

Nano Research

November · 2019

Volume 12 · Number 11



Q K 2 0 2 0 8 5 3

A review on synthesis of graphene, h-BN and MoS₂ for energy storage applications:
Recent progress and perspectives

Valleytronics in transition metal dichalcogenides materials

Low-temperature epitaxy of transferable high-quality Pd(111) films on hybrid graphene/Cu(111) substrate



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Review Articles

A review on synthesis of graphene, h-BN and MoS₂ for energy storage applications: Recent progress and perspectives

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² Indian Institute of Technology (ISM), India

³ Centre for Information Technology Renato Archer (CTI), Brazil

⁴ Central University of Himachal Pradesh (CUHP), India

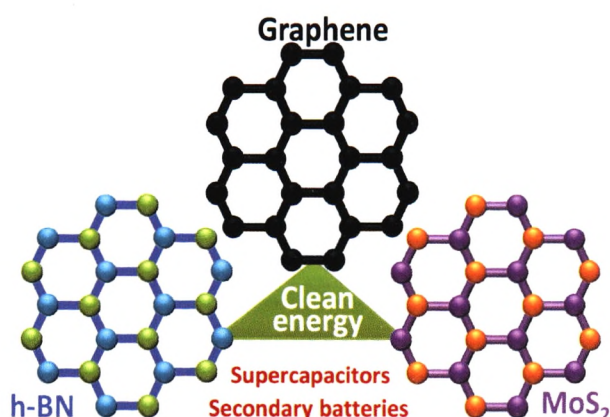
⁵ VSSD College, India

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⁸ Instituto de Ciencia de Materiales de Barcelona, Consejo Superior de Investigaciones Científicas (ICMAB-CSIC), Spain

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Owing to unique structures and properties, two-dimensional (2D) layered materials have exhibited great potentials for energy storage applications. This review article contains synthesis of graphene, hexagonal boron nitride (h-BN) and molybdenum disulphide (MoS₂) and detailed discussion about their application in supercapacitor and secondary batteries.

2655–2694

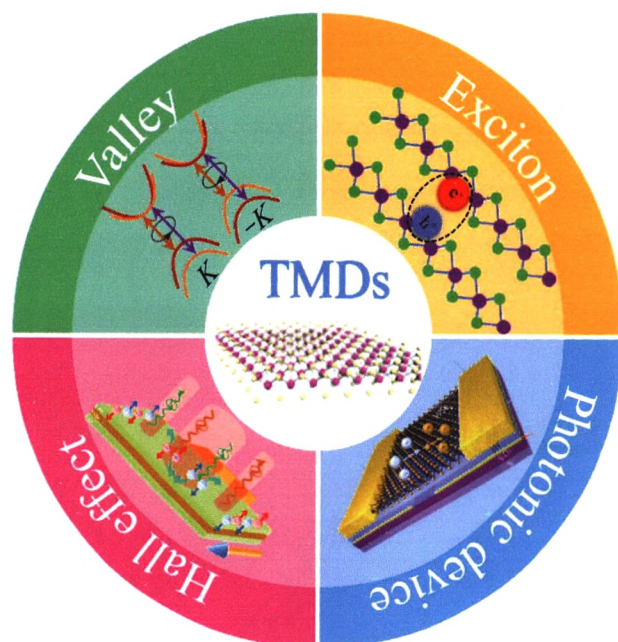
Valleytronics in transition metal dichalcogenides materials

Yanping Liu^{1,*}, Yuanji Gao¹, Siyu Zhang¹, Jun He¹, Juan Yu^{1,2}, and Zongwen Liu^{3,*}

¹ Central South University, China

² Hangzhou Dianzi University, China

³ The University of Sydney, Australia



The emerging transition metal dichalcogenide materials provide a significant research platform for valleytronics. Novel physical effects contribute to the realization of valleytronic devices.

2695–2711

Research Articles

Low-temperature epitaxy of transferable high-quality Pd(111) films on hybrid graphene/Cu(111) substrate

Zhihong Zhang^{1,2}, Xiaozhi Xu^{1,3}, Ruixi Qiao¹, Junjiang Liu¹, Yuxia Feng¹, Zhibin Zhang¹, Peizhao Song¹, Muhong Wu^{1,4}, Lan Zhu⁵, Xuelin Yang¹, Peng Gao¹, Lei Liu¹, Jie Xiong⁶, Enge Wang^{1,2,4}, and Kaihui Liu^{1,*}

¹ Peking University, China

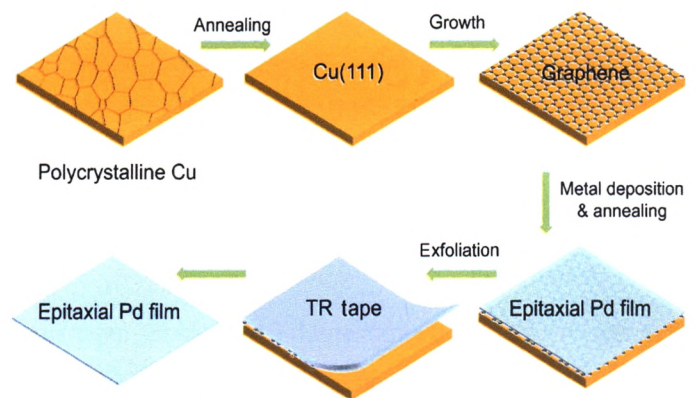
² Huairou National Comprehensive Science Centre, China

³ South China Normal University, China

⁴ Institute of Physics, Chinese Academy of Sciences, China

⁵ Peking Union Medical College Hospital, China

⁶ University of Electronic Science and Technology of China, China



Low-temperature epitaxy of transferable high-quality Pd(111) films is realized on hybrid single-crystal graphene/Cu(111), which can be obtained from commercial polycrystalline Cu foil. This facile production method can be widely applicable to epitaxially grow other metal films, like Au and Ag films.

