Nano-Micro Conference 2018

Conference Program

December 17-20 2018 Jeju, South Korea

Conference Program

Contents

General Information

Nano-Micro Conference 2018 is an international conference focused on Nano-Micro Science and Engineering. The aim of this conference is to bring together world-renowned experts, academicians, senior scientists, industry executives and project leaders from all over the world to discuss new developments and frontier researches in the multidisciplinary field of Nano-Micro Science and Engineering.

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Shanghai Jiao Tong University, China
Editor in Chief of Nano-Micro Letters

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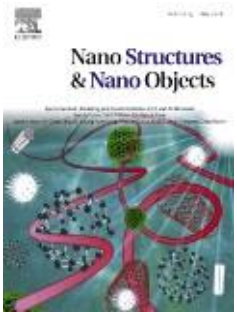


Registration desk hours

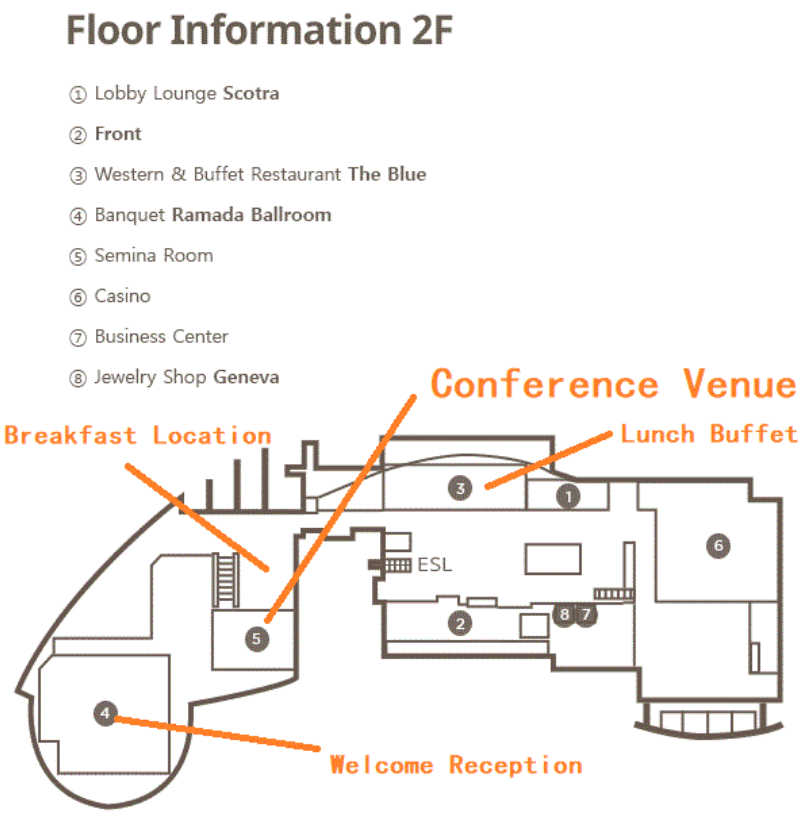
The Nano-Micro Conference 2018 registration desk, located outside the meeting rooms, will be open during the following hours:

Data	Time
Sunday, December 16th	2:00pm – 6:00pm
Monday, December 17th	8:30am – 6:00pm
Tuesday, December 18th	8:30am – 6:00pm
Wednesday, December 19th	8:30am – 6:00pm

If you have questions, or need assistance, please don't hesitate to seek answer or help from the staffs in the registration desk.

Conference Venue

Location: Ramada Plaza Jeju (Ramada Plaza by Wyndham Jeju Ocean Front)
Address: 66 Tapdong ro Jeju-si, Republic Of Korea +82-64-7298224
Meeting Room: The Second floor, MEETING Room A, Room B, Room C



Nano-Micro Conference 2018 December 17th – December 20th Ramada Plaza Jeju, Jeju-si, Jeju Island, Republic of Korea
Sunday, December 16 2018 14:00 – 18:00 Conference On-site Registration Location: Ramada Plaza Jeju (Ramada Plaza by Wyndham Jeju Ocean Front)

Monday, December 17 2018 Room A		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
Keynote Talk **Chair: Saskia F. Fischer**		
9:00-9:45AM	K01: Topological Phases of Quantum Matter, Novel Superconductors, and Ultra-Thin Films Beyond Graphene	**Arun Bansil** Northeastern University, USA
9:45-10:30AM	K02: Graphene: The Thinnest Known Coating for Corrosion Protection	**Raman Singh** Monash University, Australia
10:30-11:00AM	**Coffee Break**	
December 17 2018, Room A **Monday** **Session A1: Topological Insulators** **Chair: Arun Bansil**		
11:00-11:30AM	A01: Photovoltaic anomalous Hall effect and orbital effect in line-node semimetals	**Katsuhisa Taguchi** Kyoto University, Japan
11:30-12:00PM	A02: Topological Surface States and Two-Dimensional Layered Transport in bulk Bi_2Se_3	**Saskia F. Fischer** Humboldt-Universität zu Berlin, Germany
12:00-14:00PM	**Lunch Break** (Buffet, The Blue Restaurant)	

December 17 2018, Room A Monday Session A2: Topological Insulators Chair: Katsuhisa Taguchi		
14:00-14:30PM	A03: Imaging stacking domain walls and topological edge states in bi- and trilayer graphene by STM/STS	**Long-Jing Yin** Hunan University, China
14:30-15:00PM	A04: Nuclear magnetic resonance in topological insulators: Bi_2Te_3 and Bi_2Se_3	**Anastasia Antonenko** Saint Petersburg State University, Russia
15:00-15:30PM	A05: Graphene Supported Graphone/Graphane Bilayer Nanostructure Material for Spintronics	**Sekhar Chandra Ray** University of South Africa (UNISA), South Africa
15:30-16:00PM	**Coffee Break**	
December 17 2018, Room A Monday Session A3: Graphene and carbon nanomaterials Chair: Sang-Yong Ju		
16:00-16:30PM	A06: Large positive magnetoresistance in twisted few layer graphene	**Oleg Kononenko** Institute of Microelectronics Technology and High Purity Materials Russian Academy of Sciences, Russia
16:30-17:00PM	A07: Graphene nanotubes reinforced aluminum based superprofile	**Hansang Kwon** Pukyong National University, Republic of Korea
17:00-17:30PM	A08: Electron emission theories for 2D-materials and applications	**Ricky Lay-Kee Ang** Singapore University of Technology and Design, Singapore
17:30-18:00PM	A09: Graphene nanoribbons formed by a sonochemical graphene unzipping using supramolecular template	**Sang-Yong Ju** Yonsei University, Republic of Korea
19:00-21:00PM	**Welcome Reception**	

Monday, December 17 2018 Room B		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
Keynote Talk **Chair: Ray Chen**		
9:00-9:45AM	K03: Synthesis of Two Different Types of Phase-selectively Disordered Blue TiO_2 Nanomaterials and their Applications	**Hyoyoung Lee** Sungkyunkwan University, Republic of Korea
9:45-10:30AM	K04: Highly Efficient Photoconversion of CO_2: Controllable Transition from C1 to C2 Products	**Su-il In** Daegu Gyeongbuk Institute of Science and Technology, Republic of Korea
10:30-11:00AM	Coffee Break	
December 17 2018, Room B **Monday** **Session B1: Nanomaterials for Energy and Environmental Applications** **Chair: Elijah Thimsen**		
11:00-11:30AM	B01: Effective solar energy conversion based on spectral control of thermal radiation via monolithic absorber/emitter	**Makoto Shimizu** Tohoku University, Japan
11:30-12:00PM	B02: MoS_2-based electrocatalysts for hydrogen evolution catalysis: a comparative study on synthesis methods	**Yo-Sep Min** Konkuk University, Republic of Korea
12:00-12:30PM	B03: Novel concept of intermediate band for III-V Nitride solar cells	**Liwen Sang** National Institute for Materials Science (NIMS), Japan

12:30-14:00PM	**Lunch Break** (Buffet, The Blue Restaurant)	
December 17 2018, Room B Monday Session B2: Nanomaterials for Energy and Environmental Applications Chair: Liwen Sang		
14:00-14:30PM	B04: A high throughput synthesis of semiconductor nanocrystals and preparation of highly luminescent composite beads for LEDs	**Young-Kuk Kim** Korea Institute of Materials Science (KIMS), Republic of Korea
14:30-15:00PM	B05: Two-dimensional semiconductor based transparent solar cell and its performance enhancement	**Ah-Jin Cho** Yonsei University, Republic of Korea
15:00-15:30PM	B06: Modulation by modelling of the morphology of (nano) micromaterials	**Amanda Fernandes Gouveia** Federal University of São Carlos, Brazil
15:30-16:00PM	Coffee Break	
December 17 2018, Room B Monday Session B3: Nanomaterials for Energy and Environmental Applications Chair: SuIl In		
16:00-16:30PM	B08: Magnetically recyclable Z-scheme photocatalyst for organic pollutants removal in aqueous media	**Lu Gan** Nanjing Forestry University, China
16:30-17:00PM	B09: Electron transport characteristics of films comprised of transparent conducting nanocrystals synthesized by plasma	**Elijah Thimsen** Washington University in St. Louis, USA
17:00-17:30PM	B10: Noble photocatalytic systems for degradation and detection of pollutants towards wastewater treatment applications	**Raju Kumar Gupta** Indian Institute of Technology Kanpur, India
19:00-21:00PM	**Welcome Reception**	

Tuesday, December 18 2018 Room A		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
Session A4: Graphene and carbon nanomaterials Chair: Hiroshi Sakaguchi		
9:00-9:30AM	A10: Nanoporous gold for sensor and fuel cell catalysts	**Jianguo Liu** Nanjing University, China
9:30-10:00AM	A11: Sensitive Room-Temperature H_2S Gas Sensors Employing SnO_2 Quantum Wire/Reduced Graphene Oxide Nanocomposites	**Huan Liu** Huazhong University of Science and Technology, China
10:00-10:30AM	A12: Screened strong light-matter coupling of excitons in multilayer 2D-semicondutors and plasmonic nanocavities	**Jaime Gomez Rivas** Eindhoven University of Technology (TU/e), The Netherlands
10:30-11:00AM	Coffee Break	
December 18 2018, Room A Tuesday Session A5: Graphene and carbon nanomaterials Chair: Xianjun Huang		
11:00-11:30AM	A13: Functional Molecular Junctions derived from Double Self-assembled Monolayers on Graphene	**Sohyeon Seo** Sungkyunkwan University, Republic of Korea
11:30-12:00PM	A14: Spin-valley transport property in silicene junction	**Bumned Soodchomshom** Kasetsart University, Thailand
12:00-12:30PM	A15: Comparison of electrical energy and power of PV cells or module with different cells materials in clear sky day condition	**Rohit Tripathi** Galgotias University, India

12:30-14:00PM	**Lunch Break** (Buffet, The Blue Restaurant)	
December 18 2018, Room A Tuesday Session A6: Graphene and carbon nanomaterials Chair: Jaime Gomez Rivas		
14:00-14:30PM	A16: Printed graphene nanoflakes for radio frequency antennas and wireless sensors	**Xianjun Huang** National University of Defence Technology, China
14:30-15:00PM	A17: Bio-inspired on-surface fabrication of graphene nanoribbons	**Hiroshi Sakaguchi** Kyoto University, Japan
15:00-15:30PM	A18: Facile Synthesis of 2D Nitrogen-Containing Porous Carbon Nanosheets Induced by Graphene Oxide for High-Performance Supercapacitors	**Xu Zhang** Dalian University of Technology, China
15:30-16:00PM	Coffee Break	
December 18 2018, Room A Tuesday Session A7: Graphene and carbon nanomaterials Chair: Jianguo Liu		
16:00-16:30PM	A19: Electrochemical Synthesis of Nano-Structured Si for Energy Storage Application	**Indrajit Mukhopadhyay** Pandit Deendayal Petroleum University, India
16:30-17:00PM	A20: Coherent phonons of high- and low-symmetry in the topological insulators	**Oleg Misochko** Institute of Solid State Physics, Russian Academy of Sciences, Russia
17:00-17:30PM	A21: Switchable valley polarization by external electric field effect in graphene/CrI_3 heterostructures	**Jisang Hong** Pukyong National University, Republic of Korea

Tuesday, December 18 2018 Room B		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
Session B4 Nanomaterials for Energy and Environmental Applications Chair: Lingling Huang		
9:00-9:30AM	B11: Metasurfaces for Solar Thermophotovoltaic Energy Harvesting	**Abul K. Azad** Los Alamos National Laboratories, USA
9:30-10:00AM	B12: Solar cell and photoelectrochemical properties of Cu_2ZnSnS_4 thin films fabricated by wet chemical techniques	**Shigeru Ikeda** Konan University, Japan
10:00-10:30AM	B13: A novel absorber material $ZnSnP_2$ - crystal growth and device	**Yoshitaro Nose** Kyoto University, Japan
10:30-11:00AM	Coffee Break	
December 18 2018, Room B Tuesday Session B5: Nanomaterials for Energy and Environmental Applications Chair: Jinsub Park		
11:00-11:30AM	B14: Solar energy conversion to high-value-added reagents on nanoporous sponge photoanodes	**Tomohiko NAKAJIMA** National Institute of Advanced Industrial Science and Technology, Japan
11:30-12:00PM	B15: Key technologies for the novel solar driven heating and cooling systems	**Xudong Zhao** University of Hull, United Kingdom

12:00-14:00PM	**Lunch Break** (Buffet, The Blue Restaurant)	
December 18 2018, Room B Tuesday Session B6: Nanophotonic Devices and Materials Chair: Xudong Zhao		
14:00-14:30PM	B16: Silicon Photonics for 2020 and beyond	**Ray Chen** The University of Texas, USA
14:30-15:00PM	B17: Light emission effects mediated by Bloch Surface Waves	**Emiliano Descrovi** Politecnico di Torino, Italy
15:00-15:30PM	B18: High-dimentional vectorial holographic encryption with metasurfaces	**Lingling Huang** Beijing Institute of Technology Beijing, China
15:30-16:00PM	Coffee Break	
December 18 2018, Room B Tuesday Session B7: Nanophotonic Devices and Materials Chair: Abul K Azad		
16:00-16:30PM	B19: Application of transferable ZTO nanosphere monolayers to optoelectronic devices	**Jinsub Park** Hanyang University, Republic of Korea
16:30-17:00PM	B20: Development and characterization of metallo-dielectric nanomaterials	**Yan Hong** University of Electronic Science and Technology of China, China
17:00-17:30PM	B21: Electrons dynamics control in ultrafast laser micro/nanofabrication by spatially/temporally shaped pulses	**Xiaowei Li** Beijing Institute of Technology Beijing, China
17:30-18:00PM	B22: Plasmon-enhanced nanoscopy for nanoscale analysis	**Taka-aki Yano** Tokyo Institute of Technology, Japan

