

# Green Chemistry

Cutting-edge research for a greener sustainable future

[rsc.li/greenchem](https://rsc.li/greenchem)

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

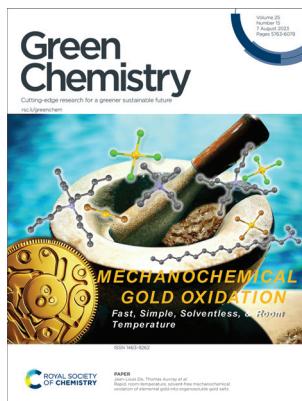
ISSN 1463-9262 CODEN GRCHFJ 25(15) 5763–6078 (2023)



### Cover

See Jun Yue *et al.*,  
pp. 5878–5898.

Image reproduced by  
permission of Jun Yue from  
*Green Chem.*, 2023, **25**,  
5878.



### Inside cover

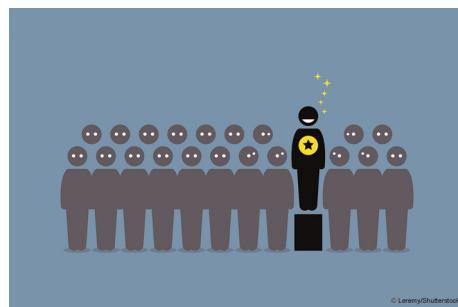
See Jean-Louis Do,  
Thomas Auvray *et al.*,  
pp. 5899–5906.

Image reproduced by  
permission of Thomas Auvray  
from *Green Chem.*, 2023, **25**,  
5899.

## EDITORIAL

5774

Outstanding Reviewers for *Green Chemistry* in  
2022

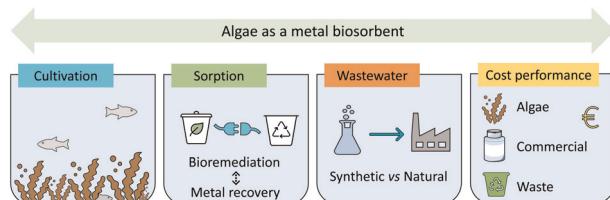


## CRITICAL REVIEWS

5775

**Metal biosorption onto non-living algae: a critical review on metal recovery from wastewater**

Ana R. F. Carreira, Helena Passos\* and  
João A. P. Coutinho



# Green Chemistry

Cutting-edge research for a greener sustainable future

rsc.li/greenchem

*Green Chemistry* focuses on cutting-edge research that attempts to reduce the environmental impact of the chemical enterprise by developing a technology base that is inherently non-toxic to living things and the environment.

## Editorial Board

### Chair

Professor Doctor Javier Pérez-Ramírez, ETH Zurich, Switzerland

### Associate Editors

Professor Aiwen Lei, College of Chemistry and Molecular Sciences, The Institute for Advanced Studies, Wuhan University, P. R. China  
Dr Elsje A. Quadrelli, CNRS and CPE Lyon, France

### Members

Professor André Bardow, ETH Zurich, Switzerland  
Dr François Jérôme, University of Poitiers, France  
Professor Laurel Shafer, The University of British Columbia, Canada  
Dr Helen Sneddon, University of York, UK  
Dr Tao Zhang, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China

## Advisory Board

### Paul Anastas, Yale University, USA

Isabel Arends, TU Delft, The Netherlands

Gregg Beckham, NREL, USA

Asim Bhaumik, Indian Association for the Cultivation of Science, India

Fabrizio Cavani, University of Bologna, Italy  
Yonas Chebude, Addis Ababa University, Ethiopia

James Clark, University of York, UK

Avelino Corma, Universidad Politécnica de Valencia, Spain

Robert H Crabtree, Yale University, USA

Paul Dauenhauer, University of Minnesota, USA

Pierre Dixneuf, University of Rennes, France  
James Dumesic, University of Wisconsin-Madison, USA

Peter Dunn, Pfizer, UK

Martin Eastgate, Bristol Myers Squibb, USA  
Karen Goldberg, University of Washington, USA

Buxing Han, Chinese Academy of Sciences, China  
Mark Harmer, SAC Technologies, USA

Milton Hearn, Monash University, Australia  
Steve Howdle, Nottingham University, UK

Andrew J. Hunt, Kohn Kaen University, UK

### Thailand

Graham Hutchings, Cardiff University, UK

Philip Jessop, Queen's University, Canada

C. Oliver Kappe, University of Graz, Austria  
Shu Kobayashi, University of Tokyo, Japan

Mihkel Koel, Tallinn University of Technology, Estonia

Burkhard Koenig, University of Regensburg, Germany

Michael Kopach, Eli Lilly and Company, USA  
Dhireep Krishnamurthy, Jubilant Ingrevia Limited, India

