

Energy & Environmental Science

rsc.li/ees

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 1754–5706 CODEN EESNBY 18(12) 5661–6310 (2025)



Cover

See Ifan E. L. Stephens *et al.*, pp. 5897–5901. Image reproduced by permission of Craig Burdis from *Energy Environ. Sci.*, 2025, **18**, 5897.



Inside cover

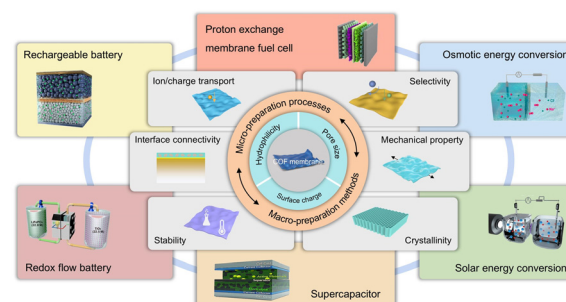
See Ting Xu, Fusheng Pan, Chaoji Chen, Chuanling Si *et al.*, pp. 5675–5739. Image reproduced by permission of Ting Xu, Fusheng Pan, Chaoji Chen and Chuanling Si from *Energy Environ. Sci.*, 2025, **18**, 5675.

REVIEWS

5675

Covalent organic framework membranes for energy storage and conversion

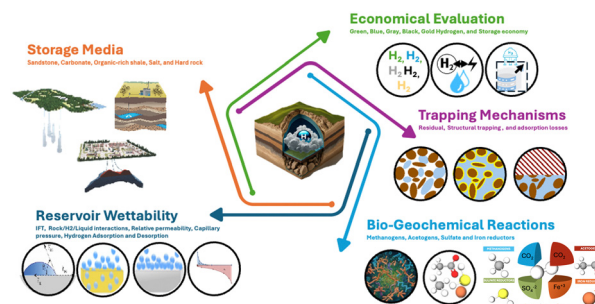
Liyu Zhu, Yu Cao, Ting Xu,* Hongbin Yang, Luying Wang, Lin Dai, Fusheng Pan,* Chaoji Chen* and Chuanling Si*



5740

Recent progress in underground hydrogen storage

Muhammad Ali,* Abubakar Isah,* Nurudeen Yekeen,* Aliakbar Hassanpouryouzband, Mohammad Sarmadivaleh, Esuru Rita Okoroafor, Mohammed Al Kobaisi, Mohamed Mahmoud, Volker Vahrenkamp and Hussein Hoteit



**GOLD
OPEN
ACCESS**

EES Batteries

**Exceptional research on
batteries and energy storage**

Part of the EES family

**Join
in** | Publish with us
rsc.li/EESBatteries

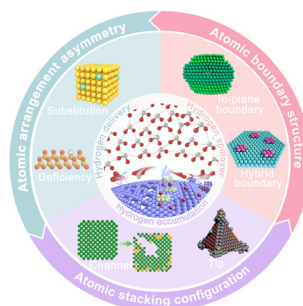


REVIEWS

5811

Atomic-level insights for engineering interfacial hydrogen microenvironments of metal-based catalysts for alkaline hydrogen electrocatalysis

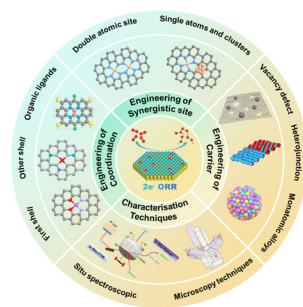
Kunjie Wang, Xingyu Cui, Jingxuan Zhao, Qing Wang and Xu Zhao*



5833

Atomically dispersed catalysts: for the efficient and stable industrial electrosynthesis of H_2O_2

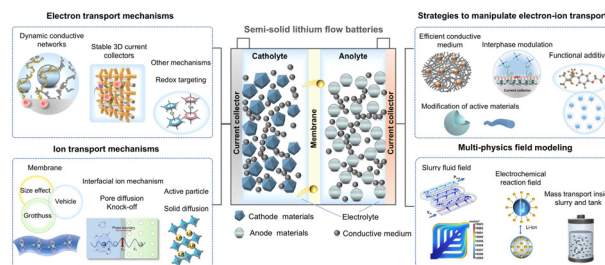
Yapeng Du, Xueqin Mu, Shengchen Wang, Yifan Zhang, Fanjiao Chen, Mengyang Zhang, Junlin Li, Pingping Cao, Jiayao Yuan, Yue Zhang, Linsheng Liu, Zhengyang Liu, Qin Ma, Suli Liu,* Dingsheng Wang* and Zhihui Dai*



