



Chinese Journal of Catalysis

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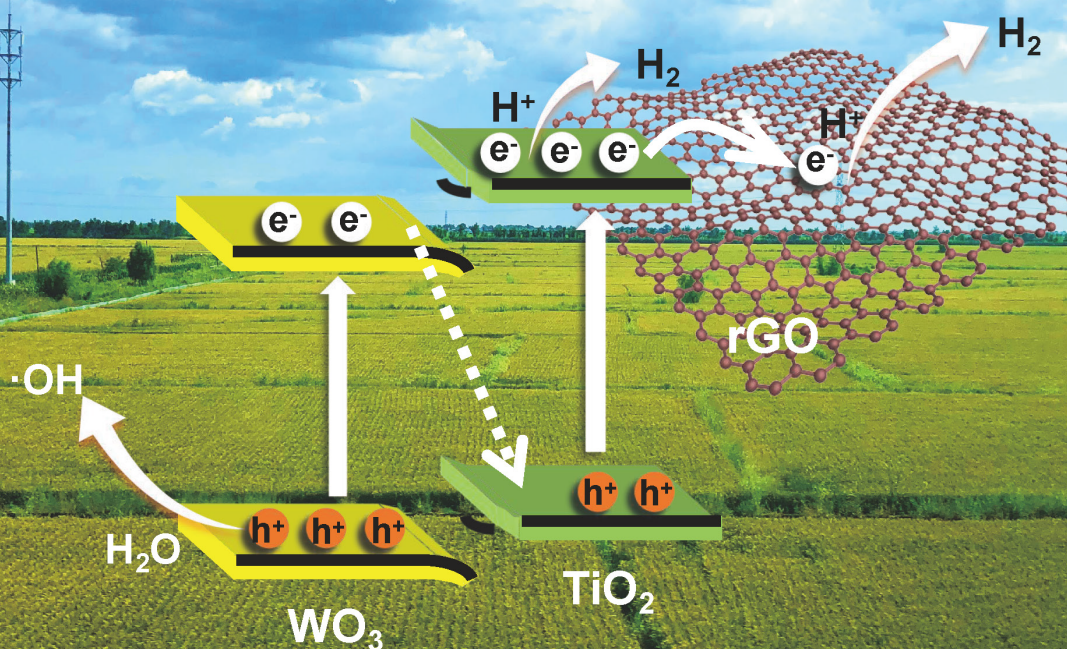
Volume 41 | Number 1 | January 2020

光催化产氢和CO₂还原专刊

Special Issue on Photocatalytic H₂ Production and CO₂ Reduction

Guest Editors: Jiaguo Yu (余家国), Jian Ru Gong (宫建茹), Quanjun Xiang (向全军)

Step-Scheme Heterojunction



催化
学报

Chinese Journal of Catalysis

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In This Issue



Cover: Yu and coworkers in their article on pages 9–20 reported a graphene-modified WO_3/TiO_2 step-scheme heterojunction composite photocatalyst, which was fabricated by a facile hydrothermal method. The prepared ternary $\text{WO}_3/\text{TiO}_2/\text{rGO}$ composite photocatalyst demonstrated a remarkably enhanced photocatalytic H_2 -production activity by water splitting, which was about 3.5-fold that of pure TiO_2 .

封面: 余家国及其同事报道了一种水热方法制备的石墨烯改性 WO_3/TiO_2 梯形异质结复合光催化剂, 其光催化分解水产氢活性是纯 TiO_2 的 3.5 倍。见本期第 9–20 页。

About the Journal

Chinese Journal of Catalysis is an international journal published monthly by Chinese Chemical Society, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, and Elsevier. The journal publishes original, rigorous, and scholarly contributions in the fields of heterogeneous and homogeneous catalysis in English or in both English and Chinese. The scope of the journal includes:

- ◆ New trends in catalysis for applications in energy production, environmental protection, and production of new materials, petroleum chemicals, and fine chemicals;
- ◆ Scientific foundation for the preparation and activation of catalysts of commercial interest or their representative models;
- ◆ Spectroscopic methods for structural characterization, especially methods for in situ characterization;
- ◆ New theoretical methods of potential practical interest and impact in the science and applications of catalysis and catalytic reaction;
- ◆ Relationship between homogeneous and heterogeneous catalysis;
- ◆ Theoretical studies on the structure and reactivity of catalysts.
- ◆ The journal also accepts contributions dealing with photo-catalysis, bio-catalysis, and surface science and chemical kinetics issues related to catalysis.

Types of Contributions

- **Reviews** deal with topics of current interest in the areas covered by this journal. Reviews are surveys, with entire, systematic, and important information, of recent progress in important topics of catalysis. Rather than an assemblage of detailed information or a complete literature survey, a critically selected treatment of the material is desired. Unsolved problems and possible developments should also be discussed. Authors should have published articles in the field. Reviews should have more than 80 references.
- **Communications** rapidly report studies with significant innovation and major academic value. They are limited to four Journal pages. After publication, their full-text papers can also be submitted to this or other journals.
- **Articles** are original full-text reports on innovative, systematic and completed research on catalysis.
- **Highlights** describe and comment on very important new results in the original research of a third person with a view to highlight their significance. The results should be presented clearly and concisely without the comprehensive details required for an original article.
- **Perspectives** are short reviews of recent developments in an established or developing topical field. The authors should offer a critical assessment of the trend of the field, rather than a summary of literatures.
- **Viewpoints** describe the results of original research in general in some area, with a view to highlighting the progress, analyzing the major problems, and commenting the possible research target and direction in the future.

