

IN THIS ISSUE

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Cover
See O'Hayre *et al.*,
pp. 2957–2964.
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Inside cover
See Shen, Li, Fan *et al.*,
pp. 2965–2971.
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OPINION

2791

Implanted biofuel cells operating *in vivo* – methods, applications and perspectives – feature article

Evgeny Katz* and Kevin MacVittie

Biofuel cells implanted in living organisms and operating *in vivo* were considered as power sources for biomedical and sensor devices.



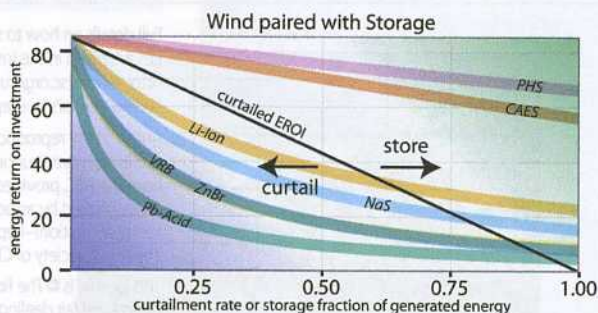
ANALYSIS

2804

The energetic implications of curtailing *versus* storing solar- and wind-generated electricity

Charles J. Barnhart,* Michael Dale, Adam R. Brandt and Sally M. Benson

Should society store or curtail excess renewable generation?
A net energy perspective.

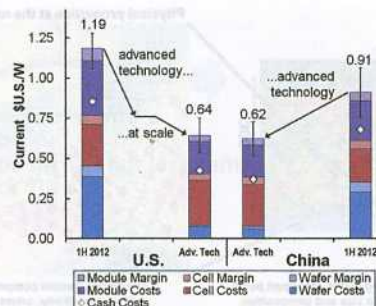


2811

Assessing the drivers of regional trends in solar photovoltaic manufacturing

Alan C. Goodrich,* Douglas M. Powell,* Ted L. James, Michael Woodhouse and Tonio Buonassisi*

Using a bottom-up cost analysis, we elucidate the drivers for historic regionalization trends in the solar photovoltaic (PV) industry. We conclude that the competitive advantage of leading production locations (e.g., China) is not inherent, but built. Consequently, we propose that technological innovations and scale may equalize manufacturing prices in the United States and China.



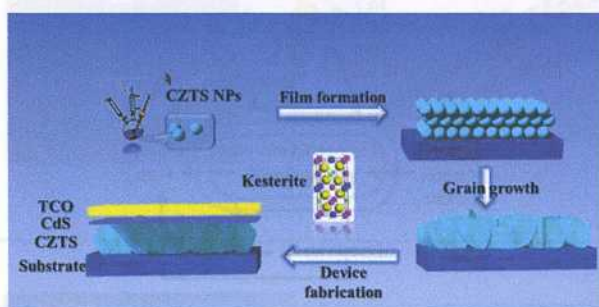
REVIEWS

2822

CZTS nanocrystals: a promising approach for next generation thin film photovoltaics

Huanping Zhou, Wan-Ching Hsu, Hsin-Sheng Duan, Brion Bob, Wenbing Yang, Tze-Bin Song, Chia-Jung Hsu and Yang Yang*

$\text{Cu}_2\text{ZnSnS}_4$ nanocrystals represent a unique approach to realize low cost and high performance next generation solar cells.

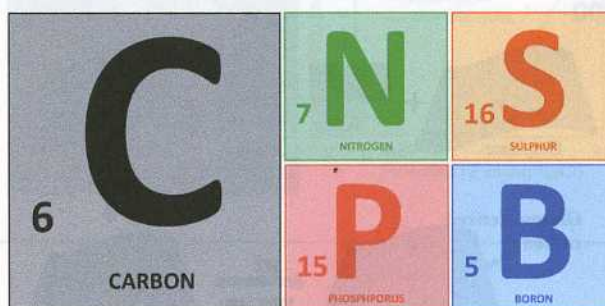


2839

Doping carbons beyond nitrogen: an overview of advanced heteroatom doped carbons with boron, sulphur and phosphorus for energy applications

Jens Peter Paraknowitsch* and Arne Thomas

In this review an overview of the most recent trends in carbon doping with heteroatoms for energy related applications is given – with a strong focus on dopants other than nitrogen.