Room C Tuesday, December 18 2018 Poster Session		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
10:30-11:00; 15:30-16:00;		
P1	Dimension-dependent Perovskite-metal oxide core-shell nanocrystals for CO_2 reduction	**Yunhee Cho** Sungkyunkwan University, Republic of Korea
P2	Continuous degradation of toxic molecules through in-situ reduction of CO_2 using metal doped B-TiO_2 photocatalysts	**Hee Min Hwang** Sungkyunkwan University, Republic of Korea
P3	Ultraviolet photodetector using pn junction of p-CuO hollow nanospheres and n-ZnO nanorods	**Yuexing Ji** Hanyang University, Republic of Korea
P4	Highly carbon-doped TiO_2 derived from MXene boosting the photocatalytic hydrogen evolution	**Guangri Jia** Jilin University, China
P5	Hexagonal $FeIn_2S_4$: Layer Dependent Band Structure of Ternary Metal Chalcogenides	**Hyunjung Kim** Sungkyunkwan University, Republic of Korea
P6	Ligand exchanged colloidal WSe_2 and its counter cation dependent HER study	**Meeree Kim** Sungkyunkwan University, Republic of Korea
P7	The Fabrication of ZnO Nanoarrays and Its Applications for Photoelectrochemical Water Splitting and Protein Microarray based Biosensing	**Chang Liu** Jilin University, China
P8	Electrochemical fabrication of hierarchical pseudocapacitive electrode for supercapacitor	**Xiaoxia Liu** Northeastern University, China

P9	Energy Band Modulation of Phase-selectively Disordered Pt-TiO_2 for Highly Active Photocatalysts	**Simgeon Oh** Sungkyunkwan University, Republic of Korea
P10	The effects of Ga_2O_3 interlayer on the emission of n-In_2O_3 nanorod/p-GaN heterojunction light emitting diode	**Dong Su Shin** Hanyang University, Republic of Korea
P11	Silver-incorporated Cu_2ZnSnS_4 thin film as an absorber for solar cells and a cathode for photoelectrochemical water splitting	**Takato Kawaguchi** Konan University, Japan
P12	Impacts of Zr-doping into crystalline lattices of bismuth vanadate powder and thin film on their photocatalytic and photoelectrochemical properties	**Takato Kawaguchi** Konan University, Japan
P13	Graphene quantum dots decorated graphene as an enhanced sensing platform for sensitive and selective detection of copper(II)	**Ying Wang** Jilin University, China
P14	Elastic nanoscale spongy graphene-functionalized silicon as excellent stability anode in Li ion battery	**Jong-Sung Yu** Daegu Gyeongbuk Institute of Science and Technology, Republic of Korea
P15	Structure and visible-light induced photocatalytic activity of metal cyanamide composites	**Xia Zhang** Department of Chemistry, Northeastern University, China
P16	Nanoporous Sulfur-doped Copper Oxide ($Cu_2O_xS_{1-x}$) for Overall Water Splitting	**Xiaolin Zhang** Jilin University, China

Wednesday, December 19 2018 Room A		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
Session A8: 2D Materials Chair: Peng Wang		
9:00-9:30AM	A22: Multiscale Modeling of Heat Transfer in Low-Dimensional Materials	**Yuan Dong** University of Missouri, USA
9:30-10:00AM	A23: Advanced materials and processes for Silicon based solar cells	**Rosaria Puglisi** Institute for Microelectronics and Microsystems, Italy
10:00-10:30AM	A24: Vacancy diffusion in graphene	**Mukul Kabir** Indian Institute of Science Education and Research, India
10:30-11:00AM	Coffee Break	
December 19 2018, Room A Wednesday Session A9: 2D materials Chair: Seongil Im		
11:00-11:30AM	A25: Chirality Effects on an Electron Transport in Single-walled Carbon Nanotube	**Suthee Boonchui** Kasetsart University, Thailand
11:30-12:00PM	A26: Ionic liquids assisted synthesis of porous carbon materials for energy storage devices	**Yang Yan** Dalian University of Technology, China
12:00-14:00PM	**Lunch Break** (Buffet, The Blue Restaurant)	

December 19 2018, Room A Wednesday Session A10: Nanomaterials for Energy and Environmental Applications Chair: Mukul Kabir		
14:00-14:30PM	A28: Intrinsic field effect and Hall mobility in multilayer III-VI 2D semiconductor InSe FETs	**Sukrit Sucharitakul** RIKEN Center for Emergent Matter Science, Japan
14:30-15:00PM	A29: Nano-enabled clean water production by sunlight	**Peng Wang** King Abdullah University of Science and Technology, Saudi Arabia
15:00-15:30PM	A30: Thin Graphite Contact for 2D-Layered Material CMOS Device and Band Gap Estimation	**Seongil Im** Yonsei University, Republic of Korea
15:30-16:00PM	Coffee Break	
December 19 2018, Room A Wednesday Session A11: 2D Materials Chair: Yang Yan		
16:00-16:30PM	A31: Energy dissipation and light emission in graphene	**Myung-Ho Bae** Korea Research Institute of Standards and Science, Republic of Korea
16:30-17:00PM	A32: Unexpectedly Promoting Effect of Carbon Nanotubes Grown During the Non-oxidative Coupling of Methane over Copper Catalysts	**Jarrn-Horng Lin** National University of Tainan, Tainan

Wednesday, December 19 2018 Room B		
8:00-9:00AM	Coffee Breakfast (Location: Near the conference registration desk)	
Session B8: Nanomaterials for Biomedical Applications Chair: Yanzhong Zhang		
9:00-9:30AM	B23: Micro and nanocoatings for biomedical applications improving Ti50Zr alloy performance	**Ioana Demetrescu** Politehnica University of Bucharest, Romania
9:30-10:00AM	B24: Plasmonic semiconductors for photothermal therapy in the NIR-II window	**Jiang Jiang** International Lab of Adaptive Biotechnology, SINANO, CAS, China
10:00-10:30AM	B25: Janus Drug-Drug Conjugate Nanocapsules for enhancing Cancer Therapeutic Efficacy	**Zhifei Dai** Peking University, China
10:30-11:00AM	Coffee Break	
December 19 2018, Room B Wednesday Session B9: Nanomaterials for Biomedical Applications Chair: Zhifei Dai		
11:00-11:30AM	B26: Formation of micro/nano wrinkles on polymeric surfaces	**Dae Kun Hwang** Ryerson University, Canada
11:30-12:00PM	B27: A Novel “Micro-capillary ELISA” for Detecting Salivary Biomarkers Aiming for POC Applications	**Young Jun Kim** Electronics & Telecommunications Research Institute, Republic of Korea
12:00-12:30PM	B28: Surface Modification of ZnO Nanoparticles by Core-Shell Nanoparticles Decreased Cytotoxicity towards HeLa Cancer Cells: A facile Approach for Safer Nanomaterials	**Amna Sirelkhatim** Sudan University of Science and Technology, Sudan

12:30-14:00PM	**Lunch Break** (Buffet, The Blue Restaurant)	
December 19 2018, Room B Wednesday Session B10: Nanomaterials for Biomedical Applications Chair: Ioana Demetrescu		
14:00-14:30PM	B29: Shape memory fibrous scaffolds for bone tissue engineering	**Yanzhong Zhang** Donghua University, China
14:30-15:00PM	B30: Capped gold and silver clusters as efficient contrast agents for bio-imaging? Exploring new routes to enhance their emission properties	**Rodolphe Antoine** CNRS et Université Lyon 1, France
15:00-15:30PM	B31: Peptide-Modified PLL-coated Aligned PEDOT:PSS Fibers Promotes the Growth of PC12-derived Nerve Cells	**Jiashing Yu** National Taiwan University, Taipei
15:30-16:00PM	Coffee Break	
December 19 2018, Room B Wednesday Session B11: Nanomaterials for Biomedical Applications Chair: Jiashing Yu		
16:00-16:30PM	B32: Bio-Hybrid Hydrogel Comprising Animal and Plant Sources Embedded with Protein Capped Silver Nanoparticles for Accelerated Tissue Regeneration in Chronic Tissue Defects	**Palanisamy Thanikaivelan** CSIR-Central Leather Research Institute Adyar, India
16:30-17:00PM	B33: Multifunctional Bio-Plasmonic and Luminescent Nanomaterials for Smart Biosensors and Theranostics Applications	**Yen Nee TAN** Newcastle University (Singapore Campus), Singapore
17:00-17:30PM	B34: T1/T2 Dual functional iron oxide MRI contrast agent with super stability and low hypersensitivity	**Hongchen Gu** Shanghai Jiao Tong University, China
17:30-18:00PM	B35: Nanotechnology and Environmental Application: Future with Electrospinning	**Shivendu Ranjan** University of Johannesburg, South Africa

Thursday, December 20 2018

All Day Tour, 9:00 - 6:00PM

(**Transportation, tickets & lunch covered**)

Meeting Point: Hotel Lobby (Second Floor)

Meeting Time: 9:00 AM

Keynote Talk
9:00 - 9:45 AM Room A December 17

K01: Topological Phases of Quantum Matter, Novel Superconductors, and Ultra-Thin Films Beyond Graphene

Arun Bansil*
Northeastern University, Boston, Massachusetts, USA
*Corresponding author. Email: ar.bansil@northeastern.edu

Abstract
I will discuss some of our recent work aimed at understanding the electronic structure and spectroscopy of novel superconductors, topological materials, and atomically thin 2D films beyond graphene. [1-6] Illustrative examples will include: (i) How by exploiting electronic structure techniques we have been able to successfully predict and understand the characteristics of many new classes of binary, ternary and quaternary topologically interesting materials, including topological crystalline insulators and Weyl and other more exotic semi-metallic topological phases; (ii) How atomically thin 'beyond graphene' 2D and layered materials offer exciting new possibilities for manipulating electronic structures and provide novel platforms for fundamental science and applications; (iii) With regard to the high-Tc's, I will discuss recent breakthroughs in modeling first-principles the insulating pristine compounds and the transition from the insulating to the metallic state with doping without invoking any free parameters such as U. A first-principles description of the competing stripe and magnetic phases in the cuprates also then becomes possible, providing a new pathway for modeling correlated materials more generally.

References
[1] Bansil, Lin and Das, Reviews of Modern Physics 88, 021004 (2016)
[2] Xu et al., Science Advances 3, e1603266 (2017)
[3] Vargas et al., Science Advances 3, e1601741 (2017)
[4] Hafiz et al., Science Advances 3, e1700971 (2017)
[5] Furness et al., Nature Communications Physics 1, 11 (2018)
[6] C. Lane et al., Physical Review B 98, 125140 (2018)

Keynote Talk
9:45 - 10:30 AM Room A December 17

K02: Graphene: The Thinnest Known Coating for Corrosion Protection

Raman Singh*
Monash University, Australia
*Corresponding author. Email: raman.singh@monash.edu

Abstract
Graphene, a two-dimensional (2-D) atomically thin film of carbon atoms, has unique characteristics that have triggered unprecedented research excitement. Besides several other unique properties, graphene possesses remarkable chemical inertness. Graphene coatings either a single or a few atomic layers thick on metals has been shown to improve their corrosion resistance by up to one-and-half orders of magnitude. Although the studies on this topic are limited to just a few carried out in 2011–2013, great variability is found in the extent of corrosion resistance from graphene reported in these studies. This article presents a brief review of graphene as a corrosion-protecting coating, identifies potential and presents some new data to suggest graphene as durable corrosion-resistant coating.

Keywords

Corrosion Resistance; Electrochemical Impedance Spectroscopy; Duplex Stainless Steel; Graphene Film; Chemical Vapor Deposition Process

Session A1
11:00 - 11:30 AM Room A December 17

A01: Photovoltaic anomalous Hall effect and orbital effect in line-node semimetals

Katsuhisa Taguchi*
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Abstract
To show characteristic phenomena in line-node semimetal, which is one of the topological materials generated by a closed loop shape touching between multiple valance and conduction bands, we theoretically study photovoltaic anomalous Hall effect as well as the orbital magnetization in line-node semimetal in the presence of a circularly polarized light. When the polarized light propagates along the direction to break mirror-symmetry of the close loop of the multiple band touching, unconventional photovoltaic interaction is emerged, and nonzero Berry curvature is generated. This work discusses the light frequency and electric fields of light dependency of the photovoltaic interaction. In the presence of the photovoltaic interaction, there is nonzero Berry curvature, and the orbital magnetization is generated. Besides, anomalous Hall current is triggered when we additionally apply an external electric field perpendicular to the surface of the closed loop. These phenomena could be applicable for optical devices.

Keywords

Photovoltaic anomalous Hall effect; Line-node semimetal

Introduction
Recently, topological materials with linear energy dispersion in multiple bands, which host Dirac fermions and Weyl fermions, have been studied in condensed matter physics. For example, in three-dimensional topological insulators, there are Dirac fermions on the surface of topological insulators, where the Dirac fermions have unconventional spin-momentum locking because of strong spin-orbit coupling. As a result, unconventional characteristic charge transports have been revealed. These characteristic phenomena are caused by nonzero Berry curvature at the point node of the multiple bands. On the other hand, it is possible to make a closed line node by touching between multiple conduction band and valance bands. The materials are named as line-node semimetals. The dimension of nodes of the line-node semimetal is different from that of a point node, and unconventional transport via the nodes have been expected. In this work, to show characteristic phenomena in line-node semimetals, we consider the photovoltaic anomalous Hall effect as well as orbital magnetization in a line-node semimetal.

