

Journal of Materials Chemistry A

Materials for energy and sustainability

rsc.li/materials-a

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 2050-7488 CODEN JMCAET 11(22) 11537–11910 (2023)



Cover

See Ali K. Sekizkardes *et al.*, pp. 11670–11674. Image reproduced by permission of Ali K. Sekizkardes from *J. Mater. Chem. A*, 2023, **11**, 11670.



Inside cover

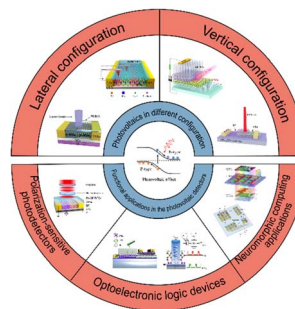
See Juan Miguel López del Amo *et al.*, pp. 11675–11683. Image reproduced by permission of Fundación CIC energiGUNE from *J. Mater. Chem. A*, 2023, **11**, 11675.

REVIEWS

11548

Recent progress in functional two-dimensional photovoltaic photodetectors and related emerging applications

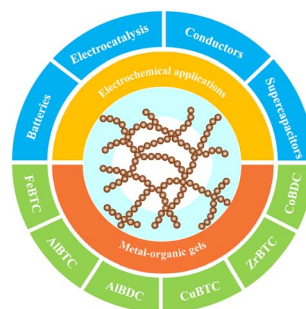
Xiang Li, Xiaoting Wang,* Yang Ma, Wenjie Deng, Yi Wu, Jingtao Li, Kexin Li and Yongzhe Zhang*



11572

Metal–organic gels and their derived materials for electrochemical applications

Shasha Ma, Jie Xu, Somayeh Sohrabi and Jianyong Zhang*



Editorial Staff

Executive Editor

Michaela Muehlberg

Deputy Editor

Geraldine Hay

Editorial Production Manager

Jonathon Watson

Senior Publishing Editor

Isobel Tibbetts

Development Editor

Rose Wedgbury

Publishing Editors

Matthew Blow, Chris Dias, Hemna Fathima, Juan Gonzalez, Ellie Griffiths, Rob Hinde, Sam Howell, Ash Hyde, Francesca Jacklin, Evie Karkera, Shruti Karnik, Sophie Koh, Tamara Kosikova, Brian Li, Sam Mansell, Carole Martin, Kirsty McRoberts, Yasmin Mehanna, Tiffany Rogers, Cat Schofield, Charu Storr-Vijay, Manman Wang, Ella White, Tom Williams

Editorial Assistant

Daniel Smith

Publishing Assistant

Julie-Ann Roszkowski

Publisher

Sam Keltie

For queries about submitted papers, please contact Jonathon Watson, Editorial Production Manager in the first instance. E-mail: materialsA@rsc.org

For pre-submission queries please contact Michaela Muehlberg, Executive Editor. E-mail: materialsA-rsc@rsc.org

Journal of Materials Chemistry A (electronic: ISSN 2050-7496) is published 48 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WE.

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 0WE, UK
Tel +44 (0)1223 432398; E-mail orders@rsc.org
2023 Annual (electronic) subscription price: £1968, \$4085. 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

Journal of Materials Chemistry A

rsc.li/materials-a

Journal of Materials Chemistry A, B & C cover high quality studies across all fields of materials chemistry. The journals focus on those theoretical or experimental studies that report new understanding, applications, properties and synthesis of materials. *Journal of Materials Chemistry A* covers materials with applications in energy & sustainability.

