

# EES Catalysis

rsc.li/eescatalysis

The Royal Society of Chemistry is the world's leading chemistry community. Through our high impact journals and publications we connect the world with the chemical sciences and invest the profits back into the chemistry community.

## IN THIS ISSUE

eISSN 2753–801X CODEN ECEACE 1(4) 325–582 (2023)



### Cover

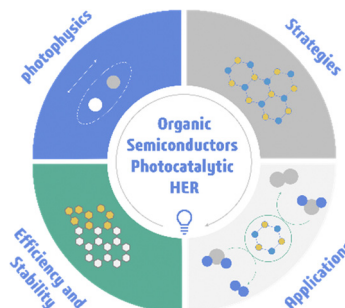
See Wenzhen Li, Shuang Gu *et al.*, pp. 504–515. Image reproduced by permission of Wenzhen Li and Shuang Gu from *EES Catal.*, 2023, 1, 504.

## REVIEWS

333

### Advances in organic semiconductors for photocatalytic hydrogen evolution reaction

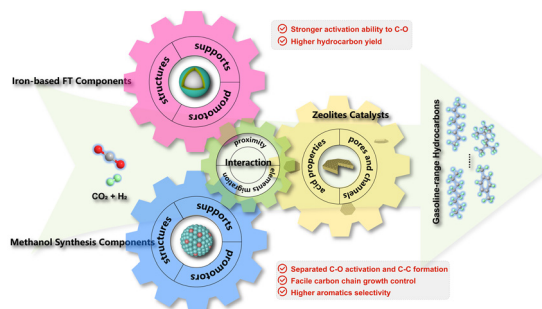
Yan Guo, Qixin Zhou, Bowen Zhu, Chuyang Y. Tang\* and Yongfa Zhu\*



353

### A review of the recent progress on direct heterogeneous catalytic CO<sub>2</sub> hydrogenation to gasoline-range hydrocarbons

Xin Shang, Guodong Liu, Xiong Su,\* Yanqiang Huang\* and Tao Zhang



## Editorial Staff

### Executive Editor

Emma Eley

### Deputy Editor

Jon Ferrier

### Editorial Production Manager

Sarah Whitbread

### Assistant Editors

Jamie Purcell, Aphra Murray, Alexander John, Emily Ellison, Jack Pitchers

### Editorial Assistant

Alex Holiday

### Publishing Assistant

Lee Colwill

### Publisher

Neil Hammond

For queries about submitted papers, please contact Sarah Whitbread, Editorial Production Manager in the first instance. E-mail: [EESCatalysisRSC@rsc.org](mailto:EESCatalysisRSC@rsc.org)

For pre-submission queries please contact

Emma Eley, Executive Editor.

E-mail: [EESCatalysis-RSC@rsc.org](mailto:EESCatalysis-RSC@rsc.org)

EES Catalysis (electronic: ISSN 2753-801X) is published 6 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WF.

EES Catalysis is a Gold Open Access journal and all articles are free to read. Please email [orders@rsc.org](mailto:orders@rsc.org) to register your interest or contact Royal Society of Chemistry Order Department, Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, CB4 0WF, UK Tel +44 (0)1223 432398; E-mail: [orders@rsc.org](mailto:orders@rsc.org)

Whilst this material has been produced with all due care, the Royal Society of Chemistry cannot be held responsible or liable for its accuracy and completeness, nor for any consequences arising from any errors or the use of the information contained in this publication. The publication of advertisements does not constitute any endorsement by the Royal Society of Chemistry or Authors of any products advertised. The views and opinions advanced by contributors do not necessarily reflect those of the Royal Society of Chemistry which shall not be liable for any resulting loss or damage arising as a result of reliance upon this material. The Royal Society of Chemistry is a charity, registered in England and Wales, Number 207890, and a company incorporated in England by Royal Charter (Registered No. RC000524), registered office: Burlington House, Piccadilly, London W1J 0BA, UK, Telephone: +44 (0) 207 4378 6556.

