

纳米研究 (英文版)



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# Nano Research

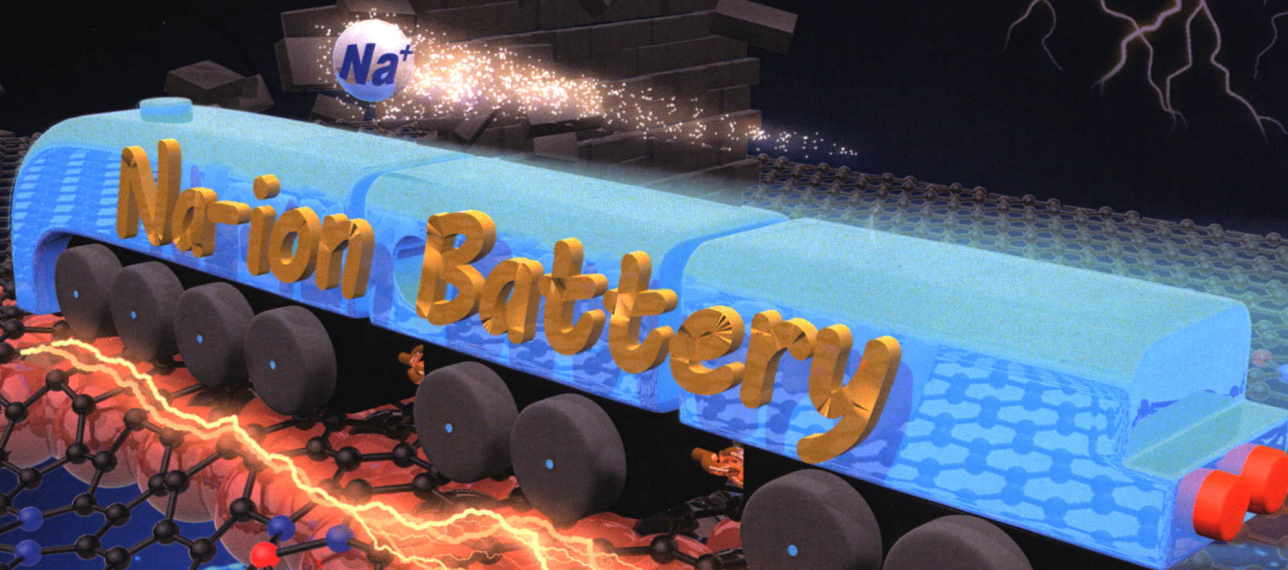
**August · 2022**

Volume 15 · Number 8

The synthesis of MOF derived carbon and its application in water treatment

Probing the active sites of 2D nanosheets with Fe-N-C carbon shell encapsulated Fe<sub>3</sub>C/Fe species for boosting sodium-ion storage performance

Electrostatic self-assembly of 2D/2D CoWO<sub>4</sub>/g-C<sub>3</sub>N<sub>4</sub> p-n heterojunction for improved photocatalytic hydrogen evolution: Built-in electric field modulated charge separation and mechanism unveiling



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# Contents

## Carbon

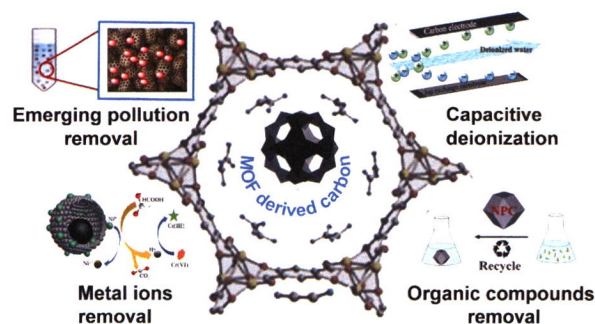
### Review Article

#### The synthesis of MOF derived carbon and its application in water treatment

Jiani Ding<sup>1</sup>, Yijian Tang<sup>1</sup>, Shasha Zheng<sup>1</sup>, Songtao Zhang<sup>1</sup>, Huaiguo Xue<sup>1</sup>, Qingquan Kong<sup>2</sup>, and Huan Pang<sup>1,\*</sup>

<sup>1</sup> Yangzhou University, China

<sup>2</sup> Chengdu University, China



Metal-organic framework (MOF) derived carbon represents a promising kind of adsorbing material due to the appealing merits such as large surface area and pore volume as well as desirable chemical stability. The practical applications of MOF derived carbon materials and their wide applications for water treatment are comprehensively summarized in this review.

6793–6818

### Research Articles

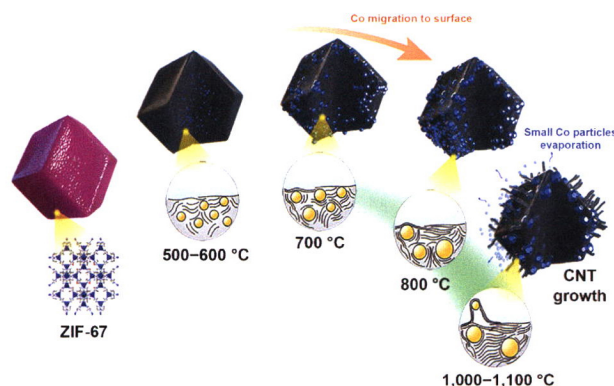
#### Dynamically observing the formation of MOFs-driven Co/N-doped carbon nanocomposites by *in-situ* transmission electron microscope and their application as high-efficient microwave absorbent

You Zhou<sup>1</sup>, Xia Deng<sup>2</sup>, Hongna Xing<sup>1</sup>, Hongyang Zhao<sup>3</sup>, Yibo Liu<sup>1</sup>, Lisong Guo<sup>1</sup>, Juan Feng<sup>1</sup>, Wei Feng<sup>1</sup>, Yan Zong<sup>1</sup>, Xiuhong Zhu<sup>1</sup>, Xinghua Li<sup>1,\*</sup>, Yong Peng<sup>2,\*</sup>, and Xinliang Zheng<sup>1</sup>

<sup>1</sup> Northwest University, China

<sup>2</sup> Lanzhou University, China

<sup>3</sup> Xi'an Jiaotong University, China



The formation process of zeolitic imidazolate framework (ZIF)-67 derived Co/N-doped carbon nanocomposites is dynamically investigated by *in-situ* transmission electron microscopy (TEM) assisted with *ex-situ* characterizations. Several key findings were observed: (1) graphitization of carbon; (2) volatilization of Co nanocrystals; (3) generation process of carbon nanotubes (CNTs) catalyzed by Co. The nanocomposites show high-efficient microwave absorption performance that can be tuned by pyrolysis temperature, heating rate, and mass fraction. These findings are helpful to understand the formation of metal-organic frameworks (MOFs) derived carbon-based composites and expand their practical applications.

6819–6830



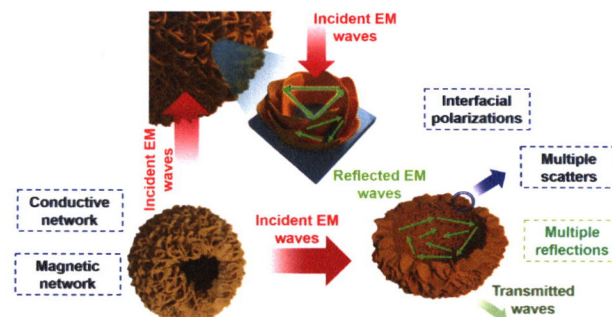
## Hollow hydrangea-like nitrogen-doped NiO/Ni/carbon composites as lightweight and highly efficient electromagnetic wave absorbers

Jin Liang<sup>1</sup>, Chunwei Li<sup>1</sup>, Xin Cao<sup>1</sup>, Yuxiang Wang<sup>1</sup>, Zongcheng Li<sup>1</sup>, Benzhen Gao<sup>2</sup>, Zeyou Tong<sup>2</sup>, Bin Wang<sup>3,\*</sup>, Shuchen Wan<sup>2</sup>, and Jie Kong<sup>1,\*</sup>

<sup>1</sup> Northwestern Polytechnical University, China

<sup>2</sup> China Academy of Launch Vehicle Technology, China

<sup>3</sup> Minmetals exploration & development CO. LTD, China



The uniform hierarchical magnetic–dielectric composites of hollow hydrangea-like nitrogen doped NiO/Ni/carbon were successfully achieved and applied as absorbers in electromagnetic wave absorption. The magnetic coupling network and conductivity network of the hollow structure combined with the multiple components and structures endow the HF NiO/Ni/C with matched impedance and good attenuation ability. The HF NiO/Ni/C 800–10 composites possess the strong reflection loss of −45.8 dB at 1.7 mm and wide bandwidth of 5.6 GHz.

6831–6840

## Engineering hierarchical heterostructure material based on metal-organic frameworks and cotton fiber for high-efficient microwave absorber

Yan Guo<sup>1</sup>, Hu Liu<sup>1,\*</sup>, Dedong Wang<sup>1</sup>, Zeinhom M. El-Bahy<sup>2</sup>, Jalal T. Althakafy<sup>3</sup>, Hala M. Abo-Dief<sup>4</sup>, Zhanhu Guo<sup>5</sup>, Ben Bin Xu<sup>6</sup>, Chuntai Liu<sup>1</sup>, and Changyu Shen<sup>1</sup>

<sup>1</sup> Zhengzhou University, China

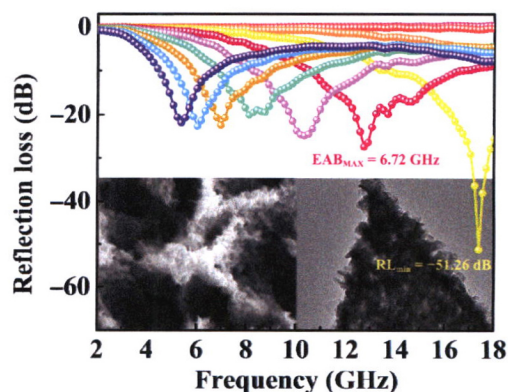
<sup>2</sup> Al-Azhar University, Egypt

<sup>3</sup> Umm Al-Qura University, Saudi Arabia

<sup>4</sup> Taif University, Saudi Arabia

<sup>5</sup> University of Tennessee, USA

<sup>6</sup> Northumbria University, UK



Hierarchical heterostructure WS<sub>2</sub>/CoS<sub>2</sub>@carbonized cotton fiber (CCF) derived from metal-organic frameworks (MOFs) anchored cotton fiber possesses multiple loss mechanisms and exhibits high-performance electromagnetic wave absorption capacity.

6841–6850

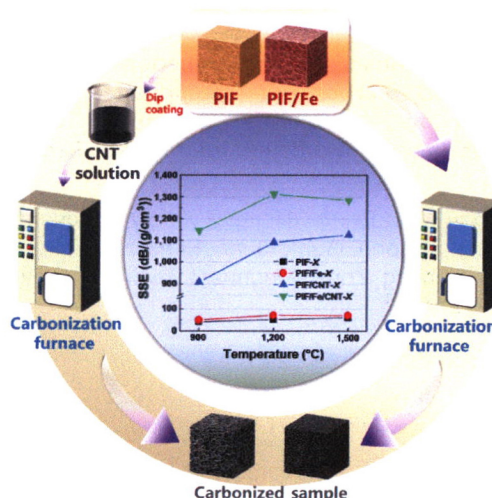
## High-performance porous carbon foams via catalytic pyrolysis of modified isocyanate-based polyimide foams for electromagnetic shielding

Zhouping Sun<sup>1</sup>, Bin Shen<sup>1,2,\*</sup>, Yang Li<sup>3,\*</sup>, Jiali Chen<sup>1</sup>, and Wenge Zheng<sup>1,2</sup>

<sup>1</sup> Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, China

<sup>2</sup> University of Chinese Academy of Sciences, China

<sup>3</sup> Huanghuai University, China



The introduction of ferric acetylacetonate and carbon nanotube (CNT) coating in isocyanate-based polyimide foams (PIFs) could suppress the serious shrinkage and improve the graphitization degree of the final carbon foams through the Fe-catalytic graphitization process, thereby endowing them with better electromagnetic interference (EMI)-shielding performance even at lower pyrolysis temperature.

6851–6859



## Highlight

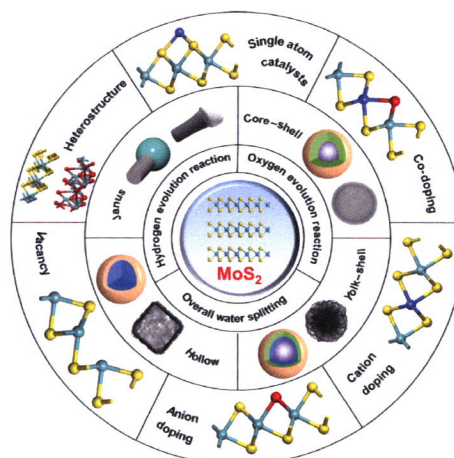
Revealing structure-selectivity correlations in pulsed CO<sub>2</sub> electrolysis via time-resolved operando synchrotron X-ray studies

Dunfeng Gao\*

Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China

6860–6861

## Review Articles

Modulation of morphology and electronic structure on MoS<sub>2</sub>-based electrocatalysts for water splittingMengmeng Liu<sup>1</sup>, Chunyan Zhang<sup>1</sup>, Ali Han<sup>2</sup>, Ling Wang<sup>1</sup>, Yujia Sun<sup>1</sup>, Chunna Zhu<sup>1</sup>, Rui Li<sup>1</sup>, and Sheng Ye<sup>1,\*</sup><sup>1</sup> Anhui Agricultural University, China<sup>2</sup> Institute of Metal Research, Chinese Academy of Sciences, China

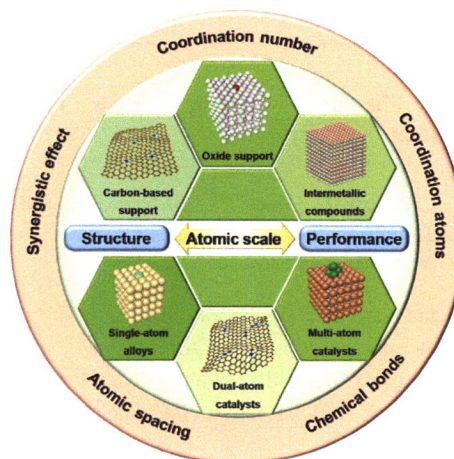
The present topic focuses on the recent advances on the fabrication approaches of MoS<sub>2</sub> ultrathin nanosheets (MoS<sub>2</sub> NSs), and modification strategies including morphology modulation or electronic structure modulation to improve the intrinsic catalytic activity of bulk MoS<sub>2</sub>.

6862–6887

## Understanding the structure–performance relationship of active sites at atomic scale

Runze Li and Dingsheng Wang\*

Tsinghua University, China



It is very important to understand the relationship between structure and performance of catalysts at atomic scale by using key descriptors for rational design and performance improvement of catalysts.

6888–6923

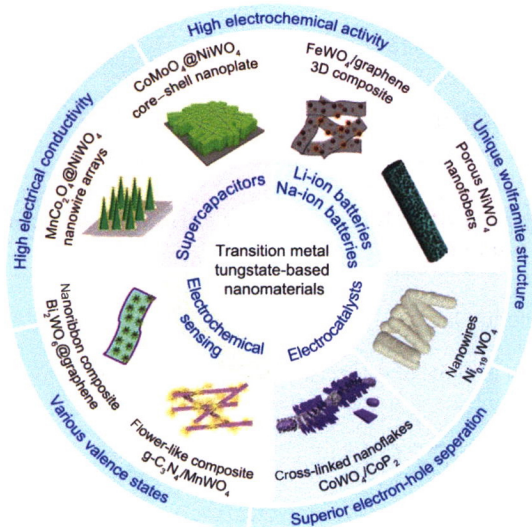


## Shining light on transition metal tungstate-based nanomaterials for electrochemical applications: Structures, progress, and perspectives

Kaijia Feng<sup>1</sup>, Zhefei Sun<sup>2</sup>, Yong Liu<sup>1,\*</sup>, Feng Tao<sup>1</sup>, Junqing Ma<sup>1</sup>, Han Qian<sup>1</sup>, Renhong Yu<sup>1</sup>, Kunming Pan<sup>1,\*</sup>, Guangxin Wang<sup>1</sup>, Shizhong Wei<sup>1</sup>, and Qiaobao Zhang<sup>2,\*</sup>

<sup>1</sup> Henan University of Science and Technology, China

<sup>2</sup> Xiamen University, China



The advantages and recent advances of transition metal tungstate-based nanomaterials in electrochemical applications are systemically summarized.

6924–6960

## Research Articles

### Phosphorus-doping-tuned PtNi concave nanocubes with high-index facets for enhanced methanol oxidation reaction

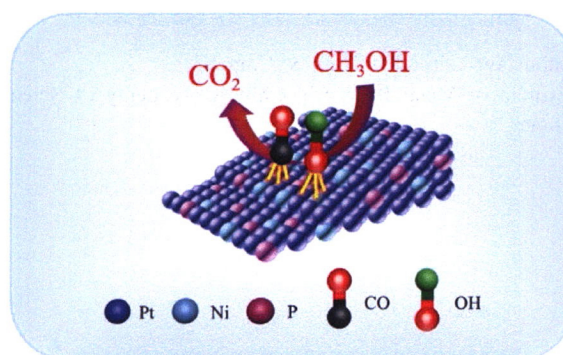
Aixin Fan<sup>1,3</sup>, Congli Qin<sup>1</sup>, Ruxia Zhao<sup>2</sup>, Haixiao Sun<sup>3</sup>, Hui Sun<sup>3</sup>, Xiaoping Dai<sup>3</sup>, Jin-Yu Ye<sup>4</sup>, Shi-Gang Sun<sup>4</sup>, Yanhong Lu<sup>1,\*</sup>, and Xin Zhang<sup>3,\*</sup>

<sup>1</sup> Langfang Normal University, China

<sup>2</sup> ShanDong Drug and Food Vocational College, China

<sup>3</sup> China University of Petroleum, China

<sup>4</sup> Xiamen University, China



This work provides an effective strategy for fine-tuning PtNi alloy nanocrystals with high-index facets (HIFs) via surface P doping to boost the electro-oxidation reaction of methanol (CH<sub>3</sub>OH).

6961–6968

### There is life after coking for Ir nanocatalyst superlattices

Antonio J. Martínez-Galera<sup>1,‡,\*</sup>, Haojie Guo<sup>1</sup>, Mariano D. Jiménez-Sánchez<sup>1</sup>, Stefano Franchi<sup>2,⊥</sup>, Kevin C. Prince<sup>2</sup>, and José M. Gómez-Rodríguez<sup>1,†</sup>

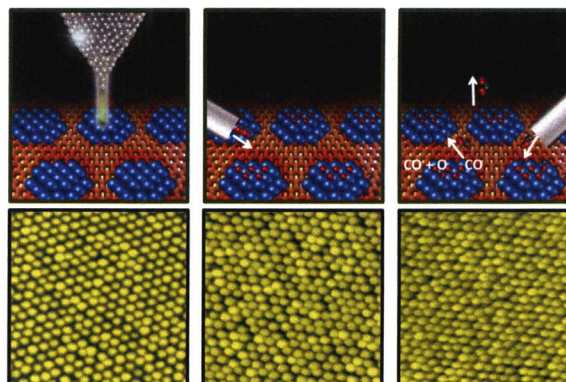
<sup>1</sup> Universidad Autónoma de Madrid, Spain

<sup>2</sup> Elettra-Sincrotrone Trieste S.C.p.A., Italy

<sup>‡</sup> Present address: Universidad Autónoma de Madrid, Spain

<sup>⊥</sup> Present address: National Research Council (CNR), Italy

<sup>†</sup> Deceased



Ordered networks of Ir nanocrystals, with a tunable narrow size distribution and good chemical and thermal stabilities, are proposed as a novel testbed to draw up a profile of the perfect catalyst in oxidation reactions.

