中国 · 南京
2019年11月29日–12月01日
Nanjing, China
NOV 29-DEC 01, 2019

南京大学–Wiley国际联合会议
微结构材料与应用

NJU-Wiley Joint Conference on Microstructured Materials and Advanced Applications

PROGRAM

Nanjing,Jiangsu
China
NJU
NOV 29-DEC 01 2019

电子程序册
Scan the QR code for the electronic program

现场照片直播
Scan the QR code for the event photos

Nanjing,Jiangsu

China

NJU

NOV 29-DEC 01 2019

南京大学-Wiley国际联合会议

微结构材料与应用

NJU-Wiley Joint Conference on Microstructured Materials and Advanced Applications

PROGRAM

SPONSORED BY

南京大学 NANJING UNIVERSITY

WILEY

LAFM

双一流学科专项引导经费

国际化示范学院推进计划

TABLE OF CONTENTS

CONFERENCE INTRODUCTION

Ordered structures with functional units has been adopted as a paradigm of materials design. The advancement of microstructured materials has granted the materials community unprecedented capability to synthesize or construct new materials/structures that exhibit properties not usually found in nature, therefore enabling new phenomena, techniques and applications.

This NJU-Wiley Joint Conference aims to provide a platform to scientists from the fields of microstructured materials for reporting new findings, exchanging new ideas, and inspiring new concepts and designs.

Plenary Speakers

Prof. Ji Zhou *Tsinghua University*
Prof. Sang Il Seok *Ulsan National Institute of Science and Technology*
Prof. Tiejun Cui *Southeast University*
Prof. Yong Cao *South China University of Technology*
Prof. Yongjun Tian *Yanshan University*
Prof. Yuri Kivshar *The Australian National University*

Invited Speakers

Prof. Daoxin Dai *Zhejiang University*
Prof. Dehui Deng *Dalian Institute of Chemical Physics, CAS*
Prof. Dongsheng Liu *Tsinghua University*
Prof. Etienne Brasselet *University of Bordeaux*
Prof. Fei Xu *Nanjing University*
Prof. Gengfeng Zheng *Fudan University*
Prof. Ghimwei Ho *National University of Singapore*
Prof. Hiroyuki Yoshida *Osaka University*
Prof. Hong Lu *Nanjing University*
Prof. Hui Wei *Nanjing University*
Prof. Jiang Tang *Huazhong University of Science and Technology*
Prof. Jiangli Fan *Dalian University of Technology*
Prof. Jingbi You *Institute of Semiconductors,CAS*
Prof. Jinzhi Du *South China University of Technology*
Prof. Lei Zhou *Fudan University*
Prof. Lin Zhou *Nanjing University*
Prof. Liwei Chen *Suzhou Institute of Nano-Tech and Nano-Bionics, CAS*
Prof. Michael Chen *University of Edinburgh*
Prof. Min Qiu *Westlake University*
Prof. Mingwei Zhu *Nanjing University*
Prof. Peng Wang *Nanjing University*
Prof. Ping He *Nanjing University*
Prof. Qiang Zhang *Tsinghua University*
Prof. Qiangbin Wang *Suzhou Institute of Nano-Tech and Nano-Bionics, CAS*
Prof. Tao Li *Nanjing University*
Prof. Tierui Zhang *Technical Institute of Physics and Chemistry, CAS*
Prof. Ting Xu *Nanjing University*
Prof. Vitali Goussev *Le Mans Université*
Prof. Weihua Zhang *Nanjing University*
Prof. Wenqing Zhang *Southern University of Science and Technology*
Prof. Wenzhong Shen *Shanghai Jiao tong University*
Prof. Xu Zhen *Nanjing University*
Prof. Xuebin Wang *Nanjing University*
Prof. Yanglong Hou *Peking University*
Prof. Yanyi Huang *Peking University*
Prof. Ye Tian *Nanjing University*
Prof. Yitao Long *Nanjing University*
Prof. Yizheng Jin *Zhejiang University*
Prof. Yong Jiang *Nanjing University*
Prof. Yong Zhang *Nanjing University*
Prof. Yuefeng Nie *Nanjing University*
Prof. Zhenda Lu *Nanjing University*
Prof. Zheng Hu *Nanjing University*
Prof. Zhong Jin *Nanjing University*

COMMITTEE

Chair

Prof.
Shining Zhu

Co-Chairs

Prof.
Yanfeng Chen

Prof.
Yan-Qing Lu

Dr.
Guangchen Xu
(Wiley)

Scientific Committee

Prof. Min Xiao
Prof. Shining Zhu
Prof. Shuming Nie
Prof. Yanfeng Chen
Prof. Zhigang Zou
Prof. Zijian Guo

Organizing Committee

Prof. Di Wu
Prof. Hui Wei
Prof. Jia Zhu
Dr. Lu Shi (Wiley)
Prof. Tao Zhang
Prof. Ting Xu
Prof. Wei Hu
Prof. Zhenda Lu

SCOPE

- Artificial Functional Materials and Engineering
- Optical Metamaterials and Advanced Applications
- Advanced Healthcare Science and Engineering
- Energy Conversion and Storage

CONFERENCE VENUE / HOTEL & LOGISTICS

Conference Venue

NUICC
南大国际会议中心

Nanjing University International Conference Center (NUICC)

Address: Nanjing University International Conference Center 163 Xianlin Avenue, Nanjing, PRC

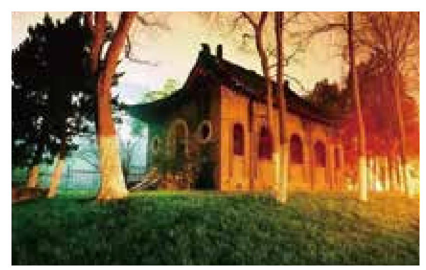
Tel: 86-25-8968 6666
Post Code: 210046

Location:
The hotel is located in the northeast of the city.
- Distance from the airport (Km): 60
- Distance from the South Nanjing railway station (Km): 30
- Distance from the Nanjing railway station (Km): 20
- Distance to downtown (Km): 25

Introduction to Nanjing

Nanjing, an ancient capital of China, located in the downstream Yangtze River drainage basin and Yangtze River Delta economic zone, enjoys a worldwide reputation for its history and culture. It has achieved its fame as "an ancient capital of ten dynasties" in the past years. Nanjing has also served as a national hub of education, research, transportation and tourism throughout history, as well as an important commercial center in the East China region.

Nanjing is decorated by the majestic scenery intertwined with many cultural antiquities. To the east is Mt. Zhongshan, also called Zijin (Purple Golden) Shan Scenic Area. To the west of the mountain is the enthralling Mt. Qixia. The great Yangtze River traverses the northern part of the city and the spectacular scenery is best viewed from the railway & highway Bridge. Nanjing is also appealing for the blend of modern and classical offerings. One unique bustling area in Nanjing is Qin Huai River, cultivated some well-known talented and patriotic heroines at the turning point of the former dynasties. The well-trodden Confucius Temple is located beside the river. The most famous handicrafts in Nanjing are Yunjin Brocade and Yuhua Stone.



PROGRAM & SPEAKERS

November 29, 2019 (Friday)

On-site Registration

Time	(1st Floor – ZIJIN HALL) 一楼紫金厅
14:00-14:15	**Opening Ceremony** *Welcome speech by Shining Zhu, Conference Chair* *Welcome speech by Yan-Qing Lu, Vice President of NJU* *Welcome speech by Guangchen Xu, Wiley & Conference Co-Chair*
14:15-14:45	**Plenary Talk 1** – *Recent progress in printable polymer solar cells - materials, devices engineering and processing*– **Yong Cao (South China University of Technology)**
14:45-15:15	**Plenary Talk 2** – *Metaphotonics and metasurfaces governed by Mie resonances*– **Yuri Kivshar (Australian National University)**
15:15-15:45	**Plenary Talk 3** – *The Rise and Evolution of Perovskite Solar Cells*– **Sang Il Seok (Ulsan National Institute of Science and Technology)**
15:45-16:00	Group Photo
16:00-16:30	Coffee Break & Poster Session

Time	Parallel session A (1st Floor – ZIJIN HALL) 一楼紫金厅	Parallel session B (2nd Floor – ZHONGDA LECTURE HALL) 二楼中大厅
16:30-16:50	**Invited Talk A1** – *Functional Scanning Force Microscopy for Energy Nano Devices* – **Liwei Chen (Suzhou Institute of Nano-Tech and Nano-Bionics, CAS)**	**Invited Talk B1** – *The Frame Guided Assembly*– **Dongsheng Liu (Tsinghua University)**
16:50-17:10	**Invited Talk A2** – *Carbon Nanocages: A New Platform for Advanced Energy Conversion and Storage* – **Zheng Hu (Nanjing University)**	**Invited Talk B2** – *Advanced In Vivo Fluorescence Imaging: Seeing is Believing* – **Qiangbin Wang (Suzhou Institute of Nano-Tech and Nano-Bionics, CAS)**
17:10-17:30	**Invited Talk A3** – *Nanostructured Layered Double Hydroxide Based Photocatalysts for Solar Fuels and Value-added Chemicals* – **Tierui Zhang (Technical Institute of Physics and Chemistry, CAS)**	**Invited Talk B3** – *Visualizing Dynamic Folding/Unfolding Process of Single Peptide Molecule in a Confined SiNx Nanopore* – **Yitao Long (Nanjing University)**
18:30-20:30	Conference Banquet Location: 3F Chengpu Hall (317) 317诚朴厅	

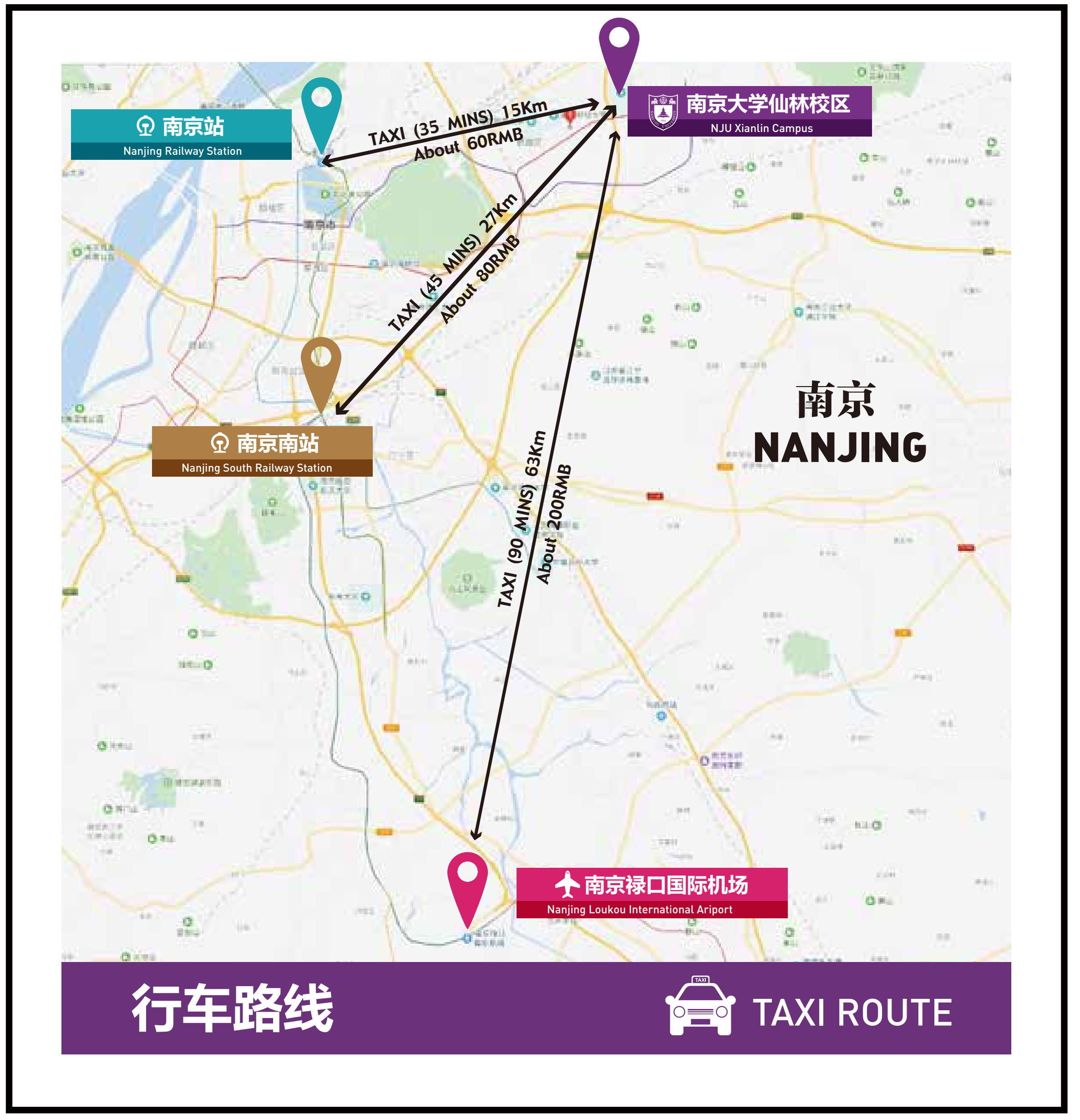
November 30, 2019 (Saturday)		
Time	Parallel session C (2nd Floor – ZHONGDA LECTURE HALL) 二楼中大厅	Parallel session D (2nd Floor – Vip 211) 二楼躬行厅
09:00-09:20	**Invited Talk C1** – *Efficient and Stable Perovskite Optoelectronic Devices*– **Jingbi You (Institute of Semiconductors,CAS)**	**Invited Talk D1** – *High throughput Error-correction code DNA sequencing*– **Yanyi Huang (Peking University)**
09:20-09:40	**Invited Talk C2** – *Emission from self trapped exciton: mechanism, materials and application* – **Jiang Tang (Huazhong University of Science and Technology)**	**Invited Talk D2** – *Fluorescent Dyes for Cancer Theranostics* – **Jiangli Fan (Dalian University of Technology)**
09:40-10:00	**Invited Talk C3** – *Nanostructured Electro-catalyst for CO_2 Reduction* – **Gengfeng Zheng (Fudan University)**	**Invited Talk D3** – *Micro and Nanotechnologies for Advanced Drug Delivery Systems* – **Michael Chen (The University of Edinburgh)**
10:00-10:20	**Invited Talk C4** – *Design of Nanostructured Materials for Photo/Photothermal Energy Conversion Functionalities* – **Ghimwei Ho (National University of Singapore)**	**Invited Talk D4** – *Rational Design of Peroxidase-like Nanozymes* – **Hui Wei (Nanjing University)**
10:20-10:50	Coffee Break & Poster Session	
Time	Parallel session E (2nd Floor – ZHONGDA LECTURE HALL) 二楼中大厅	Parallel session F (2nd Floor – Vip 211) 二楼躬行厅
10:50-11:10	**Invited Talk E1** – *Imaging the Interface of van der Waals Nanolayers by Picosecond Ultrasonics* – **Vitali Goussev (Le Mans Université)**	**Invited Talk F1** – *Controlling thermal emission with nanophotonic structures*– **Min Qiu (Westlake University)**
11:10-11:30	**Invited Talk E2** – *Synthesizing freestanding oxide perovskites as building units of materials with novel functionalities* – **Yuefeng Nie (Nanjing University)**	**Invited Talk F2** – *Spectrally agile topological beam shaping from liquid crystals* – **Etienne Brasselet (University of Bordeaux)**
11:30-11:50	**Invited Talk E3** – *Wood microstructures tuning for high performance ecological materials* – **Mingwei Zhu (Nanjing University)**	**Invited Talk F3** – *Subwavelength Silicon Photonics for Mode Manipulations* – **Daoxin Dai (Zhejiang University)**
11:50-12:10	**Invited Talk E4** – *Big-data, multi-channel 4D STEM with Ptychography* – **Peng Wang (Nanjing University)**	**Invited Talk F4** – *Recent developments in periodically poled $LiNbO_3$ crystal* – **Yong Zhang (Nanjing University)**
12:30-14:00	Lunch Location: 1F All Day Restaurant 一楼自助餐厅	

