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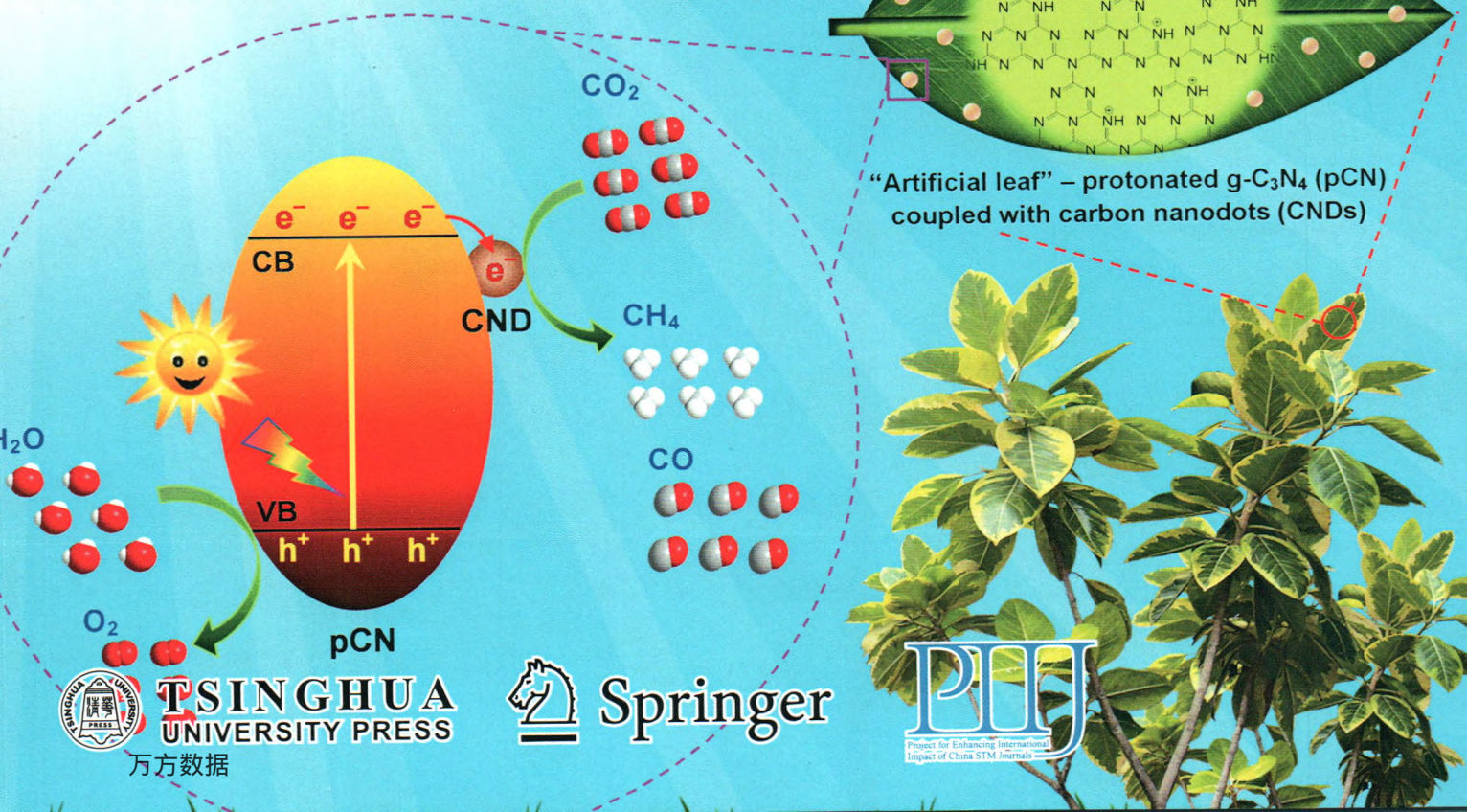
Congratulations to Professor Peidong Yang on winning the 2016 Nano Research Award

Transition metal–nitrogen–carbon nanostructured catalysts for the oxygen reduction reaction:
From mechanistic insights to structural optimization

Tailoring interface of lead-halide perovskite solar cells

Recent progress in thermoelectric nanocomposites based on
solution-synthesized nanoheterostructures

Metal-Free Photocatalysts for CO₂ Reduction



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Contents

Review Articles

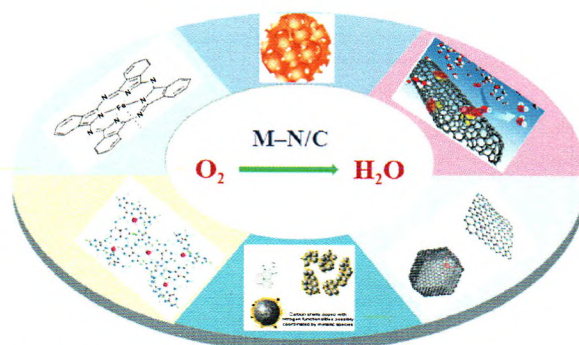
Transition metal–nitrogen–carbon nanostructured catalysts for the oxygen reduction reaction: From mechanistic insights to structural optimization