Walter Leitner, RWTH Aachen University, Germany

Chao-Jun Li, McGill University, Canada

Bruce Lipshutz, University of California, USA  
Rafael Luque, University of Cordoba, Spain

Doug MacFarlane, Monash University, Australia

Tomoo Mizugaki, Osaka University, Japan  
Regina Palkovits, RWTH Aachen, Germany

Alvise Perosa, Università Ca' Foscari, Italy  
Martina Peters, Bayer AG, Germany

Martyn Poliakoff, University of Nottingham, UK

Colin Raston, Flinders University, Australia

Roberto Rinaldi, Imperial College London, UK

Robin D. Rogers, McGill University, Canada  
Gadi Rothenberg, University of Amsterdam, The Netherlands

Susannah Scott, University of California, USA  
Roger Sheldon, Delft University of Technology, The Netherlands

Christian Stevens, Ghent University, Belgium  
Natalia Tarasova, Mendeleev University of Chemical Technology, Russia

Rajender Varma, US Environmental Protection Agency, USA

Peter Wasserscheid, Friedrich-Alexander Universität Erlangen-Nürnberg, Germany

Tom Welton, Imperial College London, UK  
Kevin C. W. Wu, National Taiwan University, Taiwan

Ganapati D. Yadav, Institute of Chemical Technology, India

Hisao Yoshida, Kyoto University, Japan  
Suojiang Zhang, Institute of Process Engineering, Chinese Academy of Sciences, China

Julie Zimmerman, Yale University, USA  
Vânia Zuin, Federal University of São Carlos, Brazil

## Information for Authors

Full details on how to submit material for publication in *Green Chemistry* 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/greenchem

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

## Editorial Staff

### Executive Editor

Michael A. Rowan

### Deputy Editor

Vikki Pritchard

### Development Editors

Bee Hockin, Andrea Carolina Ojeda Porras

### Editorial Production Manager

Gisela Scott

### Publisher

Jeanne Andres

### Senior Publishing Editor

Robin Brabham

### Publishing Editors

Catherine Au, Isabel Darlington, Konoya Das, Alexandre Dumon, Amy Lucas, Kieran Nicholson, Rini Prakash, Charlotte Pugsley, Hugh Ryan

### Editorial Assistant

Daphne Houston

### Publishing Assistant

Robert Griffiths

For queries about submitted articles please contact Gisela Scott, Editorial Production Manager, in the first instance. E-mail [green@rsc.org](mailto:green@rsc.org)

For pre-submission queries please contact Michael A. Rowan, Executive Editor. E-mail [green-rsc@rsc.org](mailto:green-rsc@rsc.org)

Green Chemistry electronic:  
ISSN 1463-9270 is published 24 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, CB4 0WF, UK.

All orders, with cheques made payable to the Royal Society of Chemistry, should be sent to the 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)

2023 Annual electronic subscription price: £2578; US\$4544. Customers in Canada will be subject to a surcharge to cover GST. Customers in the EU subscribing to the electronic version only will be charged VAT.

If you take an institutional subscription to any Royal Society of Chemistry journal you are entitled to free, site-wide web access to that journal. You can arrange access via Internet Protocol (IP) address at [www.rsc.org/ip](http://www.rsc.org/ip)

Customers should make payments by cheque in sterling payable on a UK clearing bank or in US dollars payable on a US clearing bank.

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)

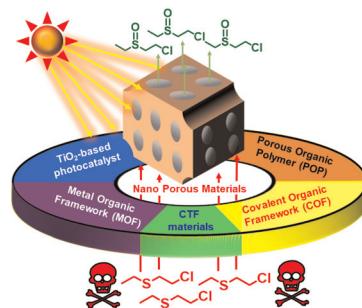


## CRITICAL REVIEWS

5789

**A critical review on emerging photoactive porous materials for sulfide oxidation and sulfur mustard decontamination**

Priyanka Kalita, Ratul Paul, Ankita Boruah, Duy Quang Dao, Asim Bhaumik\* and John Mondal\*

