

# 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 17(3) 827–1296 (2024)



### Cover

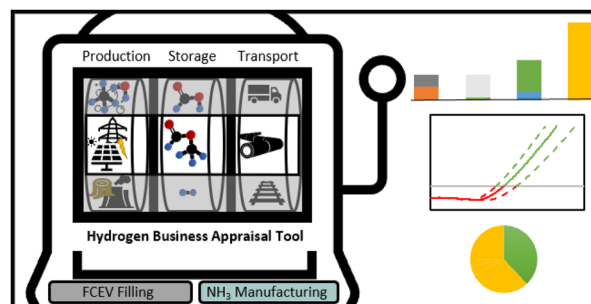
See Chang Kook Hong *et al.*, pp. 1046–1060. Image reproduced by permission of Dr Sawanta S. Mali from *Energy Environ. Sci.*, 2024, 17, 1046.

## ANALYSIS

838

### Nurturing the blossoming hydrogen economy using HBAT: modelling every link in the H<sub>2</sub> supply chain

Nicolas Alfonso Vargas,\* Moon Jung Kim, Carlos D. Alfonso Vargas, Daniel F. Alfonso and Justin T. Evans

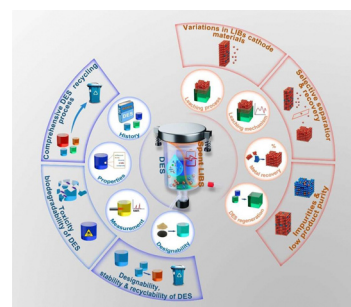


## REVIEWS

867

### Green recycling of spent Li-ion battery cathodes via deep-eutectic solvents

Jingxiu Wang, Yanqiu Lyu, Rong Zeng, Shilin Zhang, Kenneth Davey, Jianfeng Mao\* and Zaiping Guo\*



# Advance your career in science

with professional recognition that showcases  
your **experience, expertise and dedication**

## Stand out from the crowd

Prove your commitment  
to attaining excellence in  
your field

## Gain the recognition you deserve

Achieve a professional  
qualification that inspires  
confidence and trust

## Unlock your career potential

Apply for our professional  
registers (RSci, RSciTech)  
or chartered status  
(CChem, CSci, CEnv)

## Apply now

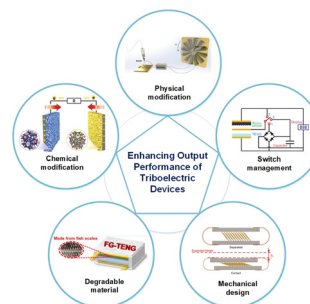
[rsc.li/professional-development](https://rsc.li/professional-development)



885

## Progress in techniques for improving the output performance of triboelectric nanogenerators

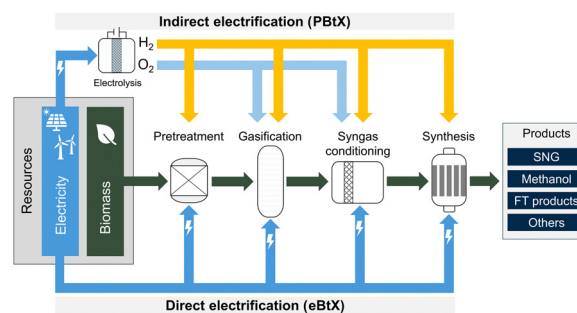
Chen Cao, Zhongjie Li,\* Fan Shen, Qin Zhang, Ying Gong, Hengyu Guo, Yan Peng\* and Zhong Lin Wang\*



925

## Electrification of gasification-based biomass-to-X processes – a critical review and in-depth assessment

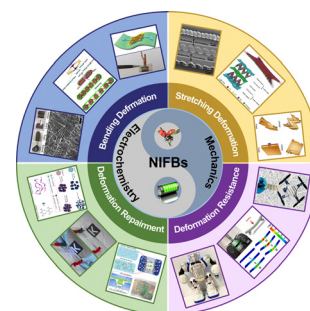
Marcel Dossow,\* Daniel Klüh,\* Kentaro Umeki, Matthias Gaderer, Hartmut Spliethoff and Sebastian Fendt