PERSPECTIVES

2856

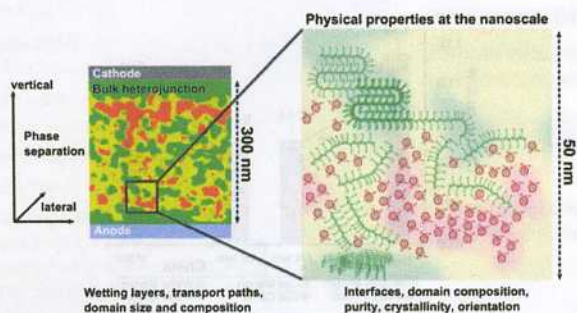
3D nanostructured conductive polymer hydrogels for high-performance electrochemical devices

Yu Zhao, Borui Liu, Lijia Pan* and Guihua Yu*

Recent promising achievements based on 3D nanostructured conductive polymer hydrogels for high-performance electrochemical devices.



2871



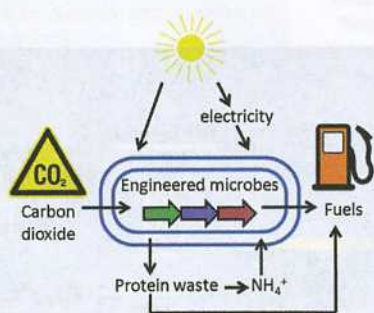
Visualizing physical, electronic, and optical properties of organic photovoltaic cells

Martin Pfannmöller,* Wolfgang Kowalsky and Rasmus R. Schröder*

This review summarizes advances and explores future directions in multi-dimensional, functional imaging of nanoscale physical properties of organic photovoltaic blends.

MINIREVIEW

2892



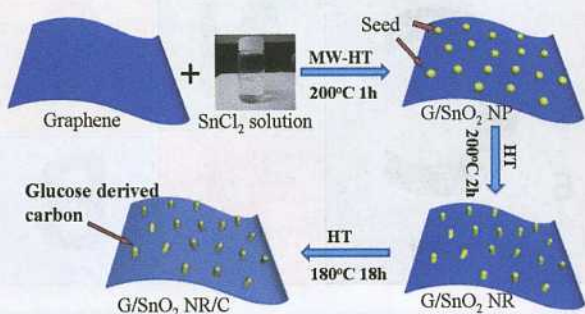
Biological conversion of carbon dioxide to photosynthetic fuels and electrofuels

Han Li and James C. Liao*

CO₂ can be directly converted to fuels by autotrophic microorganisms, which can use sunlight directly or sunlight-derived electricity as the energy source.

COMMUNICATIONS

2900

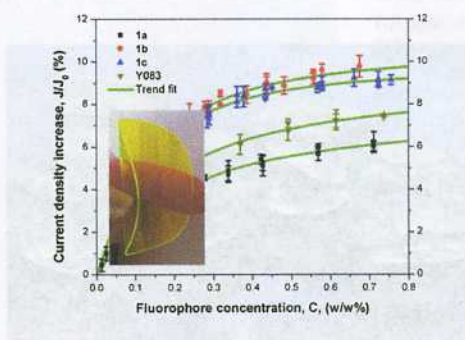


Layer by layer assembly of sandwiched graphene/SnO₂ nanorod/carbon nanostructures with ultrahigh lithium ion storage properties

Dongniu Wang, Jinli Yang, Xifei Li, Dongsheng Geng, Ruying Li, Mei Cai, Tsun-Kong Sham* and Xueliang Sun*

Carbon coated SnO₂ nanorods rooted on graphene nanocomposites exhibit an ultrahigh capacity (1419 mA h g⁻¹) benefiting from structural features.

