



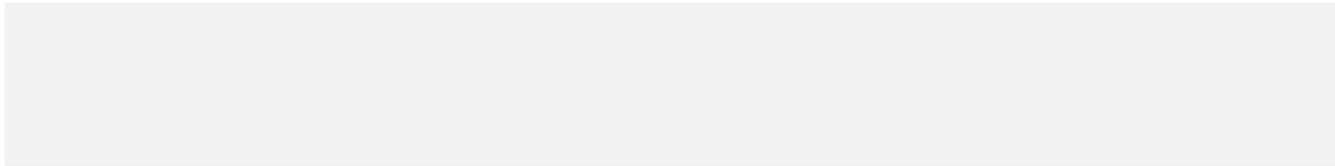
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IIT Guwahati team develops dual-purpose material for hydrogen fuel and desalination

IIT Guwahati researchers develop a MXene catalyst that enables both hydrogen fuel production and seawater desalination. This innovation promises advancements in clean energy and water accessibility in India

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Story highlights

IIT Guwahati researchers created a MXene-based catalyst for hydrogen generation

The catalyst also supports solar-powered seawater desalination

Material shows low hydrogen evolution reaction overpotential of 12 mV

Researchers at the Indian Institute of Technology Guwahati have developed a material capable of producing hydrogen fuel through water electrolysis while also enabling solar-powered desalination, addressing two major global challenges—clean energy and safe drinking water.

The study, published in Advanced Functional Materials, was co-authored by Prof P K Giri from the Department of Physics, along with research scholars Koushik Ghosh and Sanjoy Sur Roy.

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Hydrogen is widely regarded as a clean fuel since its use produces only water and no carbon emissions. However, most hydrogen today is derived from fossil fuels, underlining the need for sustainable production methods. At the

same time, access to safe drinking water remains a growing concern, with desalination often limited by high costs.

The IIT Guwahati team addressed both issues by developing an MXene-based catalyst that can efficiently generate hydrogen and support desalination using solar energy.

MXenes, a class of two-dimensional materials known for high electrical conductivity, typically suffer from limited active surface area. To overcome this, the researchers engineered ultra-thin, ribbon-like structures to improve charge transport and increase the number of active sites. Ruthenium atoms were introduced into oxygen-deficient regions to further enhance catalytic efficiency.

Experimental results showed that the material achieved an ultralow hydrogen evolution reaction overpotential of 12 mV, outperforming the commercial platinum-based Pt/C electrode. The catalyst also demonstrated stability over extended use, with minimal performance degradation.

The team used advanced computational modelling to examine how atomic-level modifications improved performance. Under simulated sunlight, the material exhibited enhanced efficiency due to strong photothermal conversion.

Commenting on the findings, Prof Giri said, "Two-dimensional layered material MXene is a wonder material with multifunctional applications." He added that the study demonstrates "the sustainable development of clean hydrogen energy and a drinking water solution using defect engineering of ultrathin MXene," noting its "potential for commercial use" due to high performance and stability.

For desalination, the material was incorporated into a three-dimensional "Janus evaporator", designed to float on water and minimise energy loss by heating only the surface. Under standard sunlight, the system recorded an evaporation rate of about 3.2 kg per square metre per hour. It operated continuously in saltwater for five days without salt accumulation.

Tests confirmed that the system effectively removed salts and contaminants, producing water that meets international drinking standards.

The findings highlight the potential of a single material system to support both solar-driven desalination and sustainable hydrogen production, with possible applications across transport, industry and energy storage sectors.