6969–6976



### Exsolution of CoFe(Ru) nanoparticles in Ru-doped ( $\text{La}_{0.8}\text{Sr}_{0.2}$ ) $_{0.9}\text{Co}_{0.1}\text{Fe}_{0.8}\text{Ru}_{0.1}\text{O}_{3-\delta}$ for efficient oxygen evolution reaction

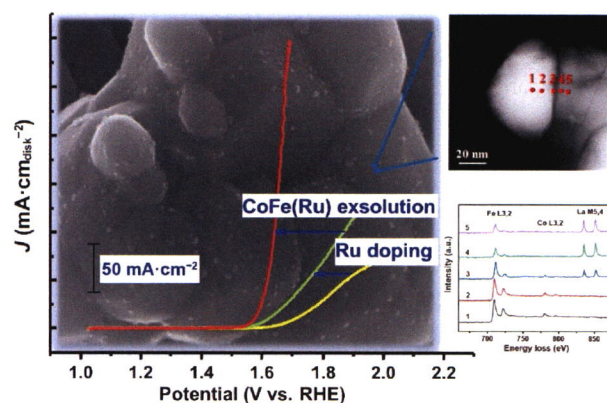
Yi Liang<sup>1</sup>, Yu Cui<sup>1</sup>, Yang Chao<sup>1</sup>, Ning Han<sup>2</sup>, Jaka Sunarso<sup>3</sup>, Ping Liang<sup>1,\*</sup>, Xin He<sup>1</sup>, Chi Zhang<sup>1,\*</sup>, and Shaomin Liu<sup>4</sup>

<sup>1</sup> Wuyi University, China

<sup>2</sup> KU Leuven, Belgium

<sup>3</sup> Swinburne University of Technology, Malaysia

<sup>4</sup> Beijing University of Chemical Technology, China



Ru doping was found to promote the generation of CoFe(Ru) alloy on ( $\text{La}_{0.8}\text{Sr}_{0.2}$ ) $_{0.9}\text{Co}_{0.1}\text{Fe}_{0.8}\text{Ru}_{0.1}\text{O}_{3-\delta}$  perovskite surface in reducing atmosphere. The exsolved CoFe(Ru) and Ru doping both enhanced the oxygen evolution reaction performance of perovskite.

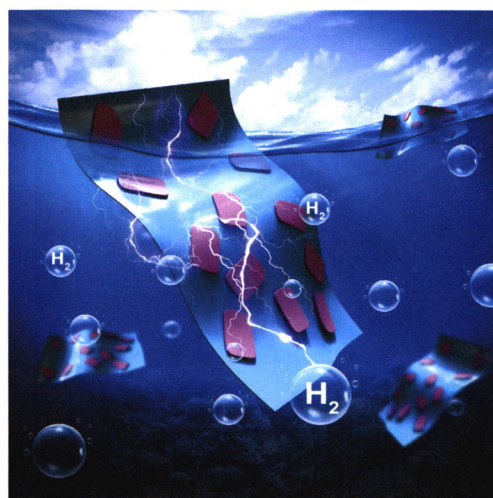
6977–6986

### Electrostatic self-assembly of 2D/2D $\text{CoWO}_4/\text{g-C}_3\text{N}_4$ p–n heterojunction for improved photocatalytic hydrogen evolution: Built-in electric field modulated charge separation and mechanism unveiling

Haiyang Wang<sup>1</sup>, Ranran Niu<sup>1</sup>, Jianhui Liu<sup>1</sup>, Sheng Guo<sup>2,\*</sup>, Yongpeng Yang<sup>1</sup>, Zhongyi Liu<sup>1</sup>, and Jun Li<sup>1,\*</sup>

<sup>1</sup> Zhengzhou University, China

<sup>2</sup> Wuhan Institute of Technology, China



An 2D/2D p–n heterojunction was successfully synthesized by self-assembled strategy for efficient photocatalytic  $\text{H}_2$  generation. This work demonstrates a high-efficient p–n heterojunction photocatalyst with II-scheme charge migration pathway and paves the way to design highly active p–n junction photocatalysts for  $\text{H}_2$  generation.

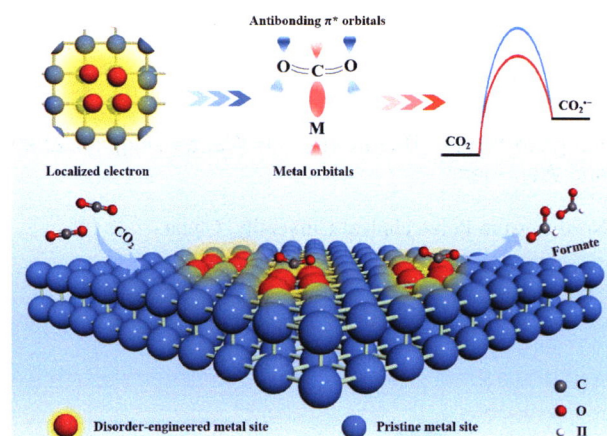
6987–6998

### Industrial-current-density $\text{CO}_2$ -to-formate conversion with low overpotentials enabled by disorder-engineered metal sites

Zhiqiang Wang<sup>1</sup>, Xiaolong Zu<sup>1</sup>, Xiaodong Li<sup>1</sup>, Li Li<sup>1</sup>, Yang Wu<sup>1</sup>, Shumin Wang<sup>1</sup>, Peiquan Ling<sup>1</sup>, Yuan Zhao<sup>1</sup>, Yongfu Sun<sup>1,2,\*</sup>, and Yi Xie<sup>1,2</sup>

<sup>1</sup> University of Science and Technology of China, China

<sup>2</sup> Hefei Comprehensive National Science Center, China



The disorder-engineered metal sites on the designed two-dimensional (2D) metallic nanosheets could effectively lower the formation energy of rate-limiting  $\text{CO}_2^{*}$  intermediate during  $\text{CO}_2$  reduction to formate. Moreover, the uniform sites and high electron conductivity of metallic nanosheets offer the designed electrocatalyst a higher opportunity to realize selective  $\text{CO}_2$  to formate at large current densities.

6999–7007

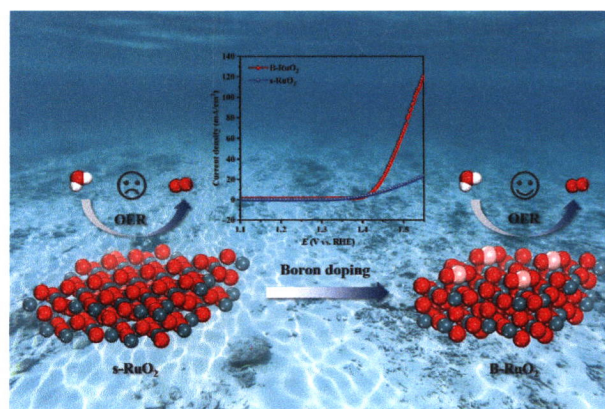


## Motivating Ru-bri site of RuO<sub>2</sub> by boron doping toward high performance acidic and neutral oxygen evolution

Chongjing Liu<sup>1</sup>, Beibei Sheng<sup>1,2</sup>, Quan Zhou<sup>1</sup>, Dengfeng Cao<sup>1,2</sup>, Honghe Ding<sup>1</sup>, Shuangming Chen<sup>1,\*</sup>, Pengjun Zhang<sup>1</sup>, Yujian Xia<sup>1</sup>, Xiaojun Wu<sup>1</sup>, and Li Song<sup>1,2</sup>

<sup>1</sup> University of Science and Technology of China, China

<sup>2</sup> Hefei Comprehensive National Science Center, China



The anomalous B–O bonding formed by boron doping of RuO<sub>2</sub> motivates the inactive fully coordinately bridge ruthenium site (Ru-bri site) into oxygen evolution reaction (OER)-active and thus greatly improves the performances of acidic and neutral OER.

7008–7015

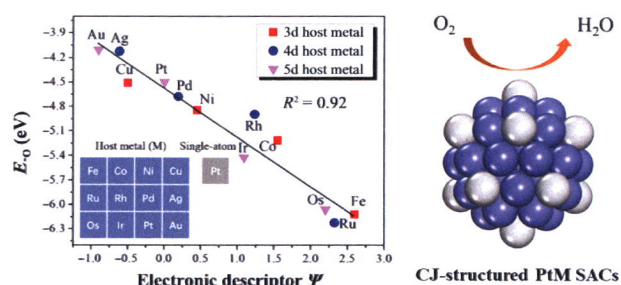
## Design of platinum single-atom doped metal nanoclusters as efficient oxygen reduction electrocatalysts by coupling electronic descriptor

Qing Liu<sup>1,2</sup>, Xiaoxu Wang<sup>3</sup>, Lu Li<sup>1</sup>, Keke Song<sup>1</sup>, Ping Qian<sup>1,\*</sup>, and Yuan Ping Feng<sup>2,\*</sup>

<sup>1</sup> University of Science and Technology Beijing, China

<sup>2</sup> National University of Singapore, Singapore

<sup>3</sup> DP Technology, China



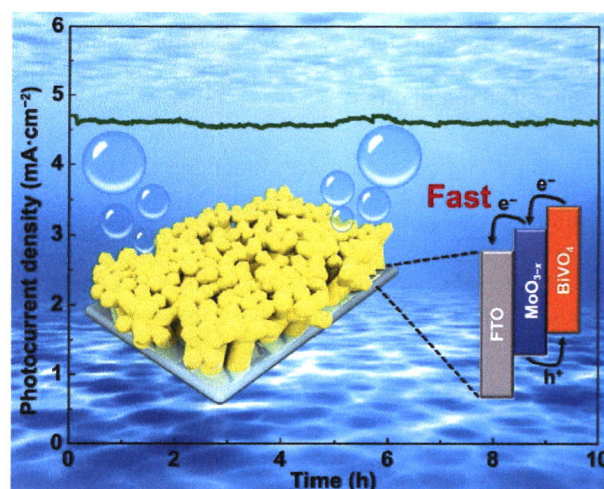
Catalytic properties and stability of single-atom catalysts (SACs) with crown-jewel structure are explored using density functional theory (DFT) calculations. A descriptor  $\Psi$  is established to predict oxygen reduction reaction (ORR) catalytic activity of SACs.

7016–7025

## Nanoporous MoO<sub>3-x</sub>/BiVO<sub>4</sub> photoanodes promoting charge separation for efficient photoelectrochemical water splitting

Songcan Wang<sup>\*</sup>, Boyan Liu, Xin Wang, Yingjuan Zhang, and Wei Huang

Northwestern Polytechnical University, China



A MoO<sub>3-x</sub>/BiVO<sub>4</sub> nanoporous heterojunction photoanode is designed to provide an electron “highway” for charge separation and transport, leading to a high and stable photocurrent density of 4.81 mA·cm<sup>-2</sup> for photoelectrochemical water splitting.

7026–7033

### Constructing the separation pathway for photo-generated carriers by diatomic sites decorated on MIL-53-NH<sub>2</sub>(Al) for enhanced photocatalytic performance

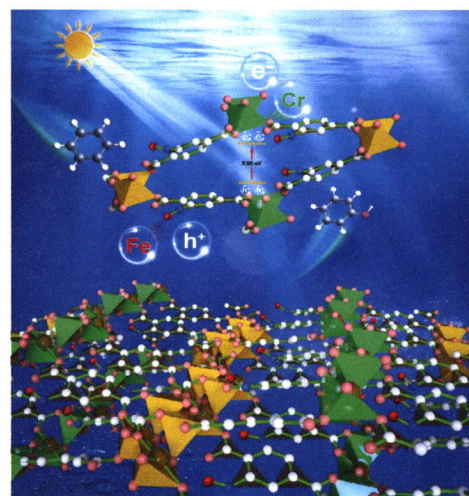
Gang Wang<sup>1</sup>, Yan Liu<sup>1</sup>, Ning Zhao<sup>1</sup>, Huimei Chen<sup>1</sup>, Wenjie Wu<sup>1</sup>, Yueyue Li<sup>1</sup>, Xiangwen Liu<sup>2</sup>, Ang Li<sup>3</sup>, Wenxing Chen<sup>4</sup>, and Junjie Mao<sup>1,\*</sup>

<sup>1</sup> Anhui Normal University, China

<sup>2</sup> Institute of Analysis and Testing, Beijing Academy of Science and Technology (Beijing Center for Physical and Chemical Analysis), China

<sup>3</sup> Beijing University of Technology, China

<sup>4</sup> Beijing Institute of Technology, China



A diatomic synergistic modulation (DSM) strategy was developed to effectively control the separation of photo-generated carriers. Theoretical and experimental results reveal that the diatomic sites of Cr and Fe act as electron acceptor and electron donor, respectively, and then enhance the photocatalytic activity.

7034–7041

### Confining shell-sandwiched Ag clusters in MnO<sub>2</sub>-CeO<sub>2</sub> hollow spheres to boost activity and stability of toluene combustion

Menglan Xiao<sup>1,6</sup>, Xueqin Yang<sup>2</sup>, Yue Peng<sup>4</sup>, Yucong Guo<sup>1</sup>, Yuechang Wei<sup>5</sup>, Maofa Ge<sup>1,3,6</sup>, and Xiaolin Yu<sup>1,6,\*</sup>

<sup>1</sup> Institute of Chemistry, Chinese Academy of Sciences, China

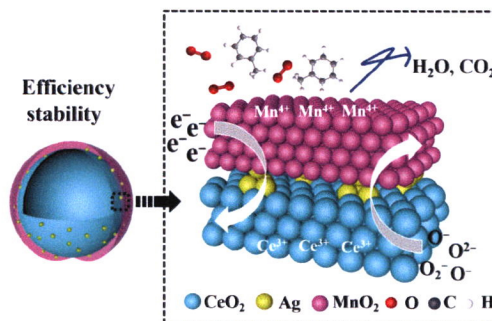
<sup>2</sup> Henan Agricultural University, China

<sup>3</sup> Institute of Urban Environment, Chinese Academy of Sciences, China

<sup>4</sup> Tsinghua University, China

<sup>5</sup> China University of Petroleum, China

<sup>6</sup> University of Chinese Academy of Sciences, China



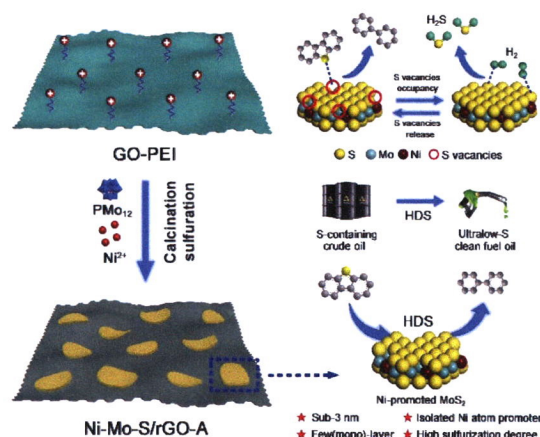
Ag clusters in the sandwich shell of MnO<sub>2</sub>-Ag-CeO<sub>2</sub> catalyst could be effectively stabilized, maximizing the active interface to boost volatile organic compounds (VOCs) combustion.

7042–7051

### The confined growth of few-layered and ultrashort-slab Ni-promoted MoS<sub>2</sub> on reduced graphene oxide for deep-degree hydrodesulfurization

Dongxu Wang, Lei Wang, Yanqing Jiao, Aiping Wu, Haijing Yan, Xin Kang, Chungui Tian\*, Jiancong Liu, and Honggang Fu\*

Heilongjiang University, China



The few-layered and ultrashort-slab Ni-promoted MoS<sub>2</sub>, in which the edge Mo atoms are partially substituted by isolated Ni atoms, supported on graphene is constructed by anchoring PMo<sub>12</sub> clusters and Ni<sup>2+</sup> on polyethyleneimine (PEI)-modified graphite oxide (GO). The catalyst possesses the high sulfuration degree and rich accessible edge-sites, thus being promising for hydrodesulfurization (HDS) reaction with the superior performance to the ever reported catalysts.

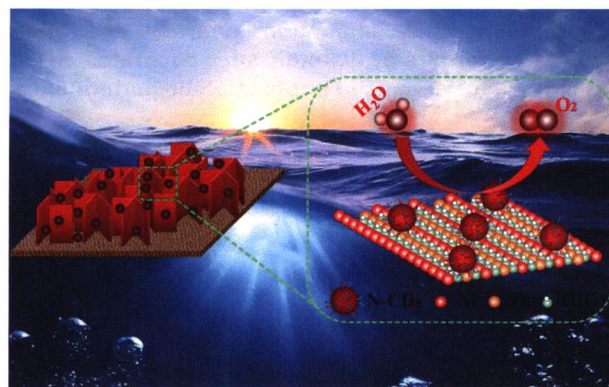
7052–7062



### N-doped carbon dots coupled NiFe-LDH hybrids for robust electrocatalytic alkaline water and seawater oxidation

Peng Ding, Haoqiang Song, Jiangwei Chang\*, and Siyu Lu\*

Zhengzhou University, China



Nitrogen-doped carbon dots strongly coupled NiFe layered double hydroxide nanosheet arrays on Ni foam (N-CDs/NiFe-LDH/NF) electrocatalysis exhibits excellent oxygen evolution reaction (OER) performance with low overpotentials of 260 and 340 mV at 100 mA·cm<sup>-2</sup> in 1 M KOH and alkaline seawater electrolytes, respectively, and meanwhile maintain high stability within dozens of hours.

7063–7070

### A dual plasmonic core-shell Pt/[TiN@TiO<sub>2</sub>] catalyst for enhanced photothermal synergistic catalytic activity of VOCs abatement

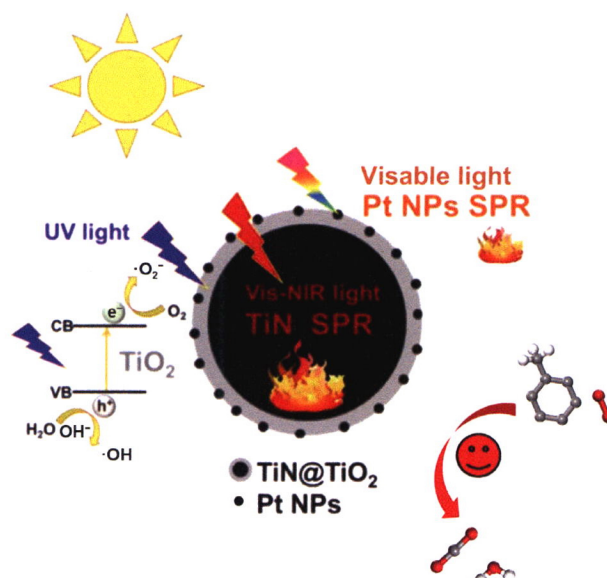
Anqi Li<sup>1</sup>, Qianpeng Zhang<sup>2,3</sup>, Shuaiqi Zhao<sup>1</sup>, Yanan Chong<sup>1</sup>, Peng Wu<sup>1</sup>, Yifei Li<sup>1</sup>, Xiaojing Jin<sup>1,\*</sup>, Guangxu Chen<sup>1</sup>, Yongcai Qiu<sup>1,\*</sup>, Shihe Yang<sup>4</sup>, and Daiqi Ye<sup>1</sup>

<sup>1</sup> South China University of Technology, China

<sup>2</sup> The Hong Kong University of Science and Technology, Hong Kong, China

<sup>3</sup> Guangzhou HKUST Fok Ying Tung Research Institute, China

<sup>4</sup> Peking University, China



A dual plasmonic core-shell Pt/[TiN@TiO<sub>2</sub>] catalyst obtained by quenching exhibited excellent photothermal synergistic catalytic oxidation of toluene, benefiting from the integration of the photocatalysis and thermal effect.

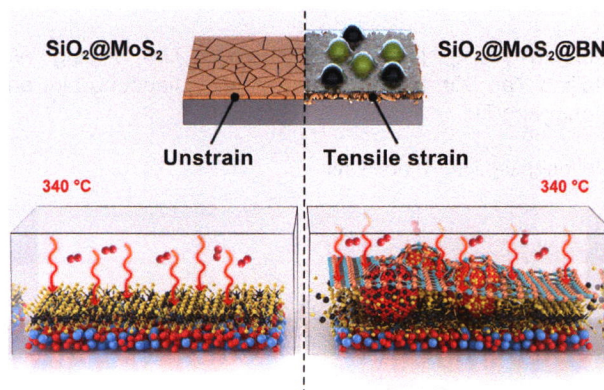
7071–7080

### Anomalous enhancement oxidation of few-layer MoS<sub>2</sub> and MoS<sub>2</sub>/h-BN heterostructure

Siming Ren<sup>1,\*</sup>, Yanbin Shi<sup>1</sup>, Chaozhi Zhang<sup>1</sup>, Mingjun Cui<sup>2</sup>, and Jibin Pu<sup>1,\*</sup>

<sup>1</sup> Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, China

<sup>2</sup> Ningbo University, China



The construction of tensile strain in few-layer molybdenum disulfide (MoS<sub>2</sub>) and MoS<sub>2</sub>/hexagonal boron nitride (MoS<sub>2</sub>/h-BN) heterostructure films enhances their oxidation at elevated temperature.