November 30, 2019 (Saturday)		
Time	Parallel session G (2nd Floor – ZHONGDA LECTURE HALL) 二楼中大厅	Parallel session H (2nd Floor – Vip 211) 二楼躬行厅
14:00-14:20	**Invited Talk G1** – *Interface-driven unusual anomalous Hall effect in MnxGa/Pt bilayers*– **Kangkang Meng (University of Science and Technology Beijing)**	**Invited Talk H1** – *Topological phase transitions in spin-orbit photonics*– **Lei Zhou (Fudan University)**
14:20-14:40	**Invited Talk G2** – *Single crystalline metal/semiconductor heterostructures grown by molecular beam epitaxy* – **Hong Lu (Nanjing University)**	**Invited Talk H2** – *Bragg-Berry Reflective Flat Optics based on Chiral Liquid Crystals* – **Hiroyuki Yoshida (Osaka University)**
14:40-15:00	**Invited Talk G3** – *DNA shapes-driven assembly of ordered nano-structures* – **Ye Tian (Nanjing University)**	**Invited Talk H3** – *Flexible optoelectronic and optomechanical fiber devices based on two-dimensional materials* – **Fei Xu (Nanjing University)**
15:00-15:20	**Invited Talk G4** – *Ultrahigh-Resolution Combinatorial Patterning of Functional Nanoparticles* – **Zhenda Lu (Nanjing University)**	**Invited Talk H4** – *Modulation of Topological Zero Modes in Finite Non-Hermitian Optical Lattices* – **Tao Li (Nanjing University)**
15:20-15:50	Coffee Break & Poster Session	
Time	Parallel session K (2nd Floor – ZHONGDA LECTURE HALL) 二楼中大厅	Parallel session L (2nd Floor – Vip 211) 二楼躬行厅
15:50-16:10	**Invited Talk K1** – *Quasi-omnidirectional Silicon Solar Cells*– **Wenzhong Shen (Shanghai Jiao tong University)**	**Invited Talk L1** – *Towards High-Performance Light-Emitting Didoes Based on Quantum Dots*– **Yizheng Jin (Zhejiang University)**
16:10-16:30	**Invited Talk K2** – *Emerging Energy Chemistry of Li Metal Anode in Safe Batteries* – **Qiang Zhang (Tsinghua University)**	**Invited Talk L2** – *All-dielectric metasurfaces and their applications at visible frequencies* – **Ting Xu (Nanjing University)**
16:30-16:50	**Invited Talk K3** – 二维材料表界面化学与能源小分子催化转化 – **Dehui Deng (Dalian Institute of Chemical Physics, CAS)**	**Invited Talk L3** – *Nanophotonic materials: from sensing to imaging* – **Weihua Zhang (Nanjing University)**
16:50-17:10	**Invited Talk K4** – *Porous Monolith of Graphene for Electrochemical Energy Storage and Conversion* – **Xuebin Wang (Nanjing University)**	**Invited Talk L4** – *Nanophotonic designs of plasmonic metals for advanced energy devices* – **Lin Zhou (Nanjing University)**
18:00-20:00	Buffet Dinner Location: 1F All Day Restaurant 一楼自助餐厅	

December 1, 2019 (Sunday)		
Time	**Parallel session M** (1st Floor – ZIJIN HALL) 一楼紫金厅	**Parallel session N** (2nd Floor – ZHONGDA LECTURE HALL) 二楼中大厅
09:00-09:20	**Invited Talk M1** – *Fabrication and Multifunctional Regulations of Magnetic Nanomaterials* – **Yanglong Hou (Peking University)**	**Invited Talk N1** – *Tumor Acidity-Activated Nanomedicine for Improved Cancer Therapy*– **Jinzhi Du (South China University of Technology)**
09:20-09:40	**Invited Talk M2** – *Advanced Energy Storage Materials and Batteries Based on Multi-Electron Redox Processes* – **Zhong Jin (Nanjing University)**	**Invited Talk N2** – *Order-disorder and Materials Genomes in Thermoelectrics* – **Wenqing Zhang (Southern University of Science and Technology)**
09:40-10:00	**Invited Talk M3** – *Title Research on Mechanism of electrochemical reaction at Interface of Li-O_2 battery in Complex Systems* – **Ping He (Nanjing University)**	**Invited Talk N3** – *Semiconducting Polymer Nanoparticles for Bioimaging and Theranostics* – **Xu Zhen (Nanjing University)**
10:00-10:20	Coffee Break & Poster Session	
Time	(1st Floor – ZIJIN HALL) 一楼紫金厅	
10:20-10:50	**Plenary Talk 4** – *Merging of Metamaterials and Conventional Materials*– **Ji Zhou (Tsinghua University)**	
10:50-11:20	**Plenary Talk 5** – *Nanostructured Ultrahard Materials*– **Yongjun Tian (Yanshan University)**	
11:20-11:50	**Plenary Talk 6** – *Smart Metamaterials and Metasurfaces*– **Tiejun Cui (Southeast University)**	
11:50-12:10	Closing Remarks	

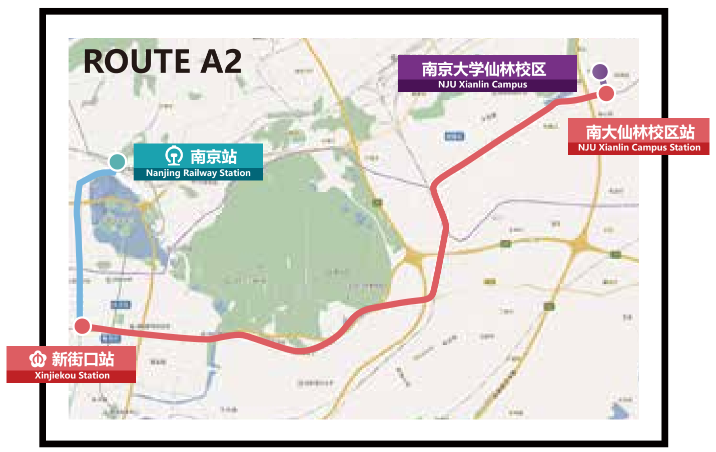
TRANSPORTATION GUIDANCE

Taxi Route



Public Transportation

南京站 Nanjing Railway Station



ROUTE A1
6 RMB

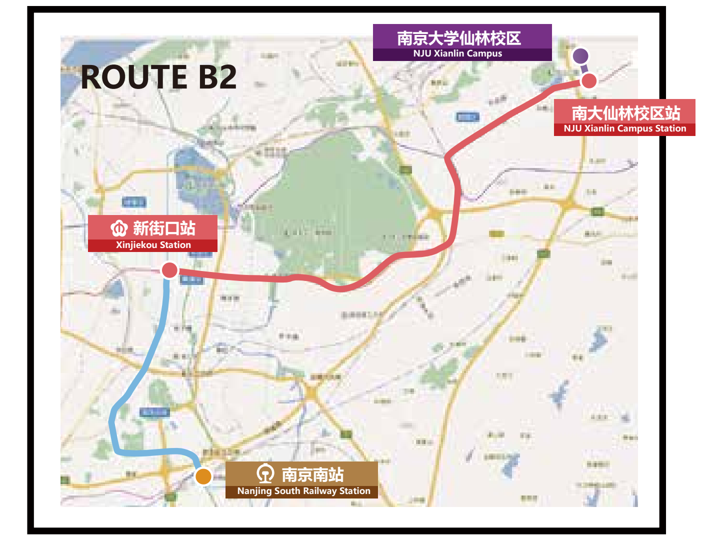
南京站 Nanjing Railway Station → 地铁三号线 Metro Line 3 → 大行宫站 Daxinggong Station → 地铁二号线 Metro Line 2 → 南大仙林校区站 NJU Xianlin Campus Station → 南京大学仙林校区 NJU Xianlin Campus

ROUTE A2
6 RMB

南京站 Nanjing Railway Station → 地铁一号线 Metro Line 1 → 新街口 Xinjiekou Station → 地铁二号线 Metro Line 2 → 南大仙林校区站 NJU Xianlin Campus Station → 南京大学仙林校区 NJU Xianlin Campus

Public Transportation

南京南站 Nanjing South Railway Station



ROUTE B1
7 RMB

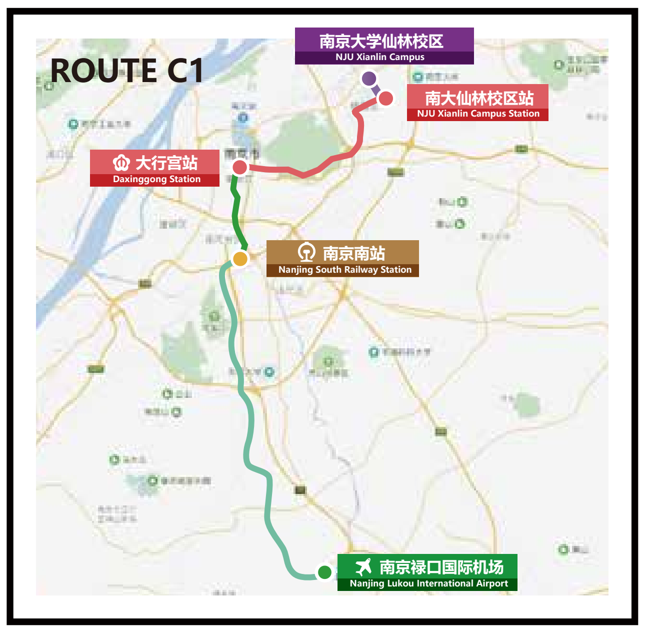
南京南站 Nanjing South Railway Station → 地铁三号线 Metro Line 3 → 大行宫站 Daxinggong Station → 地铁二号线 Metro Line 2 → 南大仙林校区站 NJU Xianlin Campus Station → 南京大学仙林校区 NJU Xianlin Campus

ROUTE B2
7 RMB

南京南站 Nanjing South Railway Station → 地铁一号线 Metro Line 1 → 新街口 Xinjiekou Station → 地铁二号线 Metro Line 2 → 南大仙林校区站 NJU Xianlin Campus Station → 南京大学仙林校区 NJU Xianlin Campus

Public Transportation

南京禄口国际机场 Nanjing Lukou International Airport



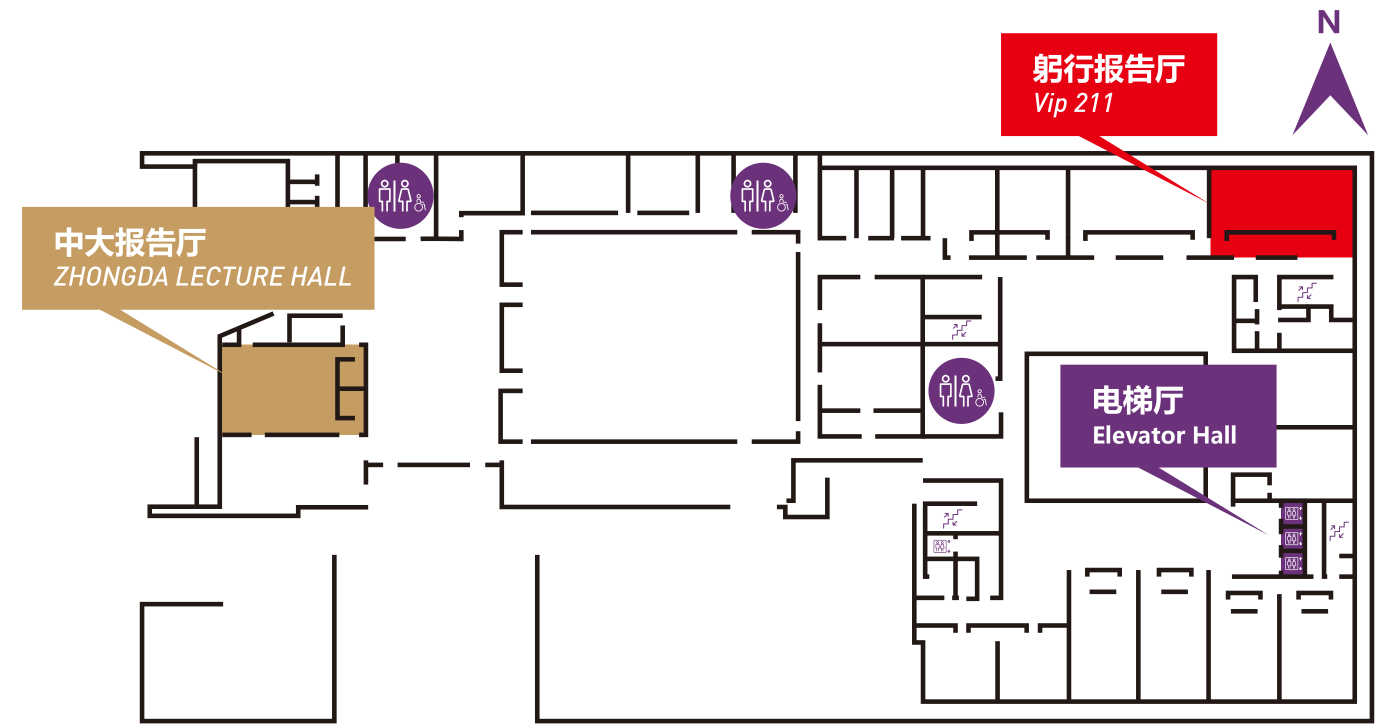
ROUTE C1 9 RMB

南京禄口国际机场 Nanjing Lukou International Airport — 机场S1线 Metro Line S1 — 南京南站 Nanjing South Railway Station — 地铁三号线 Metro Line 3 — 大行宫站 Daxinggong Station — 地铁二号线 Metro Line 2 — 南大仙林校区站 NJU Xianlin Campus Station — 南京大学仙林校区 NJU Xianlin Campus

ROUTE C2 9 RMB

南京禄口国际机场 Nanjing Lukou International Airport — 机场S1线 Metro Line S1 — 南京南站 Nanjing South Railway Station — 地铁一号线 Metro Line 1 — 新街口 Xinjiekou Station — 地铁二号线 Metro Line 2 — 南大仙林校区站 NJU Xianlin Campus Station — 南京大学仙林校区 NJU Xianlin Campus

THE 2F FLOOR PLAN



REGISTRATION

Registration Fees

	Early registration by Oct. 25, 2019	Regular registration by Nov. 29, 2019
Student	RMB 1000/USD150	RMB 1500/USD225
Academic	RMB 1500/USD225	RMB 2000/USD285

Registration Fee Includes

- Admission to All scientific sessions
- Admission to Poster sessions
- Meals as indicated in the conference program
- Program book

ABSTRACTS & NOTES

Plenary Talk 1

Recent progress in printable polymer solar cells - materials, devices engineering and processing

Yong Cao
Institute of Polymer Optoelectronic Materials and Devices, State Key Laboratory of Luminescent Materials and Devices,
South China University of Technology, Guangzhou, 510640, China
yongcao@scut.edu.cn

Polymer solar cells (PSCs) have attracted considerable attention due to their unique characteristics, such as low cost, light weight, and possible fabrication by roll-to-roll printing on the large-area flexible substrate. In recent years, due to pioneering work on non- fullerene acceptors of Prof. ZHAN Xiaowei's group (Beijing University) and then many other groups in Mainland of China and worldwide, power conversion efficiency of polymer solar cells have made a big jump , and currently, it is still in a rising period.

In this presentation we report recent efforts at SCUT group in PSCs materials design、synthesis and device optimization towards to realization of all-printable polymer solar cells on flexible substrate via solution processing. Special emphasis will be focused on the efforts in following aspects:

1. Design and synthesis of novel low band-gap conjugated polymers as donor and non-fullerenes acceptor in polymer bulk heterojunction devices suitable for large-area roll-to-roll printing of high-efficiency polymer solar cell modules;

2. Novel water/alcohol soluble conjugated polyelectrolyte and their neutral precursors(WSCPs) used for polymer/electrode interface optimization in polymer bulk heterojunction solar cells;

3. Possible application and commercialization of polymer solar cells-development of printed flexible translucent solar cell

Relevant scientific questions and experimental results will be discussed along with the latest developments in this research field of domestic and abroad groups in recent years.

Notes

Plenary Talk 2

Metaphotonics and metasurfaces governed by Mie resonances

Yuri Kivshar
Nonlinear Physics Center, Australian National University, Canberra ACT 2601, Australia

Metamaterials---artificial electromagnetic media that are structured on the subwavelength scale---were initially suggested for the realization of negative-index media, and later they became a paradigm for engineering electromagnetic space and control¬ling propagation of waves. However, applications of metamaterials in optics are limited due to inherent losses in metals employed for the realization of artificial optical magnetism. Recently, we observe the emergence of a new field of all-dielectric resonant meta-optics aiming at the manipulation of strong optically-induced electric and magnetic Mie-type resonances in dielectric and semiconductor nanostructures with relatively high refractive index. Unique advantages of dielectric resonant nanostructures over their metallic counterparts are low dissipative losses and the enhancement of both electric and magnetic fields that provide competitive alternatives for plasmonic structures including optical nanoantennas, efficient biosensors, passive and active metasurfaces, and functional metadevices. This talk will highlight some recent advances in all-dielectric Mie-resonant meta-optics including active nanophotonics as well as the recently emerged fields of topological photonics and nonlinear metasurfaces.

