

Journal of Materials Chemistry A

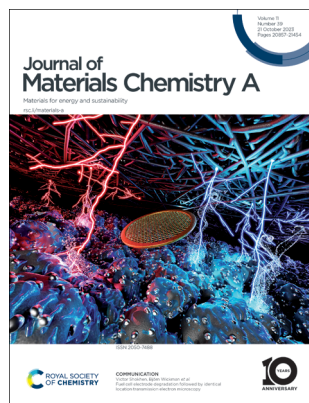
Materials for energy and sustainability

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(39) 20857–21454 (2023)



Cover

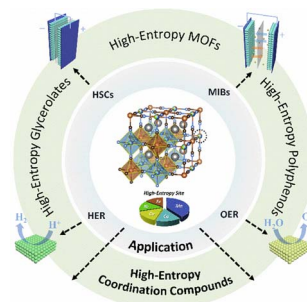
See Victor Shokhen, Björn Wickman *et al.*, pp. 21029–21035. Image reproduced by permission of Victor Shokhen from *J. Mater. Chem. A*, 2023, **11**, 21029.

HIGHLIGHT

20872

Emerging high-entropy coordination compounds and their derivatives for energy application

Josué M. Gonçalves* and José G. Ruiz-Montoya



REVIEWS

20886

Recent progress in anion exchange membranes (AEMs) in water electrolysis: synthesis, physico-chemical analysis, properties, and applications

Ganesan Sriram,* Karmegam Dhanabalan, Kanalli V. Ajeya, Kanakaraj Aruchamy, Yern Chee Ching, Tae Hwan Oh,* Ho-Young Jung* and Mahaveer Kurkuri*



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, Clara Humann, Ash Hyde, Francesca Jacklin, Evie Karkera, Shruti Karnik, Tamara Kosikova, Brian Li, Sam Mansell, Carole Martin, Kirsty McRoberts, Yasmin Mehanna, Tiffany Rogers, Cat Schofield, Charu Storr-Vijay, Manman Wang, 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

Serena Cussen, University of Sheffield, UK
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
Yi-Chun Lu, Chinese University of Hong Kong

Kong, Hong Kong
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 Womens 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

S. Qiao, University of Adelaide, Australia
Z. Schniepp, 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

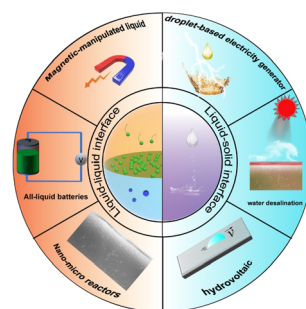


REVIEWS

21009

Liquid interfaces: an emerging platform for energy conversion and harvesting

Sai Zhao, Yuchen Fu, Haowu Cao and Yu Chai*

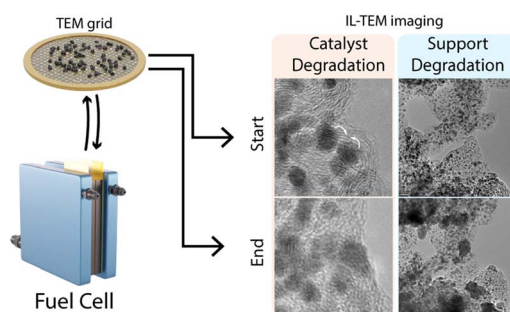


COMMUNICATION

21029

Fuel cell electrode degradation followed by identical location transmission electron microscopy

Victor Shokhen,* Linnéa Strandberg, Magnus Skoglundh and Björn Wickman*

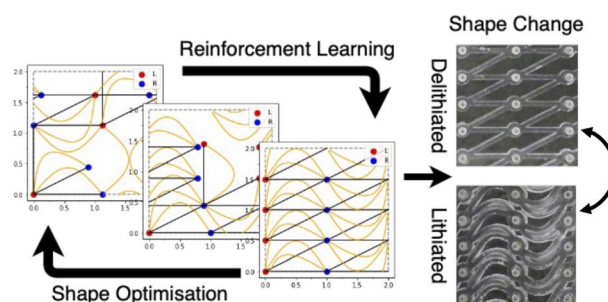


PAPERS

21036

Reinforcement learning-based design of shape-changing metamaterials

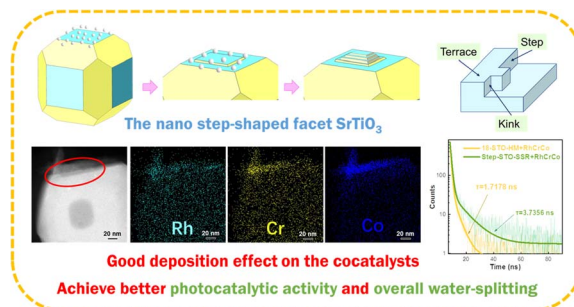
Sergi Bernaus Oliva, Felix T. Bölle, A. T. Las, Xiaoxing Xia* and Ivano E. Castelli*



