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## IN THIS ISSUE

ISSN 1754-5692 CODEN EESNBY 8(12) 3383-3756 (2015)



### Cover

See Yan Yu *et al.*, pp. 3531-3538.  
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### Inside cover

See Youngsik Kim *et al.*, pp. 3589-3596.  
Image reproduced by permission of Youngsik Kim from *Energy Environ. Sci.*, 2015, 8, 3589.

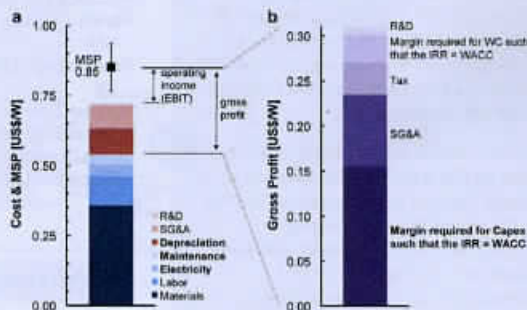
## ANALYSIS

3395

### The capital intensity of photovoltaics manufacturing: barrier to scale and opportunity for innovation

Douglas M. Powell, Ran Fu, Kelsey Horowitz, Paul A. Basore, Michael Woodhouse and Tonio Buonassisi\*

Using a bottom-up cost model, we assess the impact of initial factory capital expenditure (capex) on photovoltaic (PV) module minimum sustainable price (MSP) and industry-wide trends, including sustainable growth rate and barriers to innovation.

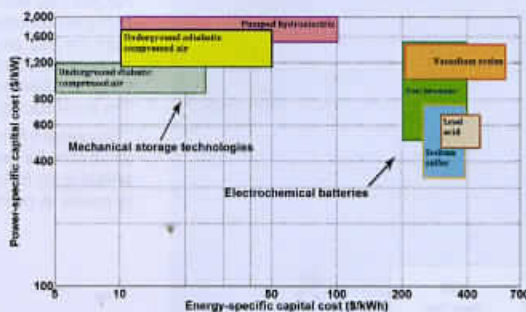


3409

### How much bulk energy storage is needed to decarbonize electricity?

Hossein Safaei and David W. Keith\*

Impacts of capital cost of bulk energy storage on cost of electricity supply is parametrically studied under various emissions constraints.

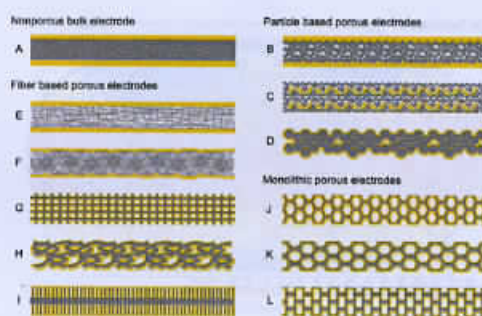


3418

## Design and fabrication of bioelectrodes for microbial bioelectrochemical systems

Xing Xie, Craig Criddle\* and Yi Cui\*

Schematic of microbial bioelectrodes with different configurations.

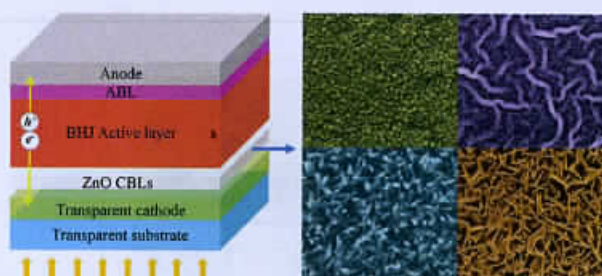


3442

## ZnO cathode buffer layers for inverted polymer solar cells

Zhiqiang Liang, Qifeng Zhang, Lin Jiang\* and Guozhong Cao\*

This article provides an overview of the most widely used cathode buffer layers (CBLs) constructed using pristine ZnO, doped-ZnO, and ZnO-based composites as well as the surface modified ZnO-based CBLs for the improvement of power conversion efficiency (PCE) and long-term device stability of inverted polymer solar cells (PSCs).