Editorial Board

Editor-in-Chief

Anders Hagfeldt, EPFL, Switzerland

Scientific Editors

Frank Osterloh, University of California, Davis, USA

Associate Editors

Veronica Augustyn, North Carolina State University, USA
Viola Birss, University of Calgary, Canada
Goutam De, S N Bose National Centre for Basic Sciences, India
Ghim Wei Ho, National University of Singapore, Singapore
Yun Jeong Hwang, Seoul National University, South Korea
Kisuk Kang, Seoul National University, South Korea

Subrata Kundu, Central Electrochemical Research Institute (CECRI), India
Dan Li, Jinan University, China
David Lou, Nanyang Technological University, Singapore
Yi-Chun Lu, Chinese University of Hong Kong, Hong Kong
Shizhang Qiao, University of Adelaide, Australia
Jennifer Rupp, Technical University Munich, Germany

Miriam Unterlass, University of Konstanz, Germany
Lydia Wong, Nanyang Technological University, Singapore
Li-Zhu Wu, Technical Institute of Physics and Chemistry, China
Yusuke Yamauchi, University of Queensland, Australia
Zhen Zhou, Nankai University, China

Advisory Board

P. Adelhelm, Humboldt-University Berlin, Germany
R. Ahuja, Uppsala University, Sweden
C. Ania, CNRS Orleans, France
J.-B. Baek, Ulsan National Institute of Science and Technology, Korea
C. Berlinguette, University of British Columbia, Canada
K. Biswas, Jawaharlal Nehru Centre for Advanced Scientific Research, India
E. Bucher, University of Leoben, Austria
M. Chabinye, University of California, Santa Barbara, USA
A. Chattopadhyay, IIT Guwahati, India
J.-S. Chen, Shanghai Jiao Tong University, China
W. Chueh, Stanford University, USA
S. Cussen, University of Sheffield, UK
X. Duan, University of Adelaide, Australia
M. Eddaoudi, King Abdullah University of Science and Technology, Saudi Arabia
T. Edvinsson, Uppsala University, Sweden
X. Feng, Dresden University of Technology, Germany
J. Fleig, Dresden University of Technology, Germany
M. Florea, University of Bucharest, Romania
G. Galli, University of Chicago, USA
N. Garcia-Araez, University of Southampton,

UK
G. Grancini, University of Pavia, Italy
J. Huang, Northwestern University, USA
H. Imahori, Kyoto University, Japan
T. Ishihara, Kyushu University, Japan
S. Islam, University of Bath, UK
F. Jiao, University of Delaware, USA
E. Kendrick, University of Birmingham, UK
B. Kim, KAIST, Korea
D.-H. Kim, Ewha Womans University, Korea
U. Kramm, TU Darmstadt, Germany
Y.J. Lee, Hanyang University, Korea
B. Li, Tsinghua University, China
J. Li, Rutgers University, USA
Z. Lin, National University of Singapore, Singapore
B. Lotsch, Max Planck Institute for Solid State Research, Stuttgart, Germany
J. Luo, Nankai University, China
C.-B. Mullins, University of Texas at Austin, USA
A. K. Nandi, IACS, India
L. Nazar, University of Waterloo, Canada
M. Niederberger, ETH Zürich, Switzerland
A.F. Nogueira, University of Campinas, Brazil
C. Osuji, University of Pennsylvania, USA
S. Parker, University of Bath, UK
S. Patil, Indian Institute of Science, Bangalore, India

Z. Schnopp, University of Birmingham, UK
Z. Shao, Curtin University, Australia
Y. Shimakawa, Kyoto University, Japan
S. Skinner, Imperial College London, UK
M.C. Stefan, University of Texas at Dallas, USA
C.-Y. Su, Sun Yat-Sen University, China
S.-G. Sun, Xiamen University, China
V. Thangadurai, University of Calgary, Canada
M. Titirici, Imperial College London, UK
S. Uk Son, Sungkyunkwan University, Korea
E. Unger, Lund University, Sweden
R.-N. Vannier, ENSC Lille, France
M. Wang, Sun Yat-Sen University, China
M. Wei, Beijing University of Chemical Technology, China
E. Weiss, Northwestern University, USA
C. Williams, University of Oxford, UK
C. Xiong, Boise State University, USA
Y. Xu, University College London, UK
Y.-J. Xu, Fuzhou University, China
M. Ye, Xiamen University, China
Q. Zhang, Tsinghua University, China
X.S. Zhao, University of Queensland, Australia
G. Zheng, Fudan University, China

Information for Authors

Full details on how to submit material for publication in Journal of Materials Chemistry A 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/materials-a. Submissions: The journal welcomes submissions of manuscripts for publication as Full Papers, Communications, Reviews, Highlights and Applications. Full Papers and Communications should describe original work of high quality and impact which must highlight the novel properties or applications (or potential properties/applications) of the materials studied.