974

## Mechanics and electrochemistry in nature-inspired functional batteries: fundamentals, configurations and devices

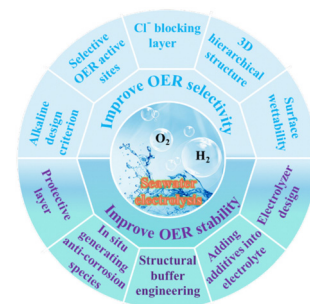
Xiangjun Xiao, Qi Meng, Jiaming Zhu, Yan Zhang, Yulin Ma, Hua Huo, Geping Yin\* and Shuaifeng Lou\*



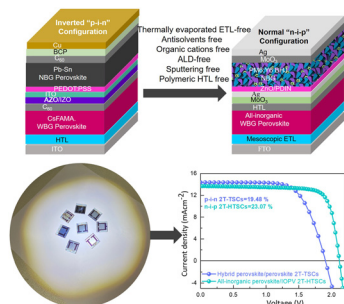
1007

## Highly efficient sustainable strategies toward carbon-neutral energy production

Jingbin Huang, Bin Hu, Jiashen Meng, Tao Meng, Wenxin Liu, Yiting Guan, Lin Jin\* and Xingcai Zhang\*



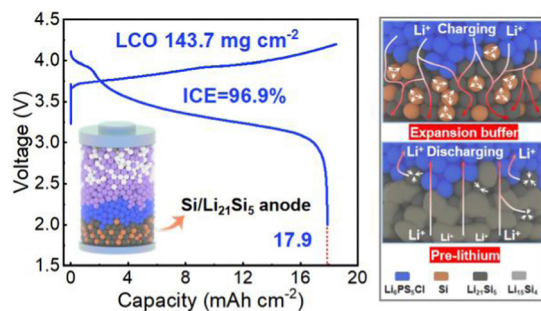
1046



### All-inorganic halide perovskites for air-processed "n-i-p" monolithic perovskite/organic hybrid tandem solar cells exceeding 23% efficiency

Sawanta S. Mali, Jyoti V. Patil, Julian A. Steele, Mohammad Khaja Nazeeruddin, Jin Hyeok Kim and Chang Kook Hong\*

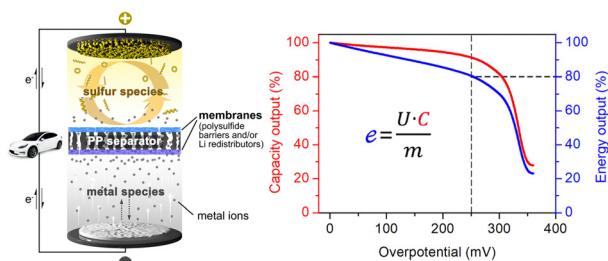
1061



### An all-electrochem-active silicon anode enabled by spontaneous Li-Si alloying for ultra-high performance solid-state batteries

Zhiyong Zhang, Zhefei Sun, Xiang Han, Yan Liu, Shanpeng Pei, Yahui Li, Linshan Luo, Pengfei Su, Chaofei Lan, Ziqi Zhang, Shaowen Xu, Shengshi Guo, Wei Huang,\* Songyan Chen\* and Ming-Sheng Wang\*