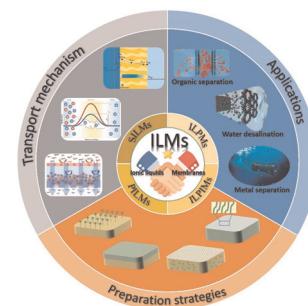


## TUTORIAL REVIEWS

5813

**Ionic liquids membranes for liquid separation: status and challenges**

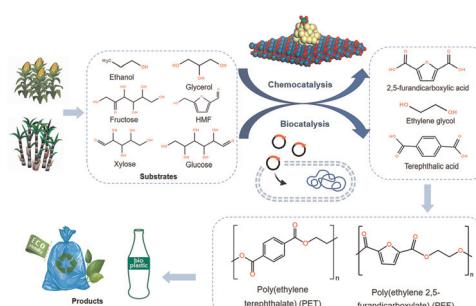
Shangqing Chen,\* Yanan Dong, Jingjing Sun, Peng Gu, Junfeng Wang\* and Suojiang Zhang



5836

**Progress in the biosynthesis of bio-based PET and PEF polyester monomers**

Yanan Cui, Chen Deng, Liqiang Fan, Yongjun Qiu and Liming Zhao\*

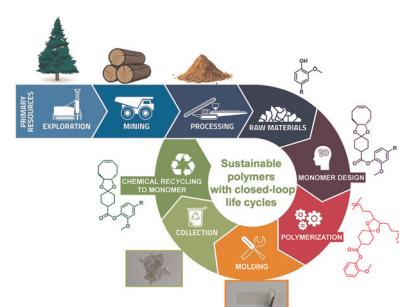


## COMMUNICATIONS

5858

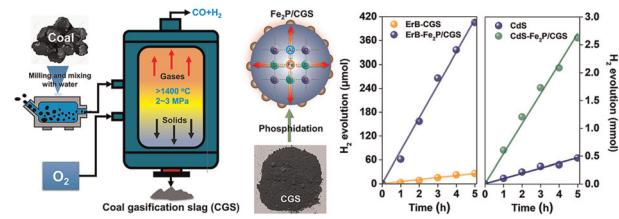
**Closed-loop recycling of lignin-based sustainable polymers with an all-hydrocarbon backbone**

Yuan Hu, Qiyi Ran, Siping Wei, Chengcheng Wang, Zhijing Wu, Enhua Xu, Zhenyang Luo, Puyou Jia\* and Ye Sha\*



## COMMUNICATIONS

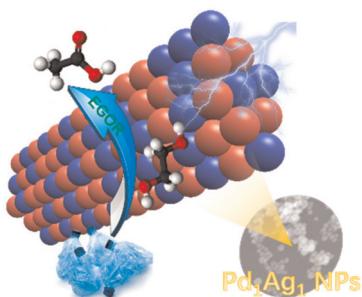
5865



### Upcycling endogenous Fe from coal gasification slag waste into a cocatalyst for the photocatalytic $H_2$ evolution reaction

Fang Wang, Kailu Li, Alkut Anwar, Zhengguo Zhang, Weibing Xu\* and Shixiong Min\*

5872

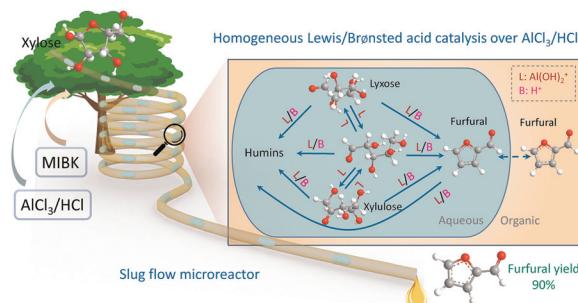


### Selective electro-reforming of waste polyethylene terephthalate-derived ethylene glycol into $C_2$ chemicals with long-term stability

Yuxiang Wang, Kesheng Liu, Fulai Liu, Chuxuan Liu, Rui Shi\* and Yong Chen\*

## PAPERS

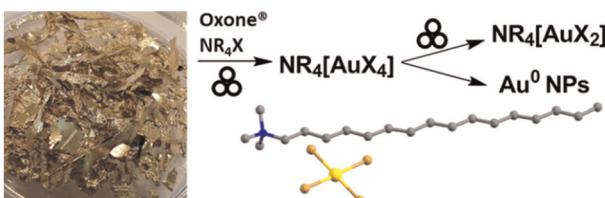
5878



### Insights into the reaction network and kinetics of xylose conversion over combined Lewis/Brønsted acid catalysts in a flow microreactor

