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RESEARCH HIGHLIGHT

Has large-scale artificial photosynthesis become real?

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Apart from the discussion about whether fossil fuels will be depleted sooner or later or the tremendous impact of the increase in atmospheric CO_2 on the environment, solar energy conversion and utilization is intrinsic to meeting energy demands that have been increasing and will continue to increase in coming years. To achieve this goal, efficient devices and systems have been investigated to achieve artificial photosynthesis, i.e., the use of solar (photon) energy to fuel energetically uphill reactions, such as water-splitting ($H_2O \rightarrow H_2+1/2O_2$). *ARPChem*, a consortium involving some Japanese universities and several companies sponsored by METI, Japan, has been working on a long-term plan to establish strategic novel processes, including the chemical process of H_2 production from solar energy, followed by CO_2 hydrogenation. The water-splitting project is led by Prof Domen at the University of Tokyo, whose team has achieved the leading solar energy conversion efficiency values by using novel and creative ideas.

The paper published by Wang *et al.*[1] involves a novel device for photocatalytic water-splitting, producing H_2 and O_2 from H_2O using a single photocatalytic sheet. The authors have shown a pathway to move from the laboratory scale toward practical applications, which requires photon collection on a large scale. The successful cogeneration of a mixture of hydrogen and oxygen from pure water was achieved on the basis of varied knowledge accumulated by the authors. A two-step reaction, the so called Z-scheme, using two photocatalysts for H_2 and O_2 evolution, respectively, was achieved, where each photocatalyst was successfully optimized to enhance the evolution of H_2 ($SrTiO_3$:La,Rh) or O_2 ($BiVO_4$:Mo). Another critical aspect of the study was the effective suppression of the back reaction (H_2O formation) by two types of surface decoration.[2,3] Then, these photocatalysts were uniformly spread to obtain a scalable photoreactor by a relatively simple method, the so-called particle transfer method.[4,5] Metal evaporation (in this study, the authors used gold), followed by the peeling off of the photocatalyst resulted in a very thin photocatalytic sheet. With further optimization of the annealing temperature for the improved Au-photocatalyst interface and the reaction temperature, an apparent quantum yield of 33% at 419 nm was achieved, and the overall solar to hydrogen efficiency reached 1.1% (the photoreactor is shown in Figure 1).

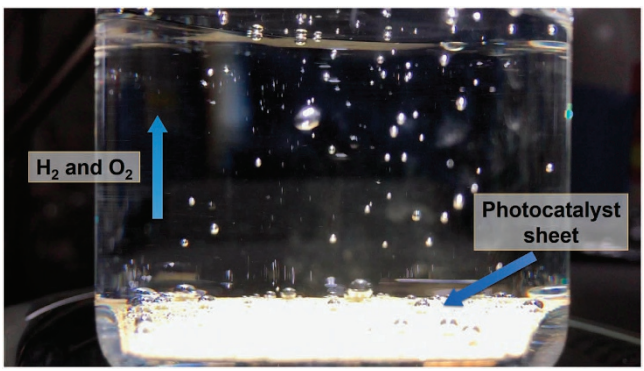

Figure 1 Photograph of a water-splitting reactor containing a photocatalytic sheet (bottom) under illumination.

Nevertheless, continuous efforts are necessary to achieve a benchmark STH efficiency of 10%. The absorption of more photons from the solar spectrum by choosing improved photocatalysts is one potential way to increase the overall efficiency, but the strength of the method reported here is that this method can be applied to other photocatalyst powders.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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