Methods
The photovoltaic anomalous Hall effect is calculated by using Green's function techniques in an effective model Hamiltonian of the line-node semimetal with an applied circularly polarized light. The photovoltaic anomalous Hall effect is generated by nonzero the photovoltaic interaction. Its interaction is given by the effective Hamiltonian of the line-node semimetal with and without applied circularly polarized light shown in Reference [1]. The effective Hamiltonian with circularly polarized light is obtained by using the Floquet method within the second harmonic electric fields of the polarized light. The detail procedure is shown in literature [2].

Results and Discussion

From the above method, the photovoltaic interaction indicates the coupling between spin angular momentum of the circularly polarized light and momentum of electrons. The coefficient of its interaction Ly is proportional to the square of the electric field E of the polarized light as shown in Figure 1(a). In addition, the chemical potential of the line-node semimetal μ is also changed by δμ. [Figure 1(b)].

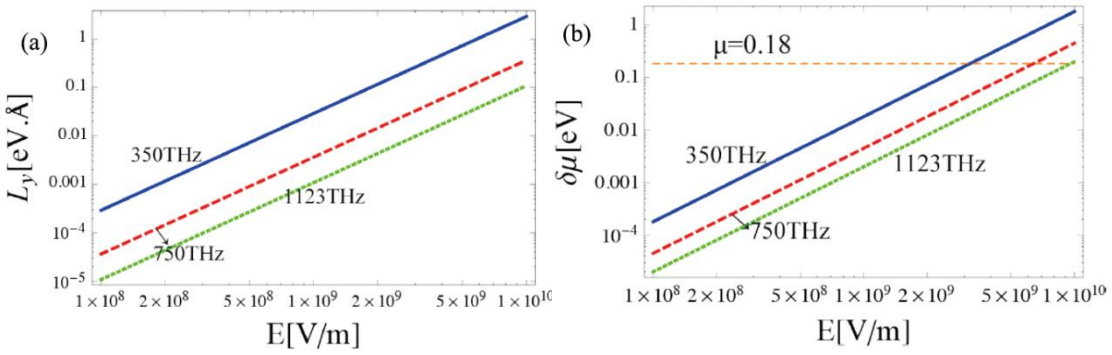

Figure 1. The electric field E dependence of (a) the coefficient of photovoltaic interaction Ly and (b) the photovoltaic chemical potential δμ for several frequency of the polarized light. These figures are based on realistic parameters, which are the same as those used in Fig.2 in Reference [2].

In the presence of photovoltaic interaction, it is found that nonzero Berry curvature is generated. In generally, the Berry curvature relates the orbital magnetization [3]. From its analogy, nonzero orbital magnetization could be emerged only when the circularly polarized light is traveling along the mirror-symmetry breaking direction. It could be evidence for the characteristic phenomena of line-node semimetal without using an external applied electric field, if the orbital magnetization could be measured.

Conclusions

We theoretically study the light-induced anomalous Hall current and orbital magnetization in line-node semimetals. It is found that in the presence of the circularly polarized light, nonzero Berry curvature is generated by the photovoltaic interaction between spin angular momentum of light and momentum of electrons. As a result, the orbital magnetization and the photovoltaic anomalous Hall effect are triggered. They could be applicable to optical devices based on the anisotropic optical properties of line-node semimetals.

Acknowledgement

This work was supported by YITP of Kyoto University.

References

[1] Y. Kim, B. J. Wieder, C. L. Kane, and A. M. Rappe, Phys. Rev. Lett. 115, 036806 (2015). doi: 10.1103/PhysRevLett.115.036806

[2] K. Taguchi, D.-H. Xu, A. Yamakage, and K. T. Law, Phys. Rev. B 94, 155206 (2016). doi: 10.1103/PhysRevB.94.155206

[3] W. Yao, D. Xiao, and Q. Niu, Phys. Rev. B 77, 235406 (2008). doi: 10.1103/PhysRevB.77.235406

Session A1
11:30 - 12:00 PM Room A December 17

A02: Topological Surface States and Two-Dimensional Layered Transport in bulk Bi_2Se_3

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Abstract
Helically spin-polarized Dirac fermions in topologically protected surface states are of high interest as a new state of quantum matter and they are studied in so-called topological insulators (TI). However, we found that in a prototypical three-dimensional TI material, Bi_2Se_3, the magneto-transport experiments indicate that these surface states may coexist with a layered two-dimensional electron system in the bulk [1]. Recently, we demonstrated quantization effects in the Hall resistance at temperatures up to 50 K in nominally undoped bulk Bi_2Se_3 single crystals with a high electron density ($n \sim 2 \cdot 10^{19}$ cm^{-3}). From the angular and temperature dependence of the Hall resistance and the Shubnikov-de Haas oscillations we identify 3D and 2D contributions to transport. Angular resolved photoemission spectroscopy proves the existence of TSS. Here, I will outline a model for Bi_2Se_3 and suggest that the coexistence of TSS and 2D layered transport may stabilize the quantum oscillations of the Hall resistance [2].

Keywords

Topological Surface States; Two-Dimensional Layered Transport; Magneto-transport; Quantum osciallations; Bi_2Se_3 single crystals

References
[1] O. Chiatti et al., Scientific Reports 6, 27483 (2016)
[2] M. Busch et al., Scientific Reports 8, 485 (2018)

Session A2
14:00 - 14:30 PM Room A December 17

A03: Imaging stacking domain walls and topological edge states in bi- and tri-layer graphene by STM/STS

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Abstract
Looking for systems where topological edge states persist in the absence of external magnetic fields boosts rapid developments in condensed matter physics in the past few years. Gapped graphene bilayer with smooth domain walls is predicted to be one of the most promising candidates where charge carriers can travel long distances without dissipation. Although it has been extensively studied in theory, a direct imaging of topological edge states in bilayer graphene domain walls is still missing. The experimental challenge comes from both the fabrication of bilayer graphene sample which contains AB-BA domain wall and the precise measurement of the topological edge states at such stacking boundary. Here, we present direct imaging of the topologically protected 1D conducting channels in the AB-BA domain wall in exfoliated graphene bilayer [1]. With the help of the high-resolution scanning tunnelling microscope (STM) [2-5], we successfully detected the AB-BA domain wall structure in exfoliated graphene bilayer. Subsequently, we obtained the spatial distribution of the topological states around the domain wall for the first time via using the scanning tunnelling spectroscopy (STS) with high energy- and spatial-resolution. We found that the conducting edge states are mainly located at the two edges of the AB-BA domain wall and these states are quite robust even in the highest magnetic field ~ 8 T of our STM system. The related experimental results are reproduced quite well by theoretical calculations. Moreover, we also imaged ABA-ABC trilayer graphene domain walls by using the same measurement technique [6]. Our studies directly confirm the existence of the topological edge states at AB-BA bilayer graphene domain wall, opening a wide vista of graphene-based topological transport properties.

Keywords

Topological edge states; graphene; domain wall; scanning tunnelling microscope (STM); scanning tunnelling spectroscopy (STS)

References
[1] L.-J. Yin; H. Jiang; J.-B. Qiao; L. He, Direct imaging of topological edge states at a bilayer graphene domain wall. Nature Communications. 7, 11760 (2016). doi:10.1038/ncomms11760
[2] L.-J. Yin; Y. Zhang; J.-B. Qiao; S.-Y. Li; L. He, Experimental observation of surface states and Landau levels bending in bilayer graphene. Physical Review B. 93, 125422 (2016). doi:10.1103/PhysRevB.93.125422
[3] L.-J. Yin; J.-B. Qiao; W.-J. Zuo; W.-T. Li; L. He, Experimental evidence for non-Abelian gauge potentials in twisted graphene bilayers. Physical Review B. 92, 081406(R) (2015). doi:10.1103/PhysRevB.92.081406
[4] L.-J. Yin; J.-B. Qiao; W.-X. Wang; W.-J. Zuo; W. Yan; R. Xu; R.-F. Dou; J.-C. Nie; L. He, Landau quantization and Fermi velocity renormalization in twisted graphene bilayers. Physical Review B. 92, 201408(R) (2015). doi:10.1103/PhysRevB.92.201408
[5] L.-J. Yin; S.-Y. Li; J.-B. Qiao; J.-C. Nie; L. He, Landau quantization in graphene monolayer, Bernal bilayer, and Bernal trilayer on graphite surface. Physical Review B. 91, 115405 (2015). doi:10.1103/PhysRevB.91.115405
[6] L.-J. Yin; W.-X. Wang; Y. Zhang; Y.-Y. Ou; H.-T. Zhang; C.-Y. Shen; L. He, Observation of chirality transition of quasiparticles at stacking solitons in trilayer graphene. Physical Review B. 95, 081402(R) (2017). doi:10.1103/PhysRevB.95.081402

Session A2
14:30 - 15:00 PM Room A December 17

A04: Nuclear magnetic resonance in topological insulators: Bi_2Te_3 and Bi_2Se_3

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Abstract
High quality single-crystalline topological insulators Bi_2Te_3 and Bi_2Se_3 were investigated by NMR in a large temperature range from 11 to 293 K. It was shown that NMR spectra for both compounds consisted of two lines which correlated to two nonequivalent positions of tellurium and selenium atoms in the crystallographic structures of Bi_2Te_3 and Bi_2Se_3, respectively. It was found for Bi_2Te_3 and Bi_2Se_3 single-crystalline plates that the less intensive line of the NMR spectra at room temperature began to dominate at low temperatures for the orientation when the crystallographic ***c*** axis was parallel to the external magnetic field $\boldsymbol{B}_0$. This behavior could not be explained with the angular dependence. The thermal-activation character of the temperature dependence of the Knight shift for the single-crystalline plate (when the ***c*** axis was perpendicular to $\boldsymbol{B}_0$) and powder Bi_2Te_3 was shown with activation energy 26 meV. The results provide information about electron-nuclear interactions in the materials studied. This could be useful for further theoretical and experimental studies of the electron properties in the three-dimensional topological insulators.

Keywords

Topological insulators (TIs); Nuclear magnetic resonance (NMR); Condensed matter physics; Low temperatures

Session A2
15:00 - 15:30 PM Room A December 17

A05: Graphene Supported Graphone/Graphane Bilayer Nanostructure Material for Spintronics

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Abstract
We have investigated the magnetic and electronic properties of partially hydrogenated vertically aligned few layers graphene (FLG) known as Graphone, synthesized by the microwave plasma enhanced chemical vapor deposition (PECVD). The FLGs are hydrogenated at different substrate temperatures to alter the degree of hydrogenation (Graphone/Graphane) and their depth profile. The unique morphology of the structure gives rise to a unique geometry in which Graphone/Graphane is supported by Graphene layers in the bulk, which is very different from other widely studied structures such as one-dimensional nanoribbons. Synchrotron based x-ray absorption fine structure spectroscopy measurements have been used to investigate the electronic structure and the underlying hydrogenation mechanism responsible for the magnetic properties. While ferromagnetic interactions seems to be predominant, the presence of antiferromagnetic interaction was also observed. Free spins available via the conversion of sp2 to sp3-hybridized structures, and the possibility of unpaired electrons from defects induced upon hydrogenation are thought to be likely mechanisms for the observed ferromagnetic orders.

References
[1] Ray et al. 2014. Scientific Reports 4, 3862:1-7

Session A3
16:00 - 16:30 PM Room A December 17

A06: Large positive magnetoresistance in twisted few layer graphene

Oleg V. Kononenko[1,2,*], A.V. Zotov[1], V.T. Volkov[1], V.I. Levashov[1], V.A. Tulin[1], V.N. Matveev[1]

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Abstract

Twisted or turbostratic bi- and multilayer graphene attracts much attention due to its unique properties [1-2]. Graphene films were grown on an iron film catalyst deposited on oxidized silicon substrate by the low-pressure chemical vapor deposition (LPCVD) method with a single injection of acetylene. Studies with the SENTERRA Bruker Raman microscope showed that the graphene films are a turbostratic few layer graphene. The electron transport and magnetotransport properties of the films were investigated. The temperature dependence of the graphene film resistance exhibits the thermally activated (TA) behavior at temperatures above 120° K. At lower temperature the dependence deviates from TA behavior and at temperatures below 40° K becomes close to the variable range hopping conduction. Unusually high positive magnetoresistance (MR) at a room temperature (100% in the magnetic field of 0.5 T) was found in the films. The MR was measured at different temperatures in the magnetic fields normal to the film plane. In low fields up to ~ 0.005 T at temperatures below ~ 40° K, negative MR was observed, caused by weak localization (WL). In magnetic fields above ~ 0.005 T, the MR increases with increasing magnetic field and becomes positive with quadratic magnetic-field dependence in the fields up to ~ 0.03 T and quasi linear dependence in the fields higher than ~ 0.03 T.

Keywords

Twisted few layer graphene; CVD; electrical transport; magnetoresistance

Acknowledgements

O.V.K. gratefully acknowledge the financial support of the Ministry of Education and Science of the Russian Federation in the frame-work of Increase Competitiveness Program of NUST «MISiS» (grant K2-2017-009).

References

[1] T.-F. Chung, Y. Xu, Y. P. Chen, Transport measurements in twisted bilayer graphene: Electron-phonon coupling and Landau level crossing. Phys. Rev. B 98, 035425 (2018). doi:10.1103/PhysRevB.98.035425
[2] U. Mogera, S. Walia, B. Bannur, M. Gedda, G. U. Kulkarni, Intrinsic Nature of Graphene Revealed in Temperature Dependent Transport of Twisted Multilayer Graphene. J. Phys. Chem. C, 121, 13938 (2017). doi: 10.1021/acs.jpcc.7b04068

Session A3
16:30 - 17:00 PM Room A December 17

A07: Graphene nanotubes reinforced aluminum based superprofile

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Abstract

Single walled carbon nanotubes (SWCNT) or graphene nanotubes was mixed with aluminum powders by mechanical ball milling and the composite powders was directly extruded after special billet preparation [1]. The superprofile was successfully fabricated the combination of the Al and graphene nanotubes by a hot extrusion [2] process as a world first. It specially the superprofiles could be used for composed of various frame elements and brackets needed for assembling with T-slot structure which has advantage of no welding, simple designed, short manufacturing time and easy to recycling and so on. The superprofile was combined with nano and micro sized powder and microstructure [3]. The mechanical properties were increased than that of general Al profile, especially young's modulus was 3times higher than that of Al. It is possible to use for many automation system frame, electric vehicle parts and customized solar battery frame and so on.