Notes

Plenary Talk 3

The Rise and Evolution of Perovskite Solar Cells

Sang Il Seok
School of Energy and Chemical Engineering, Ulsan National Institute of Science and Technology (UNIST), Ulsan. Korea
seoksi@unist.ac.kr

Inorganic-organic hybrid perovskite solar cells (PSCs), which first appeared in 2009 and began to be studied substantially in 2012, have shown dramatic achievements in photovoltaic performance. In particular, the PSCs, which first began with the expansion of dye-sensitized solar cells, were reported by our group as a new architecture [1] of solar cells, which improved the efficiency by more than 25%. In addition, the efficiency of PSC was greatly improved by the uniform and dense deposition of halide perovskite with salt-like properties using methods such as solvent engineering and anti-solvent dripping [2]. The role of anti-solvents in solvent engineering processes to control nucleation and crystal growth, precursor-coordinating molecule interactions in solution are also affected by various additives. Recently, various additives have been added to perovskite precursor solution to improve the efficiency with ⊠-phase stabilization and defect passivation of formamidinium (FA) based-perovskite materials [3-7]. Furthermore, additives contribute not only to the formation of uniform and dense coatings but also to efficiency and stability improvement due to defect concentration and passivation effect of the resultant perovskite film. As far as the fabrication of perovskite solar cells by the solution process is concerned, it is necessary to consider not only the chemical factors of the precursor solution but also the physical properties of the coating solution such as viscosity, evaporation rate of solvents, the wettability and penetration onto substrates. In this talk, I would like to present our findings on the rise and evolution of these PSCs.

References

(1) J. H. Heo, S, I. Seok et al., Nature Photonics, 7, 486-491 (2013).
(2) N, J, Jeon, S, I, Seok et al., Nature Materials, 13, 897-903 (2014).
(3) N. J. Jeon, S. I. Seok et al., Nature, 517, 476-480 (2015).
(4) W. S. Yang, S. I. Seok et al., Science, 348, 1234-1237 (2015).
(5) W S. Yang, S. I. Seok et al.,, Science 356, 1376–1379 (2017).
(6) H. Min, S. I. Seok et al.,, Adv. Energy Meter., 9, 1803476 (2019)
(7) H. Min, S. I. Seok et al.,, Science (in press).

Notes

Invited Talk A1

Functional Scanning Force Microscopy for Energy Nano Devices

*Liwei Chen [1,2,]**
[1] i-Lab, Suzhou Institute of Nanotech and Nanobionics, Chinese Academy of Sciences, Suzhou, Jiangsu 215123, China
[2] in-situ Center for Physical Sciences, Shanghai Jiaotong University, Shanghai 200240, China
** Corresponding author: lwchen2008@sinano.ac.cn*

Energy nano devices, including energy conversion and energy storage devices, have become a major cross-disciplinary field in recent years. These devices feature long-range electron and ion transport coupled with chemical transformation, which call for novel characterization tools to understand the device operation mechanism. This talk will recent developments from my group in functional scanning force microscopy techniques and their application in thin-film photovoltaic devices and lithium batteries. Advantages of scanning force microscopy, such as high spatial resolution, multimodal imaging and the possibility of in-situ and in-operando imaging, are emphasized. It is demonstrated that functional scanning force microscopy can make significant contribution in understanding materials and interfaces in energy nano devices.

Notes

Invited Talk A2

Carbon Nanocages: A New Platform for Advanced Energy Conversion and Storage

*Qiang Wu, Lijun Yang, Xizhang Wang, Zheng Hu**
School of Chemistry and Chemical Engineering, Nanjing University, Nanjing 210023, China
** Corresponding author: zhenghu@nju.edu.cn*

The past 35 years witnessed the discovery of nanocarbon family from 0D fullerenes (sp2) to 1D carbon nanotubes (sp2), 2D graphene (sp2) and graphdiyne (sp2+sp), which constituted the mainstream research of carbon nanomaterials. With the availability of high specific surface area (SSA), well-balanced pore distribution, high conductivity, and tunable electronic structures, carbon-based nanomaterials have been playing the crucial roles as advanced materials for energy conversion and storage. In this context, attention is usually attracted by the star material of graphene in recent years. In this talk, I will overview our studies on carbon-based nanomaterials from nanotubes to nanocages, including the synthesis, energy applications and related mechanisms. Special attention will be paid to the mesostructured carbon nanocages consisting of sp2 carbon shells, which feature the hollow interior cavity with subnanometer microchannels across the shells in addition to the general advantages of nanocarbons, much different from the intensively-studied nanocarbons such as carbon nanotubes and graphene. The unique structural and morphological characteristics make the carbon-based nanocages emerge as a new platform for advanced energy conversion and storage associated with catalysis, supercapacitors and lithium-sulphur batteries and so on, either as the host for encapsulating/supporting foreign active species or as the active materials themselves, which is of great significance to promote the exciting field of carbon-based nanomaterials. The research challenges and trends are also envisaged for deepening and extending the related studies and applications. [1,2]

References
(1) Q. Wu, L. J. Yang, X. Z. Wang, Z. Hu, Acc. Chem. Res. 50 (2017) 435-444.
(2) Q. Wu, L. J. Yang, X. Z. Wang, Z. Hu, Adv. Mater. 31(2019)1904177.

Notes

Invited Talk A3

Nanostructured Layered Double Hydroxide Based Photocatalysts for Solar Fuels and Value-added Chemicals

*Tierui Zhang**
Key Laboratory of Photochemical Conversion and Optoelectronic Materials/Technical Institute of Physics and Chemistry, Beijing, 10190, China
** Corresponding author: tierui@mail.ipc.ac.cn*

Low-cost and high efficient photocatalysts are very critical for the practical application of photocatalysis technology. Some very recent research progress in my group will be reported in this talk on rational design of nanostructured Layered Double Hydroxide (LDH) based photocatalysts for highly efficient photoreduction of CO2 or CO into hydrocarbons and N2 fixation into ammonia. Ultrathin LDH nanosheets with abundant surface defect structures serving as active sites were prepared to promote adsorption and activation of reactant molecules such as CO2 for enhanced activity. We also developed LDH-based 2D metal/oxide heterostructures of which the optimized interfacial structures played critical roles in the directsynthesis of high value-added products through the regulation of intermediates reaction pathway.[1-8]

References
(1) Tierui Zhang*, et al., Chem. Soc. Rev., 2019, 48, 1972-2010.
(2) Tierui Zhang*, et al., Adv. Mater., 2019, 180642.
(3) Tierui Zhang*, et al., Adv. Mater., 2018, 30, 1800527.
(4) Tierui Zhang*, et al., Adv. Mater., 2018, 30, 1704663.
(5) Tierui Zhang*, et al., Adv. Mater., 2018, 30, 1803127.
(6) Tierui Zhang*, et al., Adv. Mater., 2017, 29, 1703828.
(7) Tierui Zhang*, et al., Angew. Chem. Int. Ed., 2016, 55, 4215-4219.
(8) Tierui Zhang*, et al., Adv. Mater., 2015, 27, 7824-7831.

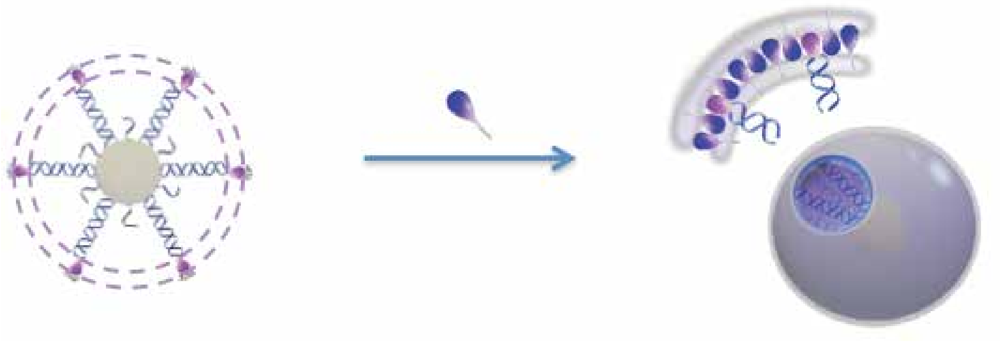
Notes

Invited Talk B1

The Frame Guided Assembly

Dongsheng LIU
Department of Chemistry, Tsinghua University, Beijing 100084, China
E-mail: liudongsheng@tsinghua.edu.cn

How to precisely control the shape and size of final assemblies, especially using same amphiphilic molecules and under the same environmental conditions, is always a challenge in molecular assembly. Inspired by the cytoskeletal/membrane protein/lipid bilayer system that determines the shape of eukaryotic cells, we proposed and 'the Frame Guided Assembly' (FGA) strategy to prepare heterovesicles with programmed geometry and dimensions. This method offers greater control over self-assembly: with same molecular system, the size of final assemblies could be tuned at 1 nm level and their shape could vary from spherical to cubic, and even given sized two dimensional sheets. Most importantly, the principle of the FGA could be applied to various materials such as bock copolymers, small molecules including surfactants and lipids, which is a general rule in self-assembly.



Scheme 1. Schematic illustration of the Frame Guided Assembly

References
Dong, Y., Yan, H.,* Liu, D.,* et al. Angew. Chem. Int. Ed., 2017, 56, 1586-1589.
Zhou, C., Liu, D.,* et al. Small 2015, 11(9-10), 1161-1164.
Zhao, Z., Fan, Q.,* Liu, D.,* et al. Angew. Chem. Int. Ed. 2014, 53, 13468-13470.
Dong, Y., Liu, D.,* et al. Angew. Chem. Int. Ed. 2014, 53(10), 2607-2610.

Notes

Invited Talk B2

Advanced In Vivo Fluorescence Imaging: Seeing is Believing

Qiangbin Wang
CAS Key Laboratory of Nano-Bio Interface, Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences
** Corresponding author: qbwang2008@sinano.ac.cn*

Fluorescence imaging in the second near-infrared window (NIR-II, 1.0~1.7 μm) is appealing in in vivo imaging due to negligible tissue absorbance and tissue scattering, as well as minimal autofluorescence in this region, affording maximal penetration depth for deep tissue imaging with high feature fidelity. Herein, for the first time, we reported a new type of NIR-II QDs-Ag_2S QDs and executed a series of in vivo imaging studies with Ag_2S QDs. The results show that, by using Ag_2S QDs, the tissue penetration length can reach 1.5 cm, and the spatial and temporal resolution of the in vivo imaging can down to 25 μm and 30 ms, respectively, which are improved several to dozens of times in comparison with those using conventional fluorescence nanoprobes in the visible and the first near-infrared window (650-900 nm), offering in situ, real-time visualization of the biological events in vivo. With the advanced NIR-II fluorescence of Ag_2S QDs, high signal to noise ratio imaging of tumor growth and metastasis, imaging-guided drug delivery and therapeutics, imaging-guided precision surgery, and stem cell tracking and regeneration in vivo, etc, have been achieved.

Notes

Invited Talk B3

Visualizing Dynamic Folding/Unfolding Process of Single Peptide Molecule in a Confined SiNx Nanopore

Yi-Tao Long
State Key Laboratory of Analytical Chemistry for Life Science, School of Chemistry and Chemical Engineering, Nanjing University, Nanjing 210023, P. R. China
** Corresponding author: yitaolong@nju.edu.cn*

Dynamic folding/unfolding process of peptides is a fundamental process in all organisms. However, the comprehensive understanding of folding/unfolding pathway of peptide has been an open question in biomolecular for the past two decades [1]. Monitoring the dynamic process of peptide folding remains a challenge owing to the free energy landscape dictating the folding pathway is perplexing and contains misfolded regions and complex intermediate [1]. Here we report the direct observation of multiple transit paths of single peptide folding via electrochemically confined SiNx nanopore [2]. A clever marriage between the nanopore-based technique and molecular plug docking is employed to confine the single peptide molecular within the confined space [3, 4]. The folding/unfolding process of peptide within the confined nanopore results in distinguished ionic current signals. Combining with Markov modeling, this unique single molecule approach has ability to reveal the 5 transition paths of the β-hairpin peptide which shows 4 nonequilibrium fluctuating stages. The statistical analyzing of each peptide from high throughput shows that 78.5% of the peptide adopt the pathway I during the folding/unfolding process while 21.5% of the peptide undergoes the hidden folding/unfolding of transit pathways II-V. This electrochemically sensing method based on the SiNx confined nanopore makes it possible to visualize the dynamically folding/unfolding process of single peptide molecule, and opens an exciting avenue for investigating transition paths of single biomolecules.

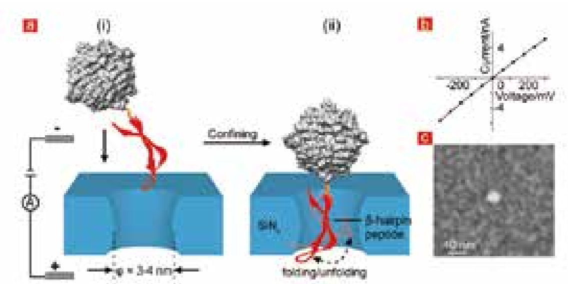


Figure 1. Reading the folding/unfolding pathway of a β-hairpin peptide using a SiNx nanopore.

References
(1) Žoldák, G.; Rief, M. Curr. Opin. Struct. Biol. 2013, 23, 48.
(2) Ying, Y L.; Long, Y T. Sci. China Chem, 2017, 9, 49.
(3) Ying, Y L.; Liu, S C.; Shi, X.; Li, W H.; Wan, Y J.; Long, Y T. ChemRxiv6394925v1. 2018.
(4) Shi, X.; Li, Q.; Gao, R.; Si, Wei.; Liu, S C.; Aksimentiev, A.; Long, Y T. J. Phys. Chem. Lett. 2018, 9, 4686.

Notes

Invited Talk C1

Efficient and Stable Perovskite Optoelectronic Devices

Jingbi You
Institute of Semiconductors, Chinese Academy of Sciences, China
**E-mail: jyou@semi.ac.cn*

Lead halide perovskite is a new type of semiconductor optoelectronic material, which owns large absorption coefficient, long diffusion length, and also it shows high emission efficiency. This advantages feature it a great potential in in solar cells and also in light-emitting diodes. Recently, there are great breakthrough in these two types of optoelectronic devices, the power conversion efficiency (PCE) and the electroluminescence external quantum efficiency (EQE) have been pushed to 25.2% and 20% for perovskite solar cells and light-emitting diodes, respectively. In this talk, I will talk about how we achieve high performance and stable of perovskite based optoelectronic devices according to perovskite film growth control, interface engineering and surface passivation [1-5].

References
[1]. Q. Jiang et al., Nat. Photon. 2019, 13, 460.
[2]. Q. Jiang et al. Nat Energy, 2016, 2, 16177.
[3]. P. Y. Wang et al. Nat. Commun. 2018, 9, 2225.
[4]. X. L. Yang et al. Nat. Commun. 2018, 9, 570.
[5]. L. Q. Zhang et al. Nat. Commun. 2017, 8, 15640.

Notes

Invited Talk C2

Emission from self trapped exciton: mechanism, materials and application

*Jiang Tang**
1 Wuhan National Laboratory for Optoelectronics and School of Optical and Electronic Information, Huazhong University of Science and Technology
** Corresponding author: jtang@mail.hust.edu.cn*

For materials with soft lattice, the coupling between exciton and phonon is strong, often leading to self trapped exciton (STE) upon photo-excitation. The features of STE emission are large Stokes shift and broad spectrum. In this presentation I will talk about the mechanism of STE emission, and two typical STE materials and their applications: i) by taking advantage of broad emission, we engineered double perovskite with Na alloying and Bi doping and achieved stable and efficient white emissive Cs2AgNaInCl6:Bi phosphors, which has potential application for green lighting [1]. ii) Large Stokes shift means small self-absorption, which is crucial for a scintillator film with mm to cm thickness [2]. We successfully fabricated 25 cm2 size, mm thick Rb2CuBr3 films and applied these film for dynamic X-ray imaging with high spatial resolution and negligible ghost effect.

