

# Chem Soc Rev

Chemical Society Reviews

rsc.li/chem-soc-rev

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 0306-0012 CODEN CSRVBR 52(17) 5805-6222 (2023)



### Cover

See Xi Kang, Manzhou Zhu *et al.*, pp. 5892–5967.

Image reproduced by permission of Xi Kang from *Chem. Soc. Rev.*, 2023, 52, 5892.



### Inside cover

See Bintian Zhang, Longhua Tang *et al.*, pp. 5968–6002.

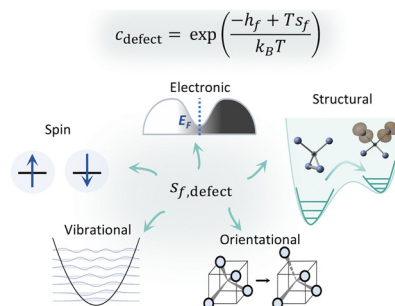
Image reproduced by permission of Longhua Tang from *Chem. Soc. Rev.*, 2023, 52, 5968.

## TUTORIAL REVIEWS

5812

### Imperfections are not 0 K: free energy of point defects in crystals

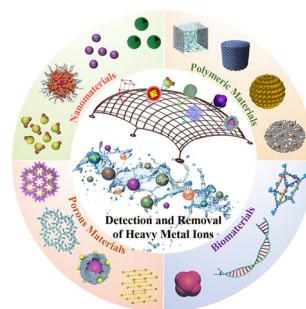
Irea Mosquera-Lois, Seán R. Kavanagh, Johan Klarbring, Kasper Tolborg and Aron Walsh\*



5827

### Current trends in the detection and removal of heavy metal ions using functional materials

Meng Li,\* Quanyu Shi, Ningxin Song, Yumeng Xiao, Lidong Wang, Zhijun Chen\* and Tony D. James\*



## Editorial Staff

### Executive Editor

Richard Kelly

### Deputy Editor

Harriet Riley

### Editorial Production Manager

Helen Saxton

### Development Editors

Danny Andrews, Ershad Abubacker

### Senior Publishing Editor

Becky Webb

### Publishing Editors

Kirstine Anderson, Matthew Bown, Laura Cooper, Hannah Fielding, Clare Fitzgerald, Anoushka Handa, Claire Harding, Alan Holder, Charlie Palmer, Rosie Rothwell, Donna Smith, Laura Smith

### Editorial Assistant

Jade Holliday

### Publishing Assistant

Natalie Ford

### Publisher

Jeanne Andres

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

For pre-submission queries, please contact Richard Kelly, Executive Editor.

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

Chemical Society Reviews (print: ISSN 0306-0012; electronic: ISSN 1460-4744) is published 24 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WF.

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: £1,259; US\$1997. 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)

# Chem Soc Rev

Chemical Society Reviews

[rsc.li/chem-soc-rev](http://rsc.li/chem-soc-rev)

Chemical Society Reviews publishes accessible, succinct and reader-friendly articles on topics of current interest in the chemical sciences. The promotion of international and multidisciplinary awareness and cooperation is particularly encouraged. Chemical Society Reviews publishes three article types: tutorial reviews, which present an accessible introduction to the topic; review articles, which provide a deeper evaluation of the current literature; and Viewpoints, which are short, opinion-based articles

## Editorial Board

### Chair

Jennifer Love, University of Calgary

### Associate Editors

Xian-He Bu, Nankai University of China  
Louise Berben, University of California Davis  
Rebecca Goss, University of St Andrews  
Giulia Grancini, University of Pavia  
Zhong-Qun Tian, Xiamen University

### Members

Osamu Ishitani, Tokyo Institute of Technology  
Raghaven Sunoj, IIT Bombay  
Tatjana Parac-Vogt, KU Leuven

## Advisory Board

Ryu Abe, Kyoto University  
Dave Adams, University of Glasgow  
David Amabilino, Institute of Materials Science of Barcelona  
Ruchi Anand, IIT Bombay  
Ivan Arahamian, Dartmouth College  
Parisa A. Ariya, McGill University  
Tom Baker, University of Ottawa  
Thomas Bennett, University of Cambridge  
Gonçalo Bernardes, Cambridge University  
Barry Blight, New Brunswick  
Anne-Marie Caminade, University of Toulouse  
Araceli Campaña, University of Granada  
Rui Cao, Shaanxi Normal University  
Hong Chen, Soochow University  
Yong Cui, Shanghai Jiao Tong University  
Abhishek Dey, IACS  
Huw Davies, Emory University  
Wim Dehaen, Catholic University of Leuven  
William Dichtel, Northwestern University  
Yves Dufréne, Université catholique de Louvain  
Antonio Echavarren, Institute of Chemical Research of Catalonia  
Elena Fernández, Universitat Rovira i Virgili  
Miriam Freedman, Pennsylvania State University  
Philip A. Gale, The University of Sydney  
Debashree Ghosh, IACS  
Duncan Graham, University of Strathclyde  
Stefan Grimme, Universität Bonn  
Frances Houle, Joint Centre for Artificial Photosynthesis  
Ashlee Howarth, Concordia University  
Feihe Huang, Zhejiang University  
Masako Kato, Kwansei Gakuin University  
Jong Seung Kim, Korea University  
Rafal Klajn, Weizmann Institute of Science