2907



Increasing the power output of a CdTe solar cell via luminescent down shifting molecules with intramolecular charge transfer and aggregation-induced emission characteristics

Yilin Li, Zhipeng Li, Yang Wang, Alvin Compaan, Tianhui Ren* and Wen-Ji Dong*

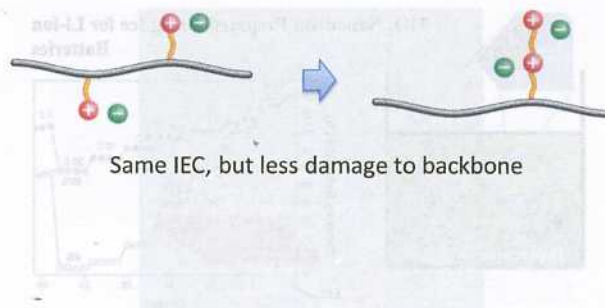
The output power of a CdTe solar cell was increased by the luminescent down-shifting materials.

2912

A strategy for disentangling the conductivity–stability dilemma in alkaline polymer electrolytes

Jing Pan, Yao Li, Juanjuan Han, Guangwei Li, Lisheng Tan, Chen Chen, Juntao Lu and Lin Zhuang*

A strategy to simultaneously obtain high ionic conductivity and high chemical stability of alkaline polymer electrolytes has been proposed.

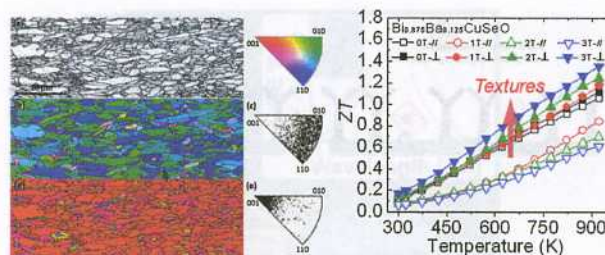


2916

Texturation boosts the thermoelectric performance of BiCuSeO oxyselenides

Jiehe Sui, Jing Li, Jiaqing He,* Yan-Ling Pei, David Berardan, Haijun Wu, Nita Dragoe, Wei Cai and Li-Dong Zhao*

A high ZT of ~ 1.4 at 923 K for $\text{Bi}_{0.875}\text{Ba}_{0.125}\text{CuSeO}$ has been achieved by textured processing through improving the carrier mobility.

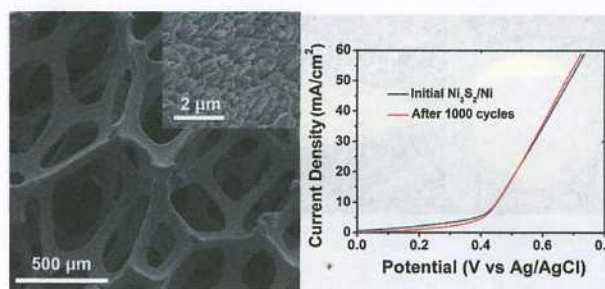


2921

Ni_3S_2 nanorods/Ni foam composite electrode with low overpotential for electrocatalytic oxygen evolution

Weijia Zhou, Xue-Jun Wu, Xiehong Cao, Xiao Huang, Chaoliang Tan, Jian Tian, Hong Liu,* Jiyang Wang and Hua Zhang*

Ni_3S_2 nanorods/Ni foam composite electrode exhibits excellent oxygen evolution reaction activity with a small onset overpotential of ~ 157 mV.