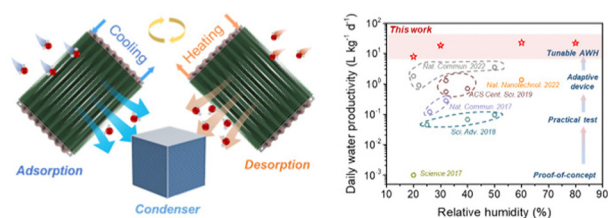
1073



### Balancing polysulfide containment and energy loss in lithium-sulfur batteries

Borui Liu, Huimin Gu, Juan F. Torres, Zongyou Yin\* and Antonio Tricoli\*

1083



### Active MOF water harvester with extraordinary productivity enabled by cooling-enhanced sorption

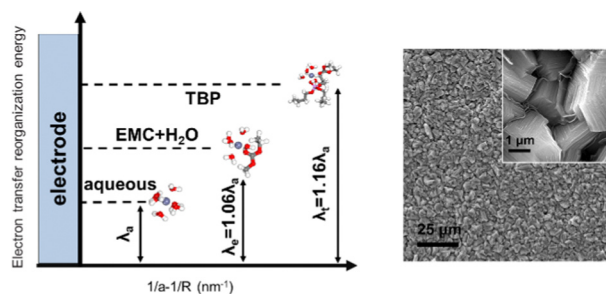
Yahui Feng, Lurong Ge, Yao Zhao, Qian Li, Ruzhu Wang and Tianshu Ge\*



1095

### Regulating the electrochemical reduction kinetics by the steric hindrance effect for a robust Zn metal anode

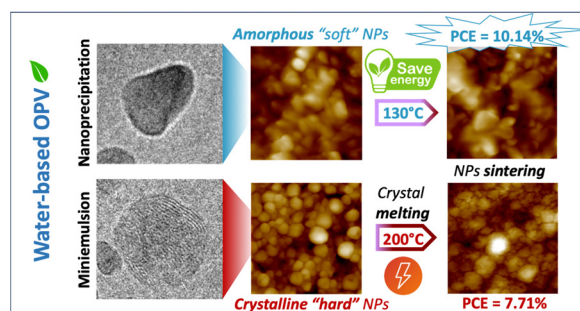
Shuo Yang, Ao Chen, Zijie Tang, Zhuoxi Wu, Pei Li, Yanbo Wang, Xiaoqi Wang,\* Xu Jin, Shengchi Bai and Chunyi Zhi\*



1107

### Water-based solar cells over 10% efficiency: designing soft nanoparticles for improved processability

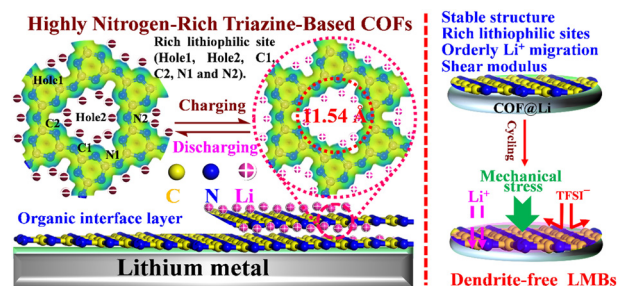
Alexandre Holmes, Hugo Laval, Michele Guizzardi, Valentina Maruzzo, Giulia Folpini, Nadia Barbero, Elise Deniau, Marc Schmutz, Sylvie Blanc, Annamaria Petrozza, Giuseppe Maria Paternò, Guillaume Wantz, Sylvain Chambon,\* Christine Lartigau-Dagron\* and Antoine Bousquet\*



1117

### In situ interface engineering of highly nitrogen-rich triazine-based covalent organic frameworks for an ultra-stable, dendrite-free lithium-metal anode

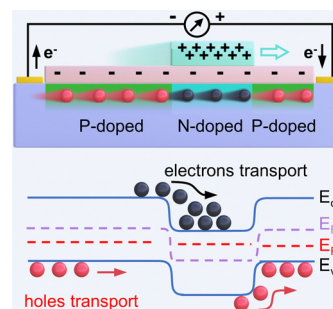
Liguo Yue, Xinying Wang, Li Chen, Dijun Shen, Zhuhang Shao, Hao Wu, Shengfu Xiao, Weiquan Liang, Yaojiang Yu and Yunyong Li\*