Keywords

Single walled carbon nanotubes (SWCNT); Graphene nanotubes; Aluminum; Profile; Extrusion

References

[1] H. Kwon; M. Estili; K. Takagi; T. Miyazaki; A. Kawasaki, Combination of hot extrusion and spark plasma sintering for producing carbon nanotube reinforced aluminium matrix composites. Carbon. 47, 570 (2009). doi.org/10.1016/j.carbon.2008.10.041
[2] H. Kwon; M. Laparoux. Hot extruded carbon nanotube reinforced aluminium matrix composite materials. Nanotechnology. 23, 415701 (2016). doi:10.1088/0957-4484/23/41/415701
[3] H. Kurita; H. Kwon; M. Estili; A. Kawasaki. Multi-walled carbon nanotube-aluminum matrix composites prepared by combination of hetero-agglomeration method, spark plasma sintering and hot extrusion. Materials Transactions. 52, 1960 (2011). doi:10.2320/matertrans.M2011146

Session A3
17:00 - 17:30 PM Room A December 17

A08：Electron emission theories for 2D-materials and applications

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Abstract

Electron emission from a material through an interface such as vacuum or another material is a fundamental process in cathode, diode, ionization, electric contact and many other areas. Depending on the energy used for electron emission, it can be broadly characterized into 3 different processes known as thermionic emission TE (by thermal energy), field emission FE (by quantum tunneling) and photoemission PE (by absorption of photons or optical tunneling). The basic models for these processes (TE, FE, PE) have been formulated many decades ago, respectively, known as the Richardson law, Fowler-Nordheim (FN) law, and photo-electric effect or Keldysh model. At high current regime, the emission laws will become space charge limited, which is known as Child-Langmuir (CL) law and Mott-Gurney (MG) law for vacuum gap and solid-diode respectively. With the development of two-dimensional (2D) atomic scale materials in the 2000's, the above-mentioned classical laws may require revisions to account for new material properties, as well as novel operating regimes in nanometer dimensions and in ultrashort time scales. In this presentation, we will present some recent and self-consistent emission models [1-6] to illustrate that the classical laws are no longer valid for 2D materials such as graphene. These new models exhibit smooth transition to the classical models and provides new scaling laws due to the unique properties of 2D materials. Comparison with some experimental results will be discussed. Some selected applications of these models on areas such as energy harvesting, electronics and material characterization.

Keywords

2D materials; interface physics; emission models; nano-electronics; modeling

References

[1] Y. S. Ang, H. Y. Yang, and L. K. Ang, "Universal scaling in nanoscale lateral Schottky heterostructures", Phys. Rev. Lett. 121, 056802 (2018). doi: 10.1103/PhysRevLett.121.056802

[2] Y. S. Ang, S. J. Liang, and L. K. Ang, "Theoretical Modelling of Electron Emission from Graphene", MRS Bulletin 42, 505 (2017). doi: 10.1557/mrs.2017.141

[3] Y. S. Ang, M. Zubair, and L. K. Ang, "Relativistic space charge limited current for massive Dirac fermions", Phys. Rev. B 95, 165409 (2017). doi: 10.1103/PhysRevB.95.165409

[4] Shijun Liang, Bo Liu, Wei Hu, Kun Zhou and L. K. Ang, "Thermionic Energy Conversion Based on Graphene van der Waals Heterostructures", Scientific Report 7:46211 (2017). doi: 10.1038/srep46211

[5] Y. S. Ang, and L. K. Ang, "Current-temperature scaling for a Schottky interface with non-parabolic energy Dispersion", Phys. Rev. Applied 6, 034013 (2016). doi: 10.1103/PhysRevApplied.6.034013

[6] Shijun Liang, and L. K. Ang, "Electron Thermionic Emission from Graphene and thermionic energy convertor", Phys. Rev. Applied 3, 014002 (2015). doi: 10.1103/PhysRevApplied.3.014002

Session A3
17:30 - 18:30 PM Room A December 17

A09: Graphene nanoribbons formed by a sonochemical graphene unzipping using supramolecular template

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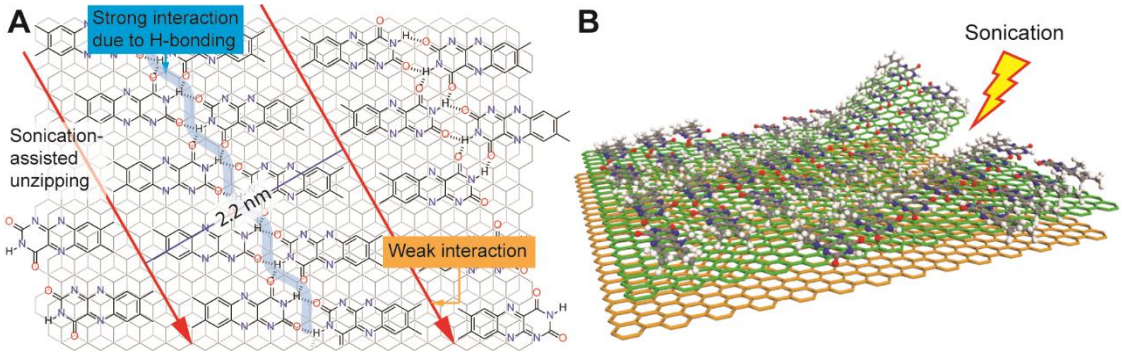
Abstract
When the width of a graphene nanoribbon (GNR) is below 10 nm, it possesses semiconducting properties that enable various high-end electronic applications. Here, we report that the dense and stable dispersion of a natural graphite flake by using flavin mononucleotide (FMN) as a surfactant produces GNRs as small as 10 nm in width. High-resolution transmission electron microscopy reveals GNRs with various widths, along with a graphene flake containing straight-edged GNRs and cuts. GNR formation originates from sonochemical graphene unzipping along a one-dimensional FMN supramolecular template. Various Raman methods demonstrate the universal intensity ratio of D over D' bands near 4, supporting formation of continuous edge defect. Thermal annealing enhances the optical contrast and van der Waals interactions of the graphene film, resulting in increased conductivity compared to the as-prepared graphene film, which is also better than that of reduced graphene oxide.



Keynote Talk
9:00 - 9:45 AM Room B December 17

K03: Synthesis of Two Different Types of Phase-selectively Disordered Blue TiO_2 Nanomaterials and their Applications

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Abstract
A low energy absorbed semiconducting materials has been sought for a long time for the visible light-driven photocatalytic reactions. To prepare the low energy absorbed semiconducting materials such as TiO_2, various types of low energy band gap TiO_2 materials have been introduced. Most low energy band gap TiO_2 materials such as black TiO_2 has a large amount of phase-disordered defect sites. The phase-disordered defects can efficiently absorb the visible light but also are served as charge recombination sites of the electrons and holes produced under light irradiation. This charge recombination decreases an efficiency for any kinds of devices and systems. Therefore, it is quite necessary to find new semiconducting nanomaterials that have a disordered TiO_2 phase for the light absorption as well as a crystalline phase for the fast charge separation within a nanometer scale. Here, we report novel synthesis method for the phase-selectively disordered, rutile-only phase in a phase-mixed P25 TiO_2 (ordered anatase and disordered rutile, OA/DR) and anatase-only phase in a phase-mixed P25 TiO_2 (disordered anatase and ordered rutile, DA/OR), which are produced via alkali metal-liquid ammonia treatments under room temperature and ambient atmosphere in solution. The strong advantage of phase selective reduction method can allow to control an active site where Ti^{3+} is generated while keeping the other crystalline phase. Both resulting blue colored TiO_2 (HYL′ s blue TiO_2) namomaterials shows a high light absorption including visible light and simultaneously high charge transport ability that is confirmed by photoluminescence light measurement. For a possible application, we like to introduce new findings about hydrogen evolving reaction (HER) [1], removal of algae from water [2], visible light-driven CO_2 reduction, decomposition of organic compounds and particle mattes, and etc.

Keywords

Phase-selective reduction; Blue TiO_2; Hydrogen evolution reaction (HER); Organic compound and particle matter's decomposition; CO_2 reduction

References
[1] Kan Zhang et al. An order/disorder/water junction system for highly efficient co-catalyst-free photocatalytic hydrogen generation, Energy & Environmental Science 2016, 9, 499-503
[2] Youngmin Kim et al. Solar-light photocatalytic disinfection using crystalline/amorphous low energy bandgap reduced TiO_2, Scientific Reports, 2016, 6, 25212; doi: 10.1038/srep25212

Keynote Talk
9:45 - 10:30 AM Room B December 17

K04: Highly Efficient Photoconversion of CO_2: Controllable Transition from C1 to C2 Products

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Abstract
Photocatalytic reduction of CO_2 to fuel offers an exciting opportunity for helping to solve current energy and global warming problems. Although a number of solar active catalysts have been reported, most of them suffer from low product yield, instability, and low quantum efficiency. Therefore, the design and fabrication of highly active photocatalysts remains an unmet challenge. We seek CO_2 photoconversion efficiencies large enough for translation of the technology from laboratory to industry, a key step of which is achieving higher-order hydrocarbon products. Ethane, C_2H_6, for example, can be relatively easily converted into ethanol, a liquid fuel. In the current work, under AM1.5G illumination, utilitzing a photocatalyst of reduced titania, graphene, and Pt nanoparticles, we demonstrate stable operation, significant rates of product formation, as well as a controllable product transformation from CH_4 to C_2H_6. We find the switch from C1 to C2 products is dependent upon upward band bending at the reduced blue-titania/graphene interface.

References
[1] Saurav Sorcar, Jamie Thompson, Yunju Hwang, Young Ho Park, Tetsuro Majima, Craig A. Grimes, James R. Durrant* and Su-il In*, "High-Rate Solar-spectrum Photoconversion of CO_2: Controllable Transition from C1 to C2 Products", Energy & Environmental Science 11 (2018) 3183-3193
[2] Muhammad Zubair, Hye Rim Kim, Abdul Razzaq, Craig A. Grimes, and Su-il In*, "Solar spectrum photocatalytic conversion of CO_2 to CH_4 utilizing TiO_2 nanotube arrays embedded with graphene quantum dots", Journal of CO_2 Utilization 26 (2018) 70-79
[3] Abdul Razzaq, Apurba Sinhamahapatra, Tong-Hyung Kang, Craig A. Grimes, Jong-Sung Yu* and Su-il In*, "Efficient Solar Light Photoreduction of CO_2 to Hydrocarbon Fuels via Magnesiothermally Reduced TiO_2 Photocatalyst", Applied Catalysis B 215 (2017) 28-35
[4] Hye Rim Kim, Abdul Razzaq, Craig A. Grimes, and Su-Il In*, "Synthesis of Heterojunction p-n-p Cu_2O/S-TiO_2/CuO, and Application to the Photocatalytic Conversion of CO_2 and Water Vapor to Methane", Journal of CO_2 Utilization 20 (2017) 91-96
[5] Saurav Sorcar, Yunju Hwang, Craig A. Grimes, and Su-il In*, "Highly Enhanced and Stable Activity of Defect Induced Titania Nanoparticles for Solar Light Driven CO_2 Reduction into CH_4", Materials Today Volume 20, Issue 9 (Nov. 2017) 507-51

Session B1
11:00 - 11:30 AM Room B December 17

B01: Effective solar energy conversion based on spectral control of thermal radiation via monolithic absorber/emitter

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Abstract

In this presentation, we will introduce the effective solar energy conversion technology using thermophotovoltaic (TPV) systems. In TPV systems, thermal radiation from the heated material is converted into electricity by photovoltaic (PV) cells. The systems that use concentrated solar energy as a heat source is especially called as solar-TPV systems which is recently attract much attention [1-3]. In this system, solar energy can be converted into useful thermal radiation by a monolithic absorber/emitter. Most of photon energy of sunlight can be turned into heat at the absorber and then the monolithic emitter emits the useful photon of which energy is above the bandgap of the PV cells. Efficiency of a solar-TPV system, therefore, can be expected to reach close to 45% [4] even with single-junction cells.

At first, we will explain a result of a solar-TPV system's design. Total efficiency of solar-TPV systems can be described with two types of efficiencies such as the extraction efficiency $\eta_{extract}$ and the PV cell conversion efficiency η_{PV} [5]. The $\eta_{extract}$ expresses how effectively solar energy is converted into thermal radiation power from the emitter. The η_{PV} shows how effectively the thermal radiation power is converted into electric energy. To achieve high efficiency, spectral shaping of thermal radiation from absorber and emitter is essential. Geometric design such as the absorber/emitter shape and configuration of each component is also important.

We will also show experimental results of the spectral shaping of thermal radiation using metal-dielectric layered structure. A solar-TPV system is usually working at very high-temperature (>1000 ^{o}C) to have high η_{PV}. Therefore, both high spectral selectivity and high thermal stability are required for the structure. It is revealed that the layered structure composed of molybdenum nanometric film sandwiched by hafnium oxide layer shows high spectral selectivity and is thermally stable up to 1150 ^{o}C [6].

Finally, we will represent results of power generation tests using high power density solar simulator. Gallium antimonide cell which have a band gap of 0.67 eV is used as a PV cell. Two shapes of the monolithic absorber/emitter such as planar type and cube type system are demonstrated in the tests. In both test, total efficiency reach to more than 5%.