2712-2717

Au-catalysed free-standing wurtzite structured InAs nanosheets grown by molecular beam epitaxy

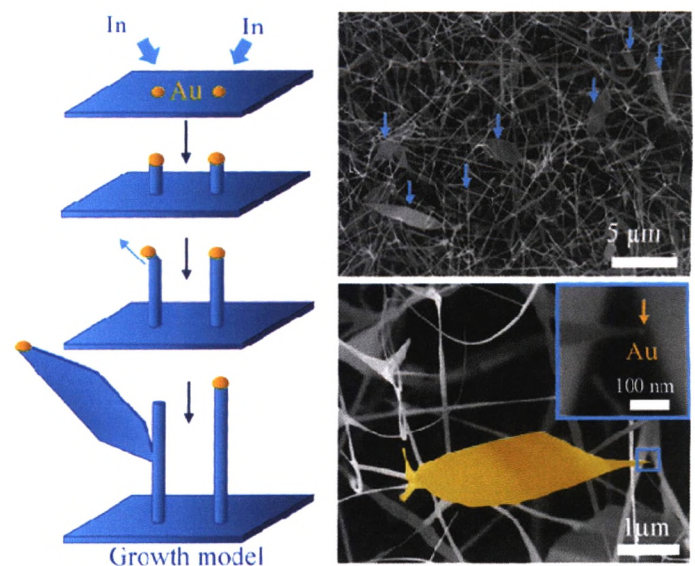
Qiang Sun¹, Han Gao¹, Xiaomei Yao^{1,2,3}, Kun Zheng⁴, Pingping Chen², Wei Lu², and Jin Zou^{1,*}

¹ The University of Queensland, Australia

²Shanghai Institute of Technical Physics, Chinese Academy of Sciences, China

³University of Chinese Academy of Sciences, China

⁴Beijing University of Technology, China



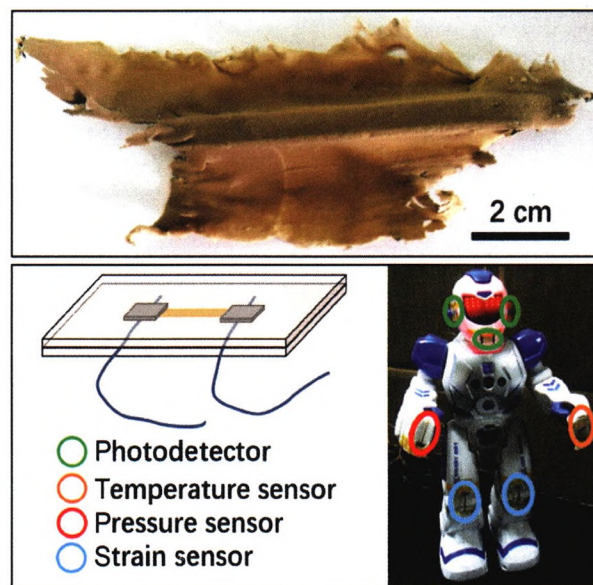
Freestanding wurtzite structured InAs nanosheets have been grown using Au catalysts in molecular beam epitaxy (MBE).

2718–2722

One-step growth of large-area silicon nanowire fabrics for high-performance multifunctional wearable sensors

Bing-Chang Zhang, Jian-Sheng Jie*, Zhi-Bin Shao, Si-Yi Huang, Le He*, and Xiao-Hong Zhang*

Soochow University, China



One-step growth of large-area silicon nanowire fabrics is achieved through a massive metal-assisted chemical vapor deposition method. In addition to intrinsic electronic properties of Si materials, the silicon nanowire fabrics also feature high flexibility, good tailorability and light weight, rendering them ideal for fabricating high-performance multifunctional wearable sensors to detect temperature, light, strain and pressure.

2723–2728

Self-powered electrochemical system by combining Fenton reaction and active chlorine generation for organic contaminant treatment

Yawei Feng^{1,2}, Kai Han^{1,2}, Tao Jiang^{1,2}, Zhenfeng Bian³, Xi Liang^{1,2}, Xia Cao^{1,2,*}, Hexing Li^{4,*}, and Zhong Lin Wang^{1,2,5,*}

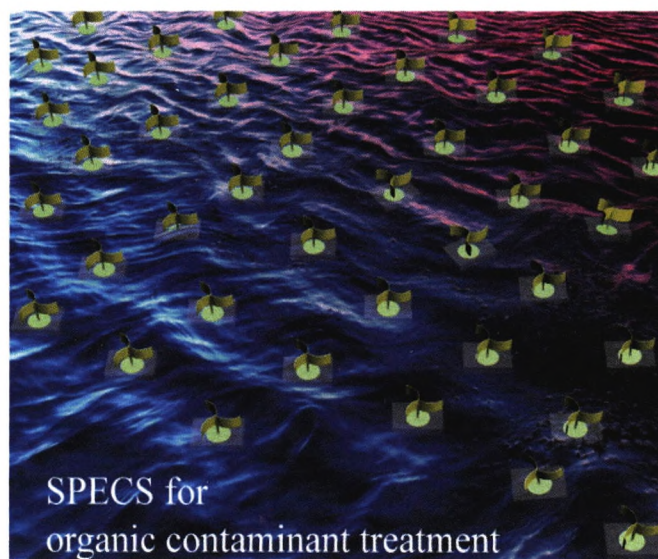
¹ Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, China

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³ Shanghai Normal University, China

⁴ Shanghai University of Electric Power, China

⁵ Georgia Institute of Technology, USA



A self-powered electrochemical system (SPECS) is constructed by integrating a rotary triboelectric nanogenerator with an electrochemical cell for hydrogen peroxide, hydroxyl radical and active chlorine generation. Under the drive of mechanical energy or wind flow, such SPECS can efficiently degrade organic contaminant.

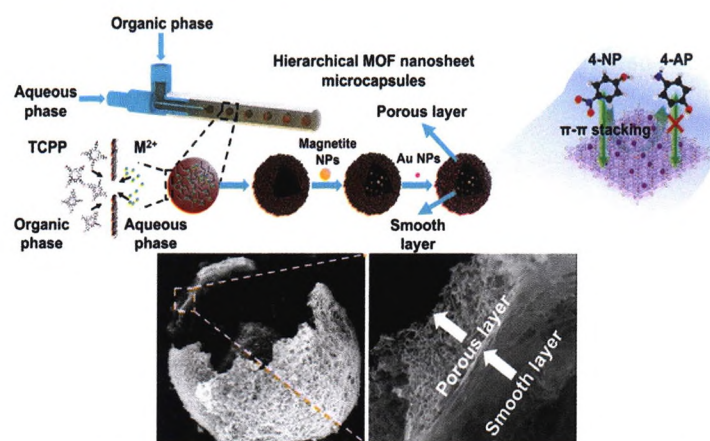
2729–2735

High-throughput droplet microfluidic synthesis of hierarchical metal–organic framework nanosheet microcapsules

Songting Wu¹, Zhong Xin¹, Shicheng Zhao^{1,*}, and Shengtong Sun^{2,*}

¹ East China University of Science and Technology, China

² Donghua University, China



With a high-throughput droplet microfluidic method, hierarchical metal–organic framework (MOF) nanosheet microcapsules can be prepared, which exhibit enhanced catalytic activity through introducing functional nanoparticles.

