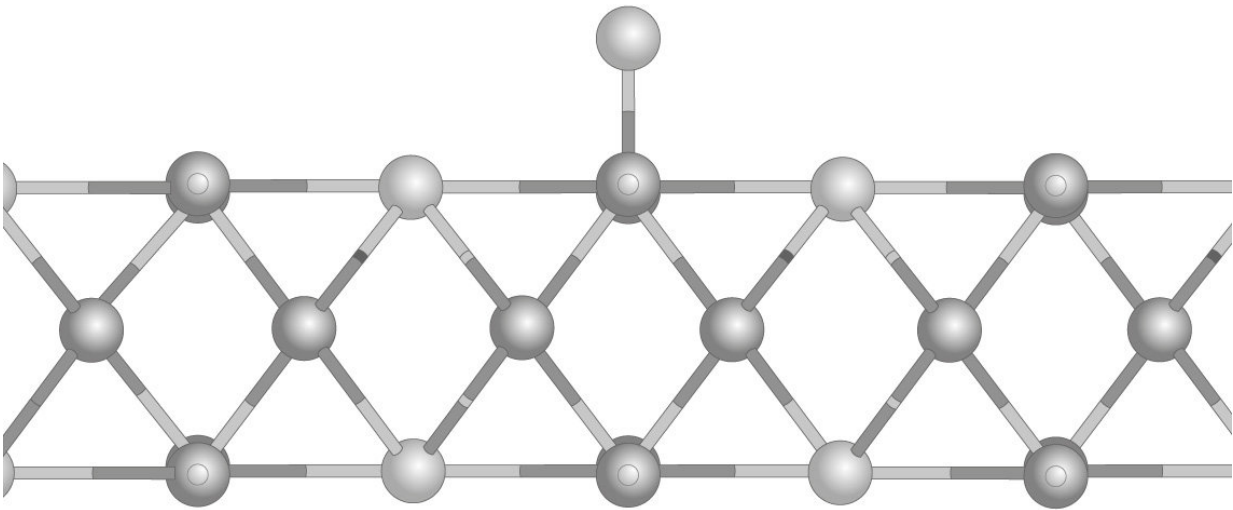


A newly discovered catalyst promises cheaper hydrogen production

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Credit: American Chemical Society

A new catalyst could dramatically decrease the cost of producing hydrogen, one of the cleanest renewable fuels. Based on molybdenum sulfide, the catalyst was developed by a group at the A*STAR Institute of Materials Research and Engineering, led by Shi Jie Wang.

The new [catalyst](#) could revolutionize industrial use of the [hydrogen](#) evolution reaction (HER), which generates hydrogen gas by splitting water molecules. The most efficient catalysts for HER use noble metals such as platinum, which are prohibitively expensive for large-scale

production. Current global production of hydrogen is estimated at 50 million tonnes, but demand could take off if production costs can be reduced to make it competitive as a transport fuel.

"We are intensively exploring catalysts made with Earth-abundant materials with HER performances comparable to noble metals," says Wang.

The team's success came when they stumbled across a new crystalline form of molybdenum sulfide, with composition Mo_6S_4 .

The common structure, [molybdenum disulfide](#) (MoS_2), initially showed promise as a catalyst, but was limited by the low efficiency of hydrogen adsorbing to the surface. The transfer of electrical charge—central to the catalysis process—also proved slow.

Unexpectedly, researchers found MoS_2 catalysis occurred most efficiently at the edges of the material or at flaws in the [lattice](#) where there were unpaired electrons.

This led Wang and his team to attempt to introduce MoS_2 flaws by varying the ratio of [molybdenum](#) to sulfur. At a particular ratio they were surprised to find that, instead of flawed MoS_2 , they had produced a regular two-dimensional crystal.

Examining the structure with a scanning tunneling microscope, the team found a square lattice structure made of repeating units of Mo_6S_4 —quite different from MoS_2 's hexagonal lattice structure.

Modelling of the square structure suggested it would be an efficient catalyst, as its characteristics were closer to metals such as platinum than the semiconductor-like MoS_2 .

Experiments confirmed the performance of Mo_6S_4 : the voltage required to drive the HER reaction was about 0.1 volts, 50 per cent lower than flawed lattice MoS_2 , and approaching platinum (~ 0.05 volts).

"It's not quite as good as [platinum](#), but considering that it's very cheap and very stable, I think it has great potential," Wang said.

More information: Tong Yang et al. Hydrogen Evolution Catalyzed by a Molybdenum Sulfide Two-Dimensional Structure with Active Basal Planes, *ACS Applied Materials & Interfaces* (2018). [DOI: 10.1021/acsami.8b03977](https://doi.org/10.1021/acsami.8b03977)

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