21046

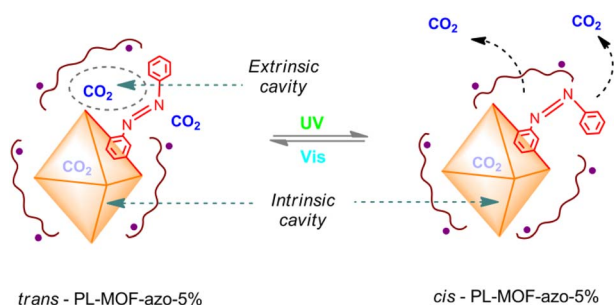
A unique octadecahedron SrTiO₃ perovskite oxide with a nano step-shaped facet structure for enhanced photoredox and hydrogen evolution performance

Chuyu Wang, Yan Li, Xiaojiao Cai, Dongping Duan* and Qibo Jia*



PAPERS

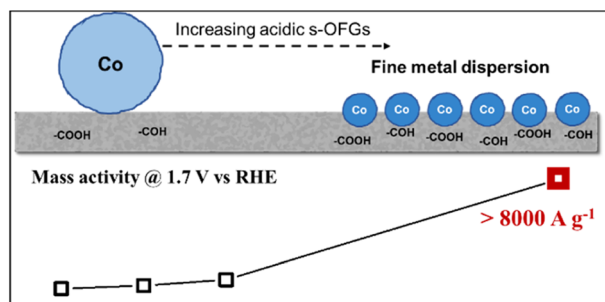
21058



Role of cavities created by azobenzene-modified UiO-66 in bulky ionic liquid for high photoresponsive CO₂ uptake behavior

Meng-Meng Li, Manish Kumar Dinker, Yang Liu, Mingrui Zuo, Lifeng Ding,* Xiao-Qin Liu and Lin-Bing Sun*

21066

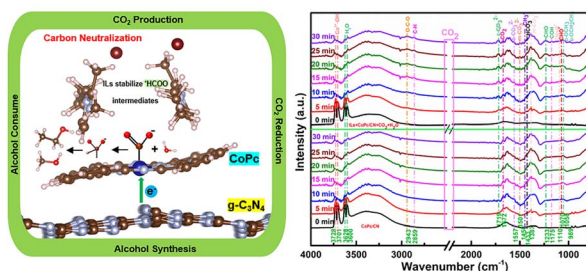


Understanding the role of surface oxygen-containing functional groups on carbon-supported cobalt catalysts for the oxygen evolution reaction

Thi Ha My Pham, Youngdon Ko, Manhui Wei, Kangning Zhao, Liping Zhong* and Andreas Züttel

21078

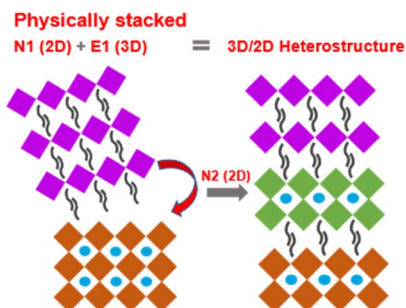
Carbon Neutrality Target: Opportunities and Challenges



Efficient photoelectrocatalytic CO₂ reduction to CH₃OH via porous g-C₃N₄ nanosheets modified with cobalt phthalocyanine in ionic liquids

Pengyan Li, Yuhang Lin, Zhenhong Qi and Dongpeng Yan*

21089



Diffusion of bulky organic cations in the 3D/2D heterostructures to form interfacial quasi-2D (N2) phase for tin perovskite solar cells

Ashank Seetharaman, Sudhakar Narra, Parameswaran Rajamanickam, Raghunath Putikam, Ming-Chang Lin and Eric Wei-Guang Diao*

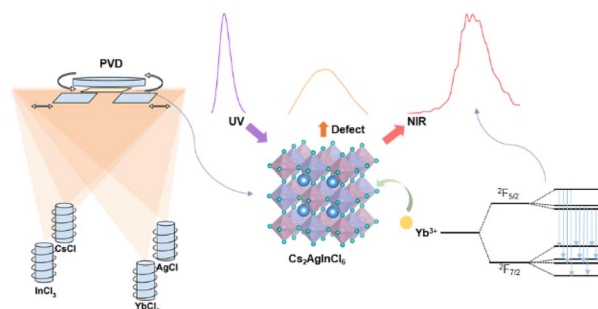


PAPERS

21099

Optical properties of ytterbium-doped and undoped $\text{Cs}_2\text{AgInCl}_6$ thin films deposited by co-evaporation of chloride salts

