

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.

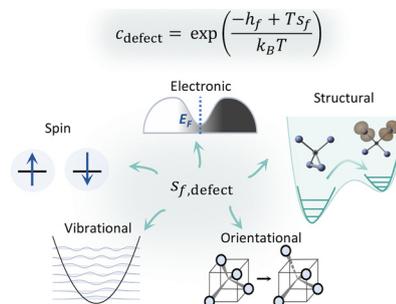
Image reproduced by permission of Longhua Tang from *Chem. Soc. Rev.*, 2023, 52, 5968.

TUTORIAL REVIEWS

5812

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

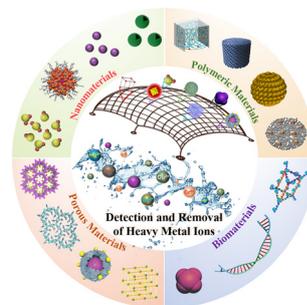
Irea Mosquera-Lois, Seán R. Kavanagh, Johan Klarbring, Kasper Tolborg and Aron Walsh*



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

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

E-mail: 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

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

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

For marketing opportunities relating to this journal, contact marketing@rsc.org

Chem Soc Rev

Chemical Society Reviews

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 Dufrene, 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
Hélmer 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 Weckhuyzen, 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

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). 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

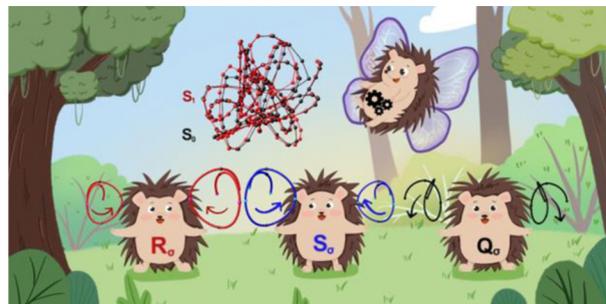


TUTORIAL REVIEWS

5861

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

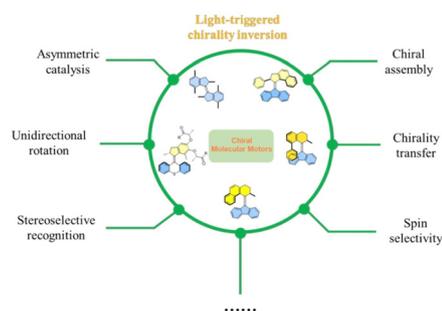
Steven R. Kirk and Samantha Jenkins*



5875

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

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

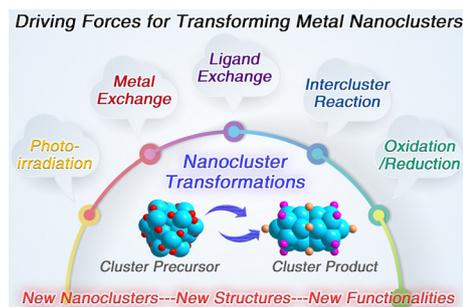


REVIEW ARTICLES

5892

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

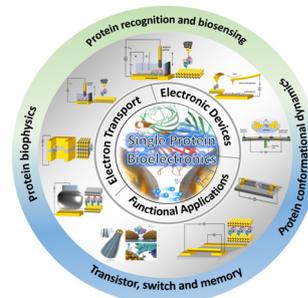
Xuejuan Zou, Xi Kang* and Manzhou Zhu*



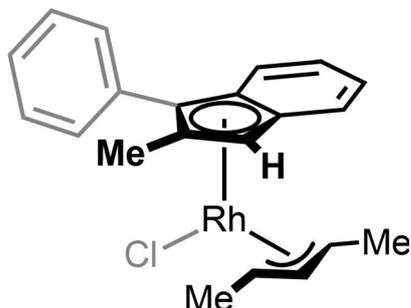
5968

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

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



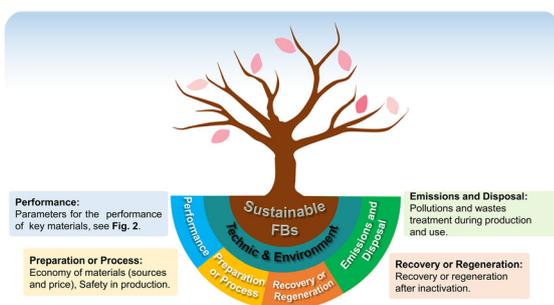
6003



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*

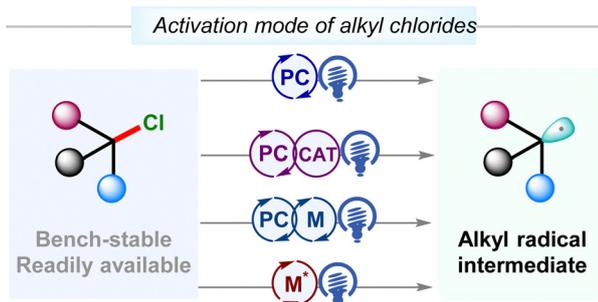
6075



Potential of nonporous adaptive crystals for hydrocarbon separation

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

6120



Photoinduced activation of alkyl chlorides

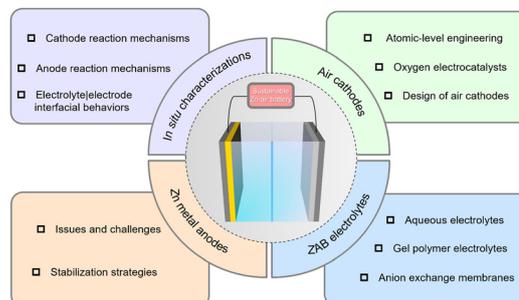
Cheng-Long Ji, Xinyi Zhai, Qing-Yun Fang, Chengjian Zhu, Jie Han and Jin Xie*



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*