Wenze Guo, Herman Carolus Bruining, Hero Jan Heeres and Jun Yue\*

5899



### Rapid, room-temperature, solvent-free mechanochemical oxidation of elemental gold into organosoluble gold salts

Jean-Louis Do, Thomas Auvray, Cameron B. Lennox, Hatem M. Titi, Louis A. Cuccia and Tomislav Friščić\*

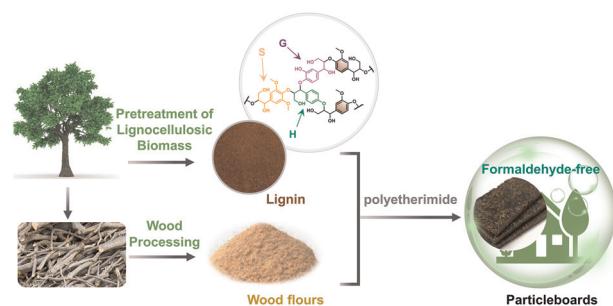


## PAPERS

5907

**A facile strategy to fabricate a lignin-based thermoset alternative to formaldehyde-based wood adhesives**

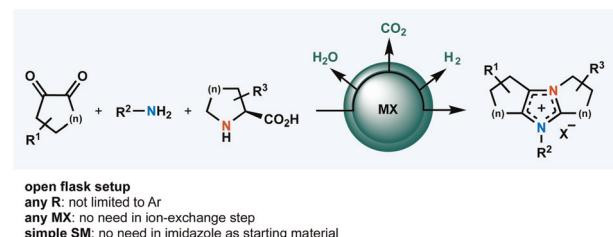
Xiaoyu Shi, Shishuai Gao, Can Jin, Daihui Zhang,\* Chenhuan Lai,\* Chunpeng Wang, Fuxiang Chu, Arthur J. Ragauskas and Mi Li\*



5916

**Direct access to polycyclic imidazolium salts via decarboxylative condensation of  $\alpha$ -enaminones with proline**

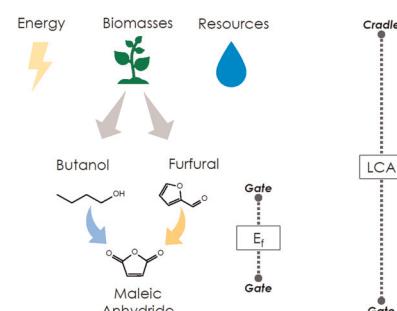
Yuval Simha, Gil Daniels, Amalya Goldman, Eliyah Kuniavsky and Dmitry Tsvetikhovsky\*



5922

**Maleic anhydride from bio-based 1-butanol and furfural: a life cycle assessment at the pilot scale**

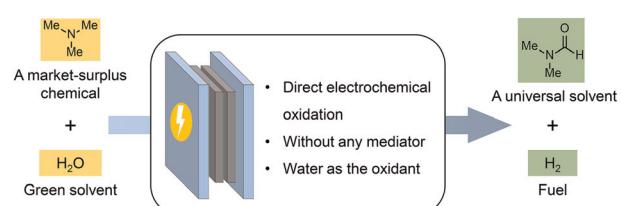
Raffaele Cucciniello, Daniele Cespi,\* Matteo Riccardi, Elena Neri, Fabrizio Passarini and Federico Maria Pulselli



5936

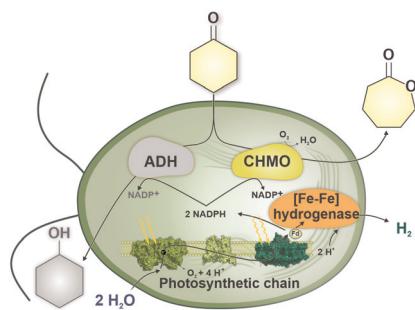
**Electrosynthesis of *N,N*-dimethylformamide from market-surplus trimethylamine coupled with hydrogen production**

Meng Jin, An-Zhen Li, Ye Wang, Jing Li, Hua Zhou, Bi-Jie Li\* and Haohong Duan\*



## PAPERS

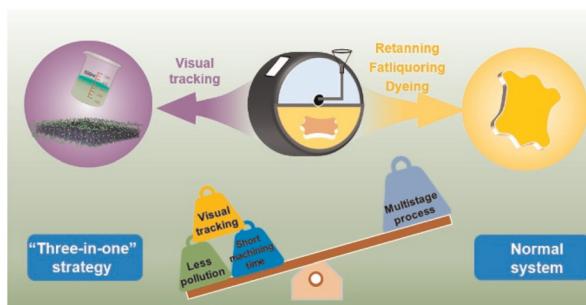
5945



**Engineered green alga *Chlamydomonas reinhardtii* as a whole-cell photosynthetic biocatalyst for stepwise photoproduction of H<sub>2</sub> and ε-caprolactone**