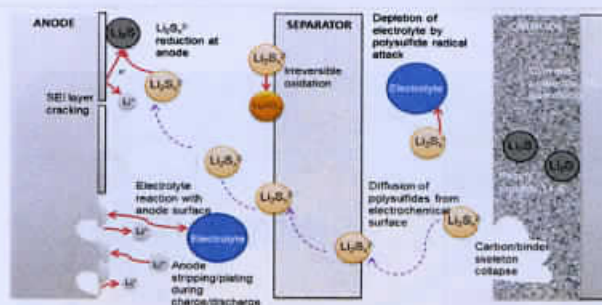


3477

## Lithium sulfur batteries, a mechanistic review

M. Wild,\* L. O'Neill, T. Zhang, R. Purkayastha, G. Minton, M. Marinescu and G. J. Offer\*

Lithium sulfur batteries, review of current mechanistic understanding and the gap between experimentally derived mechanisms and those used for modelling.



3495

## Stability assessment of alternative platinum free counter electrodes for dye-sensitized solar cells

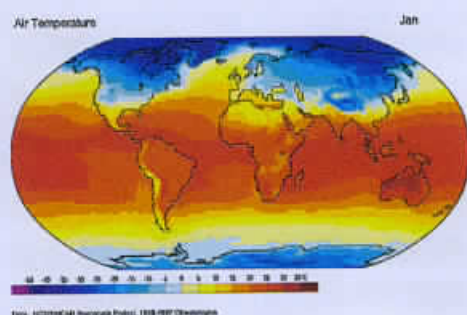
Sining Yun,\* Peter D. Lund and Andreas Hinsch

A comprehensive experimental evaluation using different techniques can provide a systematical assessment for CE stability of DSSCs from different angles.





3515



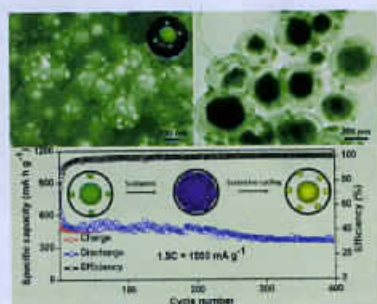
### Nonaqueous redox-flow batteries: organic solvents, supporting electrolytes, and redox pairs

Ke Gong, Qianrong Fang, Shuang Gu,\*  
Sam Fong Yau Li and Yushan Yan\*

As members of the redox-flow battery (RFB) family, nonaqueous RFBs can offer a wide range of working temperature, high cell voltage, and potentially high energy density.

## COMMUNICATIONS

3531

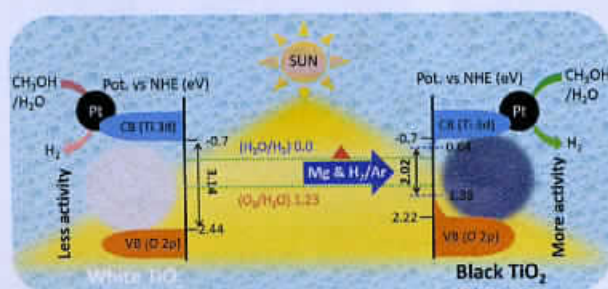


### Uniform yolk-shell $\text{Sn}_4\text{P}_3\text{@C}$ nanospheres as high-capacity and cycle-stable anode materials for sodium-ion batteries

Jun Liu, Peter Kopold, Chao Wu, Peter A. van Aken,  
Joachim Maier and Yan Yu\*

Uniform yolk-shell  $\text{Sn}_4\text{P}_3\text{@C}$  nanospheres exhibit very high reversible capacity, superior rate capability and stable cycling performance for Na-ion batteries.

3539

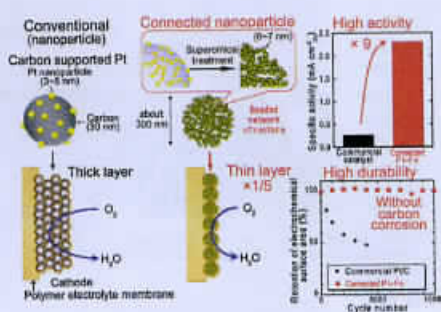


### A new approach to prepare highly active and stable black titania for visible light-assisted hydrogen production

Apurba Sinhamahapatra, Jong-Pil Jeon and  
Jong-Sung Yu\*

A highly active nano black  $\text{TiO}_2$  photocatalyst with Pt as a co-catalyst for visible light-assisted hydrogen production from methanol-water is prepared by controlled magnesiothermic treatment in a  $\text{H}_2/\text{Ar}$  atmosphere.