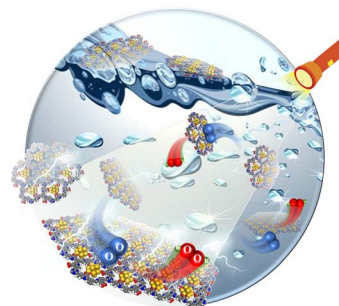
Yukun Liu, Pulkita Jain, Iver J. Cleveland, Minh Tran, Seda Sarp, Kajini Sandrakumar, Rafaella Saa Rodriguez and Eray S. Aydil*



21109

Embedding Au nanoclusters into the pores of carboxylated COF for the efficient photocatalytic production of hydrogen peroxide

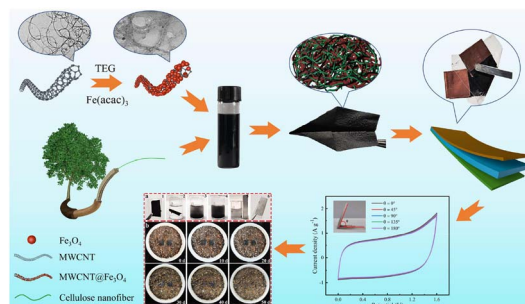
Qigao Shang, Yanyang Liu, Jing Ai, Ying Yan, Xiaofang Yang, Dongsheng Wang and Guiying Liao*



21123

Recyclable Fe_3O_4 /MWCNT/CNF composite nanopaper as an advanced negative electrode for flexible asymmetric supercapacitors

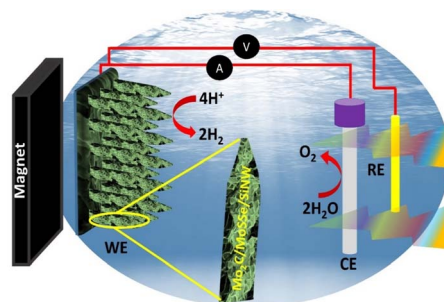
Haoran Zhao, Haidong Jin, Shenghui Li, Yahui Dong, Shipeng Wang, Qian Cheng* and Yu Li*



21135

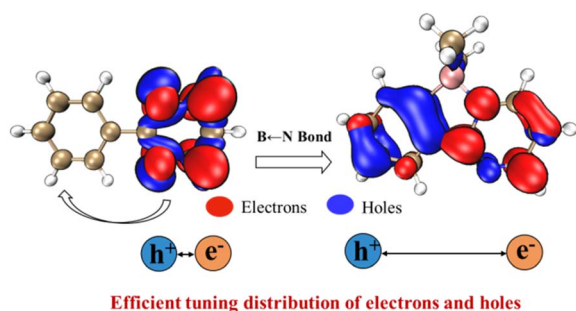
Enhanced hydrogen evolution reaction via photoelectrochemical water splitting utilizing asymmetric MoSSe under a low external magnetic field

Krishnendu Roy, Dibyendu Ghosh, Soumyajit Maitra and Praveen Kumar*



PAPERS

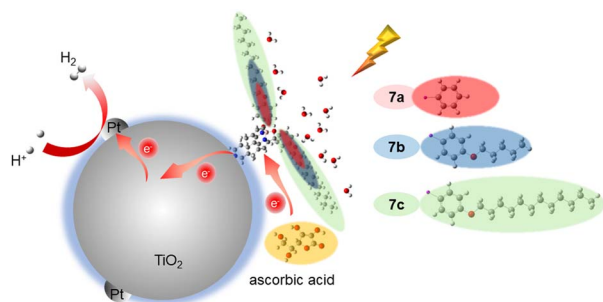
21146



B←N bonds alter the photo-generated electron/hole separation ability of conjugated polymers to promote photocatalytic performance

Peiyan Chen, Fanbo Ji, Detian Ma, Yangbin Xie, Xuan Wu, Mingcai Zhang, Chenglong Ru,* Lian Zhou,* Jincai Wu and Xiaobo Pan*

