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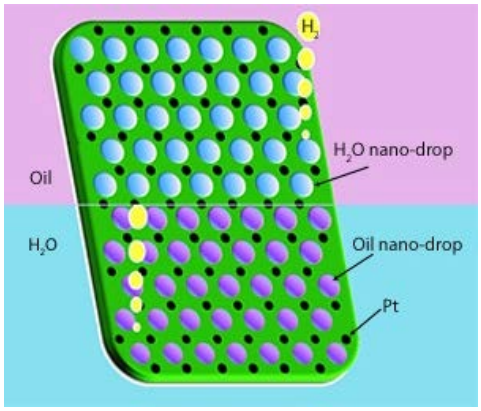
Alternative energy: Going forward

Trapping oil–water mixtures inside nanoscale photocatalytic pores takes solar hydrogen production to new levels of efficiency.

Nanostructured photocatalysts that use solar energy to transform water into hydrogen gas may one day enable the easy production of this clean-burning, renewable fuel. Currently, however, there are several obstacles to be overcome, including the tendency of oxygen and hydrogen gas to recombine spontaneously back into water at the catalyst site. Xue-Wei Liu from Nanyang Technological University in Singapore and co-workers[1] have now developed an elegant way to make this water-splitting reaction more efficient through the use of the distinct phase separation behavior of an oil–water interface.



An oil–water interface enhances hydrogen fuel production from solar-powered Pt–CdS nanosheets.

The researchers were investigating platinum-loaded cadmium sulfide (Pt–CdS) nanosheets for use as a photocatalyst when they made their discovery. These thin CdS layers dotted with numerous tiny pores have a large, stable surface area that is extremely responsive to visible and ultraviolet light. Furthermore, owing to an external coating of platinum nanoparticles, the catalyst has the electrochemical potential needed to crack water apart.

Despite the high photocatalytic activity of Pt–CdS nanosheets, however, only a few studies have examined how to optimize hydrogen generation rates for this material. The approach taken by Liu and his team involved a simple change to the reaction conditions: adding organic solvents such as hexane to water to produce two immiscible liquid phases. In a typical water-only photocatalysis reaction, the hydrogen gas produced remains close to the reactive nanosheets. As hydrogen is more soluble in hexane than in water, however, hydrogen escapes the aqueous phase in the hexane-containing system, thus preventing backward recombination (see figure). Experiments revealed that this hexane–water biphase system enhanced the rate of hydrogen production by up to 40%.

“Hexane has higher hydrogen solubility and lower viscosity than water, making it act like a superhighway for hydrogen diffusion and evolution,” explains Liu. The researchers believe that the pores of the Pt–CdS nanosheets increase the hexane–water interface area by trapping aqueous or organic nanodrops in place — creating highly efficient ‘nanoreactors’ for water splitting.

“These results are really encouraging for solar energy conversion and clean energy storage,” says Liu. “With further optimization and improved scalability, our ultimate goal is to apply these nanoreactors in industrial production.”

Reference

1. Liu, J.,[1] Wei, X.,[1] Yu, Y.,[2] Wang, X.,[2] Deng, W.-Q.[3] & Liu, X.-W.[1] ‘Nanoreactors’ for photocatalytic H_2 evolution in oil–water biphase systems. *Phys. Chem. Chem. Phys* **12**, 14449 (2010). | article

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This research highlight has been approved by the author of the original article and all empirical data contained within has been provided by said author.

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