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.

Registered charity number: 207890

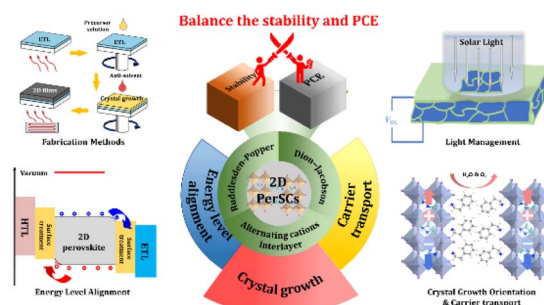


REVIEWS

11607

Crystal growth of two-dimensional organic–inorganic hybrid perovskites and their application in photovoltaics

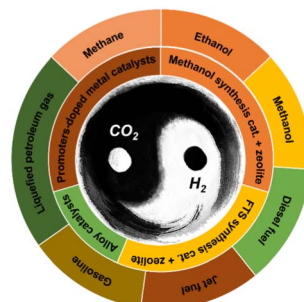
Yuling Zhang, Ruyue Wang and Zhan'ao Tan*



11637

CO₂ heterogeneous hydrogenation to carbon-based fuels: recent key developments and perspectives

Lisheng Guo, Xiaoyu Guo, Yinglue He and Noritatsu Tsubaki*

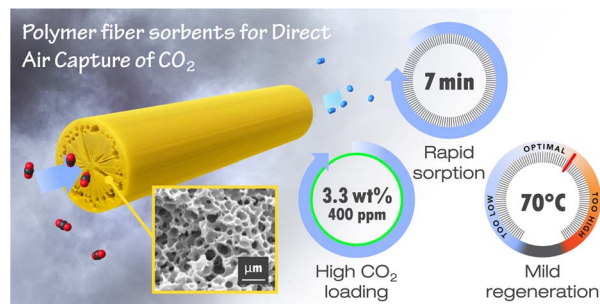


COMMUNICATION

11670

Single polymer sorbent fibers for high performance and rapid direct air capture

Ali K. Sekizkardes,* Victor A. Kusuma, Jeffrey T. Culp, Patrick Muldoon, James Hoffman, Janice A. Steckel and David Hopkinson

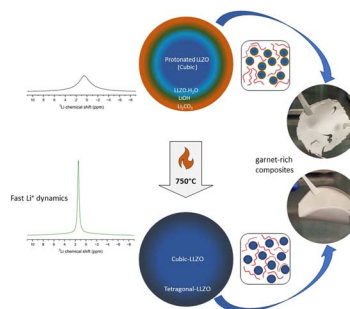


PAPERS

11675

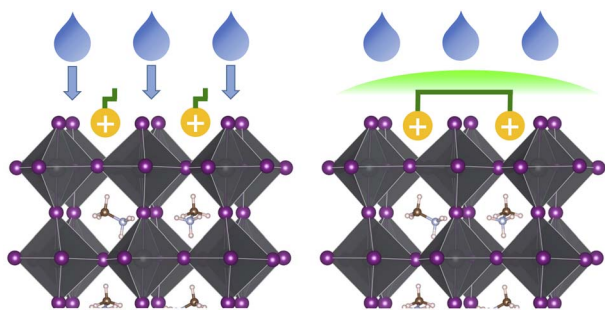
Impact of thermal treatment on the Li-ion transport, interfacial properties, and composite preparation of LLZO garnets for solid-state electrolytes

Pedram Ghorbanzade, Arianna Pesce, Kerman Gómez, Grazia Accardo, Shanmukaraj Devaraj, Pedro López-Aranguren and Juan Miguel López del Amo*