### Advertisement sales:

Tel +44 (0) 1223 432246; Fax +44 (0) 1223 426017;

E-mail [advertising@rsc.org](mailto:advertising@rsc.org)

For marketing opportunities relating to this journal, contact [marketing@rsc.org](mailto:marketing@rsc.org)

# EES Catalysis

[rsc.li/EESCatalysis](http://rsc.li/EESCatalysis)

*EES Catalysis* publishes exceptional research on energy and environmental catalysis.

## Editorial Board

### Editor-in-Chief

Shizhang Qiao, The University of Adelaide, Australia

### Associate Editors

Honggang Fu, Heilongjiang University, China  
Susan Habas, National Renewable Energy Laboratory, USA  
Zhichuan Xu, Nanyang Technological University, Singapore  
Rebecca Melen, Cardiff University, UK

## Advisory Board

Joel W. Ager III, Lawrence Berkeley National Laboratory, USA  
Alexis Bell, University of California, Berkeley, USA  
Annemie Bogaerts, University of Antwerp, Belgium  
Charles T. Campbell, University of Washington, USA  
Jingguang Chen, Columbia University, USA  
Zhongwei Chen, University of Waterloo, Canada  
Ib Chorkendorff, Technical University of Denmark, Denmark  
Charles Dismukes, Rutgers University, USA  
Shaojun Guo, Peking University, China  
Qian He, National University of Singapore, Singapore  
Ungyu Paik, Hanyang University, Korea  
Menny Shalom, Ben-Gurion University of the Negev, Israel  
Licheng Sun, KTH Royal Institute of Technology, Sweden  
Zhiyong Tang, National Center for Nanoscience and Technology, China  
David Tilley, University of Zurich, Switzerland  
Ye Wang, Xiamen University, China

## Information for Authors

Full details on how to submit material for publication in EES Catalysis are given in the Instructions for Authors (available from <http://www.rsc.org/authors>). Submissions should be made via the journal's homepage: [rsc.li/EESCatalysis](http://rsc.li/EESCatalysis)

Authors may reproduce/republish portions of their published contribution without seeking permission from the Royal Society of Chemistry, provided that any such republication is accompanied by an acknowledgement in the form: (Original Citation)–Reproduced by permission of the Royal Society of Chemistry.

This journal is © The Royal Society of Chemistry 2023. Apart from fair dealing for the purposes of research or private study for non-commercial purposes, or criticism or review, as permitted under the Copyright, Designs and Patents Act 1988 and the Copyright and Related Rights Regulation 2003, this publication may only be reproduced, stored or transmitted, in any form or by any means, with the prior permission in writing of the Publishers or in the case of reprographic reproduction in accordance with the terms of licences issued by the Copyright Licensing Agency in the UK. US copyright law is applicable to users in the USA.

Registered charity number: 207890

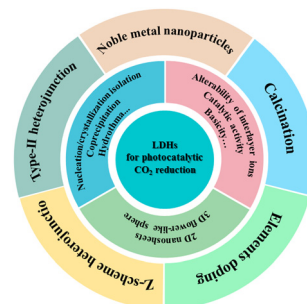


## REVIEWS

369

Layered double hydroxides and their composites as high-performance photocatalysts for CO<sub>2</sub> reduction

Guixiang Ding, Chunxue Li, Yonghao Ni, Lihui Chen, Li Shuai and Guangfu Liao\*



392

## Strategies for reducing the overpotential of one-dimensional Si nanostructured photoelectrodes for solar hydrogen production

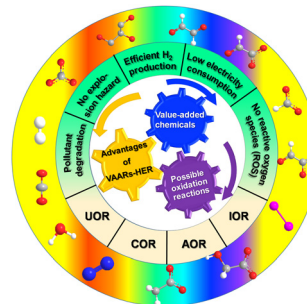
Guangwei She,\* Jingxuan Ma, Xue Hao, Changzhou Ru, Haoyue Zhang, Lixuan Mu, Xiaopeng Qi\* and Wensheng Shi



