Researchers develop a novel organic device for obtaining hydrogen from water and sunlight

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Credit: Àlex Pérez

Hydrogen has great potential as a fuel. Researchers at the Photovoltaic and Optoelectronic Devices Group at the Universitat Jaume I have

developed an organic device reduces water into hydrogen using only sunlight. Currently, organic materials used in these devices offer greater versatility and efficiency at a lower cost than the available inorganic ones, but they show stability problems when in contact with an aqueous medium. A study published in the *Journal of Physical Chemistry* achieves an exceptional stability in these devices and represents an important step in obtaining solar fuels from organic materials.

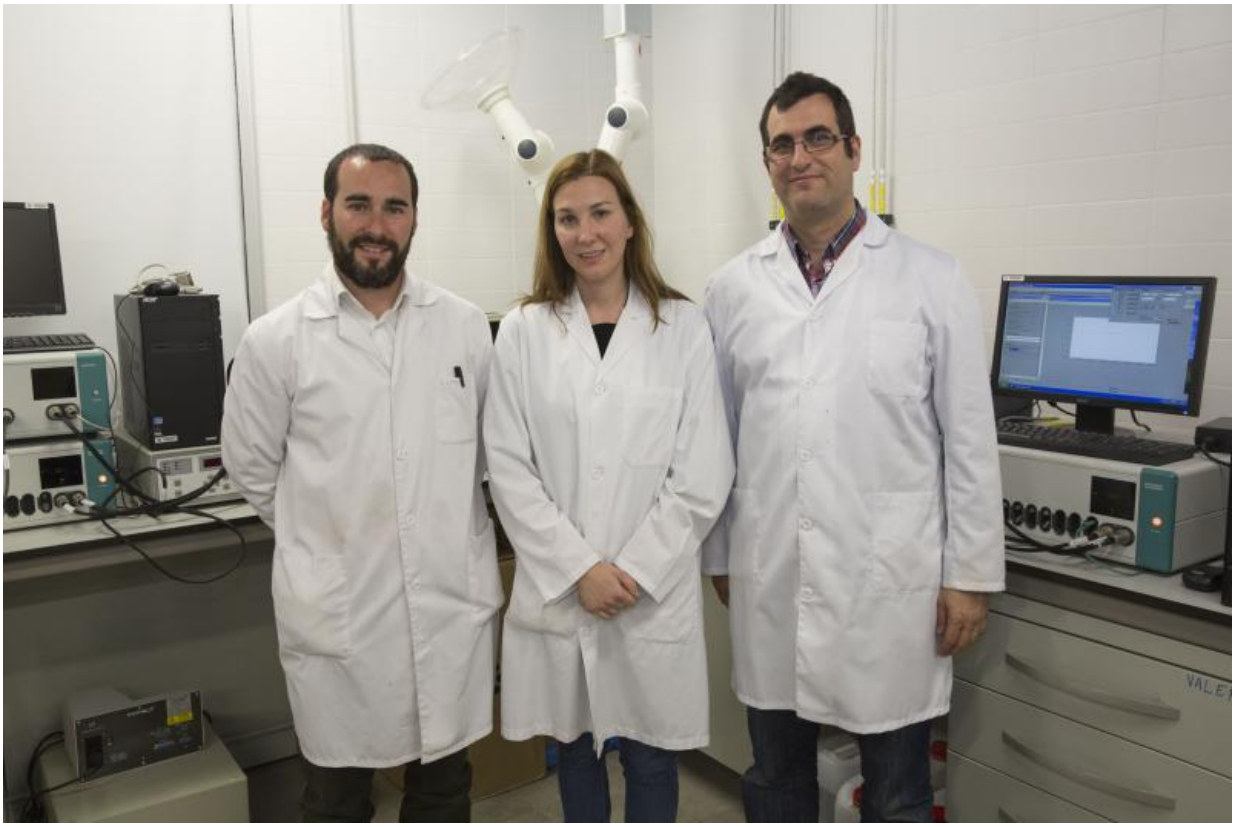
Sixto Giménez, coordinator of the research, noted, "The production of hydrogen has been achieved in three hours, demonstrating a stability of organic materials that had not been reached so far."

Organic photovoltaic devices corrode in water and damage very easily. "Our strategy has been to place a physical barrier between the photovoltaic component and the catalyst that makes the hydrogen generation reaction. In order to achieve this, we have deposited compact layers with nanometric titanium oxide material that not only acts as a barrier between the water and the photovoltaic part, but also connects electrically the photovoltaic part and the platinum catalyst. Using this strategy, we can greatly increase stability while maintaining the performance of these devices," said the researcher Antonio Guerrero.

Obtaining solar fuels like hydrogen from water and sunlight is a strategy aimed at solving the global energy problem. "We can have totally renewable resources like sunlight and water for obtaining an energetic conductor such as hydrogen. In addition, hydrogen is a chemical compound with endless applications in industry such as the generation of fertilizers or the synthesis of hydrogen compounds," noted Giménez.

The research has been developed under the PHOCS (Photogenerated Hydrogen by Organic Catalytic Systems) project, funded under the 7th Framework Programme of the European Union, which aims to develop new devices based on organic semiconductor materials to perform the

photodecomposition of water, leading to the efficient generation of hydrogen. It seeks to optimize the use of cheaper and more sustainable materials for the production of hydrogen.



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One of the main challenges of the project, which will finish in November, is to demonstrate that organic materials (plastics) can be used for photoelectrochemical hydrogen generation, a target that has already been reached. Giménez explains, "Hydrogen can be used as petrol due to its high energy potential, an energy that can be converted into electricity and into mechanical energy." The use of these solar fuels "will allow you

to go in the near future to a service station and, instead of filling up with petrol, you will be able to refuel with hydrogen that will be transformed into electricity via a fuel cell and then into mechanical energy. Water will be the only waste product." Thus, the research project contributes to the transition from the current energy model based on fossil fuels to a sustainable model that respects the environment focused on the use of solar energy. This transition will be possible with the development of new semiconductor materials.

The contribution to the PHOCS project by the team led by Sixto Giménez at the Universitat Jaume I has been to understand which are the physicochemical mechanisms that operate these devices. They have used different techniques developed in the laboratories of the Photovoltaic and Optoelectronic Devices Group. Moreover, the group has developed its own organic device that stands out for its level of stability. The next step will be improving the efficiency of the device, especially its energy conversion capacity.

More information: "Organic photoelectrochemical cells with quantitative photocarrier conversion" *Energy Environ. Sci.*, 2014,7, 3666-3673 DOI: 10.1039/C4EE01775G

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