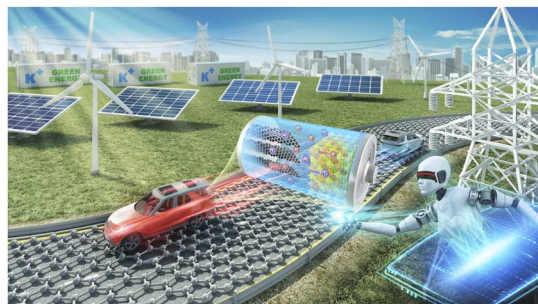
PAPERS

11684

**Divalent organic cations as a novel protective layer for perovskite materials**

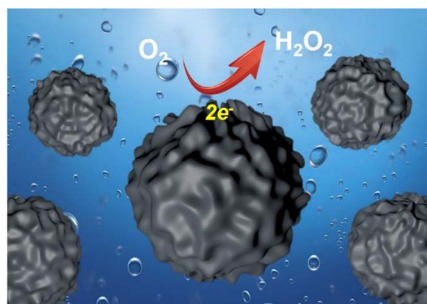
Yan Chen, Xun-Lei Ding,* Han-Bin He, Ya-Ya Wang, Shao-Peng Xu, Meng-Meng Wang and Wei Li

11696

**Hierarchical porous N/S-doped carbon with machine learning to predict advanced potassium-ion batteries**

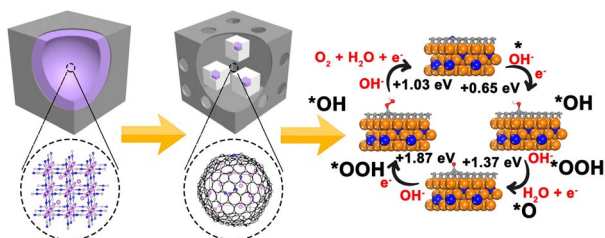
Ke Bi, Yue Wang and Guangyuan Zhou*

11704

**Nitrogen-doped sp^3 carbon dot catalysed two-electron electrochemical oxygen reduction for efficient production of hydrogen peroxide**

Jianhua Shen, Xinyue Qiu and Yihua Zhu*

11712

**Thin carbon layer covered Co_4N cubes encapsulated in N-doped porous carbon nanocage as tri-functional catalysts with enhanced charge-transfer efficiency for Zn-air battery and overall water-splitting**

Guanghui Zhang, Lingxue Zhao, Guangda Li* and Liqiang Xu*

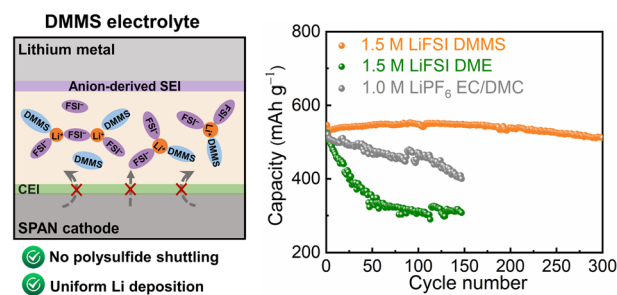


PAPERS

11721

Two birds with one stone: engineering siloxane-based electrolytes for high-performance lithium–sulfur polyacrylonitrile batteries

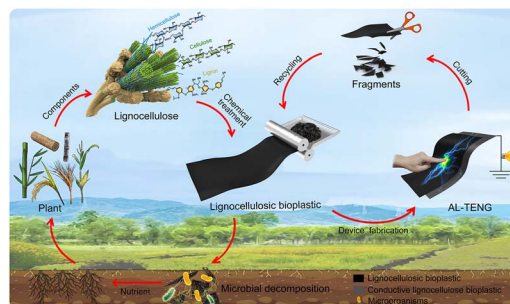
Manxian Li, Hongyang Chen, Yaxin Wang, Xiaochuan Chen,* Junxiong Wu,* Jiaqian Su, Manxi Wang, Xuan Li, Chuanping Li, Lianbo Ma, Xiaoyan Li* and Yuming Chen*



11730

A strong, biodegradable, and recyclable all-lignocellulose fabricated triboelectric nanogenerator for self-powered disposable medical monitoring

