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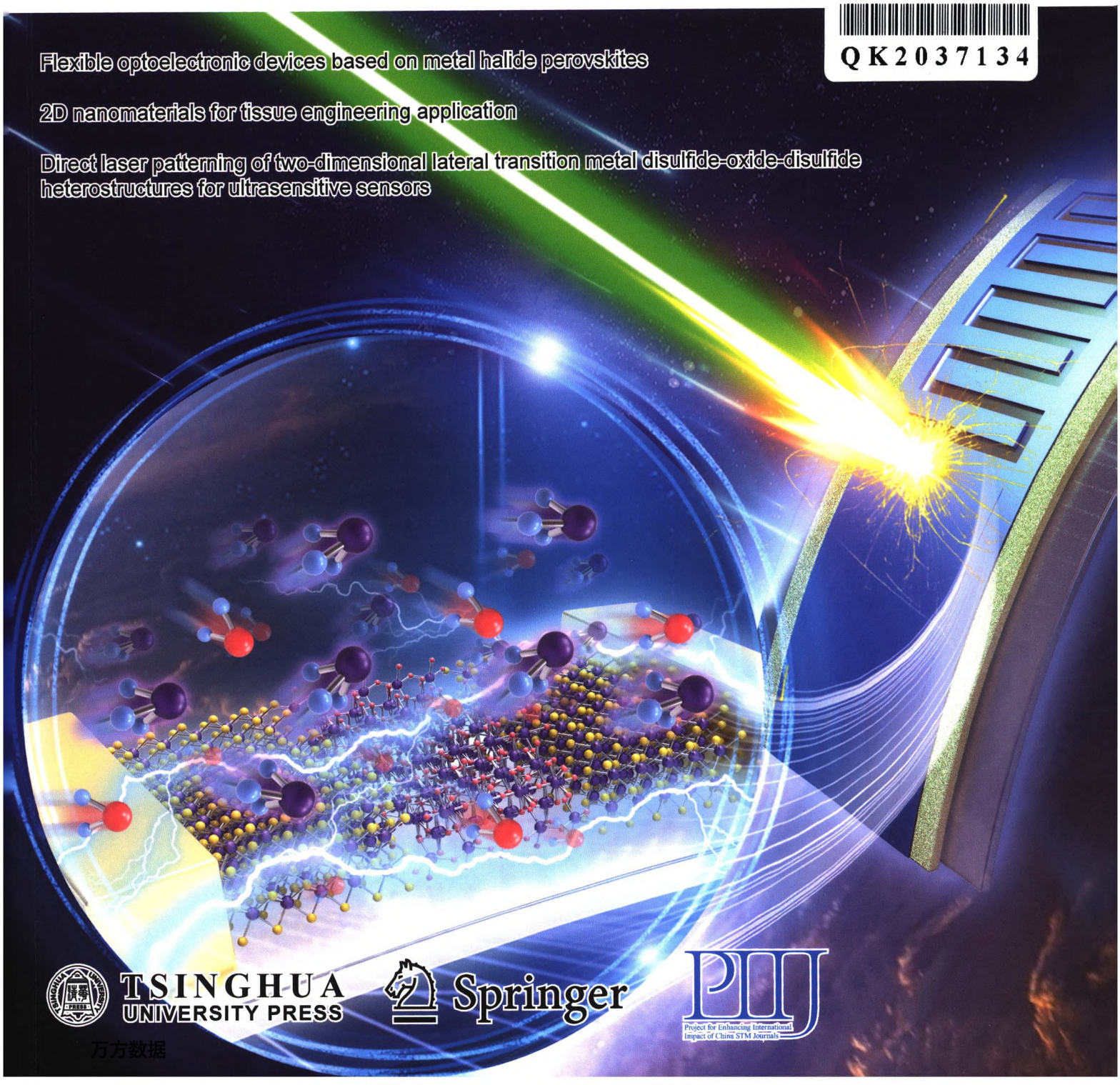
Nano Research

Flexible optoelectronic devices based on metal halide perovskites

2D nanomaterials for tissue engineering application

Direct laser patterning of two-dimensional lateral transition metal disulfide-oxide-disulfide heterostructures for ultrasensitive sensors



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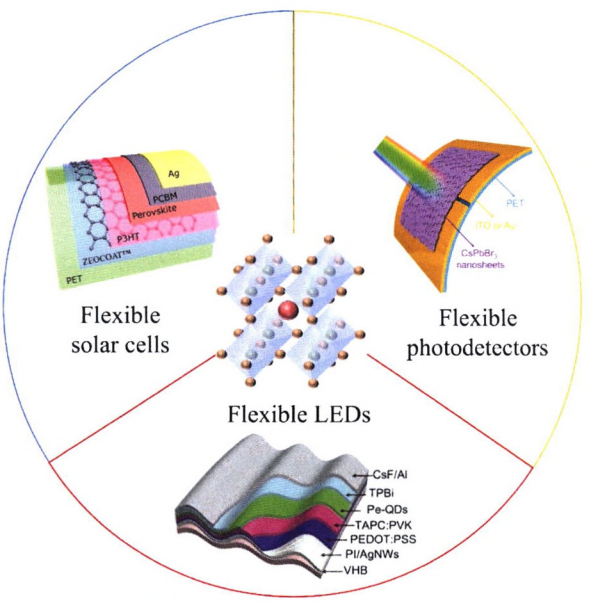
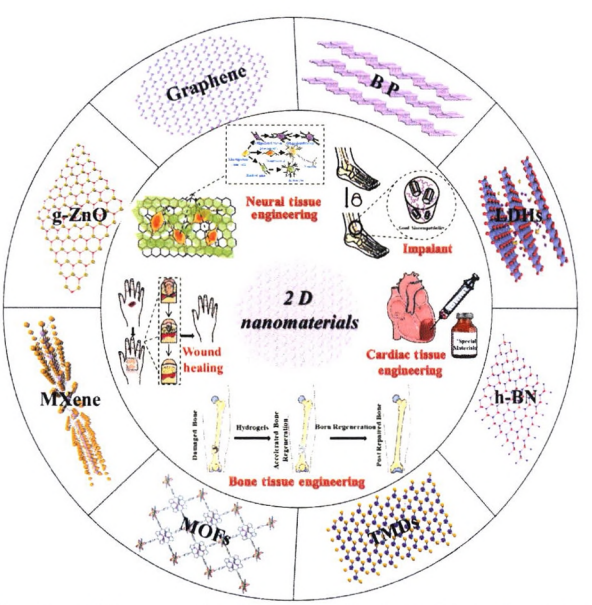
Review Articles



Recent progress of flexible perovskite optoelectronic devices is summarized. And the further developing trend is discussed.

1997–2018



This scheme illustrates the diverse applications of two-dimensional (2D) nanomaterials in tissue engineering, including graphene, transition metal dichalcogenides, transition metal carbides, nitrides and carbonitrides, black phosphorus nanosheets, layered double hydroxides, 2D metal-organic frameworks (MOFs) and other types of 2D nanosheets.