Keywords

Thermophotovoltaics; Solar; Thermal radiation; Spectral shaping; Gallimu antimonide cells

References

[1] A. Datas; C. Algora, Development and experimental evaluation of a complete solar thermophotovoltaic system. Progress in Photovoltaics. 21(5), 1025-1039 (2013). doi: 10.1002/pip.2201

[2] M. Shimizu; A. Kohiyama; H. Yugami, High-efficiency solar-thermophotovoltaic system equipped with a monolithic planar selective absorber/emitter. Journal of Photonics for Energy. 5(1), 053099 (2015). doi: 10.1117/1.JPE.5.053099

[3] D. M. Bierman; A. Lenert; W. R. Chan; B. Bhatia; I. Celanović; M. Soljačić; E. N. Wang, Enhanced photovoltaic energy conversion using thermally based spectral shaping. Nature Energy. 1, 16068 (2016). doi: 10.1038/nenergy.2016.68
[4] A. Datas; C. Algora, Detailed balance analysis of solar thermophotovoltaic systems made up of single junction photovoltaic cells and broadband thermal emitters. Solar Energy Materials and Solar Cells. 94(12), 2137-2147 (2010). doi: 10.1016/j.solmat.2010.06.042
[5] A. Kohiyama; M. Shimizu; H. Yugami, Unidirectional radiative heat transfer with a spectrally selective planar absorber/emitter for high-efficiency solar thermophotovoltaic systems. Applied Physics Express. 9(11), 112302 (2016). doi: 10.7567/APEX.9.112302
[6] M. Shimizu; A. Kohiyama; H. Yugami, Evaluation of thermal stability in spectrally selective few-layer metallo-dielectric structures for solar thermophotovoltaics. Journal of Quantitative Spectroscopy and Radiative Transfer. 212, 45-49 (2018). doi: 10.1016/j.jqsrt.2018.02.037

Session B1
11:30 - 12:00 PM Room B December 17

B02: MoS_2-based electrocatalysts for hydrogen evolution catalysis: a comparative study on synthesis methods

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Abstract
Molybdenum disulfide (MoS_2) is one of promising catalysts for hydrogen evolution reaction. In the 2H structure of MoS_2, which is one of layered transition metal chalcogenides, basal planes are electrochemically inactive but its edge sites are active for the HER catalysis. Various strategies such as doping, vacancy engineering, and structural engineering have been extensively investigated to activate the basal planes and/or to improve the HER activity. Recently, it is reported that amorphous molybdenum sulfide (a-MoS_x) has a high active site density due to the presence of disorderly-arranged atoms unlike crystalline MoS_2. Furthermore, isotropic electrical conductivity of the a-MoS_x is much more advantageous to the electron transfer for the HER, comparing to the anisotropic conductivity of the crystalline MoS_2. [1] Here, we report an amorphous catalyst of oxygen-incorporated molybdenum sulfide (a-MoO_xS_y) synthesized at 90 ^oC on carbon fiber paper (CFP) by chemical bath deposition (CBD) method. Ammonium heptamolybdate and thioacetamide were used as molybdenum and sulfur precursors, respectively. Sodium dithionite was added to the precursor solution as a reducing agent to adjust the oxygen content and oxidation states of molybdenum and sulfur ions. The HER performance of a-MoO_xS_y is much more excellent than that of a-MoS_x without any incorporated oxygen. The high activity of a-MoO_xS_y is strongly related to the oxidation states of molybdenum and sulfur ions. [2] The importance of the oxidation state will be discussed by comparing activities of various amorphous catalysts previously reported by using atomic layer deposition [1, 3] and hydrothermal method [4, 5].

Keywords

Molybdenum sulfide; oxygen incorporation; oxidation state; hydrogen evolution reaction

References
[1] S. Shin; Z. Jin; D. H. Kwon; R. Bose; Y. Min, Langmuir. 31, 1196-1202 (2015). Doi:10.1021/la504162u
[2] P. D. Tran; T. V. Tran; M. Orio; S. Torelli; Q. D. Truong; K. Nayuki; Y. Sasaki; S. Y. Chiam; R. Yi, I. Honma; J. Barber; V. Artero, Nature materials, 15, 640-646 (2016). Doi:10.1038/NMAT4588
[3] D.H. Kwon; Z. Jin; S. Shin; W. Lee; Y. Min, Nanoscale. 8, 7180-7188 (2016). Doi:10.1039/c5nr09065b
[4] R. Bose; S. K. Balasingam; S. Shin; Z. Jin; D. H. Kwon; Y. Jun; Y Min, Langmuir. 31, 5220-5227 (2015). Doi:10.1021/acs.langmuir.5b00205
[5] R. Bose; Z. Jin; S. Shin; S. Kim; S. Lee; Y. Min; Langmuir. 33, 5628-5635 (2017). Doi:10.1021/acs.langmuir.7b00580

Session B1
12:00 - 12:30 PM Room B December 17

B03: Novel concept of intermediate band for III-V Nitride solar cells

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Abstract

III-Nitride semiconductor $In_xGa_{1-x}N$ has the unique advantage of the widest adjustament of direct bandgaps from infrared (InN at 0.65 eV) to ultraviolet (UV) (GaN at 3.42 eV) region. Compared with Si, GaAs, CuInGaSe or Ge systems, it is the only semiconductor system that can provide the perfect match to the solar spectrum. On the other hand, InGaN-based alloys also have the favorable physical properties of high absorption coefficient ($\sim 10^5 cm^{-1}$), high radiation resistance, high drift velocity, and high carrier mobility. The theoretical power conversion efficiency of a four-junction solar cell based on InGaN is expected to be more than 50% according to the balance modeling estimation. However, creating high-quality InGaN alloys with this wide range of energy bandgap for photovoltaic application remains a challenge.

In this paper, we propose a novel concept of intermediate-band (IB) transition to the InGaN-based p-n junctions, and demonstrated the first IB solar cells from deep UV to near infrared region by InGaN/GaN multi-level quantum dots (QDs). The multiple IB by embedding a high-quality multi-stacked InGan/GaN QDs into on p-n junction was demonstrated on AlN/sapphire template. The quantum confinement in the QDs leads to the splitting of the energy levels and the coupling among the QDs forms the three-dimensional minibands. The short-circuit current density of the solar cell is greatly improved. The intermediate band transitions are confirmed and further discussed with regard to the device physics.

Keywords

Intermediate band; solar cells; III-V nitrides; InGaN; quantum dots

References

[1] L. Sang, M. Liao, Q. Liang, M. Takeguchi, B. Dierre, B. Shen, T. Sekiguchi, Y. Koide, and M. Sumiya, Adv. Mater., 26, 1414-1420(2014)

Session B2
14:00 - 14:30 PM Room B December 17

B04: A high throughput synthesis of semiconductor nanocrystals and preparation of highly luminescent composite beads for LEDs

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Abstract
Highly luminescent quantum dots (QDs) with narrow emission spectra were continuously synthesized with a fluid dynamically controlled reactor. Here, we developed a continuous synthesis method for QDs based on Taylor-Couette reactor (TCR). Stable continuous synthesis process was achieved after 20 minutes from the start of continuous injection of precursors and the measured standard deviation of wavelength and width of emission spectra was less than 1nm. As a result, high space-time yield of 1kg/hour-liter was achieved for synthesis of highly quality QDs. Near unity quantum yield (~ 0.9) was demonstrated after surface capping of TCR-processed cores with CdS. The prepared CdSe/CdS QDs showed intense photoluminescence at 645nm with a spectral linewidth of 35nm, which is much narrower than PL spectra of QDs synthesized from conventional batch-type synthesis route using reaction vessel with large volume capacity. Polymer beads containing highly luminescent QDs were prepared by "bead in bead" configuration via swelling of polymer beads and subsequent adsorption of QDs. After in-situ surface coating with aluminosilicates exceptional stability was attained even under irradiation of ultraviolet light and presence of ozone.

Keywords

Quantum dots; Core-shell structure; polymer beads; Quantum yield; Continuous synthesis

References

[1] Y. K. Kim, S. H. Ahn, K. Chung, Y. S. Cho, C. J. Choi, The photoluminescence of $CuInS_2$ nanocrystals: effect of non-stoichiometry and surface modification, J. Mater. Chem., 2012,22, 1516-1520, DOI: 10.1039/C1JM13170B
[2] W. K. Bae, K. Char, H. Hur, S. Lee, Single-step synthesis of quantum dots with chemical composition gradients, Chem. Mater. 2008, 20, 2, 531-539, DOI: 10.1021/cm070754d

Session B2
14:30 - 15:00 PM Room B December 17

B05: Two-dimensional semiconductor based transparent solar cell and its performance enhancement

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Abstract
As a means to overcome the limitation of installation space and to promote the utilization of the solar cell in various applications, a transparent thin-film solar cell has been studied by many researchers [1-2]. To achieve a transparent solar cell, the choice of materials which are transparent enough and showing the photovoltaic property at the same time is the key. Here, we suggest a two-dimensional (2D) p-n heterojunction of WSe_2/MoS_2 and an Indium tin oxide (ITO) electrode to fabricate a transparent thin-film photovoltaic cell. Due to advantages that 2D materials possess [3-4], a highly transparent (~80 %) solar cell with considerable efficiency was achieved. Furthermore, by introducing a transparent passivation layer composed of a fluoropolymer, the photovoltaic performance was much improved. With the passivation layer, our WSe_2/MoS_2 transparent photovoltaic cell reached an efficiency of ~10 %. Comparison of photovoltaic parameters before and after applying passivation and analysis on the origin of such differences will be also presented. To the best of our knowledge, we are the first group to fabricate a 2D material-based fully transparent photovoltaic device. Our result exhibits a great potential of the van der Waals (vdW) p-n heterojunction of 2D semiconductors to be utilized for an active layer of a highly transparent and light-weighted thin-film solar cell.

Keywords

Transparent solar cell; 2D semiconductor; van der Waals heterostructure; fluoropolymer; p-n junction

Session B2
15:00 - 15:30 PM Room B December 17

B06: Modulation by modelling of the morphology of (nano) micromaterials

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Abstract
Experiment and theoretical researchers often asked themselves if 'Can they believe modelling?'. Answering it requires informed understanding of the strengths and limitations of both current computational modelling and simulation methods as well as experimental techniques and their ranges of application. It is mandatory to enter a self-critical dialogue between theory and experiment rather than to do either theory or experimental in isolation and put unconditional trust in the results of such studies. This is a fertile and growing area, with exciting opportunities and an enormous range of potential applications. It is crucial for the modeler in nanotechnology and materials science to understand the issues of interest to experimentalists, the complexity of chemical systems and how to tackle them effectively by modelling.

In our case, the modulation of the morphologies of (nano) micromaterials imply the joint the use of the first principles to calculate the most stable surfaces and the Wulff construction and the screening of the relative values of surface energies of exposed facets. Analyzing this procedure, we can propose how reach a desired morphology and the pathway linking the ideal (more stable) to the experimental observed morphology. Then, it is possible to understand and rationalize the morphology evolution process, i.e. the modulation process.

In this study, it was investigated the influence of a surfactant anionic and the temperature during the synthesis process of α-Ag_2WO_4 and $ZnWO_4$, respectively, and their facet-dependent photocatalytic activities are unraveled.

Keywords

1. To provide scientific guidance for morphological control of (nano)micromaterial synthesis
2. An analysis of how the idealized in vacuo surface results can be related to the in situ behavior
3. This study provides new insights into the crystal growth habit and morphology transformation
4. To develop a programmable 3D chemical shaping strategy for morphology modulation based on the Wulff construction
5. This new strategy not only decouples the degree of shape complexity from the production costs and time, but also enables a versatile, low-cost, scalable process for 3D shaping of diverse materials, which could lead to new material functions and applications

Session B3
16:00 - 16:30 PM Room B December 17

B07: Black liquor-derived porous carbons from rice straw for high-performance supercapacitors

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Abstract
Supercapacitors are energy storage devices that retain electrical charge by an electrostatic double-layer or through electrochemical pseudocapacitance and have high power density and charge-discharge rates and their longer lifetime compared with traditional energy storage devices [1-3]. Activated carbons are widely used to prepare electrode materials due to their large surface area and relatively low cost [4]. In this work, rice straw was pretreated with KOH aqueous solution and the resulting liquid was used to synthesize a black liquor-derived porous carbon (BLPC) in which KOH acts as both lignin extraction solvent and chemical activation agent. The addition of melamine into the black liquor led to an increase in the surface area (2646 $m^2 \cdot g^{-1}$), pore volume (1.285 $cm^3 \cdot g^{-1}$) and promoted the formation of nitrogen covalent bonds in the carbon materials (N-BLPC). Melamine used as additive has dual roles as nitrogen source and pore modifier of the carbon material. The as-prepared materials had specific capacitances of 242 $F \cdot g^{-1}$ (BLPC) and 337 $F \cdot g^{-1}$ (N-BLPC) when used as electrodes in 6 M KOH electrolyte at a current density of 0.5 $A \cdot g^{-1}$. The assembled N-BLPC-based symmetric supercapacitor showed stable cycling (>98 % retention after 3000 cycles at 10 $A \cdot g^{-1}$). The proposed strategy offers a facile method to produce porous carbons from waste black liquor in biorefinery or pulp and paper processes, which has potential applications for adsorption, catalysis and energy storage.

Keywords

Supercapacitor; biomass; lignin; black liquor; carbon

References
[1] J.R. Miller; P. Simon, Electrochemical capacitors for energy management, Science 321, 651 (2008). Doi:10.1126/science.1158736
[2] T. Lin; I.W. Chen; F. Liu; C. Yang; H. Bi; F. Xu; F. Huang, Nitrogen-doped mesoporous carbon of extraordinary capacitance for electrochemical energy storage, Science 350, 1508 (2015). doi: 10.1126/science.aab3798
[3] H.S. Huang; K.H. Chang; N. Suzuki; Y. Yamauchi; C.C. Hu; K.C. Wu, Evaporation-induced coating of hydrous ruthenium oxide on mesoporous silica nanoparticles to develop high-performance supercapacitors, Small 9, 2520 (2013). doi: 10.1002/smll.201202786
[4] M. Sevilla; R. Mokaya, Energy storage applications of activated carbons: supercapacitors and hydrogen storage, Energy & Environmental Science 7, 1250 (2014). doi: 10.1039/c3ee43525c

Session B3
16:30 - 17:00 PM Room B December 17

B08: Making structured metals transparent for broadband electromagnetic waves

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Abstract
In this talk, we present our recent work on making structured metals transparent for broadband electromagnetic waves via excitation of surface waves. First, we theoretically show that one-dimensional metallic gratings can become transparent and completely antireflective for extremely broadband electromagnetic waves by relying on surface plasmons or spoof surface plasmons [1]. Second, we experimentally demonstrate that metallic gratings with narrow slits are highly transparent for broadband terahertz waves at oblique incidence and high transmission efficiency is insensitive to the metal thickness [2]. In the third, we significantly develop oblique metal gratings transparent for broadband electromagnetic waves (including optical waves and terahertz ones) under normal incidence [3]. Besides, the principles of broadband transparency for structured metals can be further extended to other systems [4,5]. These investigations provide guidelines to develop many novel materials and devices, such as transparent conducting panels, antireflective solar cells, and other broadband metamaterials and stealth technologies.