Xue Shi, Pengfei Chen, Kai Han, Chengyu Li, Renyun Zhang,* Jianjun Luo* and Zhong Lin Wang*



11740

A two-dimensional heterogeneous structured $\text{Ni}_3\text{Se}_2@\text{MoO}_3$ catalyst for seawater electrolysis

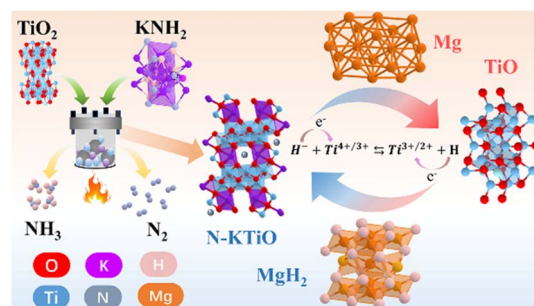
Suyang Feng, Chengshan Gu, Yanhui Yu, Peng Rao, Peilin Deng,* Jing Li, Zhenye Kang, Xinlong Tian* and Zhifu Wu*



11748

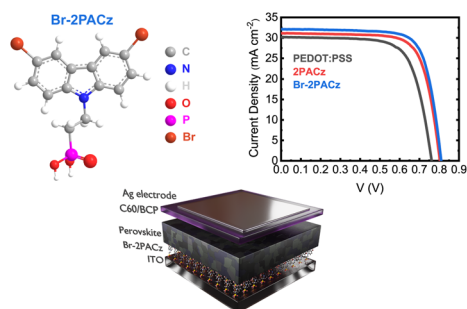
Enhancing the cycling stability of MgH_2 using nitrogen modified titanate

Ren Zou, Jialing Li, Weijin Zhang, Gangtie Lei, Zhi Li and Hujun Cao*



PAPERS

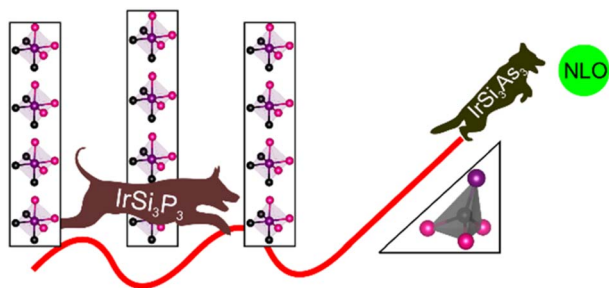
11755



A carbazole-based self-assembled monolayer as the hole transport layer for efficient and stable $\text{Cs}_{0.25}\text{FA}_{0.75}\text{Sn}_{0.5}\text{Pb}_{0.5}\text{I}_3$ solar cells

Matteo Pitaro, Javier Sebastian Alonso, Lorenzo Di Mario, David Garcia Romero, Karolina Tran, Teodor Zaharia, Malin B. Johansson, Erik M. J. Johansson and Maria Antonietta Loi*

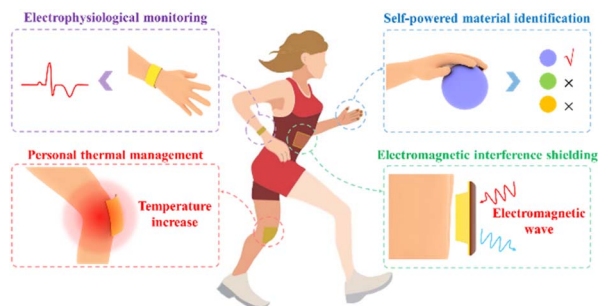
11767



IrSi_3As_3 : a first transition metal arsenide non-linear optical material

Shannon J. Lee, Georgiy Akopov, Adedoyin N. Adeyemi, Ernesto Soto, Kui Wu and Kirill Kovnir*