3545



### Connected nanoparticle catalysts possessing a porous, hollow capsule structure as carbon-free electrocatalysts for oxygen reduction in polymer electrolyte fuel cells

Takanori Tamaki, Hidenori Kuroki, Shun Ogura,  
Teruaki Fuchigami, Yoshitaka Kitamoto and  
Takeo Yamaguchi\*

Connected Pt-Fe nanoparticle catalysts with beaded network structure show both high activity and durability for oxygen reduction.

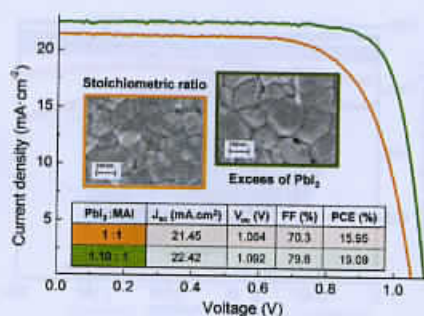


3550

### High efficiency methylammonium lead triiodide perovskite solar cells: the relevance of non-stoichiometric precursors

C. Roldán-Carmona, P. Gratia, I. Zimmermann, G. Grancini, P. Gao, M. Graetzel and Mohammad Khaja Nazeeruddin\*

Improved crystallinity and device performance of  $\text{CH}_3\text{NH}_3\text{PbI}_3$  perovskite solar cells by using a non-stoichiometric  $\text{PbI}_2:\text{CH}_3\text{NH}_3\text{I}$  precursor ratio.

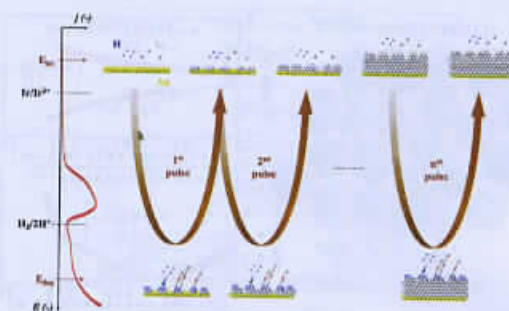


3557

### Self-terminated electrodeposition of iridium electrocatalysts

Sang Hyun Ahn, Haiyan Tan, Mareike Haensch, Yihua Liu, Leonid A. Bendersky and Thomas P. Moffat\*

This study details a "wet" atomic layer deposition process that uses potential modulation and H adsorption to terminate Ir deposition at high deposition overpotentials. The ultrathin Ir films match or exceed the best reported electrocatalytic activity for the oxygen evolution reaction (OER) and hydrogen production and oxidation reaction (HER and HOR) on bulk Ir electrodes.

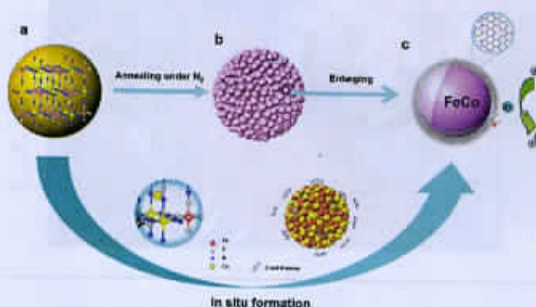


3563

### Non-precious alloy encapsulated in nitrogen-doped graphene layers derived from MOFs as an active and durable hydrogen evolution reaction catalyst

Yang Yang, Zhengyan Lun, Guoliang Xia, Fangcai Zheng, Mengni He and Qianwang Chen\*

An FeCo alloy covered with nitrogen doped graphene is prepared by direct annealing of  $\text{Fe}_3[\text{Co}(\text{CN})_6]_2$  nanoparticles, exhibiting efficient HER catalysis.