Mengxia Shen^{1,2}, Changting Wei^{1,2}, Kelong Ai¹, and Lehui Lu^{1,*}

¹ Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China

² University of Chinese Academy of Sciences, China

1449–1470



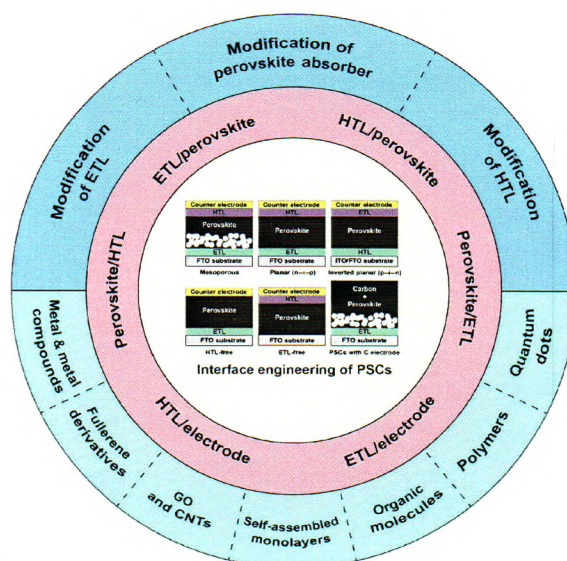
In this review, we demonstrate recent breakthroughs related to elucidating the nature of active sites using a variety of physicochemical methodologies and describe the substantial progress in engineering nanostructured metal–nitrogen–carbon (M–N/C, M = Fe, Co, etc.) catalysts by employing diverse precursors and synthetic strategies, which may offer some perspective for developing advanced electrocatalysts for the oxygen reduction reaction.

Tailoring interface of lead-halide perovskite solar cells

Peimei Da and Gengfeng Zheng*

Fudan University, China

1471–1497



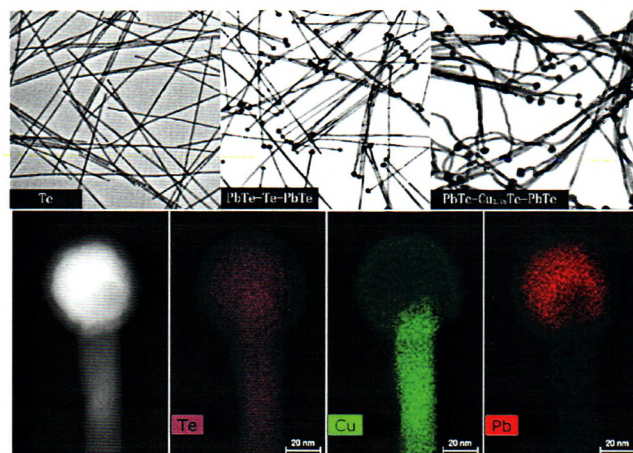
This review focuses on the interface tailoring of lead-halide perovskite solar cells, including the modification of each layer of the cell structure (i.e., perovskite absorber, electron-transport layers, and hole-transport layers) and the interfacial materials that can be introduced into the cell.

Recent progress in thermoelectric nanocomposites based on solution-synthesized nanoheterostructures

Wei Zheng¹, Biao Xu¹, Lin Zhou¹, Yilong Zhou², Haimei Zheng², Chenghan Sun¹, Enzheng Shi¹, Tanner Dale Fink¹, and Yue Wu^{1,*}

¹ Iowa State University, USA

² Lawrence Berkeley National Laboratory, USA



Recent progress in thermoelectric materials based on solution-synthesized nanoheterostructures is reviewed. We also present our latest effort in a phase-change-material ($\text{Cu}_{1.75}\text{Te}$)-incorporated thermoelectric nanocomposite.

1498–1509

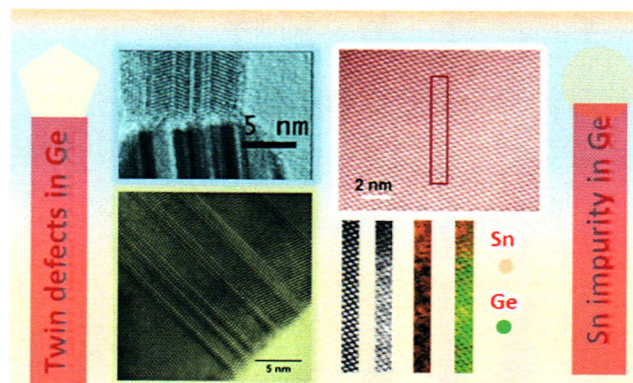
Inducing imperfections in germanium nanowires

Subhajit Biswas^{1,2,*}, Sven Barth³, and Justin D. Holmes^{1,2,*}

¹ University College Cork, Ireland

² Trinity College Dublin, Ireland

³ Institute of Materials Chemistry, Austria



Three phase bottom-up growth is utilized to incorporate and engineer imperfections such as crystal defects and impurities in semiconductor Ge nanowires via catalyst and/or interfacial manipulation. High density of twin boundaries and above equilibrium amount of Sn in Ge enhance the functionality of the nanowires.

1510–1523

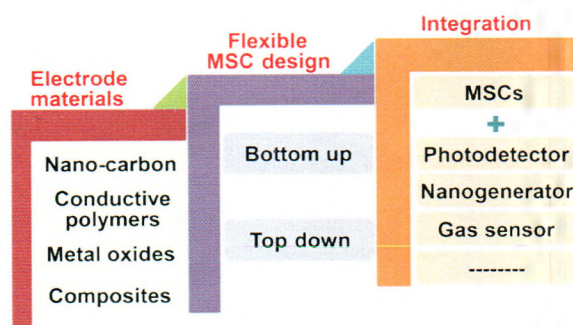
Design and integration of flexible planar micro-supercapacitors

Lili Liu¹, Zhiqiang Niu^{2,*}, and Jun Chen²

¹ Tianjin University of Technology, China

² Nankai University, China

1524–1544



This review highlights the recent developments in the device design of flexible planar micro-supercapacitors (MSCs) and their integration with other electronic devices. The current challenges and future prospects for the development of flexible MSCs are also discussed.