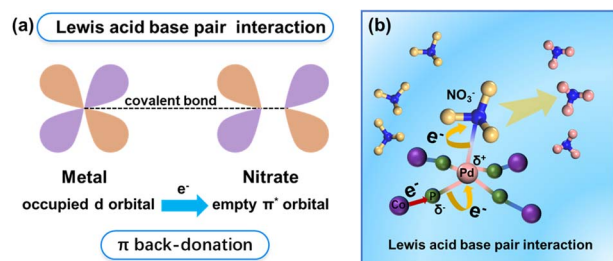
21153



The acceleration of BODIPY dye-sensitized photocatalytic hydrogen production in aqueous ascorbic acid solutions using alkyl-chain formed second coordination sphere effects

Xiao-Feng Shen, Motonori Watanabe,* Jun Tae Song, Atsushi Takagaki, Tatsuki Abe, Keiji Tanaka and Tatsumi Ishihara

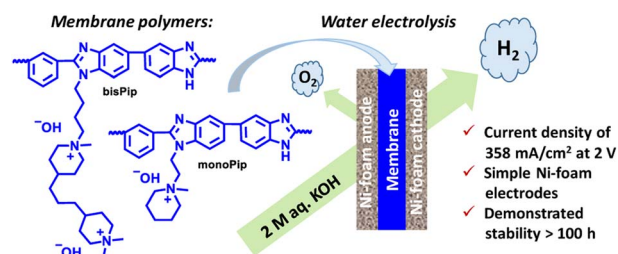
21161



Enhancing the selective electrochemical conversion of nitrate *via* π back-donation on Lewis acid sites induced by noble-metal doped CoP

Yihong Gao, Kunpeng Wang, Shikuo Li,* Hui Zhang* and Fangzhi Huang*

21170



Alkali-stable polybenzimidazole anion exchange membranes tethered with *N,N*-dimethylpiperidinium cations for dilute aqueous KOH fed water electrolyzers

Oskar Boström, Seung-Young Choi, Lu Xia, Shviro Meital, Felix Lohmann-Richters and Patric Jannasch*

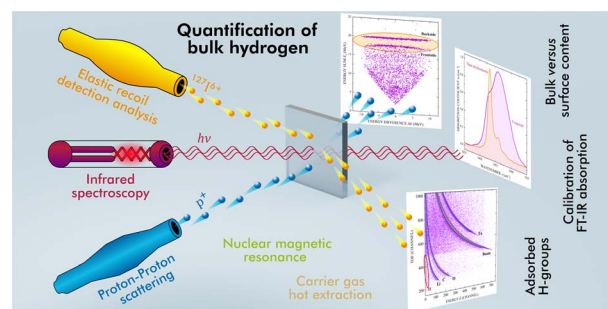


PAPERS

21183

On the quantification of hydrogen in lithium metal oxides

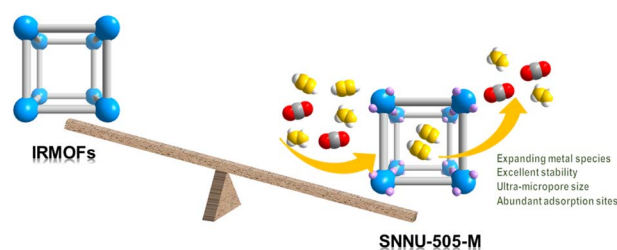
Thomas Köhler,* Patrick Reichart, Erica Brendler, Anastasia Vyalikh, Andre Klostermeier, Zdravko Siketić, Erik Mehner, Günther Dollinger, Hartmut Stöcker and Dirk C. Meyer



21203

Development of MOF-5-like ultra-microporous metal-squarate frameworks for efficient acetylene storage and separation

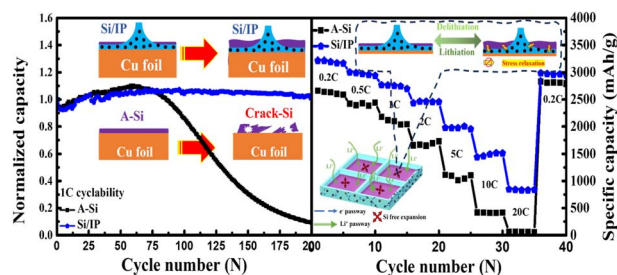
Hai-Peng Li, Jia-Wen Wang and Quan-Guo Zhai*



21211

Waterbed inspired stress relaxation strategies of patterned silicon anodes for fast-charging and longevity of lithium microbatteries

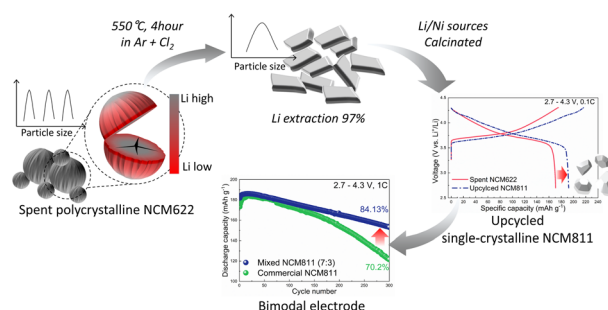
Yi-Xiu Chen, Yin-Wei Cheng, Jun-Han Huang and Chuan-Pu Liu*