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Abstracting and Indexing

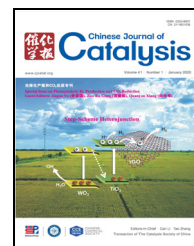
Abstract Journals (VINITI)
Cambridge Scientific Abstracts (CIG)
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Special Issue on Photocatalytic H₂ Production and CO₂ Reduction

Guest Editors: Jiaguo Yu, Jian Ru Gong, Qianjun Xiang

Chinese Journal of Catalysis

Graphical Contents

Editorial

Chin. J. Catal., 2020, 41: 1 doi: S1872-2067(19)63521-7

Preface to the Special Issue on Photocatalytic H₂ Production and CO₂ Reduction

Jiaguo Yu, Jian Ru Gong, Qianjun Xiang

Wuhan University of Technology; National Center for Nanoscience and Technology; University of Electronic Science and Technology of China



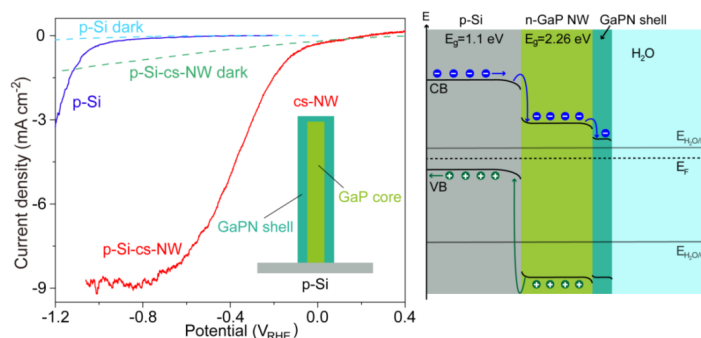
Photocatalytic H₂ production

Chin. J. Catal., 2020, 41: 2-8 doi: S1872-2067(19)63465-0 [Communication]

GaP/GaPN core/shell nanowire array on silicon for enhanced photoelectrochemical hydrogen production

Guancai Xie, Saad Ullah Jan, Zejian Dong, Yawen Dai, Rajender Boddula, Yuxuan Wei, Chang Zhao, Qi Xin, Jiao-Na Wang, Yinfang Du, Lan Ma, Beidou Guo*, Jian Ru Gong*

National Center for Nanoscience and Technology; University of Chinese Academy of Sciences; Beijing Institute of Fashion Technology



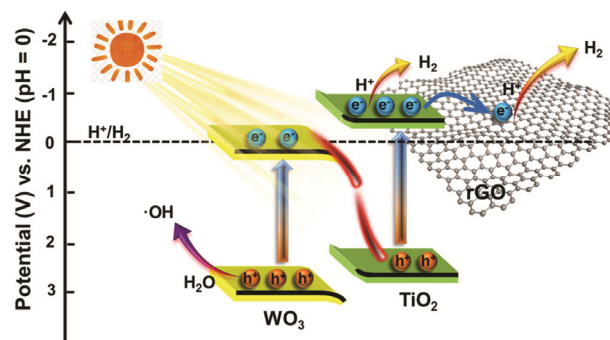
p-Si-GaP/GaPN core/shell heterostructure demonstrates improved PEC HER performance owing to enhanced charge separation and increased light absorption, which result from the novel structural design.

Chin. J. Catal., 2020, 41: 9–20 doi: S1872-2067(19)63382-6 [Article]

Enhanced photocatalytic H₂-production activity of WO₃/TiO₂ step-scheme heterojunction by graphene modification

Fei He, Aiyun Meng, Bei Cheng, Wingkei Ho*, Jiaguo Yu*
 Wuhan University of Technology, China;
 The Education University of Hong Kong, China;
 King Abdulaziz University, Saudi Arabia

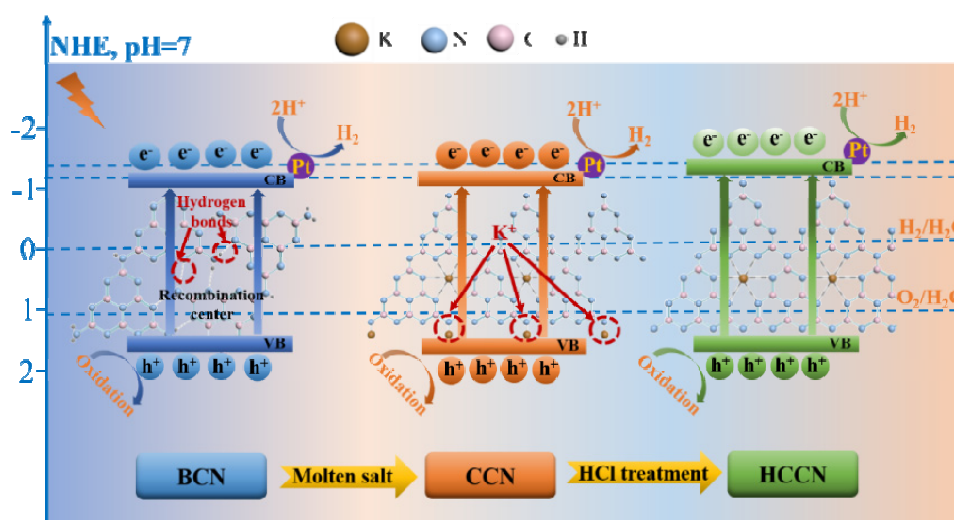
WO₃/TiO₂ S-scheme heterojunction photocatalysts modified by graphene (WTG) exhibited remarkably enhanced photocatalytic H₂-production activities.