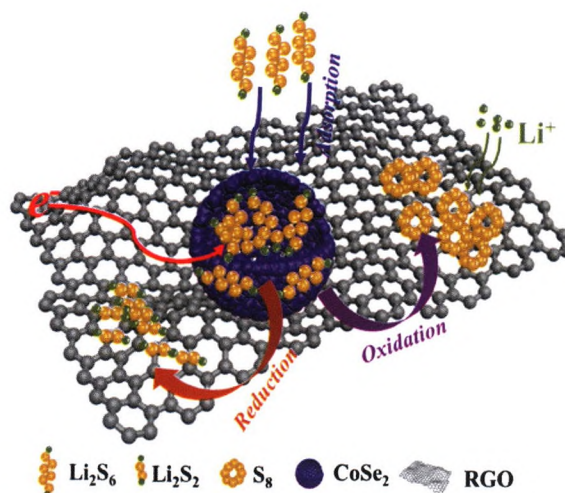
2736–2742

Decorating CoSe₂ hollow nanospheres on reduced graphene oxide as advanced sulfur host material for performance enhanced lithium-sulfur batteries

Liang Chen^{1,2,*}, Weiwei Yang², Jianguo Liu², and Yong Zhou²

¹ Changsha University, China

² Nanjing University, China



RGO embellished with CoSe₂ hollow nanospheres was developed to serve as sulfur host material for advance lithium-sulfur (Li-S) batteries. Benefitting from the excellent chemical absorption and catalysis properties, CoSe₂ hollow nanospheres effectively prevent the diffusion and accelerate the conversion of lithium polysulfides.

2743–2748

Enhanced CH₄ selectivity in CO₂ photocatalytic reduction over carbon quantum dots decorated and oxygen doping g-C₃N₄

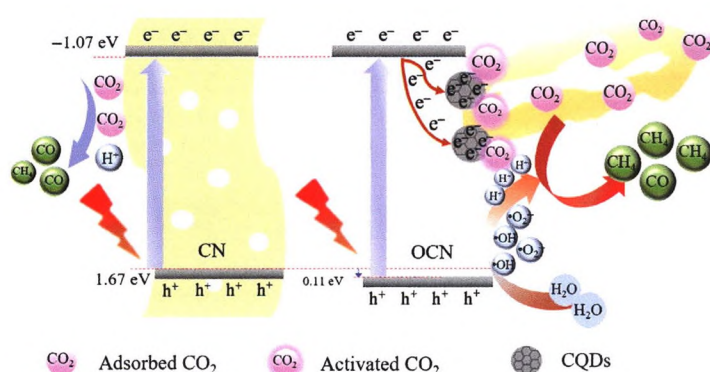
Qian Li^{1,2}, Songcan Wang³, Zhuxing Sun⁴, Qijun Tang^{1,2}, Yiqiu Liu^{1,2}, Lianzhou Wang^{3,*}, Haiqiang Wang^{1,2,*}, and Zhongbiao Wu^{1,2}

¹ Zhejiang University, China

² Zhejiang Provincial Engineering Research Center of Industrial Boiler and Furnace Flue Gas Pollution Control, China

³ The University of Queensland, Australia

⁴ Shanghai Jiao Tong University, China



With carbon quantum dots (CQDs) accelerating charge transfer, promoting CO₂ activation and oxygen doping facilitating the dissociation of H₂O to provide more H⁺, excellent CH₄ production and selectivity in CO₂ photocatalytic reduction was obtained over CQDs and oxygen doping co-modified graphitic carbon nitride (g-C₃N₄, CN) (CQDs/OCN).

2749–2759

Special interstitial route can transport nanoparticles to the brain bypassing the blood-brain barrier

Nan Hu^{1,2,3}, Xiaoli Shi^{1,2,*}, Qiang Zhang^{1,2}, Wentao Liu^{1,2}, Yuting Zhu^{1,2}, Yuqing Wang^{1,2}, Yi Hou⁴, Yinglu Ji¹, Yupeng Cao^{1,2}, Qian Zeng^{1,2}, Zhuo Ao^{1,2}, Quanmei Sun^{1,2}, Xiaohan Zhou^{1,2}, Xiaochun Wu¹, and Dong Han^{1,2,*}

¹ National Center for Nanoscience and Technology, China

² University of Chinese Academy of Sciences, China

³ Chengde Medical University, China

⁴ Institute of Chemistry, Chinese Academy of Sciences, China



After directly injected 10 nm golden nanoparticles (AuNPs) into the tarsal tunnel interstitial architecture of rats, AuNPs can be delivered to the brain bypassing the blood-brain barrier (BBB). With NaGdF₄ NPs as agents, the magnetic resonance imaging (MRI) results displayed that the agents exited in the perivascular interstitial space of carotid arteries and brain vessels and demonstrated that the transportation to the brain was not through the blood circulation, but based on the interstitial architecture and interstitial stream. This kind of transportation exists throughout the whole body no matter in physiological or pathological status, which is the pathway not only connecting but also with high efficiency.

2760–2765

Wavy PtCu alloy nanowire networks with abundant surface defects enhanced oxygen reduction reaction

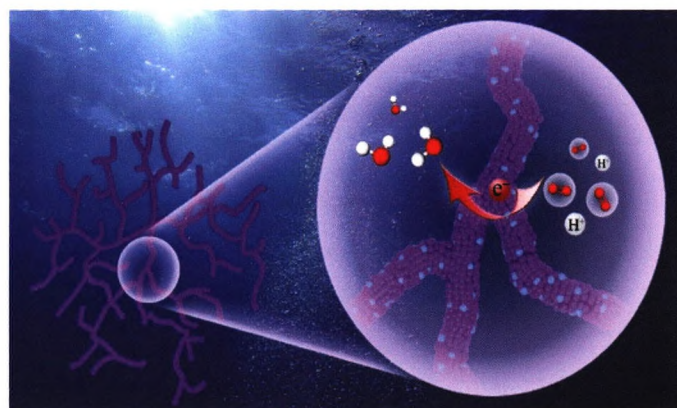
Dahui Fang^{1,2}, Lei Wan³, Qike Jiang¹, Hongjie Zhang¹, Xuejun Tang^{1,2}, Xiaoping Qin¹, Zhigang Shao^{1,*}, and Zidong Wei^{4,*}

¹ Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China

² University of Chinese Academy of Sciences, China

³ Tsinghua University, China

⁴ Chongqing University, China



PtCu alloy nanowire networks (NWNs) with 2.4 nm ultrathin wavy nanowires and plentiful surface defects are fabricated by a modified polyol method accompanied by a salt-mediated self-assembly process in a water/ethylene glycol mixing media. The PtCu_{NWNs}/C presents superior activity and durability over most of the recently reported Pt-based nanowire ORR electrocatalysts.

