

# Green Chemistry

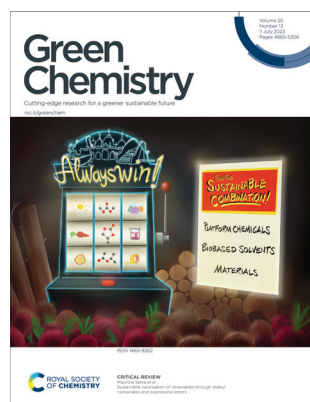
Cutting-edge research for a greener sustainable future

[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(13) 4865–5306 (2023)



**Cover**  
See Maurizio Selva *et al.*,  
pp. 4878–4911.

Image reproduced  
by permission of  
Davide Brunelli, Giulia Fiorani,  
Alvise Perosa, Maurizio Selva  
from *Green Chem.*,  
2023, **25**, 4878.

Artwork by  
Professor Giulia Fiorani and  
Mr Davide Brunelli.



**Inside cover**  
See Mei Cui,  
Rongxin Su *et al.*,  
pp. 5041–5050.

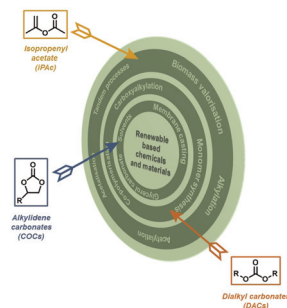
Image reproduced  
by permission of  
Mei Cui from  
*Green Chem.*,  
2023, **25**, 5041.

## CRITICAL REVIEWS

4878

### Sustainable valorisation of renewables through dialkyl carbonates and isopropenyl esters

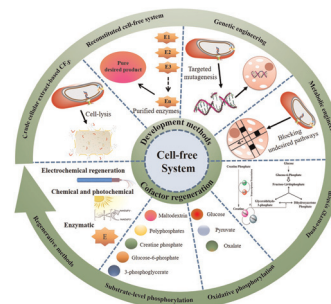
Giulia Fiorani, Alvise Perosa and Maurizio Selva\*



4912

### Cell-free systems for biosynthesis: towards a sustainable and economical approach

Muhammad Wajid Ullah, Sehrish Manan, Mazhar Ul-Islam, Waleed Ahmad Khattak, Khalid Ali Khan, Jun Liu, Guang Yang\* and Jianzhong Sun\*



## 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, Isobel Darlington, Konoya Das, Alexandre Dumon, Amy Lucas, Kieran Nicholson, 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)

# Green Chemistry

Cutting-edge research for a greener sustainable future

[rsc.li/greenchem](http://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 Elsie A. Quadrelli, CNRS and CPE Lyon,

France

Professor Magdalena Titirici, Imperial College

London, UK

Dr Keiichi Tomishige, Tohoku University,

Japan

### Members

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, Khon Kaen University,

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

Limited, India

Dhileep 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](http://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

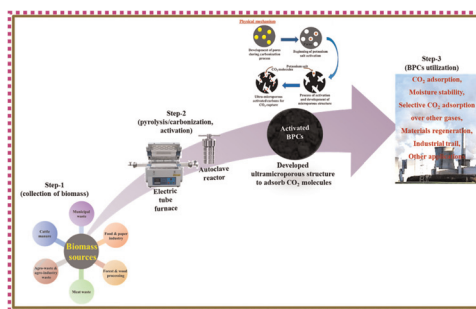


## CRITICAL REVIEWS

4941

### Towards a sustainable conversion of biomass/biowaste to porous carbons for CO<sub>2</sub> adsorption: recent advances, current challenges, and future directions

Ghazanfar Nazir,\* Adeela Rehman,\* Sajjad Hussain, Qasim Mahmood, Mehdi Fteiti, Kwang Heo, Muhammad Ikram and Muhammad Aizaz Ud Din