References

(1) Luo, J. J; Wang, X. M.; Li, S. R.; Liu, J.; Yan, Y. Y.; Tang. J.; et. al. Nature, 2018, 563,541.
(2) Yang, B.; Yin, L. X.; Niu, G. D.; Tang, J.; et. al. Adv. Mater. 2019,

Notes

Invited Talk C3

Nanostructured Electrocatalyst for CO2 Reduction

Gengfeng Zheng [1,]*
[1] Laboratory of Advanced Materials, Department of Chemistry, Fudan University, Shanghai 200438, China
** Corresponding author:gfzheng@fudan.edu.cn*

Climate change, caused by heavy CO2 emission, has been driving new demands to alleviate the rising concentration of atmospheric CO2 levels. Among various artificial photosynthetic systems, the solar-driven electrochemical CO2 reduction is widely recognized to possess high efficiencies and potentials for practical application. The efficient and selective electroreduction of CO2 is the key to the overall solar-to-chemical efficiency of artificial photosynthesis. Various metallic materials possess the capability to play as electrocatalysts for CO2 reduction. In order to achieve high selectivity for CO2 reduction products, various efforts have been made including the studies in the electrolytes, crystal facets, oxide-derived catalysts, electronic and geometric structures, nanostructures, and mesoscale phenomena. Attributed to their high electrochemically active surface area, fast charge transport, efficient mass transfer and gas release, these nanostructured electrocatalysts enable much enhanced activity, such as reduced overpotentials, high current densities and long stability [1, 2]. Moreover, we will show new photosynthesis design that allows a unique tuning capability of the CO2 conversion activity and selectivity by the discharging current densities [3].

References

(1) Yifei Wang, Zheng Chen, Peng Han, Yonghua Du, Zhengxiang Gu, Xin Xu*, Gengfeng Zheng*, ACS Catal., 2018, 8, 7113-7119.
(2) Yifei Wang, Peng Han, Ximeng Lv, Lijuang Zhang, Gengfeng Zheng*, Joule, 2018, 2, 2551-2582.
(3) Yuhang Wang, Junlang Liu, Yifei Wang, Yonggang Wang, Gengfeng Zheng*,Nat. Commun., 2018, 9, 5003

Notes

Invited Talk C4

Design of Nanostructured Materials for Photo/Photothermal Energy

*Ghim Wei Ho[a,b] **
[a]Department of Electrical and Computer Engineering, National University of Singapore, Singapore 117576, Singapore.
[b]Materials Science Engineering, National University of Singapore, 4 Engineering Drive 3, 117576, Singapore
Presenter e-mail address: elehgw@nus.edu.sg

Using readily available renewable resources i.e. solar energy and seawater to secure sustainable fuel and freshwater for humanity is an impactful quest. The utilization of photothermal materials with broad solar absorption, in parallel to engineered evaporator designs, offers new approach to achieve efficient solar light conversion. Here, we have designed solar thermal collector nanocomposites that possess efficient photothermic properties for highly targeted interfacial phase transition reactions that are synergistically favorable for catalysis, vaporization and energy generation. The photothermic effect arises from plasmonic metal, semiconductor and carbon nanomaterials exhibit localized interfacial heating which directly triggers surface-dominated catalysis and steam generation processes, with minimal heat losses, reduce thermal masses and optics implementation. The solar thermal collector nanocomposites are photo stable for practical solar conversion to simultaneously produce clean energy, water and electricity. Finally, proof-of-concept prototypes demonstrate the viability of sustainable photothermic driven catalysis, desalination/distillation and energy generation under natural sunlight. Furthermore, the opportunities of solar water evaporation should be explored beyond silos so as to conjointly address the interlinked water, energy and environmental nexus.

Notes

Invited Talk D1

High throughput Error-correction code DNA sequencing

*Yanyi Huang **
Biomedical Pioneering Innovation Center (BIOPIC), Beijing Advanced Innovation Center for Genomics (ICG), College of Engineering, College of Chemistry, Peking-Tsinghua Center for Genomics, Peking University, Beijing 100871, China
** Corresponding author: yanyi@pku.edu.cn*

Eliminating errors in next-generation DNA sequencing has proved challenging. I am going to talk about our newly developed error-correction code (ECC) sequencing, a method to greatly improve sequencing accuracy by combining fluorogenic sequencing-by-synthesis (SBS) with an information theory–based error-correction algorithm. ECC embeds redundancy in sequencing reads by creating three orthogonal degenerate sequences, generated by alternate dual-base reactions. This is similar to encoding and decoding strategies that have proved effective in detecting and correcting errors in information communication and storage. We showed that, when combined with a fluorogenic SBS chemistry with raw accuracy of 98.1%, ECC sequencing provides single-end, error-free sequences up to 200 bp. ECC approaches should enable accurate identification of extremely rare genomic variations in various applications in biology and medicine.

Notes

Invited Talk D2

Fluorescent Dyes for Cancer Theranostics

*Mingli Le, Ming Xiao, Xiaojun Peng, Jiangli Fan**
State Key Laboratory of Fine Chemicals, Dalian University of Technology

The development of molecular theranostic prodrugs for in vivo cancer diagnosis and targeted chemotherapy is urgently required. Enzyme-activated prodrugs display superior selectivity as a result of cancer-specifc enzymes which serve as cancer biomarkers. Herein, an aminopeptidase N (APN)-activated theranostic prodrug Nile blue-C6-amide-p-fluorophenylalanyl-lmelphalanyl (NBFMel) is reported for fluorescence cancer diagnosis and local tumor treatment. NBFMel is successfully utilized to report the presence of tumor and for in situ tracking of drug release in tumor-bearing mouse models. Moreover, NBFMel demonstrates effcient tumor inhibition when intravenously injected into mice. Therefore, the APN-activated theranostic prodrug provides a new platform for in vivo cancer diagnosis and targeted anticancer chemotherapy.[1] On the other hand, Structure-inherent targeting (SIT) agents are of particular importance for clinical precision medicine; however, there still exists a great lack of SIT phototheranostics for simultaneous cancer diagnosis and targeted photodynamic therapy (PDT). Herein, for the first time, we propose a "one for-all" strategy by using the Förster resonance energy transfer (FRET) mechanism to construct such omnipotent SIT phototheranostics. Of note, this novel tactic can not only endow conventional sensitizers with highly effective native tumor-targeting potency but also simultaneously improve their photosensitization activities, resulting in dramatically boosted therapeutic index. More importantly, benefiting from the FRET effect, markedly amplified light harvesting ability and 1O2 production are demonstrated. Better still, other favorable features are also simultaneously achieved, including specific mitochondria anchoring, augmented cellular uptake (↑13-fold), as well as ideal biocompatibility, all of which allow orders-of-magnitude promotion in anticancer efficiency both in vitro and in vivo.[2]

References
(1) Xiao M.; Sun,W.; Fan, J. L.; Cao, J. F.; Li,Y. Q.; Shao, K.; Li, M. Li, X. J.; Kang,Y.; Zhang, W. D.; Long, S. R.; Du, J. J.; Peng, X. J. Adv. Funct. Mater. 2018, 1805128.
(2) Li, M. L.; Long, S. R.; Kang,Y.; Guo, L. Y.; Wang, J. Y.; Fan, J. L.; Du, J. J.; Peng, X. J. J. Am. Chem. Soc., 2018, 140, 15820-15826.

Notes

Invited Talk D3

Micro and Nanotechnologies for Advanced Drug Delivery Systems

*Xianfeng Chen, [1]**
[1]School of Engineering, Institute for Bioengineering, The University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JL, UK
** Corresponding author: Michael.Chen@ed.ac.uk*

The market for advanced drug delivery systems is rising rapidly, because many new medicines rely on novel and innovative delivery techniques, and the improvement of delivery platforms can as well promote existing drugs' therapeutic efficacy, alleviate their side effects, and reduce the cost, etc. Here I would like to introduce our research development in innovating and improving drug delivery and bioimaging based on micro and nanotechnologies, including microneedle arrays for painless and efficient transdermal vaccination, nanoneedle arrays for high-throughput intracellular delivery, and nanomaterials for enhanced cancer therapy and tumor imaging [1-4].

References
(1) X Chen, Advanced Drug Delivery Reviews, 2018, 127, 85-105.
(2) X Chen, WJ Zhang, Chemical Society Reviews, 2017, 46, 734-760.
(3) Y Wang, Y Yang, L Yan, SY Kwok, W Li, ZG Wang, XY Zhu, GY Zhu, WJ Zhang, X Chen, P Shi, Nature Communications, 2014, 5, 4466.
(4) L Yan, Y Yang, WJ Zhang, X Chen, Advanced Materials, 2014, 26, 5533-5540.

Notes

Invited Talk D4

Rational Design of Peroxidase-like Nanozymes

Hui Wei [1,2,*]
[1] Department of Biomedical Engineering, College of Engineering and Applied Sciences, Nanjing University, Nanjing, Jiangsu 210093, China
* Corresponding author: weihui@nju.edu.cn

Rational design of nanozymes, the nanomaterials with enzymatic activities, still remains a great challenge because there currently lacks of predictive design principles to correlate the nanomaterials' properties with their enzyme mimicking activities. To tackle this challenge, herein I will talk about our recent efforts for identifying design principles that can predict the peroxidase mimicking activities of transition metal oxides based nanozymes. Specifically, for ABO3 type perovskite oxides (or binary metal oxides) with a transition metal-oxygen octahedral coordination geometry, their peroxidase mimicking activities were primarily determined by the eg (σ*) occupancy of the transition metal's d electrons. The nanozymes with eg around 1 exhibit high peroxidase mimicking activities while that with eg of 0 and 2 have negligible activities. The peroxidase mimicking activities could be further enhanced by higher covalency between the transition metal and surrounding oxygen atoms. Moreover, a detailed DFT calculation study was carried out to elucidate the catalytic mechanism, which further support the proposed design principles. Our work will be helpful for rational design of high performance nanozymes for wide applications.

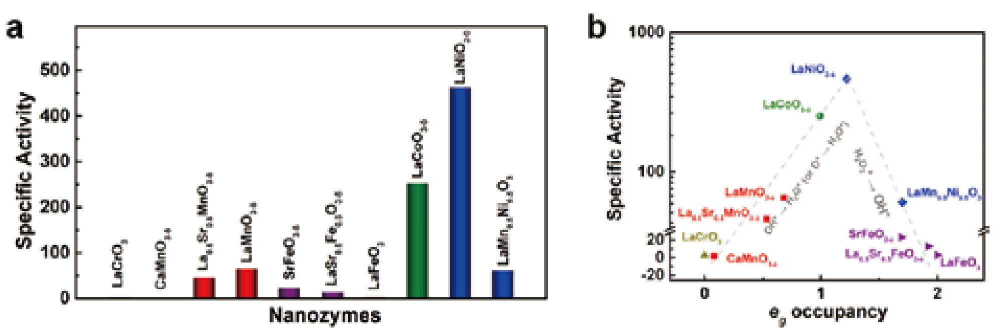


Fig. 1 (a) Specific peroxidase-like activities of perovskite metal oxides. (b) Specific peroxidase-like activities of perovskite metal oxides plotted as a function of eg occupancy, in which equations shown in grey are the rate-limiting reaction steps (note: the rate-limiting steps of the catalytic reaction would be discussed in DFT calculations Section). The two lines are shown for eye-guiding only.

References
(1) Wei, H.; Wang, E. Nanomaterials with enzyme-like characteristics (nanozymes): next-generation artificial enzymes. Chem. Soc. Rev. 2013, 42, 6060-6093.
(2) Wu, J.; Wang, X.; Wang, Q.; Lou, Z.; Li, S.; Zhu, Y.; Qin, L.; Wei, H. Nanomaterials with enzyme-like characteristics (nanozymes): next-generation artificial enzymes (II). Chem. Soc. Rev. 2019, 48, 1004-1076.
(3) Wang, X.; Gao, X. J.; Qin, L.; Wang, C.; Song, L.; Zhou, Y.-N.; Zhu, G.; Cao, W.; Lin, S.; Zhou, L.; Wang, K.; Zhang, H.; Jin, Z.; Wang, P.; Gao, X.; Wei, H. eg occupancy as an effective descriptor for the catalytic activity of perovskite oxide-based peroxidase mimics. Nature Communi. 2019, 10, 704.

Notes

Invited Talk E1

Imaging the Interface of van der Waals Nanolayers by Picosecond Ultrasonics

Jake D. G. Greener,[1] Elton de Lima Savi,[2] Andrey V. Akimov,[1] Samuel Raetz,[2] Zakhar Kudrynskyi,[3] Zakhar D. Kovalyuk,[3] Nikolay Chigarev,[2] Anthony Kent,[1] Amalia Patané,[1] and Vitalyi Gusev [2],*
[1] School of Physics and Astronomy, The University Nottingham, Nottingham NG7 2RD, U.K.
[2] Laboratoire d'Acoustique de l'Université du Mans, LAUM - UMR 6613 CNRS, Le Mans Université, Avenue Olivier Messiaen, 72085 Le Mans Cedex 9, France
[3] Chernivtsi Branch of Frantsevich Institute for Problems of Materials Science, the National Academy of Sciences of Ukraine 5, I. Vilde Street, Chernivtsi, 58001, Ukraine
*Vitalyi Gusev: vitali.goussev@univ-lemans.fr

Although the topography of van de Waals (vdW) layers and heterostructures can be imaged by scanning probe microscopy, high-frequency interface elastic properties are more difficult to assess. These can influence the stability, reliability, and performance of electronic devices that require uniform layers and interfaces. Here, we use picosecond ultrasonics to image these properties in vdW layers and heterostructures based on well-known exfoliable materials, i.e., InSe, hBN, and graphene. We reveal a strong, uniform elastic coupling between vdW layers over a wide range of frequencies of up to tens of gigahertz (GHz) and in-plane areas of 100 μm2. In contrast, the vdW layers can be weakly coupled to their supporting substrate, behaving effectively as free-standing membranes. Our data and analysis demonstrate that picosecond ultrasonics offers opportunities to probe the high-frequency elastic coupling of vdW nanolayers and image both "perfect" and "broken" interfaces between different materials over a wide frequency range, as required for future scientific and technological developments.

References
(1) Greener, D. G.; Akimov, A. V.; Gusev, V. E.; Kudrynskyi, Z. R.; Beton, Z. R.; Kovalyuk, Z. D.; Taniguchi, T.; Watanabe, K.; Kent, A. J.; Patanè, A. Phys. Rev. B 2018, 98, 075408.
Greener, J. D. G.; de Lima Savi, E.; Akimov, A. V.; Raetz, S.; Kudrynskyi, Z.; Kovalyuk, Z. D.; Chigarev, N.; Kent, A.; Patanè, A.; Gusev V. ACS Nano 2019, 13, 11530.

Notes

Invited Talk E2

Synthesizing freestanding oxide perovskites as building units of materials with novel functionalities

Yuefeng Nie
Nanjing University
Email: ynie@nju.edu.cn

Perovskite transition metal oxides (TMO) host a variety of amazing properties, such as ferroelectricity, ferromagnetism, colossal magnetism, and high Tc superconductivity. However, direct epitaxial growth of TMO on silicon wafers is extremely challenging due to the lattice incompatibility between TMO and silicone, which hinders the application of the amazing properties of TMO in semiconductor electronics. Here, we demonstrate the synthesis of freestanding TMO films with high crystalline quality down to the single unit-cell limit[1], which opens a new path to construct novel oxide materials with these functional units. Freestanding multiferroic $BiFeO_3$ films have been successfully transferred onto silicon wafer and exhibit a giant polarization as the film thickness approaches the two-dimensional limit. This breakthrough sheds light on the integration of oxide functionalities with semiconductor for the new general multifunctional electronics. In addition, due to the absent of substrate clamping, one- or two-dimensional strain along arbitrary directions can be freely applied on these freestanding films, providing a superior new knob to engineer the symmetry, electronic structure and prosperities in these freestanding films. As an example, we show that a giant one-dimensional tensile strain up to 6.4% has been realized and drives an exotic ferroelectric phase transition in freestanding $PbTiO_3$ films. Moreover, stacking freestanding oxide functional units to construct oxide heterostructures with artificial twisted angles will be explored in the near future.