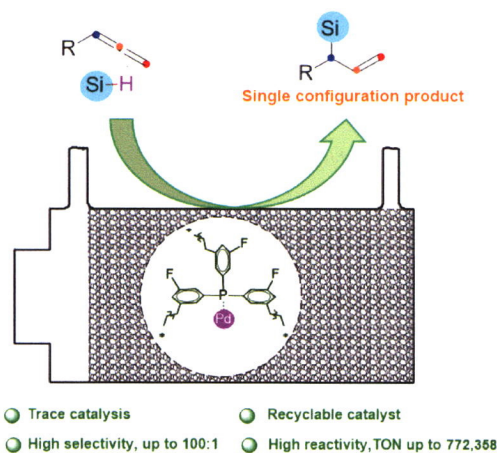
7081–7090

### Trace amount of single-atom palladium-catalyzed selective hydrosilylation of allenes

Li-Ping Pang<sup>1</sup>, Xin-Yu Li<sup>1</sup>, Shi-Cheng Ren<sup>1</sup>, Hong-Min Lin<sup>1</sup>, Ying-Chun Wang<sup>2</sup>, Ying-Ming Pan<sup>1,2,\*</sup>, and Hai-Tao Tang<sup>1,\*</sup>

<sup>1</sup> Guangxi Normal University, China

<sup>2</sup> Jishou University, China



This work designed and synthesized a single-atom Pd-metalated porous organic ligand polymer, denoted as Pd@POL, and used the polymer to realize the regioselective hydrosilylation of allenes (turnover number was up to 772,358, which was 200 times higher than previously recorded, and regioselectivity >100:1).

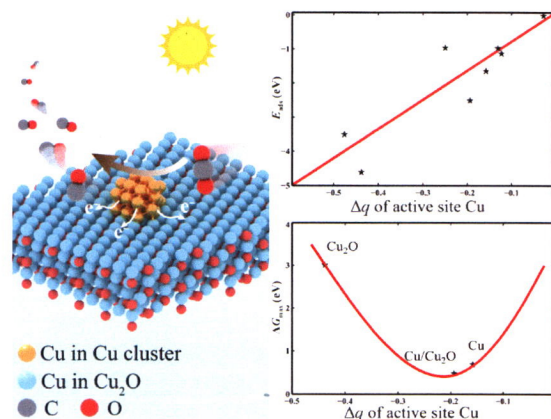
7091–7098

### Electron transfer in Cu/Cu<sub>2</sub>O generated by disproportionation promoting efficient CO<sub>2</sub> photoreduction

Qian Zhu<sup>1</sup>, Kainan Zhu<sup>1</sup>, Minmin Cai<sup>1</sup>, Yaowen Zhang<sup>1</sup>, Zhiyu Shao<sup>1</sup>, Mengpei Jiang<sup>1</sup>, Xiyang Wang<sup>1</sup>, Zhibin Geng<sup>1</sup>, Xiaofeng Wu<sup>1</sup>, Manrong Li<sup>2</sup>, Keke Huang<sup>1,\*</sup>, and Shouhua Feng<sup>1</sup>

<sup>1</sup> Jilin University, China

<sup>2</sup> Sun Yat-Sen University, China



By constructing Cu/Cu<sub>2</sub>O composite, the charge transfer between the two phases is realized. Density functional theory calculations prove that the amount of charge change of Cu in Cu/Cu<sub>2</sub>O has a linear relationship with the adsorption of the CO<sub>2</sub> reduction intermediates, and further affects the Gibbs free energy of the reaction steps. Finally, the rate-determining step of CO<sub>2</sub> photoreduction and the charge change on Cu form an inverse volcano curve.

7099–7106

### Engineering electrophilic atomic Ir sites on CeO<sub>2</sub> colloidal spheres for selectivity control in hydrogenation of $\alpha,\beta$ -unsaturated carbonyl compounds

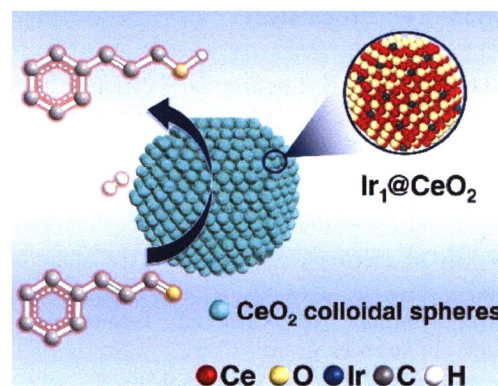
Muhammad Mateen<sup>1,\*</sup>, Muhammad Nadeem Akhtar<sup>2</sup>, Ling Gao<sup>1</sup>, Weng-Chon (Max) CHEONG<sup>3,\*</sup>, Shanshan Lv<sup>4</sup>, Yan Zhou<sup>4</sup>, and Zheng Chen<sup>4,\*</sup>

<sup>1</sup> Chongqing Technology and Business University, China

<sup>2</sup> The Islamia University of Bahawalpur, Pakistan

<sup>3</sup> University of Macau, Macao, China

<sup>4</sup> Anhui Normal University, China



We developed a novel emulsion-based molecule-nanoparticle self-assembly strategy for the atomic engineering of Ir species on three-dimensional CeO<sub>2</sub> spheres. The formation of electrophilic Ir sites with highly depleted d-states at metal-support interface played a key role for achieving exceptional selectivity towards unsaturated alcohols during selective hydrogenation of various  $\alpha,\beta$ -unsaturated carbonyl compounds (UCCs).

7107–7115



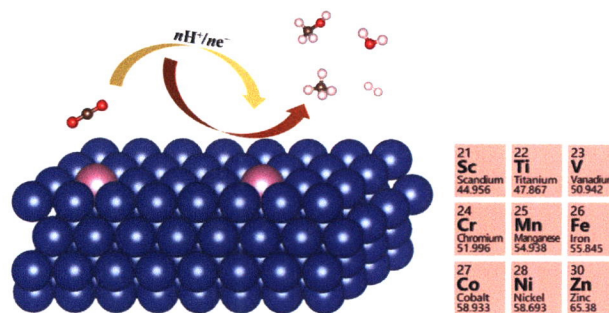
## Rational design of copper-based single-atom alloy catalysts for electrochemical CO<sub>2</sub> reduction

Jian-Chao Jiang<sup>1,2</sup>, Jun-Chi Chen<sup>2</sup>, Meng-die Zhao<sup>1</sup>, Qi Yu<sup>1,\*</sup>, Yang-Gang Wang<sup>2,\*</sup>, and Jun Li<sup>2,3</sup>

<sup>1</sup> Shaanxi University of Technology, China

<sup>2</sup> Southern University of Science and Technology, China

<sup>3</sup> Tsinghua University, China



Cu-based single-atom alloy catalysts for CO<sub>2</sub> reduction reaction converting to high added value products have been calculated by density functional theory (DFT) method.

7116–7123

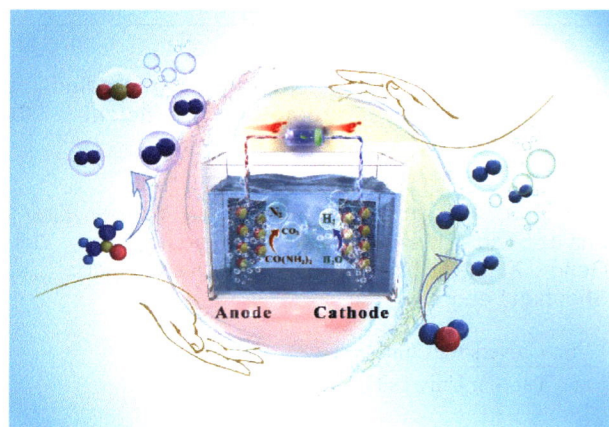
## Controllable Ni/NiO interface engineering on N-doped carbon spheres for boosted alkaline water-to-hydrogen conversion by urea electrolysis

Xiujuan Xu<sup>1</sup>, Xianbiao Hou<sup>1</sup>, Puyu Du<sup>1</sup>, Canhui Zhang<sup>1</sup>, Shucong Zhang<sup>1</sup>, Huanlei Wang<sup>1</sup>, Arafat Toghan<sup>2,3,\*</sup>, and Minghua Huang<sup>1,\*</sup>

<sup>1</sup> Ocean University of China, China

<sup>2</sup> South Valley University, Egypt

<sup>3</sup> Imam Mohammad Ibn Saud Islamic University (IMSIU), Saudi Arabia



Our work deliberately constructs the ideal model system for identifying the contributions of crystalline/amorphous or crystalline/crystalline heterostructure on improving catalytic activity toward urea electrolysis.

7124–7133

## Enhanced N<sub>2</sub>-to-NH<sub>3</sub> conversion efficiency on Cu<sub>3</sub>P nanoribbon electrocatalyst

Qian Liu<sup>1</sup>, Yiting Lin<sup>2</sup>, Shuang Gu<sup>3</sup>, Ziqiang Cheng<sup>3</sup>, Lisi Xie<sup>1</sup>, Shengjun Sun<sup>2</sup>, Longcheng Zhang<sup>2</sup>, Yongsong Luo<sup>2</sup>, Abdulmohsen Ali Alshehri<sup>4</sup>, Mohamed S. Hamdy<sup>5</sup>, Qingquan Kong<sup>1</sup>, Jiahong Wang<sup>3,\*</sup>, and Xuping Sun<sup>2,\*</sup>

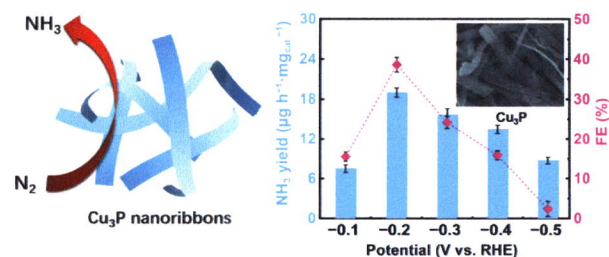
<sup>1</sup> Chengdu University, China

<sup>2</sup> University of Electronic Science and Technology of China, China

<sup>3</sup> Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

<sup>4</sup> King Abdulaziz University, Saudi Arabia

<sup>5</sup> King Khalid University, Saudi Arabia



Cu<sub>3</sub>P nanoribbon is an effective and stable nitrogen reduction electrocatalyst, achieving high-efficiency for ammonia synthesis with an excellent Faraday efficiency up to 37.8% and a high ammonia yield of 18.9 μg·h<sup>-1</sup>·mg<sub>cat</sub><sup>-1</sup>.

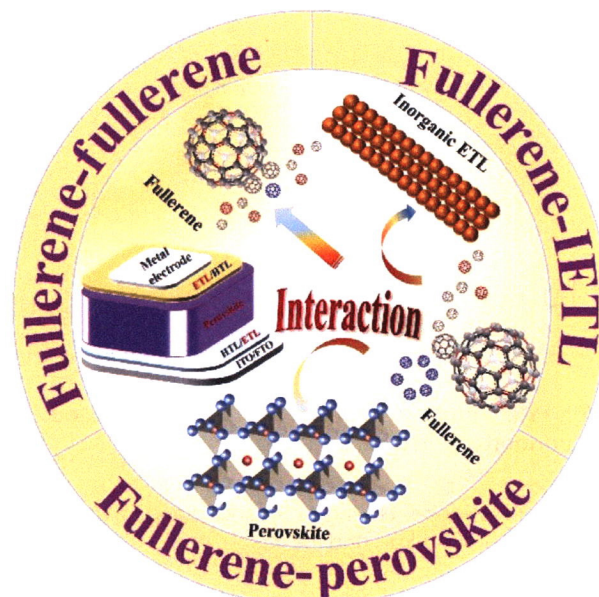
7134–7138

## Review Article

## Progress toward understanding the fullerene-related chemical interactions in perovskite solar cells

Kaikai Liu, Chengbo Tian\*, Yuming Liang, Yujie Luo, Liqiang Xie, and Zhanhua Wei\*

Huaqiao University, China



This review provides a broader summary and in-depth insights about the function of fullerene materials in perovskite solar cells and highlights the crucial role of the fullerene-related chemical interaction, including fullerene-perovskite, fullerene-inorganic electron transport layer (IETL), and fullerene-fullerene.

7139–7153

## Research Articles

Probing the active sites of 2D nanosheets with Fe-N-C carbon shell encapsulated  $\text{Fe}_3\text{C}/\text{Fe}$  species for boosting sodium-ion storage performances

Huicong Xia<sup>1,2</sup>, Pengfei Yuan<sup>1</sup>, Lingxing Zan<sup>2,4</sup>, Gan Qu<sup>1</sup>, Yunchuan Tu<sup>2</sup>, Kaixin Zhu<sup>2</sup>, Yifan Wei<sup>1</sup>, Zeyu Wei<sup>2</sup>, Fangying Zheng<sup>2</sup>, Mo Zhang<sup>2,3</sup>, Yongfeng Hu<sup>5</sup>, Dehui Deng<sup>2,\*</sup>, and Jianan Zhang<sup>1,\*</sup>

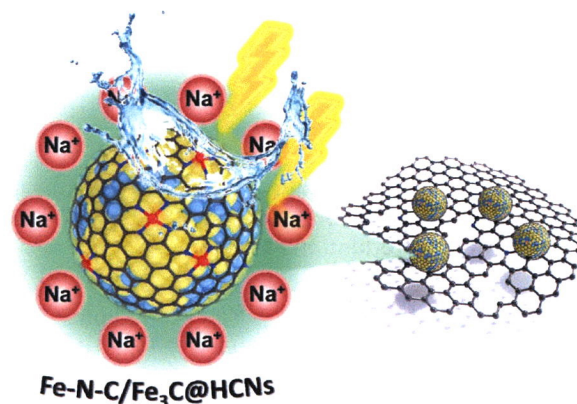
<sup>1</sup> Zhengzhou University, China

<sup>2</sup> Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China

<sup>3</sup> Xiamen University, China

<sup>4</sup> Yan'an University, China

<sup>5</sup> Canadian Light Source, Canada



Fe-N-C graphitic carbon layers-encapsulating  $\text{Fe}_3\text{C}$  species within hard carbon nanosheets ( $\text{Fe-N-C}/\text{Fe}_3\text{C}@HCNs$ ) were rationally engineered by pyrolysis of self-assembled polymer. The coupling effect of atomically dispersed Fe-N-C and  $\text{Fe}_3\text{C}$  species play a significant role in enhancing the binding ability towards  $\text{Na}^+$  ions, allowing the robust rate performance and prolonged cycling life for sodium-ion battery.

7154–7162

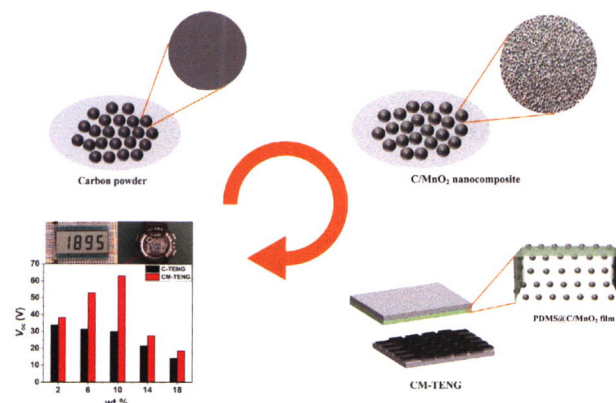


## Enhanced performance triboelectric nanogenerator based on porous structure C/MnO<sub>2</sub> nanocomposite for energy harvesting

Honghao Zhang<sup>1</sup>, Ping Zhang<sup>1,\*</sup>, Pengfei Li<sup>1</sup>, Lu Deng<sup>1</sup>, Weikang Zhang<sup>1</sup>, Baocheng Liu<sup>2</sup>, and Zhengchun Yang<sup>2</sup>

<sup>1</sup> Tianjin University, China

<sup>2</sup> Tianjin University of Technology, China



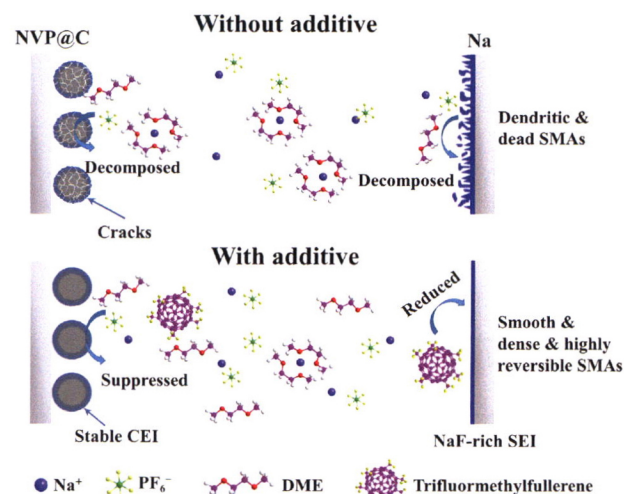
A facile method is used to prepare porous structure C/MnO<sub>2</sub> nanocomposite for realizing high-performance C/MnO<sub>2</sub> triboelectric nanogenerator (CM-TENG) self-powered system.

7163–7171

## High-rate sodium metal batteries enabled by trifluoromethylfullerene additive

Pengju Li, Xiaobo Huang, Zhipeng Jiang, Han Zhang, Pengwei Yu, Xing Lu\*, and Jia Xie\*

Huazhong University of Science and Technology, China



Trifluoromethylfullerene as an electrolyte additive enables the high-rate performance of sodium metal batteries by inhibiting the decomposition of electrolytes and forming robust electrode/electrolyte interface layers, which suppress side reactions and promote the uniform Na deposition.

7172–7179

## Constructing stable Li-solid electrolyte interphase to achieve dendrites-free solid-state battery: A nano-interlayer/Li pre-reduction strategy

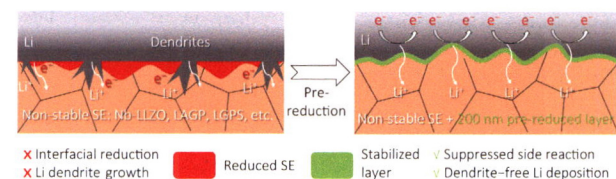
Yajun Niu<sup>1,2</sup>, Zhaozhe Yu<sup>1,\*</sup>, Yongjian Zhou<sup>2</sup>, Jiawen Tang<sup>2</sup>, Maoxin Li<sup>2</sup>, Zechao Zhuang<sup>3</sup>, Yan Yang<sup>4</sup>, Xiao Huang<sup>2,\*</sup>, and Bingbing Tian<sup>2,\*</sup>

<sup>1</sup> Guilin University of Electronic Technology, China

<sup>2</sup> Shenzhen University, China

<sup>3</sup> Tsinghua University, China

<sup>4</sup> Dalian Maritime University, China



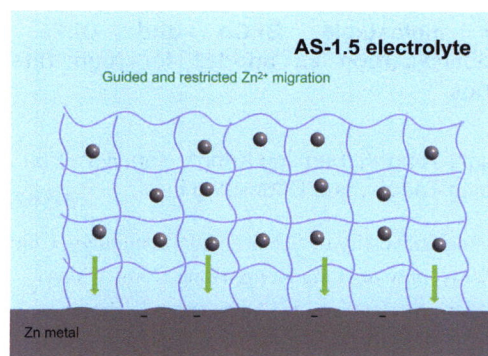
The Li phosphorus oxynitride (LiPON) layer deposited on the surface of non-stable solid electrolyte (SE) *in-situ* reacts with Li to form a lithiophilic, electronically insulating, and ionic conductive layer. This layer effectively inhibits the reduction of non-stable SE against Li, thus improving interfacial stability and suppressing the formation of Li dendrites.