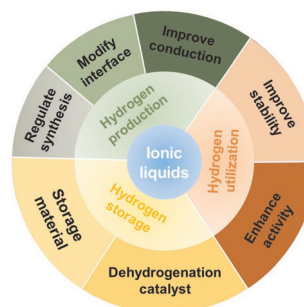


## TUTORIAL REVIEWS

4981

### Ionic liquids as a new cornerstone to support hydrogen energy

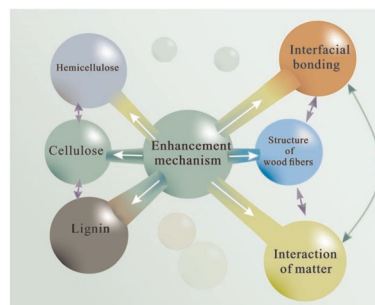
Yanrong Liu, Jiayao Cui, Hao Wang, Ke Wang, Yuan Tian, Xiaoyi Xue, Yueyang Qiao, Xiaoyan Ji and Suojiang Zhang\*



4995

### Lignin-enhanced wet strength of cellulose-based materials: a sustainable approach

Haohe Huang, Chenglong Xu, Xuhao Zhu, Bo Li and Chongxing Huang\*

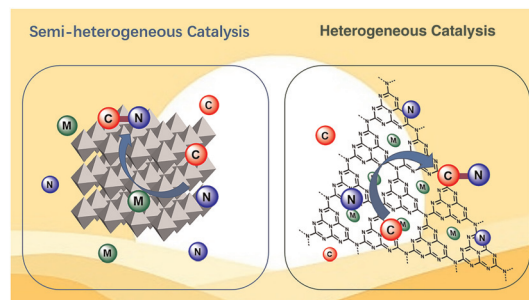


## PERSPECTIVE

5010

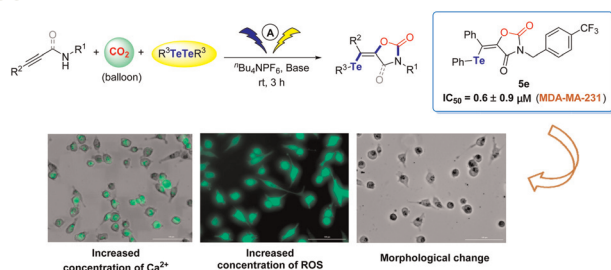
### Recent advances in the heterogeneous photochemical synthesis of C–N bonds

Jinming Wang, Yichang Liu, Xupeng Zong, Aiwen Lei\* and Zaicheng Sun\*



## COMMUNICATIONS

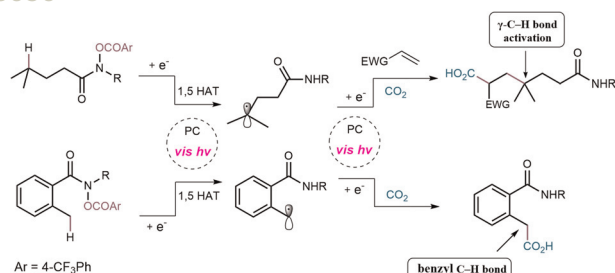
5024



### Electrocatalytic three-component reactions: synthesis of tellurium-containing oxazolidinone for anticancer agents

Xue-Qi Zhou, Hai-Tao Tang, Fei-Hu Cui,\* Ying Liang,\*  
Shu-Hui Li and Ying-Ming Pan\*

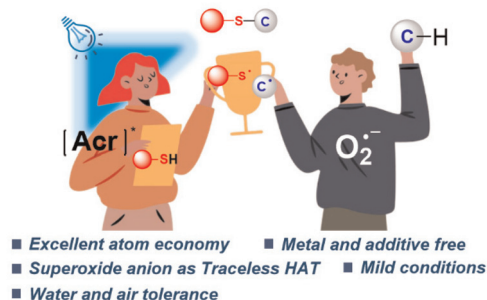
5030



### Photocarboxylation of remote C–H bonds through nitrogen-centred radical 1,5-hydrogen atom transfer

Wenke Li, Beiqi Sun, Lei Zhang and Fanyang Mo\*

5035

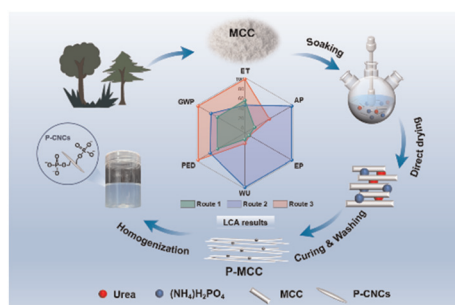


### Visible light-induced $\text{C}(\text{sp}^3)\text{--S}$ bond formation

Gongbo Liu, Nan Zheng,\* Xuelun Duan, Xinhao Sun and Wangze Song\*

## PAPERS

5041



### Pre-phosphorylation for facile production of phosphorylated cellulose nanocrystals with high charge content: an optimised design and life cycle assessment