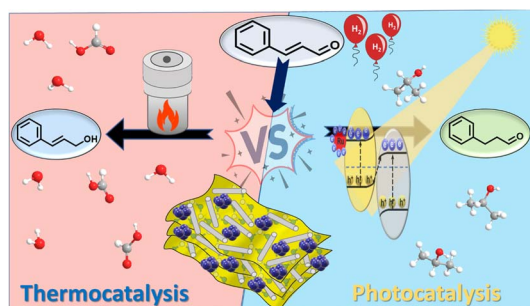
11773



Multi-functional graphene/leather for versatile wearable electronics

Qiaohang Guo,* Jing Guo, Huamin Chen,* Peidi Zhou, Congwei Li, Kaihuai Yang, Nengbin Hua, Jun Wang and Mingcen Weng*

11786



Thermocatalytic and photocatalytic chemoselective reduction of cinnamaldehyde to cinnamyl alcohol and hydrocinnamaldehyde over Ru@ZnO/CN

Arzoo Chauhan, Rajat Ghalta, Rajaram Bal and Rajendra Srivastava*



PAPERS

11804

Two birds with one stone: cobalt/silicon species encapsulated in MOF-derived nitrogen-doped carbon as an integrated electrode for next-generation symmetric pseudocapacitors with energy density over 100 W h kg⁻¹

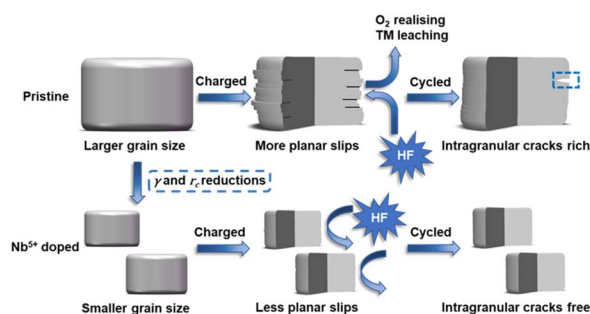
Abdul Mateen, Muhammad Sufyan Javed,* Xiaofeng Zhang, Iftikhar Hussain, Tayyaba Najam, Awais Ahmad, Asma A. Alothman, Mohamed Ouladsmame, Sayed M. Eldin, Weihua Han* and Kui-Qing Peng*



11819

Surface energy alteration-derived grain size regulation countering capacity deterioration in high-voltage single-crystal Ni-rich cathodes

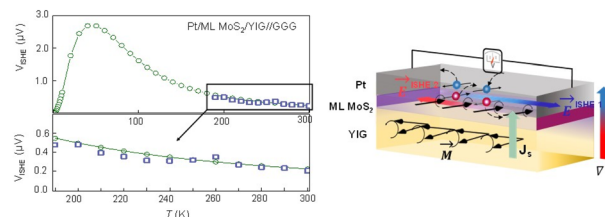
Fuqiren Guo, Yang Hu, Lang Qiu, Yuandi Jiang, Yuting Deng, Junbo Zhou, Zhuo Zheng, Yang Liu, Yan Sun, Zhenguo Wu, Yang Song* and Xiaodong Guo



11831

Role of two-dimensional monolayer MoS₂ interlayer in the temperature-dependent longitudinal spin Seebeck effect in Pt/YIG bilayer structures

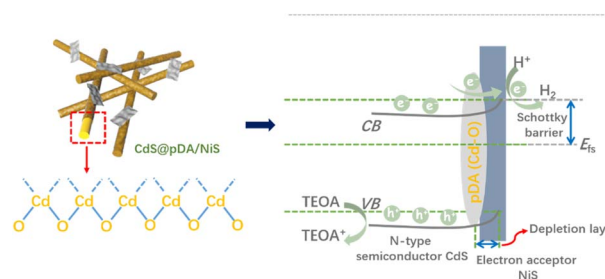
Chanho Park, Jae Won Choi, No-Won Park, Gil-Sung Kim, Takashi Kikkawa, Eiji Saitoh and Sang-Kwon Lee*



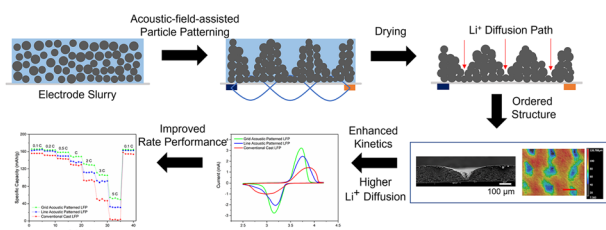
11840

Strongly coupled interface facilitating charge separation to the improved visible light-driven hydrogen production on CdS@polydopamine/NiS photocatalyst