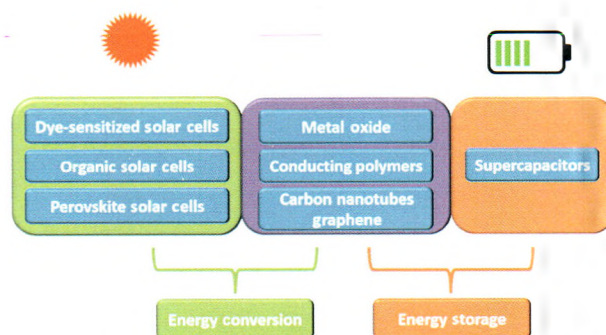
Integrated solar capacitors for energy conversion and storage

Ruiyuan Liu^{1,2}, Yuqiang Liu¹, Haiyang Zou², Tao Song^{1,*}, and Baoquan Sun^{1,*}

¹ Soochow University, China

² Georgia Institute of Technology, USA

1545–1559



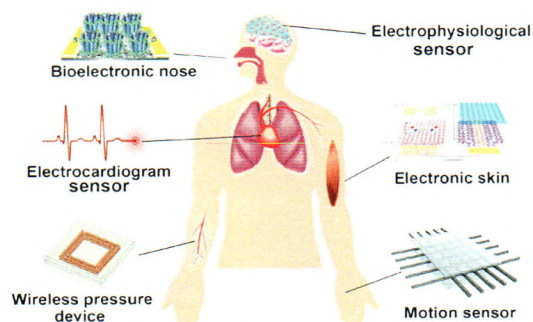
The integration of solar cells and energy-storage devices yields a promising self-powering system for simultaneously harvesting and storing energy from sunlight.

Recent progress in flexible and wearable bio-electronics based on nanomaterials

Yanbing Yang, Xiangdong Yang, Yaning Tan, and Quan Yuan*

Wuhan University, China

1560–1583



The recent progress of flexible and wearable biosensors based on nanomaterials is described. The challenges and opportunities for effective integration of multifunctional nanomaterials in bio-electronics are also proposed.

Research Articles

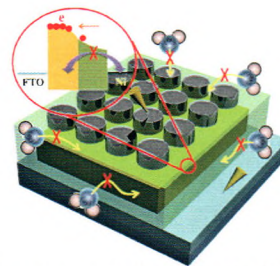
Capping CsPbBr₃ with ZnO to improve performance and stability of perovskite memristors

Ye Wu¹, Yi Wei¹, Yong Huang¹, Fei Cao¹, Dejian Yu¹, Xiaoming Li^{1,2,*}, and Haibo Zeng^{1,2,*}

¹ Nanjing University of Science and Technology, China

² Nanjing University of Aeronautics and Astronautics, China

1584–1594



Memristors based on inorganic halide perovskite are fabricated for the first time. Their device stability and performance are improved greatly via ZnO capping within the device to modify the contact of the perovskite layer with the electrode, prevent reactions at the interface between the perovskite and electrode due to moisture, and completely change the conductive mechanism, thus improving the performance in all aspects. The proposed design and fabrication procedures endow the device with electro- and photo-reading functions, as well as advantages of solution and room-temperature processability for flexible devices.

Coaxial multi-interface hollow Ni-Al₂O₃-ZnO nanowires tailored by atomic layer deposition for selective-frequency absorptions

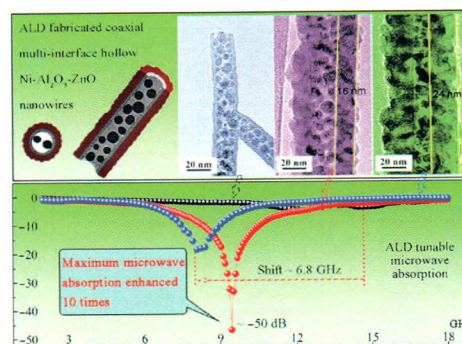
Lili Yan^{1,2}, Jia Liu³, Shichao Zhao^{1,2}, Bin Zhang¹, Zhe Gao¹, Huibin Ge^{1,2}, Yao Chen^{1,2}, Maosheng Cao^{3,*}, and Yong Qin^{1,*}

¹ Institute of Coal Chemistry, Chinese Academy of Sciences, China

² University of Chinese Academy of Sciences, China

³ Beijing Institute of Technology, China

1595–1607



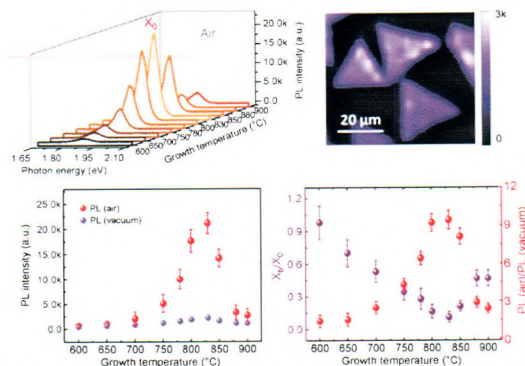
A novel structure, coaxial multi-interface hollow Ni-Al₂O₃-ZnO nanowires, is fabricated by atomic layer deposition. By adjusting ZnO cycles easily, the microwave absorption capacity and frequency-shift can be effectively tuned.

Probing the intrinsic optical quality of CVD grown MoS₂

Amina Zafar, Haiyan Nan, Zainab Zafar, Zhangting Wu, Jie Jiang, Yumeng You*, and Zhenhua Ni*

Southeast University, China

1608–1617



The intrinsic optical quality of chemical vapor deposition (CVD) grown MoS₂ is evaluated using the defect-induced PL emission spectra as well as the photoluminescence (PL) intensity ratio, obtained from measurements in air and vacuum. A correlation between electrical and optical properties in terms of mobility and defect-related PL intensity is also established.