5868

Multiscale coupled electron–ion transport in semi-solid lithium flow batteries

Shanshan Pan, Wenhao Fang, Jie Yan, Suojia Zhang* and Haitao Zhang*

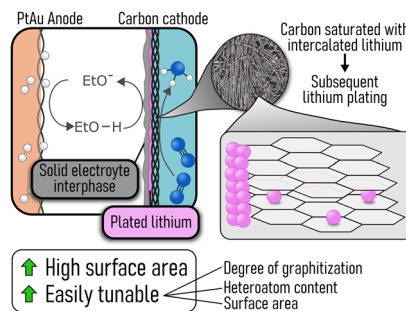


COMMUNICATION

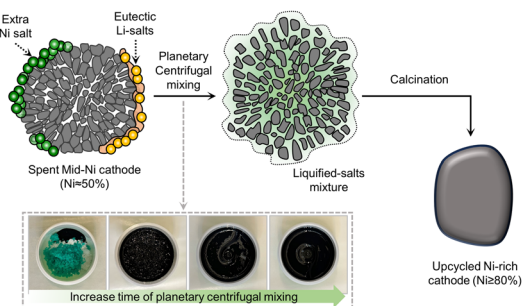
5897

A carbon cathode for lithium mediated electrochemical ammonia synthesis

Craig Burdis, Romain Tort, Anna Winiwarter, Johannes Rietbrock, Jesús Barrio, Maria Magdalena Titirici and Ifan E. L. Stephens*



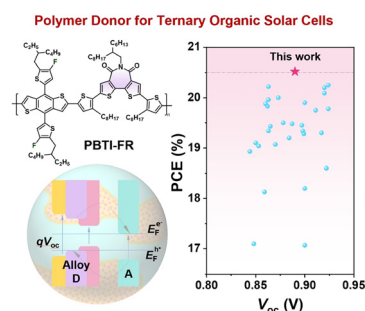
5902



Upcycling spent medium-Ni cathodes via novel liquified salt sourcing

Moonsu Yoon, Jin-Sung Park, Weiyan Chen, Yimeng Huang, Tao Dai, Yumin Lee, Jungmin Shin, Seungmi Lee, Yongil Kim, Dongsoo Lee, Daiha Shin, Jaephil Cho, Yanhao Dong* and Ju Li*

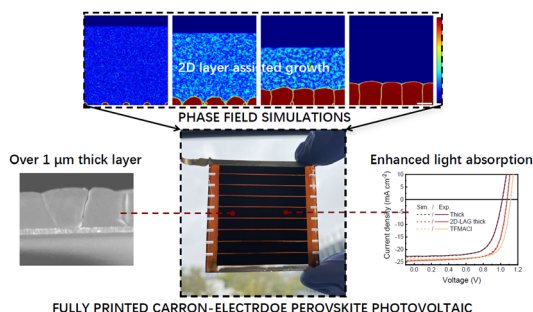
5913



A bithiophene imide-based polymer donor for alloy-like ternary organic solar cells with over 20.5% efficiency and enhanced stability

Changjing Xu, Jie Yang, Sergio Gámez-Valenzuela, Jin-Woo Lee, Jiaxu Che, Peng Chen, Guodong Zhang, Dingqin Hu, Yufei Wang, Jichen Lv, Zhicheng Zhong, Xihan Chen, Guangye Zhang, Fuwen Zhao, Bumjoon J. Kim,* Xugang Guo* and Bin Liu*

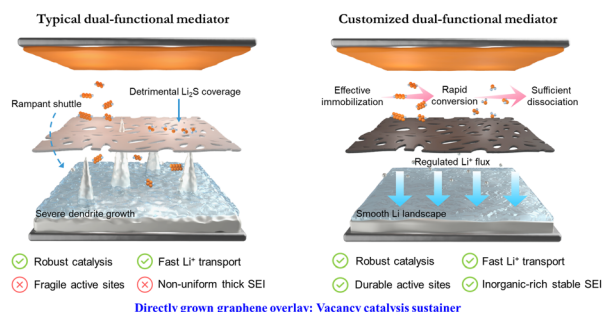
5926



Over one-micron-thick void-free perovskite layers enable highly efficient and fully printed solar cells

Shudi Qiu, Martin Majewski, Lirong Dong, Andreas Distler, Chaohui Li, Karen Forberich, Jingjing Tian, Naveen Harindu Hemasiri, Chao Liu, Jiyun Zhang, Fu Yang, Vincent M. Le Corre, Max Bibrack, Robin Basu, Anastasia Barabash, Jens Harting, Olivier J. J. Ronsin,* Tian Du,* Hans-Joachim Egelhaaf and Christoph J. Brabec*