Chin. J. Catal., 2020, 41: 21–30 doi: S1872-2067(19)63427-3 [Article]

Enhanced photocatalytic hydrogen production activity of highly crystalline carbon nitride synthesized by hydrochloric acid treatment

Yang Li, Dainan Zhang, Xionghan Feng, Quanjun Xiang*
 University of Electronic Science and Technology of China; Huazhong Agricultural University



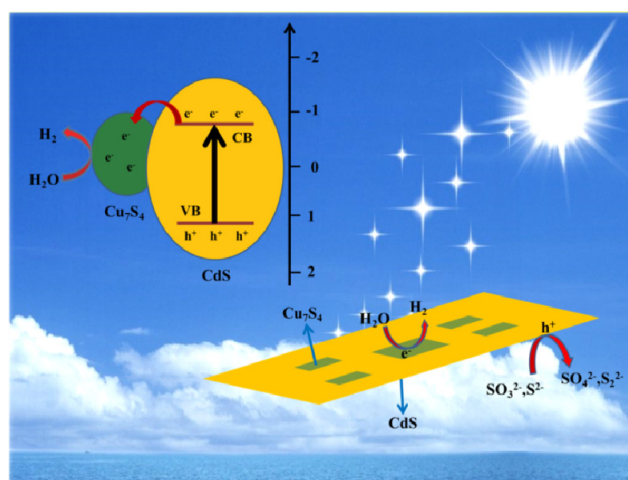
Highly crystalline carbon nitride, prepared by a molten-salt method with aqueous hydrochloric acid solution treatment, exhibited an enhanced photocatalytic H₂ production activity.

Chin. J. Catal., 2020, 41: 31–40 doi: S1872-2067(19)63467-4 [Article]

Highly efficient visible-light photocatalytic H₂ evolution over 2D–2D CdS/Cu₇S₄ layered heterojunctions

Doudou Ren, Rongchen Shen, Zhimin Jiang, Xinyong Lu, Xin Li*
 South China Agricultural University

The 2D/2D CdS/Cu₇S₄ layered heterojunctions were, for the first time, fabricated by a one-step ultrasonic-assisted electrostatic self-assembly, which could reach a visible-light H₂-generation rate of 27.8 mmol g⁻¹ h⁻¹, with an apparent quantum efficiency of 14.7% at 420 nm.

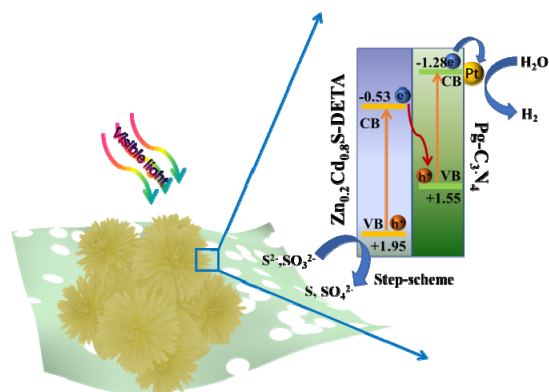


Chin. J. Catal., 2020, 41: 41–49 doi: S1872-2067(19)63389-9 [Article]

Step-scheme porous g-C₃N₄/Zn_{0.2}Cd_{0.8}S-DETA composites for efficient and stable photocatalytic H₂ production

Feifei Mei, Zhen Li, Kai Dai*, Jinfeng Zhang*, Changhao Liang*
Huaibei Normal University, Hefei Institutes of Physical Science, Chinese Academy of Sciences

Step-scheme Pg-C₃N₄/Zn_{0.2}Cd_{0.8}S-DETA composites with enhanced photocatalytic activity and durability were successfully fabricated by a solvothermal method. Compared to those of Zn_{0.2}Cd_{0.8}S-DETA and Pg-C₃N₄, the photocatalytic H₂ production rate and stability of Pg-C₃N₄/Zn_{0.2}Cd_{0.8}S-DETA composites are high, which is attributed to the spatial separation of electron-hole pairs and improved transmission efficiency.

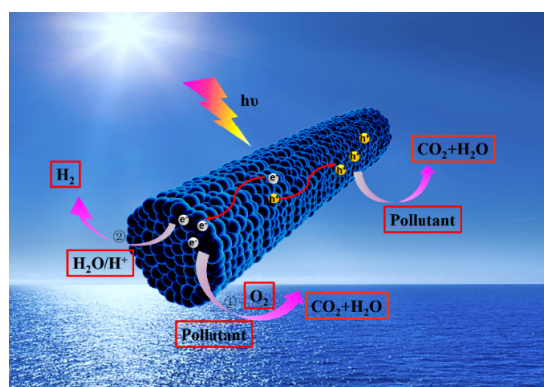


Chin. J. Catal., 2020, 41: 50–61 doi: S1872-2067(19)63424-8 [Article]

Hydrogen producing water treatment through mesoporous TiO₂ nanofibers with oriented nanocrystals

Guocheng Huang, Xueyan Liu, Shuangru Shi, Sitan Li, Zhengtao Xiao, Weiqian Zhen, Shengwei Liu*, Po Keung Wong*
Sun Yat-sen University;
The Chinese University of Hong Kong;
Guangdong University of Technology

Hydrogen recovering photocatalytic water treatment process was achieved by a cascading oxidic-anoxic process where the dye is degraded in the oxidic phase and hydrogen is generated in the successive anoxic phase.