Valley polarization in stacked MoS₂ induced by circularly polarized light

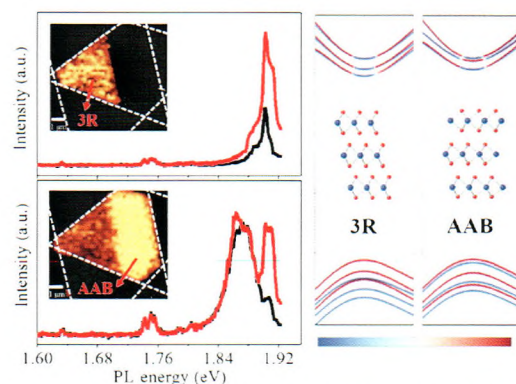
Juan Xia¹, Xingli Wang¹, Beng Kang Tay^{1,2}, Shoushun Chen¹, Zheng Liu^{1,2}, Jiaxu Yan^{1,3,*}, and Zexiang Shen^{1,*}

¹ Nanyang Technological University, Singapore

² Research Techno Plaza, Singapore

³ Nanjing Tech University (NanjingTech), China

1618–1626



In addition to valley and layer pseudospins, stacking pseudospin generates distinct valley polarization behaviors in stacked trilayer MoS₂. Specifically, the AAB (ABB)-stacked samples exhibit two distinct photoluminescence (PL) peaks: One has strong valley polarization, and the other one is unpolarized.

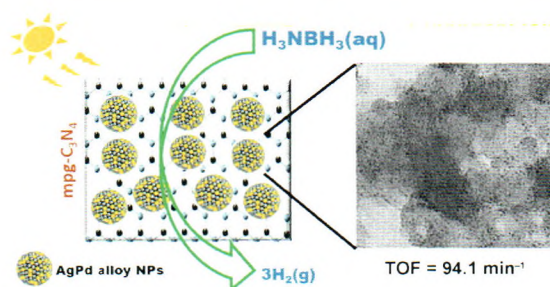
Enhanced catalytic activity of monodispersed AgPd alloy nanoparticles assembled on mesoporous graphitic carbon nitride for the hydrolytic dehydrogenation of ammonia borane under sunlight

Hamza Kahri^{1,2}, Melike Sevim¹, and Önder Metin^{1,*}

¹ Atatürk University, Turkey

² Université de Monastir, Tunisia

1627–1640



Herein, we report the first synthesis of mesoporous graphitic carbon nitride (mpg-C₃N₄)-assembled monodispersed AgPd alloy nanoparticles (mpg-C₃N₄@AgPd) and their unprecedented catalysis in the hydrolytic dehydrogenation of ammonia borane (AB) at room temperature. The activation energy and the total turnover frequency for the hydrolysis reaction were 28.2 kJ·mol⁻¹ and 94.1 min⁻¹, respectively. These values are better than those for most heterogeneous catalyst systems tested for AB hydrolysis and are the best among all Pd-based catalysts.

Enhanced CO₂ electroreduction on armchair graphene nanoribbons edge-decorated with copper

Guizhi Zhu^{1,2}, Yawei Li^{1,2}, Haiyan Zhu^{1,3}, Haibin Su^{1,4}, Siew Hwa Chan^{1,4}, and Qiang Sun^{1,2,*}

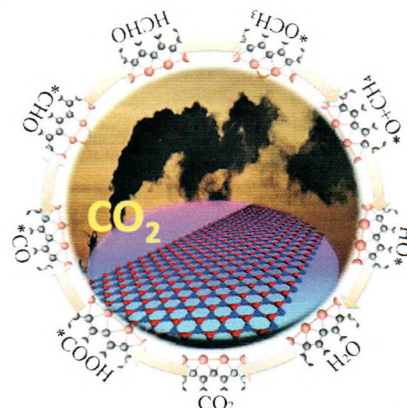
¹ Campus for Research Excellence & Technological Enterprise (CREATE), Singapore

² Peking University, China

³ Northwest University, China

⁴ Nanyang Technological University, Singapore

1641–1650



The Cu-terminated armchair GNRs with a width of $n = 3p + 2$ are more efficient catalysts for producing methanol from CO₂ with a free energy barrier of less than 0.5 eV, offering the advantages of a lower overpotential and higher selectivity than bulk Cu and other graphene-supported Cu structures.

A pH-switched mesoporous nanoreactor for synergetic therapy

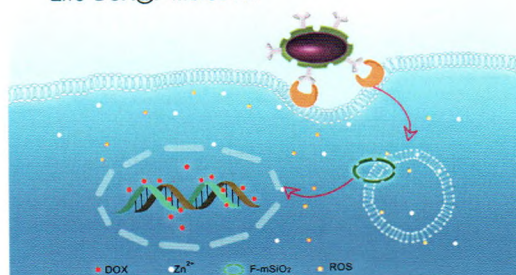
Zhengqing Yan^{1,2}, Andong Zhao^{1,2}, Xinping Liu^{1,2}, Jinsong Ren¹, and Xiaogang Qu^{1,*}

¹ Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China

² University of Chinese Academy of Sciences, China

1651–1661

ZnO-DOX@F-mSiO₂-FA



A multifunctional pH-responsive mesoporous silica nanoreactor is presented. This well-designed nanoreactor avoids the non-specific degradation of ZnO nanoparticles, resulting in synergetic therapy by taking advantage of ZnO nanoparticle-induced oxidative stress and targeted drug release.

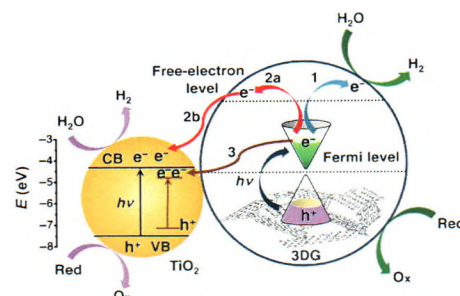
High activity of hot electrons from bulk 3D graphene materials for efficient photocatalytic hydrogen production

Yanhong Lu^{1,2}, Bo Ma¹, Yang Yang¹, Erwei Huang¹, Zhen Ge¹, Tengfei Zhang¹, Suling Zhang², Landong Li^{1,*}, Naijia Guan¹, Yanfeng Ma¹, and Yongsheng Chen^{1,*}

¹ Nankai University, China

² Langfang Teachers University, China

1662–1672



With a unique hot-electron mechanism, an efficient ultraviolet–visible (UV–vis) light driven hydrogen production from water splitting was demonstrated for the first time using a carbon-only bulk three-dimensionally cross-linked graphene (3DG) material as a robust catalyst. Combined with the widely used semiconductor TiO₂, a dramatically enhanced catalytic activity with a rate of 1,205 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$ under UV–vis light and a 7.2% apparent quantum efficiency at 350 nm is achieved for hydrogen production due to the synergetic effects between TiO₂ and such a bulk graphene material.