5940



Directly grown graphene overlay: Vacancy catalysis sustainer

Sustaining vacancy catalysis via conformational graphene overlays boosts practical Li-S batteries

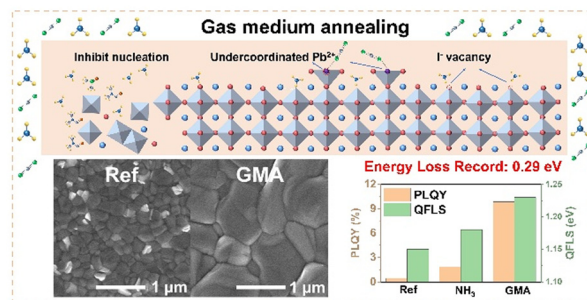
Jiaxi Gu, Zixiong Shi, Yongbiao Mu, Yuzhu Wu, Meng Tian,* Ziang Chen, Kaihui Chen, Huicun Gu, Miaoyu Lu, Lin Zeng,* Yuqing Song,* Qiang Zhang and Jingyu Sun*



5952

Gas-medium annealing for perovskite solar cells with state-of-the-art energy loss

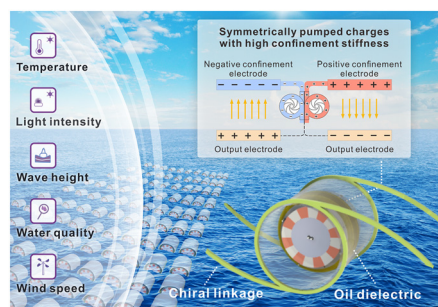
Mengjiong Chen, Zhenzhen Qin, Ziyang Zhang, Yanbo Wang* and Liyuan Han*



5961

Symmetrically pumped charges with high confinement stiffness for boosted performance in wave energy harvesting

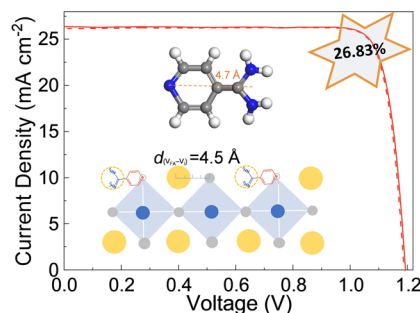
Huijing Qiu, Weizhi Song, Zichao Deng, Zhong Lin Wang* and Liang Xu*



5973

Dual-site passivation by heterocycle functionalized amidinium cations toward high-performance inverted perovskite solar cells and modules

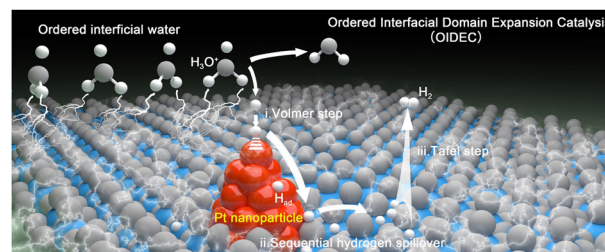
Menghan Lu, Jike Ding, Quanxing Ma, Zuolin Zhang, Mengjia Li, Wenhuan Gao, Wenlong Mo, Boxue Zhang, Thierry Pauporté, Jiajia Zhang,* Yang Wang,* Jian-Xin Tang,* Jiangzhao Chen* and Cong Chen*



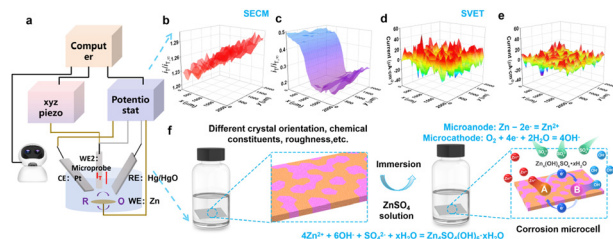
5985

Ordered interfacial domain expansion catalysis enhances hydrogen evolution for proton exchange membrane electrolysis

Ming-Rong Qu, Yu-Xiao Cheng, Si-Hua Feng, Jie Xu, Jia-Kang Yao, Wen-Sheng Yan, Sheng Zhu,* Liang Cao,* Rui Wu* and Shu-Hong Yu*



