

Energy & Environmental Science

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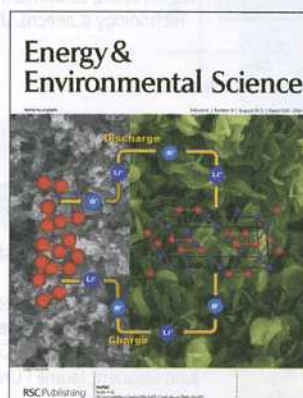
IN THIS ISSUE

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Cover

See Aurbach *et al.*, pp. 2265–2279. Image reproduced by permission of Doron Aurbach from *Energy Environ. Sci.*, 2013, **6**, 2265.



Inside cover

See Nazar *et al.*, pp. 2257–2264. Image reproduced by permission of Linda Nazar from *Energy Environ. Sci.*, 2013, **6**, 2257.

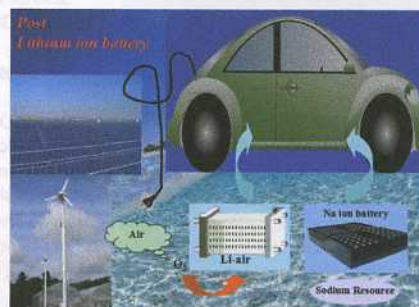
EDITORIAL

2256

New energy storage devices for post lithium-ion batteries

Haoshen Zhou

In this themed issue, recent research progress into post lithium-ion batteries is reviewed.



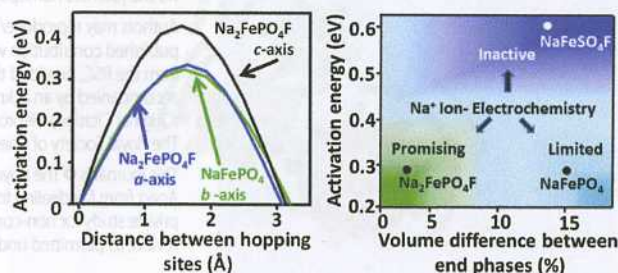
PAPER

2257

Na-ion mobility in layered $\text{Na}_2\text{FePO}_4\text{F}$ and olivine $\text{Na}[\text{Fe,Mn}]\text{PO}_4$

R. Tripathi, S. M. Wood, M. S. Islam* and L. F. Nazar*

This atomistic modelling study presents insight into Na-ion transport and its correlation to reversible Na-ion intercalation in olivine $\text{Na}(\text{Fe,Mn})\text{PO}_4$ and layered $\text{Na}_2\text{FePO}_4\text{F}$.

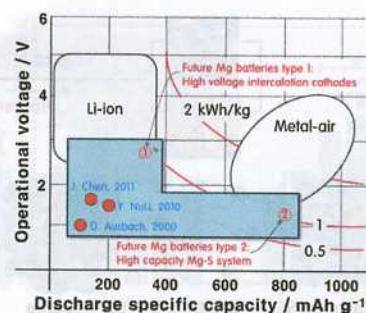


2265

Mg rechargeable batteries: an on-going challenge

Hyun Deog Yoo, Ivgeni Shterenberg, Yosef Gofer, Gregory Gershinsky, Nir Pour and Doron Aurbach*

Advances in Mg rechargeable battery science and technologies are updated and the key issues for the commercialization are addressed.



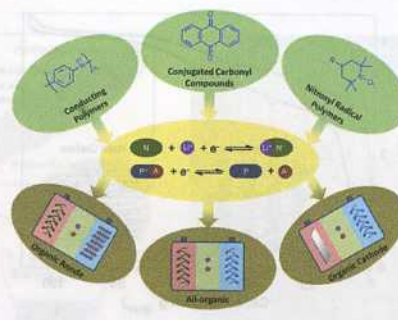
REVIEWS

2280

Towards sustainable and versatile energy storage devices: an overview of organic electrode materials

Zhiping Song* and Haoshen Zhou*

Electroactive organics are promising high performance electrode materials, towards cheap, green, sustainable and versatile energy storage devices beyond Li-ion batteries.

