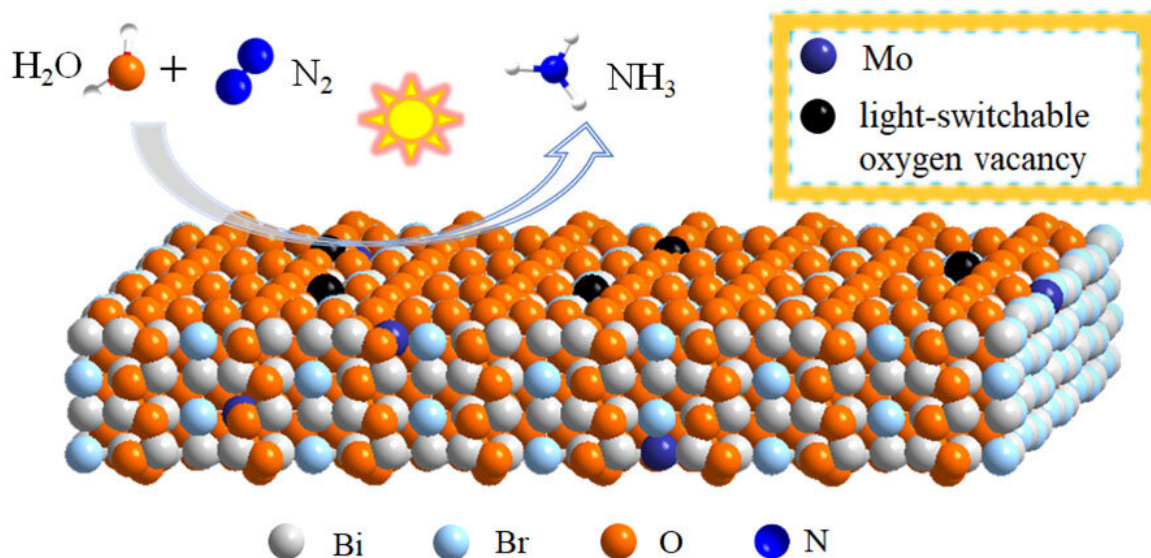


Enhanced ambient ammonia photosynthesis using nanosheets with light-switchable oxygen vacancies

September 3 2021



Researchers have presented a strategy by simultaneously introducing light-switchable oxygen vacancy and doping mo into $\text{Bi}_5\text{O}_7\text{Br}$ nanosheets for efficient photocatalytic N_2 fixation. The modified photocatalyst has achieved elevated N_2 fixation photoactivities by virtue of the optimized conduction band position, enhanced light availability, improved N_2 adsorption and charge carrier separation. Credit: Chinese Journal of Catalysis

Researchers have presented a strategy for simultaneously introducing

light-switchable oxygen vacancy and doping Mo into $\text{Bi}_5\text{O}_7\text{Br}$ nanosheets for efficient photocatalytic N_2 fixation. The modified photocatalyst has achieved elevated N_2 fixation photoactivities by virtue of the optimized conduction band position, enhanced light availability, improved N_2 adsorption and charge carrier separation.

The issue to achieve efficient nitrogen (N_2) reduction to ammonia (NH_3) has posed a significant challenge for decades as the inert $\text{N}\equiv\text{N}$ bond could be hardly broken because of the extremely large bond energy of $940.95 \text{ kJ mol}^{-1}$. To date, the industrial fixation of N_2 to NH_3 is monopolized by the energy-intensive Haber-Bosch process (673-873 K and 15-25 MPa), which unsustainably employs [natural gas](#) to make the hydrogen (H_2) feedstock with enormous energy consumption from fossil fuels, leading to a large amount of carbon dioxide (CO_2) emission. In this context, photocatalytic N_2 reduction is regarded as a sustainable alternative way for NH_3 synthesis from N_2 and water under ambient conditions.

However, the efficiency of most traditional photocatalysts is still far from satisfactory mainly due to the hard bond dissociation of the inert N_2 , which results from the weak binding of N_2 to the catalytic material and further inefficient electron transfer from photocatalyst into the antibonding orbitals of N_2 . In order to promote efficiency of N_2 photofixation, introducing the electron-donating centers as the catalytic activation sites for optimizing the N_2 adsorption properties and improving the photoexcited charge transport in the catalysts is a promising strategy.

Oxygen vacancy (OV) represents the most widely and prevalent studied type of surface defect for N_2 fixation. On one hand, OV can be facilely created for its relatively low formation energy; on the other hand, OV can assist photocatalysts to gain exciting N_2 fixation photoactivity by virtue of its superiority in N_2 capture and activation. Therefore, a

semiconductor with sufficient OVs may be favorable to improve their N₂ fixation performance. Transition metal (TM) doping is another widely investigated effective method to improve the photoactivity of N₂ fixation, because the TM species possess the advantageous ability of binding (and even functionalizing) with inert N₂ at low temperatures due to their empty and occupied d-orbitals, which can achieve the TM-N₂ interaction *via* "acceptance-donation" of electrons. Mo, as a critical element of the catalytic center in mysterious Mo-dependent nitrogenase, has attracted a lot of attention for the N₂ fixation. To this end, OVs-rich and Mo-doped materials would be ideal candidates for N₂ photofixation. In addition, layered bismuth oxybromide (BiOBr) materials have attracted numerous attentions because of their suitable band gaps and unique layer structures. For BiOBr-based semiconductors, such as Bi₃O₄Br and Bi₅O₇Br, it has been revealed that OV with sufficient localized electrons on their surface facilitates the capture and activation of inert N₂ molecules.

Recently, a research team led by Prof. Yi-Jun Xu from Fuzhou University, China reported that the introduction of OVs and Mo dopant into Bi₅O₇Br nanosheets can remarkably improve the photoactivity of N₂ fixation. The modified photocatalysts have showed the optimized conduction band position, the enhanced light absorption, the improved N₂ adsorption and charge carrier separation, which jointly contribute to the elevating N₂ fixation photoactivities. This work provides a promising approach to design photocatalysts with light-switchable OVs for N₂ reduction to NH₃ under mild conditions, highlighting the wide application scope of nanostructured BiOBr-based photocatalysts as effective N₂ [fixation](#) systems. The results were published in *Chinese Journal of Catalysis*.

More information: Xue Chen et al, Enhanced ambient ammonia photosynthesis by Mo-doped Bi₅O₇Br nanosheets with light-switchable oxygen vacancies, *Chinese Journal of Catalysis* (2021). [DOI:](#)

[10.1016/S1872-2067\(21\)63837-8](https://doi.org/10.1016/S1872-2067(21)63837-8)

Provided by Chinese Academy of Sciences

Citation: Enhanced ambient ammonia photosynthesis using nanosheets with light-switchable oxygen vacancies (2021, September 3) retrieved 26 April 2024 from <https://phys.org/news/2021-09-ambient-ammonia-photosynthesis-nanosheets-light-switchable.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.