Vilja Siitonen, Anna Probst, Gábor Tóth, Robert Kourist, Michael Schröda, Sergey Kosourov and Yagut Allahverdiyeva\*<sup>\*</sup>

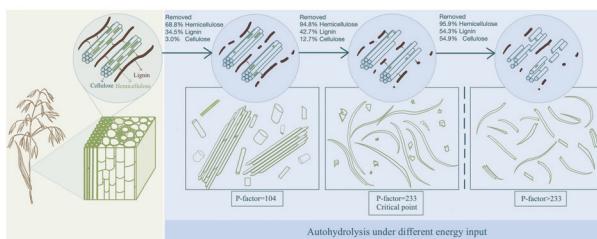
5956



**A “three-in-one” strategy based on an on-demand multifunctional fluorescent amphoteric polymer for ecological leather manufacturing: a disruptive wet-finishing technique**

Chao Wei, Xuechuan Wang,\* Siwei Sun, Qiangqiang Lu, Xiaoliang Zou, Long Xie, Peiyao Huo, Dongyan Hao and Xinhua Liu\*

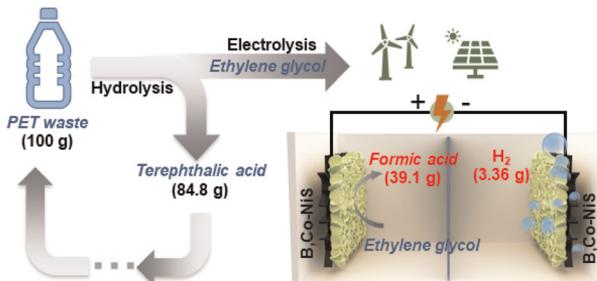
5968



**Effect and control of energy input on tissue and cell dissociation and chemical depolymerization in pure subcritical water autohydrolysis of naked oat stem**

Jiahui Wei, Haonan Zhang, Shengcheng Zhai, Hao Ren\* and Huamin Zhai

5979



**Defective nickel sulfide hierarchical structures for efficient electrochemical conversion of plastic waste to value-added chemicals and hydrogen fuel**

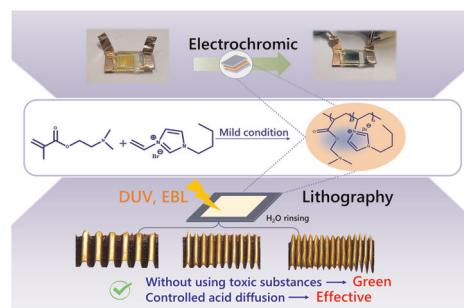
Zhijie Chen, Wei Wei, Yansong Shen and Bing-Jie Ni\*

## PAPERS

5989

## Towards environmentally friendly processing of ionic liquid-based photoresists with a boosted lithography performance

Leifei Liu, Kuntong Song, Tong Feng, Ting Song, Jintong Li, Shangqing Chen, Weizhen Zhao\* and Suojiang Zhang\*



5999

## NH<sub>3</sub> production from absorbed NO with synergistic catalysis of Pd/C and functionalized ionic liquids

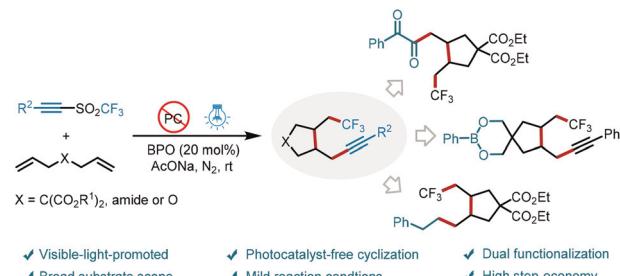
Yuanyuan Zhang, Wanxiang Zhang, Yan Wang, Shuhang Ren, Yucui Hou and Weize Wu\*



6009

## Visible-light-induced photocatalyst-free activation of alkynyl triflones for trifluoromethylalkynylation of unactivated 1,6-dialkenes