2766–2773

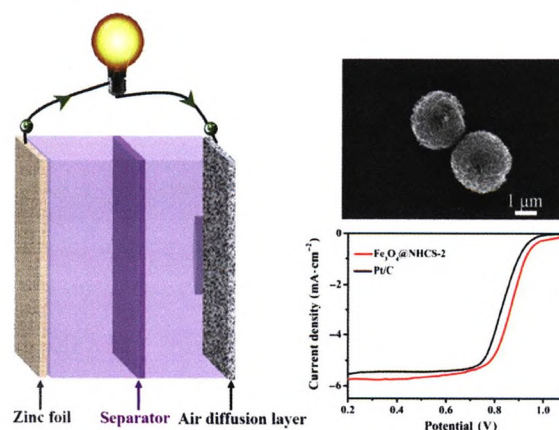
2D nanoplate assembled nitrogen doped hollow carbon sphere decorated with Fe₃O₄ as an efficient electrocatalyst for oxygen reduction reaction and Zn-air batteries

Yanqiang Li^{1,*}, Huiyong Huang¹, Siru Chen^{3,*}, Xin Yu¹, Chao Wang¹, and Tingli Ma^{2,*}

¹ Dalian University of Technology, China

² Kyushu Institute of Technology, Japan

³ Zhongyuan University of Technology, China



Two-dimensional (2D) nanoplate assembled nitrogen doped hollow carbon sphere encapsulated with Fe₃O₄ nanoparticle is synthesized and the catalyst exhibits highly oxygen reduction reaction electrocatalytic activity for Zn-air batteries.

2774–2780

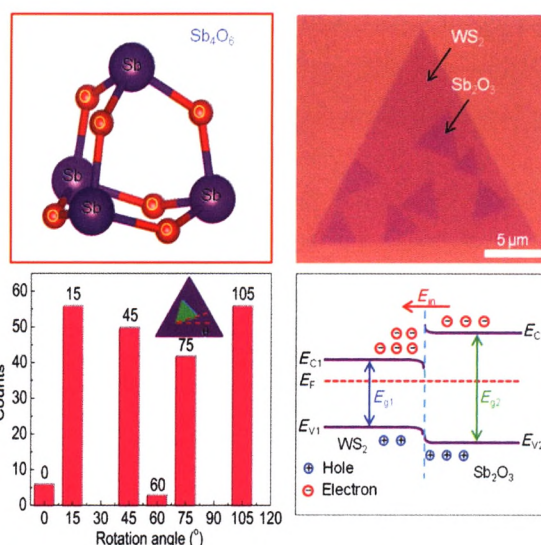
Selective growth of wide band gap atomically thin Sb_2O_3 inorganic molecular crystal on WS_2

Guangzhuang Sun¹, Bo Li¹, Shifa Wang², Zhengwei Zhang¹, Jia Li¹, Xidong Duan^{1,*}, and Xiangfeng Duan³

¹ Hunan University, China

² Chongqing Three Gorges University, China

³ University of California, Los Angeles, USA



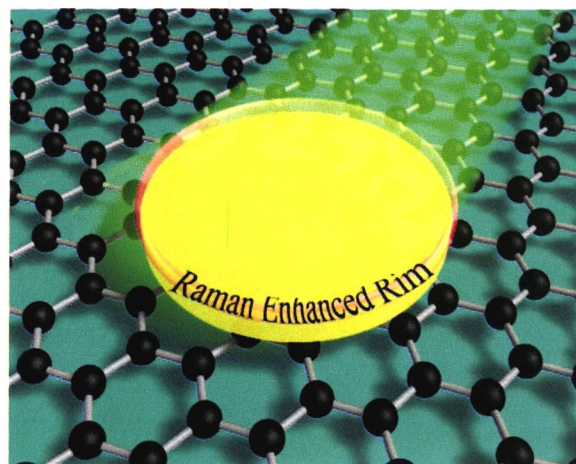
In this study, we synthesized $\text{Sb}_2\text{O}_3/\text{WS}_2$ heterostructures by direct vapor phase epitaxy and further studied the electrical and optoelectronic performance.

2781–2787

Large-scale highly ordered periodic Au nano-discs/graphene and graphene/Au nanoholes plasmonic substrates for surface-enhanced Raman scattering

Yansheng Liu and Feng Luo*

Ciudad Universitaria de Cantoblanco, Spain



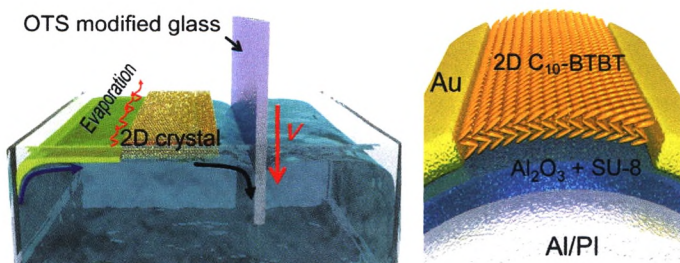
Periodic graphene/Au NDs and Au NHs/graphene plasmon structure have been fabricated through a cost-efficient way. The SERS performances of these substrate have been studied and the Raman mappings reveal the hot-spots region which related to electric field.

2788–2795

External-force-driven solution epitaxy of large-area 2D organic single crystals for high-performance field-effect transistors

Jinwen Wang, Wei Deng, Wei Wang, Ruofei Jia, Xiuzhen Xu, Yanling Xiao, Xiujuan Zhang, Jiansheng Jie*, and Xiaohong Zhang*

Soochow University, China



An external-force-driven solution epitaxy (EFDSE) method is developed for large-area growth of two-dimensional organic single crystals (2DOSCs) on water surface. Flexible organic field-effect transistors (OFETs) based on the 2,7-didecylbenzothienobenzothiophene ($\text{C}_{10}\text{-BTBT}$) 2DOSCs also show excellent bending stability.

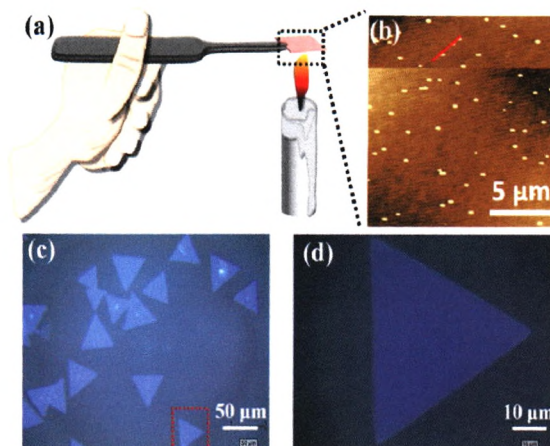
2796–2801

Carbon-nanoparticle-assisted growth of high quality bilayer WS₂ by atmospheric pressure chemical vapor deposition

Jieyuan Liang¹, Lijie Zhang^{1,*}, Xiaoxiao Li¹, Baojun Pan¹, Tingyan Luo¹, Dayan Liu¹, Chao Zou¹, Nannan Liu¹, Yue Hu¹, Keqin Yang¹, and Shaoming Huang^{2,*}

¹ Wenzhou University, China

² Guangdong University of Technology, China



Thickness-dependent optical and electronic properties of WS₂ imply the importance of layer-number-controlled fabrication. In this work, a carbon-nanoparticle-assisted chemical vapor deposition (CVD) was developed to obtain bilayer WS₂ domains on sapphire substrates.

