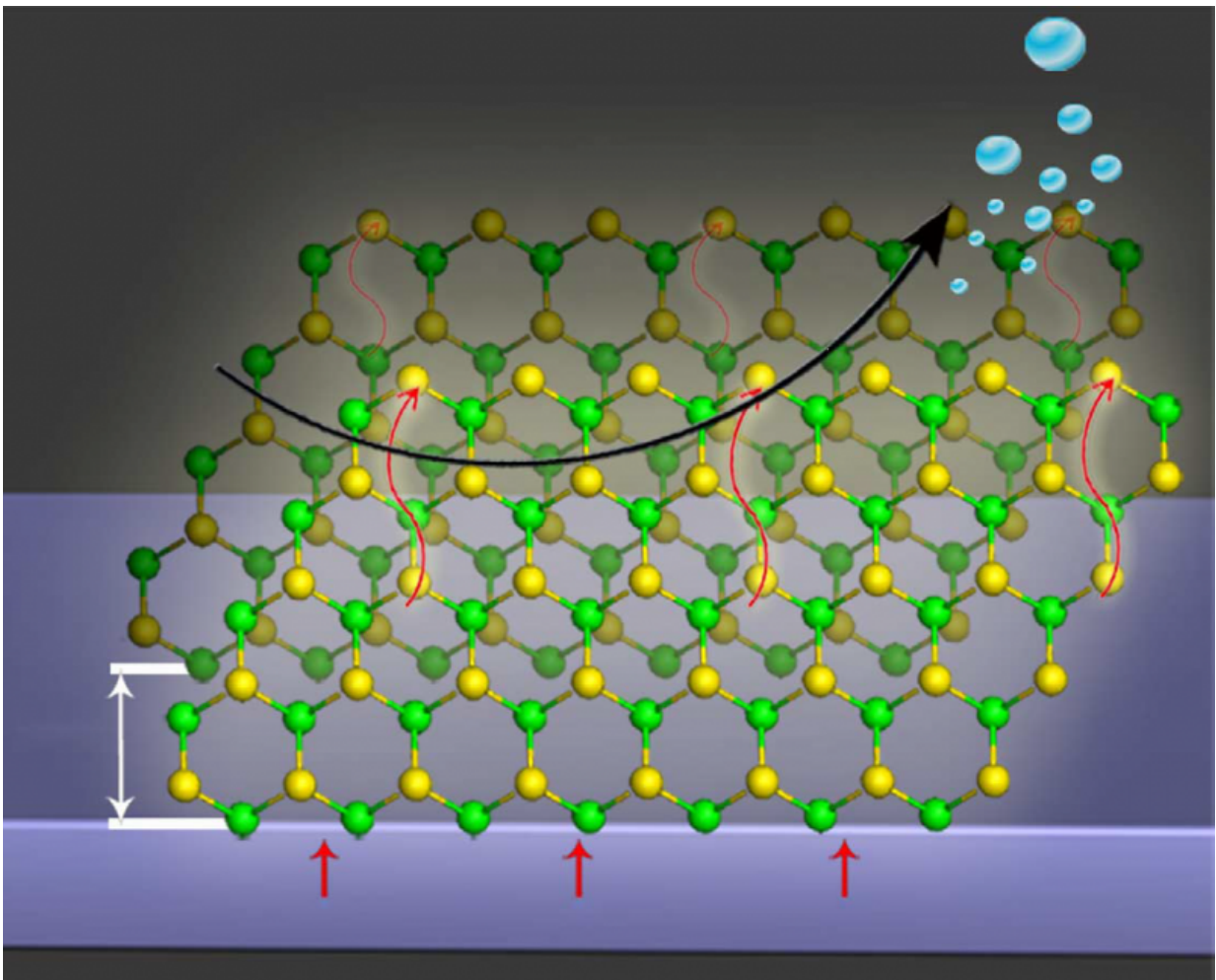


# Promising technique improves hydrogen production of affordable alternative to platinum

October 27 2015, by Angela Hardin



A schematic representation of the edge-terminated MoS<sub>2</sub> on glassy carbon electrode