References
[1] X. R. Huang, R. W. Peng, and R. H. Fan, “Making metals transparent for ehite light by spoof surface plasmons”, Phys. Rev. Lett. 105, 243901 (2010)
[2] R. H. Fan, R. W. Peng, X. R. Huang, J. Li, Y. Liu, Q. Hu, Mu Wang, and X. Zhang, “Transparent metals for ultrabroadband electromagnetic waves”, Adv. Mater. 24, 1980 (2012)
[3] R. H. Fan, J. Li, R. W. Peng, X. R. Huang, D. X. Qi, D. H. Xu, X. P. Ren, and Mu Wang, “Oblique metal gratings transparent for broadband terahertz waves”, Appl. Phys. Lett. 102, 171904 (2013)
[4] R. H. Fan, L. H. Zhu, R. W. Peng, X. R. Huang, D. X. Qi, X. P. Ren, Q. Hu, and Mu Wang, “Broadband antireflection and light-trapping enhancement of plasmonic solar cells”, Phys. Rev. B 87, 195444 (2013)
[5] X. P. Ren, R. H. Fan, R. W. Peng, X. R. Huang, D. H. Xu, Y. Zhou, and Mu wang, “Nonperiodic metallic gratings transparent for broadband terahertz waves”, Phys. Rev. B 91, 045111 (2015)

Session B3
17:00 - 17:30 PM Room B December 17

B09: Electron transport characteristics of films comprised of transparent conducting nanocrystals synthesized by plasma

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Abstract
Transparent conducting oxide (TCO) thin films comprised of heavily doped wide-gap semiconductors are a ubiquitous feature of modern optoelectronics such as flat panel displays and touch screens. TCO materials also find application in thin film photovoltaic devices wherein charge carriers must be collected in the direction of the substrate surface normal. For the solar energy harvesting application, which is high volume and low margin, production cost is a key technology driver. Thus thin films comprised of TCO nanocrystals have attracted attention because they can be deposited at very high rates and relatively low cost by aerosol or solution phase processing. Among the two material properties that determine the figure of merit for a TCO, namely the light transmission and electrical conductivity, achieving facile charge carrier transport has proved to be much more difficult. In this talk, I will discuss the chemical and structural characteristics that are required for achieving high electrical conductivity in thin films comprised of TCO nanocrystals synthesized by plasma. The talk will focus primarily on results related to our work on ZnO. More recently, we have begun to focus on SnO_2. SnO_2 is much more chemically robust compared to ZnO and therefore finds a broader class of applications (e.g. electrochemical). A quantitative framework for describing the relationship of structure to electrical conductivity for thin films comprised of nanocrystals will be presented that is based on classical percolation theory and also incorporates aspects of state-of-the-art electron transport theory.

Session B3
17:30 - 18:00 PM Room B December 17

B10: Noble photocatalytic systems for degradation and detection of pollutants towards wastewater treatment applications

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Abstract

Water pollution is an emerging problem across the world due to rapid population growth and modern industrialization. Waste water contains organic (such as phenolic derivatives, polycyclic aromatic hydrocarbons etc.) and inorganic compounds (e.g. heavy metals) which can cause serious disorder. Photocatalytic technology as a part of promising green technology has recently received a lot of interest in contemporary literature for treating pollutants in waste water. ZnO and TiO_2 are well known photocatalysts to degrade organic and inorganic pollutants. However, these materials still require modifications with other nanomaterials because these materials absorb only ultraviolet part of sun light due to wide bandgap and the excitons created under the UV light recombine rapidly. In this talk, I will present our group's recent work about nanostructured TiO_2 based photocatalysts for degradation and detection of organic compounds. Their photocatalytic activity was enhanced through sensitization with carbon/quantum dots, doping with transition metals and functionalization with metal nanoparticles. Enhancement in visible light absorption as well as in charge separation at the interface was obtained through these modifications. These materials are reusable, and their nanostructures do not change after repetitive usage. Our current research focus is to develop visible light activated low-cost and scalable photocatalysts to treat effluent water from industries in particular, pharmaceutical and tannery.

Keywords

Photocatalyst; Dye degradation; Water treatment; Nanofibers; Quantum dots

References

[1] M. Misra, N. Singh and R. K. Gupta, "Enhanced visible-light-driven photocatalytic activity of Au@Ag core-shell bimetallic nanoparticles immobilized on electrospun TiO_2 nanofibers for degradation of organic compounds" Catalysis Science & Technology, 7, 570-580, 2017

[2] N. Singh, J. Prakash, M. Misra, A. Sharma and R. K. Gupta, "Dual functional Ta doped electrospun TiO_2 nanofibers with enhanced photocatalysis and SERS detection for organic compounds" ACS Applied Materials & Interfaces, 9 (34), 28495–28507, 2017

[3] N. Singh, J. Prakash and R. K. Gupta, "Design and engineering of high-performance photocatalytic systems based on metal oxide-graphene-noble metal nanocomposites" Molecular Systems Design & Engineering, 2, 422-439, 2017

[4] A. Tyagi, K. M. Tripathi, N. Singh, S. Choudhary and R. K. Gupta, "Green synthesis of carbon quantum dots from lemon peel waste: Applications in sensing and photocatalysis" RSC Advances, 6, 72423-72432, 2016

[5] N. Singh, K. Mondal, M. Misra, A. Sharma and R. K. Gupta, "Quantum dot sensitized electrospun mesoporous titanium dioxide hollow nanofibers for photocatalytic applications" RSC Advances, 6, 48109 - 48119, 2016

Session A4
9:00 - 9:30 AM Room A December 18

A10: Nanoporous gold for sensor and fuel cell catalysts

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Abstract
Nanoporous gold (NPG) fabricated by dealloying Au–Ag film in nitric acid shows good performance in the detection of hydrogen peroxide and hydrazine. A maximum power density 195 mW cm^2 is obtained in a direct hydrazine-hydrogen peroxide fuel cell based on these porous gold leaves. A power density of nearly 400 mW cm^2 can be observed under the supplying of 10 wt% $NaBH_4$ and 20 wt% H_2O_2. When Pt atoms were effectively dispersed onto nanoporous substrate with sub-monolayer precision, the performance of direct formic acid fuel cell in a loading of tens of micrograms is comparable to the one with milligram loading of commercial Pt/C. These NPG–Pt core/shell nanostructures are further decorated by a sub-monolayer of Bi to create highly active reaction sites for formic acid electro-oxidation.

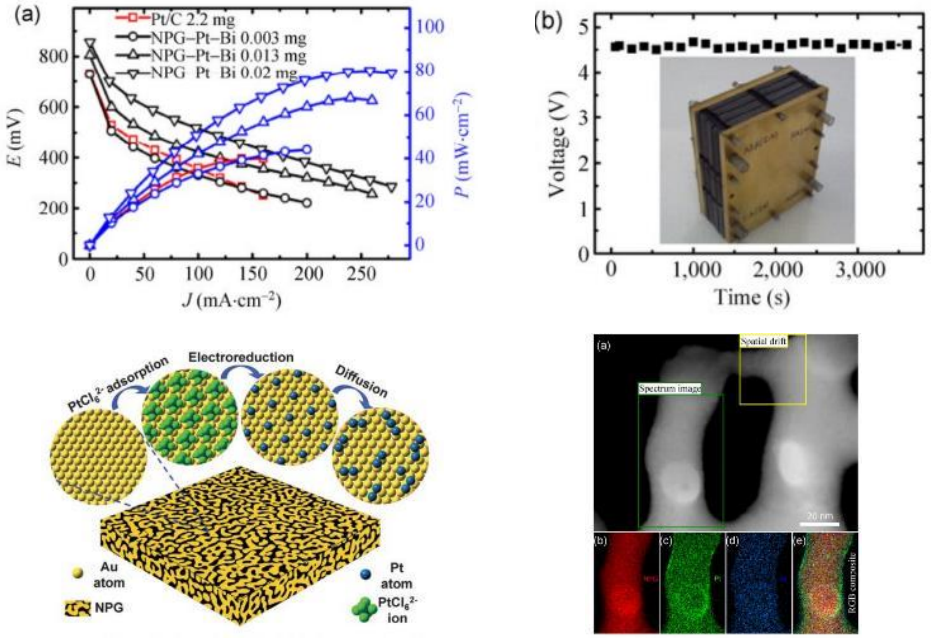

Fig. *The IV curves, stack, structure of direct formic acid fuel cell using nanoporous gold.*

References
[1] Electrochimica Acta 56 (2011) 4657–4662
[2] Journal of Electroanalytical Chemistry 661 (2011) 44–48
[3] Scientific Reports, 2012, 2, 941
[4] International Journal of Hydrogen Energy, 2013, 38, 10992-10997
[5] Chemical Sciences, 2014, 5, 403-409
[6] Nano Research, 2014, 7, 1569-1580
[7] RSC Advances, 2017, 7, 18327 - 18332

Session A4
9:30 - 10:00 AM Room A December 18

A11：Sensitive Room-Temperature H_2S Gas Sensors Employing SnO_2 Quantum Wire/Reduced Graphene Oxide Nanocomposites

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Abstract
Metal oxide/graphene nanocomposites are emerging as one of the promising candidate materials for developing high-performance gas sensors. Here, we demonstrate sensitive room-temperature H_2S gas sensors based on SnO_2 quantum wires that are anchored on reduced graphene oxide (rGO) nanosheets. Using a one-step colloidal synthesis strategy, the morphology-related quantum confinement of SnO_2 can be well-controlled by tuning the reaction time, because of the steric hindrance effect of rGO. The as synthesized SnO_2 quantum wire/rGO nanocomposites are spin-coated onto ceramics substrates without further sintering to construct chemiresistive gas sensors. The optimal sensor response toward 50 ppm of H_2S is 33 in 2 s, and it is fully reversible upon H_2S release at 22°C. In addition to the excellent gas adsorption of ultrathin SnO_2 quantum wires, the superior sensing performance of SnO_2 quantum wire/rGO nanocomposites can be attributed to the enhanced electron transport resulting from the favorable charge transfer of SnO_2/rGO interfaces and the superb transport capability of rGO. The easy fabrication and room temperature operation make our sensors highly attractive for ultrasensitive H_2S gas detection with less power consumption.

Keywords
SnO_2 quantum wires; H_2S; room-temperature; rGO

Session A4
10:00 - 10:30 AM Room A December 18

A12: Screened strong light-matter coupling of excitons in multilayer 2D-semicondutors and plasmonic nanocavities

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Abstract

Understanding the mechanisms that increase and limit the light-matter coupling strength of excitons in 2D semiconductors to photons in cavities and controlling this coupling is of utmost importance for the development of polaritonic devices. We demonstrate the strong coupling of direct transition excitons in monolayers and multilayers of WS_2 with collective plasmonic resonances in open plasmonic cavities formed by arrays of metallic nanoparticles [1]. The Rabi energy increases by increasing the number of layers. However, this increase does not scale with the square root of the number of layers as expected for strongly coupled systems. Only in-plane coupling contributes to the Rabi energy on the nanoparticle array due to the screened out-of-plane field distribution in WS_2. The decreased in-plane dipole moments of thicker WS_2 multilayers result in a smaller Rabi energy than the expected value from collective strong coupling.

Keywords

Strong light-matter coupling; 2D-semiconductors; Plasmonics; Nanoparticle Arrays; Surface Lattice Resonances

References

[1] Shaojun Wang, Quynh Le-Van, Fabio Vaianella, Bjorn Maes, Simone Eizagirre Barker, Rasmus H. Godiksen, Alberto G. Curto, Jaime Gomez Rivas, Screened Strong Coupling of Excitons in Multilayer WS_2 with Collective Plasmonic Resonances, arXiv: 1808.08388

Session A5
11:00 - 11:30 AM Room A December 18

A13: Functional Molecular Junctions derived from Double Self-assembled Monolayers on Graphene

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Abstract
Information processing through molecular junctions is getting important as the device is miniaturized into a nanoscale. Herein, we report functional molecular junctions derived by double-self-assembled monolayers (SAMs) intercalated between soft graphene electrodes. Newly assembled molecular junctions are fabricated by placing one molecular SAM/(top) electrode on the other molecular SAM/(bottom) electrode *via* a contact-assembly technique. Double-SAMs can provide a tunnelling conjugation across the van der Waals gap between the terminals of each monolayer and exhibit a new electrical function. Robust contact-assembled molecular junctions will be platforms for the development of an equivalent contact molecular junction between top and bottom electrodes, which can be applied independently to different kinds of molecules for either the structural complexity or assembly properties of molecules.

Keywords

molecular junction; double self-assembled monolayer; molecular electronics; grapheme electrode; molecular diode

Introduction
Molecular electronics have mainly focused on the well-described charge transport through single molecular junctions or the increase in stability and reproducibility of molecular self-assembled monolayer (SAM) junctions. [1-4] The fascinating points of the bottom-up fabrication using SAMs are its simplicity, low-cost, and reproducibility to at least one contact (*e.g.*, a bottom contact). Thus, the majority of the investigation for bottom-up molecular junctions has been for constructing the homogeneous structures of molecular layers at a top contact as if molecular SAMs are made at a bottom contact.

Here, we suggest new soft-sandwich configurations for solid-state molecular devices (Figure 1). One soft polymer substrate (*e.g.*, polydimethylsiloxane, PDMS) with patterned graphene electrodes can make good contacts through both graphene and PDMS areas on the other one. This can directly form the assembly junction of molecular SAM(s) sandwiched between two graphene/PDMS substrates without the transfer of electrodes such as pressing or flotation. In particular, more complex molecules than alkanethiols that contain large redox centers or functional chains inducing less packing density of SAMs require relevant contacts corresponding to the structures of the SAMs in their molecular junctions. In this work, the molecular SAM-formed top and bottom electrode arrays are vertically positioned to each other and assembled to contact for formation of the crossbar molecular junctions by a simple and reproducible position alignment. Our new equivalent contact-assembly method can provide simple,

stable, reproducible, and length controllable molecular junctions using either one or two kinds of SAM molecules for molecule-based electronics, resulting in new functional molecular junctions derived by double-SAMs.