413

## Electrocatalysts for value-added electrolysis coupled with hydrogen evolution

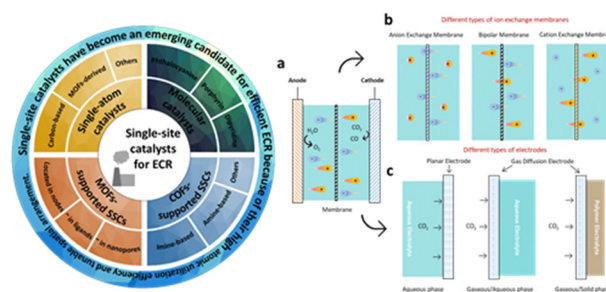
Endalkachew Asefa Moges, Chia-Yu Chang, Meng-Che Tsai,\* Wei-Nien Su\* and Bing Joe Hwang\*



434

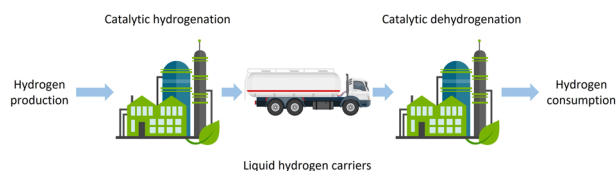
Single-site catalysts for CO<sub>2</sub> electroreduction

Wenzhong Huang, Jiexin Zhu, Shanlin Liu, Wei Zhang, Liang Zhou\* and Liqiang Mai\*



## REVIEWS

459

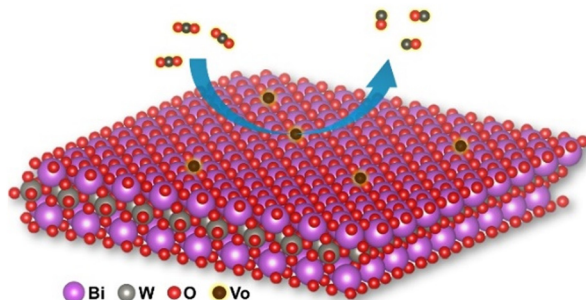


## Catalytic hydrogen storage in liquid hydrogen carriers

Yuwen Ni, Zhe Han,\* Yuchao Chai, Guangjun Wu and Landong Li\*

## COMMUNICATION

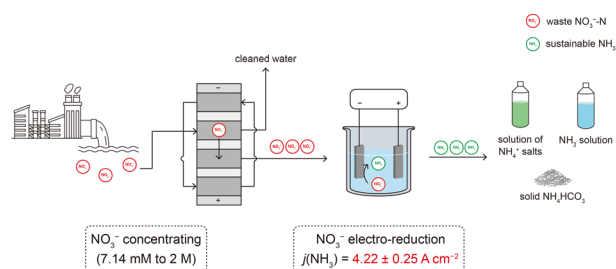
495

*In situ* solvothermal reduction engineering enables delicate control over surface-rich oxygen vacancies on Bi<sub>2</sub>WO<sub>6</sub> for highly efficient photocatalytic CO<sub>2</sub> reduction

Huanhuan Liu, Yanxu Chen, Wentao Wang, Xiaoyue He, Zixu He, Lei Li, Suyuan Zeng, Ruiguo Cao and Genqiang Zhang\*

## PAPERS

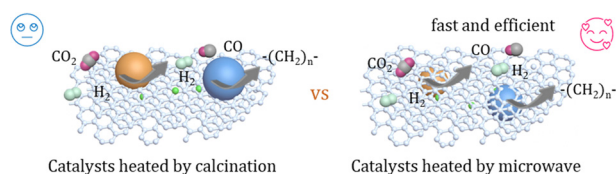
504



## Sustainable waste-nitrogen upcycling enabled by low-concentration nitrate electrodialysis and high-performance ammonia electrosynthesis

Yifu Chen, Pouya Ammari-Azar, Hengzhou Liu, Jungkuk Lee, Yu Xi, Michael J. Castellano, Shuang Gu\* and Wenzhen Li\*

516

Microwave-assisted carbon-confined iron nanoparticles for steering CO<sub>2</sub> hydrogenation to heavy hydrocarbons

Lisheng Guo,\* Peipei Ai, Xinhua Gao, Hao Wu, Xianbiao Wang, Yasuharu Kugue, Jiaming Liang, Weizhe Gao, Xiaoyu Guo, Jian Sun,\* Song Sun\* and Noritatsu Tsubaki\*