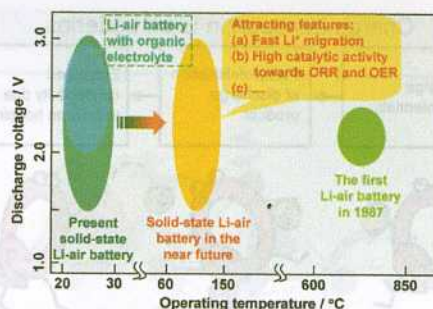


2302

The pursuit of rechargeable solid-state Li-air batteries

Fujun Li, Hirokazu Kitaura and Haoshen Zhou*

Solid-state Li-air (O₂) batteries are considered to be promising due to the stability of solid-state electrolytes. On the status, challenges, and perspectives of rechargeable solid-state Li-air (O₂) batteries a specific review is provided here.



2312

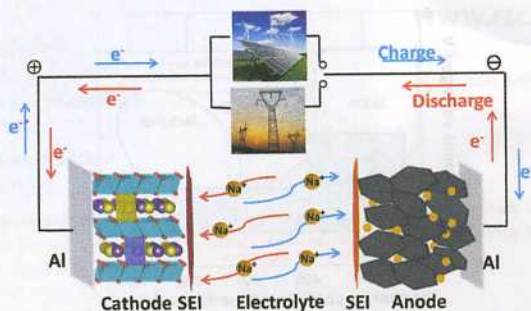
Update on Na-based battery materials. A growing research path

Verónica Palomares, Montse Casas-Cabanas, Elizabeth Castillo-Martínez, Man H. Han and Teófilo Rojo*

The growing efforts on low temperature Na-based energy storage systems are reviewed from a materials perspective.



2338



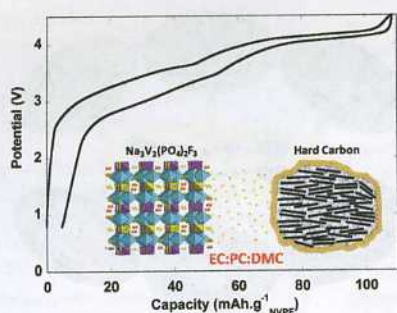
Room-temperature stationary sodium-ion batteries for large-scale electric energy storage

Huilin Pan, Yong-Sheng Hu* and Liquan Chen

This review discusses recent progress and our thoughts on the development of room-temperature "rocking chair" sodium-ion batteries particularly for large-scale electric energy storage.

PAPERS

2361



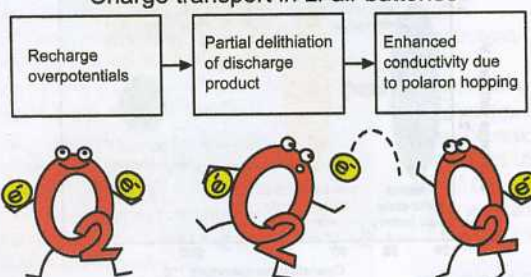
Towards high energy density sodium ion batteries through electrolyte optimization

Alexandre Ponrouch,* Rémi Dedryvère, Damien Monti, Atif E. Demet, Jean Marcel Ateba Mba, Laurence Croguennec, Christian Masquelier, Patrik Johansson and M. Rosa Palacín*

Na-ion cells with performance comparable to Li-ion cells were assembled with $\text{Na}_3\text{V}_2(\text{PO}_4)_3$ and hard carbon electrodes in an $\text{EC}_{0.45}:\text{PC}_{0.45}:\text{DMC}_{0.1}$ electrolyte.

2370

Charge transport in Li-air batteries



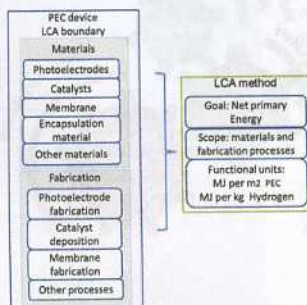
Charge transport in lithium peroxide: relevance for rechargeable metal-air batteries

Maxwell D. Radin and Donald J. Siegel*

First-principles calculations of the conductivity of Li_2O_2 indicate that sluggish charge transport may be a performance-limiting factor for Li-air batteries.

ANALYSIS

2380



Net primary energy balance of a solar-driven photoelectrochemical water-splitting device

Pei Zhai,* Sophia Haussener, Joel Ager, Roger Sathre, Karl Walczak, Jeffery Greenblatt and Thomas McKone

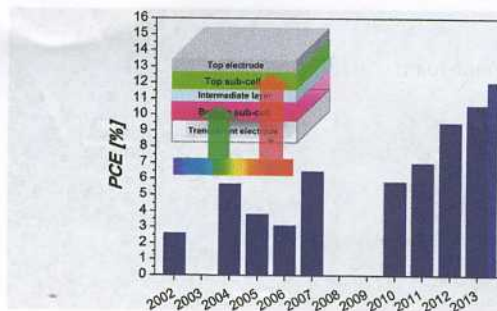
A fundamental requirement for a renewable energy generation technology is that it should produce more energy during its lifetime than is required to manufacture it.