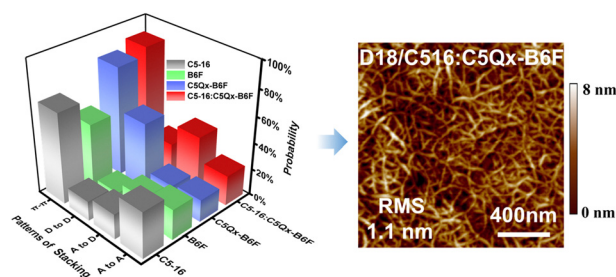
5998



Insight into the corrosion microcell and passivation mechanisms of a Zn anode for aqueous zinc-ion batteries

Ruijia Liu, Feng Hong, Qiqi Dai, Yupeng Xing, Hongfei Li, Sanlue Hu, Bo Tang, Cuiping Han* and Ding Nan*

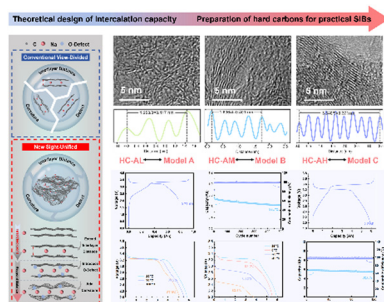
6009



Extension of the conjugated framework of non-fullerene electron acceptors toward highly efficient organic photovoltaics

Yuandong Sun, Liang Wang, Dawei Gao, Chen Chen, Zirui Gan, Jingchao Cheng, Jing Zhou, Dan Liu, Wei Li* and Tao Wang

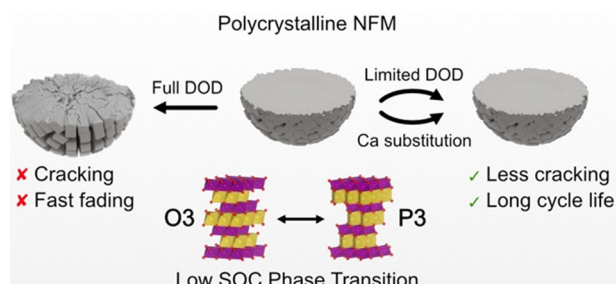
6019



Unraveling the structure–performance relationship in hard carbon for sodium-ion battery by coupling key structural parameters

Chun Wu, Yunrui Yang, Yifan Li, Xiangxi He, Yinghao Zhang, Wenjie Huang, Qinghang Chen, Xiaohao Liu, Shuangqiang Chen, Qinfen Gu, Lin Li, Sean C. Smith, Xin Tan,* Yan Yu,* Xingqiao Wu* and Shulei Chou*

6032



Navigating low state of charge phase transitions in layered cathodes for long-life sodium-ion batteries

Wenda Li, Zhaoyue Li, Lizhi Li, Alice J. Merryweather, Yilin Chen, Shaoyu Yang, Hao Shi, Yang Lu, Yixiao Qiu, Guangsu Tan, Zhipeng Chen, Weiwei Wang, Yuzhu Wang, Yi-Fan Huang, Zhengyan Lun, Christoph Schnedermann, Xiangwen Gao,* Jingyang Wang,* Clare P. Grey* and Chao Xu*

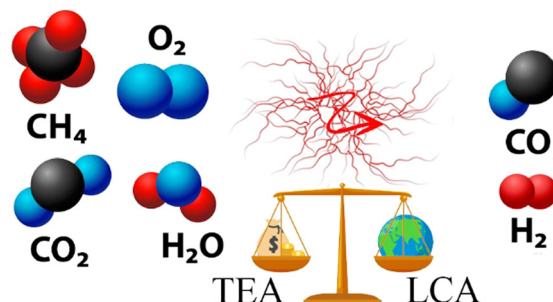


PAPERS

6043

Techno-economic and life-cycle assessment for syngas production using sustainable plasma-assisted methane reforming technologies

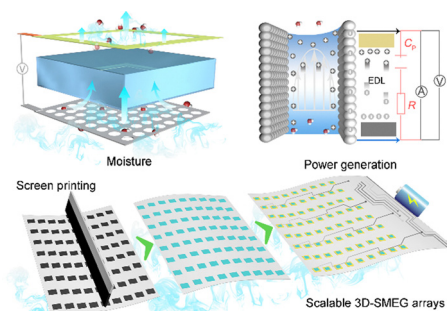
Marc Escribà-Gelonch, Jose Osorio-Tejada, Le Yu, Bart Wanten, Annemie Bogaerts* and Volker Hessel*



6063

Achieving persistent and ultra-high voltage output through an arid-adapted plant-inspired high-performance moisture-electric generator