2019–2034

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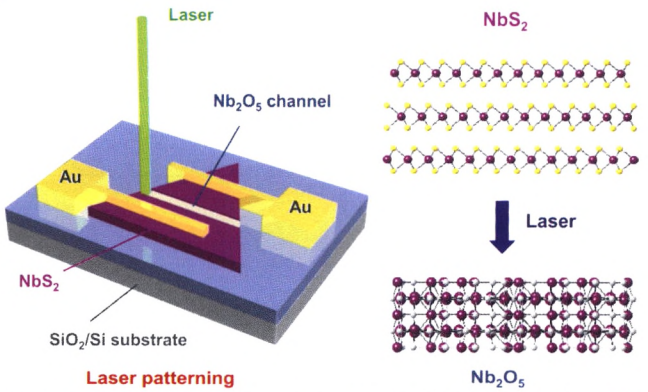
Research Articles

Direct laser patterning of two-dimensional lateral transition metal disulfide-oxide-disulfide heterostructures for ultrasensitive sensors

Bolun Wang[1], Hao Luo[1], Xuewen Wang[1], Enze Wang[1], Yufei Sun[1], Yu-Chien Tsai[1], Jinxuan Dong[1], Peng Liu[1], Huanglong Li[1], Yong Xu[1,2], Sefaattin Tongay[3], Kaili Jiang[1], Shoushan Fan[1], and Kai Liu[1,*]

[1] Tsinghua University, China
[2] RIKEN Center for Emergent Matter Science (CEMS), Japan
[3] Arizona State University, USA



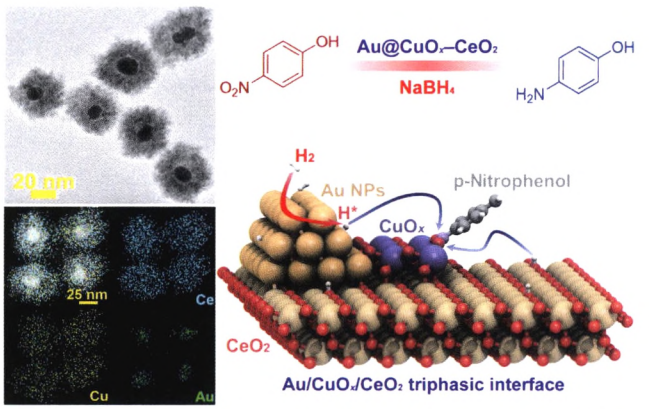
A two-dimensional lateral transition metal disulfide-oxide-disulfide heterostructure with a configuration of an ultrathin Nb_2O_5 channel and two metallic NbS_2 electrodes is fabricated by a simple lithography-free, laser-patterning technique. The heterostructure can be used as an ultrasensitive two-terminal sensor based on the modulation of Nb_2O_5 surface conduction through the naturally adsorbed water molecules.

2035–2043

Facile synthesis of Au embedded CuO_x–CeO_2 core/shell nanospheres as highly reactive and sinter-resistant catalysts for catalytic hydrogenation of p-nitrophenol

Ke Wu[1], Xin-Yu Wang[1], Ling-Ling Guo[2], Yue-Jiao Xu[1], Liang Zhou[1], Ze-Yu Lyu[1], Kang-Yu Liu[1], Rui Si[2], Ya-Wen Zhang[1], Ling-Dong Sun[1,*], and Chun-Hua Yan[1,3,*]

[1] Peking University, China
[2] Shanghai Institute of Applied Physics, Chinese Academy of Sciences, China
[3] Lanzhou University, China



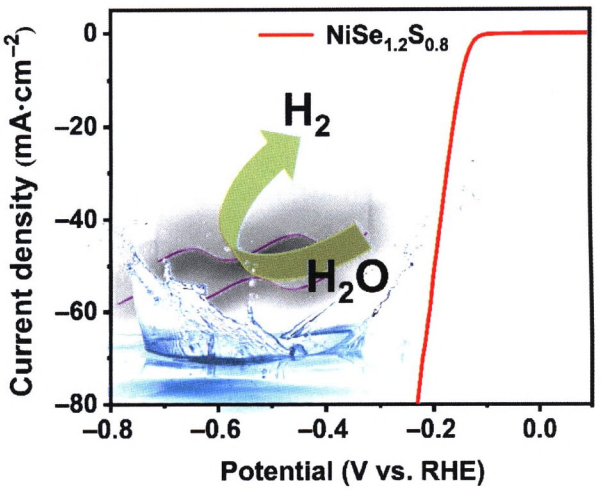
Au embedded CuO_x–CeO_2 core/shell nanospheres are successfully synthesized as highly reactive and sinter-resistant catalysts for catalytic hydrogenation of p-nitrophenol.

2044–2055

Atomically thin defect-rich Ni-Se-S hybrid nanosheets as hydrogen evolution reaction electrocatalysts

Jianpeng Sun[1], Xiangting Hu[2], Zhaodi Huang[1], Tianxiang Huang[1], Xiaokang Wang[1], Hailing Guo[1], Fangna Dai[1,*], and Daofeng Sun[1,*]

[1] China University of Petroleum (East China), China
[2] Shandong University, China



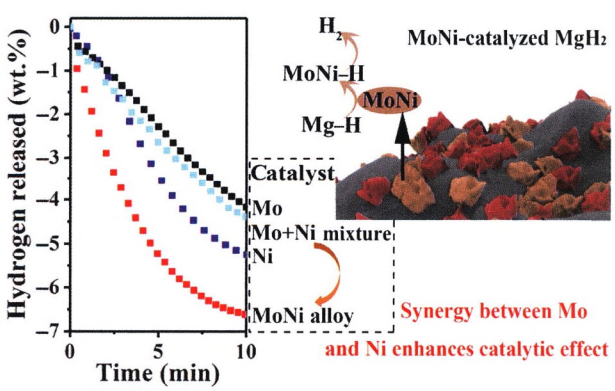
The atomically thin Ni-Se-S based hybrid nanosheet ($NiSe_{1.2}S_{0.8}$) has been synthesized via a simple solvothermal method, and the thickness of $NiSe_{1.2}S_{0.8}$ nanosheets is only about 1.1 nm. Benefiting from the ultrathin nanostructure and rich defects, the optimal $NiSe_{1.2}S_{0.8}$ exhibits good electrocatalytic activity in acid solution.

2056–2062

Synergy between metallic components of MoNi alloy for catalyzing highly efficient hydrogen storage of MgH_2

Meng Chen[1,2], Yanhui Pu[1], Zhenyang Li[1], Gang Huang[1], Xiaofang Liu[1,*], Yao Lu[1], Wukui Tang[1], Li Xu[3], Shuangyu Liu[3], Ronghai Yu[1,*], and Jianglan Shui[1,*]

[1] Beihang University, China
[2] COMAC Beijing Aircraft Technology Research Institute, China
[3] Global Energy Interconnection Research Institute Beijing, China



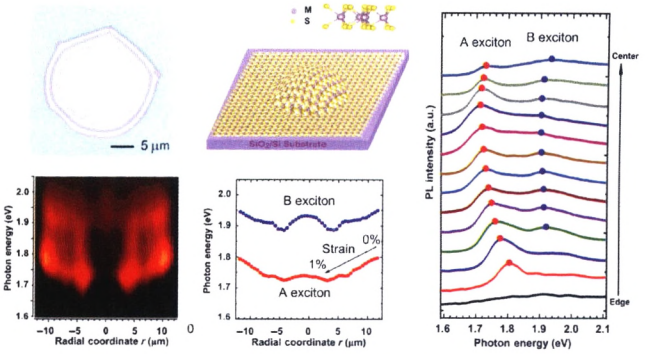
The synergy between Mo and Ni components significantly improves the catalytic effect of MoNi alloy on hydrogenation/dehydrogenation kinetics of MgH_2.