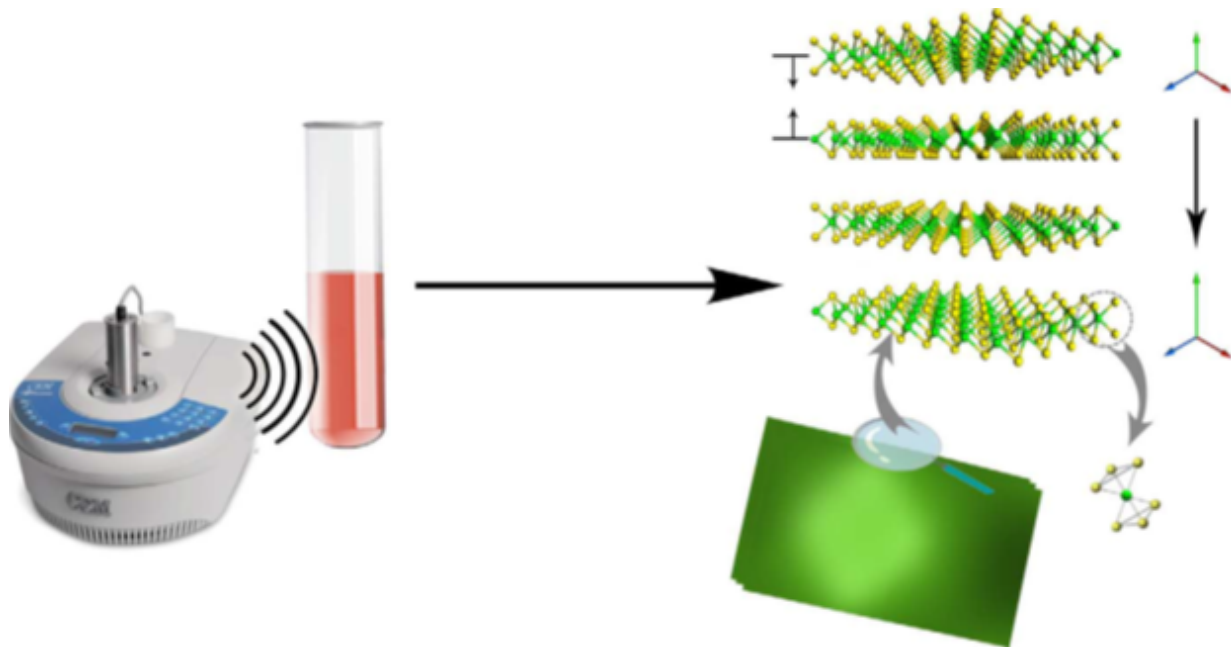
Scientists have demonstrated that microwaves can help create nanostructured molybdenum disulfide (MoS<sub>2</sub>) catalysts with an improved ability to produce hydrogen.

The microwave-assisted strategy works by increasing the space, and therefore decreasing the interaction, between individual layers of MoS<sub>2</sub> nanosheets. This exposes a larger fraction of reactive sites along the edges of these surfaces where [hydrogen](#) can be produced.

Atomistic first-principles calculations show that the increase in spacing between the layers changes the electronic and chemical properties of these edge sites, making them more effective in producing hydrogen. The strategy was demonstrated by a small group of researchers at the Center for Nanoscale Materials (CNM), a U.S. Department of Energy (DOE) Office of Science User Facility based at DOE's Argonne National Laboratory.

"The microwave-assisted strategy could be a viable way to design advanced [molybdenum disulfide](#) catalysts for [hydrogen production](#) and hydrogen fuel cells," said Yugang Sun, a nanoscience scientist in Argonne's Nanoscience and Technology Division. "Microwave-synthesized nanostructured MoS<sub>2</sub> exceeds the reactivity and stability levels of unmodified MoS<sub>2</sub>. Microwave-assisted synthesis is also a greener strategy when compared to conventional heating methods."

Microwave energy is more efficient than conventional heating because it focuses its electromagnetic waves only on the material being treated and provides quicker, more even heating of a material's interior and exterior surfaces. Conventional or surface heating is slower than microwave heating and fails to achieve the desired result because it generates different temperatures in a material's interior compared with its surface area.



A schematic illustration highlighting the synthesis of nanostructured MoS<sub>2</sub> catalyst from microwave reaction

MoS<sub>2</sub> is a common industrial catalyst that is used as a dry lubricant and in petroleum refining. It is one of a small handful of promising, Earth-abundant [materials](#) that could provide low-cost alternatives to platinum-based catalysts. Platinum is an extremely efficient catalyst for splitting water into hydrogen and oxygen, but its high-cost and scarcity limit its widespread use for hydrogen production and in [hydrogen fuel cells](#).

This method will be extended to synthesize nanostructured MoS<sub>2</sub> hybridized with other materials that can strongly interact with MoS<sub>2</sub> to influence its electronic structures and reactivity, to further improve the catalytic performance for producing hydrogen.



A molybdenum disulfide chip. Credit: MaterialsScientist, Wikipedia

The research paper, "Edge-terminated molybdenum disulfide with a 9.04-Å interlayer spacing for electrochemical hydrogen production," was published in *Nature Communications*. Argonne's Minrui Gao, Maria K.Y. Chan, and Yugang Sun are co-authors.

This research used several CNM capabilities including materials synthesis; electrocatalysis studies; the high-performance computing cluster Carbon; and characterization via X-ray diffraction, high-resolution transmission electron microscopy, Raman spectroscopy, and Fourier transform infrared spectroscopy.

**More information:** Min-Rui Gao et al. Edge-terminated molybdenum disulfide with a 9.4-Å interlayer spacing for electrochemical hydrogen

production, *Nature Communications* (2015). [DOI: 10.1038/ncomms8493](https://doi.org/10.1038/ncomms8493)

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