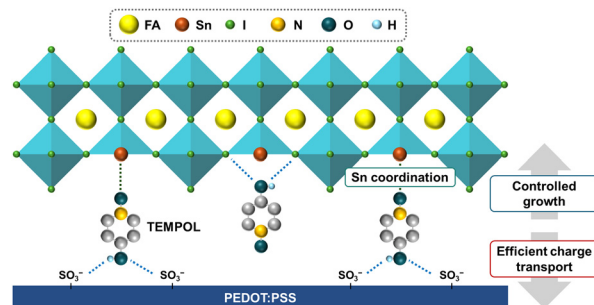
Yu Chen, Chengwei Ye, Jiajun He, Rui Guo, Liangti Qu* and Shaochun Tang*



6076

Radical scavenger-driven oxidation prevention and structural stabilization for efficient and stable tin-based perovskite solar cells

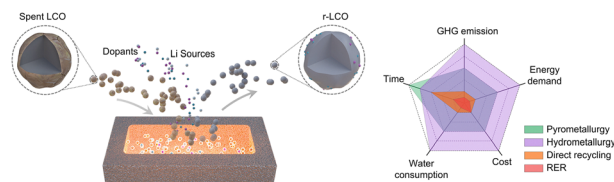
Seungon Jung, Yunjeong Jang, Hohyun Jung, Yujin Kim, Eunbin Son, Seulgi Jeong, Yihan Zhang, Joohoon Kang,* Jeong Min Baik,* Jianfeng Lu* and Hyesung Park*



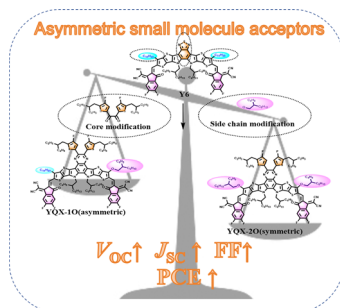
6085

Rapid electrothermal rejuvenation of spent lithium cobalt oxide cathode

Yi Cheng,* Jinhang Chen, Weiyin Chen, Qiming Liu, Obinna E. Onah, Zicheng Wang, Gang Wu, Tianyou Xie, Lucas Eddy, Boris I. Yakobson, Ju Li,* Yufeng Zhao* and James M. Tour*



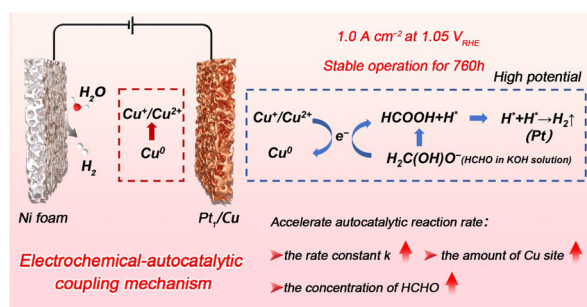
6094



Asymmetric non-fullerene acceptors with balanced crystallization kinetics enabling a trade-off between charge generation and recombination in ternary organic solar cells

Xiaoqi Yu, Jintao Zhu, Lin Xie,* Haotian Hu, Tongqiang Liu, Pengfei Ding, Xueliang Yu, Jinfeng Ge, Chengcheng Han, Wei Song* and Ziyi Ge*

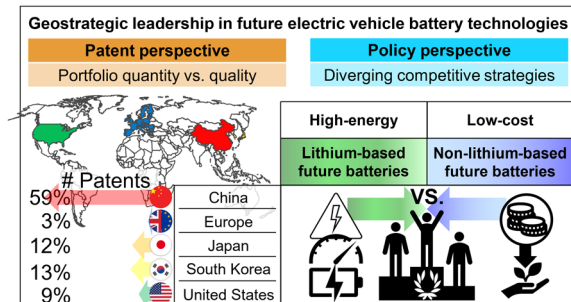
6106



Revealing the electrochemical-autocatalytic coupling mechanism of Cu-based catalysts for high-potential formaldehyde oxidation

Jia Song, Difei Xiao, Jiari He, Caiyun Zhang, Qianqian Zhang, Zeyan Wang, Yuanyuan Liu, Zhaoke Zheng, Hefeng Cheng, Yaqiang Wu, Baibiao Huang and Peng Wang*

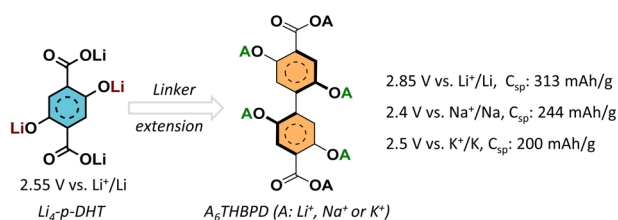
6117



The geostrategic race for leadership in future electric vehicle battery technologies