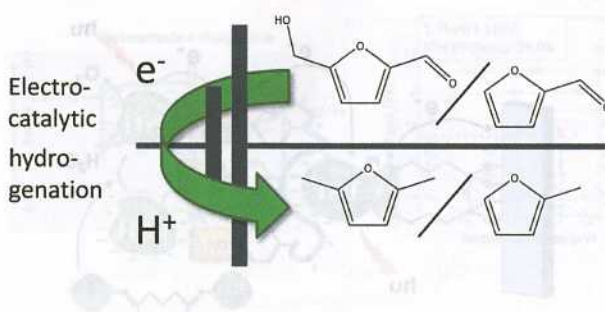


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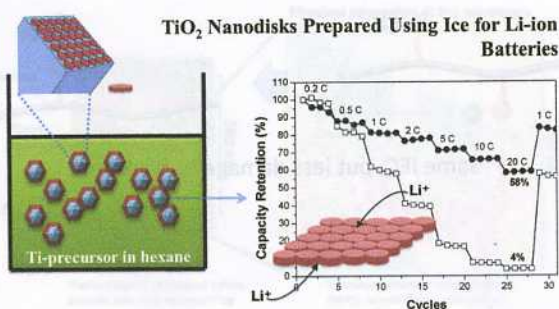
Electrochemistry for biofuel generation: production of furans by electrocatalytic hydrogenation of furfurals

Peter Nilges and Uwe Schröder*

The efficient room temperature electrochemical hydrogenation of furfural and 5-HMF to methylfuran and dimethylfuran, respectively, is demonstrated.



2932

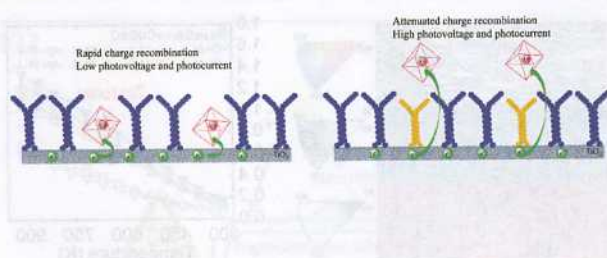


TiO₂ nanodisks designed for Li-ion batteries: a novel strategy for obtaining an ultrathin and high surface area anode material at the ice interface

Gonu Kim, Changshin Jo, Wooyul Kim, Jinyoung Chun, Songhun Yoon, Jinwoo Lee* and Wonyong Choi*

A rapid and relatively large-scale production of ultrathin TiO₂ nanodisks designed for Li-ion batteries was achieved through a novel and simple sol-gel process occurring at the interface of an organic solvent and ice.

2939

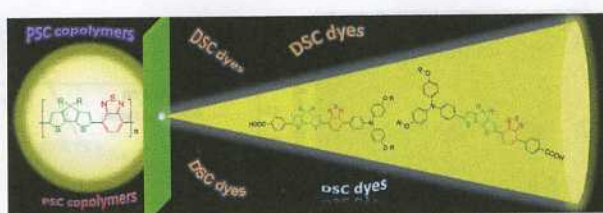


Judicious selection of a pinhole defect filler to generally enhance the performance of organic dye-sensitized solar cells

Min Zhang, Jing Zhang, Ye Fan, Lin Yang, Yinglin Wang, Renzhi Li and Peng Wang*

We demonstrate a general strategy of pinhole defect filling to enhance the performance of organic dye-sensitized solar cells.

2944

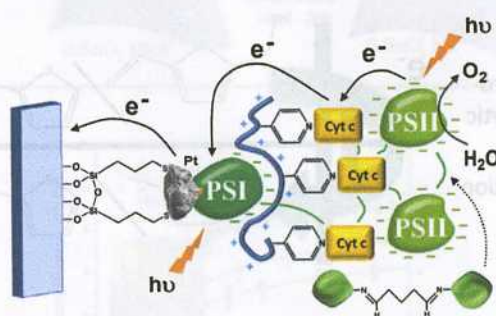


Design of high-efficiency organic dyes for titania solar cells based on the chromophoric core of cyclopentadithiophene-benzothiadiazole

Min Zhang, Yinglin Wang, Mingfei Xu, Wentao Ma, Renzhi Li and Peng Wang*

We have elaborately tailored organic dyes displaying power conversion efficiencies at the simulated air mass 1.5 full sunlight of over 11%.

