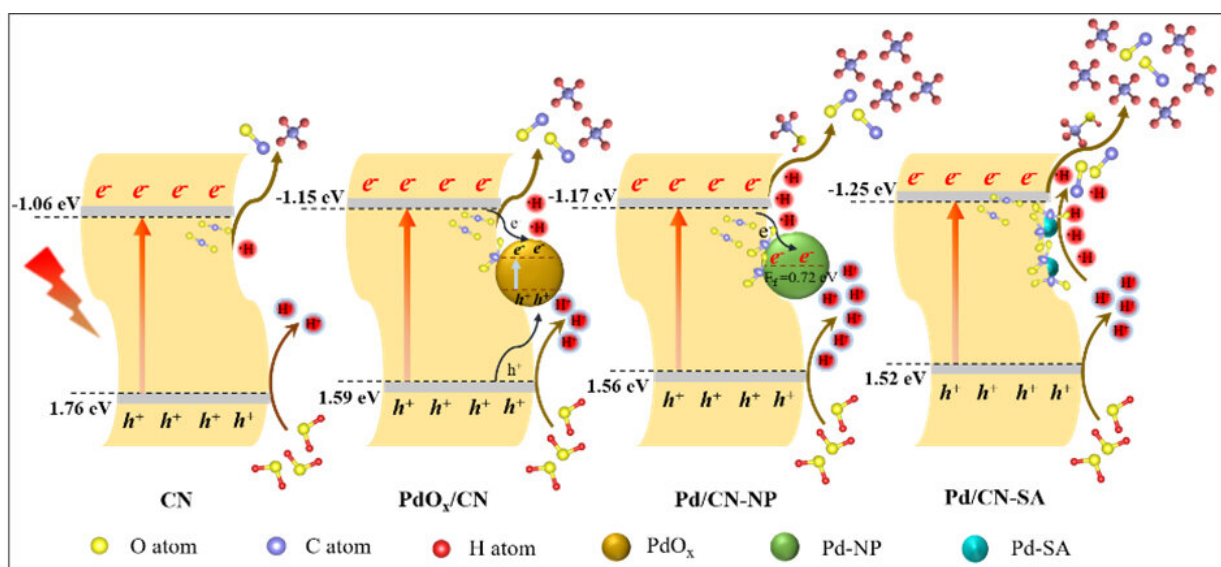


Effect of palladium chemical states on CO₂ photocatalytic reduction over g-C₃N₄

April 7 2023



Cocatalyst decoration has demonstrated to be effective in boosting CO₂ photocatalytic conversion, yet the critical role of sing-atomic state on CO₂ photocatalytic reduction, distinguished from the oxide and elemental states, remains a mystery. Herein, palladium single-atoms, palladium oxides, and palladium nanoparticles were homogeneously anchored on g-C₃N₄ to investigate their CO₂ photocatalytic reduction behaviors. And the mechanism behind their significantly different activities, especially the role of Pd-SA in boosting CH₄ production were comprehensively revealed. Credit: *Chinese Journal of Catalysis* (2023). DOI: 10.1016/S1872-2067(22)64199-8

Using solar energy and photocatalysts to convert CO₂ into high value-

added chemicals can simultaneously alleviate the greenhouse effect and energy crisis. Single atom cocatalysts decoration has been demonstrated to be an effective strategy to improve the CO₂ photocatalytic reduction efficiency.

Unfortunately, when unraveling the mechanism behind performance promotion, most studies mainly focus on clarifying the superior physicochemical and photoelectrical properties of SACs in comparison with the substrate. The critical role of the sing-atomic state distinguished from those oxide and elemental states was often neglected and remains a mystery.

Recently, a research team led by Prof. Zhongbiao Wu and Haiqiang Wang from Zhejiang University, China, comprehensively investigated the effect of Pd chemical states on CO₂ photocatalytic reduction of g-C₃N₄ (CN) under visible light irradiation, especially the critical role of Pd-SA in boosting CH₄ production. The results were published in the *Chinese Journal of Catalysis*.

Performance tests showed Pd species decoration improved the CH₄ production of CN, with Pd/CN-SA exhibiting the optimum yields (2.25 μmol g⁻¹), markedly higher than that of PdO_x/CN (1.08 μmol g⁻¹) and Pd/CN-NP (0.44 μmol g⁻¹). After comprehensive mechanism analysis with various characterization techniques, in-situ FTIR spectra and DFT calculations, it was found that the conducive activation of CO₂, negative conduction band potentials, and excellent •H utilization efficiency, collaboratively contributed to the superior CO₂ reduction performance of Pd/CN-SA, especially in the remarkably boosted CH₄ production.

In addition, despite the larger electron density of Pd/CN-NP and PdO_x/CN, the moderate reduction ability of their photogenerated electrons restricted the further reduction of adsorbed CO₂ species and CO intermediate, limiting the enhancement of CO₂ reduction activity.

Furthermore, the CH₄ evolutions of Pd/CN-NP and PdO_x/CN were also limited by the poor •H supply and inferior •H utilization efficiency, respectively.

The new insights may advance the understanding of CO₂ reduction process and inspire the design of efficient photocatalysts for CO₂ photocatalytic conversion.

More information: Qian Li et al, Effect of palladium chemical states on CO₂ photocatalytic reduction over g-C₃N₄: Distinct role of single-atomic state in boosting CH₄ production, *Chinese Journal of Catalysis* (2023). [DOI: 10.1016/S1872-2067\(22\)64199-8](https://doi.org/10.1016/S1872-2067(22)64199-8)

Provided by Chinese Academy of Sciences

Citation: Effect of palladium chemical states on CO₂ photocatalytic reduction over g-C₃N₄ (2023, April 7) retrieved 12 May 2024 from <https://phys.org/news/2023-04-effect-palladium-chemical-states-co2.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.