André Hemmelder,* Frank Tietze, Simon Lux, Jens Leker, Lars Jahnke and Stephan von Delft

6131



A hexaanionic carboxyphenolate framework for high energy alkali cation storage

Vasudeva Rao Bakuru, Petru Apostol, Darsi Rambabu, Shubhadeep Pal, Xiaodong Lin, Robert Markowski, Tom Goossens, Da Tie, Andrii Kachmar, Yan Zhang, Géraldine Chanteux and Alexandru Vlad*

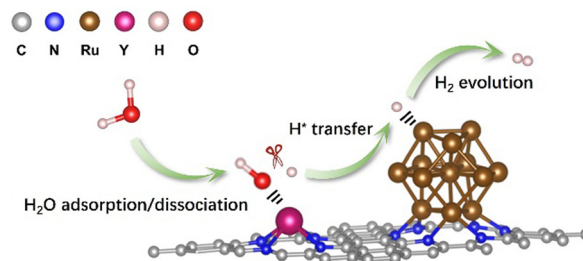


PAPERS

6141

Cascade electrocatalysis via integration of ruthenium clusters and yttrium single atoms for a boosted alkaline hydrogen evolution reaction

Haotian Zhang, Haoran Guo,* Fuhui Zhang, Jinyang Zhang, Yizhuo Cheng, Yanqing Ma, Lei Ma and Limin Qi*

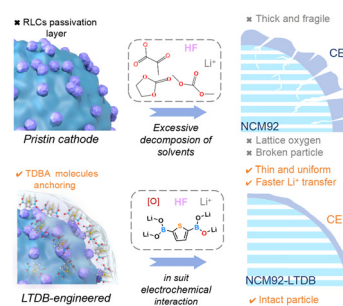


Cascade electrocatalysis mechanism for alkaline HER

6154

Molecular engineering of residual lithium compounds for stable $\text{LiNi}_{0.92}\text{Co}_{0.05}\text{Mn}_{0.03}\text{O}_2$ cathodes

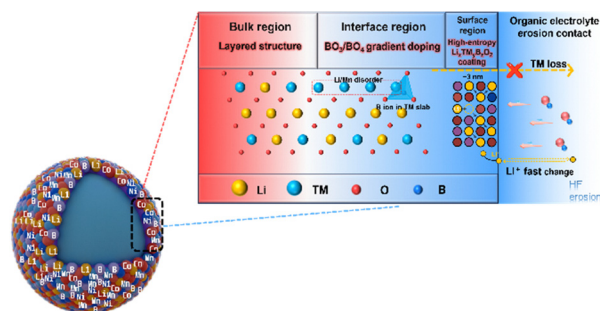
Weihong Jiang, Xianshu Wang,* Xuerui Yang, Yun Zhao, Jun Yao, Xiaoping Yang, Wei Luo, Liang Luo, Jianguo Duan,* Peng Dong, Yingjie Zhang, Baohua Li* and Ding Wang*



6168

A surface-to-interface boronation engineering strategy stabilizing the O/Mn redox chemistry of lithium-rich manganese based oxides towards high energy-density cathodes

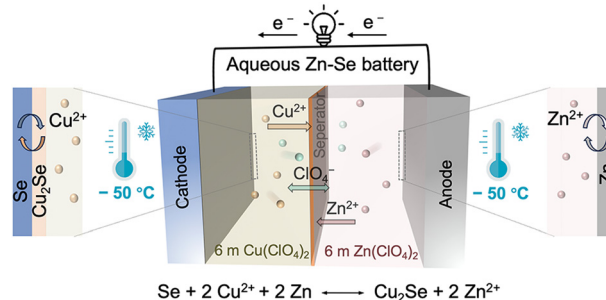
Mingzhe Yang, Tongle Chen, Gongrui Wang,* Xiaofeng Li, Yangyang Liu, Xuanxuan Ren, Ying Zhang, Lu Wu, Li Song, Juncai Sun* and Zhong-Shuai Wu*



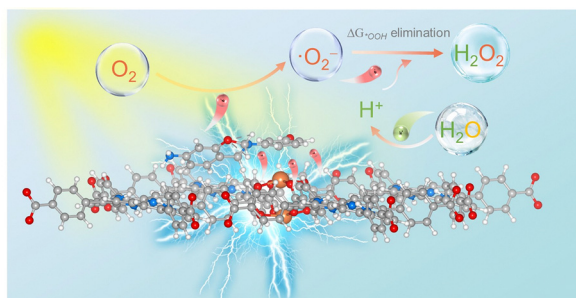
6180

A low-temperature aqueous Se-based battery with rapid reaction kinetics and unprecedented energy density

