Biomimetic design principles

The research team drew inspiration from the way tree leaves absorb sunlight. This biomimetic approach allows the system to utilize solar energy to provide the electricity needed to propel chemical interactions. Consequently, the device produces hydrogen and treats water contaminants simultaneously. According to Interesting Engineering, this method eliminates the need for separate energy inputs during operation.

Overcoming electrolysis challenges

Green hydrogen is typically produced through electrolysis, where electricity splits water molecules into hydrogen and oxygen. Electrons reach the cathode, or negative electrode, facilitating hydrogen gas formation. Using seawater could enhance sustainability by avoiding freshwater consumption and the additional processing required for desalination. However, seawater contains chloride ions that interfere with standard electrolysis and may generate corrosive, toxic chlorine compounds that damage electrodes.

To address these issues, a team led by Professor Lydia Wong from the School of Materials Science and Engineering modified the reaction at the anode. The positive electrode features a catalyst composed of iron, cobalt, and chromium. This catalyst breaks down hydrazine into hydrogen and nitrogen. Because this specific reaction demands less energy than producing oxygen during traditional water electrolysis, the system generates hydrogen with lower overall energy consumption. The anode removes hydrazine from the water while creating additional hydrogen, merging pollutant treatment with fuel generation in a single process.

Cathode material specifications

Researchers constructed the cathode using lead halide perovskite, a semiconductor material known for absorbing sunlight and converting it into electricity. They incorporated conductive epoxy resin containing silver and copper particles, along with titanium foils, to protect the cathode from degradation during device operation. Tests conducted with both simulated and real seawater demonstrated the device's ability to maintain stable electrical current under illumination.

The apparatus achieved a photocurrent density of 25 milliamps per square centimeter, measured by assessing the current generated across the illuminated electrode area. The system operated continuously for more than 72 hours under lighting conditions equivalent to clear-sky sunlight on Earth's surface. It produced hydrogen at a rate of 466 micromoles per square centimeter per hour, a performance level researchers described as comparable to other solar energy systems.

Pollutant reduction metrics

The device also proved effective in treating wastewater by analyzing hydrazine directly within the water, eliminating the need to isolate the contaminant beforehand. Over a 30-hour period, the system reduced hydrazine concentration from 0.5 molar—approximately 1.6% by weight—to 0.5 parts per billion. This final concentration was more than 20 times lower than the 10 parts per billion limit set by the U.S. Environmental Protection Agency.

Professor Wong stated in a press release that the dual-function device represents a qualitative leap in environmental technology. She noted that efficiently utilizing solar energy to break down a toxic industrial pollutant while obtaining clean fuel solves energy and pollution problems simultaneously. James Durant, a professor of photochemistry and sustainable energy at Oxford University who did not participate in the study, commented that the achievement lies not only in producing solar hydrogen but in demonstrating a practical pathway toward multifunctional photoelectrochemical systems. He suggested that such dual-purpose approaches will likely play an increasingly important role in the future deployment of solar fuel technologies, where economic value and environmental impact must proceed together.

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