References
[1] D.X. Ji, et al. Nature 570 87–90 (2019)

Notes

Invited Talk E3

Wood microstructures tuning for high performance ecological materials

Mingwei Zhu[1] & Liangbing Hu[2]
[1] National Laboratory of Solid State Microstructures & Jiangsu Key Laboratory of Artificial Functional Materials & College of Engineering and Applied Sciences, Nanjing University, Hankou Road 22, Nanjing 210093, China
[2] Department of Materials Science and Engineering, University of Maryland, College Park, Maryland 20742, USA

Materials from nature is attractive because of their environmentally friendly property. However, their performances need to be improved to satisfy the requirements of modern applications. Here, we artificially tune the micro-structures of natural wood to develop new materials and their applications.
A series of new environmental-friendly ecological materials are acquired with transformative properties beyond natural wood. By strengthen the nanofibers in wood microstructures, super-strong wood with tensile strength about 548.8 MPa is fabricated, which can replace steel in some areas[1]; By refractive matching in wood microstructures, transparent, heat-insulating, transparent wood is fabricated, which exhibit some novel structural related optical properties and may find applications in many areas[2,3]; By wood nanofibers in situ tuning and microstructures reconstruction, transparent film is developed with transmittance over 90% and high tensile strength over 350 MPa, which may be used as the substrate of transparent, flexible devices[4]; By reconstruction the nanofibers in wood cells, fine patterns ranging in size from 40 nm to 50 μm are realized on wood surface by precision imprinting technology, which breaks through wood's traditional applications and extends it to new fields of optics and photonics[5].
These new materials will promote the development and application of new ecological materials and contribute to the environment and sustainable development.

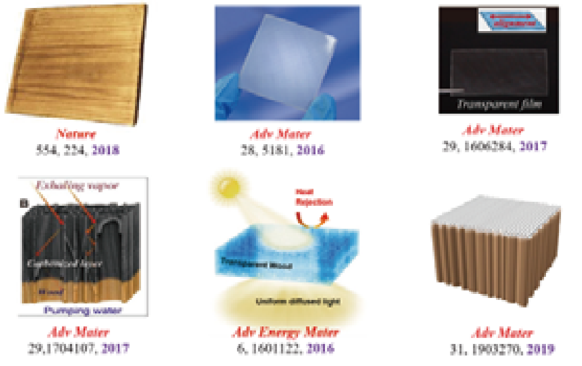


Fig. 1 The wood micstructures tuning has achieved various new materials and applications.

References
[1] J. Song, C. Chen, S. Zhu, M. Zhu, J. Dai, U. Ray, Y. Li, Y. Kuang, Y. Li, N. Quispe, Y. Yao, A. Gong, U. H. Leiste, H. A. Bruck, J. Y. Zhu, A. Vellore, H. Li, M. L. Minus, Z. Jia, A. Martini, T. Li, L. Hu, "Processing bulk natural wood into a high-performance structural material", Nature 554, 224–228 (2018).
[2] M. Zhu, J. Song, T. Li, A. Gong, Y. Wang, J. Dai, Y. Yao, W. Luo, D. Henderson, L. Hu, "Highly Anisotropic, Highly Transparent Wood Composites", Adv. Mater. 28, 5181–5187 (2016).
[3] T. Li, M. Zhu, Z. Yang, J. Song, J. Dai, Y. Yao, W. Luo, G. Pastel, B. Yang, L. Hu, "Wood Composite as an Energy Efficient Building Material: Guided Sunlight Transmittance and Effective Thermal Insulation", Adv. Energy Mater. 6, 1601122 (2016).
[4] M. Zhu, Y. Wang, S. Zhu, L. Xu, C. Jia, J. Dai, J. Song, Y. Yao, Y. Wang, Y. Li, D. Henderson, W. Luo, H. Li, M. L. Minus, T. Li, L. Hu, "Anisotropic, Transparent Films with Aligned Cellulose Nanofibers", Adv. Mater. 29, 1606284 (2017).
[5] D. Huang, J. Wu, C. Chen, X. Fu, A. H. Brozena, Y. Zhang, P. Gu, C. Li, C. Yuan, H. Ge, M. Lu, M. Zhu, L. Hu, Y. Chen, "Precision Imprinted Nanostructural Wood", Adv. Mater. (2019). doi:10.1002/adma.201903270.

Notes

Invited Talk E4

Big-data, multi-channel 4D STEM with Ptychography

Peng Wang[1]
[1] National Laboratory of Solid State Microstructures, Jiangsu Key Laboratory of Artificial Functional Materials, College of Engineering and Applied Sciences and Collaborative Innovation Center of Advanced Microstructures, Nanjing University, Nanjing 210093, China

** Corresponding author: wangpeng@nju.edu.cn*

Since the development of aberration correctors and electron optical components, scanning transmission electron microscopy (STEM) has become a widely used and powerful technique for materials science research. However, there are still remaining challenging in many areas, such as super-resolution, beam sensitive materials characterization and three-dimensional quantitative imaging. In this talk, we will show that among a number of emerged new techniques, electron ptychography is a great candidate for tackling these challenges due to its potential for super-resolution imaging, high-contrast light-element detecting1, low-dose imaging2, 3D optical sectioning3 and coupling to spectroscopic data acquisition4 based upon a large-scale dataset in 4D-STEM experiments enabled with a new generation of high speed and efficient direct electron detectors.

References

(1) Wang, Pl Zhang*, S Gao, M Zhang & AI Kirkland, Electron Ptychographic Diffractive Imaging of Boron Atoms in LaB6 Crystals, Scientific Reports, 7, 2857 (2017).
(2) Song, J; CS Allen, S Gao, C Huang, H Sawada, X Pan, J Warner, P Wang* & AI Kirkland, Atomic Resolution Defocused Electron Ptychography at Low Dose with a Fast, Direct Electron Detector, Scientific Reports, 9, 3919 (2019).
(3) Gao, S; P Wang*, F Zhang*, GT Martinez, PD Nellist, X Pan & AI Kirkland, Electron ptychographic microscopy for three-dimensional imaging, Nature Communications, 8, 163 (2017).
(4) Song, B; Z Ding, CS Allen, H Sawada, F Zhang, X Pan, J Warner, AI Kirkland & P Wang*, Hollow Electron Ptychographic Diffractive Imaging, Physical Review Letters, 121, 146101 (2018).

Notes

Invited Talk F1

Controlling thermal emission with nanophotonic structures

Min Qiu [1,2,3,]*

[1]Key Laboratory of 3D Micro/Nano Fabrication and Characterization of Zhejiang Province, School of Engineering, Westlake University, 18 Shilongshan Road, Hangzhou 310024, Zhejiang Province, China.
[2]Institute of Advanced Technology, Westlake Institute for Advanced Study, 18 Shilongshan Road, Hangzhou 310024, Zhejiang Province, China.
** Corresponding author: qiumin@westlake.edu.cn*

The ability to engineer thermal emission of objects facilitates a wide range of applications such as temperature regulation [1,2], infrared camouflage [3], infrared detectors [4], and thermophotovoltaics [5]. In the last two decades, the emerging field of nanophotonics has offered unprecedented solutions– that are impossible with conventional approaches- to engineer thermal emission by controlling the emissivity of objects with nanophotonic structures on object surfaces. In this talk, we report our recent progresses in delivering novel nanophotonic-designed thermal emitters, focusing on the applications in personal thermal management with colored nanophotonic structured textile and spatially resolved dynamically reconfigurable control of thermal emission with VO2.

References

(1) Raman, Aaswath P., et al. Nature 2014, 515, 540.
(2) H Luo, et al. Nano Energy, 2019, 65, 103998.
(3) Y. Qu, et al. Light: Science and Applications, 2018, 7, 26.
(4) Dao, Thang Duy, et al. ACS Photonics 2016, 7, 1271.
(5) Lenert, Andrej, et al. Nature Nanotechnology 2014, 9, 126.

Notes

Invited Talk F2

Spectrally agile topological beam shaping from liquid crystals

Etienne Brasselet
CNRS, University of Bordeaux, Laboratoire Ondes et Matière d'Aquitaine,
351 Cours de la Libération, F-33400 Talence, France
** Corresponding author: etienne.brasselet@u-bordeaux.fr*

Since two decades, substantial research and technological efforts have been made to develop optical elements enabling the versatile manipulation of light fields via geometrical principles, which manifest as the so-called geometric phase that find its root in the optical spin-orbit interaction. Several assets make this approach especially attractive. Indeed, being geometrical by nature, such a beam shaping approach is particularly suitable to process polychromatic light fields. Also, coupling the polarization state of light to the spatial degrees of freedom allow considering the mapping between the two-dimension spin basis and to any two-dimension orbital angular momentum sub-basis, which finds a lot of interests for instance in optical information, optical imaging, optomechanics, optical material processing, and optical sensing. Moreover, technology makes it possible to fabricate flat-optics with versatile beam shaping functionalities. Still, most of the approach are inherently designed to work efficiently for a discrete set of wavelengths only. In 2016, a novel approach was introduced which consists to combine the intrinsically broadband features of the circular Bragg photonic bandgap of helix-based materials with geometric (Berry) phase arising from space-variant anisotropic optical elements. Here we review our contributions to the development of such reflective Bragg-Berry optical elements [1-4]. We will also discuss some of our recent approaches on tunable and polychromatic options based on non-chiral Pancharatnam-Berry liquid crystal elements [5,6].

References

[1] M. Rafayelyan and E. Brasselet, Phys. Rev. Lett. 116, 253902 (2016).
[2] M. Rafayelyan and E. Brasselet, Opt. Lett. 41, 3972-3975 (2016).
[3] M. Rafayelyan, G. Agez and E. Brasselet, Phys. Rev. A 96, 043862 (2017).
[4] M. Rafayelyan and E. Brasselet, Phys. Rev. Lett. 120, 213903 (2018).
[5] E. Brasselet, Phys. Rev. Lett. 121, 033901 (2018).
[6] M. Ghadimi Nassiri and E. Brasselet, Phys. Rev. Lett. 121, 213901 (2018).

Notes

Invited Talk F3

Subwavelength Silicon Photonics for Mode Manipulations

Daoxin Dai, [1] Chaochao Ye, Jingshu Guo and Chenlei Li*
[1] State Key Laboratory for Modern Optical Instrumentation, College of Optical Science and Engineering, Zhejiang University, Zijingang Campus, Hangzhou, China.
[2] Ningbo Research Institute, Zhejiang University, Ningbo 315100, China.
** Corresponding author: dxdai@zju.edu.cn*

This paper gives a review on the recent progresses on subwavelength silicon photonics for mode manipulations by using e.g. subwavelength grating waveguides. There are two types of photonic devices included here. One is the on-chip polarization handling devices, including polarizers, polarization beam splitters and polarization rotators. The other one is the silicon photonic structures and devices with not only the fundamental modes but also the higher-order modes, including sharp waveguide bends.

References

(1) Daoxin Dai*, "Advanced Passive Silicon Photonic Devices with Asymmetric Waveguide Structures," Proceedings of the IEEE, 106(12): 2117-2143, 2018.
(2) Chenlei Li, Daijian Liu, and Daoxin Dai*, "Multimode silicon photonics," Nanophotonics, 8(2): 227-247, 2019.
(3) Hao Wu+, Chenlei Li+, Lijia Song, Hon-Ki Tsang, John E Bowers, and Daoxin Dai*, "Ultra-sharp multimode waveguide bends with subwavelength gratings," Laser & Photonics Reviews, 13(2): 1800119, 2019.

Notes

Invited Talk F4

Recent developments in periodically poled LiNbO3 crystal

*Yong Zhang 1,**
(11point, Times New Roman, Name of the presenting author is underlined.)
1 National Laboratory of Solid State Microstructures, College of Engineering and Applied Sciences, and School of Physics, Nanjing University, Nanjing 210093, China.
** Corresponding author: zhangyong@nju.edu.cn*

A periodically-poled $LiNbO_3$ (PPLN) crystal features space-dependent second-order nonlinear coefficients. Since the first PPLN crystal was experimentally grown in 1980, it has been one of the most important materials to effectively control nonlinear optical interactions through quasi-phase matching (QPM). By using electric-field poling method, 1D and 2D PPLN crystals have been successfully fabricated for laser frequency conversion, quantum light sources, nonlinear beam shaping and nonlinear optical imaging [1]. Recently, femtosecond laser engineering technique is utilized to prepare 3D domain structures inside $LiNbO_3$ crystal, which provides a promising platform to control nonlinear interacting waves in 3D configuration [2,3]. After 40 years of developments, PPLN crystals still have exciting prospects in fundamental researches and practical applications for integrated photonic chip, quantum information processing, and so on.

References

(1) Hu, X. P.; Zhang, Y.; Zhu, S. N. Adv. Mater., https://doi.org/10.1002/adma.201903775
(2) Wei, D. Z. et al., Nature Comm. 10, 4193 (2019).
(3) Wei, D. Z. et al., Nature Photon. 12, 596 (2018).

Notes

Invited Talk G1

Interface-driven unusual anomalous Hall effect in MnxGa/Pt bilayers

*K. K. Meng, Y. Jiang **
(11point, Times New Roman, Name of the presenting author is underlined.)
Beijing Advanced Innovation Center for Materials Genome Engineering, School of Materials Science and Engineering, University of Science and Technology Beijing, Beijing, China
** Corresponding author: yjiang@ustb.edu.cn*

The effects of spin-orbit coupling and symmetry breaking at the interface between a ferromagnet and heavy metal are particularly important for spin-based information storage and computation. Recent discoveries suggest they can create new types of magnetic states such as chiral spin structures, which have often been identified through the appearance of the bump/dip features of Hall signals, the so-called topological Hall effect (THE). In this work, however, we have present an unusual anomalous Hall effect (UAHE) in MnxGa/Pt bilayers and demonstrated that the features extremely similar to THE can be generated without involving chiral spin structures. The magnetic force microscopy (MFM) has been used to explore the magnetic field-dependent behavior of spin structures, and the UAHE as a function of magnetic field at the low temperature limit does not peak near the maximal density of magnetic bubbles. Therefore, the UAHE shows no correlation with chiral spin structures but is driven by the modified interfacial properties. Our work firmly demonstrated that the bump/dip features of Hall signals cannot be taken as an unambiguous signature for chiral spin structures, and it should be treated discreetly since a wealth of underlying and interesting physics are often easily missed.

Notes

Invited Talk G2

Single crystalline metal/semiconductor heterostructures grown by molecular beam epitaxy

*Kedong Zhang, [1] Yuanfeng Ding, [1] Jinshan Yao, Chen Li, [1] Hong Lu [1,2,]**
[1] National Laboratory of Solid State Microstructures, and College of Engineering and Applied Sciences, Nanjing University, Nanjing 210093, China
[2] Jiangsu Key Laboratory of Artificial Functional Materials, Nanjing 210093, China

** Corresponding author: hlu@nju.edu.cn*

Metal/semiconductor heterostructures are an important material platform for both fundamental studies such as interface and band engineering, and functional device design and fabrication in practice, for example, Schottky diodes. To realize high quality metal/semiconductor heterostructures and atomic level control of the interface, ultra high vacuum (UHV) techniques such as molecular beam epitaxy (MBE) need to be employed. At Nanjing University, we are interested in developing MBE technique to grow and engineer "new" metals and metal/semiconductor heterostructures, and study their properties and applications. In this talk, I will introduce the single crystalline metals and semimetals grown on semiconductors and focus on the strain engineering on alpha tin (α-Sn), also known as gray tin, and interface engineering on aluminum (Al), and their potential applications.

References
H. Song, J. Yao, Y. Ding, et al. Adv. Eng. Mater. 21, 1900410 (2019).

Notes

Invited Talk G3

DNA shapes-driven assembly of ordered nano-structures

*Ye Tian [1,]**
[1] College of Engineering and Applied Sciences, Nanjing University, China, 201193
** Corresponding author: ytian@nju.edu.cn*

Three-dimensional nanoparticle clusters are often considered to be mesoscale analogues of molecules. These mesoscale structures allow for tailoring the individual functional properties of nanoparticles due to the collective and proximity effects. However, creating such clusters with precisely pre-determined positions of particles is challenging. In this presentation, we will report a novel assembly approach, in which the designed 3D DNA frames with encoded vertices permit spatial arrangement of nanoparticles in 3D nano-architectures. The frame is an octahedron fabricated by DNA origami technique with functional vertices that bind in addressable manner DNA coated gold nanoparticles. Clusters of various symmetries and compositions will be demonstrated. The DNA octahedron can also be served as a programmable linker for assembly of 1D, 2D arrays and even 3D crystalline. Furthermore, we demonstrated that same set of particles can be oriented into different crystallographic lattice by geometrical shapes of DNA polyhedral frames.

References
[1] Tian, Y., et al. Nature Nanotech. 2015, 10: 637.
[2] Tian, Y.; et al. Nature Mater. 2016, 15: 654.
[3] Tian, Y.; et al. Nature Mater. 2019, accepted.