Yingying Qin, Linli Xu,* Zhi Zhu and Wai-Yeung Wong*



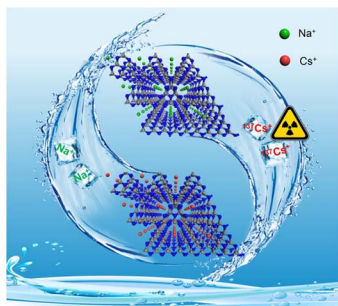
11849



Structuring electrodes via acoustic-field-assisted particle patterning for enhanced performance of lithium-ion batteries

Yifan Zhang, M. Shahriar and Shan Hu*

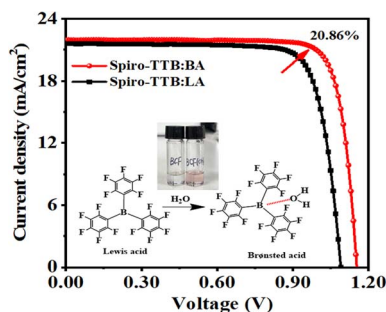
11859



Highly efficient removal of Cs⁺ from water by an ionic lamellar carbon nitride framework

Zhenchun Yang, Bixiao Guo, Zhenyu Hu, Jiahao Cui, Jianguo Cui, Lina Li, Chun Hu and Yubao Zhao*

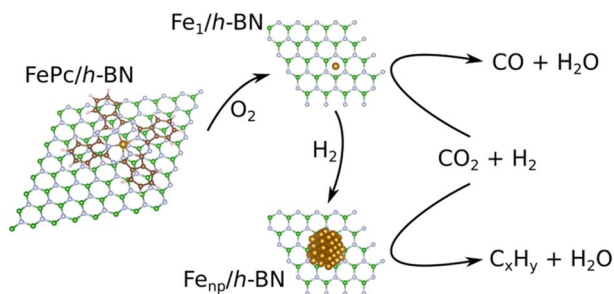
11866



Tris(pentafluorophenyl)borane–water complex doped Spiro-TTB for high-efficiency and stable perovskite solar cells

Luyan Zhang, Jiang Sheng,* Weichuang Yang, Xiangying Xue, Xuan Sha, Jingsong Sun, Chunhui Shou, Fangfang Cao, Ningjun Zhang, Chuanxiao Xiao, Xi Yang and Jichun Ye*

11874



Iron phthalocyanine derived Fe₁/h-BN single atom catalysts for CO₂ hydrogenation

Denis V. Leybo,* Anastasia A. Ryzhova, Andrei T. Matveev, Konstantin L. Firestein, Pavel A. Tarakanov, Anton S. Konopatsky, Alexander L. Trigub, Ekaterina V. Sukhanova, Zakhar I. Popov, Dmitri V. Golberg and Dmitry V. Shtansky

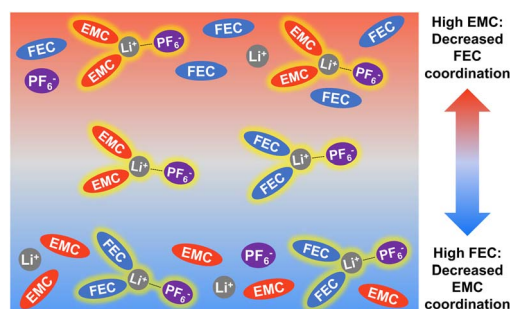


PAPERS

11889

Tuning and understanding the solvent ratios of localized saturated electrolytes for lithium-metal batteries

Michael Yi, Laisuo Su and Arumugam Manthiram*



11903

Prediction of structurally stable two-dimensional AuClO₂ with high thermoelectric performance

Puxin Cheng, Geng Li,* Yinchang Zhao, Xiangfei Meng, Shuming Zeng* and Jialiang Xu*

