Scientists explore the strategies of defects and nanostructure fabrication for promoting piezocatalytic activity

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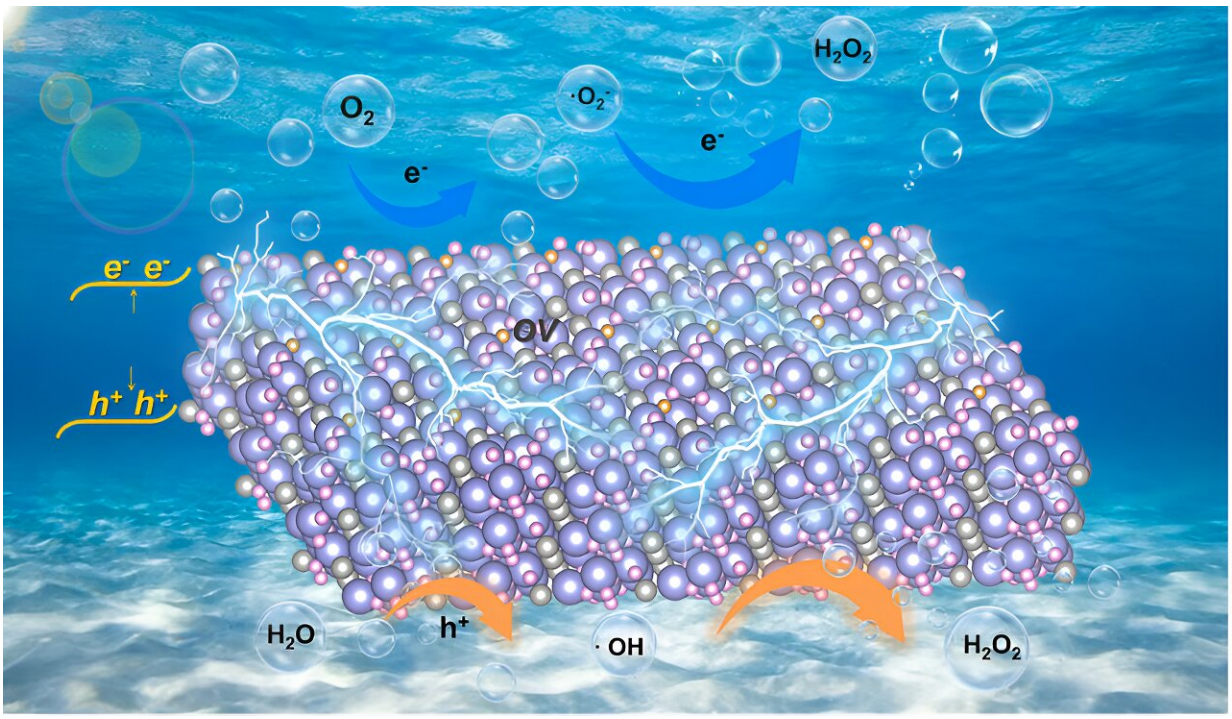

$Bi_4O_5Br_2$ is highly attractive as an efficient piezocatalyst that utilizes the ubiquitous mechanical energy for H_2O_2 synthesis. Oxygen vacancies mediated ultrathin $Bi_4O_5Br_2$ nanosheets display a better piezoelectric response and stronger adsorption and activation ability of oxygen, leading to an outstanding piezocatalytic H_2O_2 synthesis performance without any sacrificial agents and co-catalysts in pure water. Credit: Chinese Journal of Catalysis

As an important chemical raw material, hydrogen peroxide (H_2O_2) is widely applied in various aspects of industry and life. The industrial anthraquinone method for H_2O_2 production has the serious flaws, such as high pollution and energy consumption. By using ubiquitous mechanical energy, piezocatalytic H_2O_2 evolution has been proven as a promising strategy, but its progress is hindered by unsatisfied energy conversion efficiency.

$Bi_4O_5Br_2$ is regarded as a highly attractive photocatalytic material due to its unique sandwich structure, excellent chemical stability, good visible light capture ability and suitable band structure. Aspired by its non-centrosymmetric crystal structure, piezoelectric performance has begun to enter the vision of researchers recently.

However, its potential as an efficient piezocatalyst is far from being exploited, especially the impacts of defects on piezocatalysis and piezocatalytic H_2O_2 production over $Bi_4O_5Br_2$ remains scanty. Thus, mechanical energy-driven piezocatalysis provides a promising method for H_2O_2 synthesis from pure water with great attraction.

Recently, a research group led by Prof. Hongwei Huang from China University of Geosciences reported outstanding piezocatalytic H_2O_2 evolution performance that was achieved over ultrathin $Bi_4O_5Br_2$ nanosheets with appropriate oxygen vacancies, and disclosed the mechanism that thin structure and oxygen vacancies collectively enhance the piezocatalytic activity.

The results were published in the *Chinese Journal of Catalysis*.

Ultrathin $Bi_4O_5Br_2$ nanosheets with controllable oxygen vacancy concentrations are synthesized by a one-step solvothermal method by tuning the water to ethylene glycol ratio. Experiments and theoretical calculations have shown that $Bi_4O_5Br_2$ with appropriate oxygen

vacancies exhibits dramatic performance for piezocatalytic H_2O_2 production.

On the one hand, oxygen vacancies and thin structure largely increase the piezoelectric properties and piezoelectric potential of $Bi_4O_5Br_2$, which improve the separation and transfer of piezoinduced charges. On the other hand, oxygen vacancies promote oxygen adsorption and activation on the surface of $Bi_4O_5Br_2$, and lead to constantly decreased Gibbs free energy of the reaction pathway.

Therefore, the piezocatalytic H_2O_2 production performance of $Bi_4O_5Br_2$ with appropriate oxygen vacancies is higher than that of other commonly used piezocatalysts.

More information: Hao Cai et al, Oxygen vacancies mediated ultrathin Bi4O5Br2 nanosheets for efficient piezocatalytic peroxide hydrogen generation in pure water, *Chinese Journal of Catalysis* (2024). DOI: 10.1016/S1872-2067(23)64591-7

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