Xue Gao, Lei Zhang, Mei Cui,\* Renliang Huang, Wei Qi and Rongxin Su\*

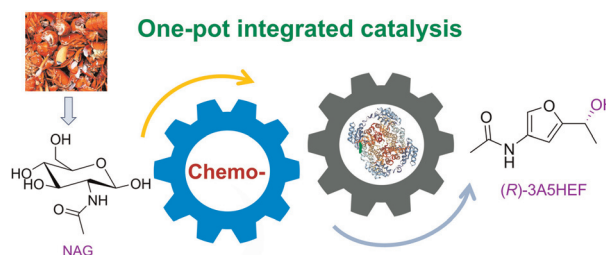


## PAPERS

5051

### Engineering carbonyl reductase for one-pot chemobiocatalytic enantioselective synthesis of a value-added N-containing chiral alcohol from *N*-acetyl-D-glucosamine

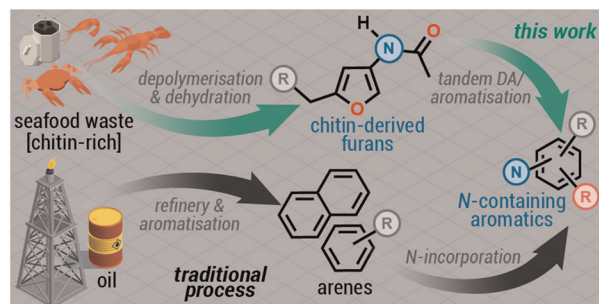
Ya-Cheng Hao, Min-Hua Zong, Qi Chen\* and Ning Li\*



5059

### Nitrogenated aromatics from chitin

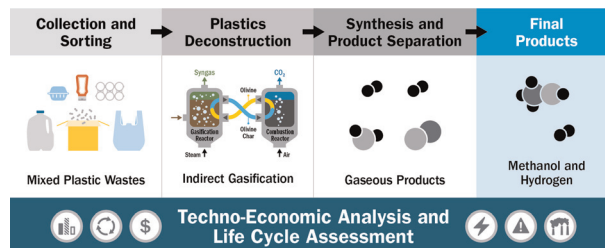
Camila Souza Santos, Renan Rodini Mattioli, Julia Soares Baptista, Vitor H. Menezes da Silva, Duncan L. Browne and Julio Cezar Pastre\*



5068

### Techno-economic analysis and life cycle assessment of mixed plastic waste gasification for production of methanol and hydrogen

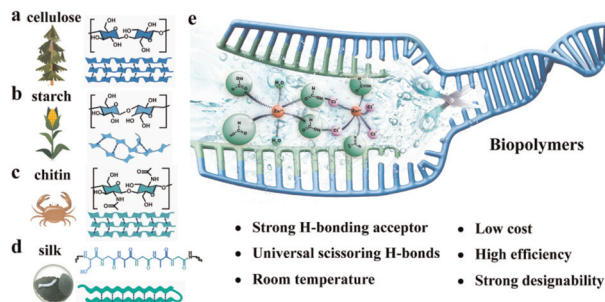
Shaik Afzal, Avantika Singh,\* Scott R. Nicholson, Taylor Uekert, Jason S. DesVeaux, Eric C. D. Tan, Abhijit Dutta, Alberta C. Carpenter, Robert M. Baldwin and Gregg T. Beckham\*



5086

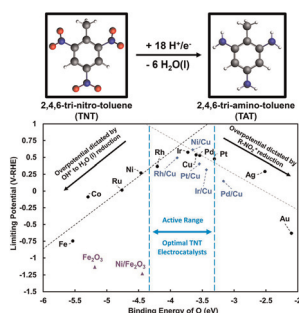
### A room temperature dissolution solvent and its mechanism for natural biopolymers: hydrogen bonding interaction investigation