Unravelling charge carrier dynamics in protonated g-C₃N₄ interfaced with carbon nanodots as co-catalysts toward enhanced photocatalytic CO₂ reduction: A combined experimental and first-principles DFT study

Wee-Jun Ong^{1,*}, Lutfi Kurnianditia Putri², Yoong-Chuen Tan², Lling-Ling Tan³, Neng Li⁴, Yun Hau Ng⁵, Xiaoming Wen⁵, and Siang-Piao Chai^{2,*}

¹ Agency for Science, Technology and Research (A*STAR), Singapore

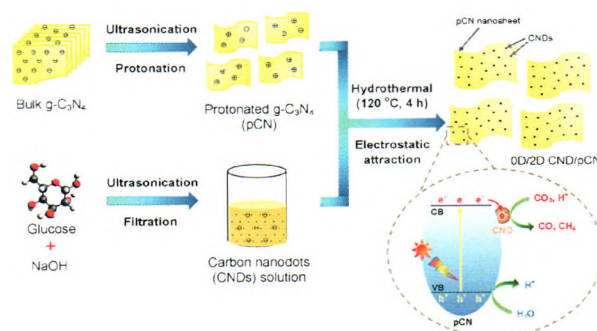
² Monash University, Malaysia

³ Heriot-Watt University, Malaysia

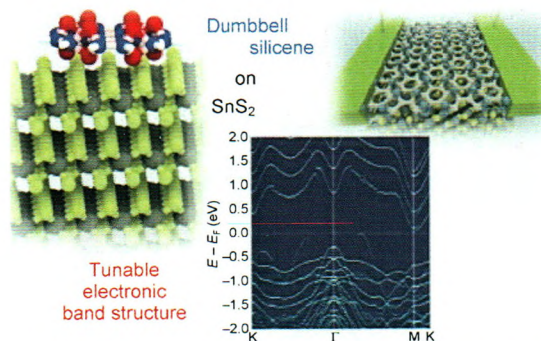
⁴ Wuhan University of Technology, China

⁵ The University of New South Wales, Australia

1673–1696



In this study, we successfully developed metal-free zero-dimensional/two-dimensional carbon nanodot (CND)-hybridized protonated g-C₃N₄ (pCN) (CND/pCN) heterojunction photocatalysts, synthesized via electrostatic attraction. The resulting enhancement of the photocatalytic reduction of CO₂ was attributed to efficient electron migration and separation from pCN to CNDs, because of the intimate interfacial coupling of CNDs and pCN. This hindered the charge recombination process, as determined by experimental results and computational simulations.

Predicting 2D silicon allotropes on SnS_2 Emilio Scalise^{1,*} and Michel Houssa²¹ Max-Planck-Institut für Eisenforschung GmbH, Germany² University of Leuven, Belgium

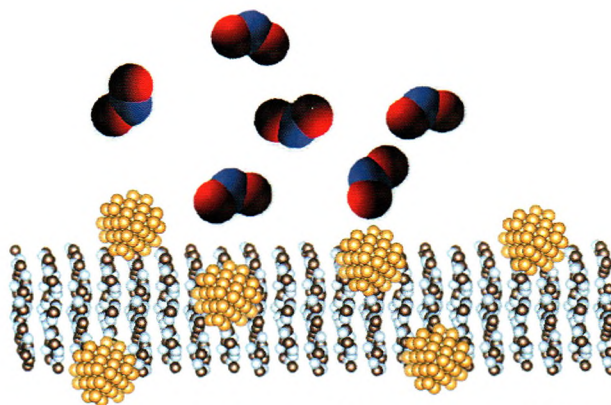
Dumbbell silicene is predicted to be stable on SnS_2 , showing tunable electronic and optical properties. The results provide guidance on the growth of silicene on nonmetallic substrates, potentially boosting its potential for application in nanoelectronics.

1697–1709

Orientation controlled preparation of nanoporous carbon nitride fibers and related composite for gas sensing under ambient conditions

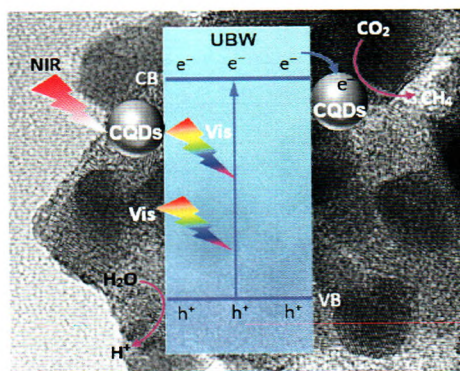
Suqin Li, Zhiwei Wang, Xiaoshan Wang, Fangfang Sun, Kai Gao, Ningxian Hao, Zhipeng Zhang, Zhongyuan Ma, Hai Li, Xiao Huang*, and Wei Huang*

Nanjing Tech University, China



Highly oriented $\text{g-C}_3\text{N}_4$ fibers with both meso- and micro-pores were prepared and hybridized with Au nanoparticles for sensitive NO_2 detection under ambient conditions.

1710–1719

Harnessing Vis–NIR broad spectrum for photocatalytic CO_2 reduction over carbon quantum dots-decorated ultrathin Bi_2WO_6 nanosheetsXin Ying Kong¹, Wen Liang Tan¹, Boon-Junn Ng¹, Siang-Piao Chai^{1,*}, and Abdul Rahman Mohamed²¹ Monash University, Malaysia² Universiti Sains Malaysia, Malaysia

A carbon quantum dots (CQDs)/ultrathin Bi_2WO_6 nanosheets (UBW) hybrid nanocomposite was demonstrated to be a visible (Vis)–near-infrared (NIR)-responsive photocatalyst for CO_2 reduction to energy-rich CH_4 hydrocarbon fuel.