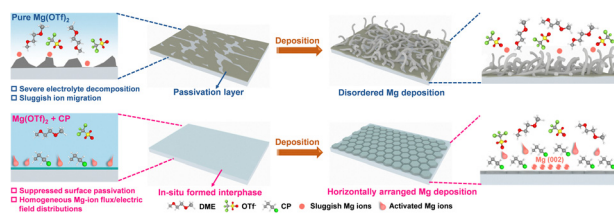
1132

### Field effect nanogenerator operated by sliding gates

Chongxiang Pan, Leo N.Y. Cao, Jia Meng, Luyao Jia, Weiguo Hu, Zhong Lin Wang\* and Xiong Pu\*



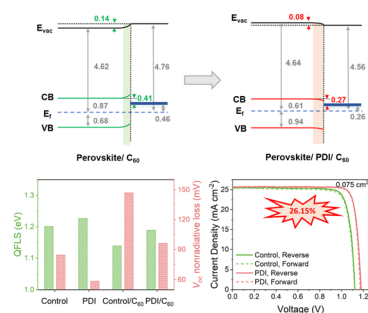
1141



### Realizing horizontal magnesium platelet deposition and suppressed surface passivation for high-performance magnesium metal batteries

Gaoliang Yang, Yuanjian Li, Jianbiao Wang, Yanwei Lum, Carina Yi Jing Lim, Man-Fai Ng, Chang Zhang, Zhi Chang, Zhonghan Zhang, Albertus D. Handoko, Tanmay Ghosh, Shuzhou Li, Zdenek Sofer, Wei Liu, Yan Yao\* and Zhi Wei Seh\*

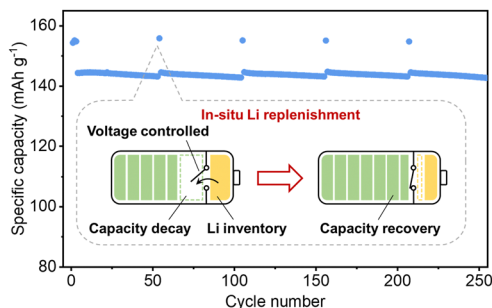
1153



### Towards 26% efficiency in inverted perovskite solar cells *via* interfacial flipped band bending and suppressed deep-level traps

Yiting Zheng, Yaru Li,\* Rongshan Zhuang, Xueyun Wu, Congcong Tian, Anxin Sun, Chen Chen, Yongsheng Guo, Yong Hua, Ke Meng,\* Kai Wu\* and Chun-Chao Chen\*

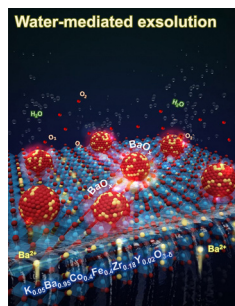
1163



### Controllable long-term lithium replenishment for enhancing energy density and cycle life of lithium-ion batteries

Ganxiong Liu, Wang Wan, Quan Nie, Can Zhang, Xinlong Chen, Weihuang Lin, Xuezhe Wei, Yunhui Huang, Ju Li\* and Chao Wang\*

1175



### Water-mediated exsolution of nanoparticles in alkali metal-doped perovskite structured triple-conducting oxygen electrocatalysts for reversible cells

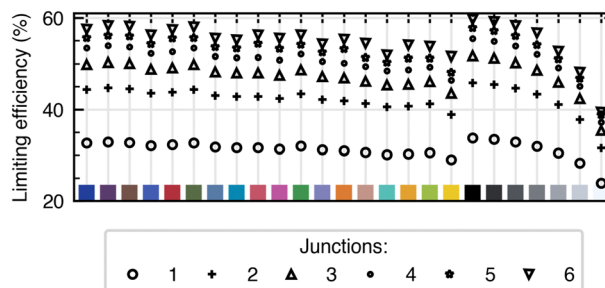
Kwangho Park, Muhammad Saqib, Hyungwoo Lee, Donghwi Shin, Minkyong Jo, Kwang Min Park, Muhammad Hamayun, Seo Hyun Kim, Sungkyu Kim, Kug-Seung Lee, Ryan O'Hayre, Minseok Choi,\* Sun-Ju Song\* and Jun-Young Park\*