Methods

Materials and characterization: In order to improve the quality of single-layer graphene, preparation steps such as well drying of a coated polymer film, careful washing of a polymer-coated graphene sheet with floating on water, and well-removing polymer residuals with hot acetone must be carefully conducted. Defect-free or less defective single-layer graphene in high quality is mechanically and chemically very stable. Apparently defect-free or less defective single-layer graphene has been used for the fabrication of graphene electrodes after synthesis; a piece of every CVD graphene batches grown in each CVD tube has been randomly evaluated by optical microscopy, AFM, and Raman after transferring onto a SiO_2 substrate.

Fabrication of equivalent contact junctions: Contact-assembled junctions were fabricated by placing one molecular assembled electrode (molecular SAM/graphene) on the other electrode to form a crossbar set of an electrode array. The top and bottom electrodes were softly and equivalently merged onto each other *via* the PDMS//PDMS soft contact, which resulted in stable crossbar junctions in the device.

Results and Discussion

Figure 2a shows histograms of log|*J*| at –0.5 V for the selected data set of log|*J*| within a range of $\mu \pm 3\sigma$ (μ = the average, and σ = the standard deviation) for G_T/Cn-C4Pyr/G_B (n = 4, 6, 8, 10). The *J* curves (Figure 2b) were plotted on a logarithmic scale as a function of applied voltage for the contact-assembly junctions composed of Cn-C4Pyr (n = 4, 6, 8, 10) SAMs (the error bars represent the standard deviation with 95% confidence intervals on the mean that correspond to the selected *J* values from 65-70 junctions). The *J* depended exponentially on molecular length (or distance between two electrodes). It is expected that the tunnelling is a dominant mechanism of the charge transport, $J = J_0 e^{-\beta d}$ (for the rectangular tunnelling barriers, where J_0 is the current density when *d* is zero, β is the tunnelling decay constant, and *d* is the barrier width) can be applied to the molecular junction.[5-6]

The fit of the *J* values from the contact-assembly junctions of Cn-C4Pyr SAMs was determined at several bias voltages as a function of molecular length. The β values were measured as 0.69–0.70 ± 0.01 $Å^{-1}$ in a voltage range from –0.1 to –0.5 V. Considering the effects of defects in bottom electrodes and alkyl SAMs on the value of β, the measured values of β ($0.5 < \beta < 1.0$) can imply low defects corresponding to the results of the voltammetry and the strong interactions between pyrene anchors and graphene electrodes *via* noncovalent π-π interactions.

For the functionalized molecular SAM junctions, the charge transport through the Fc-C4Pyr SAMs in our equivalent contact junctions was also measured (Figure 2c). In a voltage range between ± 0.5 V, we found two different types of *J* curves corresponding to two different junction states with regard to the thickness difference of the Fc-C4Pyr SAMs due to the ordering of the large functional groups. The differences in the junction distances in the Fc-C4Pyr SAMs were reflected in their *J* curves. The performance of the Fc-C4Pyr SAM showed that the current flow both forward and backward directions acting as an insulating layer as observed with other Cn-C4Pyr SAM junctions, even though electrochemically active Fc moieties are asymmetrically located near the top electrode. This indicates that the tunnelling barrier between the bottom graphene electrode and the alkyl part is supposed to be similar to that between the Fc unit and the G_T electrode (including the van der Waals gap), resulting in symmetric potential drops across the Fc part and the alkyl part.

On the other hand, molecular rectifying performance allowing for asymmetrical currents were simply applied using our contact-assembly with the junctions comprised of double-SAMs (*e.g.*, G_T/PyrC4-C4//Fc-C4Pyr/G_B or G_T/PyrC4-C6//Fc-C4Pyr/G_B, where // denotes a contact between SAMs) (Figure 2d). The *J* values measured in the double-SAM junctions (approximately 2.9 nm) of G_T/PyrC4-C4//Fc-

C4Pyr/G_B did not follow the tendency of the length-dependent *J* plots in Figure 2b, which show relatively higher current densities than that of C10-C4Pyr (approximately 1.8 nm) with a similar molecular length. According to previous papers, the junctions of double-SAMs (*e.g.*, Hg-alkyl SAM1//alkyl SAM2-Hg) exhibited a negligible influence on the van der Waals interface between the two SAMs, and the coupling of the SAM1//SAM2 interfaces was considered to be better than that of the SAM//Hg interfaces. Thus, the molecular length-dependency of the *J* values on the double-pyrene SAM junctions might be slightly deviated from the tendency of the single-pyrene SAM junctions on the molecular length-dependent *J* values. Although the same pyrene-anchored contacts on both electrodes were formed, this asymmetric double-SAM junction showed significant rectification behaviour in a voltage range of ± 0.5 V. Furthermore, the rectification ratios in the *J* values were increased in junctions of G_T/PyrC4-C6//Fc-C4Pyr/G_B in which the distance of the tunnelling barrier increased by the length of the top SAM at a negative bias. Thus, the rectification ratios can be controlled by two different SAMs in the molecular junction assembled by the contacts of two electrodes.

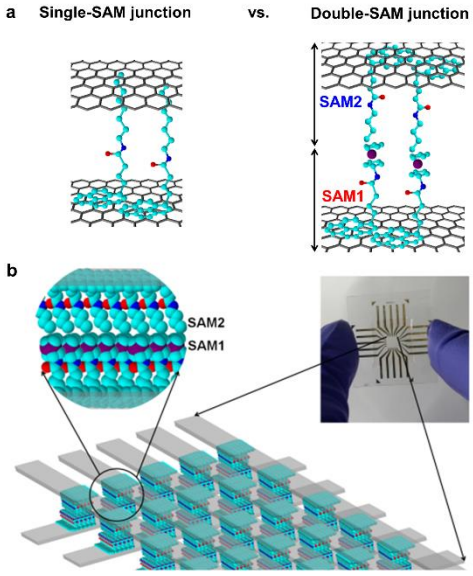

Figure 1. *(a) Schematics of molecular junctions comprising either single- or double-self-assembled monolayers (SAMs) on graphene. (b) Picture of the device.*

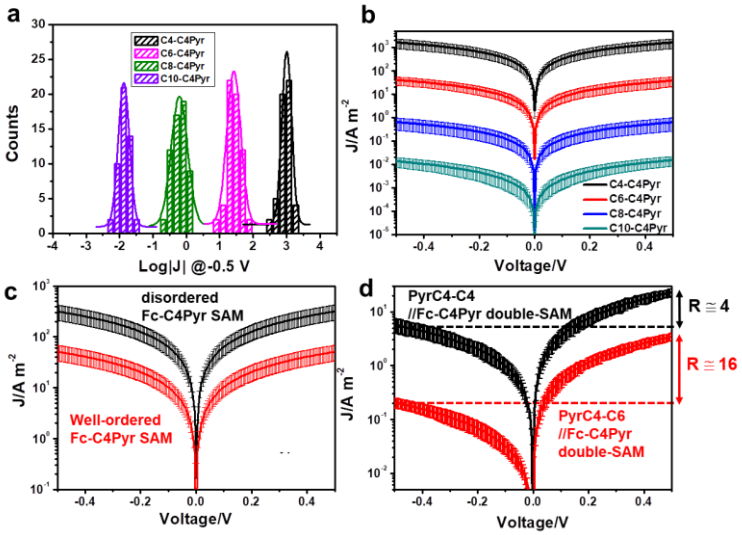

Figure 2. *(a) Histograms of log|J| at –0.5 V for the selected data set of log|J| within a range of $\mu \pm 3\sigma$ (μ = the average, and σ = the standard deviation) for G_T/Cn-C4Pyr/G_B (n = 4, 6, 8, 10). (b) Semi-log plots of J-V curves of*

single SAMs in molecular junctions contact-assembled G_T/PyrC4-Cn, n = 4, 6, 8, 10/G_B. Pyrene molecular junctions of non-shorted devices that were fabricated with well-patterned graphene electrodes allowed for >90% yield. (c) Semi-log plots of J-V curves of functionalized single-SAMs in molecular junctions of contact-assembled G_T/Fc-C4Pyr/G_B. (d) A new functional J-V curves (in semi-log plots) of double-SAMs in molecular junctions of contact-assembled G_T/PyrC4-C4//Fc-C4Pyr/G_B and G_T/PyrC4-C6//Fc-C4Pyr/G_B. Rectification ratio values (R) are measured by 4 for G_T/PyrC4-C4//Fc-C4Pyr/G_B and 16 for G_T/PyrC4-C6//Fc-C4Pyr/G_B.

Conclusions

In summary, we showed that newly functionalized molecular junctions using a contact-assembly method that places one molecular SAM/(top) electrode on the other molecular SAM/(bottom) electrode can transduce intermolecular charge transport into electronic signals. On a graphene electrode, pyrene-anchored electrochemically inactive or active molecules were used for noncovalent assembly. The insulating alkyl backbones in Cn-C4Pyr SAM junctions served as a tunnelling distance in a rectangular potential barrier; that is, the current density that flows across the junctions is exponentially dependent on the molecular length at the low bias regime (*e.g.*, ± 0.5 V). The electrochemically active Fc-C4Pyr SAM junctions also showed that the current flow both forward and backward directions at ± 0.5 V acting as an insulating layer as observed with other Cn-C4Pyr SAM junctions. However, double-SAM junctions of G_T/PyrC4-C4 (or -C6)//Fc-C4Pyr/G_B resulted in the current rectification at ± 0.5 V in one direction, coming from the asymmetric coupling effects of the HOMO level of the Fc to electrodes. Our new type of robust contact-assembled molecular junctions can be applied to new functional molecular junctions by combining two different molecular SAMs.

Acknowledgement

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References

[1] M. A. Reed, C. Zhou, C. J. Muller, T. P. Burgin, J. M. Tour, Science 1997, 278, 252-254

[2] H. B. Akkerman, P. W. M. Blom, D. M. de Leeuw, B. de Boer, Nature 2006, 441, 69-72

[3] S. Park, G. Wang, B. Cho, Y. Kim, S. Song, Y. Ji, M.-H. Yoon, T. Lee, Nat. Nanotrchnol. 2012, 7, 438-442

[4] Z. Wang, H. Dong, T. Li, R. Hviid, Y. Zou, Z. Wei, X. Fu, E. Wang, Y. Zhen, K. Norgaard, B. W. Laursen, W. Hu, Nat. Commun. 2015, 6, 7478

[5] C. A. Nijhuis, W. F. Reus, G. M. Whitesides, J. Am. Chem. Soc. 2010, 132, 18386-18401

[6] S. Seo, M. Min, S. M. Lee, H. Lee, Nat. Commun. 2013, 4, 1920

[7] P. Song, C. S. S. Sangeeth, D. Thompson, W. Du, K. P. Loh, C. A. Nijhuis, Adv. Mater. 2016, 28, 631-639

Session A5
11:30 - 12:00 AM Room A December 18

A14: Spin-valley transport property in silicene junction

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Abstract
Silicene, a silicon analogue of graphene, is a monolayer of silicon atoms arranged in a honeycomb lattice with large spin orbit coupling and bulked atomic structure. It is a 2-dimensional topological insulator and has attracted increasing attention during the past few years. The carriers in the system governed by the spin-valley dependent massive Dirac fermions. Pseudo mass of Dirac fermions is tunable by external forces such as perpendicular electric field, staggered exchange energy and off resonant circularly polarized light. This may lead to the perfect control of spin-valley polarization in silicene junction. Our talk would give the clarification of how spin-valley filtering in silicene is perfect based on ballistic quantum transport theory.

Keywords

Silicene; 2D materials; spin-valley polarization; 2D topological insulator

Session A5
12:00 - 12:30 AM Room A December 18

A15: Comparison of electrical energy and power of PV cells or module with different cells materials in clear sky day condition

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Abstract
In present communication, a comparison has been made on the basis of attainment of the electrical energy and power from solar cells or glass to glass or semitransparent photovoltaic module. To evaluate the electrical energy and power, five different materials or cases have been considered, which are named as: case (i): mono crystalline silicon (c-Si), case (ii): poly crystalline silicon (p-Si), case (iii): amorphous silicon (a-Si), case (iv): cadmium telluride (CdTe) and case (v): *copper-indium-gallium-selenide (CIGS). One PV module has been considered for the analysis which* dimension is 0.605×1 m^2. For case (i): PV cells are made of silicon crystalline, which is having 0.5 Volts and 4 Amp and 36 cells are connected in series, which are producing 72 watts. This analysis has been studied for a clear sky day condition, New Delhi, India. The comparative study is attempted to choose best for generating electrical energy and power due to high electrical demands in our society. It is observed that the maximum electrical energy and power have been obtained for case (i), whereas minimum for case (iii), due to high PV cell temperature. The electrical energy and power have been 1.8 times higher in case (i), than case (iii).

Keywords

PV cell; semitransparent module; cell material; power

References
[1] Tripathi R., Tiwari G.N., Al-Helal I.M.," Thermal modeling of N partially covered photovoltaic thermal (PVT)-Compound parabolic concentrator (CPC) collectors connected in series", Solar Energy, 123, 2016, 174-184

[2] Tripathi R., Tiwari G.N., "Annual performance evaluation (energy and exergy) of fully covered concentrated photovoltaic thermal (PVT) water collector: An experimental validation", Solar energy, 146, 2017, 180-190

[3] Cheng C.L., Sanchez Jimenez C.S. Lee M.C., Research of BIPV optimal tilted angle, use of latitude concept for south oriented plans", Renewable Energy, 34, 2009, pp. 1644-1650

[4] Duffie J, Beckman W., Solar Engineering of Thermal Processes, Wiley, New York, NY, USA, 1974

Session A6
14:00 - 14:30 PM Room A December 18

A16: Printed graphene nanoflakes for radio frequency antennas and wireless sensors

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Abstract
Printed antenna based on graphene nanoflakes has attracted increasing attention from both academic and industrial societies, with its advantages of low cost, high performance, high production efficiency and environmentally friendliness, etc [1-6]. Highly conductive graphene nanoflake laminate can be achieved through graphene nanoflakes dispersion, screen printing and compression laminating. The compression can improve the laminate conductivity by more than 50 times, and improve the radiation efficiency of printed graphene antenna as well [1, 2]. Based on successful demonstration on radiation of printed graphene nanoflakes antenna, more works on printed radio frequency identification (RFID) tag, flexile communication antennas, remote humidity sensors have been developed theoretically and experimentally [1-3, 5]. The results prove that the printed graphene antenna and sensors are the right choices for low-cost, environmentally friendly disposable electronics in internet of things (IoT), smart retails, property management, etc.