Daniele Leonori, RWTH Aachen University  
Chao-Jun Li, McGill University  
Jinghong Li, Tsinghua University  
Yan Li, Peking University  
Zhuang Liu, Peking University  
Norberto Peoporine Lopes, CEMMO  
Bettina Lotsch, Max Planck Institute for Solid State Research  
Connie Lu, University of Minnesota  
Cara Lubner, NREL  
Rafael Luque, King Saud University, Saudi Arabia  
Uday Maitra, Indian Institute of Science  
Nazario Martin, Complutense University of Madrid  
Feliu Maseras, Institute of Chemical Research of Catalonia  
Fiona Meldrum, University of Leeds  
Gugu Mhlongo, CSIR  
Simona Mura, Institut Galien Paris-Saclay  
Brenno Neto, Brasilia  
Tebello Nyokong, Rhodes University  
Martin Oestreich, Technische Universität Berlin  
Elisa Orth, Federal University of Paraná  
Mario Pagliaro, National Research Council (CNR)  
Atul Parikh, University of California Davis  
Kanyi Pu, Nanyang Technological University  
Eric Rivard, University of Alberta  
Gregory Robinson, University of Georgia  
Peter Roesky, Karlsruhe Institute of Technology  
Ashley Ross, University of Cincinnati  
Vincent Rotello, University of Massachusetts  
Paolo Samori, University of Strasbourg

D D Sarma, IISc  
Clément Sanchez, Pierre and Marie Curie University  
Hélder A. Santos, University of Helsinki  
Jennifer Schaefer, Notre Dame  
Wendy Shaw, PNNL  
Injae Shin, Yonsei University  
David Spring, University of Cambridge  
Andrew Steckl, University of Cincinnati  
Samuel Stupp, Northwestern University  
Jin Suntivich, Cornell  
Kana Sureshan, IISER Thiruvananthapuram  
Micheal Tam, University of Waterloo  
Andrea Trabocchi, University of Florence  
James Tucker, University of Birmingham  
Leyong Wang, Nanjing University  
Peng Wang, Changchun Institute of Applied Chemistry  
Bert Weckhuyesen, Utrecht University  
Helma Wennemers, ETH Zurich  
Stephen Withers, University of British Columbia  
Yujie Xiong, University of Science and Technology of China  
Makoto Yamashita, Nagoya University  
Juyoung Yoon, Ewha Womans University  
Shuli You, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences  
Guihua Yu, University of Texas at Austin  
Claudio Zannoni, University of Bologna  
Haoli Zhang, Lanzhou University  
Qiang Zhang, Tsinghua University  
Yong Zhang, NUS  
Yiping Zhao, University of Georgia  
Hongli Zhu, Northeastern University

## Information for Authors

Full details on how to submit material for publication in Chem Soc Rev 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/chem-soc-rev](http://rsc.li/chem-soc-rev)

The Editorial board typically commission articles that encourage international, interdisciplinary progress in chemical research. The board welcomes proposals for new tutorial reviews or review articles. Please contact the Editorial office for further details ([chemsocrev-rsc@rsc.org](mailto:chemsocrev-rsc@rsc.org)). Additional details are available from the Editorial office or <http://www.rsc.org/authors>

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.

© The paper used in this publication meets the requirements of ANSI/NISO Z39.48–1992 (Permanence of Paper).