2390

Highly efficient organic tandem solar cells: a follow up review

Tayebeh Ameri,* Ning Li and Christoph J. Brabec

In this article we follow up our previous work and review the most important developments that have been recently reported on organic tandem solar cells. In addition, some brief theoretical considerations addressing the potential of single and tandem solar cells, the working principles of the intermediate layer, the importance of optical simulations and finally the intricacies of a precise measurement of tandem devices based on complementary absorbers are presented.



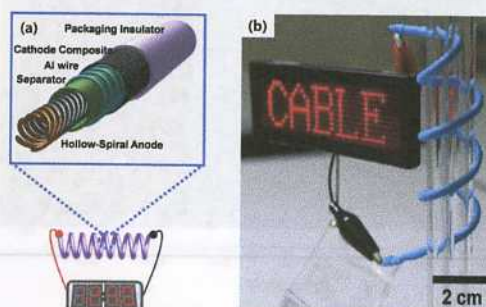
MINIREVIEW

2414

Progress in flexible energy storage and conversion systems, with a focus on cable-type lithium-ion batteries

Sang-Young Lee, Keun-Ho Choi, Woo-Sung Choi, Yo Han Kwon, Hye-Ran Jung, Heon-Cheol Shin* and Je Young Kim*

The unending demand for portable, flexible, and even wearable electronic devices that have an aesthetic appeal and unique functionality stimulates the development of advanced power sources that have excellent electrochemical performance and, more importantly, shape versatility.



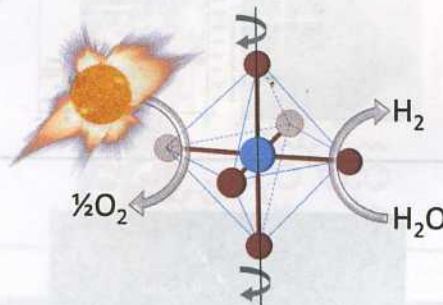
COMMUNICATIONS

2424

Sr- and Mn-doped $\text{LaAlO}_{3-\delta}$ for solar thermochemical H_2 and CO production

Anthony H. McDaniel,* Elizabeth C. Miller, Darwin Arifin, Andrea Ambrosini, Eric N. Coker, Ryan O'Hayre, William C. Chueh and Jianhua Tong*

Perovskite oxides may revolutionize water splitting chemistry via high-temperature, two-step thermochemical cycles powered by concentrating solar energy.

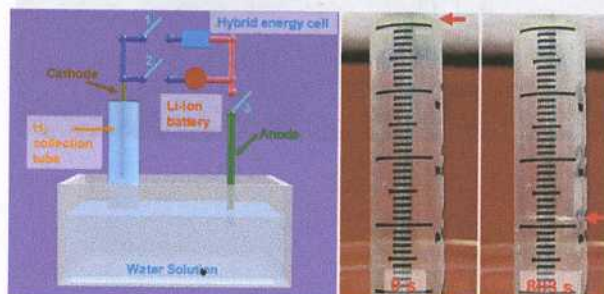


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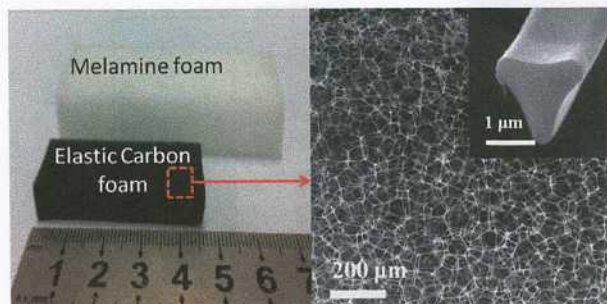
A hybrid energy cell for self-powered water splitting

Ya Yang, Hulin Zhang, Zong-Hong Lin, Yan Liu, Jun Chen, Ziyin Lin, Yu Sheng Zhou, Ching Ping Wong and Zhong Lin Wang*

The mechanical, thermal, and solar energies were harvested using a hybrid cell for self-powered water splitting.