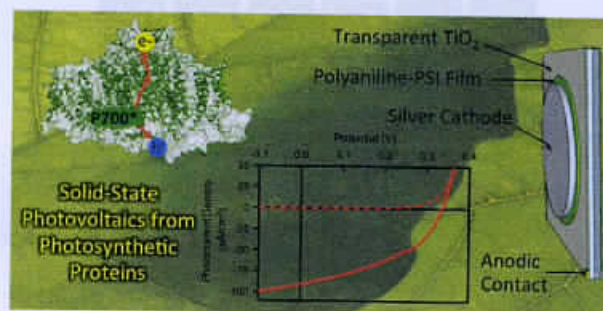


3572

### Photosystem I-polyaniline/ $\text{TiO}_2$ solid-state solar cells: simple devices for biohybrid solar energy conversion

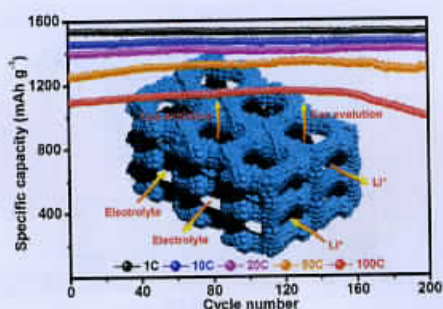
Evan A. Gizzie, J. Scott Niezgoda, Maxwell T. Robinson, Andrew G. Harris, G. Kane Jennings, Sandra J. Rosenthal and David E. Cliffel\*

Novel biophotovoltaic devices were prepared by electrochemically entrapping Photosystem I in a conductive polyaniline film, grown *in situ* on  $\text{TiO}_2$  anodes.





3577

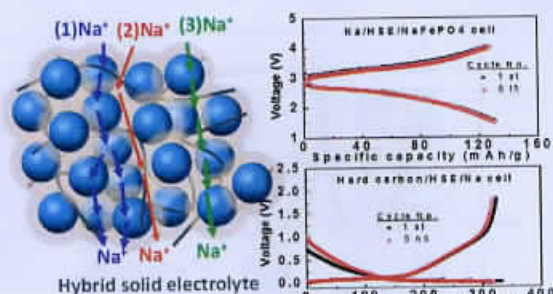


### Mass-scalable synthesis of 3D porous germanium-carbon composite particles as an ultra-high rate anode for lithium ion batteries

Duc Tung Ngo, Hang T. T. Le, Chanhon Kim, Jae-Young Lee, John G. Fisher, Il-Doo Kim and Chan-Jin Park\*

A novel, facile synthetic route has been proposed to prepare a 3D nanoarchitecture of Ge coated with carbon (3D-Ge/C) via carbothermal reduction.

3589



### A hybrid solid electrolyte for flexible solid-state sodium batteries

Jae-Kwang Kim, Young Jun Lim, Hyojin Kim, Gyu-Bong Cho and Youngsik Kim\*

Ceramic-based hybrid solid electrolyte (HSE) is designed to build a flexible pouch-type Na-ion battery.

3597

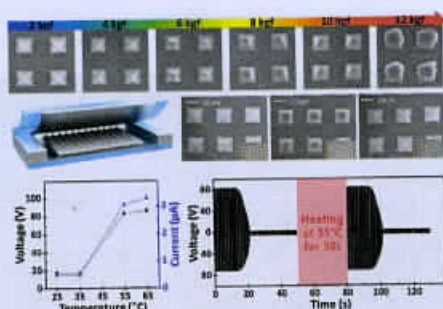


### Selective CO production by Au coupled ZnTe/ZnO in the photoelectrochemical CO<sub>2</sub> reduction system

Y. J. Jang, J.-W. Jang, J. Lee, J. H. Kim, H. Kumagai, J. Lee, T. Minegishi, J. Kubota, K. Domen and J. S. Lee\*

Au coupled ZnTe/ZnO-NW array is a new photocathode for selective CO production from CO<sub>2</sub>. The remarkable effects of an Au are to form of a Schottky junction with ZnTe to improve band bending and provide the reaction center for CO<sub>2</sub> reduction suppressing water reduction.

3605



### Shape memory polymer-based self-healing triboelectric nanogenerator

Jeong Hwan Lee, Ronan Hinchet, Sung Kyun Kim, Sanghyun Kim and Sang-Woo Kim\*

We introduce a new smart SMP-TENG structure and studied its degradation and healing process. The SMP improves the endurance and lifetime, and thus demonstrates the huge potential of self-healing SMP-TENGs.

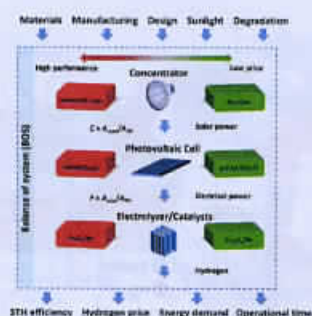


3614

### Holistic design guidelines for solar hydrogen production by photo-electrochemical routes

Mikaël Dumortier, Saurabh Tembhurne and Sophia Haussener\*

Device and system design choices for solar energy conversion and storage approaches require holistic design guidelines which simultaneously respect and optimize technical, economic, sustainability, and operating time constraints.