2802–2807

Butterfly-wing hierarchical metallic glassy nanostructure for surface enhanced Raman scattering

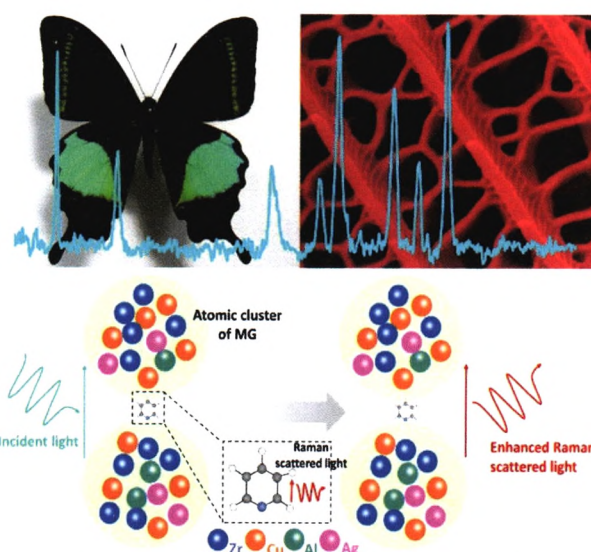
Hongyu Jiang^{1,2}, Jing Li³, Chengrong Cao¹, Xiaozhi Liu^{1,2}, Ming Liu^{1,2}, Yutian Shen^{1,2}, Yanhui Liu^{1,4}, Qinghua Zhang^{1,4}, Weihua Wang^{1,2,4}, Lin Gu^{1,2,4,*}, and Baoan Sun^{1,2,4,*}

¹ Institute of Physics, Chinese Academy of Sciences, China

² University of Chinese Academy of Sciences, China

³ Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China

⁴ Songshan Lake Materials Laboratory, China



The metallic glassy nanostructure replicating the structure of biomaterials displays an excellent surface enhanced Raman scattering effect, rendering them as a new potential surface-enhanced Raman scattering material with low cost and good durability and well extending the application of this kind of material.

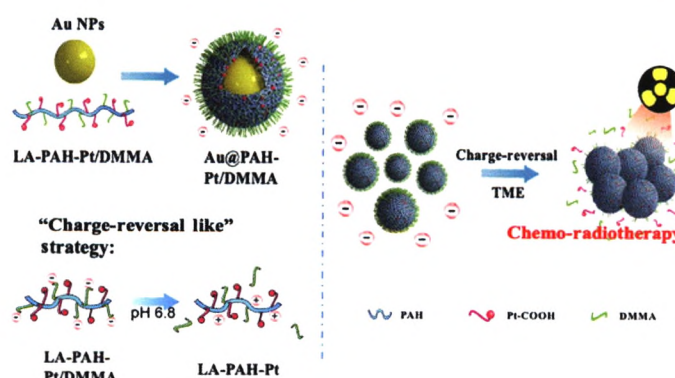
2808–2814

Dual pH-responsive “charge-reversal like” gold nanoparticles to enhance tumor retention for chemo-radiotherapy

Xiaolei Zhang¹, Chuangnian Zhang², Mingbo Cheng¹, Yahui Zhang¹, Wei Wang¹, and Zhi Yuan^{1,*}

¹ Nankai University, China

² Chinese Academy of Medical Science & Peking Union Medical College, China



A “charge-reversal like” strategy was utilized to realize irreversible stable aggregation and pH-specific release of cisplatin prodrug in tumor micro-environment (TME). And the intelligent dual pH-responsive self-aggregating nano gold system (Au@PAH-Pt/DMMA) can achieve good chemo-radiotherapy effect.

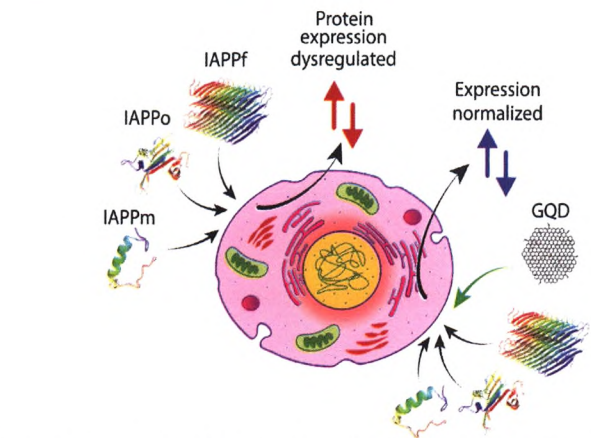
2815–2826

Graphene quantum dots rescue protein dysregulation of pancreatic β -cells exposed to human islet amyloid polypeptide

Ava Faridi¹, Yunxiang Sun^{2,3}, Monika Mortimer⁴, Ritchlynn R. Aranha¹, Aparna Nandakumar¹, Yuhuan Li¹, Ibrahim Javed¹, Aleksandr Kakinen¹, Qingqing Fan¹, Anthony W. Purcell¹, Thomas P. Davis^{1,5,*}, Feng Ding^{3,*}, Pouya Faridi^{1,*}, and Pu Chun Ke^{1,*}

- ¹ Monash University, Australia
- ² Ningbo University, China
- ³ Clemson University, USA
- ⁴ China Jiliang University, China
- ⁵ The University of Queensland, Australia

2827–2834



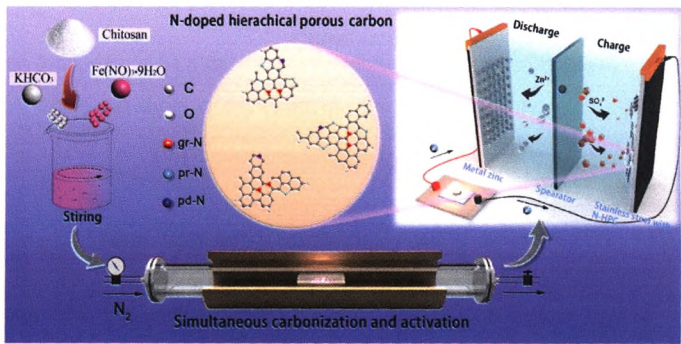
Exposure to monomeric and aggregating human islet amyloid polypeptide induced differential dysregulation of protein expression in pancreatic β -cells, which was effectively mitigated by two-dimensional graphene quantum dots.