2950



Cytochrome c-coupled photosystem I and photosystem II (PSI/PSII) photo-bioelectrochemical cells

Ariel Efrati, Ran Tel-Vered, Dorit Michaeli, Rachel Nechushtai and Itamar Willner*

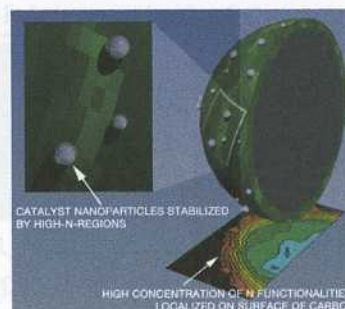
A cytochrome c-electrically wired photosystem I / photosystem II assembly mimics the natural Z-scheme and acts as a photo-bioelectrochemical electrode.

2957

Nitrogen: unraveling the secret to stable carbon-supported Pt-alloy electrocatalysts

Svitlana Pylypenko, Albina Borisevich, Karren L. More, April R. Corpuz, Timothy Holme, Arrelaine A. Dameron, Tim S. Olson, Huyen N. Dinh, Thomas Gennett and Ryan O'Hayre*

We investigate the nature of the complex interactions between nitrogen-doped carbon materials and supported catalytic nanoparticles.

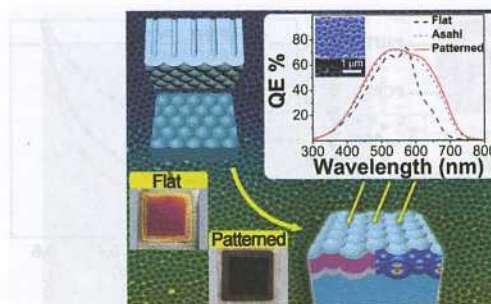


2965

Performance enhancement of thin-film amorphous silicon solar cells with low cost nanodent plasmonic substrates

Hongtao Huang, Linfeng Lu, Jun Wang, Jie Yang, Siu-Fung Leung, Yongqian Wang, Di Chen, Xiaoyuan Chen, Guozhen Shen,* Dongdong Li* and Zhiyong Fan*

Plasmonic nanodent array substrates were developed with the assistance of electrochemical anodization to enhance optical absorption in thin-film solar cells.

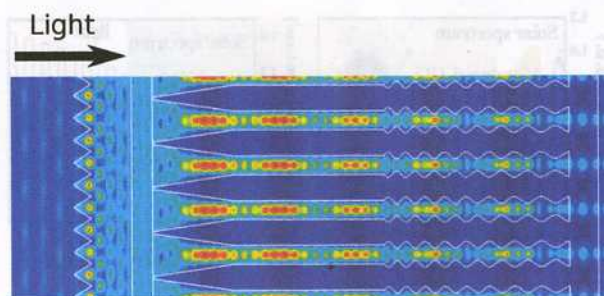


2972

Light-trapping in dye-sensitized solar cells

Stephen Foster* and Sajeev John

A new design for a nanotube-based dye-sensitized solar cell with integrated photonic crystal is presented. Numerical results show a factor of one-third enhancement in light absorption over traditional designs.