21222

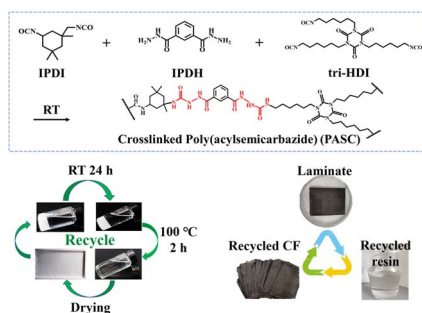
Upcycling spent cathodes into single-crystalline Ni-rich cathode materials through selective lithium extraction

Kyoung Sun Kim, Min Ku Jeon, Seok Hyun Song, Seokjae Hong, Hwa Soo Kim, Sung-Wook Kim, Jinsoo Kim, Pilgun Oh, Junhyeok Hwang, Jinju Song, Jiyoung Ma, Jung-Je Woo, Seung-Ho Yu and Hyungsub Kim*



PAPERS

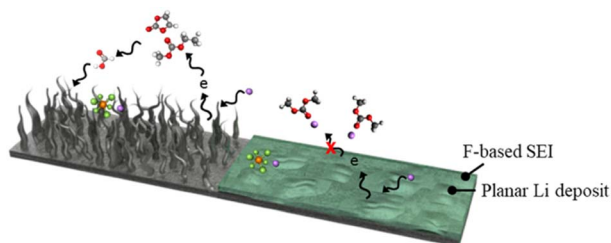
21231



Fully recyclable high-performance polyacylsemicarbazide/carbon fiber composites

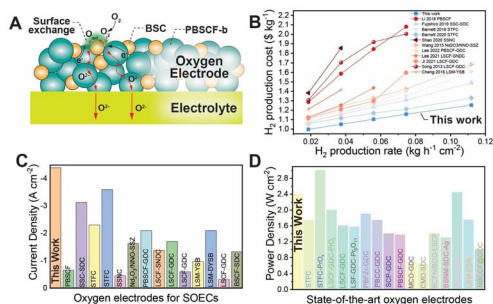
Zhiwen Jian, Yindong Wang, Xiaokang Zhang, Xi Yang, Zhanhua Wang, Xili Lu* and Hesheng Xia*

21244

Improvement of the Li metal-electrolyte interfacial stability by *cis-trans* polar conformer formation in a carbonate electrolyte

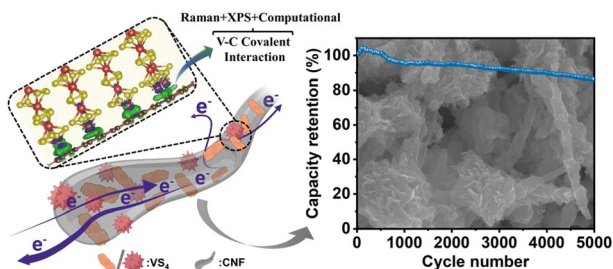
Min A Lee, Han Jun Leem, Jeong Beom Lee, Chihyun Hwang, Jisang Yu* and Hyun-seung Kim*

21251

Boosting the performance of reversible solid oxide electrochemical cells with a novel hybrid oxygen electrode, $\text{Pr}_{1.39}\text{Ba}_{0.14}\text{Sr}_{0.53}\text{Co}_{1.48}\text{Fe}_{0.76}\text{O}_{6-\delta}$ - $\text{Ba}_{0.66}\text{Sr}_{0.34}\text{CoO}_{3-\delta}$

Liyang Fang, Fan Liu, David Diercks, Praveen Kumar, Feng Zhao, Dong Ding* and Chuancheng Duan*

21263

Morphology-dependent enhancement of the electrochemical performance of CNF-guided tunable VS_4 heterostructures for symmetric supercapacitors

Saad Zafar, Arpit Thomas, Soumyasri Nikhilesh Mahapatra, Naiwrit Karmodak, Harpreet Singh Arora* and Bimlesh Lochab*