2063–2071

Direct bandgap engineering with local biaxial strain in few-layer MoS_2 bubbles

Yang Guo[1,2], Bin Li[3], Yuan Huang[1], Shuo Du[1,2], Chi Sun[1,2], Hailan Luo[1], Baoli Liu[1,2,4], Xingjiang Zhou[1], Jinlong Yang[3], Junjie Li[1,2,4], and Changzhi Gu[1,2,*]

[1] Institute of Physics, Chinese Academy of Sciences, China
[2] University of Chinese Academy of Sciences, China
[3] University of Science and Technology of China, China
[4] Songshan Lake Materials Laboratory, China

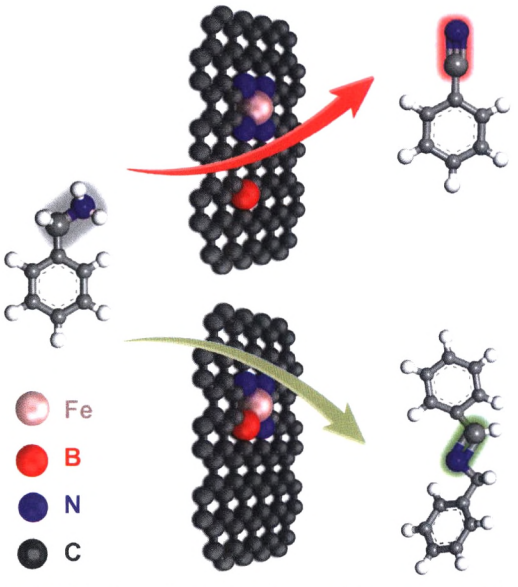


In this letter, we used scanning photoluminescence and Raman spectroscopies to quantify the local strain over few-layer MoS_2 (3–5 ML) bubbles and demonstrated a continuously varying strain distribution, which gives rise to a gradient direct bandgap profile.

Synergy of Fe-N_4 and non-coordinated boron atoms for highly selective oxidation of amine into nitrile

Hong-Hui Wang[1], Li-Bing Lv[1], Shi-Nan Zhang[1], Hui Su[1], Guang-Yao Zhai[1], Wei-Wei Lei[2], Xin-Hao Li[1,*], and Jie-Sheng Chen[1]

[1] Shanghai Jiao Tong University, China
[2] Deakin University, Australia

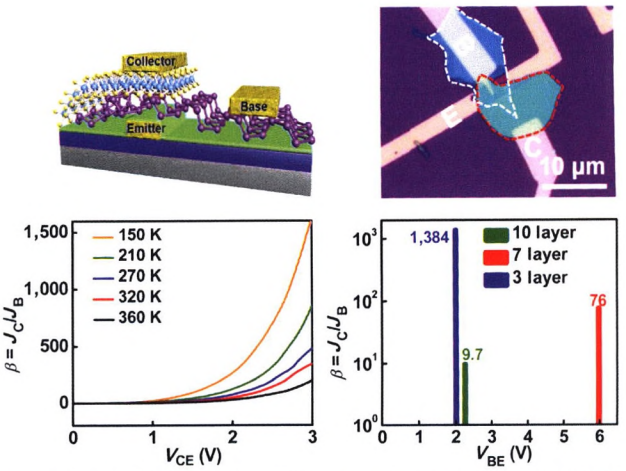


Couples of Fe-N_4 site and non-coordinated boron atom are designed to reduce the energy barrier of the reversible conversion of imines as byproduct in catalytic oxidation reaction of amines, considerably promoting the selectivity to nitriles (> 99.9%) under mild conditions. The optimized FeNC+B also provides a turn-over frequency (TOF) value of 21.6 $mol_{benzonitrile} \cdot mol_{Fe}^{-1} \cdot h^{-1}$ (100 °C), outperforming benchmarked nonnoble-metal-based homogeneous catalyst by a factor of 3.4.

Ultra-high current gain tunneling hot-electron transfer amplifier based on vertical van der Waals heterojunctions

Xu Zhao[1,*], Peng Chen[1,2], Xingqiang Liu[2,*], Guoli Li[2], Xuming Zou[2], Yuan Liu[2], Qilong Wu[2], Yufang Liu[1,*], Woo Jong Yu[3], and Lei Liao[2]

[1] Hunan University, China
[2] Henan Normal University, China
[3] Sungkyunkwan University, Republic of Korea

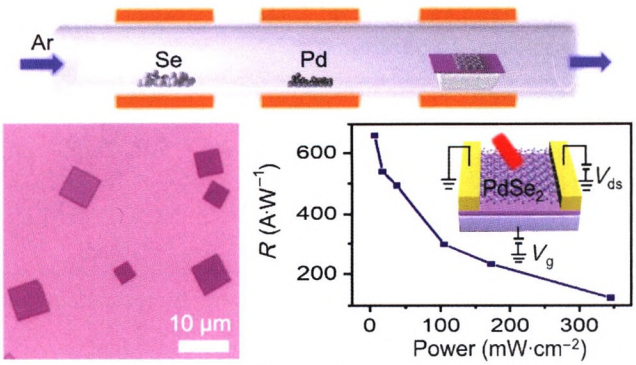


The Au/Al_2O_3/BP/MoS_2 tunneling hot-electron transfer amplifier continuously exhibits a high current on-off ratio of > 10^5, a high current density (J_C) of ~ 1,000 A/cm^2. It demonstrates a record common-emitter current gain of 1,384 with a nanowatt power consumption at room temperature.

Vapor phase growth of two-dimensional $PdSe_2$ nanosheets for high-photoresponsivity near-infrared photodetectors

Weiting Xu, Jiayang Jiang, Huifang Ma, Zhengwei Zhang, Jia Li, Bei Zhao, Ruixia Wu, Xiangdong Yang, Hongmei Zhang, Bailing Li, Weining Shu, Zucheng Zhang, Bo Li*, Yuan Liu, Lei Liao, and Xidong Duan*

Hunan University, China

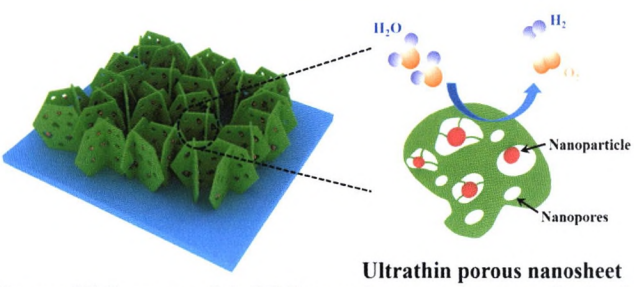


We reported the controllable synthesis of two-dimensional (2D) high-quality $PdSe_2$ nanosheets on SiO_2/Si substrate by chemical vapor deposition (CVD) and fabricated few-layer $PdSe_2$ near-infrared photodetector with high photoresponsivity.