Zhihan Tong, Suqing Zeng, Hongying Tang, Wen Wang, Yaxu Sun, Qinqin Xia\* and Haipeng Yu\*





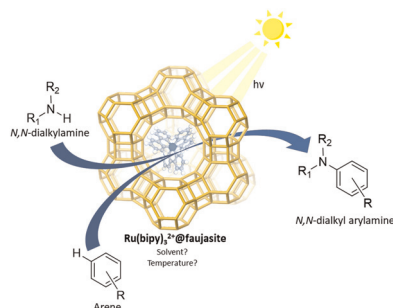
5097



## Investigating the electrocatalytic reduction of 2,4,6-tri-nitro-toluene (TNT) using density functional theory methods

Andrew Jark-Wah Wong, Joshua Lee Miller, Brandon Perdue and Michael John Janik\*

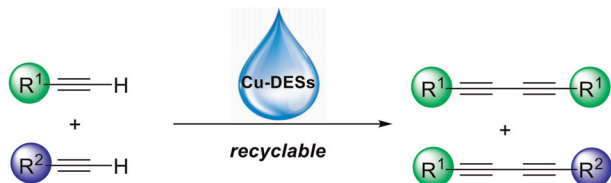
5113



## A direct pathway for the coupling of arenes and alkylamines via a heterogeneous zeolite-based photocatalyst

Vincent Lemmens, Kwinten Janssens, Jorge Gascon and Dirk E. De Vos\*

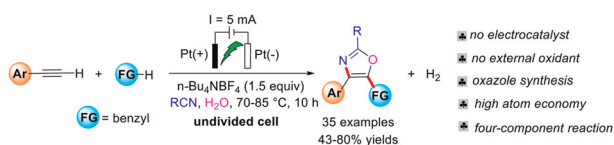
5123



## Cu-Based ternary deep eutectic solvents for homo- and cross-coupling reactions of terminal alkynes

Weixu Lu, Xiaoqiang Yu\* and Ming Bao

5128



## Electrochemical oxidation-induced benzylic C(sp<sup>3</sup>)-H functionalization towards the atom-economic synthesis of oxazole heterocycles

Na Yang, Anni Li, Hui Gao, Li-Mei Liao, Yu-Ping Yang, Pei-Long Wang\* and Hongji Li\*

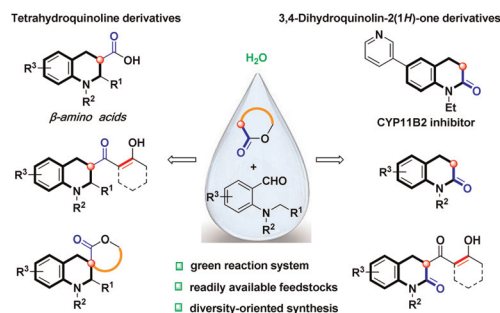


## PAPERS

5134

Divergent synthesis of nitrogen heterocycles via H<sub>2</sub>O-mediated hydride transfer reactions

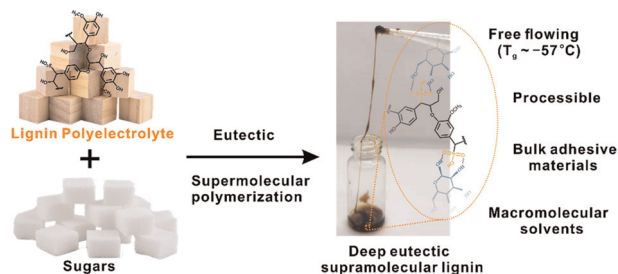
Fangzhi Hu, Zhipeng Sun, Mengzhe Pan, Liang Wang, Lubin Xu, Xiong-Li Liu and Shuai-Shuai Li\*



5142

Fluidic lignin with ultra-low glass transition temperature ( $T_g < -57^\circ\text{C}$ ): a versatile polyelectrolyte solvent platform