Registered charity number: 207890

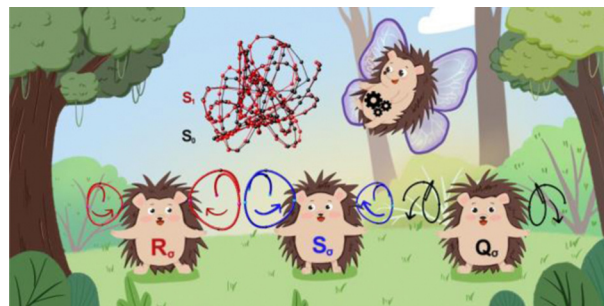


## TUTORIAL REVIEWS

5861

## Tools for overcoming reliance on energy-based measures in chemistry: a tutorial review

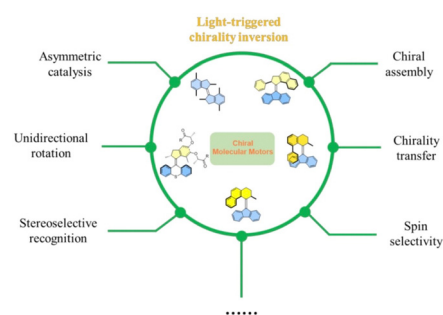
Steven R. Kirk and Samantha Jenkins\*



5875

## Enlightening dynamic functions in molecular systems by intrinsically chiral light-driven molecular motors

Jinyu Sheng, Daisy R. S. Pooler and Ben L. Feringa\*

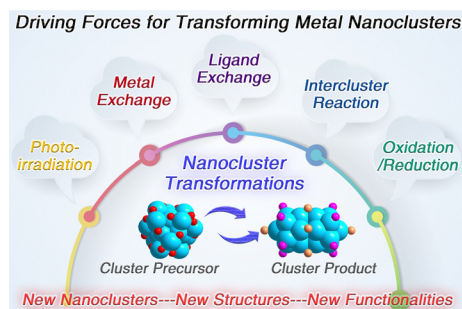


## REVIEW ARTICLES

5892

## Recent developments in the investigation of driving forces for transforming coinage metal nanoclusters

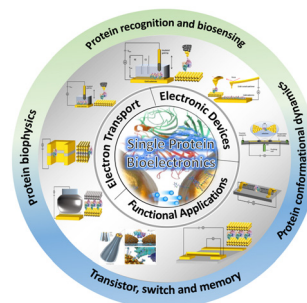
Xuejuan Zou, Xi Kang\* and Manzhou Zhu\*



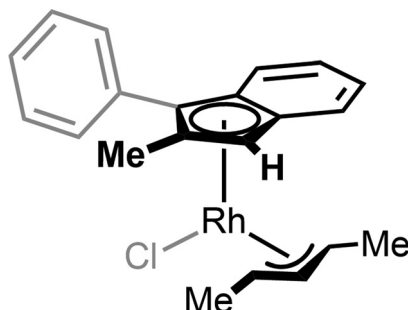
5968

## Single-molecular protein-based bioelectronics via electronic transport: fundamentals, devices and applications

Tao Jiang, Biao-Feng Zeng, Bintian Zhang\* and Longhua Tang\*



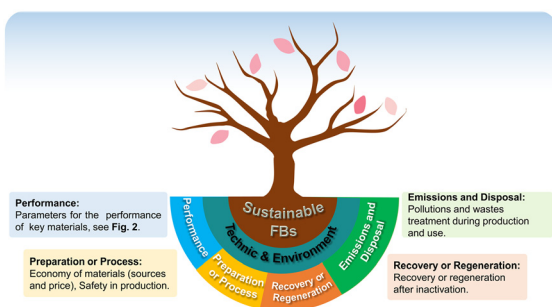
6003



### Synthesis, stereochemical assignment, and enantioselective catalytic activity of late transition metal planar chiral complexes

David Laws III, Christopher D. Poff, Ethan M. Heyboer and Simon B. Blakey\*

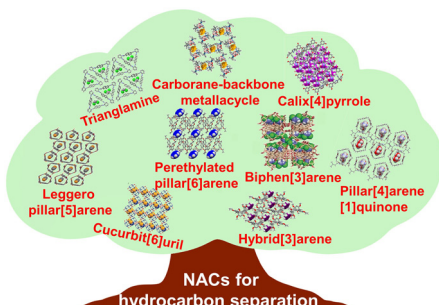
6031



### Development of flow battery technologies using the principles of sustainable chemistry

Ziming Zhao, Xianghui Liu, Mengqi Zhang, Leyuan Zhang, Changkun Zhang,\* Xianfeng Li\* and Guihua Yu\*

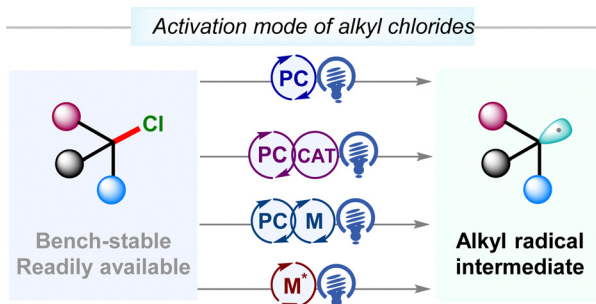
6075



### Potential of nonporous adaptive crystals for hydrocarbon separation

Miaomiao Yan, Yuhao Wang, Jingyu Chen and Jiong Zhou\*

6120



### Photoinduced activation of alkyl chlorides

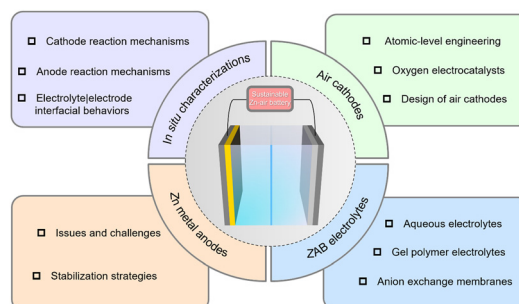
Cheng-Long Ji, Xinyi Zhai, Qing-Yun Fang, Chengjian Zhu, Jie Han and Jin Xie\*



6139

## Sustainable zinc–air battery chemistry: advances, challenges and prospects

Qichen Wang, Shubham Kaushik, Xin Xiao\* and Qiang Xu\*



6191

## Perspectives on recent advancements in energy harvesting, sensing and bio-medical applications of piezoelectric gels

Thangavel Vijayakanth, Sudha Shankar, Gal Finkelstein-Zuta, Sigal Rencus-Lazar, Sharon Gilead and Ehud Gazit\*