1720–1731

Phosphorus oxoanion-intercalated layered double hydroxides for high-performance oxygen evolution

Ma Luo¹, Zhao Cai^{1,2}, Cheng Wang³, Yongmin Bi¹, Li Qian¹, Yongchao Hao¹, Li Li¹, Yun Kuang¹, Yaping Li¹, Xiaodong Lei¹, Ziyang Huo⁴, Wen Liu^{2,*}, Hailiang Wang², Xiaoming Sun^{1,*}, and Xue Duan¹

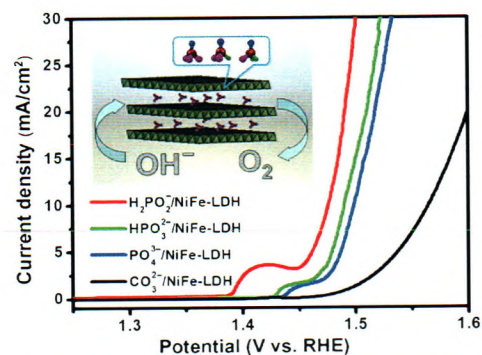
¹ Beijing University of Chemical Technology, China

² Yale University, USA

³ Chinese Research Academy of Environmental Sciences, China

⁴ Griffith University, Australia

1732–1739

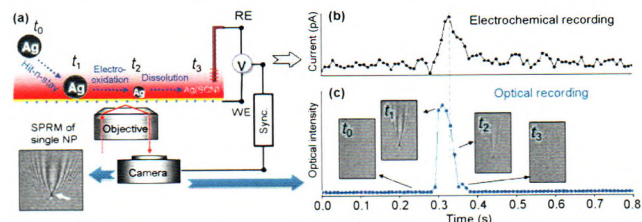


Nickel–iron layered double hydroxides with specific interlayer anions (namely, phosphate, phosphite, and hypophosphite) were fabricated by a co-precipitation method and investigated as oxygen evolution electrocatalysts. The interlayered anions modify the surface electronic structure of the Ni sites, resulting in high-performance for electrocatalytic oxygen evolution.

Simultaneous optical and electrochemical recording of single nanoparticle electrochemistry

Linlin Sun, Yimin Fang, Zhimin Li, Wei Wang*, and Hongyuan Chen*

Nanjing University, China



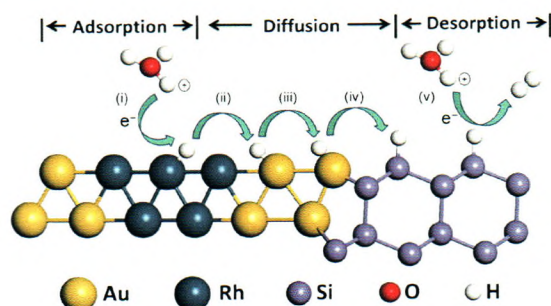
A simultaneous optical and electrochemical recording method was proposed to study dynamic electrochemical reactions during single nanoparticle collisions; this method enables an effective bottom-up strategy of elucidating the structure (optical signal)–activity (electrochemical signal) relationship at a single nanoparticle level.

1740–1748

A stepwise-designed Rh-Au-Si nanocomposite that surpasses Pt/C hydrogen evolution activity at high overpotentials

Binbin Jiang, Lulu Yang, Fan Liao, Minqi Sheng*, Haozhe Zhao, Haiping Lin*, and Mingwang Shao*

Soochow University, China



A stepwise design concept for highly efficient hydrogen evolving electrocatalysis is proposed based on a Rh-Au-Si nanocomposite and first principles calculations.

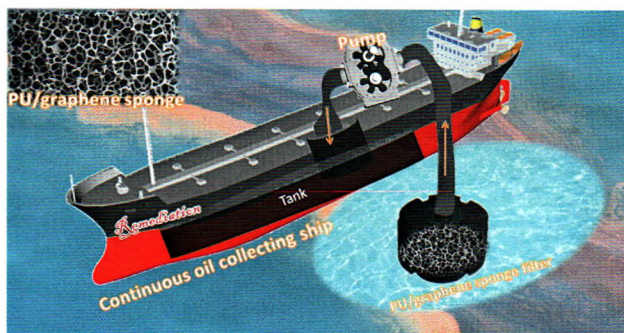
1749–1755

In situ fastening graphene sheets into a polyurethane sponge for the highly efficient continuous cleanup of oil spills

Zhuang Kong¹, Jinrong Wang¹, Xianrong Lu^{1,*}, Ying Zhu^{1,*}, and Lei Jiang^{1,2}

¹ Beihang University, China

² Technology Institute of Physics and Chemistry, Chinese Academy of Sciences, China



A graphene/polyurethane sponge with excellent chemical and physical stability prepared by *in situ* polymerization was used as an absorbing material for the continuous removal of oil from oil-spill water.

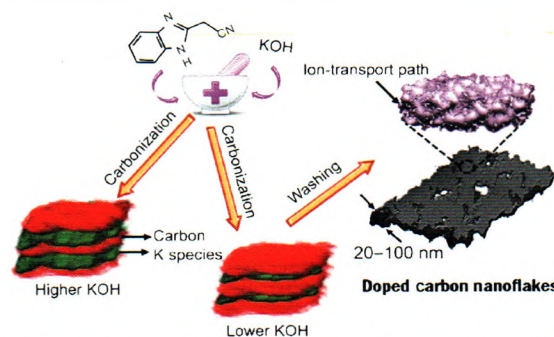
1756–1766

Extremely high-rate aqueous supercapacitor fabricated using doped carbon nanoflakes with large surface area and mesopores at near-commercial mass loading

Nan Mao¹, Huanlei Wang^{1,*}, Yang Sui¹, Yongpeng Cui¹, Jesse Pokrzywinski², Jing Shi¹, Wei Liu¹, Shougang Chen¹, Xin Wang¹, and David Mitlin^{2,*}

¹ Ocean University of China, China

² Clarkson University, USA



Carbon nanoflakes with an unparalleled combination of a large surface area, mesoporosity, and oxygen and nitrogen content are created through the single-step carbonization activation of (2-benzimidazoly) acetonitrile. When used in supercapacitor electrodes, these carbons exhibit an excellent specific capacitance and a high rate capability in both basic and neutral aqueous electrolytes.