Engineered porous Ni_2P-nanoparticle/Ni_2P-nanosheet arrays via the Kirkendall effect and Ostwald ripening towards efficient overall water splitting

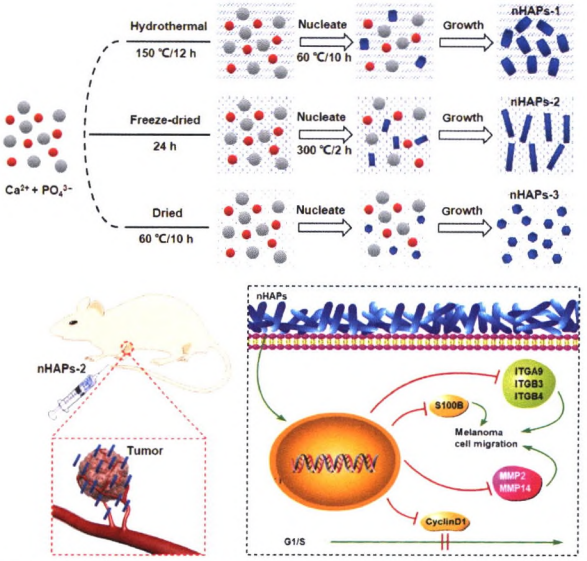
Yutai Wu[1], Hui Wang[1], Shan Ji[2,*], Bruno G. Pollet[3], Xuyun Wang[1], and Rongfang Wang[1,*]

[1] Qingdao University of Science and Technology, China
[2] Jiaxing University, China
[3] Norwegian University of Science and Technology (NTNU), Norway

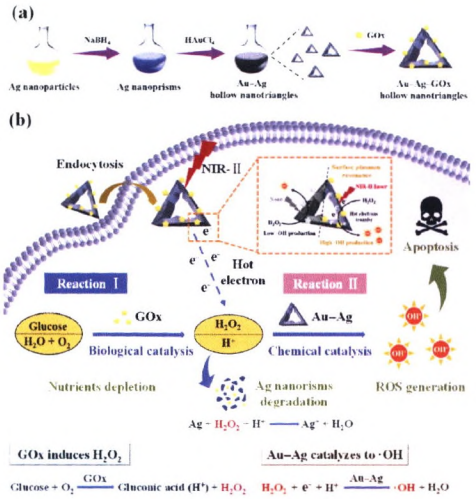


Ultrathin porous nanosheet

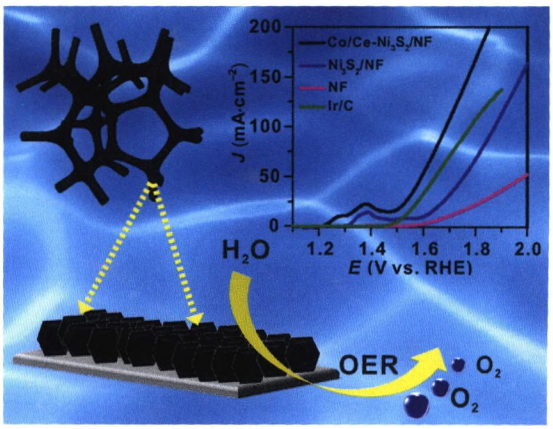
Porous Ni_2P nanoparticle/Ni_2P nanosheet arrays are synthesized. Kirkendall effect and Ostwald ripening result in the structure of Ni_2P arrays. Ni_2P arrays showed high activity for overall water splitting.



Specific nanohydroxyapatite possesses anti-melanoma ability via inhibition of tumor cell migration and cell phase transition.



Bio-breakable nanozymes based on glucose oxidase (GOx) loaded biomimetic Au–Ag hollow nanotriangles (Au–Ag–GOx HTNs) are designed, and they can trigger an NIR-II driven plasmon-enhanced cascade catalytic reaction through regulating tumor microenvironment for highly efficient tumor therapy.

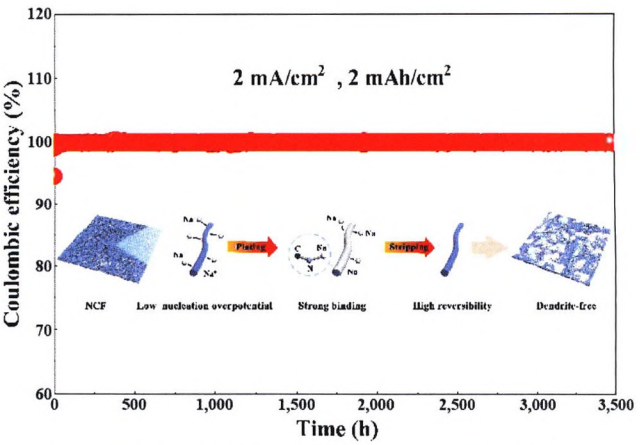


Co and Ce dual-doped Ni_3S_2 nanosheets were fabricated by a one-step solvothermal method, which can act as a highly efficient oxygen evolution reaction (OER) electrode in alkaline condition benefiting from the rational dual-dopant.

3D uniform nitrogen-doped carbon skeleton for ultra-stable sodium metal anode

Ben Liu[1], Danni Lei[2], Jin Wang[1], Qingfei Zhang[1], Yinggan Zhang[1], Wei He[1], Hongfei Zheng[1], Baisheng Sa[3], Qingshui Xie[1], Dong-Liang Peng[1], and Baihua Qu[1,*]

[1] Xiamen University, China
[2] Sun Yat-Sen (Zhongshan) University, China
[3] Fuzhou University, China

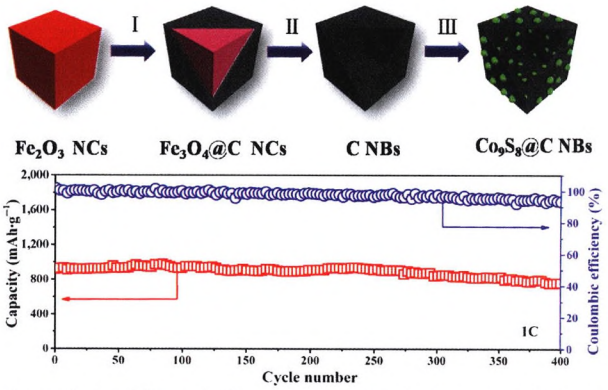


The three-dimensional (3D) nitrogen-doped carbon skeleton has the advantage of low sodium nucleation overpotential and strong nitrogen–carbon bonding on sodium metal anode. It achieves an ultra-stable cycling performance for 3,500 h with 2 mA/cm^2 and 2 mAh/cm^2.