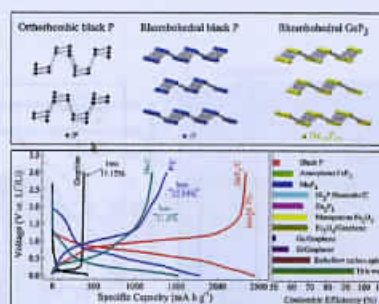


3629

### Layered phosphorus-like GeP<sub>5</sub>: a promising anode candidate with high initial coulombic efficiency and large capacity for lithium ion batteries

Wenwu Li, Huiqiao Li,\* Zhijuan Lu, Lin Gan, Linbo Ke, Tianyou Zhai\* and Haoshen Zhou

Layer structured GeP<sub>5</sub> is firstly developed as an anode material for LIB, it delivers a reversible capacity of 2300 mA h g<sup>-1</sup> with a very high initial coulombic efficiency of 95%.

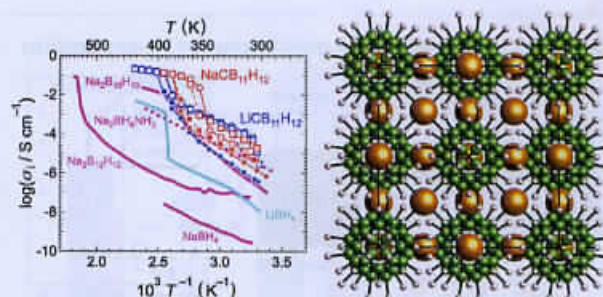


3637

### Unparalleled lithium and sodium superionic conduction in solid electrolytes with large monovalent cage-like anions

Wan Si Tang,\* Atsushi Unemoto, Wei Zhou, Vitalie Stavila, Motoaki Matsuo, Hui Wu, Shin-ichi Orimo\* and Terrence J. Udovic\*

Above their order-disorder transitions, both LiCB<sub>11</sub>H<sub>12</sub> and NaCB<sub>11</sub>H<sub>12</sub> electrolytes exhibit solid-state conductivities easily exceeding 0.1 S cm<sup>-1</sup>, unmatched by any other known polycrystalline materials at these temperatures.

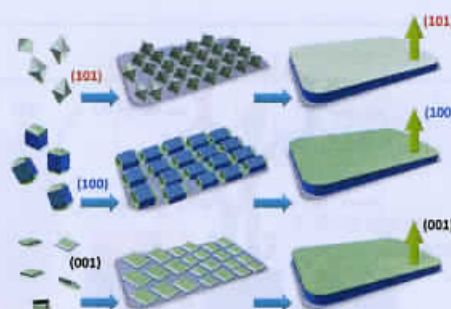


3646

### A selectively exposed crystal facet-engineered TiO<sub>2</sub> thin film photoanode for the higher performance of the photoelectrochemical water splitting reaction

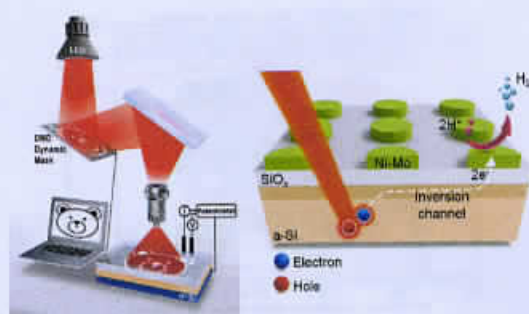
Chang Woo Kim, So Jin Yeob, Hui-Ming Cheng and Young Soo Kang\*

A selectively exposed (101)-crystal facet engineered TiO<sub>2</sub> photoanode is investigated for the higher efficiency of the hydrogen evolution reaction.