Notes

Invited Talk G4

Ultrahigh-Resolution Combinatorial Patterning of Functional Nanoparticles

Xing Xing, Zaiqin Man, Weihua Zhang, Zhenda Lu**
National Laboratory of Solid State Microstructures, Jiangsu Key Laboratory of Artificial Functional Materials, College of Engineering and Applied Sciences, Nanjing University, Nanjing 210093, China.
** Corresponding author: zwh@nju.edu.cn; luzhenda@nju.edu.cn*

Fast, low-cost, reliable and multi-component nanopatterning techniques for functional colloidal nanoparticles have been dreamed by scientists and engineers for decades. Although countless efforts have been devoted, it is still a daunting challenge to organize different nanocomponents into a predefined structure with nanometer precision over millimeter and even larger scale. To meet the challenge, we report a nanoprinting technique, which can print various functional colloidal nanoparticles into arbitrarily defined patterns with a 200 nm (or smaller) pitch (↑ 125, 000 DPI), 30 nm (or larger) pixel size/linewidth, 10 nm position accuracy and 50 nm overlay precision. The nanoprinting technique combines dielectrophoretic enrichment and deep surface-energy modulation, therefore features a high efficiency and extraordinary robustness. It can form nanostructures over millimeter scale by simply spinning, brushing or dip coating colloidal "nanoink" onto a substrate with minimum error (error ratio ↓ 2×10-6). This technique provides a powerful yet simple construction tool for large-scale positioning and integration of multiple functional nanoparticles toward next-generation optoelectronic and biomedical devices.

References

(1) Wang, PI Zhang*, S Gao, M Zhang & AI Kirkland, Electron Ptychographic Diffractive Imaging of Boron Atoms in LaB6 Crystals, Scientific Reports, 7, 2857 (2017).
(2) Song, J; CS Allen, S Gao, C Huang, H Sawada, X Pan, J Warner, P Wang* & AI Kirkland, Atomic Resolution Defocused Electron Ptychography at Low Dose with a Fast, Direct Electron Detector, Scientific Reports, 9, 3919 (2019).
(3) Gao, S; P Wang*, F Zhang*, GT Martinez, PD Nellist, X Pan & AI Kirkland, Electron ptychographic microscopy for three-dimensional imaging, Nature Communications, 8, 163 (2017).
(4) Song, B; Z Ding, CS Allen, H Sawada, F Zhang, X Pan, J Warner, AI Kirkland & P Wang*, Hollow Electron Ptychographic Diffractive Imaging, Physical Review Letters, 121, 146101 (2018).

Notes

Invited Talk H1

Topological phase transitions in spin-orbit photonics

*Lei Zhou**
Department of Physics, Fudan University, Shanghai 200438, China
** Email: phzhou@fudan.edu.cn*

We establish a unified framework to understand two distinct spin-orbit-coupling (SOC) – induced effects discovered in beam scatterings at optical interfaces (i.e., the vortex generation and photonic spin Hall effect) on the same foot, and further predict that an intriguing phase transition between them can happen under certain conditions. We show that for an incident beam striking at an optical interface, whereas some wave components inside the beam can gain Berry phases generating an optical vortex, the remaining wave components gain Berry phases contributing a spin-Hall shift, and thus the competitions between these two effects lead to many fascinating effects. Intriguingly, the strengths of these two terms can be efficiently tuned by varying the incident angle and width of the beam, dictated by the topology changes of different k-cones inside the beam. We finally describe more implications and applications of our discovery.

References

(1) Xiaohui Ling, et. al., manuscript in preparation

Notes

Invited Talk H2

Bragg-Berry Reflective Flat Optics based on Chiral Liquid Crystals

Hiroyuki Yoshida,[1,] SeongYong Cho,[1] Ryotaro Ozaki,[2] and Masanori Ozaki[1]*
[1] Division of Electrical, Electronic, and Information Engineering, Osaka University, 2-1 Yamadaoka, Suita, Osaka, 565-0871 Japan
[2]Graduate School of Science and Engineering, Ehime University,
*[3] Bunkyo-cho, Matsuyama 790-8577, Japan * Corresponding author: yoshida@eei.eng.osaka-u.ac.jp*

Conventional optical systems guide light using bulky elements such as lenses and mirrors, but the spread of wearable devices is pushing the need for miniature optical elements that control light. Diffractive optical elements (DOEs) in which light transmission or reflection characteristics is determined by the structural design is becoming more common in optical systems. Recent advances in nanofabrication techniques are opening new frontiers in diffractive devices, as they enable multiple optical functions to be integrated in a single device, based on the metasurface concept.

Liquid crystal (LC) materials with self-organized birefringent structures, on the other hand, enable fabrication of DOEs without the need of complex nano-fabrication methods. Their operation is based on the Pancharatnam-Berry phase or geometric phase, in which light propagating through a birefringence medium acquires a phase that is proportional to the azimuthal orientation of the optic axis. The nematic LC phase, which acts as a uniaxial birefringent medium, enables transmissive DOEs to be fabricated [1], whereas chiral LC phases forming a helical superstructure enables reflective diffractive devices, referred to as holographic optical elements (HOEs) or Bragg-Berry optical elements (BBOEs), to be fabricated [2].

Figure 1shows a schematic of the LC-based BBOE. The patterning of the LC orientation on a substrate maintains the helical structure of the chiral LC, but rotates its structural phase (the helix phase). Numerical simulations reveal that for a π rotation in the helix phase, a 2π modulation occurs in the optical phase of Bragg-reflected light, similar to the Pancharatnam-Berry phase effect for transmissive devices (thus the Bragg-Berry effect). A wavelength-selective reflector with diffraction capability can therefore be achieved by appropriately designing the helix phase distribution, for example, using an algorithm for computer-generated hologra-phy (CGH). Devices such as deflectors, lenses, optical vortex generators, and diffusers have been demonstrated, as well as a hologram capable of reconstructing images. [3-5]

BBOEs possess interesting properties that are not seen in standard HOEs. Because of the helical structure, the Bragg-Berry effect is circular polarization selective, only affecting light with the same circular handedness as the helical superstructure. Patterning different patterns on the two sides of the device leads to an asymmetric device, where different wavefronts are reconstructed depending

NJU-Wiley Joint Conference on Metamaterials and Advanced Applications, Nanjing,
China, Nov. 29-Dec. 1, 2019

on the direction of light illumination [4]. Finally, the helical modulation in dielectric tensor suppresses high-order reflections, enabling the fabrication of transparent and colorless holograms.

Among the various platforms available for DOEs, LCs possess properties such as high stability, optical transmittance, and solution processability, which make them attractive candidates for practical applications. In the presentation, an overview of the BBOE technology will be given and its prospects discussed.

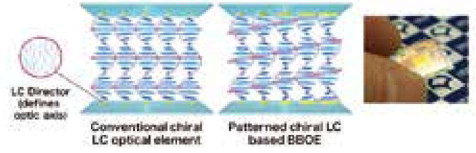


Figure 1 Schematic illustration and photo of the LC-based BBOE

References

(1) L. Marrucci, C. Manzo, and D. Paparo, Phys. Rev. Lett. 96, 163905 (2006).
(2) J. Kobashi, H. Yoshida, and M. Ozaki, Nat. Photon., 10, 389-392 (2016).
(3) J. Kobashi, Y. Mohri, H. Yoshida, and M. Ozaki, Opt. Data Process. Storage 3, 61-66 (2017).
(4) J. Kobashi, H. Yoshida, and M. Ozaki, Sci. Rep. 7, 16470 (2017).
(5) Y. Mohri, J. Kobashi, H. Yoshida, and M. Ozaki, Adv. Opt. Mater. 5, 1601071 (2017).

Acknowledgements

We thank DIC Corporation, JSR Corporation, and BASF Japan Corporation for providing materials. This work was partly supported by JST PRESTO (JPMJPR151D), MEXT KAKENHI (17H02766, 19H02581), and Osaka University Innovation Bridge Grant.

Notes

Invited Talk H3

Flexible optoelectronic and optomechanical fiber devices based on two-dimensional materials

*Yi-feng Xiong, Jin-hui Chen and Fei Xu**
National Laboratory of Solid State Microstructures, College of Engineering and Applied Sciences, Collaborative Innovation Center of Advanced Microstructures
** Corresponding author: feixu@nju.edu.cn*

All-fiber optoelectronic/ optomechanical devices have attracted great interest, however, most of those applications are severely limited because of the challenge of integrating optoelectronic materials (e.g., silicon and germanium) onto standard silica fibers. On the other hand, tow-dimensional materials (TDMs) exhibit many extraordinary optoelectronic and mechanical properties, are well suited for integration in not only planar photonic circuits but also optical fibers especially microfibers. Microfibers with strong evanescent field are attractive for TDM integration, which can be realized by integrating different TDMs onto a microfiber end face, covering or wrapping a TDMs-sheet on a straight microfiber and even wrapping a microfiber on a TDMs-coated rod. Here we will show several kinds of 1D and 3D TDM-microfiber-integrated devices and the optoelectronic and optomechanical applications (e.g., NEMS, modulator, detector and sensor) will also be discussed. In particular, an attachable and flexible smart sensor consisting of a hybrid TDM-microfiber resonator is demonstrated as ultrasensitive and wearable photonic sensor which covers the detection of strain and pressure.

Notes

Invited Talk H4

Modulation of Topological Zero Modes in Finite Non-Hermitian Optical Lattices

Wange Song, [1] Wenzhao Song, [2] Shumin Xiao, [2] Shining Zhu, [1] Tao Li[1,]*
[1] College of Engineering and Applied Sciences, Nanjing University, Nanjing, 210093, China.
[2] State Key Laboratory on Tunable Laser Technology, Shenzhen Graduate School, Harbin Institute of Technology, Shenzhen, 518055, China
** Corresponding author: taoli@nju.edu.cn*

Topological edge states enable photonic systems with robust behaviors in light localization or propagation that significantly benefits the on-chip photonic routings. While, these edge states tend to be coupled together as the system size decreases, which usually leads to loosed topological protection. Therefore, it is of great importance to study the coupling and decoupling properties between the edges states. In this work, we provide solid evidences of the breakup of zero mode in 1D topological waveguide lattice due to the coupling in finite system, and proposed a solution to recover the exact-zero mode by introducing the non-Hermitian degeneracy with Parity-Time symmetry (1). This finding deepens the understanding on the coupling of topological edge states, and is of general significance not only limited in 1D topological systems but also 2D and others systems.

References

(1) Song, W. G.; Sun, W. Z.; Chen, C.; Song, Q. H.; Xiao, S. M.; Zhu S. N.; Li, T. Phy. Rev. Lett. (2019) accepted.

Notes

Invited Talk K1

Quasi-omnidirectional Silicon Solar Cells

*Wenzhong Shen**
Institute of Solar Energy, Shanghai Jiao Tong University, China
**Corresponding author: wzshen@sjtu.edu.cn*

Semiconductor nanostructures possess outstanding broadband and omnidirectional antireflection ability, which are promising to be adopted in solar cells to form omnidirectional solar cells for enhancing electric energy output over broad incident angle of the sunlight. This invited talk presents our recent achievements on quasi-omnidirectional silicon solar cells via employing Si nanopyramids (SiNPs) as surface texture. SiNPs are produced by our proposed metal-assisted alkaline etching method, which is an all-solution-processed method and highly simple together with cost-effective. We will show that both the SiNPs-textured homojunction and heterojunction solar cells possess higher daily electric energy production with a maximum relative enhancement approaching 2.0%, when compared to their the conventional Si micropyramids-textured counterparts. The quasi-omnidirectional silicon solar cells open a new opportunity for photovoltaics to produce more electric energy with low cost.

References

(1) Sihua Zhong, Wenjie Wang, Yufeng Zhuang, Zengguang Huang, and Wenzhong Shen, All-solution-processed random Si nanopyramids for excellent light trapping in ultrathin solar cells, Advanced Functional Materials 26, 4768-4777 (2016).
(2) Sihua Zhong, Wenjie Wang, Miao Tan, Yufeng Zhuang, and Wenzhong Shen, Realization of quasi-omnidirectional solar cells with superior electrical performance by all-solution- processed Si nanopyramids, Advanced Science 4, 1700200-(1-9) (2017).
(3) Haiyuan Xu, Sihua Zhong, Yufeng Zhuang, and Wenzhong Shen, Controllable nanoscale inverted pyramids for highly efficient quasi-omnidirectional crystalline silicon solar cells, Nanotechnology 28, 365402-(1-12) (2018).
(4) Y. F. Zhuang, S. H. Zhong, H. Y. Xu, and W. Z. Shen, Broadband spectral response of diamond wire sawn mc-Si solar cell with omnidirectional performance and improved appearance, Solar Energy Materials and Solar Cells 179, 372-379 (2018).
(5) Y. Li, S. H. Zhong, Y. F. Zhuang, L. F. Yang, F. Y. Meng, W. J. Wang, Z. P. Li, and W. Z. Shen, Quasi-omnidirectional ultrathin silicon solar cells realized by industrially compatible processes, Advanced Electronic Materials 5, 1800858-(1-7) (2019).

Notes

Invited Talk K2

Emerging Energy Chemistry of Li Metal Anode in Safe Batteries

*Qiang Zhang**
Beijing Key Laboratory of Green Chemical Reaction Engineering and Technology, Department of Chemical Engineering, Tsinghua University, Beijing, 100084
**zhang-qiang@mails.tsinghua.edu.cn Phone +86 (10) 6278-9041,*
http://www.researcherid.com/rid/B-1799-2012

Li metal is considered as the "Holy Grail" of energy storage systems. The bright prospects give rise to worldwide interests in the metallic Li for the next generation energy storage systems, including highly considered rechargeable metallic Li batteries such as Li-O2 and Li-sulfur (Li–S) batteries. However, the formation of Li dendrites induced by inhomogeneous distribution of current density on the Li metal anode and the concentration gradient of Li ions at the electrolyte/electrode interface is a crucial issue that hinders the practical demonstration of high-energy-density metallic Li batteries.

In this talk, we review energy chemistry of lithium metal anode in safe batteries. Firstly, the importance and dilemma of Li metal anode issues in lithium–sulfur batteries are underscored, aiming to arouse the attentions to Li metal anode protection. Specific attentions are paid to the surface chemistry of Li metal anode. Next, the proposed strategies to stabilize solid electrolyte interface and protect Li metal anode are included. Finally, a general conclusion and a perspective on the current limitations, as well as recommended future research directions of Li metal anode in rechargeable batteries are presented.

