Expediting hydrogen creation with a non-noble metal cocatalyst under visible light

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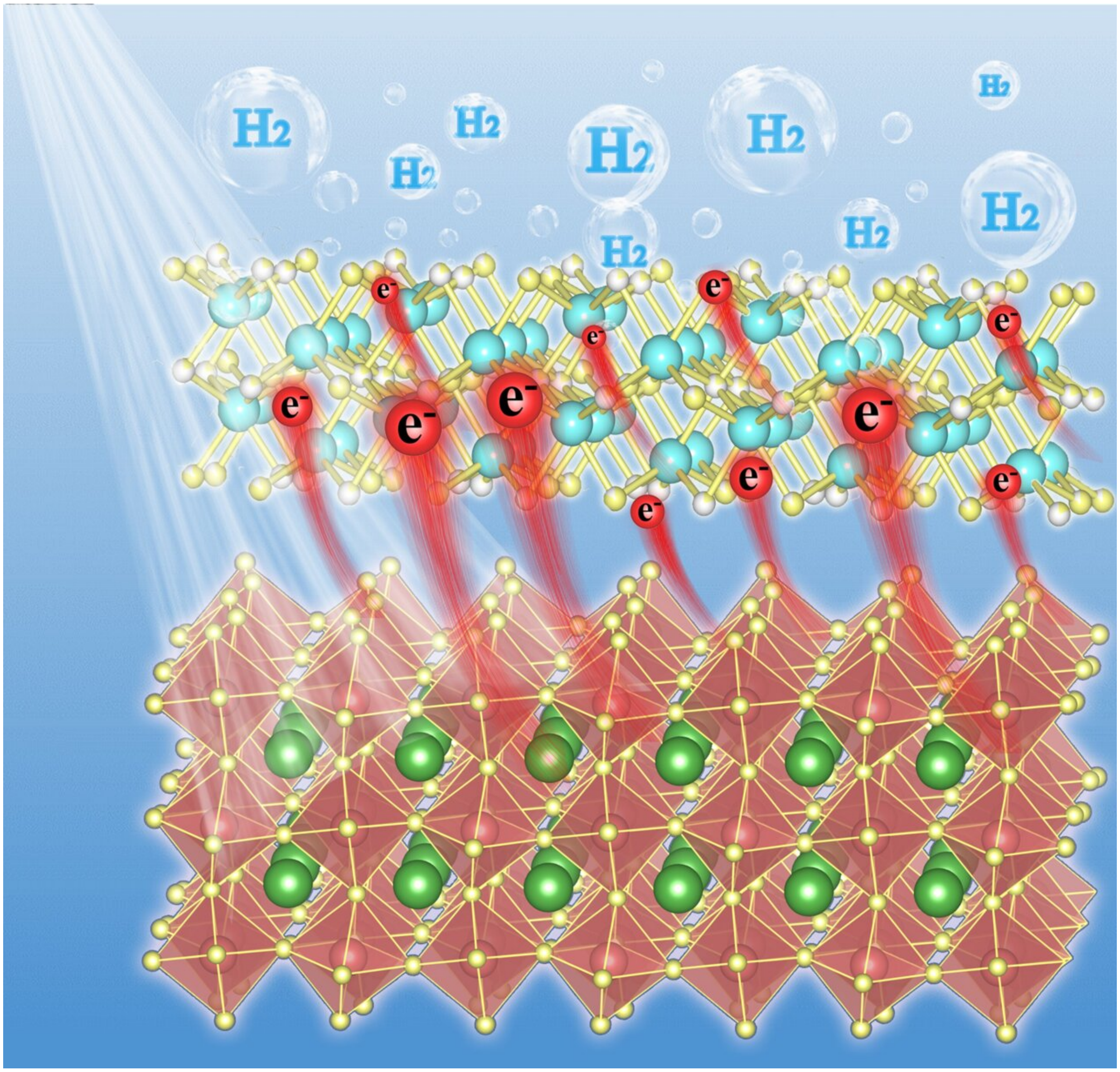

Hydrogen evolution over $Mo_2C@MAPbI_3$. Credit: Shanghai Key Lab of

Chemical Assessment and Sustainability, School of Chemical Science and Engineering, Tongji University

Halide perovskites have been emerging as promising photocatalytic materials for H_2-evolution from water due to their outstanding photoelectric properties. However, the lack of proper surface reactive sites greatly hinders the photocatalytic potential of these fascinating compounds. In this work, Mo_2C nanoparticles have been anchored onto methylammonium lead iodide ($MAPbI_3$) as a non-noble-metal cocatalyst to promote H_2-evolution reactions.

The team published their work on May. 28 in *Energy Material Advances*.

"Photocatalytic water splitting has been considered as a promising route to store solar energy as hydrogen energy," said paper author Xiaoxiang Xu, professor with the Shanghai Key Lab of Chemical Assessment and Sustainability, School of Chemical Science and Engineering, Tongji University. "Currently, halide perovskites have been gained great interest as photocatalysts for H_2-evolution reactions, but they are normally deficient in surface reactive sites where photocarriers cannot be promptly transferred for surface redox reactions."

Xu explained that the extremely acidic environment needed to stabilize halide perovskites in an aqueous solution restrains the choices of H_2-evolution cocatalyst that can be deposited.

"The noble-metal cocatalyst Pt has been introduced to promote H_2-evolution reactions but is still unsatisfactory probably due to the poor Pt/halide perovskite interfaces," Xu said. "Robust non-noble-metal-based cocatalysts have gained serious attention as alternatives to noble-metal cocatalyst."

However, their connections with halide perovskites are generally very weak often due to structural mismatch thereby preventing fast charge migrations from halide perovskites to these cocatalysts. According to Xu, Mo_2C, a promising low-cost electrocatalyst for H_2-evolution reaction, exhibits excellent electrocatalytic activity over a wide pH range thereby serving as a potential candidate cocatalyst for photocatalytic H_2-evolution.

Mo_2C is one of a few compounds that are stable in strong acids, Xu said, rendering it an excellent alternative cocatalyst for halide perovskites which are stabilized in strong acid during photocatalytic reactions, e.g. HBr and HI aqueous solution.

"The opposite Zeta potentials between Mo_2C and $MAPbI_3$ ensure firm interconnections between these compounds," Xu said. "In this paper, we illustrated recent research expediting H_2-evolution over $MAPbI_3$ with a non-noble metal cocatalyst Mo_2C under visible light."

"We have successfully loaded Mo_2C nanoparticles onto $MAPbI_3$ by an electrostatic-assembly method to fabricate $Mo_2C@MAPbI_3$ composites," Xu said.

"The Mo_2C nanoparticles are found to be homogeneously and firmly anchored at the surface of $MAPbI_3$," Xu said. "Thanks to the strong interconnections between Mo_2C and $MAPbI_3$, $Mo_2C@MAPbI_3$ composites exhibit superior photocatalytic activity for H_2-evolution from water which clearly surpasses pristine $MAPbI_3$ and Pt deposited $MAPbI_3$ under the same testing conditions."

"Further analysis suggests that Mo_2C nanoparticles not only facilitate charge separation in $MAPbI_3$ but also substantially expedite interfacial charge transfer for water reduction reactions," Xu said. "These findings justify the Mo_2C as an efficient non-noble-metal cocatalyst for halide perovskite photocatalysts that work under a highly acidic environment."

More information: Jinxing Yu et al, Expediting H_2 Evolution over $MAPbI_3$ with a Nonnoble Metal Cocatalyst Mo_2C under Visible Light, *Energy Material Advances* (2022). DOI: 10.34133/2022/9836095

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