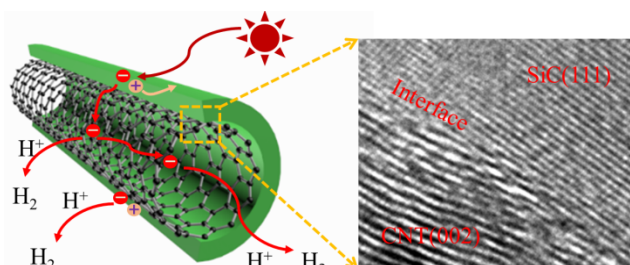


Chin. J. Catal., 2020, 41: 62–71 doi: S1872-2067(19)63421-2 [Article]

Carbon nanotube@silicon carbide coaxial heterojunction nanotubes as metal-free photocatalysts for enhanced hydrogen evolution

Xunfu Zhou, Qiongzhi Gao, Siyuan Yang*, Yueping Fang*
South China Agricultural University

One-dimensional carbon@silicon carbide coaxial heterojunction nanotubes with a perfect heterointerface and an outstanding photocatalytic activity were successfully synthesized via in situ growth of SiC coatings on CNTs that involves a vapor-solid reaction between silicon vapor and CNTs.

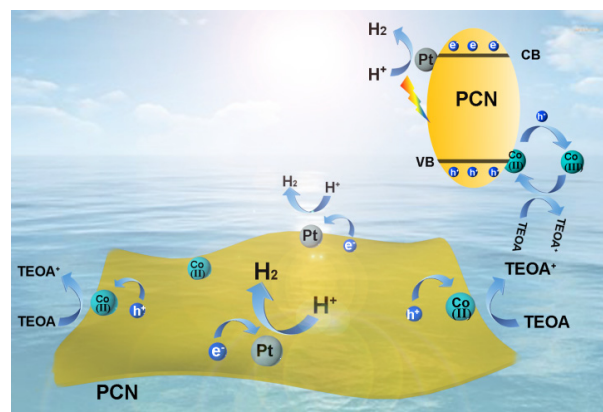


Chin. J. Catal., 2020, 41: 72–81 doi: S1872-2067(19)63430-3 [Article]

Synergistic effect of Co(II)-hole and Pt-electron cocatalysts for enhanced photocatalytic hydrogen evolution performance of P-doped g-C₃N₄

Kouhua Sun, Jun Shen, Qinqin Liu, Hua Tang*, Mingyi Zhang, Syed Zulfiqar, Chunsheng Lei*
Changzhou University;
Suzhou Vocational Health College;
Jiangsu University; Harbin Normal University

Co(II) decorated P doped g-C₃N₄ with optimized electronic structure shows excellent photocatalytic H₂-production, which is ascribed to the directional shunting of electron-hole pairs via Co(II) and Pt.

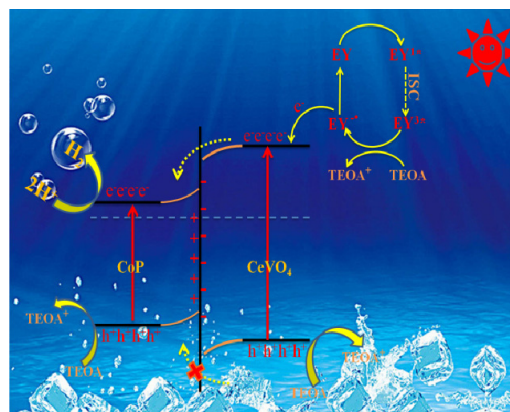


Chin. J. Catal., 2020, 41: 82–94 doi: S1872-2067(19)63454-6 [Article]

Unique synergistic effects of ZIF-9(Co)-derived cobalt phosphide and CeVO₄ heterojunction for efficient hydrogen evolution

Lijun Zhang, Xuqiang Hao *, Junke Li, Yuanpeng Wang, Zhiliang Jin *
North Minzu University

The excellent photocatalytic performance of CoP/CeVO₄ depends on the formation of a heterojunction between CoVO₄ and CoP, which promotes efficient charge carrier separation and leads to a high separation efficiency and low recombination rate of the photogenerated electron-hole pairs.