7180–7189

### High-adhesion anionic copolymer as solid-state electrolyte for dendrite-free Zn-ion battery

Jiaxu Li, Junfeng Ren, Caixia Li\*, Pengxian Li, Tingting Wu, Shiwei Liu, and Lei Wang\*

Qingdao University of Science and Technology, China



A sodium allylsulfonate (SAS)-acrylamide (AM) copolymer is designed by radical polymerization process (crosslinking of C=C) as a solid-state electrolyte. Ultra-stable Zn deposition/stripping behavior with the lifespan for the Zn//Zn cell over 1,000 h is obtained.

7190–7198

### High-density/efficient surface active sites on modified separators to boost Li-S batteries via atomic Co<sup>3+</sup>-Se termination

Shujie Liu<sup>1,2</sup>, Xiaofei Liu<sup>1</sup>, Manfang Chen<sup>3</sup>, Dong Wang<sup>4,\*</sup>, Xin Ge<sup>1</sup>, Wei Zhang<sup>1</sup>, Xiyang Wang<sup>5</sup>, Chunhui Wang<sup>6</sup>, Tingting Qin<sup>1</sup>, Haozhe Qin<sup>6</sup>, Liang Qiao<sup>2</sup>, Dan Zhang<sup>3</sup>, Xing Ou<sup>6,\*</sup>, and Weitao Zheng<sup>1,\*</sup>

<sup>1</sup> Jilin University, China

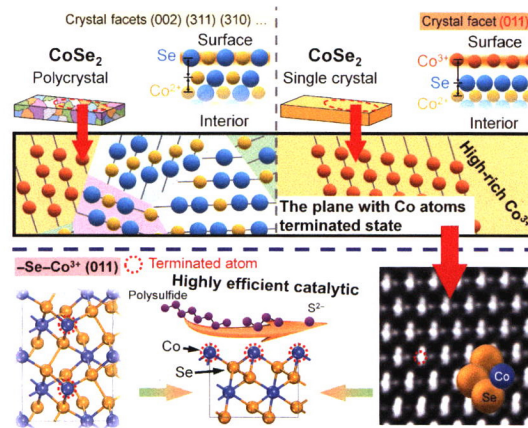
<sup>2</sup> Changchun University, China

<sup>3</sup> Xiangtan University, China

<sup>4</sup> Hunan University, China

<sup>5</sup> University of Waterloo, Canada

<sup>6</sup> Central South University, China



Single-crystal CoSe<sub>2</sub> can exhibit three types of terminated (011) facet, efficiently obtaining the surface with a high-rich Co<sup>3+</sup>-Se bond termination, in contrast with lots of surface grain boundaries and dangling bonds in polycrystalline CoSe<sub>2</sub>. As anticipated, it can provide high-density and high-efficient active sites, enormously suppressing the shuttle effect and improving the reaction kinetics via accelerating the conversion and deposition of polysulfides and Li<sub>2</sub>S during long-term charge/discharge process.

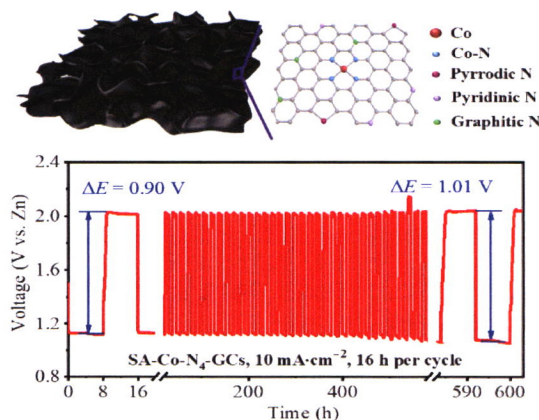
7199–7208

### Efficient oxygen electrocatalysts with highly-exposed Co-N<sub>4</sub> active sites on N-doped graphene-like hierarchically porous carbon nanosheets enhancing the performance of rechargeable Zn-air batteries

Nengfei Yu<sup>1,\*</sup>, Hui Chen<sup>1</sup>, Jingbiao Kuang<sup>1</sup>, Kailin Bao<sup>1</sup>, Wei Yan<sup>2</sup>, Jilei Ye<sup>1,\*</sup>, Zhongtang Yang<sup>1</sup>, Qinghong Huang<sup>1</sup>, Yuping Wu<sup>1,\*</sup>, and Shigang Sun<sup>2,\*</sup>

<sup>1</sup> Nanjing Tech University, China

<sup>2</sup> Xiamen University, China



Atomically dispersed Co-N<sub>4</sub> is anchored on N-doped graphene-like hierarchically porous carbon nanosheets (SA-Co-N<sub>4</sub>-GCs) where high exposed Co-N<sub>4</sub> active sites and three-dimensional (3D) interconnected hierarchically porous carbon provide efficient reactive sites and charge/mass transport environment. As a result, the rechargeable zinc-air batteries based on SA-Co-N<sub>4</sub>-GCs air electrodes exhibit superior charge-discharge performance and ultra-stable cyclability with no increase in polarization, even in the depth charging and discharging operation with 16 h per cycle over 600 h at 10 mA·cm<sup>-2</sup>.

7209–7219



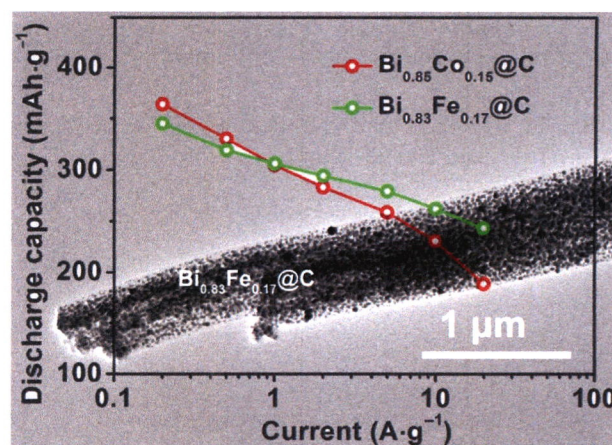
### Novel metastable Bi:Co and Bi:Fe alloys nanodots@carbon as anodes for high rate K-ion batteries

Zhongqiu Tong<sup>1,2</sup>, Tianxing Kang<sup>2</sup>, Yan Wu<sup>2</sup>, Fan Zhang<sup>3</sup>, Yongbing Tang<sup>3,\*</sup>, and Chun-Sing Lee<sup>2,\*</sup>

<sup>1</sup> Kunming University of Science and Technology, China

<sup>2</sup> City University of Hong Kong, Hong Kong, China

<sup>3</sup> Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China



New metastable Bi:Co and Bi:Fe alloys nanodots@carbon structures are synthesized by annealing metal-organic frameworks (MOF) precursors. A Bi<sub>0.83</sub>Fe<sub>0.17</sub>@C electrode delivers superior 253 mAh·g<sup>-1</sup> at 20 A·g<sup>-1</sup> and stable cycling performance at 2 A·g<sup>-1</sup> for 1,000 cycles.

7220–7226

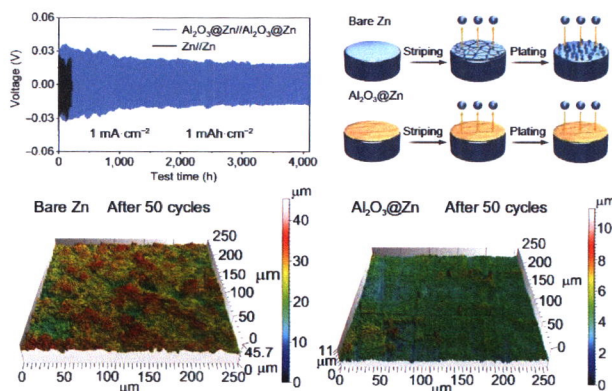
### Interface engineering of Zn meal anodes using electrochemically inert Al<sub>2</sub>O<sub>3</sub> protective nanocoatings

Rui Wang<sup>1</sup>, Qiongfei Wu<sup>1</sup>, Minjie Wu<sup>1</sup>, Jiaxian Zheng<sup>1</sup>, Jian Cui<sup>2</sup>, Qi Kang<sup>3,\*</sup>, Zhengbing Qi<sup>2,\*</sup>, JiDong Ma<sup>2</sup>, Zhoucheng Wang<sup>1</sup>, and Hanfeng Liang<sup>1,\*</sup>

<sup>1</sup> Xiamen University, Hong Kong, China

<sup>2</sup> Xiamen University of Technology, China

<sup>3</sup> Shanghai Jiao Tong University, China



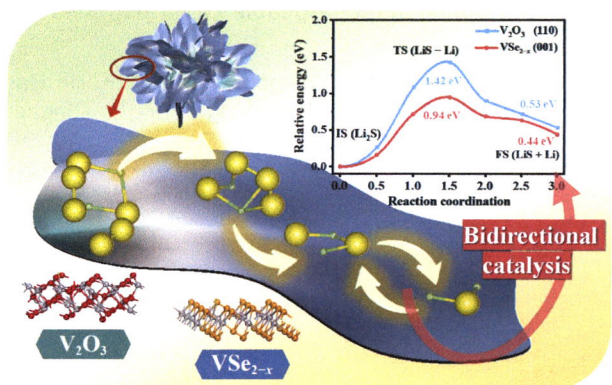
Magnetron sputtered Al<sub>2</sub>O<sub>3</sub> nanocoatings can serve as a Zn anode protective layer to effectively suppress both the Zn dendrite growth and side reactions, therefore significantly enhancing the stability of Zn anodes for aqueous zinc ion batteries.

7227–7233

### Selenium vacancies enable efficient immobilization and bidirectional conversion acceleration of lithium polysulfides for advanced Li-S batteries

Yuanchang Li, Zhenfang Zhou, Yong Li, Zhonghua Zhang<sup>\*</sup>, Xiaosong Guo, Jing Liu, Changming Mao, Zhenjiang Li, and Guicun Li<sup>\*</sup>

Qingdao University of Science and Technology, China



VSe<sub>2-x</sub> presents stronger adsorption towards lithium polysulfides due to selenium vacancies and shows the bidirectional catalysis towards the sulfur redox reactions.

7234–7246

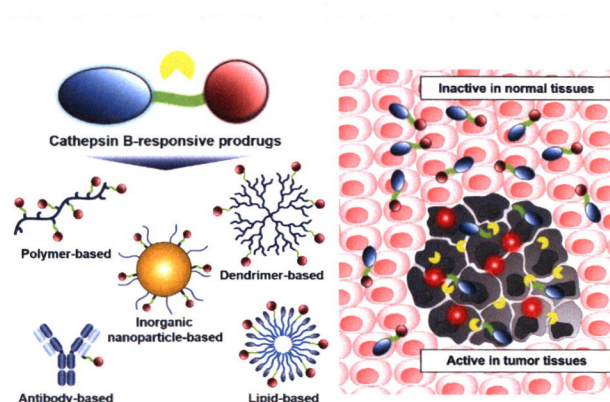
## Review Articles

**Cathepsin B-responsive prodrugs for cancer-targeted therapy: Recent advances and progress for clinical translation**

Seong Ik Jeon<sup>1</sup>, Suah Yang<sup>1,2</sup>, Man Kyu Shim<sup>1</sup>, and Kwangmeyung Kim<sup>1,2,\*</sup>

<sup>1</sup> Korea Institute of Science and Technology (KIST), Republic of Korea

<sup>2</sup> Korea University, Republic of Korea



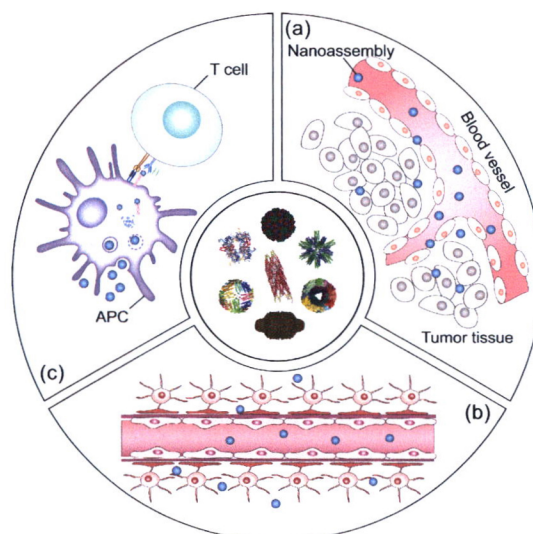
Cathepsin B-responsive prodrug is a promising strategy to reduce the systemic toxicity of the conventional anticancer drug by specifically activating the drug with the overexpressed cathepsin B inside the target cancer cell. In this review, recent advances and progress of new delivery systems for cathepsin B-responsive prodrug and their clinical trials are discussed, then their potential challenges and outlooks for clinical translation are highlighted.

7247–7266

**Emerging prospects of protein/peptide-based nanoassemblies for drug delivery and vaccine development**

Taiyu Liu, Lu Li, Cheng Cheng, Bingfang He, and Tianyue Jiang

Nanjing Tech University, China



This review summarizes recent advances in the applications of protein/peptide-based nanoassemblies for drug delivery and vaccine therapy.

7267–7285



## Research Articles

### A novel PD-L1 targeting peptide self-assembled nanofibers for sensitive tumor imaging and photothermal immunotherapy *in vivo*

Linping Fu<sup>1,2</sup>, Jianhu Zhang<sup>3</sup>, Chenchen Wu<sup>1,2</sup>, Weizhi Wang<sup>5</sup>, Dong Wang<sup>6,\*</sup>, Zhiyuan Hu<sup>1,2,3,4,\*</sup>, and Zihua Wang<sup>1,3,\*</sup>

<sup>1</sup> National Center for Nanoscience and Technology, China

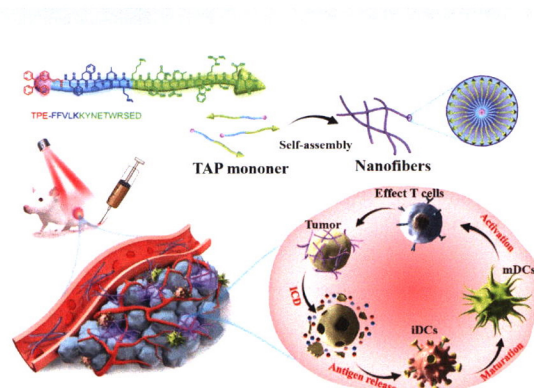
<sup>2</sup> University of Chinese Academy of Sciences, China

<sup>3</sup> Fujian Medical University, China

<sup>4</sup> Wuhan Institute of Technology, China

<sup>5</sup> Beijing Institute of Technology, China

<sup>6</sup> Shenzhen University, China



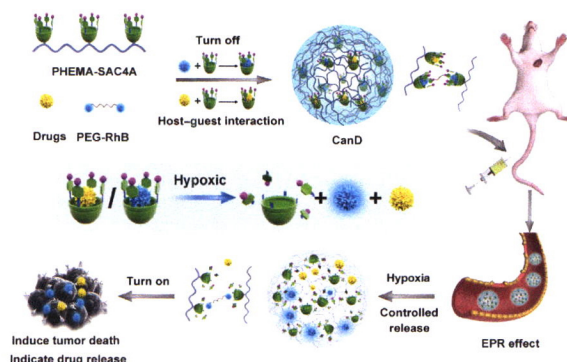
A novel programmed death-1 ligand (PD-L1) targeting self-assembled peptide-based nanomaterial was invented as a tumor-targeting agent for tumor imaging, and further developed into a combination agent for photothermal therapy and immunotherapy.

7286–7294

### Calixarene-integrated nano-drug delivery system for tumor-targeted delivery and tracking of anti-cancer drugs *in vivo*

Lina Xu, Jingshan Chai, Ying Wang, Xinzhi Zhao, Dong-Sheng Guo, Linqi Shi, Zhazhan Zhang\*, and Yang Liu\*

Nankai University, China



A hypoxia-responsive calixarene-integrated nano-drug delivery systems (CanD) was developed for tumor-targeted delivery and tracking of anti-cancer drugs *in vivo*. By co-loading anti-cancer drugs and fluorescent probes in CanD, the drug release and fluorescence recovery can be achieved simultaneously in the hypoxic tumor microenvironment, providing CanD with great potential to study the therapeutic efficacy of anti-cancer drugs.

7295–7303

### Oxygen vacancy-engineered BaTiO<sub>3</sub> nanoparticles for synergistic cancer photothermal, photodynamic, and catalytic therapy

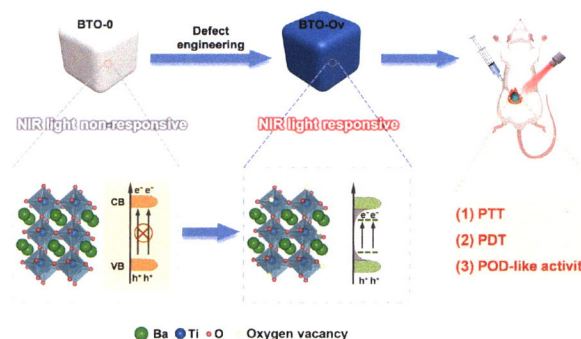
Yiming Ding<sup>1,2</sup>, Zhuo Wang<sup>2</sup>, Zeyu Zhang<sup>1,2</sup>, Yunchao Zhao<sup>1,2</sup>, Shangyu Yang<sup>3,4</sup>, Yalong Zhang<sup>1,2</sup>, Shuncheng Yao<sup>2,3</sup>, Shaobo Wang<sup>1,2</sup>, Tian Huang<sup>1,2</sup>, Yang Zhang<sup>3,4,\*</sup>, and Linlin Li<sup>1,2,5,\*</sup>

<sup>1</sup> Guangxi University, China

<sup>2</sup> Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, China

<sup>3</sup> Institute of Semiconductors, Chinese Academy of Sciences, China

<sup>4</sup> University of Chinese Academy of Sciences, China



A synergistic enhanced therapeutic nanoplatform integrating photothermal therapy (PTT), photodynamic therapy (PDT), and catalytic therapy is constructed based on BaTiO<sub>3</sub> nanoparticles via defect engineering.

7304–7312

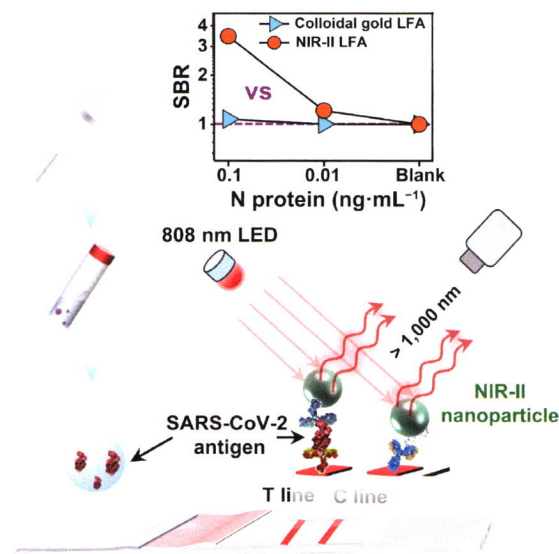
### Sensitively detecting antigen of SARS-CoV-2 by NIR-II fluorescent nanoparticles

Ruibin Hu<sup>1</sup>, Tao Liao<sup>2</sup>, Yan Ren<sup>3</sup>, Wenming Liu<sup>2</sup>, Rui Ma<sup>1</sup>, Xinyuan Wang<sup>1</sup>, Qihui Lin<sup>3,\*</sup>, Guoxin Wang<sup>2,\*</sup>, and Yongye Liang<sup>1,\*</sup>

<sup>1</sup> Southern University of Science and Technology of China, China

<sup>2</sup> WWHS Biotech. Inc., China

<sup>3</sup> Hygienic Section of Longhua Center for Disease Control and Prevention, China



The second near-infrared (NIR-II) fluorescent nanoparticles are applied to construct a lateral flow assay (LFA) for sensitive detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) antigen. The NIR-II LFA shows improved limit of detection down to 0.01 ng·mL<sup>-1</sup> and outperforms the colloidal gold-based LFA with much higher accuracy in positive sample detection in clinical sample measurements.