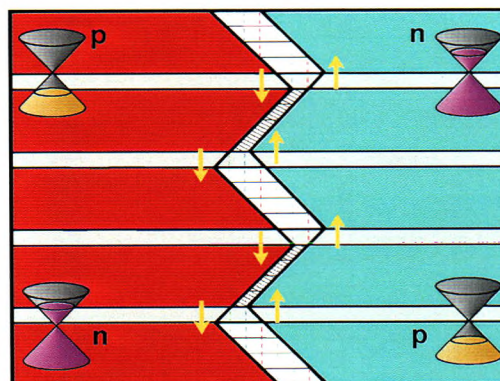
1767–1783

A realistic topological p–n junction at the Bi_2Se_3 (0001) surface based on planar twin boundary defects

Hugo Aramberri^{†,*}, M. Carmen Muñoz, and Jorge I. Cerdá*

Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), Spain

[†] Present address: Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Spain



A topological p–n junction based on stacking defects in Bi_2Se_3 is proposed. The topological surface state doping is achieved using planar twin boundaries.

1784–1793

Simple synthesis of a porous Sb/Sb₂O₃ nanocomposite for a high-capacity anode material in Na-ion batteries

Jun Pan¹, Nana Wang^{1,†}, Yanli Zhou^{1,‡}, Xianfeng Yang², Wen Yao Zhou³, Yitai Qian^{1,4,*}, and Jian Yang^{1,*}

¹ Shandong University, China

² South China University of Technology, China

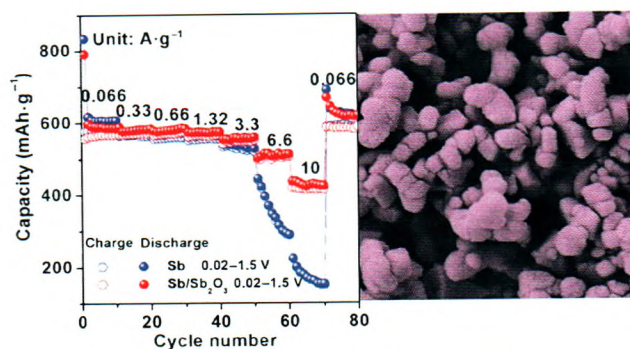
³ Jinan Licheng No.2 High School, China

⁴ University of Science and Technology of China, China

[†] Present address: Taiyuan University of Technology, China

[‡] Present address: Yantai University, China

1794–1803



A porous Sb/Sb₂O₃ nanocomposite has been synthesized by the mild oxidation of highly aggregated Sb nanocrystals. A low charge voltage inhibits the formation of Sb₂O₃ and reduces the volume change upon cycling, improving the capacity at 10 A·g⁻¹ to 412 mAh·g⁻¹, which is ~71.6% of the capacity at 0.066 A·g⁻¹.

Scanning electron microscopy imaging of single-walled carbon nanotubes on substrates

Dongqi Li¹, Jin Zhang¹, Yujun He^{1,2}, Yan Qin³, Yang Wei^{1,*}, Peng Liu¹, Lina Zhang¹, Jiaping Wang^{1,4}, Qunqing Li^{1,4}, Shoushan Fan^{1,4}, and Kaili Jiang^{1,4,*}

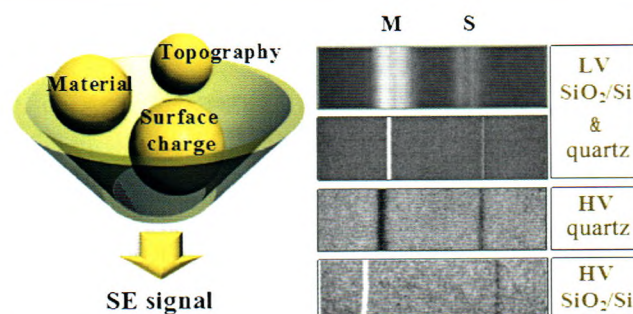
¹ Tsinghua University, China

² Sunwoda Electronic Co. Ltd., China

³ Carl Zeiss Shanghai Co., Ltd. Beijing Office, China

⁴ Collaborative Innovation Center of Quantum Matter, China

1804–1818



Scanning electron microscopy (SEM) images of single-walled carbon nanotubes (SWCNTs) on substrates are produced by the combination of signals from the topography, material, and surface charge. Modulating these factors yields m- and s-SWCNTs with various appearances.

Co-vacancy-rich Co_{1-x}S nanosheets anchored on rGO for high-efficiency oxygen evolution

Jiaqing Zhu¹, Zhiyu Ren^{1,*}, Shichao Du¹, Ying Xie¹, Jun Wu^{1,2}, Huiyuan Meng¹, Yuzhu Xue¹, and Honggang Fu^{1,*}

¹ Heilongjiang University, China

² Harbin Engineering University, China

1819–1831



Co-vacancy-rich Co_{1-x}S nanosheets were anchored on reduced graphene oxide (rGO) via a successive two-step hydrothermal reaction. The ultrathin nanosheets increased the quantity of cobalt vacancies (V_{Co}) and exposed them on the surface. Experimental results and density functional theory calculations indicated that the V_{Co} derived from the non-stoichiometric and sheet-like structure enhanced the oxygen evolution reaction activity of the Co_{1-x}S/rGO hybrid.