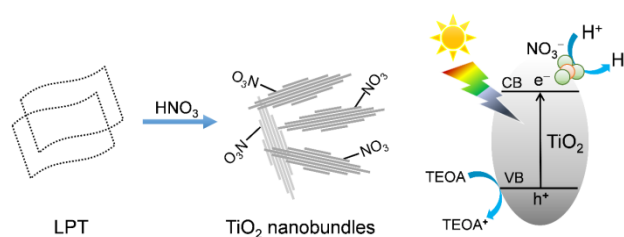


Chin. J. Catal., 2020, 41: 95–102 doi: S1872-2067(19)63452-2 [Article]

Nitrate-group-grafting-induced assembly of rutile TiO₂ nanobundles for enhanced photocatalytic hydrogen evolution

Heng Wang, Xiantao Hu, Yajuan Ma, Dajian Zhu, Tao Li, Jingyu Wang *
Huazhong University of Science and Technology

Nitrate group grafting induced the assembly of rutile TiO₂ nanorods into spindle-like nanobundles. The grafted photocatalyst exhibited a significantly enhanced H₂ evolution rate based on the improved proton trapping efficiency of the negatively charged surface.

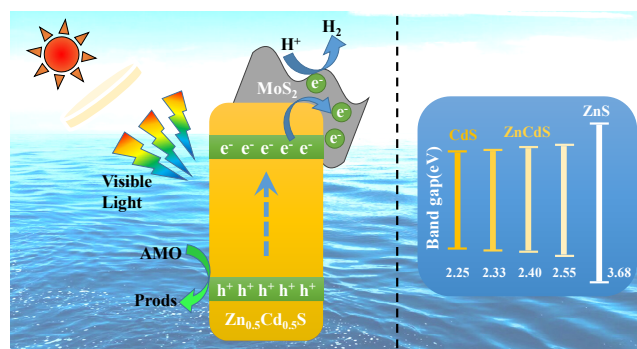


Chin. J. Catal., 2020, 41: 103–113 doi: S1872-2067(19)63479-0 [Article]

Simultaneous visible-light-induced hydrogen production enhancement and antibiotic wastewater degradation using MoS₂@Zn_xCd_{1-x}S: Solid-solution-assisted photocatalysis

Zhidong Wei, Meiqi Xu, Junying Liu, Weiqi Guo, Zhi Jiang, Wenfeng Shangguan *
Shanghai Jiao Tong University

Simultaneous photocatalytic hydrogen evolution and degradation of amoxicillin can be achieved under visible light using MoS₂@Zn_{0.5}Cd_{0.5}S. The solid solution strategy will be favorable for both the hydrogen evolution and antibiotic wastewater degradation.

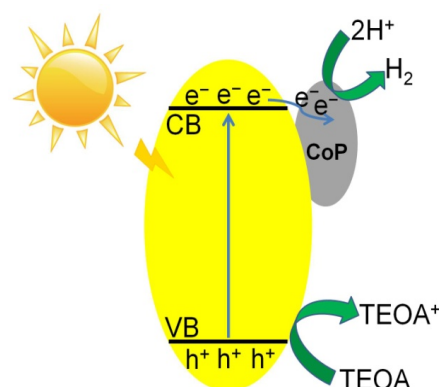


Chin. J. Catal., 2020, 41: 114–121 doi: S1872-2067(19)63459-5 [Article]

Photocatalytic H₂ generation via CoP quantum-dot-modified g-C₃N₄ synthesized by electroless plating

Kezhen Qi, Wenxiu Lv, Iltaf Khan, Shu-yuan Liu *
Shenyang Normal University; Fuzhou University;
Heilongjiang University; Shenyang Medical College;
Harbin Normal University

The photocatalytic activity of H₂ generation over g-C₃N₄/CoP composites prepared by an electroless plating method is much higher than that over pure g-C₃N₄. The composites boosted the separation and migration of photogenerated carriers, resulting in a higher photocatalytic activity.

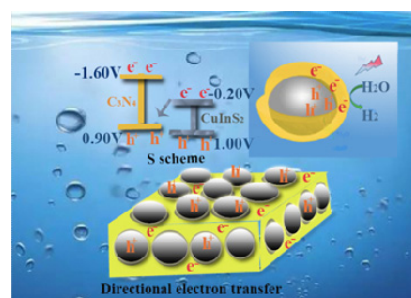


Chin. J. Catal., 2020, 41: 122–130 doi: S1872-2067(19)63490-X [Article]

The embedded CuInS₂ into hollow-concave carbon nitride for photocatalytic H₂O splitting into H₂ with S-scheme principle

Jinhua Luo, Zhexiong Lin, Yan Zhao, Shujuan Jiang*, Shaoqing Song*
Ningbo University

S-scheme principle for water splitting into H₂ over CuInS₂@C₃N₄ with directional charge-transfer under the effect of an apparent potential difference of the hollow-concave C₃N₄ caused by deviating the sp²-hybridized structure of its tri-s-triazine component from the two-dimensional plane.