7313–7319

### Biomimetic copper single-atom nanozyme system for self-enhanced nanocatalytic tumor therapy

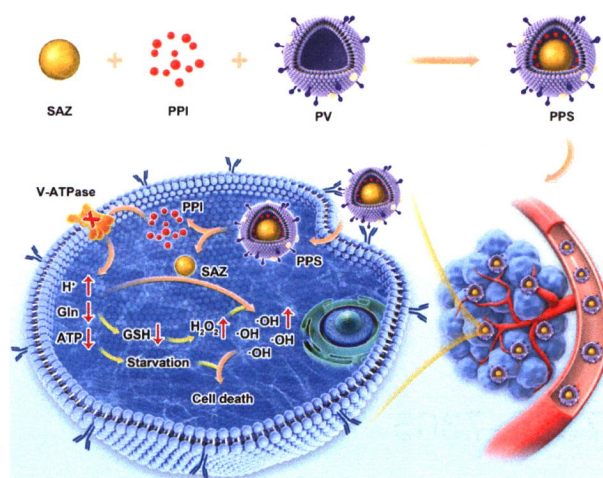
Daoming Zhu<sup>1</sup>, Ruoyu Ling<sup>1</sup>, Hao Chen<sup>1</sup>, Meng Lyu<sup>4</sup>, Haisheng Qian<sup>2</sup>, Konglin Wu<sup>3,\*</sup>, Guoxin Li<sup>1,\*</sup>, and Xianwen Wang<sup>2,\*</sup>

<sup>1</sup> Southern Medical University, China

<sup>2</sup> Anhui Medical University, China

<sup>3</sup> Anhui University of Technology, China

<sup>4</sup> Zhongnan Hospital of Wuhan University, China



A biomimetic single-atom nanozyme system was developed for self-enhanced nanocatalytic tumor therapy, which obtained satisfactory therapeutic effect.

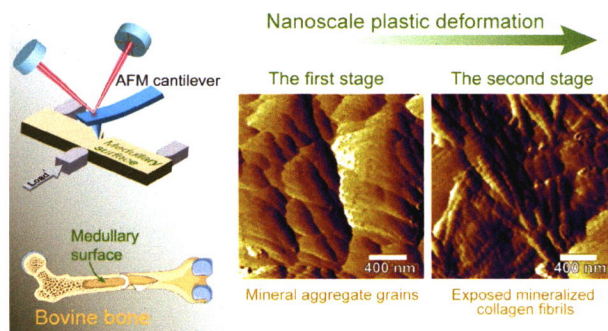
7320–7328

### Nanostructural origins of irreversible deformation in bone revealed by an *in situ* atomic force microscopy study

Tianbao Qian<sup>1,2</sup>, Lijing Teng<sup>1</sup>, Yongji Zhou<sup>1</sup>, Minghao Zhang<sup>2</sup>, Zuquan Hu<sup>1,\*</sup>, Xiaofeng Chen<sup>2,\*</sup>, and Fei Hang<sup>2,\*</sup>

<sup>1</sup> Guizhou Medical University, China

<sup>2</sup> South China University of Technology, China



The nanoscale plastic deformation process in bone includes the first stage (slipping between fibril arrays) characterized by mineral aggregate grains, and the second stage (interfibrillar slipping) with the feature of the exposed mineralized collagen fibrils.

7329–7341

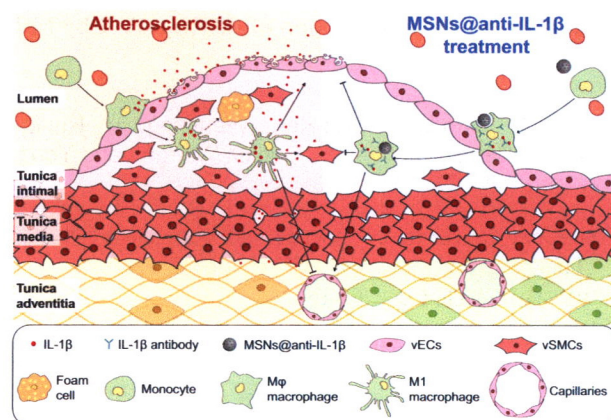


### Regulation of the macrophage-related inflammatory microenvironment for atherosclerosis treatment and angiogenesis via anti-cytokine agents

Hongji Pu<sup>1</sup>, Minghua Yao<sup>1</sup>, Zhaoyu Wu<sup>1</sup>, Zhijue Xu<sup>1</sup>, Chaoyi Cui<sup>1,\*</sup>, Renhua Huang<sup>1</sup>, Muhammad Shafiq<sup>2</sup>, Weimin Li<sup>1</sup>, Xinwu Lu<sup>1,\*</sup>, and Bo Li<sup>1,\*</sup>

<sup>1</sup> Shanghai Jiao Tong University School of Medicine, China

<sup>2</sup> Kyushu University, Japan



Mesoporous silica nanoparticles (MSNs)@anti-IL-1 $\beta$  was able to specifically accumulate in the atherosclerotic plaque, diminish atherosclerotic plaques, and promote angiogenesis to improve ischemia in mice. The anti-cytokine agents may have broad implications in clinical practice for the reduction of the atherosclerosis progression and alleviation of the ischemia.

7342–7354

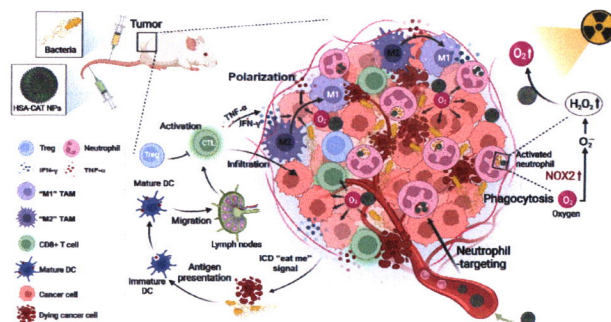
### Bacteria-assisted delivery and oxygen production of nano-enzyme for potent radioimmunotherapy of cancer

Jing Ni<sup>1</sup>, Hailin Zhou<sup>1</sup>, Jingyu Gu<sup>2</sup>, Xinpei Liu<sup>2</sup>, Jie Chen<sup>3,\*</sup>, Xuan Yi<sup>2,\*</sup>, and Kai Yang<sup>1,\*</sup>

<sup>1</sup> Soochow University, China

<sup>2</sup> Nantong University, China

<sup>3</sup> Medical Center of Soochow University, China



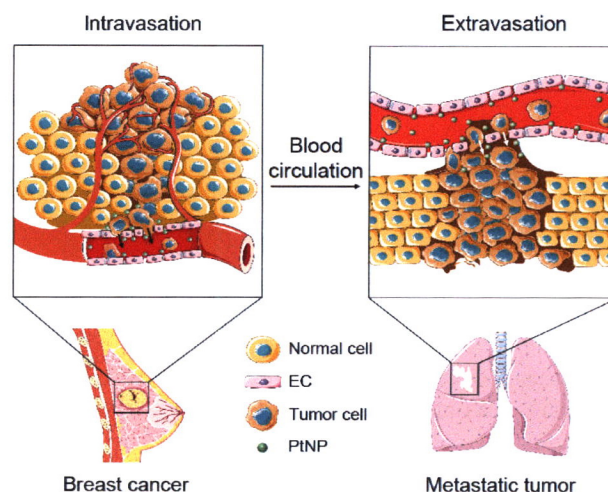
In this work, we used neutrophil-targeting denature albumin to coat catalase protein and then deliver it to the bacteria-infected tumors, relieving the tumor hypoxia under the excess hydrogen peroxide ( $H_2O_2$ ) generated by neutrophil for enhanced radiotherapy. Moreover, bacteria,  $O_2$  together with X-ray irradiation could improve the immune microenvironment of tumor, resulting in a perfect immunotherapy.

7355–7365

### Platinum nanoparticles promote breast cancer cell metastasis by disrupting endothelial barrier and inducing intravasation and extravasation

De-Ping Wang, Jing Shen, Chuan-Yue Qin, Yong-Mei Li, Li-Juan Gao, Jian Zheng, Yan-Lin Feng, Zi Yan, Xin Zhou<sup>\*</sup>, and Ji-Min Cao<sup>\*</sup>

Shanxi Medical University, China



Platinum nanoparticles (PtNPs) can promote breast cancer metastasis by damaging endothelial barrier. The unexpected detrimental effects of PtNPs should be considered in future nanomedical designs for the treatment of breast cancer.

7366–7377

## Nano detection

### Research Articles

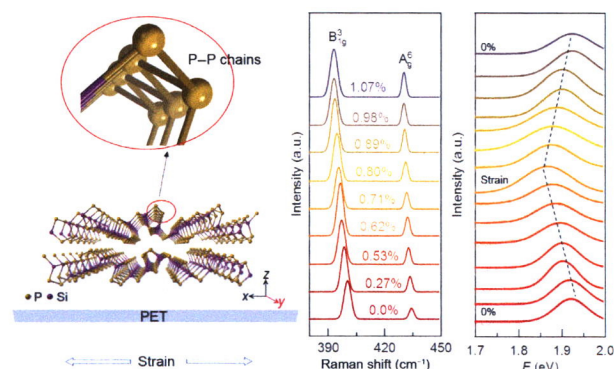
#### Strain engineering of anisotropic light-matter interactions in one-dimensional P-P chain of SiP<sub>2</sub>

Fanghua Cheng<sup>1</sup>, Junwei Huang<sup>1</sup>, Feng Qin<sup>1</sup>, Ling Zhou<sup>1</sup>, Xueting Dai<sup>1</sup>, Xiangyu Bi<sup>1</sup>, Caorong Zhang<sup>1</sup>, Zeya Li<sup>1</sup>, Ming Tang<sup>1</sup>, Caiyu Qiu<sup>1</sup>, Yangfan Lu<sup>2</sup>, Huiyang Gou<sup>3</sup>, and Hongtao Yuan<sup>1,\*</sup>

<sup>1</sup> Nanjing University, China

<sup>2</sup> Chongqing University, China

<sup>3</sup> Center for High Pressure Science and Technology Advanced Research, China



The lattice structure, phonon vibration, and the band gap energy of van der Waals crystal SiP<sub>2</sub> can be manipulated with uniaxial strain, providing a unique means to design and control the light-matter interactions for atomically thin SiP<sub>2</sub>-based devices.

7378–7383

#### Capillary grip-induced stick-slip motion

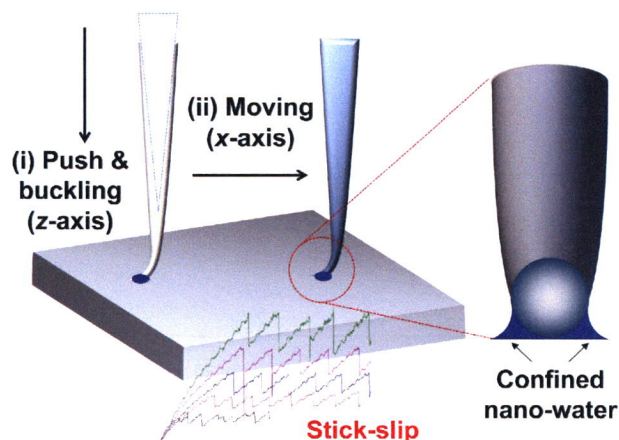
Sangmin An<sup>1,2</sup>, Manhee Lee<sup>3</sup>, Bongsu Kim<sup>1,†</sup>, and Wonho Jhe<sup>1,\*</sup>

<sup>1</sup> Seoul National University, Republic of Korea

<sup>2</sup> Jeonbuk National University, Republic of Korea

<sup>3</sup> Chungbuk National University, Republic of Korea

<sup>†</sup> Present address: Samsung Electronics, Republic of Korea



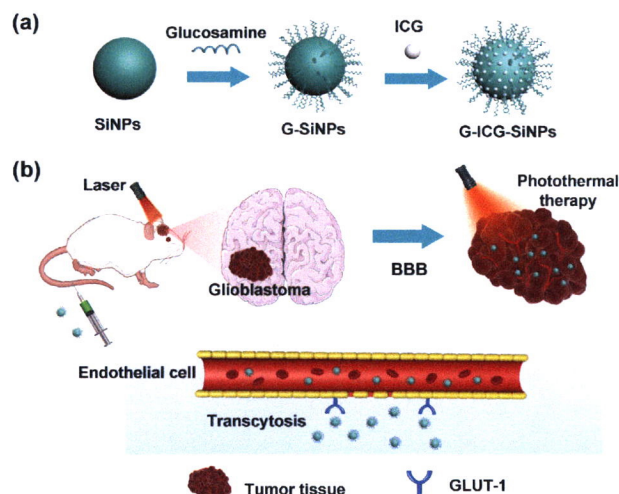
We present capillary grip-induced stick-slip friction, in which the role of a nanoconfined water meniscus formed between a buckled sharp tip and the substrate is revealed and quantified with dynamic shear force spectroscopy.

7384–7391

#### Silicon-based nanoprobe cross the blood-brain barrier for photothermal therapy of glioblastoma

Rong Sun, Mingzhu Liu, Zhaojian Xu, Bin Song, Yao He\*, and Houyu Wang\*

Soochow University, China



We present a kind of SiNPs-based nanoprobe that can bypass the blood-brain barrier, suitable for glioblastoma photothermal therapy.

7392–7401



## Nano device

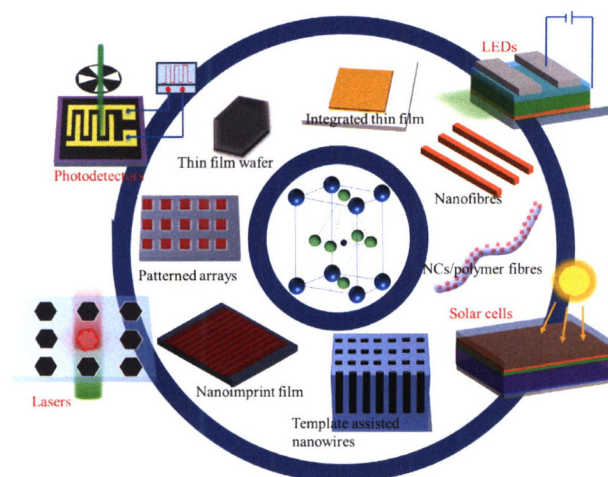
### Review Articles

#### A review of geometry-confined perovskite morphologies: From synthesis to efficient optoelectronic applications

Jinshuai Zhang<sup>1</sup>, Perry Ping Shum<sup>2</sup>, and Lei Su<sup>1,\*</sup>

<sup>1</sup> Queen Mary University of London, UK

<sup>2</sup> Southern University of Science and Technology, China



Metal halide perovskites have attracted much concern for their excellent performance and solution-processable properties. The geometry-confined method has been widely used to prepare perovskite structures with different morphologies and adjust the optoelectronic properties of materials. This review intends to give an overview of the recent advances in perovskite morphologies based on geometry-confined methods from material synthesis and their performances to optoelectronic devices.

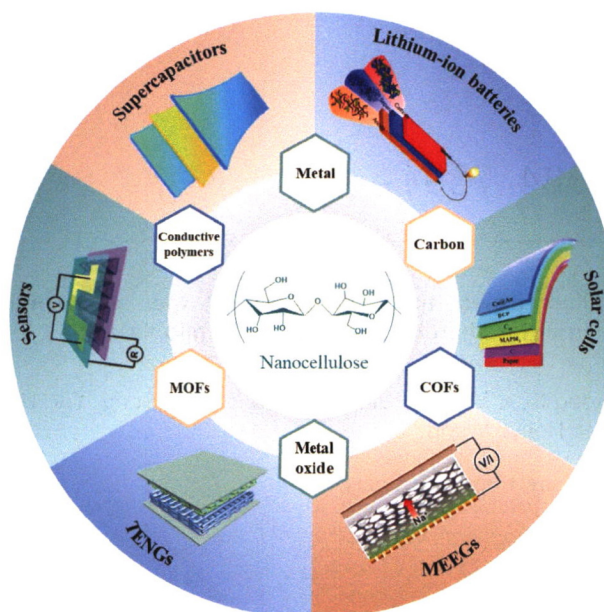
7402–7431

#### Nanocellulose-based functional materials for advanced energy and sensor applications

Lumin Chen<sup>1</sup>, Somia Yassin Hussain Abdalkarim<sup>1</sup>, Houyong Yu<sup>1,2,\*</sup>, Xiang Chen<sup>1</sup>, Dongping Tang<sup>1</sup>, Yingzhan Li<sup>1</sup>, and Kam Chiu Tam<sup>2</sup>

<sup>1</sup> Zhejiang Sci-Tech University, China

<sup>2</sup> University of Waterloo, Canada



The preparation of nanocellulose-based advanced composites and their applications in supercapacitors, lithium-ion batteries, solar cells, nanogenerator, and sensors are reviewed.

7432–7452

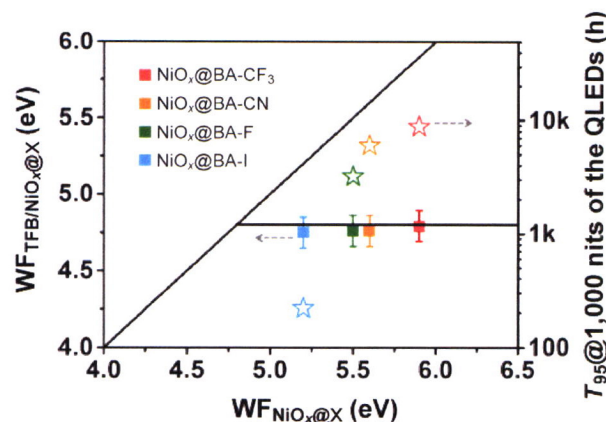
## Research Articles

### Quantum-dot light-emitting diodes with Fermi-level pinning at the hole-injection/hole-transporting interfaces

Maopeng Xu<sup>1</sup>, Desui Chen<sup>1</sup>, Jian Lin<sup>2</sup>, Xiuyuan Lu<sup>1</sup>, Yunzhou Deng<sup>1</sup>, Siyu He<sup>1</sup>, Xitong Zhu<sup>1</sup>, Wangxiao Jin<sup>1</sup>, and Yizheng Jin<sup>1,\*</sup>

<sup>1</sup> Zhejiang University, China

<sup>2</sup> Suzhou University of Science and Technology, China



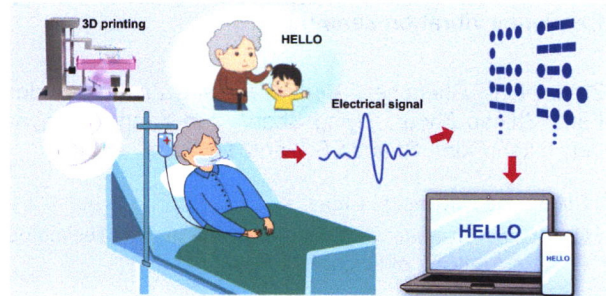
For the quantum-dot light-emitting diodes (QLEDs) with Fermi-level pinning at the hole-injection/hole-transporting interface, despite the same hole-injection barriers, hole-injection layers (HILs) with higher work functions are beneficial for improving device performance.

7453–7459

### 3D printed triboelectric nanogenerator as self-powered human-machine interactive sensor for breathing-based language expression

Pengcheng Zhu, Baosen Zhang, Hongyi Wang, Yiheng Wu, Hengjun Cao, Liubing He, Chaoyue Li, Xuepeng Luo, Xing Li, and Yanchao Mao

Zhengzhou University, China



A three-dimensional (3D) printed breath-driven triboelectric nanogenerator (TENG) serving as a self-powered human-machine interface (HMI) sensor for language expression was successfully demonstrated. A breathing-based language expressing system is further developed, which could extract subjective information from human breathing behaviors and output corresponding language text. This system with breathing-based language expressing method could make HMI interactions become more friendly and fascinating.