Catalytic Co_9S_8 decorated carbon nanoboxes as efficient cathode host for long-life lithium-sulfur batteries

Weiwei Sun*, Yujie Li , Shuangke Liu, Qingpeng Guo, Yuhao Zhu, Xiaobin Hong, Chunman Zheng*, and Kai Xie

National University of Defense Technology, China

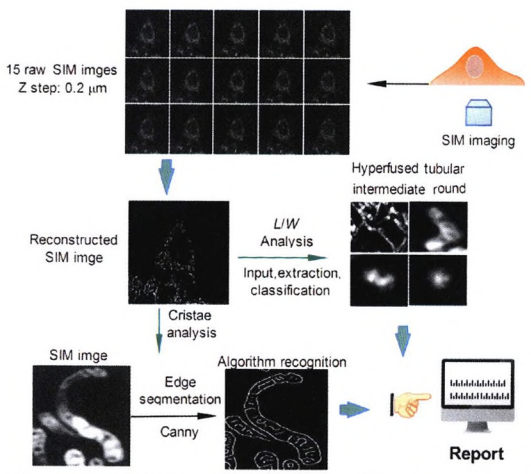


This work describes a facile strategy to synthesize novel Co_9S_8@C nanoboxes (NBs) as effective cathode host for Li-S batteries. Benefiting from their unique structural characteristics, the Co_9S_8@C NBs can not only anchor high content of sulfur and polysulfide intermediates but also enables fast electron/ion transfer and superior redox reaction kinetics. As a result, Li-S batteries based on S/Co_9S_8@C NBs cathode achieve a high reversible capacity, superior rate performances, and a long cycling life.

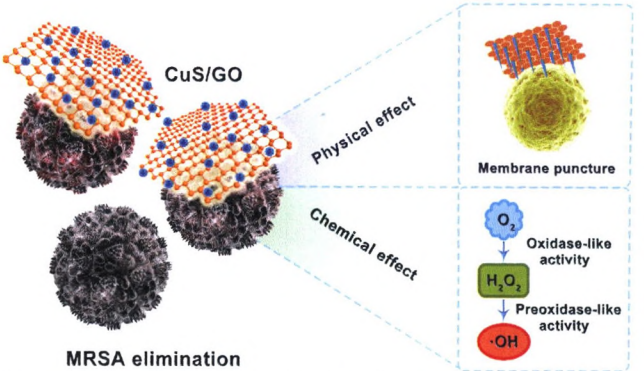
Super-resolution quantification of nanoscale damage to mitochondria in live cells

Xintian Shao[1,2,3], Qixin Chen[4], Lianting Hu[5], Zhiqi Tian[2], Liuyi Liu[6], Fei Liu[1,3], Fengshan Wang[3], Peixue Ling[1,3,*], Zong-Wan Mao[6,*], and Jiajie Diao[2,*]

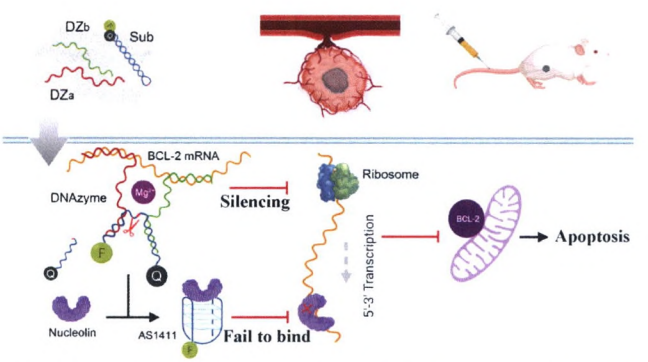
[1] National-Local Joint Engineering Laboratory of Polysaccharide Drugs, China
[2] University of Cincinnati College of Medicine, USA
[3] Shandong University, China
[4] Shandong First Medical University & Shandong Academy of Medical Sciences, China
[5] Wuhan University, China
[6] Sun Yat-Sen University, China



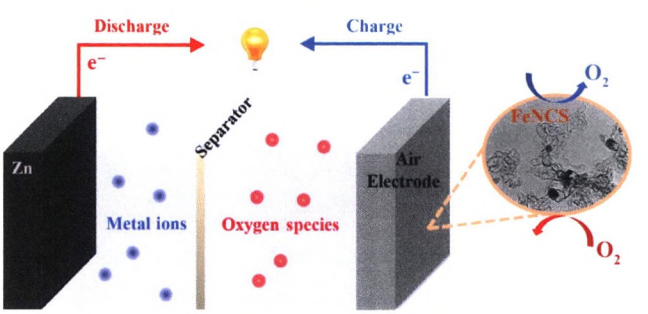
A novel automated super-resolution quantification strategy based on structured illumination microscopy can resolve the distribution of mitochondrial morphology and thus indicate a new direction for evaluating damage to mitochondrial morphology and cristae at the nanoscale level in living cells.



A copper sulfide/graphene oxide (CuS/GO) nanocomposite (NC) was prepared via a facile hydrothermal method. The unique needle-like structure and enzyme-like properties of CuS/GO NC enable efficient elimination of methicillin-resistant *Staphylococcus aureus* (MRSA) infection by acting both physically and chemically to damage bacterial cells.



A smart response DNAzyme-loaded nano-graphene oxide (GO) could silence the gene effectively through a dual-targeted and cascade-enhanced strategy. Our work presents a pure bio-therapeutic strategy that has positive implications for enhancing tumor treatment and avoiding side effects of chemotherapeutics.



The bubble-like Fe-encapsulated N,S co-doped carbon nanofibers possess bifunctional catalytic activities for oxygen reduction and evolution reactions, which is responsible for serving as highly-active electrocatalysts of the air electrodes in rechargeable Zn-air batteries.

Enhanced catalytic degradation of organic pollutants by multi-stimuli activated multiferroic nanoarchitectures

Fajer Mushtaq*, Xiangzhong Chen, Harun Torlakcik, Bradley J. Nelson, and Salvador Pané

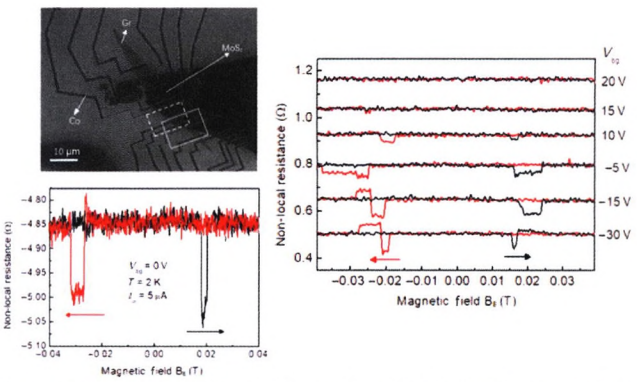
Institute of Robotics and Intelligent Systems (IRIS), Switzerland

Three shapes of core-shell magnetoelectric visible-light active nanocatalysts composed of $CoFe_2O_4$@$BiFeO_3$ were fabricated, i.e., nanooctahedrons, nanocubes, and nanowires. They were all successful in harnessing energy from three different energy sources, including UV–visible (UV–vis) light, mechanical vibrations, and alternating magnetic fields, and initiate a series of redox reactions to destroy organic contaminants. Additionally, our nanocatalysts have the unique ability to readily adapt to changing environments, and scavenge energy from multiple wireless sources, simultaneously, to deliver enhanced water remediation.