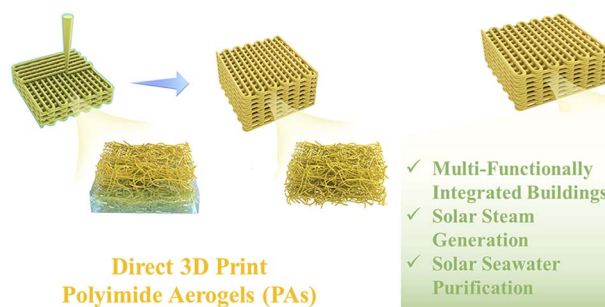


PAPERS

21272

Direct 3D print polyimide aerogels for synergy management of thermal insulation, gas permeability and light absorption

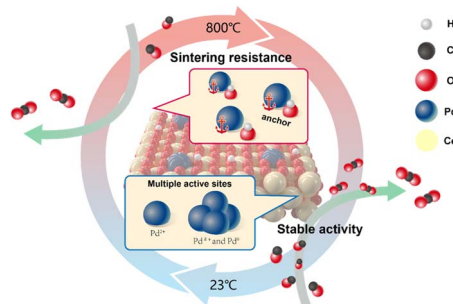
Jianming Yang, Jialu Lu, Shuang Xi, Hongqiang Wang, Dongxiao Han, Caide Fan, Zhihua Zhang, Jun Shen, Bin Zhou* and Ai Du*



21285

Sintering resistance of Pd single atoms on steam-modified ceria: deciphering the role of hydroxyl groups

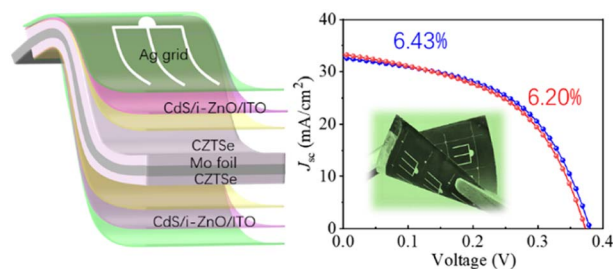
Yuanyuan An, Sheng-Yu Chen, Li Zhou, Beibei Wang, Guoxiu Hao, Junchen Chen, Yanli Wang, Hui Zhang, Zheng Peng, Tsung-Cheng Yang, Chia-Min Yang, Jeng-Lung Chen, Chia-Kuang Tsung, Zhi Liu* and Lien-Yang Chou*



21293

Interface-suppressed high-quality symmetrical bifacial flexible CZTSe solar cells through a green electrodeposition process

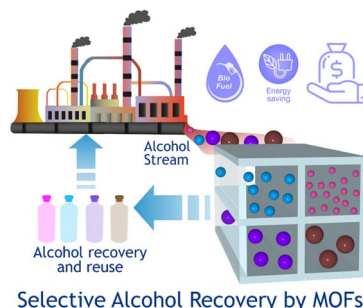
Jingling Liu, Hang Cai, Xinyu Wu, Sheng Liu, Ying Xue, Xinsheng Liu, Ke Cheng* and Zuliang Du*



21300

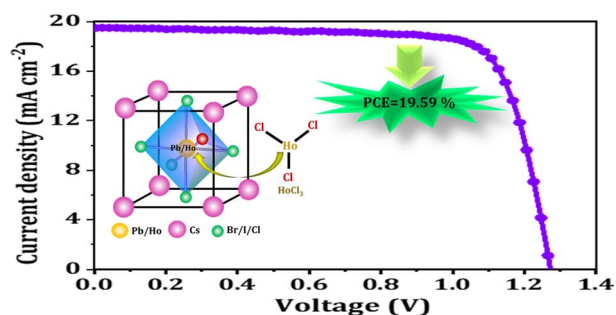
Guest-induced breathing mediated selective alcohol recovery from water by MIL-88A(Fe)

Nagore Barroso, Subhajit Dutta, Jacopo Andreo, Garikoitz Beobide, Oscar Castillo,* Antonio Luque, Sonia Pérez-Yáñez and Stefan Wuttke*



PAPERS

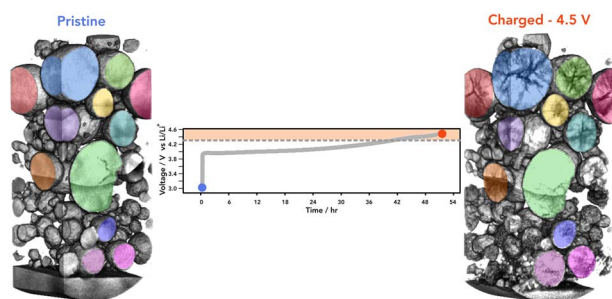
21312



Holmium rare earth metal ion incorporated and ambient-air processed all-inorganic γ -CsPbI_{2.5}Br_{0.5} perovskite solar cells yielding high efficiency and stable performance