2435

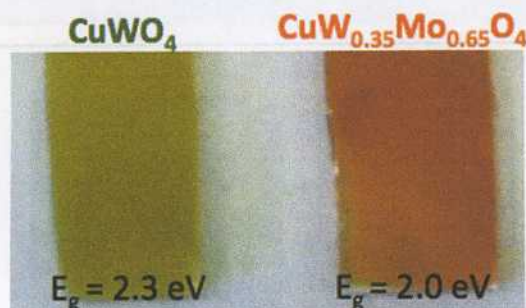


Elastic carbon foam via direct carbonization of polymer foam for flexible electrodes and organic chemical absorption

Shuiliang Chen,* Guanghua He, Huan Hu, Shaoqin Jin, Yan Zhou, Yunyun He, Shuijian He, Feng Zhao and Haoqing Hou*

A novel elastic carbon foam with a 3D interconnected network was prepared by the direct carbonization of melamine foam.

2440

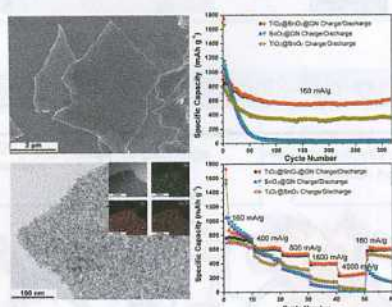


Synthesis, photoelectrochemical properties, and first principles study of n-type $\text{CuW}_{1-x}\text{Mo}_x\text{O}_4$ electrodes showing enhanced visible light absorption

James C. Hill, Yuan Ping, Giulia A. Galli* and Kyoung-Shin Choi*

A new electrochemical synthesis and first principles study of Mo-rich solid solutions of CuWO_4 and CuMoO_4 are reported, which exhibit significantly reduced bandgaps with respect to that of CuWO_4 .

2447

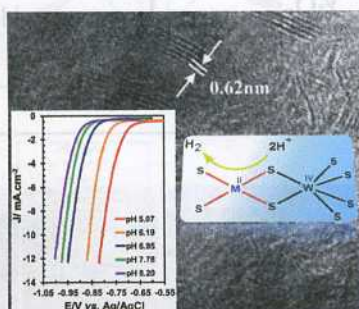


Highly reversible and ultra-fast lithium storage in mesoporous graphene-based $\text{TiO}_2/\text{SnO}_2$ hybrid nanosheets

Yanping Tang, Dongqing Wu, Si Chen, Fan Zhang,* Jinping Jia and Xinliang Feng*

Mesoporous graphene-based $\text{TiO}_2/\text{SnO}_2$ hybrid nanosheets with highly reversible and ultra-fast lithium storage are developed by a facile and scalable approach.

2452



Novel cobalt/nickel-tungsten-sulfide catalysts for electrocatalytic hydrogen generation from water

Phong D. Tran,* Sing Yang Chiam, Pablo P. Boix, Yi Ren, Stevin S. Pramana, Jennifer Fize, Vincent Artero* and James Barber*

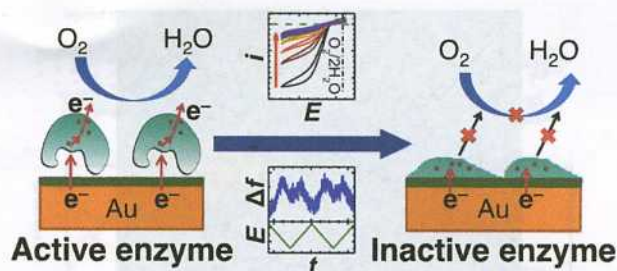
A scalable electrodeposition process was developed for preparing single phase cobalt/nickel-tungsten-sulfides which are attractive alternatives to platinum for electrocatalytic reduction of protons.

2460

Sources of activity loss in the fuel cell enzyme bilirubin oxidase

Kulveer Singh, Trevor McArdle, Patricia R. Sullivan and Christopher F. Blanford*

The catalytic lifetime of the O_2 -reducing multicopper oxidase bilirubin oxidase from *Myrothecium verrucaria* is shortened from days to hours when subjected to variations in applied potential. Covalent attachment does not improve the active lifetime of the enzyme adlayer and leads to a 0.1 V higher overpotential for O_2 reduction.