3654

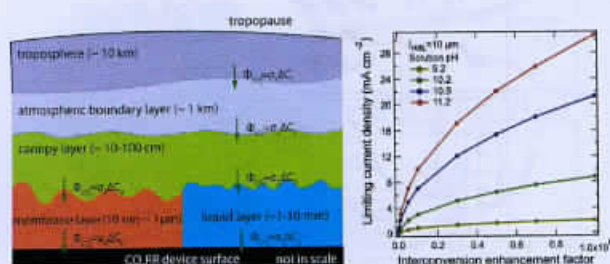


### Light-guided electrodeposition of non-noble catalyst patterns for photoelectrochemical hydrogen evolution

Sung Yul Lim, Yang-Rae Kim, Kyungyeon Ha, Jong-Kwon Lee, Jae Gyeong Lee, Woohyuk Jang, Jin-Young Lee, Je Hyun Bae and Taek Dong Chung\*

For photoelectrochemical hydrogen production, a non-noble catalyst is directly patterned onto the photocathode using a light-guided electrodeposition technique.

3663



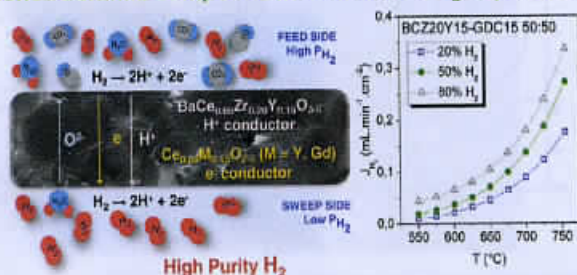
### Operational constraints and strategies for systems to effect the sustainable, solar-driven reduction of atmospheric CO<sub>2</sub>

Yikai Chen, Nathan S. Lewis\* and Chengxiang Xiang\*

A schematic illustration of CO<sub>2</sub> transport in atmosphere and enhanced limiting current density from rapid interconversion between bicarbonate and CO<sub>2</sub>.

3675

### Dense ceramic composite membrane for H<sub>2</sub>-separation

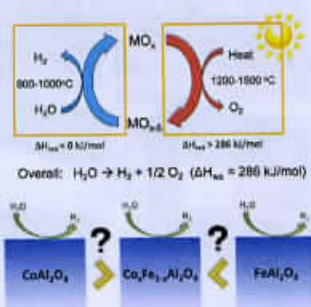


### Exceptional hydrogen permeation of all-ceramic composite robust membranes based on BaCe<sub>0.65</sub>Zr<sub>0.20</sub>Y<sub>0.15</sub>O<sub>3-δ</sub> and Y- or Gd-doped ceria

Elena Rebollo, Cecilia Mortaló,\* Sonia Escolástico, Stefano Boldrini, Simona Barison, José M. Serra and Monica Fabrizio

Mixed proton and electron conductor ceramic composites were examined as hydrogen separation membranes at moderate temperatures (higher than 500 °C).

3687



### Predicting the solar thermochemical water splitting ability and reaction mechanism of metal oxides: a case study of the hercynite family of water splitting cycles

Christopher L. Muhich, Brian D. Ehrhart, Vanessa A. Witte, Samantha L. Miller, Eric N. Coker, Charles B. Musgrave\* and Alan W. Weimer\*

We report and validate a method for predicting the solar thermal water splitting abilities of novel materials using easily calculated quantities.

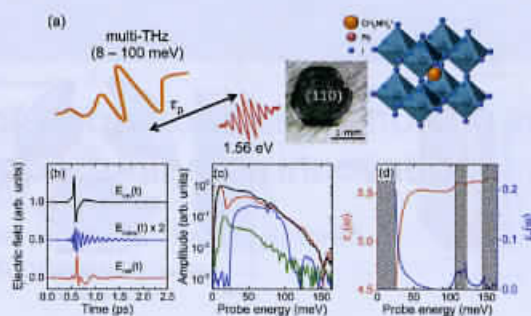


3700

### Intrinsic femtosecond charge generation dynamics in single crystal $\text{CH}_3\text{NH}_3\text{PbI}_3$

David A. Valverde-Chávez, Carlito S. Ponseca Jr., Constantinos C. Stoumpos, Arkady Yartsev, Mercouri G. Kanatzidis, Villy Sundström and David G. Cooke\*

Using time-resolved multi-THz we measure femtosecond charge generation, conductivity and exciton dissociation dynamics in single crystal methylammonium lead triiodide, the prototypical perovskite solar cell material.