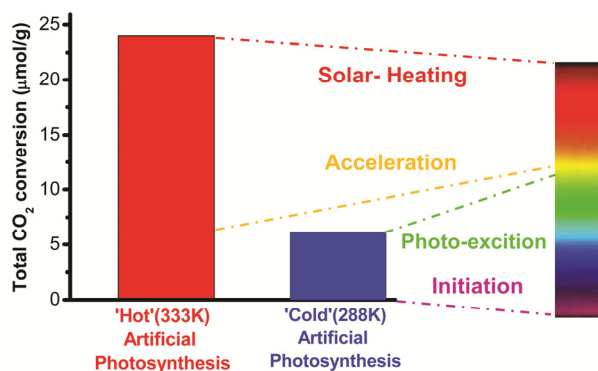


Photocatalytic CO₂ reduction

Chin. J. Catal., 2020, 41: 131–139 doi: S1872-2067(19)63393-0 [Article]

Solar-heating boosted catalytic reduction of CO₂ under full-solar spectrum

Hongjia Wang, Yanjie Wang, Lingju Guo, Xuehua Zhang, Caue Ribeiro, Tao He*
National Center for Nanoscience and Technology, China; University of Chinese Academy of Sciences, China;
Embrapa Instrumentation, Brazil; Forschungszentrum Jülich GmbH – Institute of Energy and Climate Research, Germany

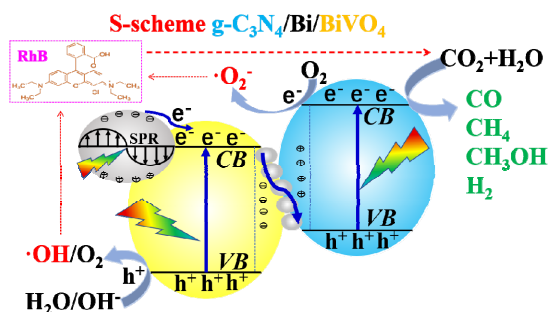


Au deposited rutile exhibits high artificial photosynthesis performance via utilizing full-solar spectrum, for which UV and visible light are used to initiate reaction and IR light is used to boost reaction kinetically through solar heating.

Chin. J. Catal., 2020, 41: 140–153 doi: S1872-2067(19)63481-9 [Article]

Bifunctional S-scheme g-C₃N₄/Bi/BiVO₄ hybrid photocatalysts toward artificial carbon cycling

Quan Xie, Wanmei He, Shengwei Liu*, Chuanhao Li*, Jinfeng Zhang*, Po Keung Wong
Sun Yat-sen University; Huaibei Normal University; The Chinese University of Hong Kong; Guangdong University of Technology



Bifunctional S-scheme g-C₃N₄/Bi/BiVO₄ hybrid photocatalysts demonstrate both superior aerobic photocatalytic organic pollutant oxidation performance and impressive anaerobic photocatalytic CO₂ reduction ability, enabling the integrated aerobic-anaerobic reaction system for photocatalytic carbon cycling.

Chin. J. Catal., 2020, 41: 154–160 doi: S1872-2067(19)63475-3 [Article]

Thermal coupled photoconductivity as a tool to understand the photothermal catalytic reduction of CO₂

Dashuai Li, Yu Huang, Songmei Li, Changhua Wang*, Yingying Li, Xintong Zhang*, Yichun Liu
Northeast Normal University

By correlating thermal coupled photoconductivity with photothermal catalysis, accelerated electron transfer to CO₂ and detrapping of electrons to conduction band of TiO₂ are confirmed, and this provides a clear explanation for the superior performance of Ov-TiO₂ in photothermal catalysis.

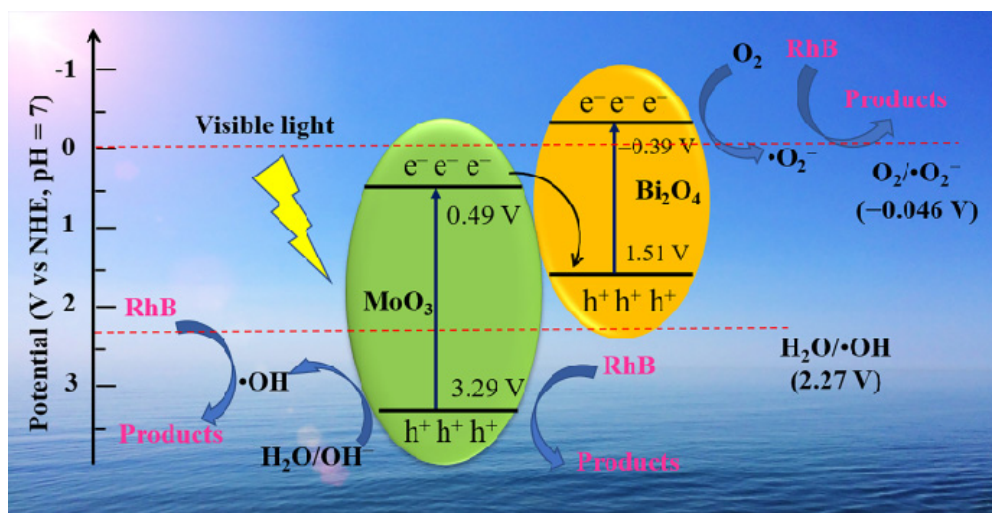


Other photocatalytic application

Chin. J. Catal., 2020, 41: 161–169 doi: S1872-2067(19)63391-7 [Article]

Fabrication of Z-scheme MoO₃/Bi₂O₄ heterojunction photocatalyst with enhanced photocatalytic performance under visible light irradiation

Tiangui Jiang, Kai Wang, Ting Guo, Xiaoyong Wu, Gaoke Zhang*
Wuhan University of Technology



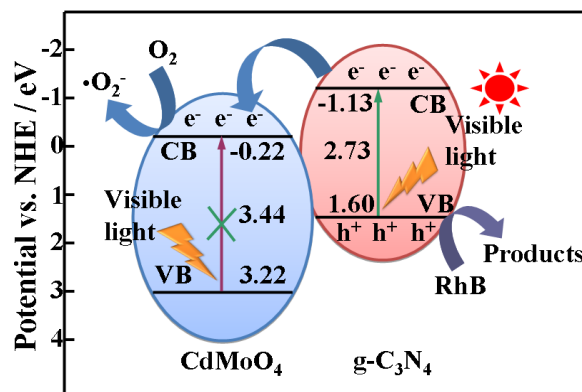
Novel Z-scheme MoO₃/Bi₂O₄ heterojunction photocatalyst exhibited excellent photocatalytic activity under visible light irradiation benefiting from efficiently charge transfer and photogenerated hole-electron separation.