1189

### Efficiency limits and design principles for multi-junction coloured photovoltaics

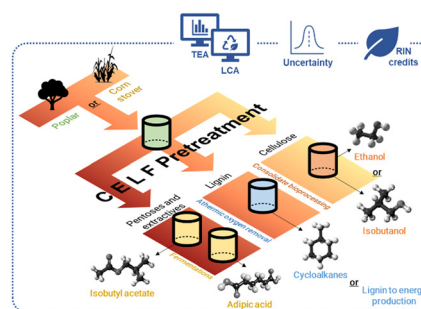
Phoebe M. Pearce,\* Janne Halme, Jessica Yajie Jiang and Nicholas J. Ekins-Daukes



1202

### Economics and global warming potential of a commercial-scale delignifying biorefinery based on co-solvent enhanced lignocellulosic fractionation to produce alcohols, sustainable aviation fuels, and co-products from biomass

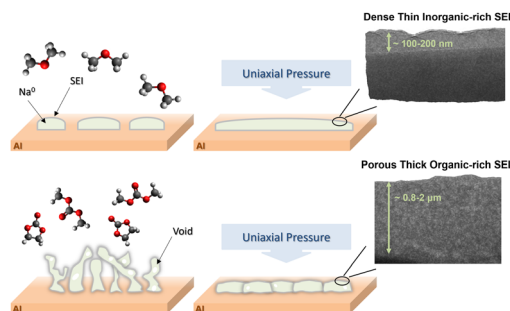
Bruno Colling Klein, Brent Scheidemantle, Rebecca J. Hanes, Andrew W. Bartling, Nicholas J. Grundl, Robin J. Clark, Mary J. Bidy, Ling Tao, Cong T. Trinh, Adam M. Guss, Charles E. Wyman, Arthur J. Ragauskas, Erin G. Webb, Brian H. Davison and Charles M. Cai\*



1216

### Quantitative analysis of sodium metal deposition and interphase in Na metal batteries

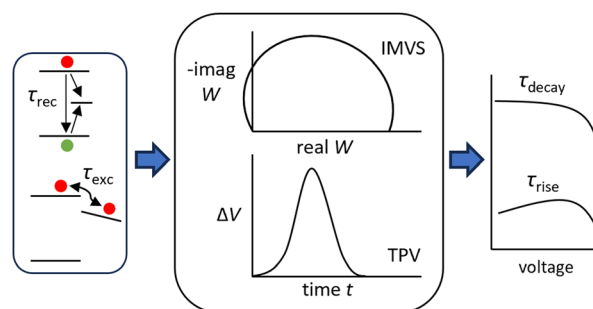
Baharak Sayahpour, Weikang Li, Shuang Bai, Bingyu Lu, Bing Han, Yu-Ting Chen, Grayson Deysher, Saurabh Parab, Phillip Ridley, Ganesh Raghavendran, Long Hoang Bao Nguyen, Minghao Zhang\* and Ying Shirley Meng\*



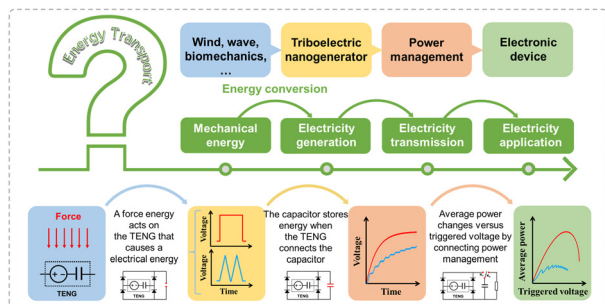
1229

### Discerning rise time constants to quantify charge carrier extraction in perovskite solar cells

Sandheep Ravishankar,\* Lennard Kruppa, Sandra Jenatsch, Genghua Yan and Yueming Wang