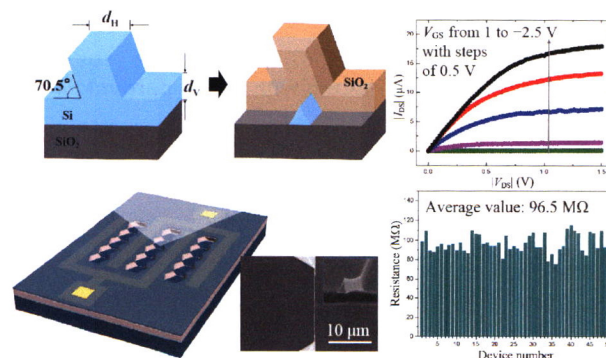
7460–7467

### A controllable fabrication improved silicon nanowire array sensor on (111) SOI for accurate bio-analysis application

Zicheng Lu<sup>1,2</sup>, Hong Zhou<sup>1</sup>, Yi Wang<sup>1</sup>, Yanxiang Liu<sup>1</sup>, and Tie Li<sup>1,\*</sup>

<sup>1</sup> Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, China

<sup>2</sup> University of Chinese Academy of Sciences, China



A controllable fabrication improved silicon nanowire array sensor is presented, the sensor made by a novel fabricated approach possessed better electrical performance, stability in the flow field, and sensing uniformity than those we previously reported.

7468–7475



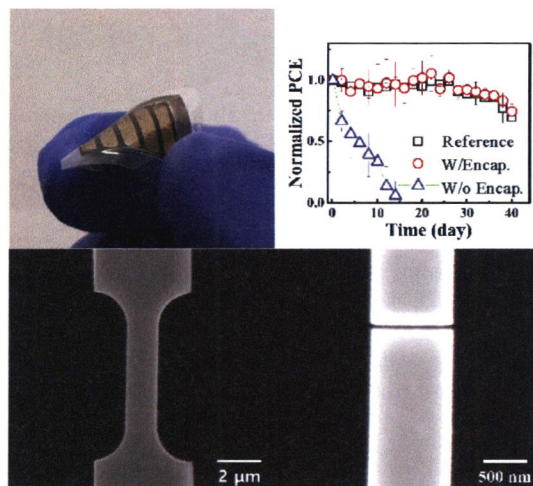
### Highly impermeable and flexible silica encapsulation films synthesized by sol-gel process

Si-Hoon Kim<sup>1,2</sup>, Gyeong-Seok Hwang<sup>2</sup>, Donghwan Koo<sup>2</sup>, Dong-Hyun Seo<sup>1</sup>, Ye-Pil Kwon<sup>1</sup>, Hansuek Lee<sup>3</sup>, Hyesung Park<sup>2,\*</sup>, Eun-chae Jeon<sup>1,\*</sup>, and Ju-Young Kim<sup>2,\*</sup>

<sup>1</sup> University of Ulsan, Republic of Korea

<sup>2</sup> Ulsan National Institute of Science and Technology (UNIST), Republic of Korea

<sup>3</sup> Korea Advanced Institute of Science and Technology (KAIST), Republic of Korea



Silica thin films synthesized sol-gel process are proposed as flexible encapsulation materials. A sol-gel process provides a dense and stable amorphous silica structure, yielding an extremely high elastic deformation limit and extremely low water vapor transmission rate.

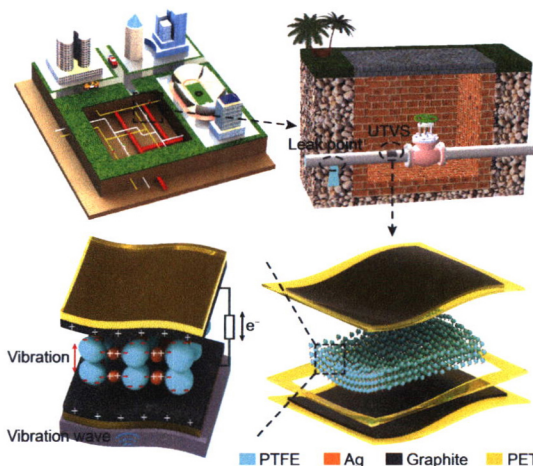
7476–7483

### Flexible triboelectric nanogenerator toward ultrahigh-frequency vibration sensing

Zhiwei Lin<sup>1</sup>, Chenchen Sun<sup>1</sup>, Gaoqiang Zhang<sup>1</sup>, Endong Fan<sup>1</sup>, Zhihao Zhou<sup>1</sup>, Ziyang Shen<sup>1</sup>, Jun Yang<sup>2</sup>, Mingyang Liu<sup>1</sup>, Yushu Xia<sup>1</sup>, Shaobo Si<sup>1</sup>, and Jin Yang<sup>1,\*</sup>

<sup>1</sup> Chongqing University, China

<sup>2</sup> Chongqing Institute of Green and Intelligent Technology, Chinese Academy of Sciences, China



A flexible ultrahigh-frequency self-powered vibration sensor is developed for vibration monitoring on curved surfaces. The sensor is demonstrated in real-time water pipeline leak monitoring, which shows great potential for serving as a versatile platform for broad applications, such as structural health monitoring, the internet of things, human-machine interactions, medical diagnosis, and environmental monitoring.

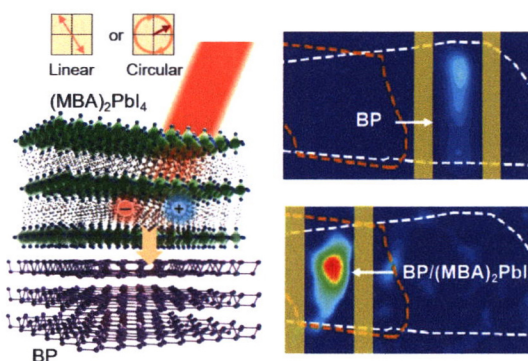
7484–7491

### Enhanced photodetector performance of black phosphorus by interfacing with chiral perovskite

Yang Cao<sup>1</sup>, Congzhou Li<sup>1</sup>, Jie Deng<sup>2</sup>, Tong Tong<sup>1</sup>, Yuchi Qian<sup>1</sup>, Guixiang Zhan<sup>1</sup>, Xu Zhang<sup>1</sup>, Kaiyue He<sup>1</sup>, Huifang Ma<sup>1</sup>, Junran Zhang<sup>1,\*</sup>, Jing Zhou<sup>2,\*</sup>, and Lin Wang<sup>1,\*</sup>

<sup>1</sup> Nanjing Tech University, China

<sup>2</sup> Shanghai Institute of Technical Physics, Chinese Academy of Sciences, China



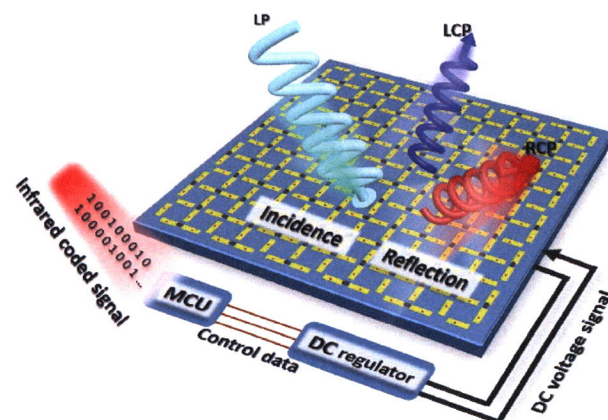
A new van der Waals heterostructure composed of black phosphorus (BP) and two-dimensional chiral perovskite is constructed, which promotes the electronic and optoelectronic performance of BP and integrates the abilities of linearly and circularly polarized photodetection.

7492–7497

## Dual-polarized and real-time reconfigurable metasurface absorber with infrared-coded remote-control system

Jiangyong Liu, Yuping Duan\*, Tuo Zhang, Lingxi Huang, and Huifang Pang

Dalian University of Technology, China



The current at both ends of each PIN diode is regulated by switching the different voltages of the intelligent voltage regulator module through infrared binary encoding, so that the active metasurface can be quickly switched between reflection and different absorption states.

7498–7505

## Nano unit

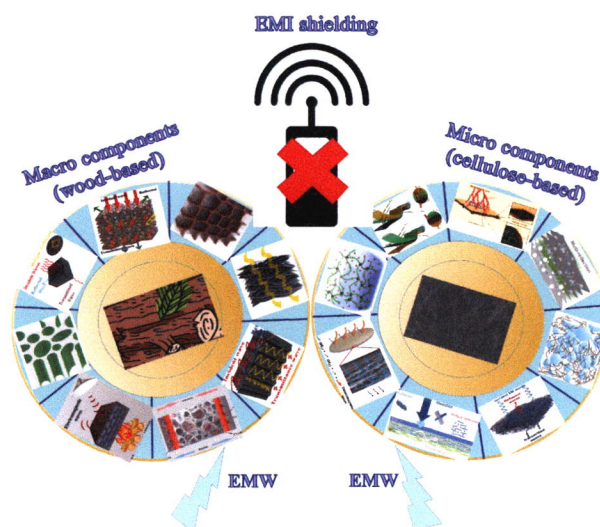
### Review Article

## Recent progress on green electromagnetic shielding materials based on macro wood and micro cellulose components from natural agricultural and forestry resources

Chuanyin Xiong<sup>1,\*</sup>, Tianxu Wang<sup>1</sup>, Yongkang Zhang<sup>1</sup>, Meng Zhu<sup>1</sup>, and Yonghao Ni<sup>1,2</sup>

<sup>1</sup> Shaanxi University of Science and Technology, China

<sup>2</sup> University of New Brunswick, Canada



With the rapid development of modern science and technology, all kinds of new materials, new technologies, and new theories emerge one after another, and the update speed of knowledge is faster and faster. In order to adapt to this fast pace and improve the efficiency of scientific researchers, it is more and more important to constantly summarize the recent work in related fields. Based on this, this review summarizes and compares the research work on wood and cellulose nano fiber (CNF) based electromagnetic interference (EMI) shielding materials in recent three years from their components, structural design, preparation methods, electromagnetic shielding properties, and mechanisms.

7506–7532

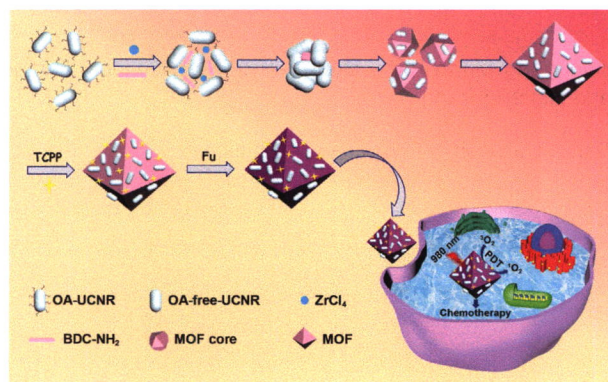


## Research Articles

### Upconversion nanorods anchored metal-organic frameworks via hierarchical and dynamic assembly for synergistic therapy

Wenfeng Guo, Li-Li Tan\*, Qiang Li, Juanmin Li, and Li Shang\*

Northwestern Polytechnical University, China



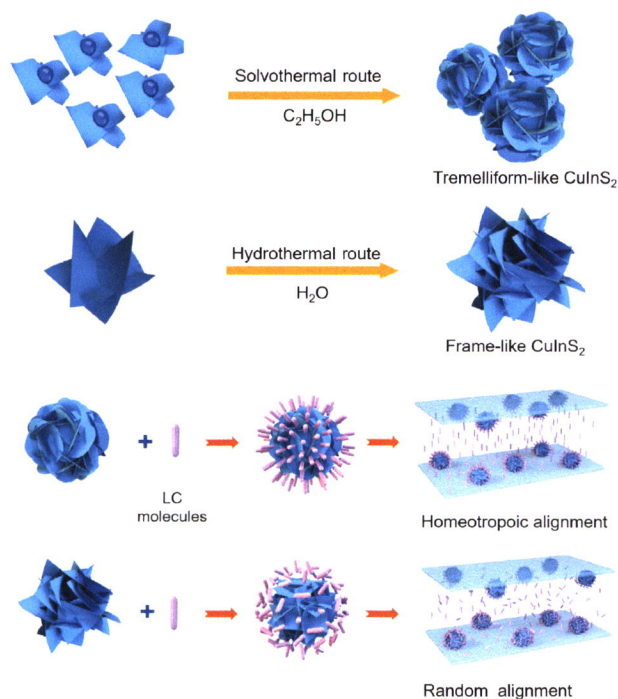
A new strategy is developed to fabricate metal-organic framework (MOF)-based heterogeneous nanomaterials with surface-anchored upconversion nanorods via hierarchical and dynamic assembly for multimodal synergistic anticancer by combining near-infrared (NIR)-induced photodynamic therapy with chemotherapy.

7533–7541

### Effects of CuInS<sub>2</sub> nanoparticles on the alignment control of liquid crystals

Dongyu Zhao\*, Yuanyuan Guo, Weihua Bi, Xin Li, Ran Duan, and Lin Guo\*

Beihang University, China



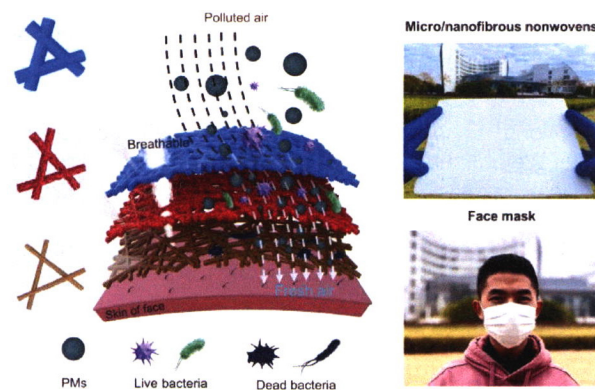
CuInS<sub>2</sub> nanoparticles containing different morphologies were prepared and utilized in inducing controllable macroscopic alignment of liquid crystals.

7542–7548

### Multi-layered micro/nanofibrous nonwovens for functional face mask filter

Yuanqiang Xu, Xiaomin Zhang, Defang Teng, Tienan Zhao, Ying Li, and Yongchun Zeng

Donghua University, China



The micro/nano-scaled fibers with porous and wrinkled surface morphologies and the multilevel pore sizes give the nonwovens high filtration efficiency under low pressure drop. Meanwhile, the nonwovens possess superior antibacterial performance by adding Ag nanoparticles as additives. These performances and function make the nonwovens promising filter core for face masks.

7549–7558

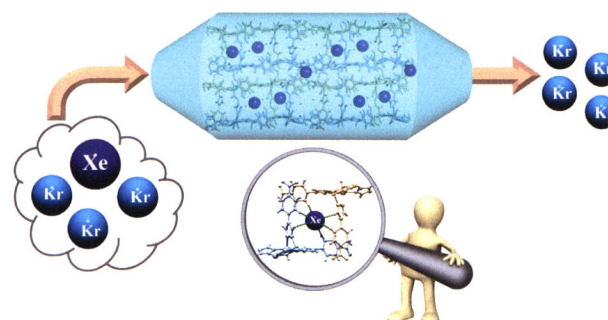
### Utilization of cationic microporous metal-organic framework for efficient Xe/Kr separation

Lingshan Gong<sup>1</sup>, Ying Liu<sup>2</sup>, Junyu Ren<sup>1</sup>, Abdullah M. Al-Enizi<sup>3</sup>, Ayman Nafady<sup>3</sup>, Yingxiang Ye<sup>1,\*</sup>, Zongbi Bao<sup>2,\*</sup>, and Shengqian Ma<sup>1,\*</sup>

<sup>1</sup> University of North Texas, USA

<sup>2</sup> Zhejiang University, China

<sup>3</sup> King Saud University, Saudi Arabia



Xenon/krypton mixtures can be efficiently separated by cationic microporous metal-organic framework with uniform three-dimensional interconnection channels.

7559–7564

### Robust superamphiphobic coatings with gradient and hierarchical architecture and excellent anti-flashover performances

Yi Xie<sup>1,\*</sup>, Wei Xiong<sup>1</sup>, Shefiu Kareem<sup>1</sup>, Chuxiong Qiu<sup>1</sup>, Yongfei Hu<sup>1</sup>, Ivan P. Parkin<sup>2</sup>, Shengwu Wang<sup>3</sup>, Huayun Wang<sup>4</sup>, Junwu Chen<sup>3</sup>, Lee Li<sup>3</sup>, Zhi Chen<sup>5</sup>, Huajun Sun<sup>1</sup>, and Xiujian Zhao<sup>1</sup>

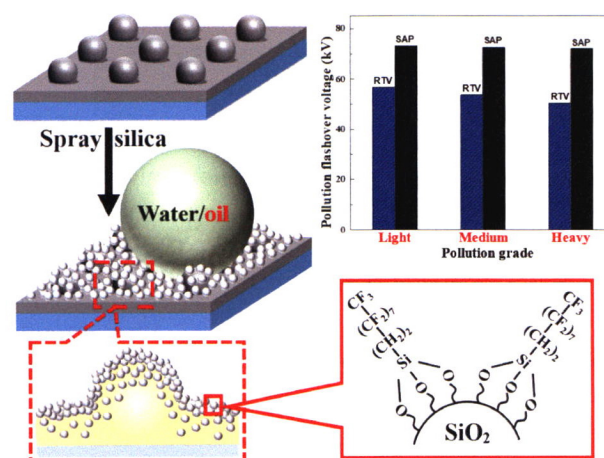
<sup>1</sup> Wuhan University of Technology, China

<sup>2</sup> University College London, UK

<sup>3</sup> Huazhong University of Science and Technology, China

<sup>4</sup> Electric Power Research Institute, China

<sup>5</sup> Wuhan Shuneng New Material Co., LTD, China



An anti-flashover material was developed by fabricating a robust superamphiphobic coating with unique gradient and micro-nanoscale hierarchical textures.

7565–7576



## Abnormal anti-oxidation behavior of hexagonal boron nitride grown on copper

Li Wang<sup>1,2,\*</sup>, Jiajie Qi<sup>1</sup>, Shuai Zhang<sup>3</sup>, Mingchao Ding<sup>2</sup>, Wei Wei<sup>4</sup>, Jinhuan Wang<sup>1,5</sup>, Zhihong Zhang<sup>1</sup>, Ruixi Qiao<sup>1</sup>, Zhibin Zhang<sup>1</sup>, Zehui Li<sup>1</sup>, Kehai Liu<sup>2</sup>, Ying Fu<sup>2</sup>, Hao Hong<sup>1</sup>, Can Liu<sup>1</sup>, Muhong Wu<sup>1</sup>, Wenlong Wang<sup>2</sup>, Jun He<sup>6</sup>, Yi Cui<sup>4</sup>, Qunyang Li<sup>3,\*</sup>, Xuedong Bai<sup>2,7,\*</sup>, and Kaihui Liu<sup>1,\*</sup>

<sup>1</sup> Peking University, China

<sup>2</sup> Institute of Physics, Chinese Academy of Sciences, China

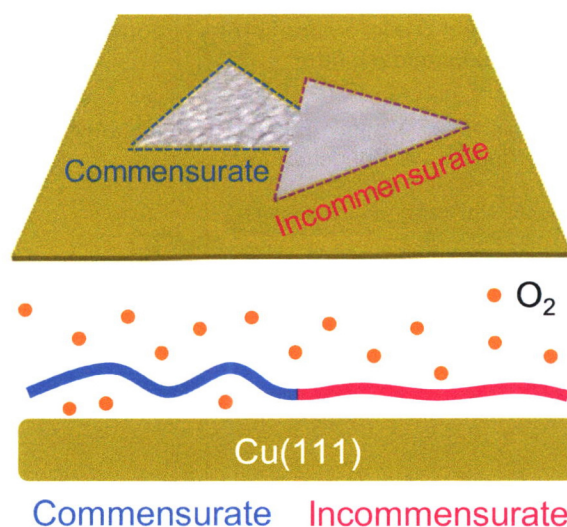
<sup>3</sup> Tsinghua University, China

<sup>4</sup> Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, China

<sup>5</sup> Beijing Institute of Technology, China

<sup>6</sup> National Center for Nanoscience and Technology, China

<sup>7</sup> University of Chinese Academy of Sciences, China



In this study, we reported that stronger interlayer coupling led to worse anti-oxidation performance of hexagonal boron nitride (hBN)/Cu(111) owing to fast diffusion of O<sub>2</sub> through higher hBN corrugations. And we developed the approach of cyclic reannealing that can effectively flatten corrugations and steps, and therefore improve the anti-oxidation performance to a great extent.