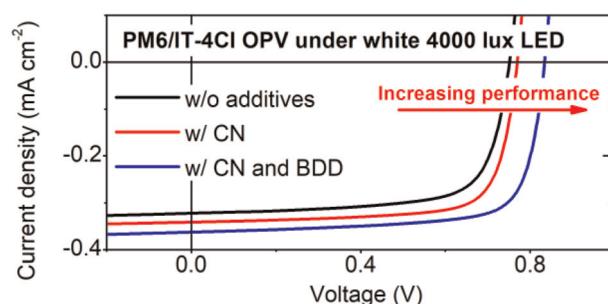
Yong-Hao Li, An-Xiang Huang, Fu-Yi Zhang, Kai Sun\* and Bing Yu\*



6014

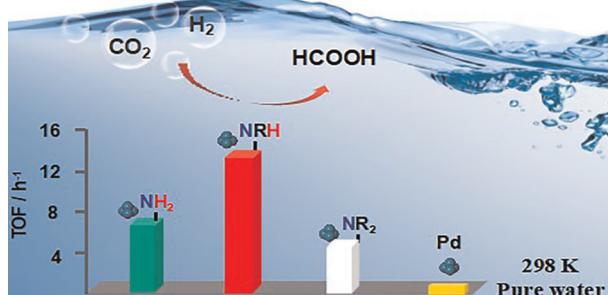
## Voltage losses in indoor light harvesting organic photovoltaic devices: a case study of green solvent processed PM6/IT-4Cl devices

Xuyan Man, Jing Wang, Deping Qian,\* Mengyang Li, Hailin Pan, Zheng Li, Ming Wang,\* Zheng Tang\* and Zaifei Ma\*



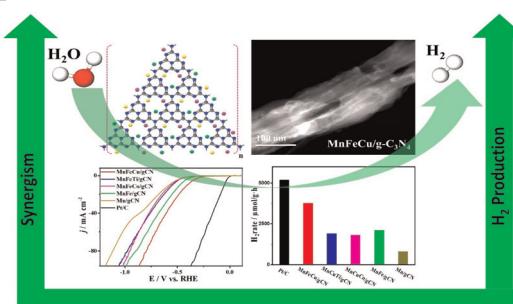
## PAPERS

6025


**Additive-free  $\text{CO}_2$  hydrogenation to pure formic acid solution via amine-modified Pd catalyst at room temperature**

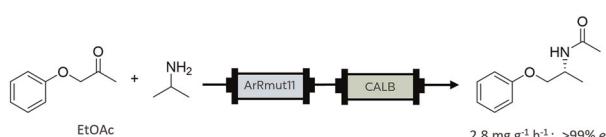
Shuchao Jiang, Xiaokong Liu, Shengliang Zhai, Xiuqin Ci, Tie Yu, Lei Sun, Dong Zhai,\* Weiqiao Deng and Guoqing Ren\*

6032


**Synergistically interactive MnFeM (M = Cu, Ti, and Co) sites doped porous  $\text{g-C}_3\text{N}_4$  fiber-like nano-structures for an enhanced green hydrogen production**

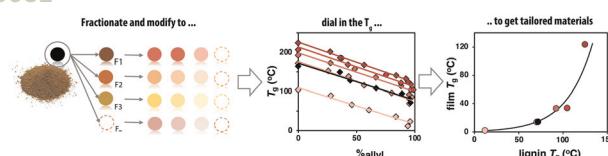
Belal Salah, Ahmed Abdelgawad, Qingqing Lu, Adewale K. Ipadeola, Rafael Luque and Kamel Eid\*

6041


**Development of an amine transaminase-lipase cascade for chiral amide synthesis under flow conditions**

Antía Pintor, Ashley P. Matthey, Iván Lavandera, Vicente Gotor-Fernández\* and Alexey Volkov\*

6051


**Expanding lignin thermal property space by fractionation and covalent modification**

Luke A. Riddell, Floris J. P. A. Enthoven, Jean-Pierre B. Lindner, Florian Meirer and Pieter C. A. Bruijnincx\*



## PAPERS

6057

**Molten salt infiltration–oxidation synergistic controlled lithium extraction from spent lithium iron phosphate batteries: an efficient, acid free, and closed-loop strategy**

Jiafeng Zhang, Jingtian Zou, Di He,\* Wenyang Hu, Dezhao Peng, Yong Li, Zaowen Zhao, Shubin Wang, Pengfei Li, Shilin Su, Keyi Ma and Xiaowei Wang\*



6067

**Aromatic long chain cations of amphiphilic ionic liquids permeabilise the inner mitochondrial membrane and induce mitochondrial dysfunction at cytotoxic concentrations**

Meryem-Nur Duman, Alexander Angeloski, Michael S. Johnson and Tristan Rawling\*