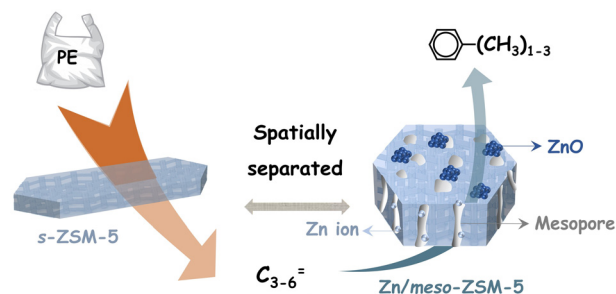


## PAPERS

529

### Selective conversion of polyethylene wastes to methylated aromatics through cascade catalysis

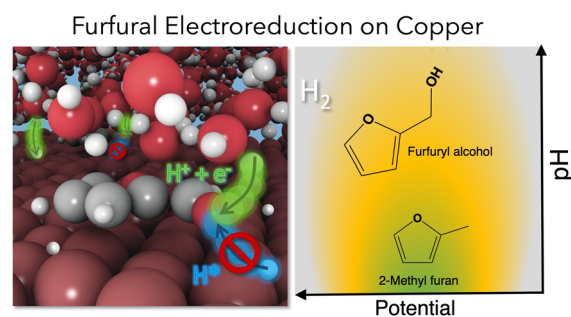
Jindi Duan, Hai Wang, Hangjie Li, Lujie Liu, Kai Fan, Xiangju Meng, Zhiguo Zhang,\* Liang Wang\* and Feng-Shou Xiao\*



539

### Unraveling the reaction mechanisms for furfural electroreduction on copper

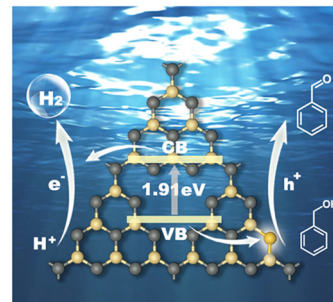
Sihang Liu, Zamaan Mukadam, Soren B. Scott, Saurav Ch. Sarma, Maria-Magdalena Titirici, Karen Chan, Nitish Govindarajan,\* Ifan E. L. Stephens\* and Georg Kastlunger\*



552

### Electron-rich pyrimidine rings enabling crystalline carbon nitride for high-efficiency photocatalytic hydrogen evolution coupled with benzyl alcohol selective oxidation

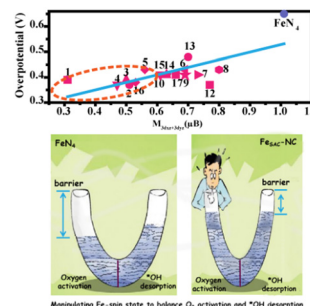
Zhi Lin, Yiqing Wang, Ta Thi Thuy Nga, Jie Zhang, Ruizhe Wang, Zhengqi Zhang, Yufei Xu, Daming Zhao, Chung-Li Dong and Shaohua Shen\*

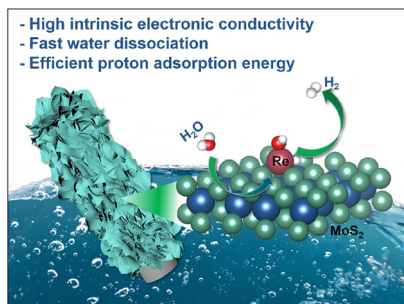


562

### Manipulating the spin state to activate the atomically dispersed Fe–N–C catalyst for oxygen reduction

Fan Liu, Chengxiang Shi, Lun Pan, Zhen-Feng Huang,\* Xiangwen Zhang and Ji-Jun Zou\*





## Single-atomic rhenium-assisted 2H-to-1T phase transformation of MoS<sub>2</sub> nanosheets boosting electrocatalytic hydrogen evolution

Jianmin Yu, Yongteng Qian, Qing Wang, Chenliang Su, Hyoyoung Lee,\* Lu Shang\* and Tierui Zhang\*