7577–7583

## The exceedingly strong two-dimensional ferromagnetism in bi-atomic layer SrRuO<sub>3</sub> with a critical conduction transition

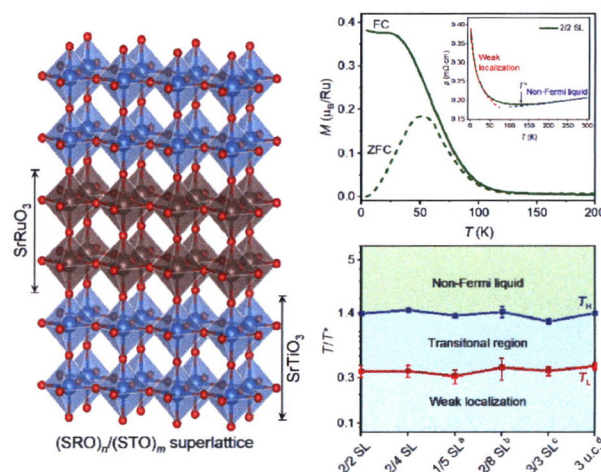
Jingxian Zhang<sup>1</sup>, Long Cheng<sup>2,\*</sup>, Hui Cao<sup>3</sup>, Mingrui Bao<sup>2</sup>, Jiyin Zhao<sup>1</sup>, Xuguang Liu<sup>1</sup>, Aidi Zhao<sup>2</sup>, Yongseong Choi<sup>3</sup>, Hua Zhou<sup>3</sup>, Padraic Shafer<sup>4</sup>, and Xiaofang Zhai<sup>2,\*</sup>

<sup>1</sup> University of Science and Technology of China, China

<sup>2</sup> ShanghaiTech University, China

<sup>3</sup> Argonne National Laboratory, USA

<sup>4</sup> Lawrence Berkeley National Laboratory, USA



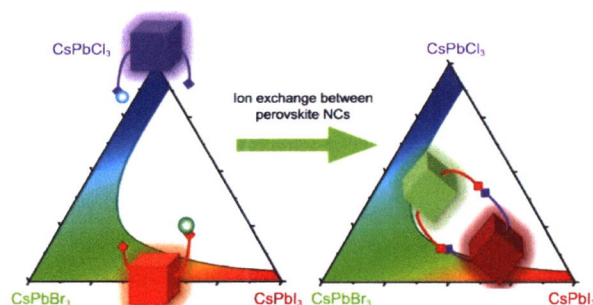
The exceedingly strong two-dimensional (2D) ferromagnetism among the correlated oxides family is revealed in bi-atomic layer SrRuO<sub>3</sub> with an identical conduction transition behavior from non-Fermi liquid to weak localization.

7584–7589

## Ternary phase diagram of all-inorganic perovskite CsPbCl<sub>a</sub>Br<sub>b</sub>I<sub>3-a-b</sub> nanocrystals

Xin Lv, Gaoyu Chen, Xia Zhu, Jiakun An, Jianchun Bao, and Xiangxing Xu\*

Nanjing Normal University, China



The ternary halide perovskite phase diagram of CsPbCl<sub>a</sub>Br<sub>b</sub>I<sub>3-a-b</sub> (0 < a + b < 3) was constructed by the strategy of halide anion exchange between perovskite nanocrystals (NCs). From the diagram, the composition and proportion of the perovskite NC final phases from any starting perovskite NC mixture can be calculated.

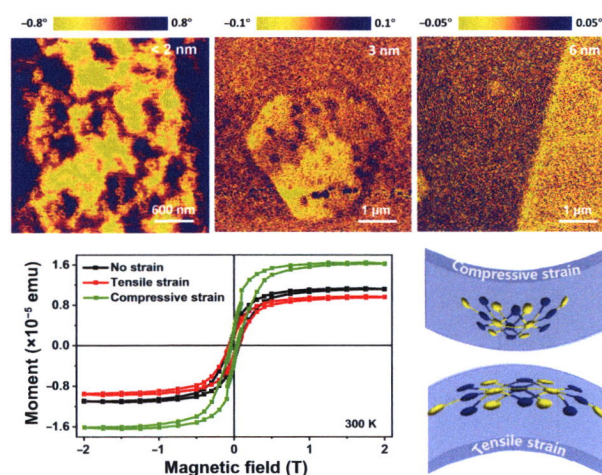
7590–7596

### Thickness-dependent and strain-tunable magnetism in two-dimensional van der Waals VSe<sub>2</sub>

Wenjuan Ci<sup>1</sup>, Huali Yang<sup>2</sup>, Wuhong Xue<sup>1,\*</sup>, Ruilong Yang<sup>1</sup>, Baohua Lv<sup>1</sup>, Peng Wang<sup>1</sup>, Run-Wei Li<sup>2</sup>, and Xiao-Hong Xu<sup>1,\*</sup>

<sup>1</sup> Shanxi Normal University, China

<sup>2</sup> Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, China



The few-layer vanadium diselenide (VSe<sub>2</sub>) nanoflakes show strong thickness dependence of magnetic domain signal at room temperature. A very clear magnetic domain structure was exhibited in the VSe<sub>2</sub> nanoflake whose thickness is close to monolayer, and the magnetic domain signal nearly disappeared for a thicker (> 6 nm) nanoflake. In addition, its magnetism including the magnetic moment and coercive field could be efficiently modulated via applying external strain. These results are of great significance for constructing novel flexible spintronic devices.

7597–7603

### Empowering magnetic strong coupling and its application for nonlinear refractive index sensing

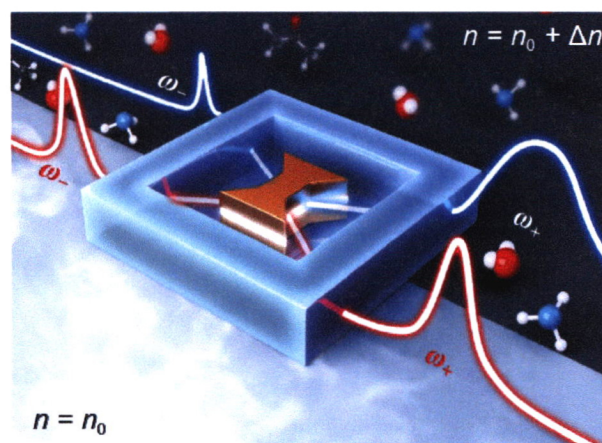
Song Sun<sup>1,2,\*</sup>, Dong Li<sup>1,2</sup>, Dacheng Wang<sup>1,2</sup>, Zheng Feng<sup>1,2</sup>, Wei Tan<sup>1,2</sup>, and Lin Wu<sup>3,4,\*</sup>

<sup>1</sup> Microsystem and Terahertz Research Center, China Academy of Engineering Physics, China

<sup>2</sup> Institute of Electronic Engineering, China Academy of Engineering Physics, China

<sup>3</sup> Singapore University of Technology and Design, Singapore

<sup>4</sup> Institute of High Performance Computing, A\*STAR (Agency for Science, Technology and Research), Singapore



A delicately designed antenna-in-cavity configuration could enable quantum strong coupling for magnetic dipole emitters with a clear Rabi-splitting spectrum, exhibiting an exotic nonlinear sensitivity to the environmental refractive index.

7604–7613



## Semiconductor

## Research Articles

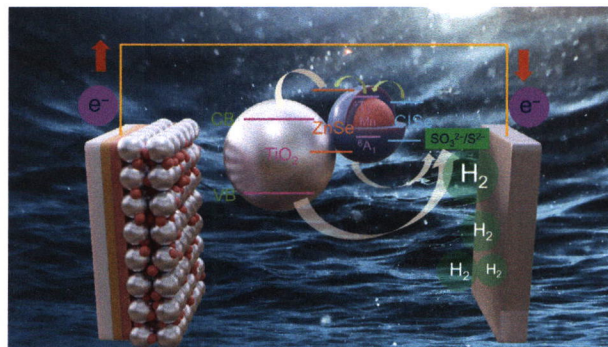
### Rational design of eco-friendly Mn-doped nonstoichiometric CuInSe/ZnSe core/shell quantum dots for boosted photoelectrochemical efficiency

Rui Wang<sup>1</sup>, Xin Tong<sup>1,2,\*</sup>, Zhihang Long<sup>1</sup>, Ali Imran Channa<sup>1,3</sup>, Hongyang Zhao<sup>1</sup>, Xin Li<sup>1</sup>, Mengke Cai<sup>1</sup>, Yimin You<sup>1</sup>, Xuping Sun<sup>1,\*</sup>, and Zhiming Wang<sup>1,2,\*</sup>

<sup>1</sup> University of Electronic Science and Technology of China, China

<sup>2</sup> Chengdu University, China

<sup>3</sup> Hongik University, Republic of Korea



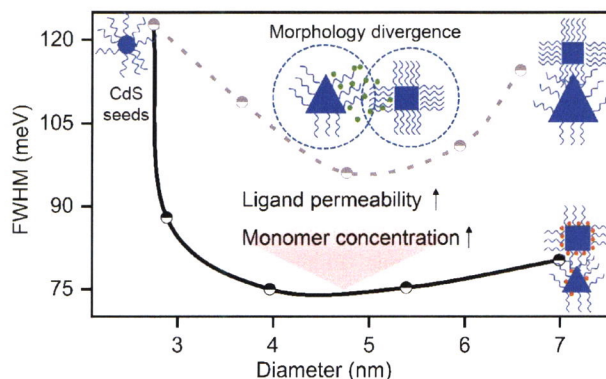
The Mn doping in eco-friendly nonstoichiometric CuInSe/ZnSe core/shell quantum dots (QDs) enables retarded charge recombination and improved electron extraction/injection to boost the photoelectrochemical (PEC) efficiency of QDs-based photoanodes.

7614–7621

### Size focusing of colloidal quantum dots under high monomer concentration

Huiyan Liu, Zhi Liu, and Chaodan Pu\*

ShanghaiTech University, China



Quantum dots in the same pot always have slightly different morphologies, resulting in different growth rates of quantum dots because of different ligand permeabilities. Under high monomer concentration, the growth of quantum dots with different morphologies can be balanced by tuning the relative ligand permeabilities and surface reaction. As a result, quantum dots with narrow size distribution are obtained.

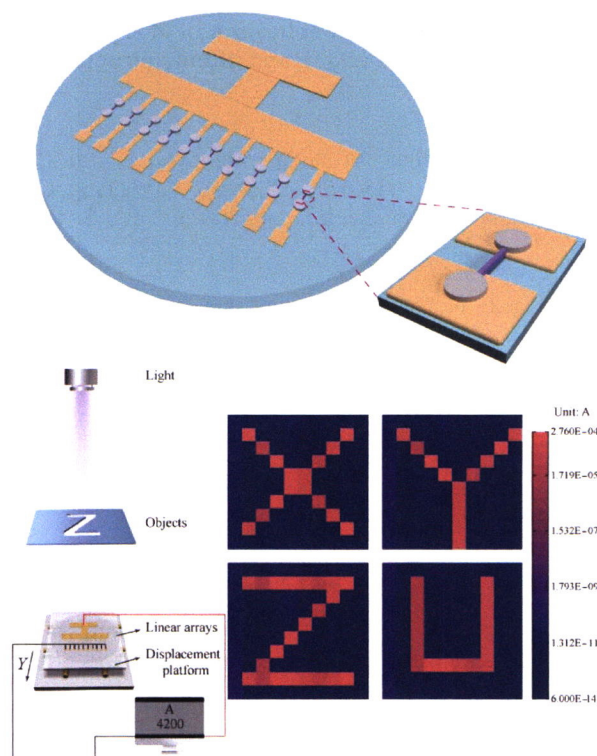
7622–7630

## High-performance solar-blind photodetector arrays constructed from Sn-doped Ga<sub>2</sub>O<sub>3</sub> microwires via patterned electrodes

Ya-Cong Lu<sup>1</sup>, Zhen-Feng Zhang<sup>1</sup>, Xun Yang<sup>1,\*</sup>, Gao-Hang He<sup>2</sup>, Chao-Nan Lin<sup>1</sup>, Xue-Xia Chen<sup>1</sup>, Jin-Hao Zang<sup>1</sup>, Wen-Bo Zhao<sup>1</sup>, Yan-Cheng Chen<sup>1</sup>, Lei-Lei Zhang<sup>1</sup>, Yi-Zhe Li<sup>1</sup>, and Chong-Xin Shan<sup>1,\*</sup>

<sup>1</sup> Zhengzhou University, China

<sup>2</sup> Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, China



High-performance solar-blind photodetectors are fabricated from Sn-doped Ga<sub>2</sub>O<sub>3</sub> microwires, which show a light/dark current ratio as high as  $10^7$  and a responsivity of 2,409 A/W. Moreover, photodetector arrays are developed based on the Sn-doped Ga<sub>2</sub>O<sub>3</sub> microwires via a patterned-electrodes method and used for solar-blind imaging. This work provides a convenient way to construct high-performance solar-blind photodetector arrays.

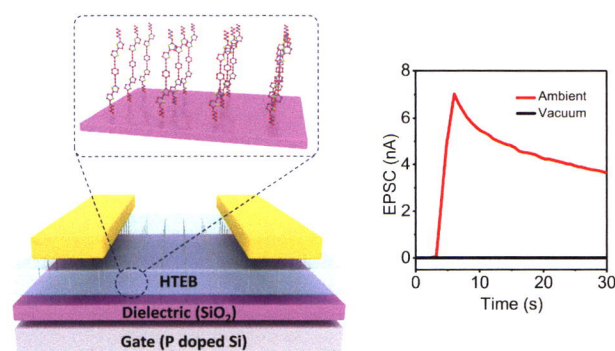
7631–7638

## Monolayer molecular crystals for low-energy consumption optical synaptic transistors

Zhekun Hua<sup>1</sup>, Ben Yang<sup>1</sup>, Junyao Zhang<sup>1</sup>, Dandan Hao<sup>1</sup>, Pu Guo<sup>1</sup>, Jie Liu<sup>2,\*</sup>, Lang Jiang<sup>2,\*</sup>, and Jia Huang<sup>1,\*</sup>

<sup>1</sup> Tongji University, China

<sup>2</sup> Institute of Chemistry, Chinese Academy of Sciences, China



This work reports the synaptic transistor based on 1,4-bis((5'-hexyl-2,2'-bithiophen-5-yl)ethyl)benzene (HTEB) monolayer molecular crystals and the synaptic behaviors can be explained by oxygen related energy levels.

7639–7645

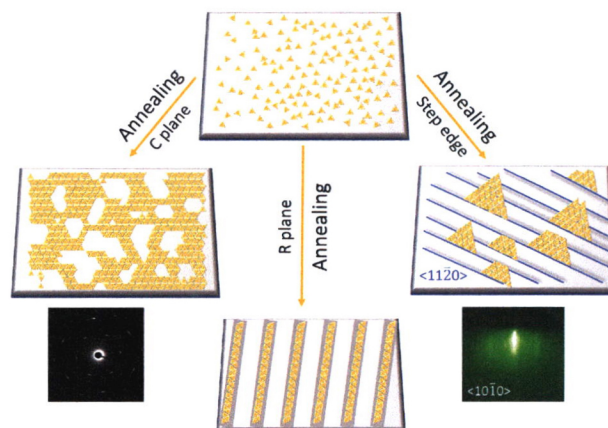


## Insight into the growth behaviors of MoS<sub>2</sub> nanograins influenced by step edges and atomic structure of the substrate

Shuangyue Wang<sup>1</sup>, Ni Yang<sup>1</sup>, Mengyao Li<sup>1</sup>, Ji Zhang<sup>1</sup>, Ashraf Azam<sup>1</sup>, Yin Yao<sup>1</sup>, Xiaotao Zu<sup>2</sup>, Liang Qiao<sup>1,2</sup>, Peter Reece<sup>1</sup>, John Stride<sup>1</sup>, Jack Yang<sup>1,\*</sup>, and Sean Li<sup>1,\*</sup>

<sup>1</sup> UNSW Sydney, Australia

<sup>2</sup> University of Electronic Science and Technology of China, China



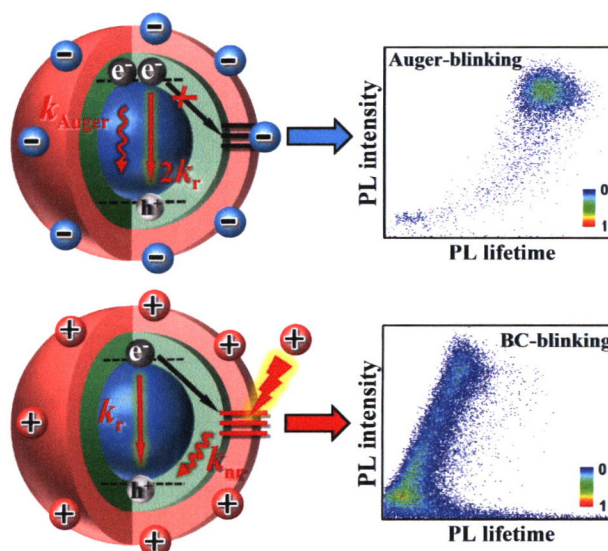
The step edges of the underlying substrate could guide the formation of unidirectional MoS<sub>2</sub> islands, and the geometric structure of the substrate determines the growth dimensionality.

7646–7654

## The role of surface charges in the blinking mechanisms and quantum-confined Stark effect of single colloidal quantum dots

Jialu Li, Dengfeng Wang, Guofeng Zhang\*, Changgang Yang, Wenli Guo, Xue Han, Xiuqing Bai, Ruiyun Chen, Chengbing Qin, Jianyong Hu, Liantuan Xiao\*, and Suotang Jia

Shanxi University, China



The negative surface charges can simultaneously suppress photoluminescence (PL) blinking and spectral diffusion of single colloidal quantum dots, while the positive surface charges can change the quantum dots' blinking mechanisms from Auger-blinking to band-edge carrier (BC)-blinking.

7655–7661

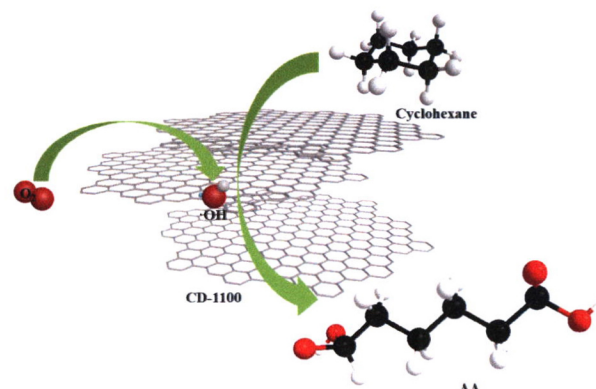
## Highly crystalline core dominated the catalytic performance of carbon dot for cyclohexane to adipic acid reaction

Xiao Wang<sup>1</sup>, Wenyi Bian<sup>1</sup>, Tianyang Zhang<sup>1</sup>, Yajie Zhao<sup>1</sup>, Mingwang Shao<sup>1</sup>, Haiping Lin<sup>3</sup>, Yang Liu<sup>1,\*</sup>, Hui Huang<sup>1,\*</sup>, and Zhenhui Kang<sup>1,2</sup>

<sup>1</sup> Soochow University, China

<sup>2</sup> Macau University of Science and Technology, Macao, China

<sup>3</sup> Shaanxi Normal University, China



Highly crystalline core of carbon dots dominated the efficient catalytic performance for cyclohexane to adipic acid.

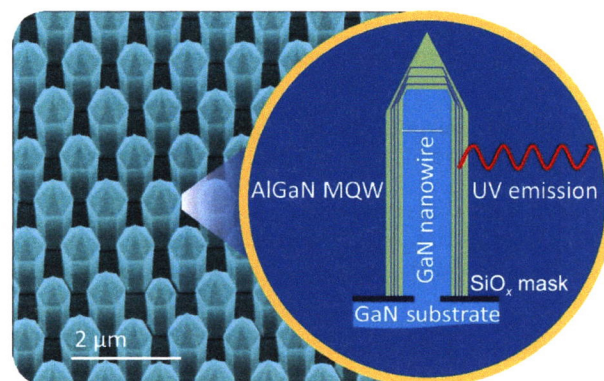
7662–7669

### Nonpolar $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{Al}_y\text{Ga}_{1-y}\text{N}$ multiple quantum wells on GaN nanowire for UV emission

Sonachand Adhikari<sup>1,2,\*</sup>, Olivier Lee Cheong Lem<sup>1</sup>, Felipe Kremer<sup>1</sup>, Kaushal Vora<sup>1</sup>, Frank Brink<sup>1</sup>, Mykhaylo Lysevych<sup>1</sup>, Hark Hoe Tan<sup>1,\*</sup>, and Chennupati Jagadish<sup>1</sup>

<sup>1</sup> The Australian National University, Australia

<sup>2</sup> CSIR-Central Electronics Engineering Research Institute, India



AlGaIn MQW on GaN nanowire

The growth of AlGaIn on GaN nanowires by metal organic chemical vapor deposition (MOCVD) is driven by vapor-phase diffusion, and consequently puts a limit on the pitch of nanowire array due to shadowing effect. An insight into the difficulty of achieving metal-polar AlGaIn nanowire by selective area growth (SAG) in MOCVD is also provided and can be attributed to the strong tendency to form pyramidal structure.