References

[1] Cheng XB, Zhang R, Zhao CZ, Zhang Q*. Chemical Reviews 2017, 117, 10403–10473.
[2] Cheng XB, Huang JQ, Zhang Q*. Journal of the Electrochemical Society 2018, 165, A6058-A6072.
[3] Chen X, Shen X, Li B, Peng HJ, Cheng XB, Li BQ, Zhang XQ, Huang JQ, Zhang Q*. Angewandte Chemie International Edition 2018, 57, 734-737
[4] Zhang XQ, Chen X, Cheng XB, Li BQ, Shen X, Yan C, Huang JQ, Zhang Q*. Angewandte Chemie International Edition 2018, 57, 5301-5305
[5] Zhang R, Chen XR, Chen X, Cheng XB, Zhang XQ, Yan C, Zhang Q*. Angewandte Chemie Interational Edition 2017, 56, 7764–7768
[6] Peng HJ, Huang JQ, Liu XY, Cheng XB, Xu WT, Zhao CZ, Wei F, Zhang Q*. Journal of the American Chemical Society 2017, 139 (25), 8458–8466.
[7] Chen X, Hou TZ, Li B, Zhu L, Yan C, Cheng XB, Peng HJ, Huang JQ, Zhang Q*. Energy Storage Materials 2017, 8, 194-201.
[8] Cheng XB, Yan C, Chen X, Guan C, Huang JQ, Peng HJ, Zhang R, Yang ST, Zhang Q*. Chem 2017, 2, 258-270.
[9] Zhang XQ, Cheng XB, Chen X, Yan C, Zhang Q*. Advanced Functional Materials 2017, 27, 1605989.
[10] Zhao CZ, Cheng XB, Zhang R, Peng HJ, Huang JQ, Ran R, Huang ZH, Wei F, Zhang Q*. Energy Storage Materials 2016, 3, 77-84.
[11] Cheng XB, Hou TZ, Zhang R, Peng HJ, Zhao CZ, Huang JQ, Zhang Q*. Advanced Materials 2016, 28, 2888-2895.
[12] Zhang R, Cheng XB, Zhao CZ, Peng HJ, Shi JL, Huang JQ, Wang JF, Wei F, Zhang Q*. Advanced Materials 2016, 28, 2155-2162.
[13] Cheng XB, Zhang R, Zhao CZ, Wei F, Zhang JG, Zhang Q*. Advanced Science 2016, 3, 1500213.
[14] Cheng XB, Peng HJ, Huang JQ, Zhang R, Zhao CZ, Zhang Q*. ACS Nano 2015, 9(6), 6373–6382.
[15] Cheng XB, Huang JQ, Peng HJ, Wei F, Zhang Q*. Small 2014, 10(21), 4257-4263

Notes

Invited Talk K3

二维材料表界面化学与能源小分子催化转化

邓德会*
（中国科学院大连化学物理研究所，催化基础国家重点实验室，大连，116023；
厦门大学，能源材料化学协同创新中心，厦门，361005；
Email: dhdeng@dicp.ac.cn）

贵金属替代催化剂已成为电催化和传统多相催化中一个重要的研究课题。然而，非贵金属稳定性较差，尤其是在强酸性、强碱性、高的过电位或高温下容易导致非贵金属催化剂的腐蚀、氧化或烧结，从而造成催化剂的不稳定，甚至失活，严重制约了非贵金属催化剂在苛刻反应条件下的应用，急需在催化材料、催化过程和催化概念上的创新研究。近年来，以石墨烯、硫化钼等为代表的二维材料引起了催化研究学者的广泛关注，这些材料电子结构独特、比表面积高、结构稳定，从而为催化剂的设计和开发带来新的机遇。报告人与研究团队结合二维催化材料表界面调控，针对能源小分子（CH_4、CO、H_2O等）转化的难题和挑战开展研究，并取得系列重要进展：1）提出"铠甲催化"概念，为苛刻条件下高稳定催化剂的设计提供了新途径；2）实现甲烷室温直接催化转化，为其温和条件下的转化提供了借鉴；3）实现室温电化学水气变换反应，为低能耗生产高纯氢气提供了新思路。

参考文献：

[1] R. X. Chen, H.-Y. Su, D. H. Deng*, et al. Angew. Chem. Int. Ed. 2019, in press;
[2] M. Zhang, J. Guan, D. H. Deng*, et al. Energy Environ. Sci. 2019, in press;
[3] X. G. Meng, D. H. Deng*, et al. Chem 2019, 5, 2296;
[4] L. Tang, D. H. Deng*, et al. Adv. Mater. 2019, 1901996;
[5] X. J. Cui, H. Y. Su, R. X. Chen, D. H. Deng*, et al. Nature Commun. 2019, 10, 86;
[6] Y. Wang, J. Mao, D. H. Deng*, X. H. Bao*, et al. Chem. Rev. 2019, 119, 1806;
[7] Z. Zheng, J. Xiao, D. Deng*, et al. Angew. Chem. Int. Ed. 2018, 57, 16339;
[8] X. J. Cui, D. H. Deng*, X. H. Bao*, et al. Chem 2018, 4, 1902;
[9] S. J. Xie, J. Cheng*, D. H. Deng*, Y, Wang*, et al. Nature Commun. 2018, 9, 1181;
[10] J. Deng, D. H. Deng*, X. H. Bao*, et al. Nature Commun. 2017, 8, 14430;
[11] J. Deng, D. H. Deng*, X. H. Bao*, Adv. Mater. 2017, 29, 1606967;
[12] D. H. Deng, K. S. Novoselov*, Z. Q. Tian*, X. H. Bao*, et al. Nature Nanotech. 2016, 11, 218;
[13] D. H. Deng*, X. Q. Chen, X. H. Bao*, et al. Science Adv. 2015, 1, e1500462;
[14] X. J. Cui, J. Xiao, D. H. Deng*, W. H. Zhang*, et al. Angew. Chem. Int. Ed. 2016, 55, 6708;
[15] J. Deng, P. J. Ren, D. H. Deng*, X. H. Bao*, Angew. Chem. Int. Ed. 2015, 54, 2100;
[16] X. J. Zheng, J. Deng, D. H. Deng*, W. H. Zhang*, et al. Angew. Chem. Int. Ed. 2014, 53, 7023;
[17] D. H. Deng, X. L. Pan*, X. H. Bao*, et al. Angew. Chem. Int. Ed. 2013, 52, 371;
[18] X. J. Cui, P. J. Ren, D. H. Deng*, X. H. Bao*, et al. Energy Environ. Sci. 2016, 9, 123;
[19] J. Deng, H. B. Li, D. H. Deng*, X. H. Bao*, et al. Energy Environ. Sci. 2015, 8, 1594;
[20] J. Deng, P. J. Ren, D. Deng*, X. Bao*, et al. Energy Environ. Sci. 2014, 7, 1919.

Notes

Invited Talk K4

Porous Monolith of Graphene for Electrochemical Energy Storage and Conversion

*Xuebin Wang**
National Laboratory of Solid State Microstructures, Collaborative Innovation Center of Advanced Microstructures, College of Engineering and Applied Sciences, Nanjing University, Nanjing 210093, China
** Corresponding author: Wangxb@nju.edu.cn*

High-surface-area conductive cellular carbon monolith, instead of traditional Ni/Ti foams or carbon cloths, is desired as the optimal electrode in electrochemistry, owing to lightweight, high surface area, conductivity, stability, and opulence of carbon. 3D network can improve energy and power in both non-Faradaic and Faradaic processes, e.g. capacitors, batteries, and electrocatalyses. The ultimate version of porous carbons, when pore-wall thins down to mono/few-atomic layers, is conceptually 3D graphene with the largest surface. 3D graphene plays a crucial role to deliver nanoscaled advantages of individuals to macroscopic bulks, and it can realize the unprecedented surface, mechanical, and electronic characteristics. We herein have developed several new syntheses based on the carbonization of organics, which routes are probably the most cost-effective, for producing the advanced 3D graphenes. The routes include the tiering pyrolysis [1], the oxidation-aminolysis method [2], and the blowing route [3,4]. Our created 3D graphenes possess the excellent surface area, conductivity, and mechanics, which equip electrodes and fillers for electrochemical capacitor, battery, electrocatalysis, thermal management, sorption and separation [1-4].

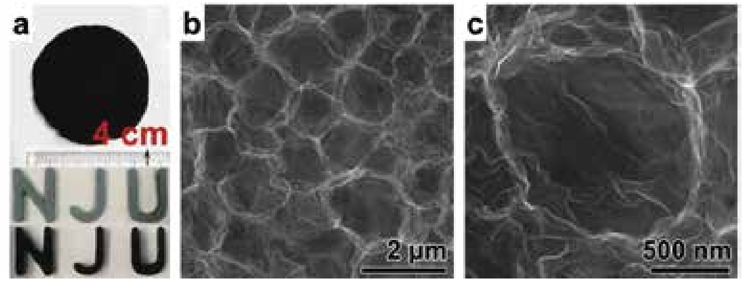


Figure 1. A type of 3D graphene monolith for the general monolithic electrochemical electrode.

References
(1) Jiang, X.F.; Li, R.Q; Hu, M.; Hu, Z., Golberg, D.; Bando, Y.; Wang, X.B.* Adv. Mater. 2019, 31, 1901186.
(2) Gao, T.; Zhang, R.; Li, R.Q.; Xu, C.Y.; Wang, B.L.; Jiang, X.F.; Hu, M., Bando, Y.; Kong, D.S.; Wang, X.B.* ACS Nano 2019, 10.1021/acsnano.9b05978.
(3) Li, R.Q.; Wang, B.L.; Gao, T.; Zhang, R.; Xu, C.Y.; Jiang, X.F.; Zeng, J.J; Bando, Y.; Hu, P.F.; Li, Y.L.; Wang, X.B.* Nano Energy 2019, 58, 870.
(4) Wang, X.B.;* Jiang, X.F.; Bando, Y. Blowing route towards advanced inorganic foams [Invited Account] Bull. Chem. Soc. Jpn. 2019, 92, 245.

Notes

Invited Talk L1

Towards High-Performance Light-Emitting Didoes Based on Quantum Dots

Yizheng Jin
Department of Chemistry, Zhejiang University, China

Quantum dots (QDs) are a unique class of emitters with size-tunable emission wavelengths, saturated emission colors, near-unity luminance efficiency, inherent photo- and thermal- stability and excellent solution processability. In the past few years, efficiency and lifetime of quantum-dot light-emitting diodes (QLEDs) achieved tremendous progresses. These encouraging facts foreshadow the commercialization of QLEDs, which promises an unprecedented generation of cost-effective, large-area, energy-saving, wide-color-gamut, ultra-thin and flexible displays [1]. Here we review our activities associated with QLEDs, including material chemistry of charge-transporting layers and device optimization [2-4]. In addition, we use the recent developed single-dot electroluminescence device [5] as a model system to investigate the unique exciton formation processes of a single quantum dot under electrical injection [6].

References
[1] X. Dai, Y. Deng, X. Peng, Y. Jin*. Adv. Mater. 2017, 29, 1607022.
[2] X. Dai, Z. Zhang, Y. Jin*, Y. Niu, H. Cao, X. Liang, L. Chen, J. Wang, X. Peng*. Nature 2014, 515, 96.
[3] Z. Zhang, Y. Ye, C. Pu, Y. Deng, X. Dai, X. Chen, D. Chen, X. Zheng, Y. Gao, W. Fang, X. Peng*, Y. Jin*. Adv. Mater. 2018, 30, 1801387.
[4] J. Lin, X. Dai, X. Liang, D. Chen, X. Zheng, Y. Li, Y. Deng, H. Du, Y. Ye, D. Chen, C. Lin, L. Ma, Q. Bao, H. Zhang, L. Wang, X. Peng, Y. Jin*. Adv. Func. Mater. Accepted.
[5] X. Lin, X. Dai, C. Pu, Y. Deng, Y. Niu, L. Tong, W. Fang*, Y. Jin*, X. Peng*, Nat. Comm. 2017, 8, 1132.
[6] Y. Deng, X. Lin, W. Fang, D. Di, L. Wang, R. H. Friend, X. Peng*, Y. Jin*. Submitted.

Notes

Invited Talk L2

All-dielectric metasurfaces and their applications at visible frequencies

*Qingbin Fan, [1] Pengcheng Huo, [1] Wenqi Zhu[2], Henri Lezec[2], Ting Xu [1,]**
[1] National Laboratory of Solid State Microstructures, College of Engineering and Applied Sciences and Collaborative Innovation, Center of Advanced Microstructures, Nanjing University, Nanjing 210093, China
[2] National Institute of Standards and Technology, Gaithersburg, Maryland 20899,United States
** Corresponding author: xuting@nju.edu.cn*

All-dielectric metasurfaces have gained significant attention in recent years due to their capability of fully controlling wave-font of light with extremely low losses [1-2]. For dielectric metasufaces, the wavefront engineering of light typically relies on the modulation effect of either waveguide phase or geometric phase, which can be realized by designing the nanostructures' lateral dimension and orientation angle of major axis relative to the reference coordinate, respectively. In this talk, I will introduce several researches on the visible dielectric metasurfaces recently performed in our labs, including photonic-spin controlled metasurface accelerating light beams generator and switchable phase contrast imaging. The single layer and ultrathin architecture of the metasurfaces realized here enables a low-cost, scalable and integration friendly platform for light field manipulation.

References
(1) Arbabi, A.; Horie, Y.; Bagheri, M.; Faraon, A. Nat. Nanotechnol. 2015, 10, 937–943.
(2) Khorasaninejad, M.; Chen, W. T.; Devlin, R. C.; Oh, J.; Zhu, A. Y.; Capasso, F. Science 2016, 352, 1190–1194.

Notes

Invited Talk L3

Nanophotonic materials: from sensing to imaging

*Jie Bian and Weihua Zhang**
College of Engineering and Applied Sciences, National Laboratory of Solid State Microstructures, Jiangsu Key Laboratory of Artificial Functional Materials, MOE Key laboratory of Intelligent Optical Sensing and Manipulation, Nanjing University, Nanjing 210093, China.
** Corresponding author: zwh@nju.edu.cn*

Nanophotonic materials and structures are often sensitive to their local environments, and exhibit strong responses to environmental changes or external stimulations. This unique property makes them an ideal system for building high performance nano-transducers, which can convert energy/information into different forms with high efficiency. In our group, we harness this capacity of nanophotonic materials and construct novel sensing and imaging tools. In this talk, we will present three different examples, (1) the metasurface-inspired refractive index sensor which can be directly read by smartphones[1], (2) high performance plasmonic substrate for substrate-assisted laser desorption/ionization mass spectrometry [2], and (3) scanning quantum dot based optical nanoscopy for super-resolution imaging [3,4]

References
(1) Bian, J. et al. Nanoscale, 2019, 11, 12471.
(2) Zhu, J. J. et al. PhysChemChemPhys, 2018, 20, 3424.
(3) Qian, Y. et al. Nanotech. 2017, 28, 46LT02.
(4) Pan, B. et al. Opt. Comm. 2019, 445, 273.

Notes

Invited Talk L4

Nanophotonic designs of plasmonic metals for advanced energy devices

Yan Jin, Yang Wang, Lin Zhou, Jia Zhu**
National Laboratory of Solid State Microstructures, College of Engineering and Applied Sciences, School of Physics, Key Laboratory of Intelligent Optical Sensing and Integration, Ministry of Education, Nanjing University, Nanjing 210093, P. R. China.
** Corresponding author: linzhou@nju.edu.cn, jiazhu@nju.edu.cn*

Plasmonic nanostructures have attracted tremendous interest due to the unique capability of subwavelength confinement of electromagnetic waves, which are unavoidably suffering from ohmic loss of metals. On the other hand, plasmonic metals are ideal candidates for nanostructured energy devices by fully utilizing the plasmon based photothermal effect of free electrons as the energy and/or information carriers. By rational designing the metallic nanostructures and engineering the full spectrum of light absorption, here we demonstrate several types of plasmonic metals for advanced energy devices, such as interfacial solar water purification, solar thermos-photovoltaics as well as alkali metal batteries, etc.

Notes

Invited Talk M1

Fabrication and Multifunctional Regulations of Magnetic Nanomaterials

Yanglong Hou[†,‡,⊥]
[†]*Beijing Key Laboratory for Magnetoelectric Materials and Devices (BKLMMD), ‡ Beijing Innovation Center for Engineering Science and Advanced Technology (BIC-ESAT),*
[⊥]*College of Engineering, Peking University, Beijing 100871, China*

Magnetic nanomaterials (MNMs) have attracted great interests in the past few decades due to their unique properties and novel physical effects resulted from nanoscale. To understand the fundamental behavior of nanomagnetism and develop relevant potential applications, various preparation routes have been explored to produce MNMs with desired features and structures, among which chemical synthesis process, especially high-temperature organic liquid phase method, plays an indispensable role in which the microstructures and physical/chemical properties of MNMs can be tuned by controlling the reaction conditions such as precursor, surfactant, solvent, reaction temperature or time, protection atmosphere, etc. In this talk, we first introduce the fundamental of high-temperature organic liquid phase method, and present recent progress on the synthesis of various of MNMs, including monocomponent nanostructures (like metals, metal alloys, metal oxides/carbides) and multicomponent nanostructures (heterostructures and exchange-coupled nanomagnets). Particularly, the latter type not only retains the intrinsic functionalities from each single component, but also possesses the synergistic properties that benefitted from interfacial coupling, improving magnetic, optical or catalytic features. After that we will discuss the multifunctional regulations of MNMs in biomedicine and catalysis. Except of conventional MNMs, i.e. Fe_3O_4, one kind of representative iron carbides, have exhibited multifunctional properties. On the one hand, iron carbide NPs hold magnetic characteristic, can be employed as magnetic courtpart for as contract agents for T_2-weighted MRI and photoacoustic imaging (PAI) even for photothermal therapy (PTT) under NIR irradiation for ablating tumors effectively. To enhance cancer therapeutic efficiency, anticancer drug doxorubicin is loaded into bovine serum albumin coated iron carbide NPs, combining PTT with chemotherapy. Such nanoplatform can respond to NIR and acidic environments, and exhibit burst drug release. On the other hand, one kind of iron carbides, Fe_5C_2 NPs exhibited excellent catalytic performance for the Fischer–Tropsch synthesis, either in efficiency or selectivity. In summary, we overview the rational design, fabrications of magnetic nanomaterials, and give perspectives in great potential applications of these materials in biomedicine and nanocatalysis.

