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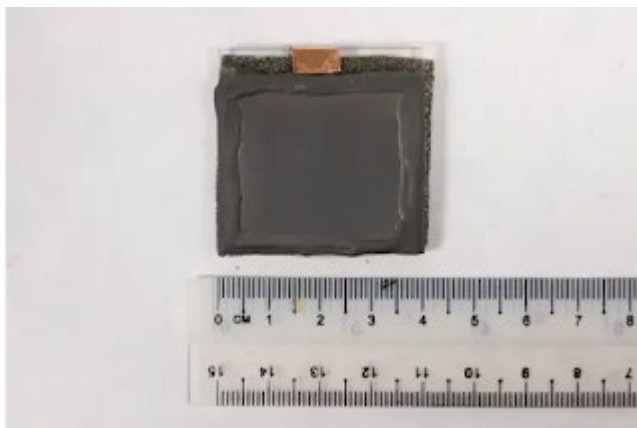
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Scientists Built a Leaf That Makes Hydrogen and Cleans Toxic Water. Here's How

Imagine a device that works like a leaf—using sunlight to produce clean fuel while also helping remove a dangerous pollutant from contaminated water.

Scientists at Nanyang Technological University (NTU), Singapore, have developed an artificial leaf that can do just that. The solar-powered device can generate hydrogen from seawater while simultaneously breaking down hydrazine, a highly toxic chemical found in some industrial wastewater.

The research, published in *Nature Communications* in 2026, combines renewable-energy production with pollution treatment in a single system. The approach could eventually contribute to technologies that produce clean fuels while treating contaminated water.



How Does the Artificial Leaf Work?

Hydrogen is considered a promising clean fuel because using it in fuel cells can produce electricity with water as the main byproduct. One common way to produce hydrogen is through electrolysis.

During electrolysis, electricity is passed through water using two electrodes. The electrical energy splits water molecules, producing hydrogen at the negative electrode and oxygen at the positive electrode.

However, conventional electrolysis requires electricity, and producing hydrogen from seawater creates additional technical problems.

Seawater contains large amounts of salt, including chloride ions. These ions can interfere with the electrochemical reactions and may contribute to the formation of unwanted chlorine-based compounds. Seawater can also accelerate corrosion, potentially damaging the electrodes.

The NTU researchers developed a different approach. Their device uses sunlight to generate the electricity needed for the reaction, eliminating the need for an external power supply.

Why Use Contaminated Seawater?

Using seawater for hydrogen production has an obvious advantage: freshwater is not required.

Freshwater is an important resource for people, agriculture and ecosystems. Producing hydrogen from seawater could therefore reduce the pressure on freshwater supplies, provided the technology can overcome the challenges created by salt and other substances in seawater.

The artificial leaf takes this idea one step further by using contaminated water containing hydrazine.

Hydrazine is a highly toxic chemical used in several industrial applications. If it enters wastewater, it must be carefully treated before the water can be safely released.

Instead of treating the pollutant separately, the researchers designed their system so that hydrazine participates in the electrochemical process.

Turning Pollution Into Part of the Reaction

The key innovation is the device's anode, or positive electrode.

In conventional water electrolysis, the anode is involved in producing oxygen. However, the researchers replaced this reaction with one involving hydrazine.

Their anode contains a catalyst made from iron, cobalt and chromium. This catalyst helps break down hydrazine into nitrogen and hydrogen.

Importantly, this reaction requires less energy than the oxygen-producing reaction normally used in water electrolysis.

That creates a useful combination.

While the sunlight-powered system produces hydrogen at the cathode, the anode simultaneously breaks down hydrazine and generates additional hydrogen.

In other words, the device is not simply producing fuel. It is also helping clean contaminated water.

The catalyst was designed to resist corrosion, which is particularly important when working with seawater. The researchers also found that the approach suppresses the formation of corrosive and toxic chlorine compounds.

A Solar-Powered Artificial Leaf

The device gets its energy from sunlight through a special semiconductor material called a lead-halide perovskite.

Perovskites are materials that can absorb sunlight and convert it into electrical energy. They have attracted significant interest in solar-energy research because of their strong light-absorbing properties.

For this artificial leaf, the researchers used a perovskite-based photocathode.

Because perovskites can be sensitive to environmental conditions, the researchers protected the photocathode using a conductive epoxy resin containing silver and copper particles, together with titanium foil.

This protective structure helps the device operate in seawater without rapidly degrading.

The result is a system that can directly harvest sunlight and use the resulting electrical energy to drive chemical reactions.

Strong Performance in Seawater

The researchers tested their artificial leaf using both simulated seawater and real seawater samples.

Under illumination equivalent to sunlight reaching Earth's surface on a clear day, the device generated a photocurrent density of 25 milliamperes per square centimetre.

This was among the highest reported values for lead-based perovskite photocathodes, according to the researchers.

The device also demonstrated stable operation for more than 72 hours under continuous illumination.

During testing, it produced hydrogen at a rate of approximately 466 micromoles per square centimetre per hour.

Another important result involved hydrazine removal.

The researchers started with water containing a hydrazine concentration of 0.5 molar, equivalent to roughly 1.6% by weight. After treatment for 30 hours, the concentration was reduced to approximately 0.5 parts per billion.

That level was more than 20 times lower than the U.S. Environmental Protection Agency's stated permissible limit of 10 parts per billion.

The result demonstrates how the same system can address both energy production and pollution treatment.

Why This Could Matter

Hydrogen production and wastewater treatment are usually considered separate technological challenges.

Hydrogen production requires energy, while contaminated wastewater requires treatment. Treating each problem independently can require additional infrastructure, energy and resources.

The artificial-leaf concept attempts to combine the two.

Sunlight provides the energy. Seawater provides the water. Hydrazine acts as the pollutant being degraded and also participates in a lower-energy reaction that helps produce hydrogen.

This creates a multifunctional photoelectrochemical system.

Professor Lydia Wong, who led the research at NTU's School of Materials Science and Engineering, described the technology as a way to address an energy problem and a pollution problem simultaneously.

Professor James Durrant of the University of Oxford, who was not involved in the research, similarly highlighted the significance of combining solar-fuel production with pollutant treatment.

What Comes Next?

The current system focuses on hydrazine, but the researchers are already looking beyond this particular pollutant.

Their future goal is to develop catalysts that can work with other contaminants and waste materials.

If successful, future versions could potentially convert different waste substances into useful products, including fuels and industrial chemicals.

However, the technology is still at the research stage. Laboratory performance does not automatically mean that a system is ready for large-scale commercial use. Long-term durability, manufacturing costs, environmental impacts, scalability and performance under changing real-world conditions will all need to be studied.

Still, the concept offers an interesting direction for sustainable technology.

Instead of viewing pollution only as something that must be removed, scientists are exploring ways to make certain waste chemicals part of useful chemical processes.

The artificial leaf developed by NTU represents this emerging idea: use sunlight as the energy source, seawater as the resource, and pollution as part of the process—while producing hydrogen as a valuable clean fuel.

If researchers can expand the approach to more pollutants and improve its durability and scalability, multifunctional solar systems like this could become an important part of future clean-energy and environmental technologies.

Reference: Ahmed, M.G., Sadhu, A., Tan, J.M.R. et al. Self-powered artificial leaf using perovskite photocathode for solar hydrogen production and hydrazine degradation. Nat Commun 17, 6641 (2026). <https://doi.org/10.1038/s41467-026-73326-3>

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