Guoqiang Liu, Linyu Hu, Ying Liu,* Maowen Xu, Jiajun Guo, Haichuan Zhou, Guoliang Ma, He Lin, Zhenhuang Su, Chang Liu, Jiangqi Zhao, Chunlong Dai* and Zifeng Lin*



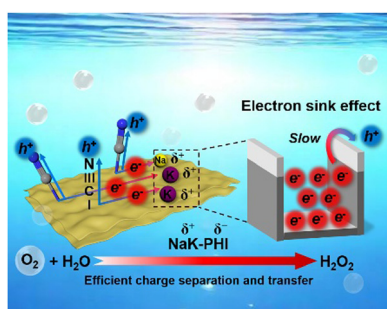
6191



Enhanced redox kinetics for hydrogen peroxide photosynthesis at high-concentration by encapsulating porphyrin metal-organic frameworks with phenolic resin

Houwei He, Zhongliao Wang, Jinfeng Zhang, Shavkat Mamatkulov, Olim Ruzimuradov, Kai Dai,* Jingxiang Low* and Yue Li*

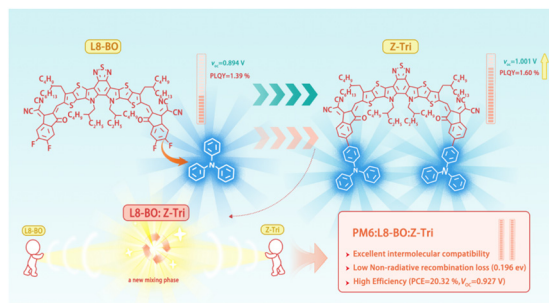
6202



Sodium/potassium poly(heptazine imide) with an electron sink effect for hydrogen peroxide photosynthesis

Xiao Fang, Bonan Li, Jiao Huang, Chunlian Hu, Xu Yang, Pengfei Feng, Xiaoyu Dong, Junhao Wu, Yuanyuan Li and Yong Ding*

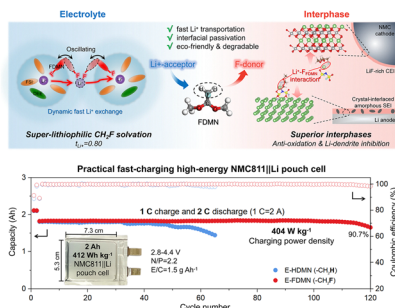
6214



Reducing energy loss by developing luminescent triphenylamine functionalized electron acceptor for high performance organic solar cells

Yue Chen, Xiaopeng Duan, Junjie Zhang, Zhongwei Ge, Haisheng Ma, Xiaobo Sun,* Huotian Zhang,* Jiabin Gao, Xuelin Wang, Xunchang Wang, Zheng Tang, Renqiang Yang, Feng Gao and Yanming Sun*

6224



Oscillating lithium ion-acceptor fluorine-donor electrolytes for practical fast-charging high-energy lithium metal pouch cells

Digen Ruan, Yanru Wang, Jiasen Guo, Zhuangzhuang Cui, Qingshun Nian, Zhihao Ma, Dazhuang Wang, Jiajia Fan, Jun Ma, Bingqing Xiong, Qi Dong, Ruiguo Cao, Shuhong Jiao and Xiaodi Ren*

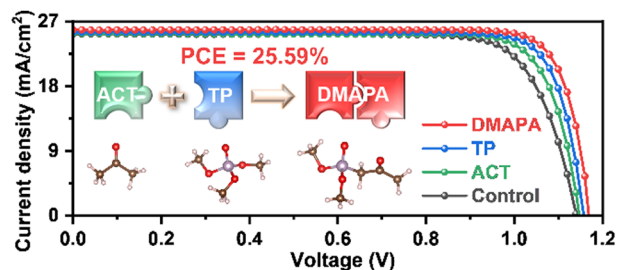


PAPERS

6237

Molecular integration of Lewis bases for efficient and stable inverted perovskite solar cells