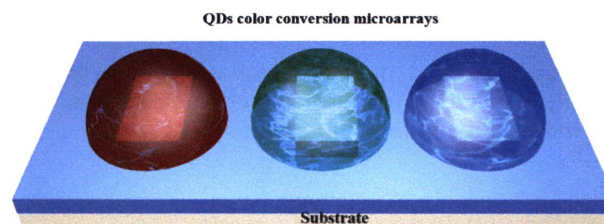
7670–7680

### Perovskite quantum dot microarrays: *In situ* fabrication via direct print photopolymerization

Xiu Liu<sup>1</sup>, Jianjun Li<sup>1</sup>, Pingping Zhang<sup>1</sup>, Weitong Lu<sup>1</sup>, Gaoling Yang<sup>1,2,\*</sup>, Haizheng Zhong<sup>1</sup>, and Yuejin Zhao<sup>1,\*</sup>

<sup>1</sup> Beijing Institute of Technology, China

<sup>2</sup> MIIT Key Laboratory for Low Dimensional Quantum Structure and Devices, China



Perovskite quantum dots (PQDs) microarrays with three-dimensional (3D) hemisphere morphology and strong photoluminescence are fabricated by combining the inkjet printing and *in situ* fabrication of PQDs during the photopolymerization of precursor ink, which is desirable for quantum dots color conversion (QDCC) applications. Large-area multicolor patterned pixelated microarrays with wide color gamut and high resolution are achieved through this *in situ* direct print photopolymerization method.

7681–7687



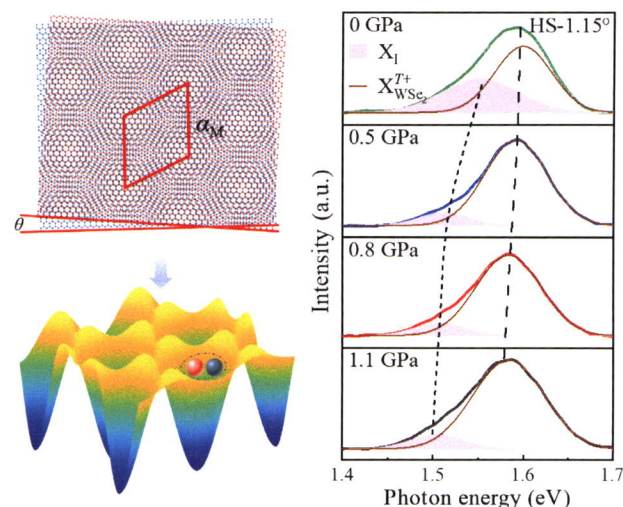
## Dynamic control of moiré potential in twisted $\text{WS}_2\text{-WSe}_2$ heterostructures

Shaofei Li<sup>1</sup>, Haihong Zheng<sup>1</sup>, Junnan Ding<sup>1</sup>, Biao Wu<sup>1</sup>, Jun He<sup>1</sup>, Zongwen Liu<sup>2</sup>, and Yanping Liu<sup>1,3,\*</sup>

<sup>1</sup> Central South University, China

<sup>2</sup> The University of Sydney, Australia

<sup>3</sup> Shenzhen Research Institute of Central South University, China



We observe the red-shift phenomenon of exciton resonances in the twisted heterostructures with a small angle at small pressures, achieving dynamic modulation *in situ* of moiré potentials by diamond anvil cell (DAC).

7688–7694

## Synthesis

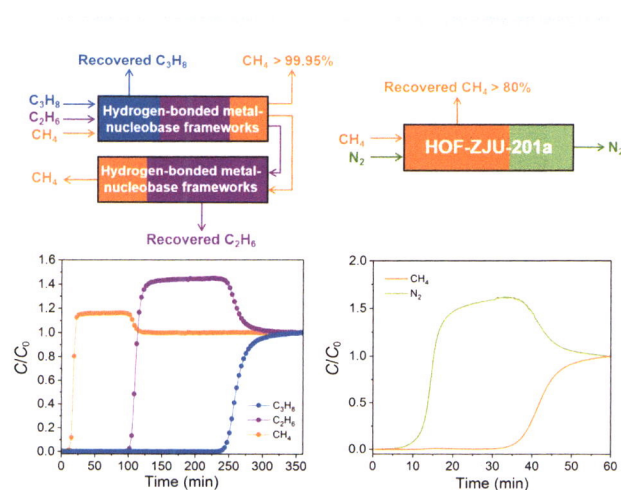
### Research Articles

## Hydrogen-bonded metal-nucleobase frameworks for highly selective capture of ethane/propane from methane and methane/nitrogen separation

Ying Liu<sup>1</sup>, Qianqian Xu<sup>1</sup>, Lihang Chen<sup>1</sup>, Changhua Song<sup>1</sup>, Qiwei Yang<sup>1,2</sup>, Zhiguo Zhang<sup>1,2</sup>, Dan Lu<sup>1</sup>, Yiwen Yang<sup>1,2</sup>, Qilong Ren<sup>1,2</sup>, and Zongbi Bao<sup>1,2,\*</sup>

<sup>1</sup> Zhejiang University, China

<sup>2</sup> Institute of Zhejiang University-Quzhou, China



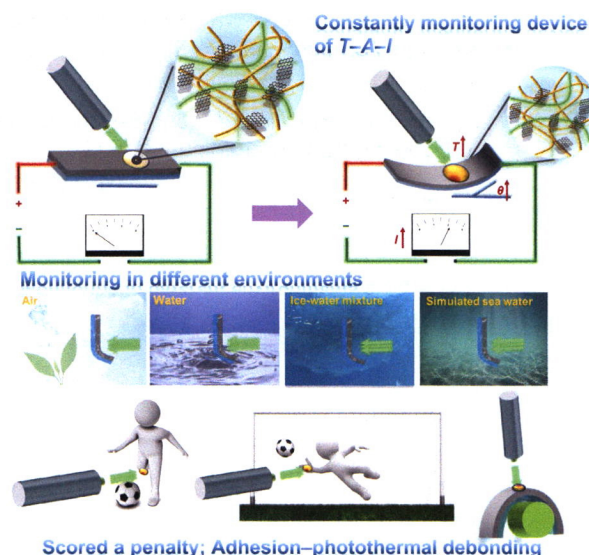
Two hydrogen-bonded metal-nucleobase frameworks are used to separate high purity  $\text{CH}_4$  from  $\text{CH}_4/\text{C}_2\text{H}_6/\text{C}_3\text{H}_8$  mixtures and efficiently separate  $\text{CH}_4/\text{N}_2$ .

7695–7702

## Conductive photo-thermal responsive bifunctional hydrogel system with self-actuating and self-monitoring abilities

Neng Chen, Yang Zhou\*, Yinping Liu, Yuanyuan Mi, Sisi Zhao, Wang Yang, Sai Che, Hongchen liu, FengJiang Chen, Chong Xu, Guang Ma, Xue Peng, and Yongfeng Li\*

China University of Petroleum, China



A dual-functional hydrogel soft actuator is capable of self-actuating with the photothermal response, as well as sensing and monitoring ability with the instantaneous change of surface temperature-bending angle-electron current. What's original is that hydrogels can be adapted to a variety of environments, such as air, water, ice-water mixture, and seawater. More importantly, the soft actuator of imitating a football player and a goalkeeper takes a penalty kick, and the adhesion-photothermally actuator can realize the behavior of debonding.

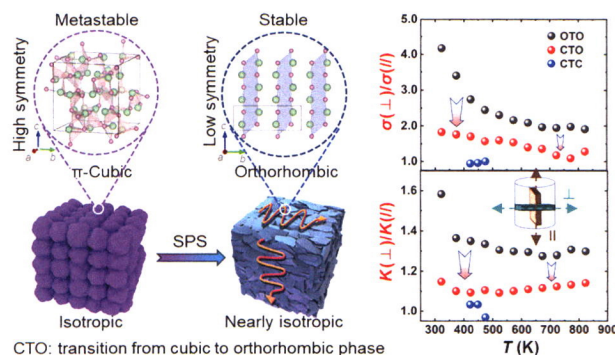
7703–7712

## Realizing nearly isotropic thermoelectric properties in 2D-layered SnS nanomaterials through highly symmetric metastable-phase powder precursors

Fanshi Wu<sup>1</sup>, Junjie Yuan<sup>1</sup>, Wenxin Lai<sup>1</sup>, Liangwei Fu<sup>1,\*</sup>, and Biao Xu<sup>1,2,\*</sup>

<sup>1</sup> Nanjing University of Science & Technology, China

<sup>2</sup> Nanjing University, China



We design a phase-conversion strategy to obtain isotropic materials through a selectively synthesized highly symmetric metastable phase as the precursor.

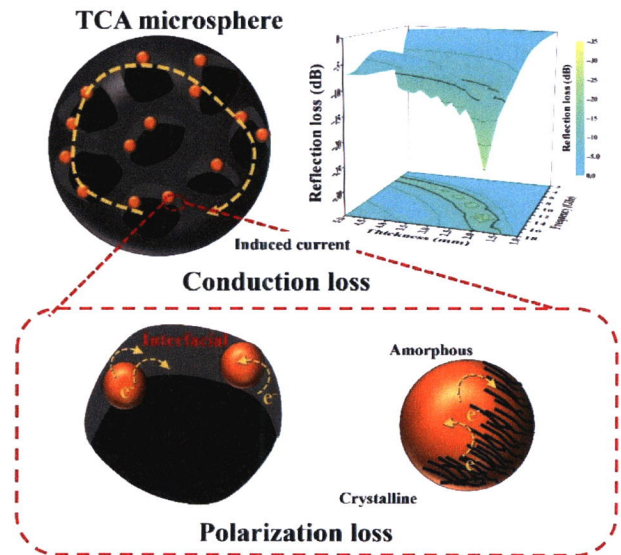
7713–7722



### Carbon aerogel microspheres with *in-situ* mineralized $\text{TiO}_2$ for efficient microwave absorption

Yue-Yi Wang, Jin-Long Zhu, Nan Li, Jun-Feng Shi, Jian-Hua Tang, Ding-Xiang Yan\*, and Zhong-Ming Li\*

Sichuan University, China



Cellulose derived carbon aerogel microspheres achieve the balance between attenuation characteristics and impedance matching performance in application of microwave absorption by *in-situ* mineralizing  $\text{TiO}_2$ .

7723–7730

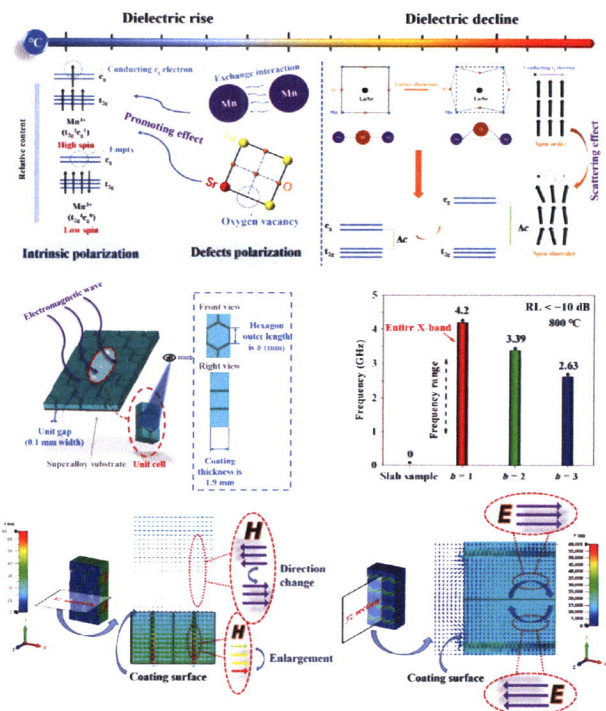
### The dielectric behavior and efficient microwave absorption of doped nanoscale $\text{LaMnO}_3$ at elevated temperature

Zhigang Mu<sup>1</sup>, Guoke Wei<sup>2,\*</sup>, Hang Zhang<sup>2</sup>, Lu Gao<sup>2</sup>, Yue Zhao<sup>1</sup>, Shaolong Tang<sup>3</sup>, and Guangbin Ji<sup>1,\*</sup>

<sup>1</sup> Nanjing University of Aeronautics and Astronautics, China

<sup>2</sup> AVIC Manufacturing Technology Institute, China

<sup>3</sup> Nanjing University, China



The complex doping effect and temperature dependence of Mn ion spin state have an important effect on the dielectric behavior of  $\text{La}_{1-x}\text{Sr}_x\text{Mn}_{1-y}\text{Fe}_y\text{O}_3$  perovskite materials at high temperature. The content of  $\text{Mn}^{3+}$  in the high-spin and low-spin states is dynamically changing with the increase of temperature. The spin state of Mn ions and the crystal structure of perovskite affect the high-temperature dielectric behavior of  $\text{La}_{1-x}\text{Sr}_x\text{Mn}_{1-y}\text{Fe}_y\text{O}_3$  by acting on the double-exchange interaction, making it possible to maintain efficient absorption of electromagnetic waves in high temperature. In addition, the cellular array structure obtained by computer simulation technology (CST) simulation software can introduce magnetic loss and further improve the service temperature of materials.

7731–7741

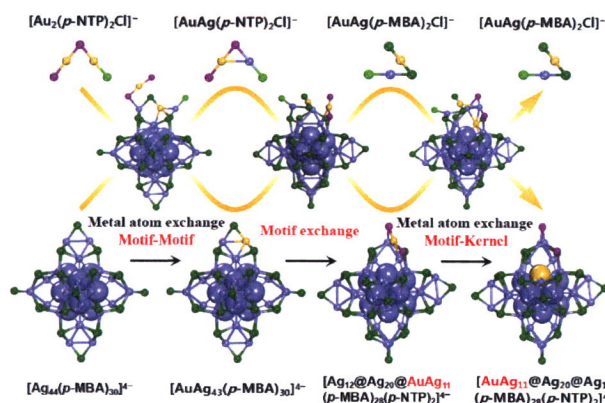
## Theory

## Research Articles

Three-stage alloying of  $[\text{Ag}_{44}(\text{p-MBA})_{30}]^{4-}$  cluster with  $[\text{Au}_2(\text{p-NTP})_2\text{Cl}]^-$ 

Baoyu Huang, Xiaomei Zhao, and Yong Pei\*

Xiangtan University, China



The density functional theory (DFT) calculation results demonstrated that the metal exchange proceeded via different mechanisms at different reaction stages. In reaction stages I and II, the metal exchange proceeded via formation of a dianionic  $[\text{Ag}_{44}(\text{p-MBA})_{30}]^{4-}-[\text{Au}_2(\text{p-NTP})_2\text{Cl}]^-$  intermediate and then broke and recombined with the ligand-shell. In stage III, the diffusion of Au(I) to icosahedral  $\text{Ag}_{12}$ -core (stage III) proceeded via a motif catalyzed heterometal atom diffusion mechanism.

7742–7751

Erratum to: Sub-gap defect density characterization of molybdenum oxide: An annealing study for solar cell applications (<https://doi.org/10.1007/s12274-020-3029-9>)

7752–7753

Erratum to: Exosome-mimicking nanovesicles derived from efficacy-potentiated stem cell membrane and secretome for regeneration of injured tissue (<https://doi.org/10.1007/s12274-021-3868-z>)

7754–7756

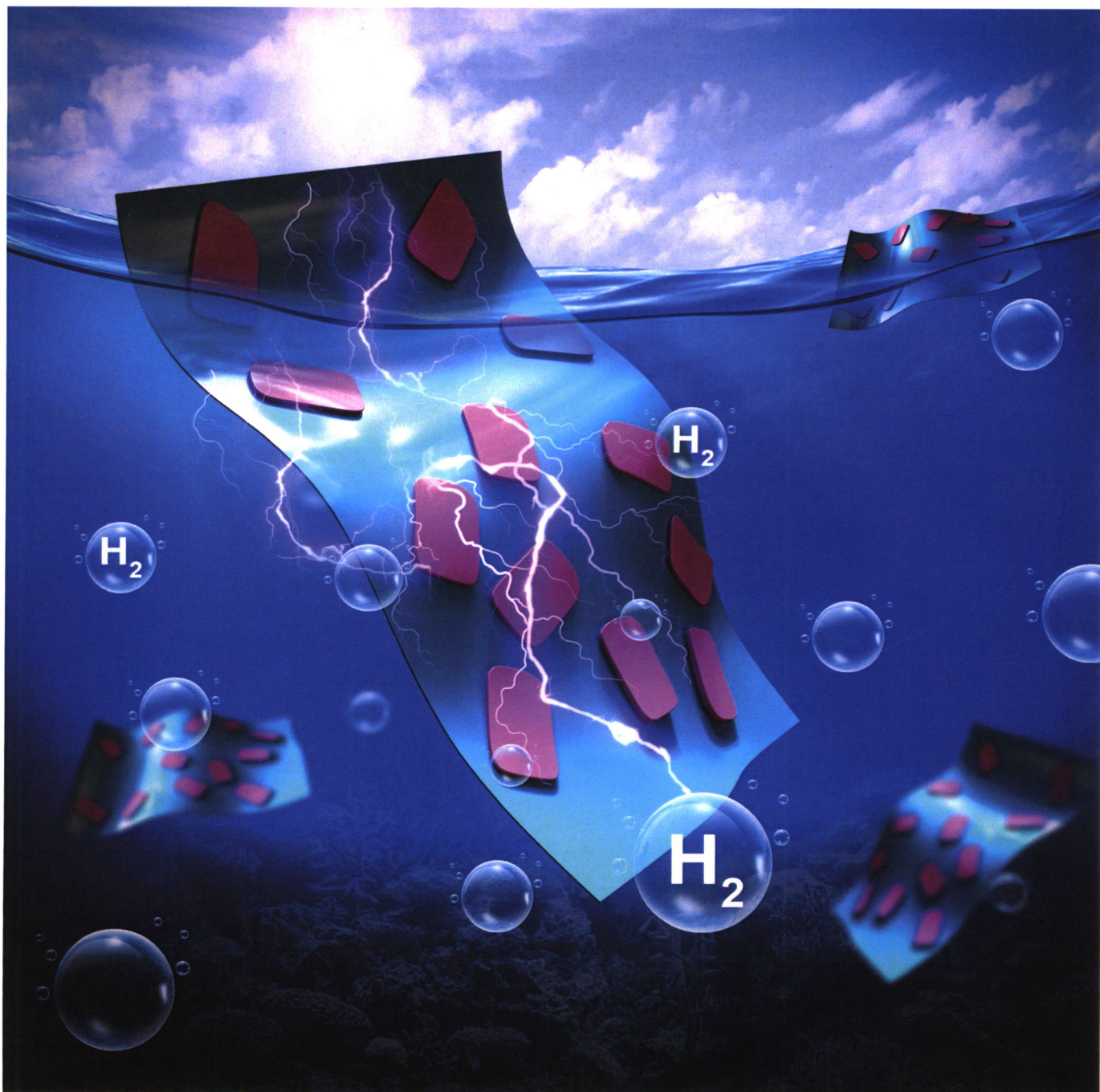
Erratum to: *In situ* construction of thiol-silver interface for selectively electrocatalytic  $\text{CO}_2$  reduction (<https://doi.org/10.1007/s12274-021-3978-7>)

7757

Erratum to: V-doped  $\text{Ni}_3\text{N}/\text{Ni}$  heterostructure with engineered interfaces as a bifunctional hydrogen electrocatalyst in alkaline solution: Simultaneously improving water dissociation and hydrogen adsorption (<https://doi.org/10.1007/s12274-021-3559-9>)

7758





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