Jyoti V. Patil, Sawanta S. Mali and Chang Kook Hong*

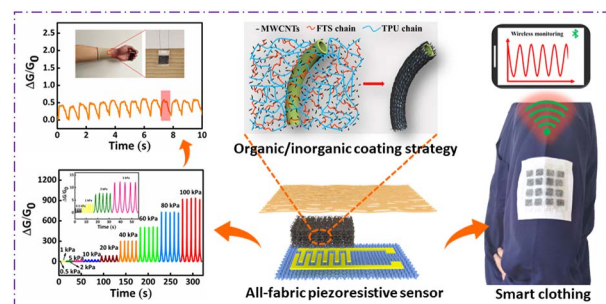
21322



Direct observations of electrochemically induced intergranular cracking in polycrystalline NMC811 particles

Huw C. W. Parks, Adam M. Boyce, Aaron Wade, Thomas M. M. Heenan, Chun Tan, Emilio Martínez-Pañeda, Paul R. Shearing, Dan J. L. Brett and Rhodri Jervis*

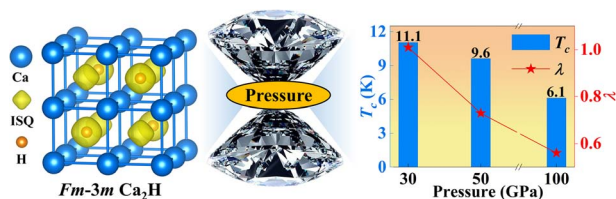
21333



An organic/inorganic coating strategy that greatly enhanced sensing performances and reliability of all-fabric piezoresistive sensors

Guangliang Tian, Kangli Xu, Yaoli Huang, Xinxin You, Wenhua Yu, Honggang Liu, Juan Li, Jiawei Liu, Xiangyu Jin, Haoxuan Li,* Qinfei Ke* and Chen Huang*

21345



Coexistence of superconductivity and electride states in Ca₂H with an antiferrotype motif under compression

Qianyi Wang, Shoutao Zhang,* Honggang Li, Hongbo Wang, Guangtao Liu, Jiangang Ma, Haiyang Xu, Hanyu Liu* and Yanming Ma

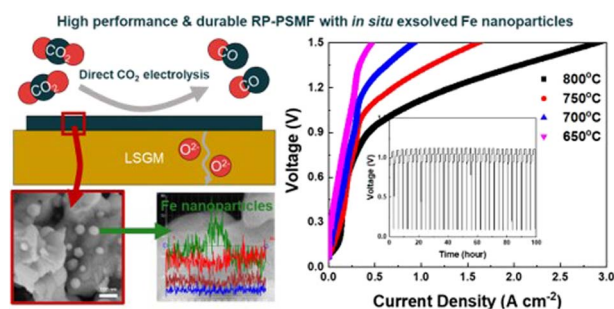


PAPERS

21354

High-performance Ruddlesden–Popper perovskite oxide with *in situ* exsolved nanoparticles for direct CO₂ electrolysis

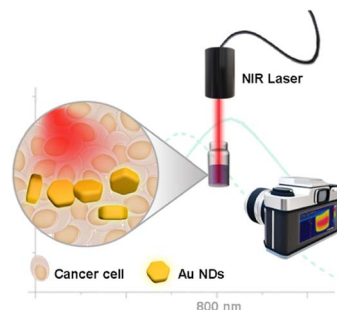
Ka-Young Park, Taehee Lee, Wanhua Wang, Haixia Li and Fanglin Chen



21365

Photothermal therapy for cancer cells using optically tunable Fe₂O₃@Au hexagonal nanodisks

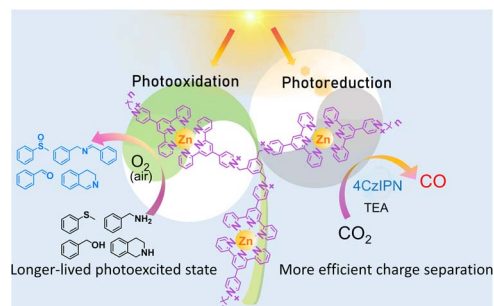
Lin Li, Fenglian Qi, Jiong Guo, Jing Fan, Wenxiang Zheng, Murtaza Ghulam, Weizhi Wang, Zihui Meng* and Lili Qiu*



21373

Unveiling dual catalysis enhancement of a pyridinium-containing Zn(II) coordination polymer in aerobic photooxidation of organic substrates and selective photoreduction of CO₂