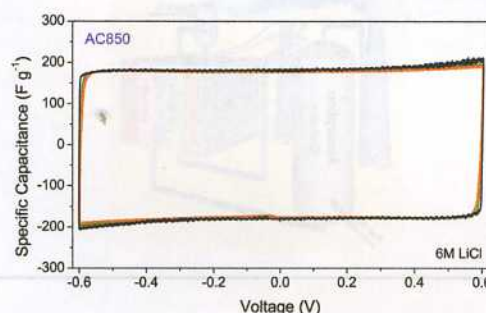
PAPERS

2465

Sulfur-containing activated carbons with greatly reduced content of bottle neck pores for double-layer capacitors: a case study for pseudocapacitance detection

Wentian Gu, Marta Sevilla, Alexandre Magasinski, Antonio B. Fuertes and Gleb Yushin*

Synthesis of S-doped activated carbons (ACs) by carbonization and activation of S-based polymers was found to be an efficient route to produce porous carbons for double layer capacitors with high specific energy and power densities.

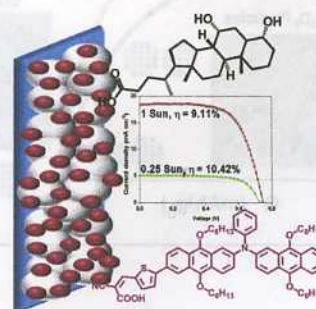


2477

2,6-Conjugated anthracene sensitizers for high-performance dye-sensitized solar cells

Ryan Yeh-Yung Lin, Hung-Wen Lin, Yung-Sheng Yen, Chia-Hao Chang, Hsien-Hsin Chou, Ping-Wei Chen, Chih-Yu Hsu, Yung-Chung Chen, Jiann T. Lin* and Kuo-Chuan Ho*

2,6-Conjugated anthracene-based dye-sensitized solar cells with a co-sensitizer and co-adsorbent exhibit high light-to-electricity conversion efficiencies of 8.08 and 9.11%, respectively.

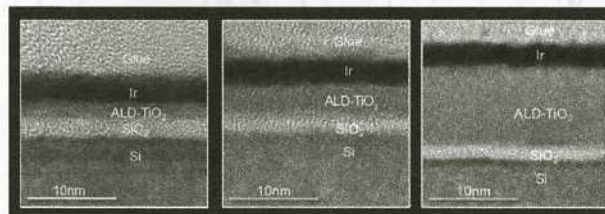


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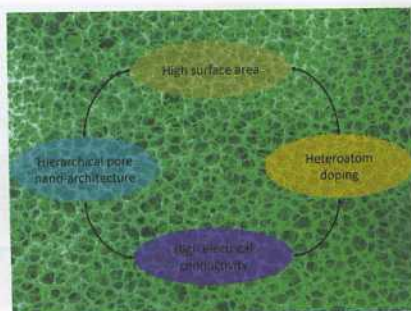
Effects of catalyst material and atomic layer deposited TiO_2 oxide thickness on the water oxidation performance of metal-insulator-silicon anodes

Andrew G. Scheuermann,* Jonathan D. Prange, Marika Gunji, Christopher E. D. Chidsey and Paul C. McIntyre*

Highly efficient ALD- TiO_2 protected silicon photoanodes are studied with different protective coating thicknesses and catalyst materials.



2497

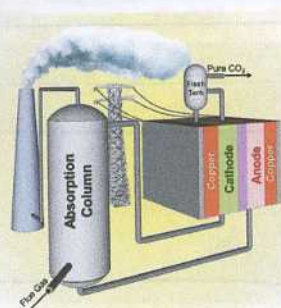


Synthesis of functionalized 3D hierarchical porous carbon for high-performance supercapacitors

Long Qie, Weimin Chen, Henghui Xu, Xiaoqin Xiong, Yan Jiang, Feng Zou, Xianluo Hu,* Ying Xin, Zhaoliang Zhang and Yunhui Huang*

A functionalized 3D hierarchical porous carbon with high specific surface area and conductivity exhibits excellent capacitance and stability as an electrode material for a supercapacitor.

2505

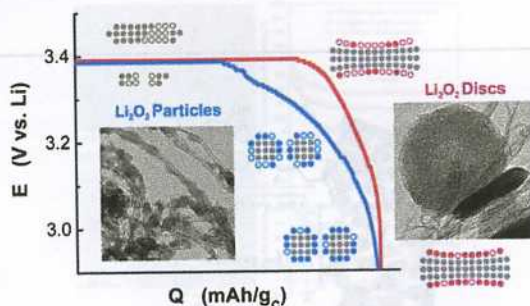


Post-combustion carbon dioxide capture using electrochemically mediated amine regeneration

Michael C. Stern, Fritz Simeon, Howard Herzog and T. Alan Hatton*

New electrochemical amine scrubbing technology for CO₂ capture uses reversible copper complexation chemistry to release CO₂ in the isothermal stripper.