Size-dependent dissociation of small cobalt clusters on ultrathin NaCl films

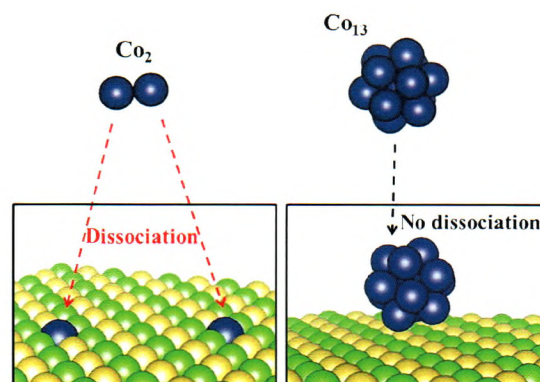
Zhe Li^{1,2,*}, Hsin-Yi Tiffany Chen³, Koen Schouteden¹, Thomas Picot¹, Arnaud Hillion¹, Gianfranco Pacchioni⁴, Chris Van Haesendonck¹, Ewald Janssens¹, and Peter Lievens¹

¹ KU Leuven, Belgium

² Dalian University of Technology, China

³ "National Tsing Hua University", Taiwan, China

⁴ Università di Milano-Bicocca, Italy



A deposited Co_2 cluster dissociates on ultrathin NaCl films grown on an Au(111) substrate, whereas a larger Co_{13} cluster does not fragment and remains stable atop the NaCl film.

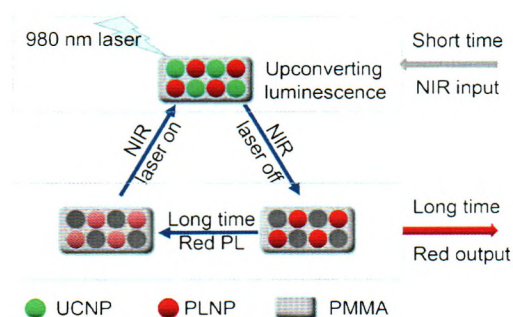
1832–1839

Near-infrared light activated persistent luminescence nanoparticles via upconversion

Zhanjun Li^{1,2}, Ling Huang¹, Yuanwei Zhang¹, Yang Zhao¹, Hong Yang¹, and Gang Han^{1,*}

¹ University of Massachusetts Medical School, USA

² Jinan University, China



Efficient upconverted persistent luminescence imaging is realized by combining the unique features of upconversion nanoparticles and persistent luminescence nanoparticles into polymethyl methacrylate.

1840–1846

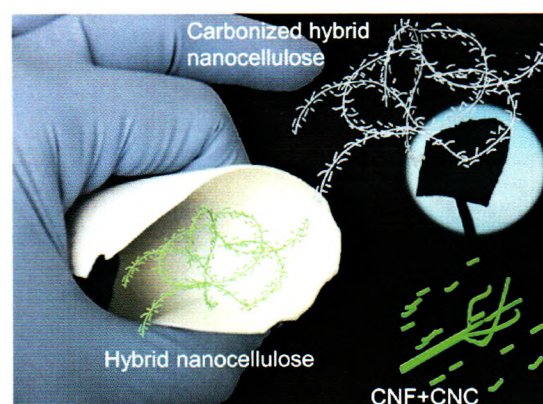
Freestanding hierarchical porous carbon film derived from hybrid nanocellulose for high-power supercapacitors

Zhi Li^{1,*}, Kaveh Ahadi¹, Keren Jiang¹, Behzad Ahvazi², Peng Li¹, Anthony O. Anyia^{2,3}, Ken Cadien¹, and Thomas Thundat^{1,*}

¹ University of Alberta, Canada

² Alberta Innovates-Technology Futures, Canada

³ National Research Council of Canada, Canada



The structural advantages of two types of nanocellulose were utilized to fabricate freestanding carbonized hybrid nanocellulose films with a specific surface area over $1,200 \text{ m}^2 \cdot \text{g}^{-1}$ as electrode materials for supercapacitors.

1847–1860

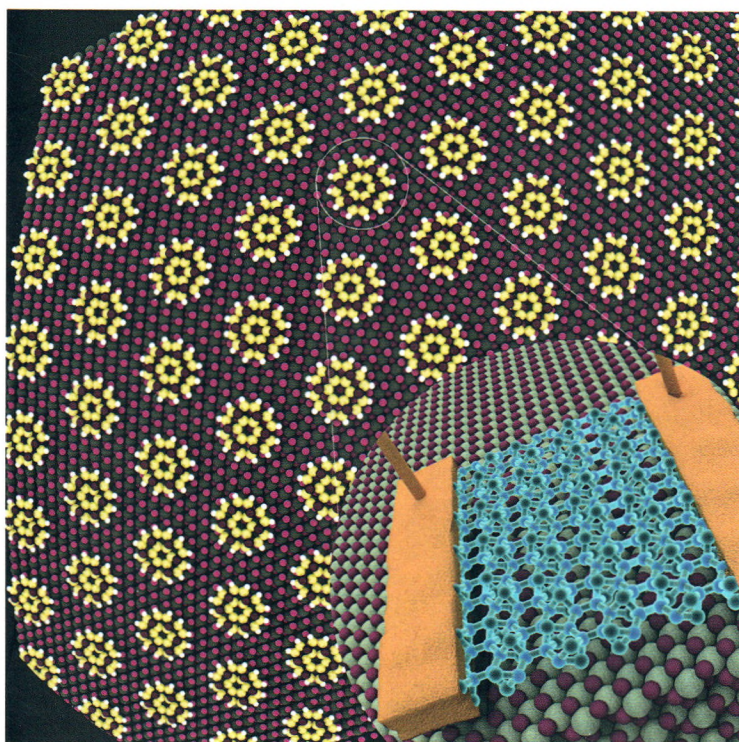
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