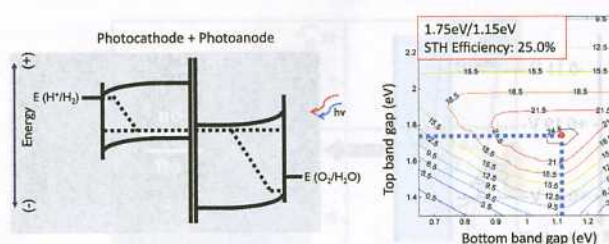


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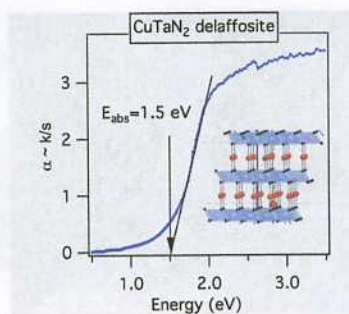
An analysis of the optimal band gaps of light absorbers in integrated tandem photoelectrochemical water-splitting systems

Shu Hu, Chengxiang Xiang, Sophia Haussener, Alan D. Berger and Nathan S. Lewis*

Band energy diagram of an integrated water-splitting system with a solar-to-hydrogen efficiency plot.



2994

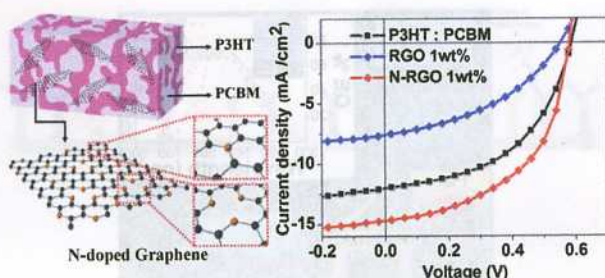


Strong optical absorption in CuTaN₂ nitride delafossite

Minghui Yang, Andriy Zakutayev,* Julien Vidal, Xiuwen Zhang, David S. Ginley* and Francis J. DiSalvo*

Copper tantalum nitride with the delafossite structure shows strong optical absorption in the energy range suitable for solar energy conversion.

3000

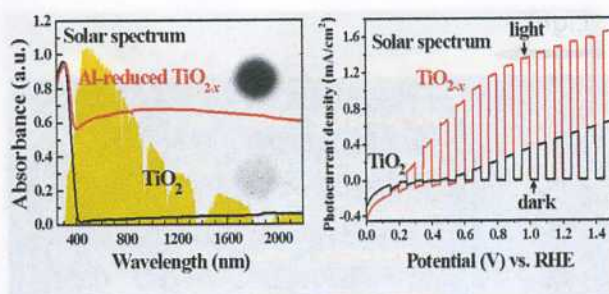


Enhanced conduction and charge-selectivity by N-doped graphene flakes in the active layer of bulk-heterojunction organic solar cells

Gwang Hoon Jun, Sung Hwan Jin, Bin Lee, Bo Hyun Kim, Weon-Sik Chae, Soon Hyung Hong* and Seokwoo Jeon*

A promising improvement of power conversion efficiency (up to 40%) can be achieved in bulk-heterojunction organic solar cells by incorporating charge-selectively N-doped graphene flakes into the active layer.

3007

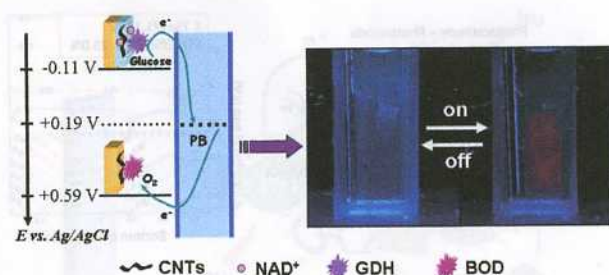


Visible-light photocatalytic, solar thermal and photoelectrochemical properties of aluminium-reduced black titania

Zhou Wang, Chongyin Yang, Tianquan Lin, Hao Yin, Ping Chen, Dongyun Wan, Fangfang Xu, Fuqiang Huang,* Jianhua Lin, Xiaoming Xie and Mianheng Jiang

High absorption of aluminium-reduced black titania in full solar spectrum boosts efficient solar energy utilization.