Rational design of nitrogen doped hierarchical porous carbon for optimized zinc-ion hybrid supercapacitors

Penggao Liu¹, Yang Gao², Yangyang Tan³, Weifang Liu¹, Yanping Huang¹, Jun Yan^{1,*}, and Kaiyu Liu^{1,*}

- ¹ Central South University, China
- ² Xinjiang University, China
- ³ Fuzhou University, China

2835–2841

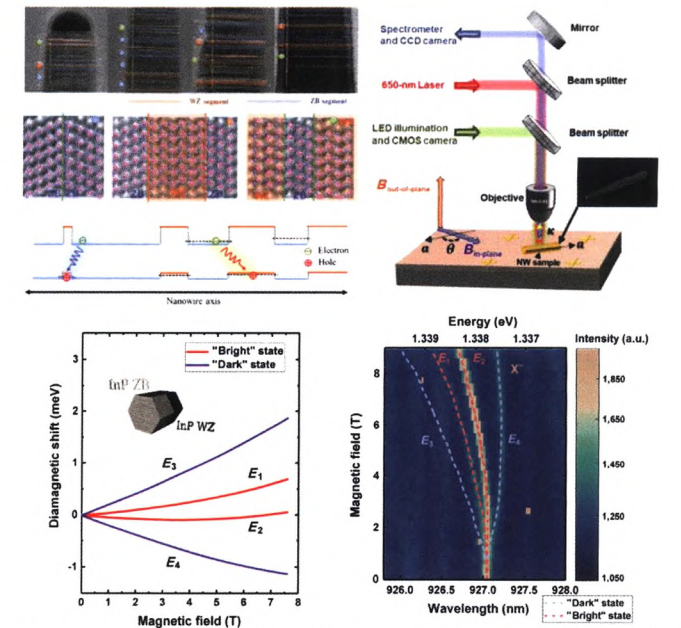


A nitrogen doped hierarchical porous carbon is evaluated as the cathode for aqueous rechargeable zinc-ion hybrid supercapacitors. Benefiting from the synergistic merits of excellent structural features of N-HPC and tiny zinc dendrite of Zn anode in ZnSO_4 electrolyte, the zinc-ion hybrid supercapacitor exhibits excellent energy storage performance.

Anisotropies of the g-factor tensor and diamagnetic coefficient in crystal-phase quantum dots in InP nanowires

Shiyao Wu^{1,2}, Kai Peng^{1,2}, Sergio Battiato³, Valentina Zannier³, Andrea Bertoni⁴, Guido Goldoni^{4,5}, Xin Xie^{1,2}, Jingnan Yang^{1,2}, Shan Xiao^{1,2}, Chenjiang Qian^{1,2}, Feilong Song^{1,2}, Sibai Sun^{1,2}, Jianchen Dang^{1,2}, Yang Yu^{1,2}, Fabio Beltram³, Lucia Sorba³, Ang Li⁶, Bei-bei Li¹, Francesco Rossella³, and Xiulai Xu^{1,2,7,*}

- ¹ Institute of Physics, Chinese Academy of Sciences, China
- ² University of Chinese Academy of Sciences, China
- ³ Scuola Normale Superiore and Istituto Nanoscienze-CNR, Italy
- ⁴ Istituto Nanoscienze-CNR, Italy
- ⁵ Universit  degli Studi di Modena e Reggio Emilia, Italy
- ⁶ Beijing University of Technology, China
- ⁷ Songshan Lake Materials Laboratory, China



Crystal-phase quantum dots (QDs) in nanowires, as an emerging confined system, show great potential for new quantum photonic device. In this work, we report and discuss the anisotropy of the g-factor tensor and diamagnetic coefficient in crystal-phase QDs realized in single InP NWs, promoting the crystal-phase QDs for applications in spin-based quantum information processing.

2842–2848

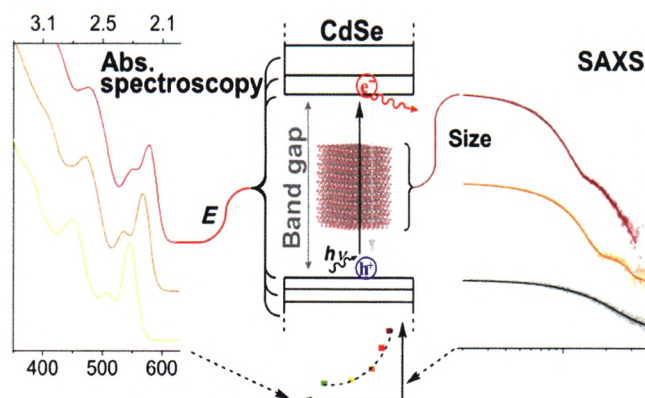
Dimensional characterization of cadmium selenide nanocrystals via indirect Fourier transform evaluation of small-angle X-ray scattering data

Julian Cedric Porsiel^{1,2}, Bilal Temel¹, Alfred Schirmacher², Egbert Buhr^{2,3}, and Georg Garnweitner^{1,3,*}

¹ Technische Universität Braunschweig, Germany

² Physikalisch-Technische Bundesanstalt Braunschweig, Germany

³ Technische Universität Braunschweig, Germany



The size dependent optical properties of semiconductor nanocrystals enable the establishment of sizing curves for their fast and accurate characterization. Small-angle X-ray scattering allows the analysis of large quantities and provides statistically firm volume weighted data with high accuracy.

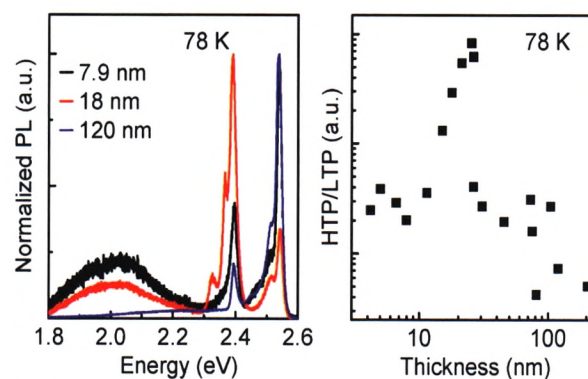
2849–2857

Surface depletion field in 2D perovskite microplates: Structural phase transition, quantum confinement and Stark effect

Wancai Li¹, Chen Fang¹, Haizhen Wang², Shuai Wang¹, Junze Li¹, Jiaqi Ma¹, Jun Wang¹, Hongmei Luo^{2,*}, and Dehui Li^{1,*}

¹ Huazhong University of Science and Technology, China

² New Mexico State University, USA



We report on how the surface depletion field affects the structural phase transition, quantum confinement and Stark effect in two-dimensional (2D) (BA)₂PbI₄ perovskite microplates by the thickness-, temperature- and power-dependent photoluminescence (PL) spectroscopy.