Notes

Invited Talk M2

Advanced Energy Storage Materials and Batteries Based on Multi-Electron Redox Processes

Zhong Jin[1,]*
[1]Nanjing University, #163 Xianlin Ave., Nanjing 201123, Jiangsu, China
**Corresponding author: zhongjin@nju.edu.cn*

To develop clean energy technologies is an important demand of global society. After decades of development, the energy density and cycling stability of traditional lithium ion batteries has reached the bottleneck. In order to improve the overall performances of electrochemical energy storage devices, the research of other secondary batteries as alternative options, such as Li-S batteries, Na/Mg/Al-ion batteries and redox flow batteries, has attracted extensive interests. To improve the key performances of these batteries, it is essential to study the operating principle and structural design of the electrode materials. Moreover, to overcome the limited charge transfer properties, kinetically slow dynamics and poor interfacial stability of existing electrode materials, the researches of interface engineering, charge/ion transfer and microscopic reaction processes are very important. In recent years, our research group has been focusing on the design of novel electrode materials and energy storage devices based on multi-electron redox progresses. The ion storage mechanism and electrochemical kinetic performances of Li-S batteries, Mg-ion batteries and organic redox flow batteries have been investigated through experimental characterizations and theoretical simulations.

References

1. W. Yan, , Z. Jin* et al., Nature Commun. 2019, 10, 2513.
2. Y. Wang, Z. Jin* et al., Adv. Mater. 2018, 30(32), 1802563.
3. X. Xue, Z. Jin* et al., Adv. Energy Mater. 2019, 9, 1900145.
4. G. Zhu, Z. Jin* et al., Adv. Funct. Mater. 2018, 28(18), 1800003.
5. T. Chen, Z. Jin* et al., J. Am. Chem. Soc. 2017, 139(36), 12710-12715.
6. C. Wang, Z. Jin* et al., ACS Energy Lett. 2018, 3(10), 2404-2409.
7. Y. Wang, Z. Jin* et al., ACS Nano 2018, 12(12), 12492-12502.
8. L. Ma, Z. Jin* et al., ACS Nano 2018, 12(5), 4868-4876.
9. L. Ma, Z. Jin* et al., ACS Nano 2017, 11(7), 7274-7283.
10. L. Ma, Z. Jin* et al., Nano Lett. 2018, 18(12), 7949-7954.
11. L. Ma, Z. Jin* et al., Nano Lett. 2017, 17(12), 7839-7846.
12. T. Chen, Z. Jin* et al., Nano Lett. 2017, 17(1), 437-444.

Notes

Invited Talk M3

Title Research on Mechanism of electrochemical reaction at Interface of Li-O2 battery in Complex Systems

*Ping He**
Center of Energy Storage Materials & Technology, College of Engineering and Applied Sciences, National Laboratory of Solid State Microstructures and Collaborative Innovation Center of Advanced Microstructures, Nanjing University, Nanjing 210093, China.
** Corresponding author: pinghe@nju.edu.cn*

The comprehensive performance of Li-air batteries is still far from practical application at present, including the cycle life, rate capability, energy conversion efficiency and so on. Further investigations on fundamental theories concerning Li-air batteries are required to promote these properties. The Li-air battery is a half-open system. During the battery operation, the process of material exchange proceeds between the open cathode and atmosphere. Since dry oxygen is incorporated into the research system, it is set as "battery-oxygen" system. During the process of discharge, the Li anode loses electrons forming Li+ and oxygen acquires electrons and reacts with Li+ to form Li2O2 at cathode. In the subsequent process of charge, it happens inversely to above reactions that Li2O2 decomposes at high voltage, producing O2 and Li at cathode and anode, respectively.

The "dry oxygen" system has been studied thoroughly, of which the reaction mechanism at the three-phase interface between "electrode/electrolyte/oxygen" has been basically probed and the performance of electrode has been optimized progressively. Nonetheless, the dry oxygen system is only a simplified ideal research object to make the original complex open system accessible. Through the study of this simplified system, it is beneficial to clarify the electrode reaction mechanism of energy conversion and storage, design high performance catalysts and establish suitable research methods for air cells. However, limitations still exist in this system. Firstly, the electrochemical reactions at the solid-liquid-gas three-phase interface of other components in the air are not considered. Secondly, the "dry oxygen" simplified system contains the processes of oxygen reduction and evolution at the catalyst/electrolyte interface, ignoring a series of parasitic reactions resulting from the instability of electrode components. For example, the carbon materials and trace amounts of water in the electrode have been proved to participant in the electrode reactions. The study on the simple "dry oxygen" system has also achieved great achievements currently. And it should be further extended--introducing other constituents like CO2, H2O and N2 from the atmosphere into the research system.

In this report, other air components such as CO2 and H2O are introduced into the electrode/electrolyte interface system. The processes of CO2 discharge and charge at electrode will be described in detail and the control of CO2 reversible and irreversible processes has been realized by Ru catalysts. Besides, the effect of H2O in electrolyte and air on the discharge and charge performance of cell will also be present. And the new reaction mechanism caused by H2O will be detailed. The great efforts have been made to focus on a series of parasitic reactions at the electrode/electrolyte interface and understand the complex electrode reactions at air electrode/electrolyte interface extensively. In the near future, the research system will be extended to the real atmosphere, and Li-air batteries will be put into practical applications gradually.

References

[1]. P. He*, et al. Angew. Chem. Int. Ed, 2018, 8(58), 2355-2359.
[2]. P. He*, et al. Energy Environ. Sci., 9 (2016), 1650-1654.
[3]. P. He*, et al. Energy Environ. Sci., 10 (2017), 972-978.
[4]. H. S. Zhou*, et al. Joule, 1 (2017), 359-370.
[5]. P. He*, et al. Adv. Mater., 30, (2018), 1705711.
[6]. P. He*, et al. Adv. Energy Mater., 8, (2018), 1702374.
[7]. P. He*, et al. Adv. Energy Mater., 8, (2018), 1701602.
[8]. P. He*, et al. Energy Storage Mater., 12, (2017), 176-182.
[9]. P. He*, et al. Adv. Energy Mater., 6, (2016), 1502303.

Notes

Invited Talk N1

Tumor Acidity-Activated Nanomedicine for Improved Cancer Therapy

*Jin-Zhi Du**
Institutes for Life Sciences, and School of Medicine, South China University of Technology, Guangzhou 510006, P. R. China
** Corresponding author: djzhi@scut.edu.cn*

Cancer nanomedicine has attracted tremendous attentions over the past decades for its versatile applications in drug delivery and cancer therapy. However, the therapeutic efficacy of nanomedicine has only been moderately improved due to the existence of tremendous delivery barriers exposed by the complicated physiological environment. Smart nanoparticles that can navigate in complex biological environment show great promise in improving the treatment efficacy. Tumor develops slightly acidic microenvironment in comparison with healthy tissues due to its abnormal metabolism, as elaborated by the "Warburg effect", which provides a powerful handle for designing intelligent delivery systems to specifically change their physical or chemical properties at tumor site to improve the delivery efficacy. Our group has developed a series of tumor acidity-responsive delivery systems that can change their essential properties such as size, surface charge et al. to overcome the various delivery barriers. Their delivery effectiveness and improved therapeutic efficacy have been investigated in a variety of tumor xenograft models. We believe our findings open a new avenue to design innovative nanoparticulate delivery carriers and are informative to researchers in related fields.

References
1. Jin-Zhi Du*, Hong-Jun Li, Jun Wang*, Acc. Chem. Res. 2018, 51, 2848–2856.
2. Jing Liu, Hong-Jun Li*, Ying-Li Luo, Cong-Fei Xu, Xiao-Jiao Du, Jin-Zhi Du*, Jun Wang ACS Nano 2019, 13, 8648-8658.
3. Hong-Jun Li#, Jing Liu#, Ying-Li Luo, Sen-Biao Chen, Rong Liu, Jin-Zhi Du*, Jun Wang*, Nano Lett 2019, DOI: 10.1021/acs.nanolett.9b03913.

Notes

Invited Talk N2

Order-disorder and Materials Genomes in Thermoelectrics

Wenqing ZHANG
[1] Department of Physics, Southern University of Science & Technology, Shenzhen, China
** Corresponding author: zhangwq@sustech.edu.cn*

Searching for high-performance thermoelectric (TE) materials, after a very long-time struggle with the traditional crystalline semiconductors of narrow gap, seems to be halted now even by considering the quite a few reported TE figure of merit zT bubbles in journals. Although thermodynamics says no up limit on the TE figure of merit zT, reliable performance of practical materials always show limited zTs, still far away from the requirements of mess industrial applications. We recently proposed that complex materials with chemical bond hierarchy could be candidates of good thermoelectric materials. Our work showed that the types of materials exhibit specific a part-crystalline part-liquid (PCPL) or part-crystalline part-amorphous (PCPA) state, containing at least two different types of sublattices, one relatively rigid crystalline and another one strongly disordered or liquid-like. The interpenetrating sublattices at atomic level seemingly serve as the genomes or functional subunits, different from the separable blocks in traditional metamaterials, to construct a large group of materials to be explored. The order-disorder mixing structure leads to interesting electrical transport, implying existence of an inherent electron conduction network, and also to extremely low lattice thermal conductivity albert different from the traditionally recognized minimum lattice thermal conductivity. The above picture of TE material substructures also implies the possibility of understanding transports in a language beyond band picture of both electrons and phonons. This talk presents our work on surveying the general characteristics of transports in order-disorder mixing materials with chemical bond hierarchy.

Notes

Invited Talk N3

Semiconducting Polymer Nanoparticles for Bioimaging and Theranostics

Xu Zhen[1,] Xiqun Jiang[1]*

[1] School of Chemistry and Chemical Engineering, Nanjing University, Nanjing, 210093
** Corresponding author: zhenxu@nju.edu.cn;*

Semiconducting polymer nanoparticles (SPNs) have emerged as a category of optical nanomaterials for molecular imaging. As SPNs are transformed from semiconducting polymers (SPs) that are originally synthesized for application of optoelectronic devices, they naturally possess excellent photostability and high brightness. Our research focused on the development of new SPNs. We have designed a series of SPNs with different biomedical function, and revealed that SPNs can serve as a versatile nanoplatform to develop chemiluminescence, afterglow and photoacoustic probes for in vivo imaging of different diseases and theranostics [1-6]. We have developed a series of chemiluminescence SPNs for ultrasensitive imaging of H_2O_2 in living mice. Such chemiluminescence avoids the tissue autofluorescence, offering a high signal-to-background ratio [2]. Photoacoustic imaging, detecting photon-induced ultrasound and avoiding strong photon scattering, could achieve superb spatial resolution at depths that deeper than the photon diffusion limit for in vivo imaging. We have developed a series of photothermal SPNs for photoacoustic imaging of tumors and theranostics [3-6]. Overall, we have designed a series of SPNs and expanded their applications in the biomedical area.

References
(1) Xu Zhen, Ye Tao, Zhongfu An, Peng Chen, Chenjie Xu, Runfeng Chen, Wei Huang, Kanyi Pu. Advanced Materials, 2017, 29, 1606665.
(2) Xu Zhen, Chengwu Zhang, Chen Xie, Qingqing Miao, Kah-Leong Lim, Kanyi Pu. ACS Nano, 2016, 10, 6400.
(3) Xu Zhen, Xiaohua Feng, Chen Xie, Yuanjin Zheng, Kanyi Pu. Biomaterials, 2017, 127, 97.
(4) Xu Zhen, Chen Xie, Kanyi Pu. Angewandte Chemie International Edition, 2018, 57, 3938.
(5) Xu Zhen, Chen Xie, Yuyan Jiang, Xiangzhao Ai, Bengang Xing, Kanyi Pu. Nano Letters, 2018, 18, 1498.
(6) Xu Zhen, Jianjian Zhang, Jiaguo Huang, Chen Xie, Qingqing Miao, Kanyi Pu. Angewandte Chemie International Edition, 2018, 57, 7804.

Notes

Plenary Talk 4

Merging of Metamaterials and Conventional Materials

Ji Zhou
School of Materials Science & Engineering, Tsinghua University, Beijing 100084, China

TMetamaterials are a class of materials that achieve novel properties from artificial structures, and expected to be the source of a series of disruptive technologies. These artificial materials are completely different from conventional materials in their basic structures, properties and synthesis methods. The interface between them is clearly distinct - conventional materials come from nature, easy to obtain and difficult to design; metamaterials are the opposite, easy to design, but usually difficult to obtain. We proposed a strategy for development of new functional materials by merging of metamaterials and conventional materials. Based on this approach, we have developed dielectric and tunable electromagnetic metamaterials, isotropic negative thermal expansion metamaterials, artificial nonlinear optics metamaterials, giant magneto-dielectric metamaterials, and the metamaterials for all-optical switching and direct photoelectric conversion.

References
[1] Q. Zhao, L. Kang, J. Zhou, Experimental demonstration of isotropic negative permeability in a three-dimensional dielectric composite, Physical Review Letters, 101 (2): No. 027402 (2008)
[2] Y.Z.Wen, and J.Zhou, Artificial nonlinearity generated from electromagnetic coupling metamolecule, Physical Review Letters, 118:167401 (2017).

Notes

Plenary Talk 5

Nanostructured Ultrahard Materials

Bo Xu and Yongjun Tian*
Center for High Pressure Science, State Key Laboratory of Metastable Materials Science and Technology, Yanshan University, Qinhuangdao 066004, China
** Corresponding author: bxu@ysu.edu.cn*

In superhard materials research, two topics are of central focus. One is to understand hardness microscopically that can guide the design or prediction of novel superhard crystals. The other is to synthesize superhard materials with enhanced comprehensive performance, with the ambition of achieving materials harder than natural diamond. Here I report our recent advances in both topics. On the base of hardness model for covalent single crystals, we established a hardness model for polycrystalline materials, and found that polycrystalline covalent materials can be continually hardened with decreasing microstructural characteristic size, contributed by the Hall-Petch effect and the quantum confinement effect [1]. Nanograining and nanotwinning are two popular strategies to minimize the microstructures. Due to the much lower excess energy of twin boundaries, nanotwinning can provide a more effective mechanism to achieve smaller microstructural characteristic size compared with nanograining. Experimentally, we synthesize nanotwinned cubic boron nitride and diamond bulks under high pressure and high temperature [2,3]. These materials exhibit greatly enhanced hardness, fracture toughness and thermal stability compared with the corresponding single crystals. The successful synthesis of nanotwinned ultrahard materials is a great promotion to the high-performance superhard materials research. With these advantages in performance, nanotwinned ultrahard materials can produce technological innovations in industry and high pressure science.

References

(1) Tian, Y. J.; Xu, B.; Zhao, Z. S. Int. J. Refract. Met. Hard Mater. 2012, 33, 93-106.
(2) Tian, Y. J.; Xu, B.; Yu, D. L.; Ma, Y. M.; et al. Nature 2013, 493, 385-388.
(3) Huang, Q.; Yu, D. L.; Xu, B.; Hu, W. T.; et al. Nature 2014, 510, 250-253.

Notes

Plenary Talk 6

Smart Metamaterials and Metasurfaces

Tie Jun Cui
State Key Laboratory of Millimeter Waves, Southeast University, Nanjing 210096, China
Email: tjcui@seu.edu.cn

Intelligence in material level is a goal that researchers have been pursuing, which is also a pursuit of digital coding metasurface. From passive to active, digital coding metasurfaces have been developed to programmable. However, the programmable metasurfaces must be controlled by human beings to switch among different functionalities. Here, we propose a smart digital metasurface that has self-adaptively reprogrammable functionalities. Based on but different from the programmable metasurface, the smart metasurface requires a sensing-feedback system that is integrated in the metasurface. We present a motion-sensitive smart digital metasurface integrated with a three-axis gyroscope and feedback software, which can adjust the radiated electromagnetic beams self-adaptively with different rotations of the metasurface. We develop a fast feedback algorithm as control software to make the smart metasurface achieve single-, multi-beam steering and other dynamic reactions adaptively. The presented metasurface is also extensible for other sensors to detect the height, humidity, temperature, and illuminating light, and various reactions based on 2-bit coding metasurface are designed and measured. Good agreements between numerical and experiment results demonstrate the self-adaptively programmable functions of the smart metasurface.

Notes

NJU

Nanjing,Jiangsu

China

NJU

NOV 29-DEC 01 2019

电子程序册

Scan the QR code for the electronic program

现场照片直播

Scan the QR code for the event photos

Wiley