Chin. J. Catal., 2020, 41: 170–179 doi: S1872-2067(19)63383-8 [Article]

In situ fabrication of CdMoO₄/g-C₃N₄ composites with improved charge separation and photocatalytic activity under visible light irradiation

Bo Chai*, Juntao Yan, Guozhi Fan, Guangsen Song*, Chunlei Wang
Wuhan Polytechnic University

CdMoO₄/g-C₃N₄ composites were rationally synthesized by a facile precipitation-calcination procedure. The enhanced photocatalytic activity of CdMoO₄/g-C₃N₄ composite could be attributed to the formation of type II heterojunctions that are based on their well-matched band energy structures.

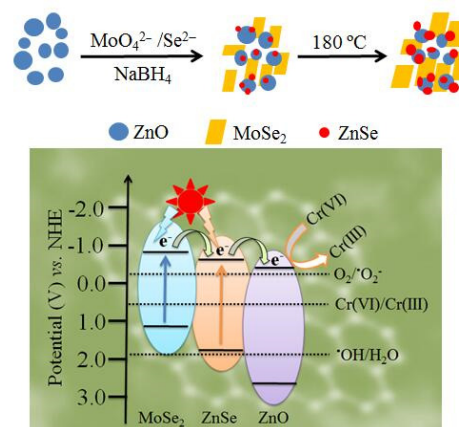


Chin. J. Catal., 2020, 41: 180–187 doi: S1872-2067(19)63484-4 [Article]

MoSe₂/ZnO/ZnSe hybrids for efficient Cr(VI) reduction under visible light irradiation

Zhenxing Ren, Xinjuan Liu *, Zhihao Zhuge, Yinyan Gong,
Chang Q. Sun *
Shanxi University, China;
China Jiliang University, China;
Nanyang Technological University, Singapore

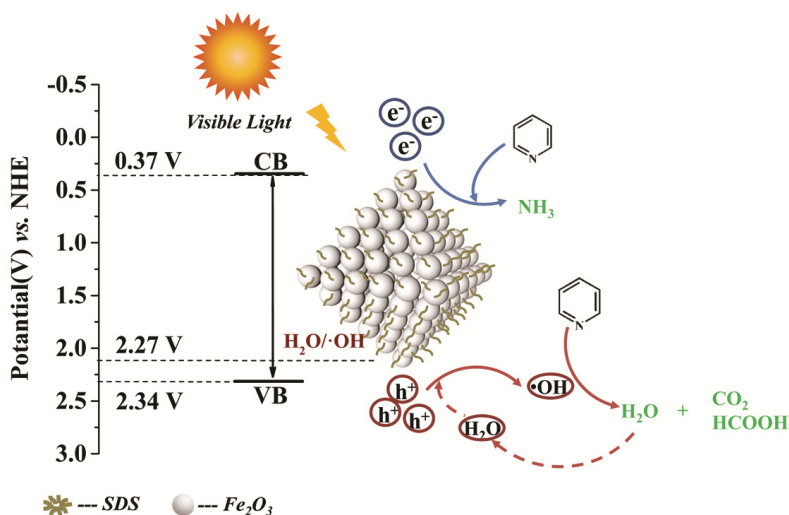
MoSe₂/ZnO/ZnSe hybrids display excellent photocatalytic activity for Cr(VI) reduction under visible light irradiation.



Chin. J. Catal., 2020, 41: 188–199 doi: S1872-2067(19)63402-9 [Article]

Sodium dodecyl sulfate-decorated MOF-derived porous Fe₂O₃ nanoparticles: High performance, recyclable photocatalysts for fuel denitrification

Ruowen Liang, Zhiyu Liang, Feng Chen, Danhua Xie, Yanling Wu, Xuxu Wang, Guiyang Yan *, Ling Wu *
Ningde Normal University; Fuzhou University



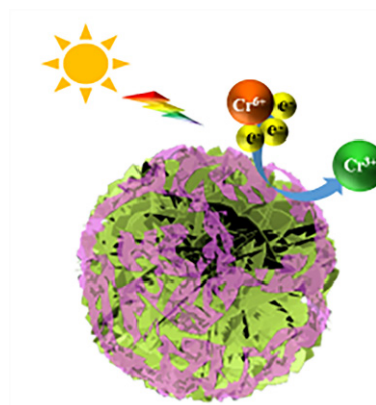
SDS/Fe₂O₃ nanocomposites have been fabricated using a simple two-step calcination strategy, followed by efficient electrostatic self-assembly. The obtained SDS/Fe₂O₃ photocatalysts have exhibited outstanding photoactivities for the denitrification of pyridine.