2858–2865

PdAg bimetallic electrocatalyst for highly selective reduction of CO₂ with low COOH* formation energy and facile CO desorption

Rui Lin¹, Xuelu Ma², Weng-Chon Cheong¹, Chao Zhang¹, Wei Zhu³, Jiajing Pei³, Kaiyue Zhang⁴, Bin Wang⁵, Shiyu Liang¹, Yuxi Liu⁴, Zhongbin Zhuang³, Rong Yu¹, Hai Xiao^{1,*}, Jun Li¹, Dingsheng Wang¹, Qing Peng¹, Chen Chen^{1,*}, and Yadong Li¹

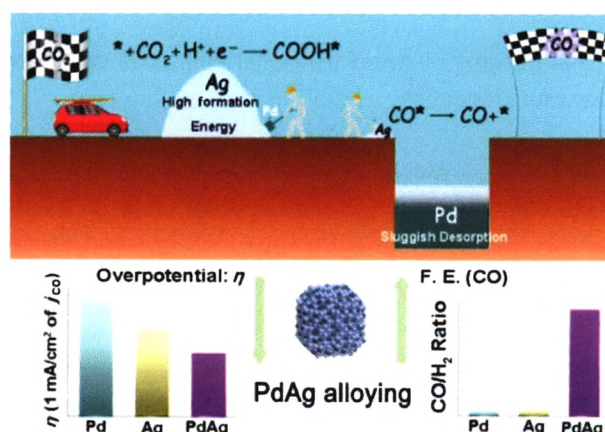
¹ Tsinghua University, China

² China University of Mining & Technology, China

³ Beijing University of Chemical Technology, China

⁴ Beijing University of Technology, China

⁵ Sinopec Beijing Research Institute of Chemical Industry, China



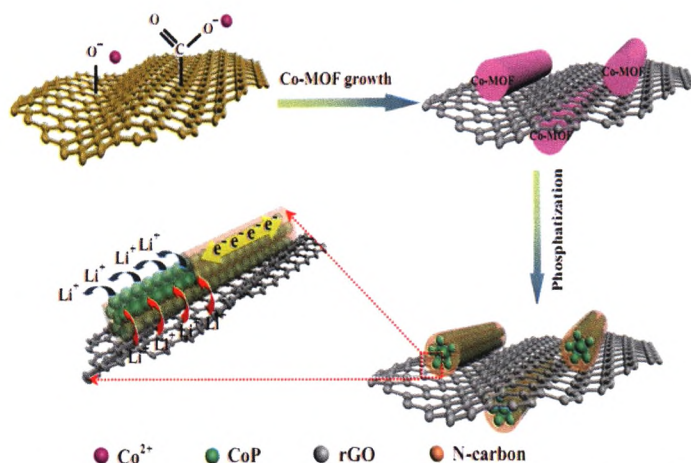
PdAg shows lower overpotential and higher CO selectivity than sole Ag and sole Pd in CO₂RR. The higher activity originates from the lower formation energy of COOH* and facile CO desorption on PdAg.

2866–2871

Reduced graphene oxide-supported CoP nanocrystals confined in porous nitrogen-doped carbon nanowire for highly enhanced lithium/sodium storage and hydrogen evolution reaction

Xiaojun Zhao, Dan Luo, Yan Wang, and Zhi-Hong Liu*

Shaanxi Normal University, China



The design of micro-/nanostructured hybrids of reduced graphene oxide-supported ultrafine CoP confined in porous nitrogen-doped carbon nanowire as 3D hierarchically ordered electrode exhibits improved electrochemical properties in Li-ion batteries (LIBs), Na-ion batteries (NIBs), and hydrogen evolution reaction (HER).

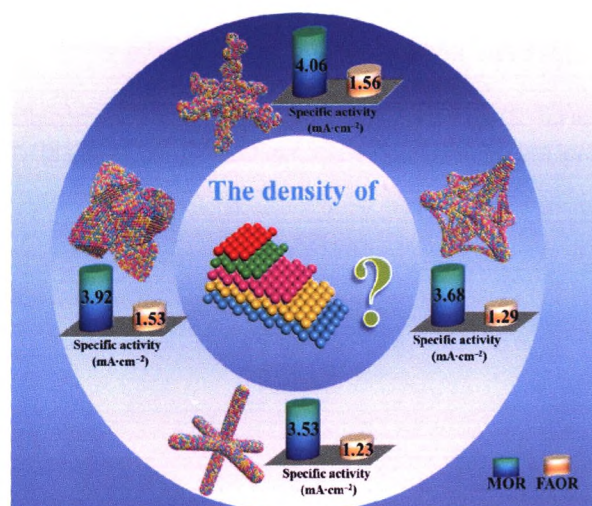
2872–2880

Defect-density control of platinum-based nanoframes with high-index facets for enhanced electrochemical properties

Shaohan Yang¹, Shuna Li¹, Lianghao Song¹, Yipin Lv^{1,*}, Zhongyao Duan¹, Chunsheng Li¹, Raphael Francesco Praeg², Daowei Gao^{1,2,*}, and Guozhu Chen^{1,*}

¹ University of Jinan, China

² Helmholtz Zentrum Berlin für Materialien und Energie GmbH, Germany



A series of three-dimensional (3D) PtCuCo trimetallic nanoframes with tunable density of defects and high-index facets have been fabricated by altering the sequential reduction kinetics in one-pot microwave-assisted wet-chemical method, which exhibit enhanced activity and durability towards the electro-oxidation reactions of methanol and formic acid.

2881–2888

Real time imaging of two-dimensional iron oxide spherulite nanostructure formation

Wenjing Zheng^{1,2}, Matthew R. Hauwiler^{2,3}, Wen-I Liang^{2,4}, Colin Ophus², Peter Ercius², Emory M. Chan², Ying-Hao Chu⁴, Mark Asta^{2,3}, Xiwen Du^{1,*}, A. Paul Alivisatos^{2,3,5}, and Haimei Zheng^{2,3,*}

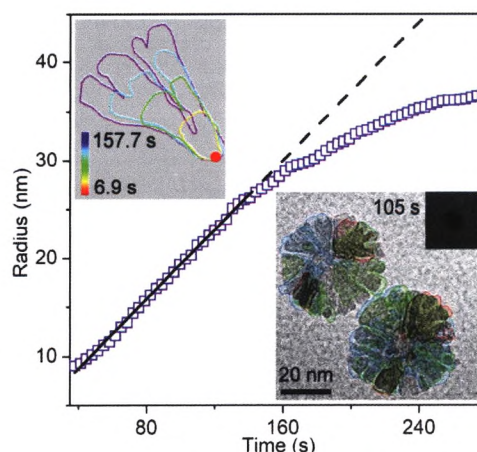
¹ Tianjin University, China

² Lawrence Berkeley National Laboratory, USA

³ University of California, Berkeley, USA

⁴ “National Chiao Tung University”, Taiwan, China

⁵ University of California-Berkeley and Lawrence Berkeley National Laboratory, USA



Through real time observation of the two-dimensional (2D) iron oxide spherulite nanostructure formation in a liquid cell using transmission electron microscopy (TEM), it is possible to reveal the atomic level details of growth, including the tip splitting, reaction front and crystallization pathways, and uncover the mechanisms of linear growth at the early stage transitioning to nonlinear growth at the later stage.