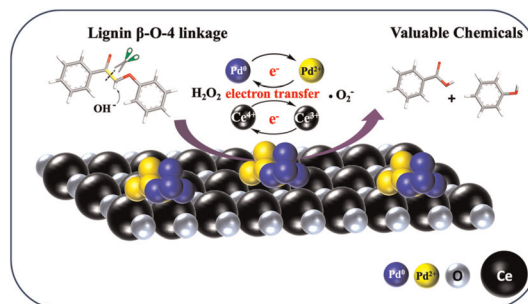
Qiaoling Liu, Yang Wang, Hairong Wang, Zhenhua Su, Xiang Hao\* and Feng Peng\*



5150

## Selective C–C bond cleavage of oxidized lignin in an aqueous phase under mild conditions

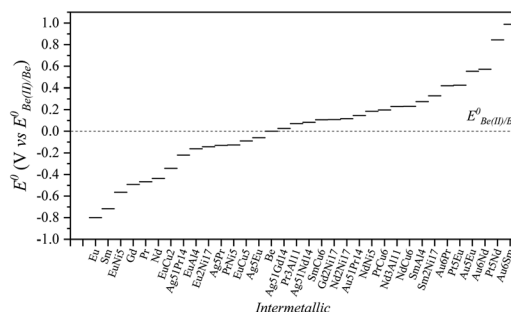
Yuzhen Hu, Yanbin Cui, Shuoxiao Zhao, Xuelai Zhao, Xiaohong Hu, Zhenlong Song, Wei Fan\* and Qi Zhang\*



5160

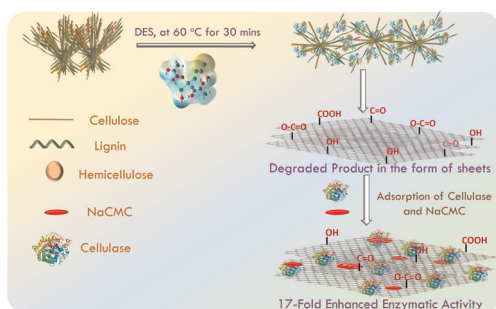
Evaluation of noble metals as reactive electrodes for separation of lanthanides from molten LiF–BeF<sub>2</sub>

Yong Zuo, Chang-Feng She, Feng Jiang, Wei Huang\* and Yu Gong



## PAPERS

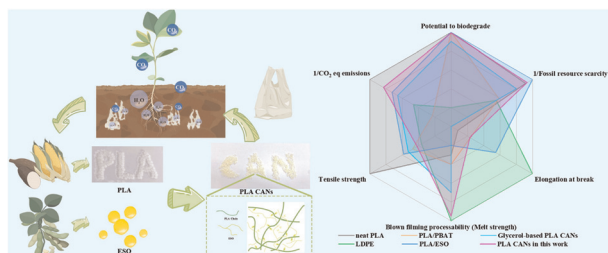
5172



### Sustainable preparation of oxidized graphitic material from wheat straw using a deep eutectic solvent for superactivity of cellulase

Harmandeep Kaur, Manpreet Singh, Kuldeep Singh, Arvind Kumar and Tejwant Singh Kang\*

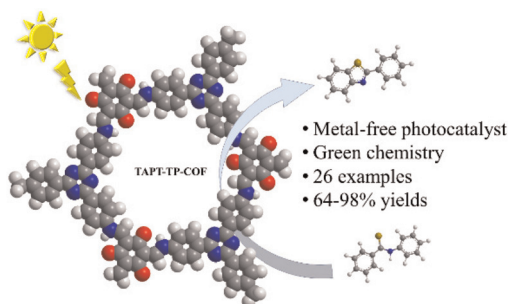
5182



### Blowing tough polylactide film enabled by the *in situ* construction of covalent adaptive networks with epoxidized soybean oil as dynamic crosslinks

Yong-Bo Liu, Zhao Xu, Zheng-Min Zhang, Rui-Ying Bao, \* Ming-Bo Yang and Wei Yang\*

5195



### A $\beta$ -ketoenamine-linked covalent organic framework as a heterogeneous photocatalyst for the synthesis of 2-arylbenzothiazoles by cyclization reaction

Ziqi Liu, Zhicheng Chen, Huixin Tong, Mengmeng Ji and Wenyi Chu\*

5206



### Heterogeneous visible-light promoted dehydrogenative [4 + 2] annulation of benzothioamides and alkynes under aerobic conditions