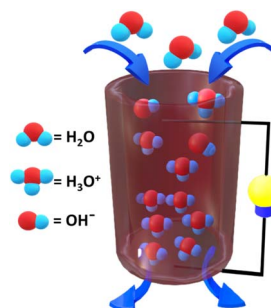
Youting Fang and Duobin Chao*



21383

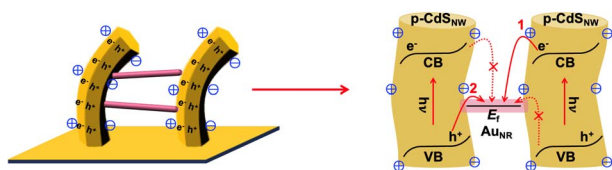
Sustainable electricity from gravity-driven nanofluidic flow of water through modified bio-channels of coir fibers

Barsha Rani Bora, Monotosh Mondal, Nabamallika Nath, K. K. R. Datta and Kalyan Raidongia*



PAPERS

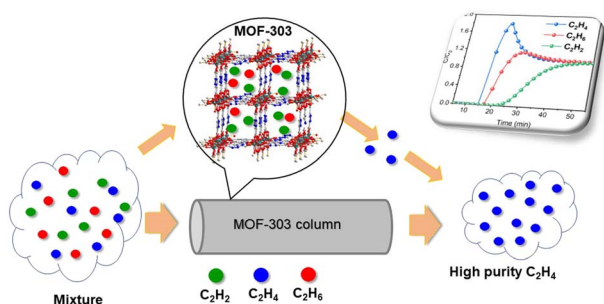
21393



Multipoint-bridging structure with a piezoelectricity-induced S-scheme junction for piezoelectricity-enhanced photoelectrochemical H_2O_2 production

Chenpu Chen and Jun Cheng*

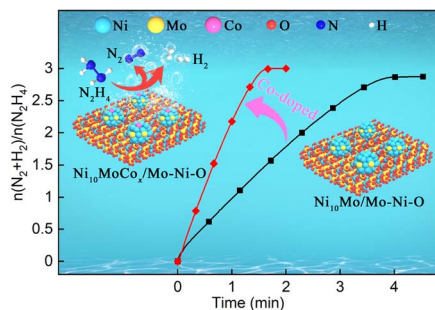
21401



Simultaneous removal of C_2H_2 and C_2H_6 for C_2H_4 purification by robust MOFs featuring a high density of heteroatoms

Shikai Xian, Junjie Peng, Haardik Pandey, Wells Graham, Liang Yu, Hao Wang, Kui Tan, Timo Thonhauser and Jing Li*

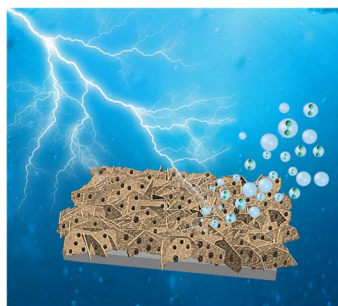
21411



Noble-metal-free $\text{Ni}_{10}\text{MoCo}_x/\text{Mo-Ni-O}$ as an active and durable catalyst for hydrogen generation from hydrazine monohydrate

Si-Huan Qin, Yu-Ping Qiu,* Mu-Hua Chen and Ping Wang*

21420



Defective NiMn LDH prepared using hydrogen evolution coupled electrodeposition for highly efficient oxygen evolution reaction

Mao Sun and Jike Wang*

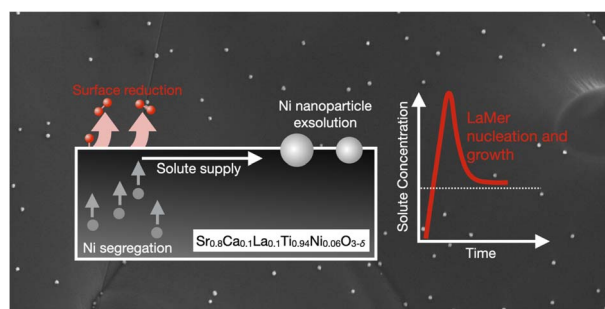


PAPERS

21429

Tuning reduction conditions to understand and control Ni exsolution from $\text{Sr}_{0.8}\text{La}_{0.1}\text{Ca}_{0.1}\text{Ti}_{0.94}\text{Ni}_{0.06}\text{O}_{3-\delta}$

Willis O'Leary, Livia Giordano and Jennifer L. M. Rupp*



21443

Maximizing energy efficiency with a mirror-structured hybrid generator leveraging triboelectric and photovoltaic cells for optimal coverage and wind awareness

Inkyum Kim and Daewon Kim*