Gate controllable spin transistor with semiconducting tunneling barrier

Shuqin Zhang, Renrong Liang*, Xiawa Wang, Wenjie Chen, Weijun Cheng, Jing Wang, and Jun Xu

Tsinghua University, China

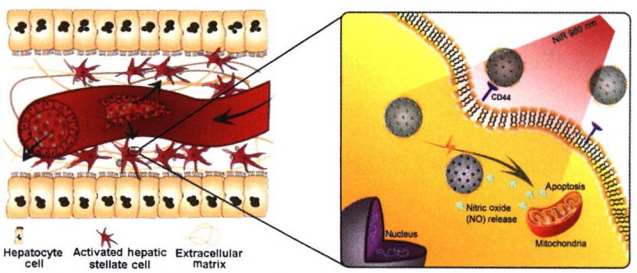


A graphene spin transistor with semiconducting MoS_2 as tunneling barrier is fabricated. It shows gate dependent spin switch signal.

Light-triggered NO-releasing nanoparticles for treating mice with liver fibrosis

Hongxia Liang[1,*], Zhenhua Li[2,3], Zhigang Ren[1], Qiaodi Jia[1], Linna Guo[4], Shasha Li[1], Hongyu Zhang[1], Shiqi Hu[2,3], Dashuai Zhu[2,3], Deliang Shen[1], Zujiang Yu[1,*], and Ke Cheng[2,3,*]

[1] The First Affiliated Hospital of Zhengzhou University, China
[2] North Carolina State University, USA
[3] University of North Carolina at Chapel Hill and North Carolina State University, USA
[4] Zhengzhou University, China

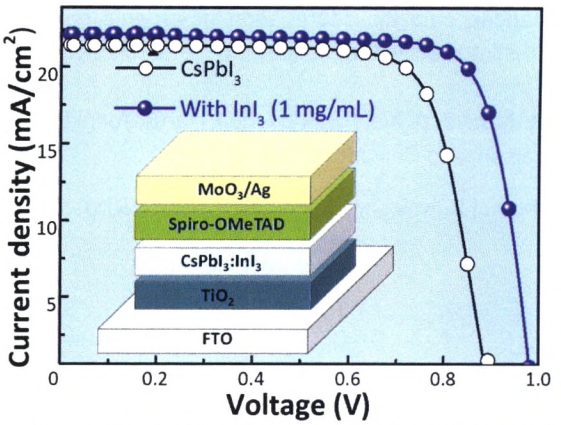


We fabricated a NO-donor-loaded upconversion nanoparticle to target activated hepatic stellate cells and reverse liver fibrosis by inducing hepatic stellate cell apoptosis.

Indium doped $CsPbI_3$ films for inorganic perovskite solar cells with efficiency exceeding 17%

Xiaomei Li[1,2], Kaili Wang[1], Femi Lgbari[1], Chong Dong[1], Wenfan Yang[1], Chang Ma[1], Heng Ma[2], Zhao-Kui Wang[1,*], and Liang-Sheng Liao[1]

[1] Soochow University, China
[2] Henan Normal University, China

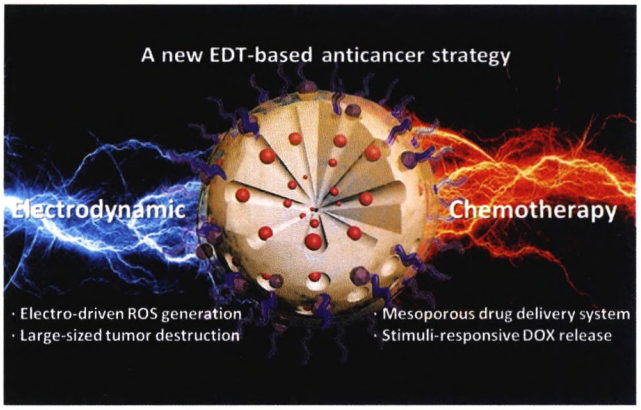


A promising device for high performance and excellent stability in inorganic $CsPbI_3$ perovskite solar cell is demonstrated. The addition of In^{3+} into $CsPbI_3$ films can enter the perovskite crystal lattice and partially replace Pb^{2+}, which could retard the crystallization to form the large grain, free-pinholes, and compact films, resulting in the good charge transport and stability.

Mesoporous silica decorated with platinum nanoparticles for drug delivery and synergistic electrodynamic-chemotherapy

Tongxu Gu[1], Tong Chen[1], Liang Cheng[2], Xiang Li[1,*], Gaorong Han[1], and Zhuang Liu[2,*]

[1] Zhejiang University, China
[2] Soochow University, China

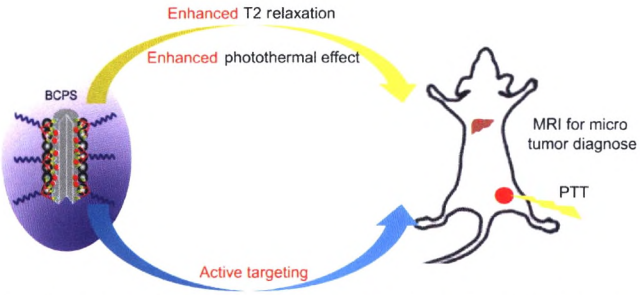


Silica-Dox@Chitosan-Pt (SDCP) nanoparticles are fabricated for electro-driven generation of reactive oxygen species and controllable drug release. This is the first study to combine electrodynamic therapy and chemotherapy for developing a synergetic nanoplatform.

A novel clustered SPIO nanoplatform with enhanced magnetic resonance T2 relaxation rate for micro-tumor detection and photothermal synergistic therapy

Hongwei Lu[1,2], Yongjing Xu[2], Ruirui Qiao[3], Ziwei Lu[4], Pin Wang[5], Xindan Zhang[6], An Chen[1], Liming Zou[2,*], and Zhongling Wang[1,*]

[1] Shanghai Jiaotong University, China
[2] Donghua University, China
[3] Monash University, Australia
[4] The First Affiliated Hospital of Soochow University, China
[5] Affiliated Hospital of Nanjing University Medical School, China
[6] Southern University of Science and Technology, China

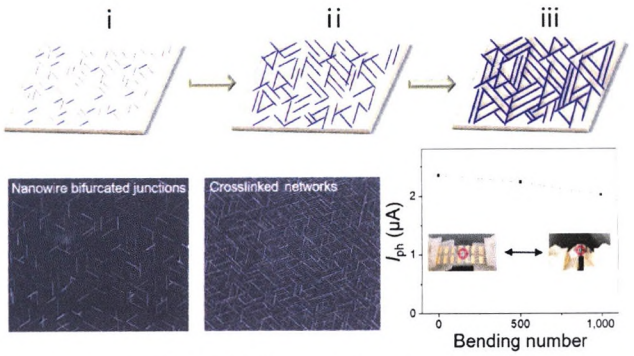


In this nanoplatform, super-paramagnetic iron oxides (SPIOs) were clustered on the surface of carbon nanotubes (CNTs), leading to the enhanced T2 relaxation rate and photothermal effect. What's more, the targeting ability to tumor was introduced with a novel dendrimer (PEG-B4) which was designed for CNTs modification and further strengthened the imaging performances and therapeutic effects.