3015



Self-powered fluorescence controlled switch systems based on biofuel cells

Lu Bai, Lihua Jin, Lei Han and Shaojun Dong*

An integrated self-powered fluorescence switch system based on biofuel cells is initially presented by employing Prussian blue with dual function.

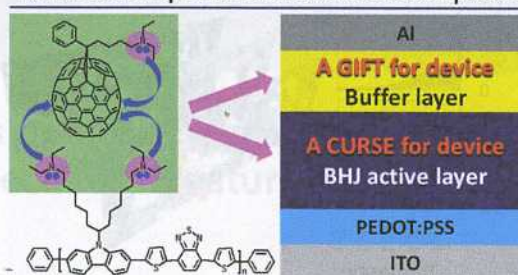
3022

Toward green solvent processable photovoltaic materials for polymer solar cells: the role of highly polar pendant groups in charge carrier transport and photovoltaic behavior

Chunhui Duan, Wanzhu Cai, Ben B. Y. Hsu, Chengmei Zhong, Kai Zhang, Chunchen Liu, Zhicheng Hu, Fei Huang,* Guillermo C. Bazan, Alan J. Heeger and Yong Cao*

Amino-groups are hole traps and can n-dope fullerene, which play different roles in different device layers.

Amine hole traps and amine-fullerene complexes

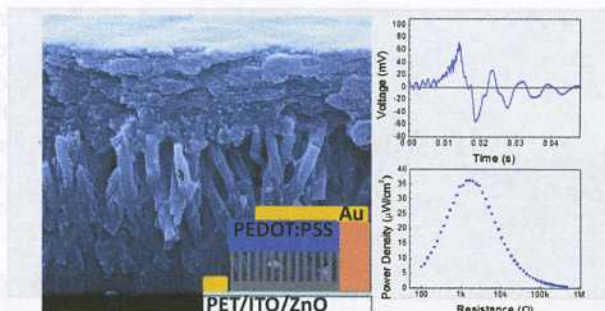


3035

Measurement techniques for piezoelectric nanogenerators

Joe Briscoe, Nimra Jalali, Peter Woolliams, Mark Stewart, Paul M. Weaver, Markys Cain and Steve Dunn*

Measurement techniques are demonstrated to characterise the output and properties of piezoelectric nanogenerators for reliable comparison between devices.

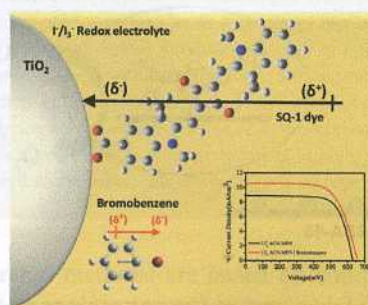


3046

Controlling dye aggregation, injection energetics and catalytic recombination in organic sensitizer based dye cells using a single electrolyte additive

Sophia Buhbut, John N. Clifford, Monica Kosa, Asaf Y. Anderson, Menny Shalom, Dan Thomas Major, Emilio Palomares and Arie Zaban*

Incorporation of substituted benzene additives into the electrolyte in DSSCs has the ability to inhibit the catalytic recombination in the $\text{TiO}_2/\text{Dye}/\text{Electrolyte}$ interface, which improves the cell efficiency.

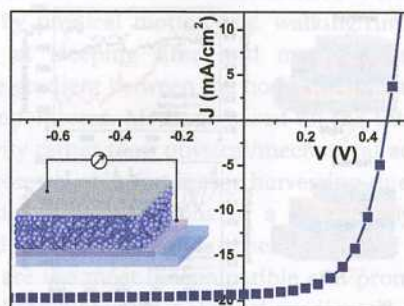


3054

5.2% efficient PbS nanocrystal Schottky solar cells

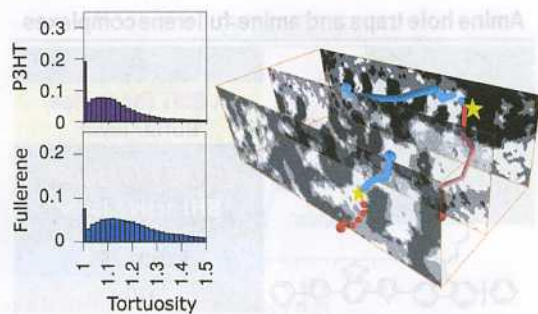
Claudia Piliago, Loredana Protesescu, Satria Zulkarnaen Bisri, Maksym V. Kovalenko and Maria Antonietta Loi*