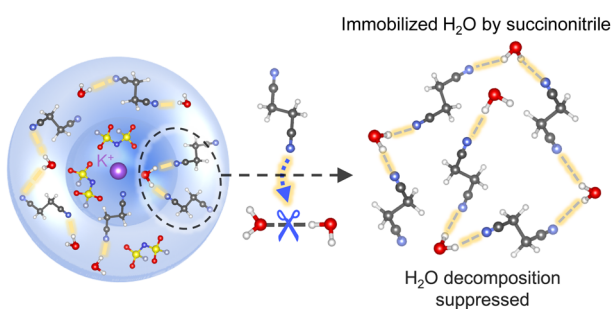
1244



## Efficient energy transport in constant-voltage triboelectric nanogenerator-based power units

Xinyuan Li, Zhihao Zhao, Yuexiao Hu, Yikui Gao, Lixia He, Wenyao Qiao, Baofeng Zhang, Youlong Xu,\* Zhong Lin Wang\* and Jie Wang\*

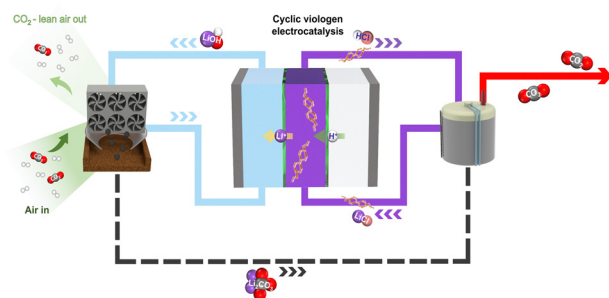
1255



## Hydrogen-bond regulation in organic/aqueous hybrid electrolyte for safe and high-voltage K-ion batteries

Maoting Xia, Hongwei Fu,\* Kairui Lin, Apparao M. Rao, Limei Cha, Huan Liu, Jiang Zhou, Chengxin Wang\* and Bingan Lu\*

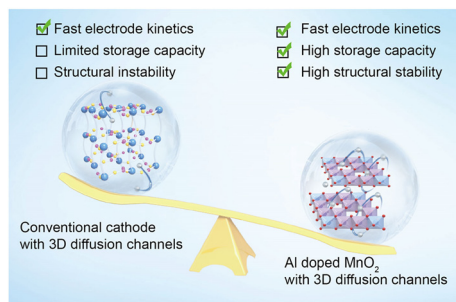
1266



## Direct air capture of CO<sub>2</sub> via cyclic viologen electrocatalysis

Shijie Liu, Jinqiang Zhang, Feng Li, Jonathan P. Edwards, Yurou Celine Xiao, Dongha Kim, Panagiotis Papangelakis, Jiheon Kim, David Elder, Phil De Luna, Mengyang Fan, Geonhui Lee, Rui Kai Miao, Tanushree Ghosh, Yu Yan, Yuanjun Chen, Yong Zhao, Zunmin Guo, Cong Tian, Peihao Li, Yi Xu,\* Edward H. Sargent\* and David Sinton\*

1279



## Vacancy-rich Al-doped MnO<sub>2</sub> cathodes break the trade-off between kinetics and stability for high-performance aqueous Zn-ion batteries

Yajun Zhao, Shuoxiao Zhang, Yangyang Zhang, Jinrui Liang, Longtao Ren, Hong Jin Fan,\* Wen Liu\* and Xiaoming Sun\*



## CORRECTIONS

1291

**Correction: Simultaneous generation of furfuryl alcohol, formate, and H<sub>2</sub> by co-electrolysis of furfural and HCHO over bifunctional CuAg bimetallic electrocatalysts at ultra-low voltage**

Liang Zhao, Zheng Lv, Yue Shi, Shuanglong Zhou, Yan Liu, Jiani Han, Qi Zhang, Jianping Lai\* and Lei Wang\*

1292

**Addendum: Self-operating transpiration-driven electrokinetic power generator with an artificial hydrological cycle**

Jaehyeong Bae, Tae Gwang Yun, Bong Lim Suh, Jihan Kim and Il-Doo Kim\*