Yanmin Guo, Rong Chang, Zhen Fu, Cong-Ying Zhou\* and Zhen Guo\*



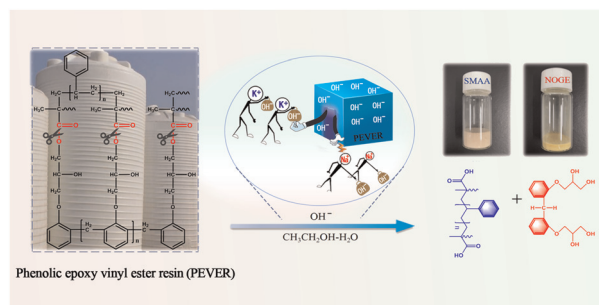


## PAPERS

5213

### Affinity of $K^+$ to organic matter promotes reactions: degradation of super stable phenolic epoxy vinyl ester resin to value-added chemicals

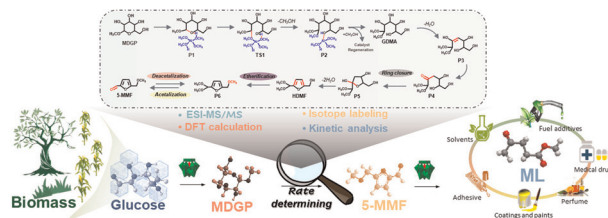
Weijie Wang, Ning Zhang, Chizhou Wang, Hongyan Li, Shiyu Jia, Yongqin Qi, Houhai Fan, Xiaojing Cui,\* Xianglin Hou\* and Tiansheng Deng\*



5222

### Understanding the mechanism of enhanced alcoholysis of biomass carbohydrates to alkyl levulinates over bifunctional catalysts: does it resemble that in water?

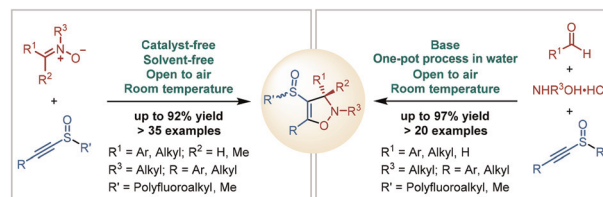
Yuxuan Zhang, Zhaoyang Ju, Xueli Chen, Qian Lyu, Jiaqi Mei, Lujia Han, Dong Liu and Weihua Xiao\*



5233

### Facile synthesis of (polyfluoro)alkanesulfinyl 4-isoxazolines: a stepwise solvent- and catalyst-free approach or a one-pot process in water

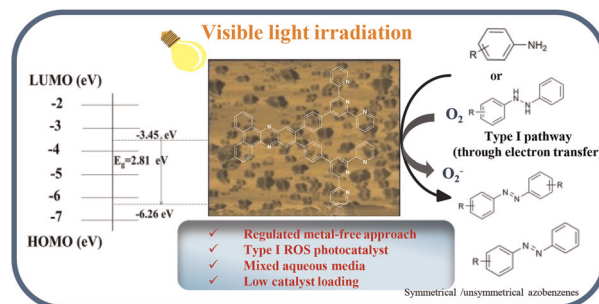
Tian-Ming Liao, Wen-Jiang Ma, Yu-Ning Gao, Ming Bian, Min Jiang, Jin-Tao Liu, Hui-Yu Chen\* and Zhen-Jiang Liu\*



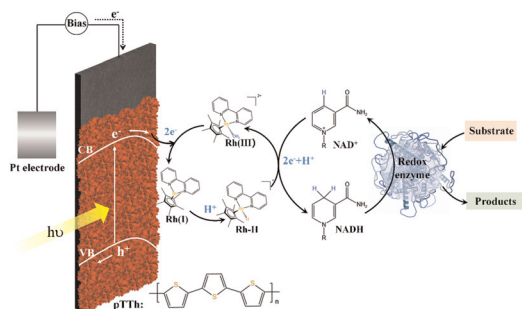
5240

### Type I strong acceptor–weak acceptor photosensitizing assemblies for the regulated aerobic oxidative coupling of anilines