2518

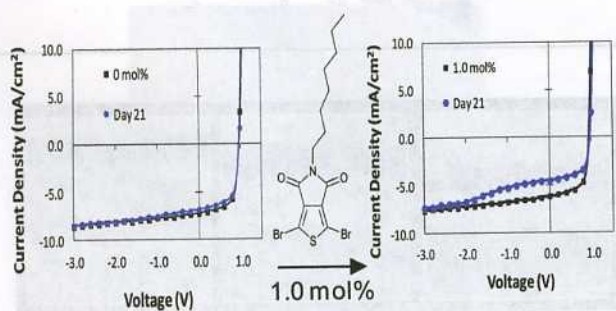


Influence of Li₂O₂ morphology on oxygen reduction and evolution kinetics in Li–O₂ batteries

Betar M. Gallant, David G. Kwabi, Robert R. Mitchell, Jigang Zhou, Carl V. Thompson and Yang Shao-Horn*

Li₂O₂ rate-dependent discharge morphologies exhibit differences in structural and surface chemical properties that influence the overpotentials and pathways during charge.

2529



Improving the long-term stability of PBDTPD polymer solar cells through material purification aimed at removing organic impurities

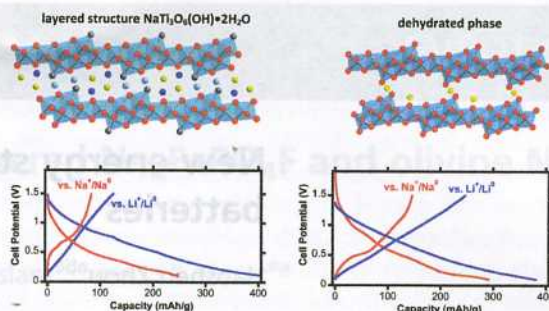
William R. Mateker, Jessica D. Douglas, Clément Cabanetos, I. T. Sachs-Quintana, Jonathan A. Bartelt, Eric T. Hoke, Abdulrahman El Labban, Pierre M. Beaujuge, Jean M. J. Fréchet and Michael D. McGehee*

We link impurities to solar cell degradation and show that stricter purification protocol improves device lifetime.

New materials based on a layered sodium titanate for dual electrochemical Na and Li intercalation systems

Mona Shirpour,* Jordi Cabana and Marca Doeff

The layered structure $\text{NaTi}_3\text{O}_6(\text{OH}) \cdot 2\text{H}_2\text{O}$, also known as sodium nonatitanate, and a dehydrated form of it have been shown, for the first time, to undergo reductive alkali metal intercalation reactions in lithium and sodium half-cells at very low voltages.



Finally, I would like to express my gratitude to all of the visitors for submitting their high quality contributions, and to the referees for their careful reviewing. I would also like to thank my co-workers, especially Prof. Yung-Shyan Chen at National Tsing-Tung University, and Prof. Hsueh-Hong Chen at National Central University, for their kind support and their colleagues at the RSC office for publication of this special issue. I am also grateful to the RSC office for publication of this special issue. I am also grateful to the RSC office for publication of this special issue.

Li-ion batteries are the most common energy storage devices used in portable electronics and electric vehicles. However, the limited energy density of Li-ion batteries has led to the development of Na-ion batteries as a promising alternative.

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We face serious problems of the balance between industrial development and environmental protection due to the quickly increasing demands for energy resources. Current main energy resources are still from fossil fuels, resulting in CO_2 emission and environmental pollution. Rechargeable batteries, which can be charged by renewable energy resources such as solar cells and wind power stations and provide clean energy by discharging, have attracted much attention as one of the main key technologies to solve these serious problems. However, the performance of present batteries is still too poor to support these industrial applications in electric vehicles, plug-in hybrid electric vehicles, and smart grid community systems connected with solar cells and wind power stations. To satisfy these industrial needs developing high energy density and low cost rechargeable batteries is a great challenge. In this special issue, some research articles show some new materials and structures for Na-ion batteries. The first article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The second article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The third article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The fourth article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The fifth article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The sixth article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The seventh article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The eighth article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The ninth article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost. The tenth article by Shao et al. reports on a new Na-ion battery material, $\text{Na}_2\text{Ti}_2\text{O}_7$, which shows a high energy density and low cost.