Controllable growth and flexible optoelectronic devices of regularly-assembled Bi_2S_3 semiconductor nanowire bifurcated junctions and crosslinked networks

Yi Hu[1], Lingyun Mao[1], Xin Yuan[1], Jingyu Lu[1], Renpeng Chen[1], Tao Chen[1], Wenjun Zhang[1], Xiaolan Xue[1], Wen Yan[1], Mohammadreza Shokouhimehr[2], Xiao Li Zhang[3], and Zhong Jin[1,4,*]

[1] Nanjing University, China
[2] Seoul National University, Republic of Korea
[3] Zhengzhou University, China
[4] Shenzhen Research Institute of Nanjing University, China



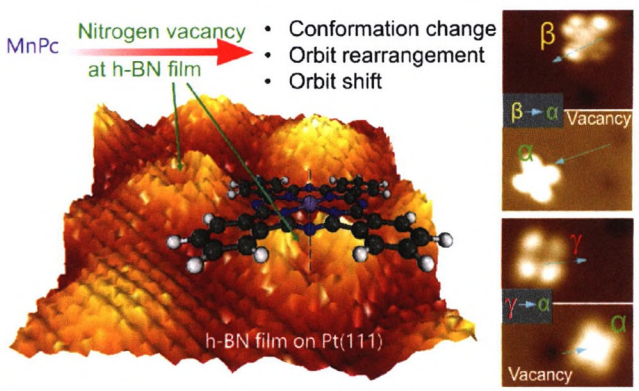
Regularly-assembled Bi_2S_3 nanowire bifurcated junctions and crosslinked networks have been controllably prepared by van der Waals epitaxy growth. The flexible optoelectronic devices are directly fabricated and show high photocurrent retention after bending for over 1,000 times.

2226–2232

Investigating molecular orbitals with submolecular precision on pristine sites and single atomic vacancies of monolayer h-BN

Liwei Liu[1,2,*], Thomas Dienel[2,3], Gino Günzburger[2], Teng Zhang[1], Zeping Huang[1], Cong Wang[4], Roland Widmer[2], Wei Ji[4], Yeliang Wang[1], and Oliver Gröning[2,*]

[1] Beijing Institute of Technology, China
[2] Swiss Federal Laboratories for Materials Science and Technology, Switzerland
[3] Cornell University and NSF-MIP Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM), USA
[4] Renmin University of China, China



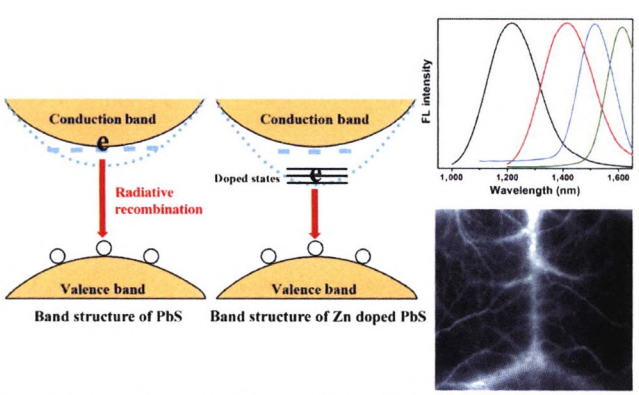
By reversible manipulation of individual MnPc molecules between pristine sites and single atomic vacancies in the h-BN lattice, the conformation and orbitals of the MnPc are tuned with submolecular precision.

2233–2238

Zn-doping enhances the photoluminescence and stability of PbS quantum dots for *in vivo* high-resolution imaging in the NIR-II window

Xiulei Shi[1], Song Chen[1], Meng-Yao Luo[2], Biao Huang[2], Guozhen Zhang[3], Ran Cui[2], and Mingxi Zhang[1,*]

[1] Wuhan University of Technology, China
[2] Wuhan University, China
[3] University of Science and Technology of China, China



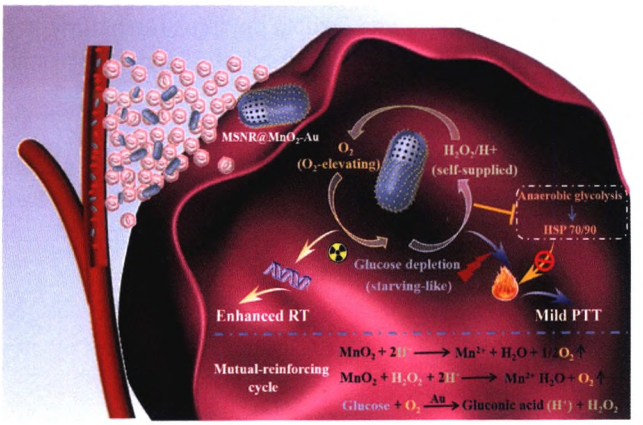
Zn dopants expediently engineer the emission bandgap of host PbS quantum dots with better optical properties for the noninvasive *in vivo* imaging with high-resolution.

2239–2245

Rod-shape inorganic biomimetic mutual-reinforcing MnO_2–Au nanozymes for catalysis-enhanced hypoxic tumor therapy

Lifang Yang[1], Chuchu Ren[1], Min Xu[1], Yilin Song[1], Qianglan Lu[1], Yule Wang[2,3], Yan Zhu[2,3], Xinxing Wang[4,*], and Nan Li[1,*]

[1] Tianjin University, China
[2] Tianjin University of Traditional Chinese Medicine, China
[3] Tianjin International Joint Academy of Biotechnology and Medicine, China
[4] Tianjin Institute of Environmental and Operational Medicine, China

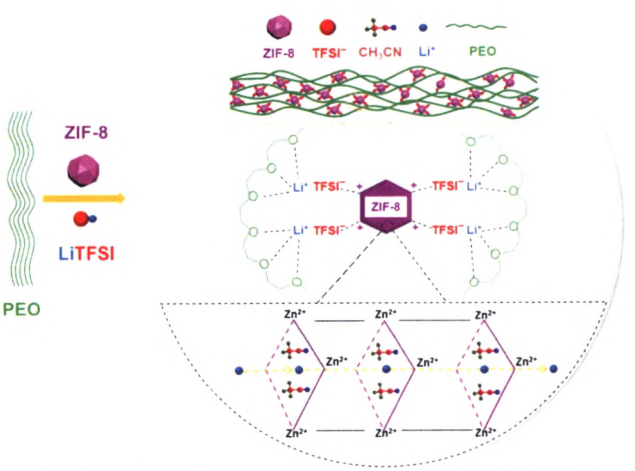


The rod-like biomimetic hybrid inorganic nanozymes linked mutually reinforcing cycle, through which effectively enhanced radiation therapy (RT) effect and starvation-promoted mild photothermal therapy were achieved by accelerated O_2 generation, acute glucose consuming induced downregulation expression of heat shock protein (HSP) against the hypoxic environment.