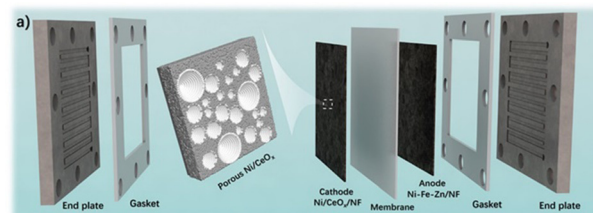
Yinhua Lv, Chi Yang,* Zhenhuang Su, Tianwei He, Ruohao Wang, Ruihao Chen,* Xingyu Gao* and Wen-Hua Zhang*



6248

Efficient hydrogen evolution at Ni/CeO_x interfaces in anion-exchange membrane water electrolyzers

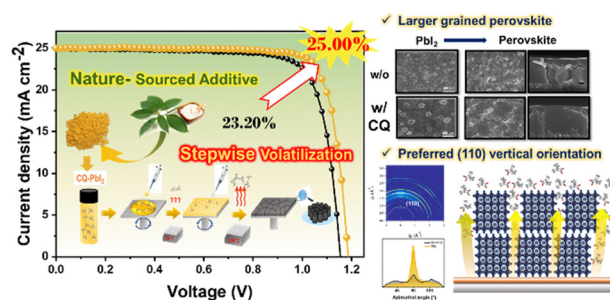
Ibrahim O. Baibars, Haisen Huang, Yang Xiao, Shuhao Wang, Yan Nie, Chen Jia, Kamran Dastafkan and Chuan Zhao*



6260

Stepwise volatilization induced by nature-sourced volatile solid additives improving the efficiency and stability of perovskite solar cells

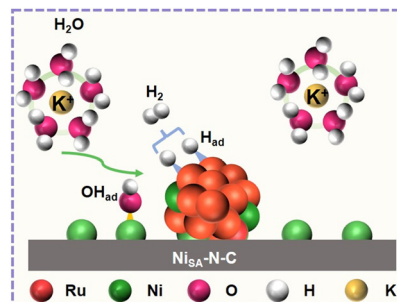
Jeewon Park, Seoyoung Kim, Wonjun Kim, Zhe Sun, Byongkyu Lee and Changduk Yang*



6273

Synergy of Ni single atom and RuNi alloy nanocluster enables boosted hydrogen evolution at industrial current densities

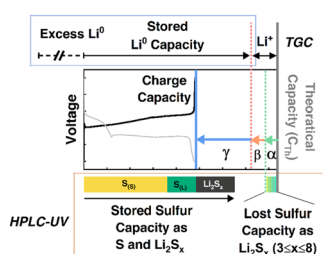
Guanghui Xu, Jinsheng Li, Youze Zeng, Zhaoping Shi, Wei Qi, Kai Li, Meiling Xiao,* Changpeng Liu, Wei Xing* and Jianbing Zhu*



PAPERS

6283

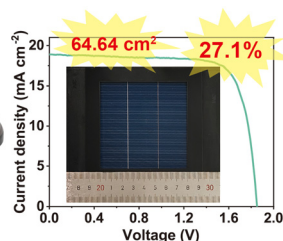
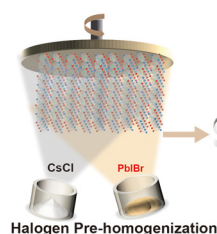
HUGS: Diagnosis Toolkit for Li-S batteries



Quantitative insights for diagnosing performance bottlenecks in lithium–sulfur batteries

Saurabh Parab, Jonathan Lee, Matthew Miyagishima, Qiushi Miao, Bhargav Bhamwala, Alex Liu, Louis Ah, Bhagath Sreenarayanan, Kun Ryu, Mingqian Li, Neal Arakawa, Robert Schmidt, Mei Cai, Fang Dai, Ping Liu, Shen Wang* and Ying Shirley Meng*

6297



Halogen anion pre-homogenization of sequentially deposited wide bandgap perovskites for commercial textured perovskite/silicon tandem solar cells

Biao Shi, Pengfei Liu, Zetong Sunli, Wei Han, Cong Sun, Ying Liu, Yuan Luo, Jin Si, Pengcheng Du, Fu Zhang, Miao Yang, Yongcai He,* Bo He, Dekun Zhang, Xiaona Du, Xixiang Xu, Rui Xia, Xueling Zhang, Yifeng Chen, Jifan Gao,* Ying Zhao and Xiaodan Zhang*

CORRECTION

6307

Correction: CO residence time modulates multi-carbon formation rates in a zero-gap Cu based CO₂ electrolyzer

Siddhartha Subramanian,* Jesse Kok, Pratik Gholkar, Asvin Sajeev Kumar, Hugo-Pieter Iglesias van Montfort, Ruud Kortlever, Atsushi Urakawa, Bernard Dam and Thomas Burdyny*