Chin. J. Catal., 2020, 41: 200–208 doi: S1872-2067(19)63422-4 [Article]

Facile fabrication of ZnIn₂S₄/SnS₂ 3D heterostructure for efficient visible-light photocatalytic reduction of Cr(VI)

Jingwen Pan, Zhongjie Guan *, Jianjun Yang, Qiuye Li *
Henan University

The charge separation and visible-light absorption efficiencies of ZnIn₂S₄ are promoted by constructing the ZnIn₂S₄/SnS₂ 3D heterostructure. A superior photocatalytic ability for Cr(VI) reduction is obtained over the ZnIn₂S₄/SnS₂ 3D heterostructure.

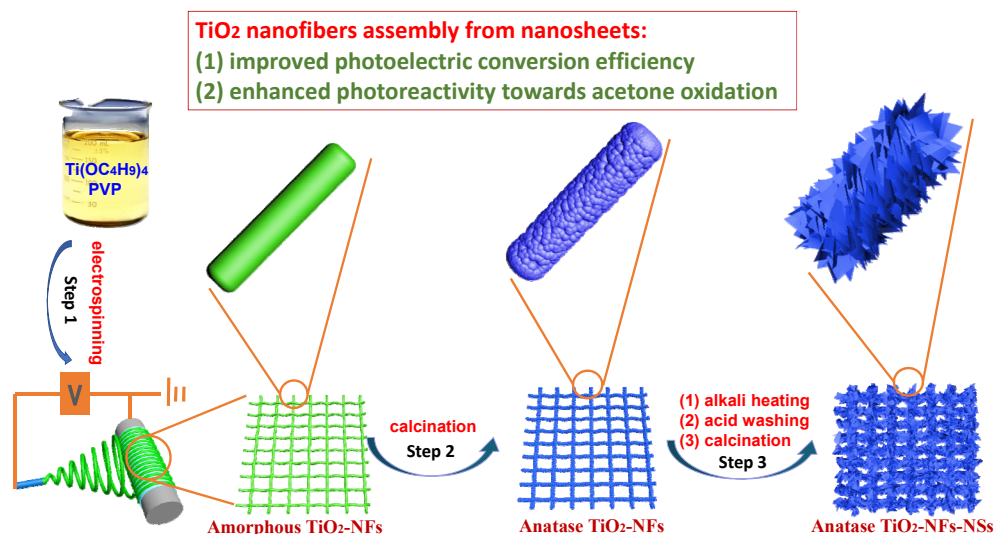


Chin. J. Catal., 2020, 41: 209–218 doi: S1872-2067(19)63470-4 [Article]

Fabrication of TiO₂ nanofiber assembly from nanosheets (TiO₂-NFs-NSs) by electrospinning-hydrothermal method for improved photoreactivity

Yachao Lu, Xiaoyu Ou, Wenguang Wang *, Jiajie Fan, Kangle Lv *

South-Central University for Nationalities; Guangdong University of Technology; Zhengzhou University



A TiO₂ nanofiber assembly was prepared from nanosheets (TiO₂-NFs-NSs) by hydrothermal reaction of TiO₂ nanofibers in NaOH solution followed by acid washing and calcination. The unique structures enable TiO₂-NFs-NSs to exhibit improved photoelectric conversion efficiency and enhanced photoreactivity toward acetone oxidation.

Chin. J. Catal., 2020, 41: 219–226 doi: S1872-2067(19)63477-7 [Article]

Controllable synthesis of Au-TiO₂ nanodumbbell photocatalysts with spatial redox region

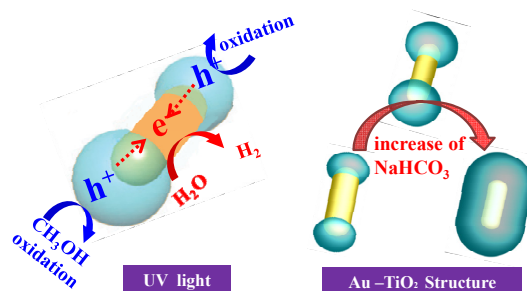
Ye Liu, Zhaozhong Xiao, Shuang Cao, Jinhui Li *, Lingyu Piao *

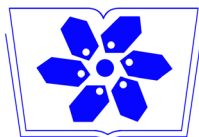
Jiangxi University of Science and Technology;

National Center for Nanoscience and Technology;

Tianjin University

We report the key factors of precise synthesis of Au NRs/TiO₂ NDs structure photocatalysts, which have spatially separated oxidation and reduction reaction zones, and we synthesized a series of one-dimensional Au NRs/TiO₂ NDs structure photocatalysts.





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光催化产氢和CO₂还原专刊

客座主编: 余家国, 宫建茹, 向全军

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1 (专刊前言)

“光催化产氢和CO₂还原专刊”前言

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光催化产氢

2 (快讯)

GaP/GaN核壳纳米线阵列修饰的硅光阴极的光电化学制氢反应
谢关才, Saad Ullah Jan, 董泽健, 代亚雯, Rajender Boddula,
魏玉轩, 赵唱, 辛琪, 王娇娜, 杜银芳, 马兰, 郭北斗, 宫建茹

9 (论文)

石墨烯修饰三氧化钨/二氧化钛S型异质结增强的光催化产
氢活性

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