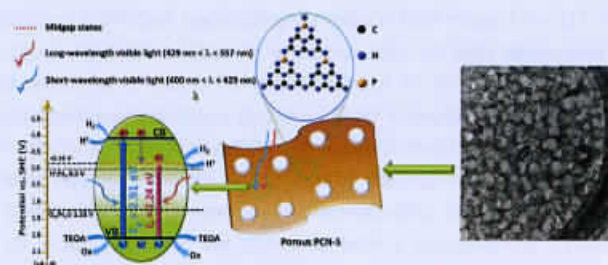


3708

### Porous P-doped graphitic carbon nitride nanosheets for synergistically enhanced visible-light photocatalytic $\text{H}_2$ production

Jingrun Ran, Tian Yi Ma, Guoping Gao, Xi-Wen Du and Shi Zhang Qiao\*

Porous P-doped g- $\text{C}_3\text{N}_4$  nanosheets prepared by combining P doping and thermal exfoliation exhibit a high visible-light photocatalytic  $\text{H}_2$ -production activity of  $1596 \mu\text{mol h}^{-1} \text{g}^{-1}$  and a quantum efficiency of 3.56% at 420 nm.

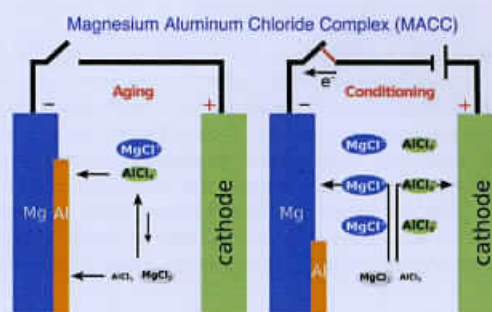


3718

### Elucidating the structure of the magnesium aluminum chloride complex electrolyte for magnesium-ion batteries

Pieremanuele Canepa,\* Saivenkataraman Jayaraman, Lei Cheng, Nav Nidhi Rajput, William D. Richards, Gopalakrishnan Sai Gautam, Larry A. Curtiss, Kristin A. Persson and Gerbrand Ceder\*

Non-aqueous Mg-ion batteries offer a promising way to overcome safety, costs, and energy density limitations of state-of-the-art Li-ion battery technology.

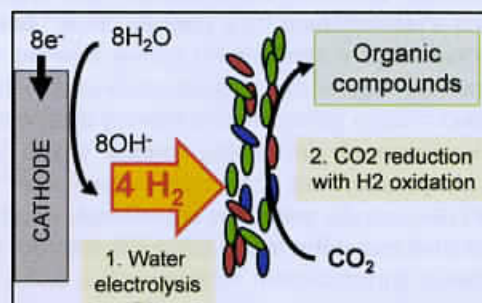


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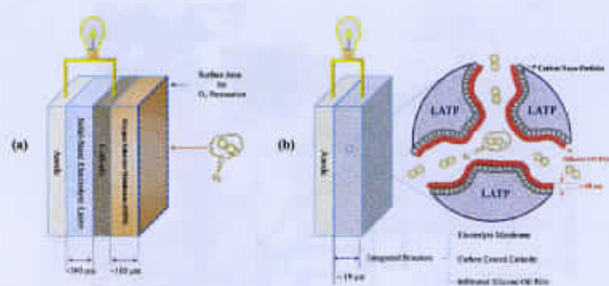
### Importance of the hydrogen route in up-scaling electrosynthesis for microbial $\text{CO}_2$ reduction

Elise Blanchet,\* François Duquenne, Yan Rafrafi, Luc Etcheverry, Benjamin Erable and Alain Bergel

Microbial electrochemical reduction of  $\text{CO}_2$  was carried out under two different applied potentials,  $-0.36 \text{ V}$  and  $-0.66 \text{ V}$  vs. SHE, using a biological sludge as the inoculum.







## A high-rate and long cycle life solid-state lithium-air battery

X. B. Zhu, T. S. Zhao,\* Z. H. Wei, P. Tan and L. An

A novel silicone-oil film blocks  $\text{H}_2\text{O}$  and  $\text{CO}_2$  from reaching reaction sites but allows a high rate of  $\text{O}_2$  transfer.



Received 15  
Accepted 15

DOI: 10.1039/

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## Broaden

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## 1. Intro capex

The traditi  
abbreviated

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<sup>b</sup> Strategic Energy  
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† Electronic sup