PbS nanocrystal Schottky junctions with a power conversion efficiency of 5.2% are reported, as a result of a systematic control of the material quality.



*Department of Chemistry and Applied Physics, University of Cambridge, Cambridge, UK
†The authors thank the EPSRC for funding this work.

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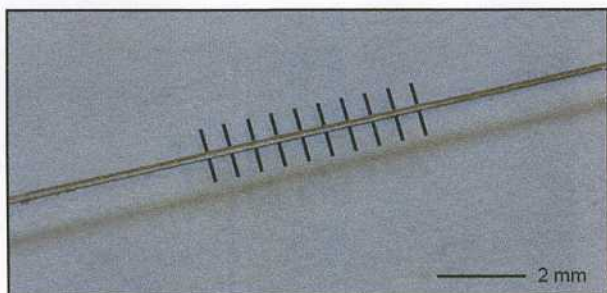


Quantifying organic solar cell morphology: a computational study of three-dimensional maps

Olga Wodo, John D. Roehling, Adam J. Moulé* and Baskar Ganapathysubramanian*

Effects of different processing conditions on the morphology are quantitatively revealed based on truly three dimensional three phase imaged data and the implications that they may have on device functionality are discussed.

3071

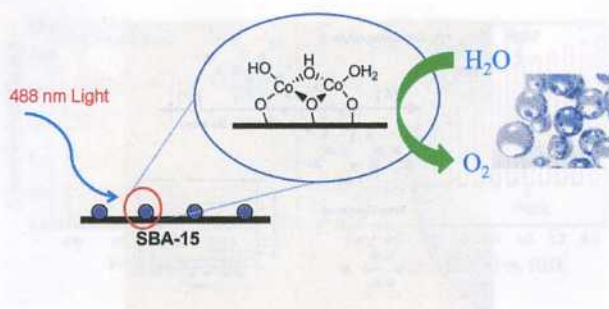


Fabrication and assembly of ultrathin high-efficiency silicon solar microcells integrating electrical passivation and anti-reflection coatings

Yuan Yao, Eric Brueckner, Lanfang Li and Ralph Nuzzo*

An array of high-efficiency silicon solar microcells integrating a thin-film light management system offers a potential route to decrease the cost of photovoltaic energy by reducing the usage of the most expensive materials components.

3080

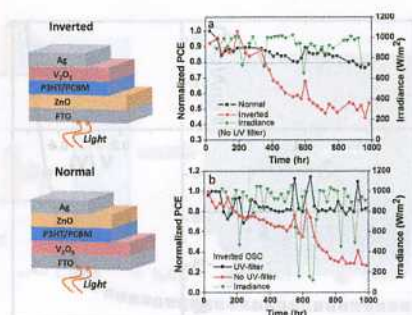


Photocatalytic water oxidation by very small cobalt domains on a silica surface

Hyun S. Ahn, Junko Yano and T. Don Tilley*

Small domains of cobalt on silica (CoSBA) were evaluated as water oxidation catalysts as the surface cobalt concentration was varied.

3088



Low-temperature, solution-processed, layered V_2O_5 hydrate as the hole-transport layer for stable organic solar cells

Gerardo Terán-Escobar, Jonas Pampel, José M. Caicedo and Mónica Lira-Cantú*

Stable organic solar cells have been fabricated applying a water-based low-temperature solution processable V_2O_5 hydrate as the hole transport layer.