Exploring porous zeolitic imidazolate frame work-8 (ZIF-8) as an efficient filler for high-performance poly(ethyleneoxide)-based solid polymer electrolytes

Zhiwen Lei[1], Jinlai Shen[1], Weide Zhang[1], Qingrong Wang[2], Jun Wang[2,*], Yonghong Deng[2,*], and Chaoyang Wang[1,*]

[1] South China University of Technology, China
[2] Southern University of Science and Technology, China

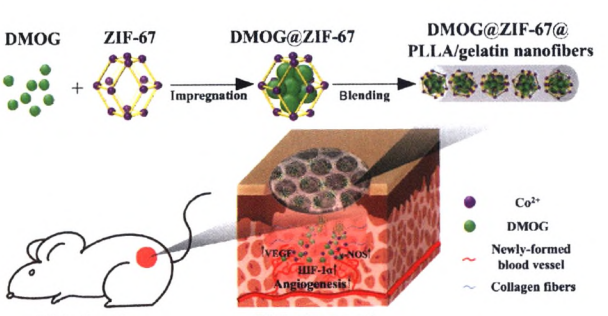


Zeolitic imidazolate frame work-8 (ZIF-8) filled poly (ethyleneoxide) (PEO) solid polymer electrolyte exhibits improved ionic conductivity as well as lithium ion transference number.

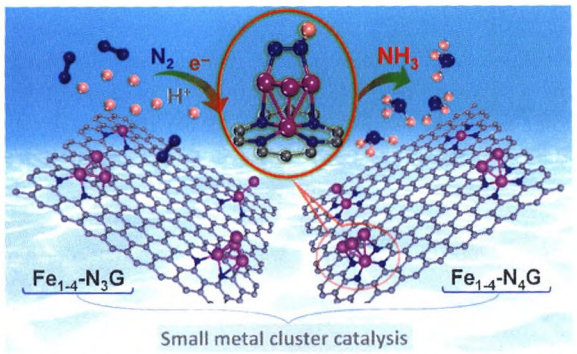
Cobalt-based metal–organic framework as a dual cooperative controllable release system for accelerating diabetic wound healing

Jiankai Li[1], Fang Lv[2,4], Jinxiu Li[1], Yuxin Li[2], Jingduo Gao[2], Jian Luo[2], Feng Xue[4,*], Qinfei Ke[1,3,*], and He Xu[1,*]

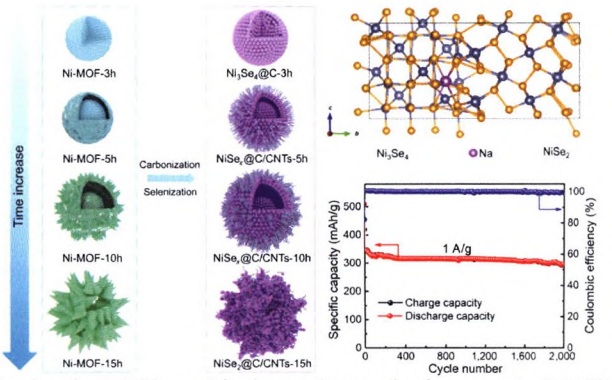
[1] Shanghai Normal University, China
[2] East China Normal University, China
[3] Shanghai Institute of Technology, China
[4] Southern Medical University Affiliated Fengxian Hospital, China



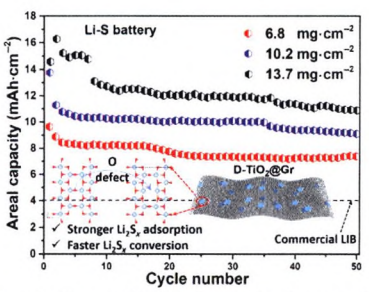
A cobalt-based metal-organic framework (ZIF-67) was introduced as carrier for loading a pro-angiogenic small molecular drug (dimethyloxalylglycine, DMOG) and a dual cooperative controllable release system has been designed by incorporating the drug-loaded ZIF-67 nanoparticles into the micro-patterned poly ($_L$-lactic acid) (PLLA)/gelatin nanofibrous scaffolds to achieve a long-term angiogenic therapy on the diabetic wound beds, which provided a new strategy for promoting diabetic wound healing.



We studied the nitrogen reduction reaction (NRR) on small iron clusters supported by N-doped graphene (–N_xG) and found Fe_4-N_4G exhibits the most prominent NRR performance among the studied clusters, shedding light on size-dependent synergistic effect of active sites for such metal cluster catalysts.



We developed hierarchical metal-organic framework (MOF)-derived carbonaceous nickel selenides with bi-phase composition, which demonstrates highly enhanced sodium storage capability at 1 A/g for 2,000 cycles. The phase boundary engineering is conducive to fabricate novel composites/hybrids for applications in batteries, catalysis, sensors, and environmental remediation.



Density functional theory (DFT) is applied to profoundly reveal the functional mechanism of defects for lithium-sulfur battery based on oxygen defective TiO_2, and the DFT calculations show that oxygen defects boost polysulfides immobilization and reaction kinetics. Furthermore, a high-performance sulfur host combining the defective TiO_2 and three-dimensional graphene is designed, which achieves a high areal capacity of 14.6 mAh·cm^{-2}.

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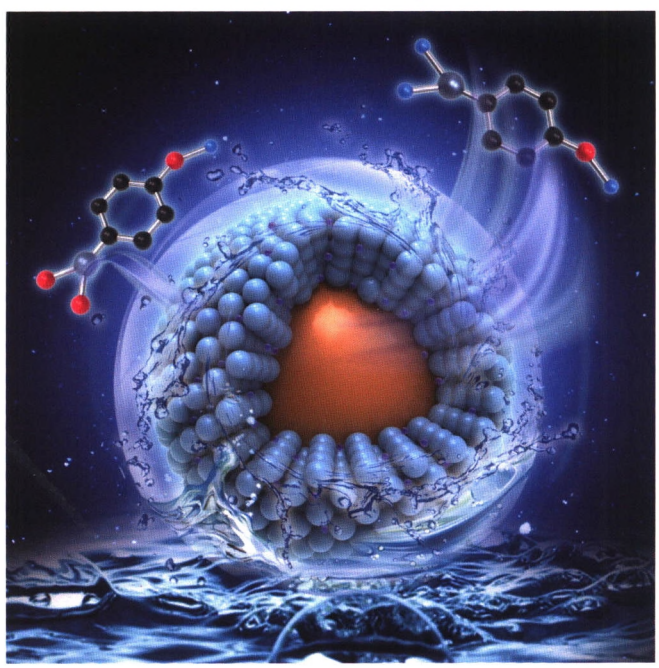

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