2889–2893

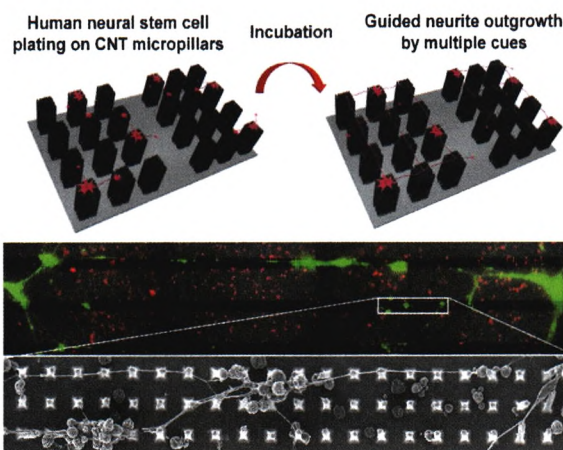
Carbon nanotube micropillars trigger guided growth of complex human neural stem cells networks

Gabriela S. Lorite^{1,*}, Laura Ylä-Outinen², Lauriane Janssen¹, Olli Pitkänen¹, Tiina Joki², Janne T. Koivisto², Minna Kellomäki², Robert Vajtai³, Susanna Narkilahti², and Krisztian Kordas¹

¹ University of Oulu, Finland

² Tampere University, Finland

³ Rice University, USA



The construction of a three-dimensional (3D) environment mimicking the physical and biochemical cues of natural extracellular matrix is the key to control neural cell growth and functionality. Direct guidance of human neurite outgrowth is achieved by using 3D carbon nanotube micropillared templates, which provide multiple cues such as nanotopographical features, stiffness, conductivity and biochemistry.

2894–2899

A DNA origami plasmonic sensor with environment-independent read-out

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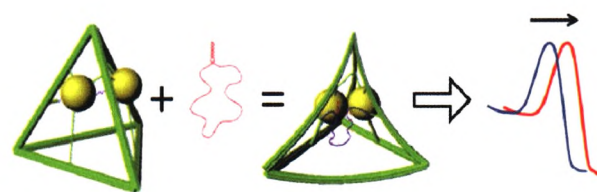
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Probe-target interaction

LSPR shift

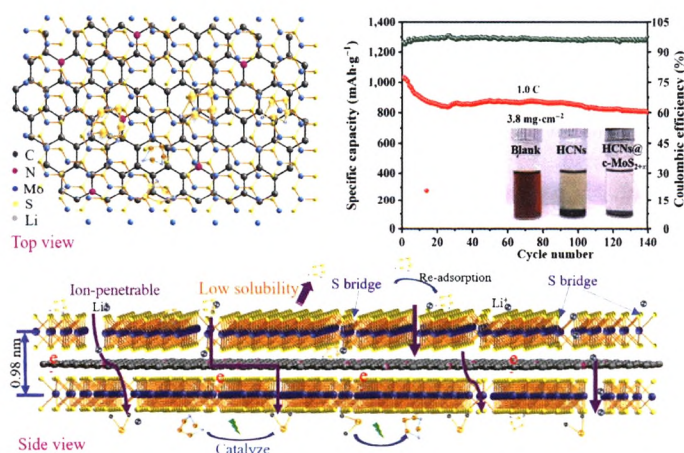
The tetragonal DNA-origami/gold-nanoparticle hybrid structure is able to change its configuration, which is transduced in a change of its plasmonic properties, upon interaction with a specific DNA target. We investigated its response when analyzed in three different media: aqueous solution, solid support and viscous gel.

2900–2907

Carbon confinement synthesis of interlayer-expanded and sulfurenriched MoS_{2+x} nanocoating on hollow carbon spheres for advanced Li-S batteries

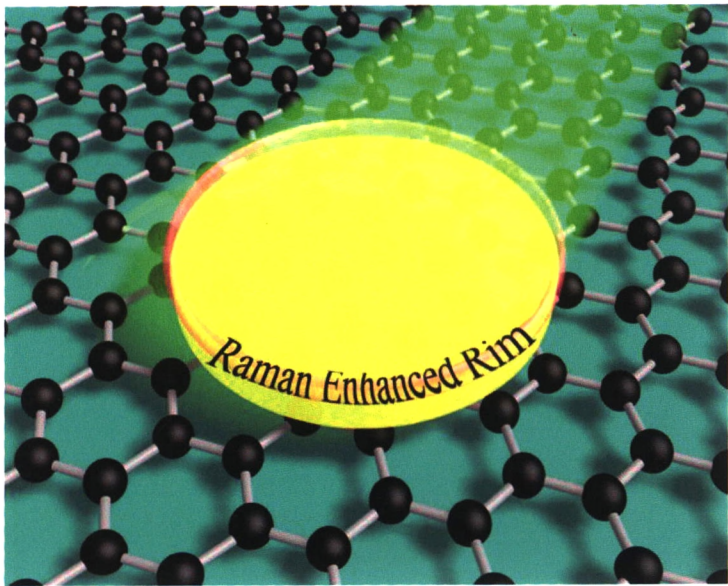
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The nanoscale defect and interlayer engineering are first time applied in Li-S batteries system. The interlayer-expanded and sulfur enriched MoS_{2+x} nanosheets not only have strong affinity to the soluble lithium polysulfides but also accelerate effectively polysulfides conversion kinetics and re-utilization.

2908–2917



纳米研究(英文版)(月刊, 2008年创刊) 第12卷 第11期 2019年11月出版

Editors-in-Chief Hongjie Dai, Yadong Li

Sponsored by Tsinghua University & Chinese Chemical Society

Edited by Nano Research Editorial Office

Published by Tsinghua University Press

Address Xueyan Building,
Tsinghua University,
Beijing 100084, China

Website www.theNanoResearch.com & www.springer.com/journal/12274

Online Manuscript Submission, Review and Tracking System www.editorialmanager.com/nare

主管单位 中华人民共和国教育部

主办单位 清华大学

中国化学会

主 编 戴宏杰 李亚栋

编 辑 《纳米研究》编辑部

出版发行 清华大学出版社有限公司

印刷单位 北京地大彩印有限公司

ISSN 1998-0124