Lovjot Kaur, Manoj Kumar and Vandana Bhalla\*



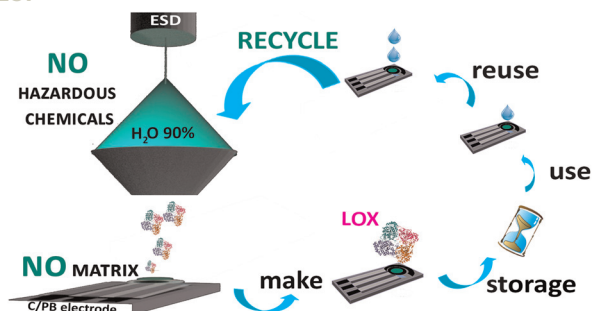
5247



### Photoelectrochemical NADH regeneration on a polymer semiconductor-based photocathode

Nanxin Li, Jia You, Lanlan Huang, Haoran Zhang, Xianlong Wang, Lihua He, Shiwei Lin,\* Bingging Zhang\* and Chunli Gong

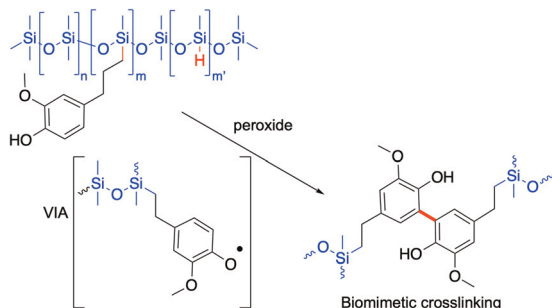
5257



### Improved reuse and storage performances at room temperature of a new environmentally friendly lactate oxidase biosensor prepared by ambient electrospray immobilization

Mattea Carmen Castrovilli,\* Viviana Scognamiglio, Emanuela Tempesta, Jacopo Chiarinelli, Mariantonietta Parracino, Valeria Frisulli, Maria Teresa Giardi, Lorenzo Avaldi, Danae Rossi and Antonella Cartoni

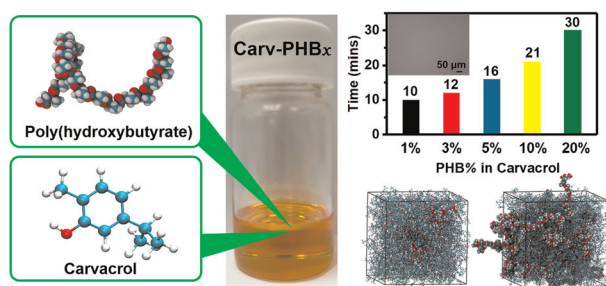
5267



### Learning from the trees: biomimetic crosslinking of silicones by phenolic coupling

Angela Yayun Li, Miguel Melendez-Zamudio, Akop Yepremyan and Michael A. Brook\*

5276



### Rapid dissolution of high concentration poly(3-hydroxybutyrate) using neoteric biosolvents: experiment and molecular dynamics simulation

Joseph Kinyanjui Muiruri, Jayven Chee Chuan Yeo, Tang Yuanting Karen, Ke Li, Enyi Ye, Xian Jun Loh\* and Zibiao Li\*

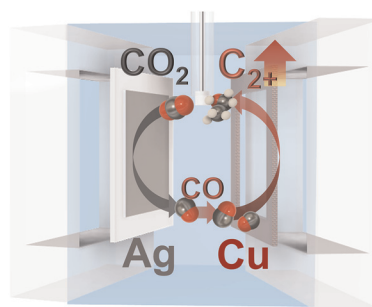


## PAPERS

5290

**Bipotentiostatic tandem electrocatalysis of the CO<sub>2</sub> reduction reaction yielding C<sub>2+</sub> fuels**

Joo Yeon Kim, Yeonsu Kim, C. Hyun Ryu and Hyun S. Ahn\*



5296

**An efficient biocatalytic oxidative dehydroaromatization approach for the construction of quinolines enabled by monoamine oxidase with molecular oxygen**

Huanhuan Jin, Shuyun Ju,\* Haoran Yu, Lirong Yang, Wenlong Zheng and Jianping Wu\*