Keywords

Printed electronics; graphene nanoflakes; flexible antenna; wireless sensing; RFID

References
[1] Huang, X., Leng, T., Zhang, X., Chen, J.C., Chang, K.H., Geim, A.K., Novoselov, K.S. and Hu, Z., Binder-free highly conductive graphene laminate for low cost printed radio frequency applications. Applied Physics Letters, 106(20), p.203105 (2015). doi:10.1063/1.4919935
[2] Huang, X., Leng, T., Zhu, M., Zhang, X., Chen, J., Chang, K., Aqeeli, M., Geim, A.K., Novoselov, K.S. and Hu, Z., Highly flexible and conductive printed graphene for wireless wearable communications applications. Scientific reports, 5, p.18298 (2015). doi:10.1038/srep18298
[3] Leng, T., Huang, X., Chang, K., Chen, J., Abdalla, M.A. and Hu, Z., Graphene nanoflakes printed flexible meandered-line dipole antenna on paper substrate for low-cost RFID and sensing applications. IEEE Antennas and Wireless Propagation Letters, 15, pp.1565-1568 (2016). doi:10.1109/LAWP.2016.2518746
[4] Huang, X., Leng, T., Chang, K.H., Chen, J.C., Novoselov, K.S. and Hu, Z., Graphene radio frequency and microwave passive components for low cost wearable electronics. 2D Materials, 3(2), p.025021 (2016).
[5] Huang, X., Leng, T., Georgiou, T., Abraham, J., Nair, R.R., Novoselov, K.S. and Hu, Z., Graphene oxide dielectric permittivity at GHz and its applications for wireless humidity sensing. Scientific reports, 8(1), p.43 (2018). doi:10.1038/s41598-017-16886-1
[6] Akbari, M., Khan, M.W.A., Hasani, M., Bjorninen, T., Sydanheimo, L. and Ukkonen, L., Fabrication and characterization of graphene antenna for low-cost and environmentally friendly RFID tags. IEEE Antennas Wirel. Propag. Lett, 15, pp.1569-1572 (2015). dos:10.1109/LAWP.2015.2498944

Session A6
14:30 - 15:00 PM Room A December 18

A17: Bio-inspired on-surface fabrication of graphene nanoribbons

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Abstract
Heterogeneous catalysis has been known to produce functional materials by the acceleration of chemical reactions on metal surface. In conventional heterogeneous catalysis, the reaction can be accelerated by electronic interactions between the reactant and metal surface, like a “hard (scrap & built)” manner. In this study, we demonstrate a synthesis of graphene nanoribbons (GNRs) by a new concept of “bio-inspired heterogeneous catalysis” similar to the enzymatic reactions in biology like a “soft” manner, which is featured by homo chirality, transformation, self-assembly and adaptation, directing an optimized chemical reaction pathway to efficiently produce the product. Our developed two-zone chemical vapor deposition of the “Z-bar-linkage” precursors designed herein, exhibiting flexible as well as complex geometry that allows them to adopt chiral (asymmetrical) conformations on a Au(111) surface, results in the efficient formation of acene-type graphene nanoribbons with a width of 1.45 nm through optimized cascade reactions. These new surface-reactions include the formation of self-assembled homochiral polymers in a chain with a planar conformation, followed by efficient stepwise dehydrogenation via a conformation-controlled mechanism. The FET devices of acene-type GNR transferred from Au(111) to the insulating substrates show an excellent semiconductor performance. Thus, our proposed concept of “bio-inspired heterogeneous catalysis” is useful to fabricate the new nanocarbon materials.

Keywords

Graphene nanoribbons; Surface Science

References
[1] H. Sakauchi; et al., Homochiral Polymerization-driven Selective Growth of Graphene Nanoribbons. Nature Chemistry, 9, 57 (2017). doi:10.1038/nchem.2614

[2] H. Sakauchi; et al., Width-Controlled Sub-Nanometer Graphene Nanoribbon Films Synthesized by Radical-Polymerized Chemical Vapor Deposition. Advanced Materials, 26, 4134 (2014). doi:10.1002/adma.201305034

[3] H. Sakauchi; et al., Strain-induced Skeletal Rearrangement of a Polycyclic Aromatic Hydrocarbon on a Copper Surface. Nature Communications, 8, 16089 (2017). doi:10.1038/ncomms16089

Session A6
15:00 - 15:30 PM Room A December 18

A18: Facile Synthesis of 2D Nitrogen-Containing Porous Carbon Nanosheets Induced by Graphene Oxide for High-Performance Supercapacitors

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Abstract
Two-dimensional (2D) nitrogen-containing porous carbon nanosheets are the ideal electrode materials for supercapacitors, which also have been the focus of increasing attention in recent years [1]. 2D nitrogen-containing porous carbon nanosheets are prepared in the presence of graphene oxide (GO) as a structure-directing agent by a simple yet facile hydrothermal method. It is found that GO can effectively turn the morphologies of the hydrothermal carbonaceous products, resulting in the unique 2D structures. The as-obtained 2D nitrogen-containing porous carbon nanosheets as electrodes for supercapacitors exhibit a high specific capacitance of 301.6 F g^{-1} at a current density of 0.5 A g^{-1} and superior rate capability with a capacitance retention of 70.5% at the high current density of 20 A g^{-1}. The 2D nitrogen-containing porous carbon nanosheet electrodes also exhibit good cycling performance, possessing the high capacitance retention over 92.3 % after 5000 charge-discharge cycles at the current density of 5 A g^{-1}. Such superior electrochemical performance of the 2D nitrogen-containing porous carbon nanosheets could be attributed to the high pseudocapacitive effect of the nitrogen-containing species and the peculiar structural characteristics featuring the short ion transport distance and abundant porous channels.

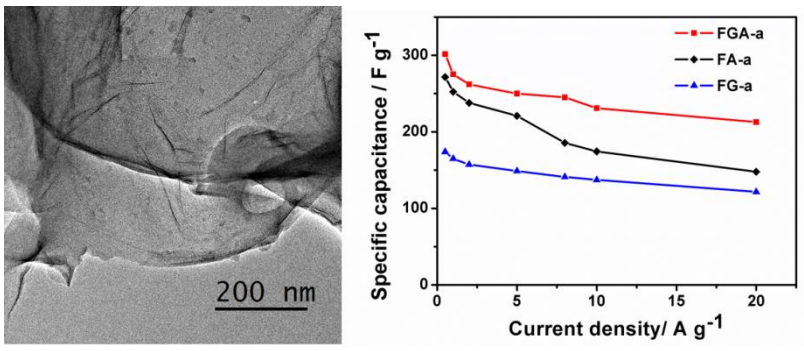

Fig. *TEM image and the electrochemical performance of 2D carbon nanosheets*

References
[1] R. Ma and T. Sasaki, Accounts Chem. Res., 2015, 48, 136

Session A7
16:00 - 16:30 PM Room A December 18

A19: Electrochemical Synthesis of Nano-Structured Si for Energy Storage Application

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Abstract
In this paper we have systematically investigated the electrodeposition of silicon over highly conductive substrates. Crystalline silicon was effectively electrodeposited on gold (Au (111)) and graphene coated copper substrates in the over potential regime using $SiCl_4$ in water contaminated 1-Butyl-3-Methylimidazolium-Bis (Trifluoromethylsulfonyl) imide ($BMImTf_2N$) under ambient conditions. It was observed that the existence of water in the ionic liquid ($BMImTf_2N$) does not affect the effective potential window significantly but it tends to induce template effect that lead to the deposition of inter-connected spherical Si particle. However, active electrolyte in water contaminated ionic liquid has been found to react with the copper substrate, forming a semiconductor film of copper oxide. In order to eliminate the oxide formation, graphene sheets were coated over copper substrates and were further used to deposited silicon. Initially, graphene (RGO) coated copper substrate was prepared from reduction of graphene oxide in Ar/H_2 containing atmosphere at high temperature before electrodeposition. The three-dimensional growths of nanospheres were characterized using scanning and transmission electron microscopy and X-ray photoelectron spectroscopy. The key findings of the obtained results was the formation of silicon nanospheres from the precursor ($SiCl_4$) which coexisted with ionic liquids and not undergoing hydrolysis even in the presence of water. In the present talk, the key to the formation of various Si morphologies on the substrate of different surface energy will be discussed on the basis of nucleation and growth mechanism from the current time relationship. Initial findings on the application of inter-connected Si nano-spheres on Au(111) in supercapacitors will also be presented.

Session A7
16:30 - 17:00 PM Room A December 18

A20: Coherent phonons of high- and low-symmetry in the topological insulators

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Abstract
Coherent and incoherent Raman active phonons in the 3D topological insulators, Bi_2Te_3 and Bi_2Se_3, have been studied with ultrafast laser and spontaneous Raman spectroscopy [1-4]. The differences between coherent and incoherent phonons are revealed through a comparison of spontaneous Raman spectra and Fourier transforms of time-resolved reflectivity [2]. Polarization dependence and different detection schemes (isotropic and anisotropic) allow to separate fully symmetric A_{1g} and doubly degenerate E_g phonons in the time-domain experiments [2]. Using coherent control to selectively excite a single fully symmetric mode [4] we observe its coupling to surface Dirac plasmon. The coupling results in a short-lived frequency chirp of the coherent A_{1g} phonon and the transient coherent phonon spectra obtained at different time frames exhibiting a Fano-like asymmetric lineshape attributed to a quantum interference between continuum-like coherent Dirac plasmons and phonons [5]. By analyzing the chirp lifetime and the time-dependent asymmetric line shape, it was established that the Fano-like resonance persists up to several hundred femtoseconds.

Keywords

Ultrafast spectroscopy; Coherent phonons; Topological insulators; Time- and frequency-domain; 3D Dirac plasmons

References

[1] K. Norimatsu, M. Hada, S. Yamamoto, T. Sasagawa, M. Kitajima, Y. Kayanuma, and K. G. Nakamura. J. Appl. Phys. 117, 143102 (2015). doi: 10.1063/1.4917384

[2] O.V. Misochko, M.V. Lebedev, JETP 126, 64 (2018). doi: 10.1134/S106377611801017X

[3] O.V. Misochko, J. Flock, and T. Dekorsy, Phys. Rev. B 91, 174303 (2015). doi: 10.1103/PhysRevB.91.174303

[4] J. Hu, K. Igarashi, T. Sasagawa, K.G. Nakamura, and O.V. Misochko, J. Appl. Phys. 112, 031901 (2018). doi: 10.1063/1.5016941

[5] R. Mondal, A. Arai, Y. Saito, P. Fons, A.V. Kolobov, J. Tominaga, and M. Hase, Phys. Rev. B 97, 144306 (2018). doi:10.1103/PhysRevB.97.144306

Session A7
17:00 - 17:30 PM Room A December 18

A21: Switchable valley polarization by external electric field effect in graphene/CrI_3 heterostructures

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Abstract
Achieving and controlling the valley polarization is a core issue for valleytronics applications. Conventionally, the valley polarization was achieved by applying the external magnetic field or structural manipulation. However, this approach is less efficient. Here, we explored the single layer and bilayer graphene on CrI_3 (g-CrI_3 and 2g-CrI_3) heterostructures to induce the valley polarization. In g-CrI_3, we found a huge valley polarization with the majority gap difference of $\Delta_{1\uparrow}$ - $\Delta_{2\uparrow}$ =44 meV. Even in 2g-CrI_3 system, we also found the valley polarization of $\Delta_{1\uparrow}$ - $\Delta_{2\uparrow}$ =21 meV. Moreover, we also investigated the electric field effect on the valley polarization. In both systems, we obtained that the valley polarisation could be switched in the majority spin band. For instance, the sign of gap difference at ±K changed from $\Delta_{1\uparrow} > \Delta_{2\uparrow}$ at zero field to $\Delta_{1\uparrow} < \Delta_{2\uparrow}$ at a small applied electric field of 0.1 V/Å. With further increase of the electric field to 0.2 V/Å, the valley polarisation disappeared. Thus, we propose that a large value of valley polarisation can be achieved and the sign of polarization can also be switched with electric field instead of magnetic field. This feature will be very beneficial for designing of valleytronic based information process devices.

Keywords

Heterostructures; Valley polarization; Valleytronics; Switchable valley polarization; pseudospin

Session B4
9:00 - 9:30 AM Room B December 18

B11: Metasurfaces for Solar Thermophotovoltaic Energy Harvesting

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Abstract

Solar energy promises a viable solution to meet the ever-increasing power demand by providing a clean, renewable energy alternative to fossil fuels. Photovoltaic (PV) solar cells have been the most prevalent solar energy harvesting technology. Despite the development over the past few decades, the efficiency of state-of-the-art, single-junction PV cells is still far below the fundamental limit predicted by Shockley and Queisser. Metasurface inspired solar thermophotovoltaics (STPV) [1] represent a promising alternative to traditional photovoltaics for solar energy harvesting. We demonstrate a broadband, polarization independent, omnidirectional absorber based on a metallic metasurface architecture, which accomplishes greater than 90% absorptance in the visible and near-infrared range of the solar spectrum, and exhibits low emissivity at mid- and far-infrared wavelengths [2]. While the gold metasurface exhibits high absorptance its application for the high temperature STPV is not possible because of the inherent low melting temperature of gold. We also demonstrate refractory metasurfaces for STPV with tailored absorptance and emittance characterized by in-situ high-temperature measurements, featuring thermal stability up to at least 1200 ºC. Our tungsten-based metasurface absorbers have close-to-unity absorption from visible to near infrared and strongly suppressed emission at longer wavelengths, while our metasurface emitters provide wavelength-selective emission spectrally matched to the band-edge of InGaAsSb photovoltaic cells [3]. The projected overall STPV efficiency is as high as 18% when employing a fully integrated absorber/emitter metasurface structure, much higher than those achievable by stand-alone PV cells.

Keywords

Metasurfaces; refractory metamaterials; solar thermophotovoltaics; solar absorbers; thermal emitters; high-temperature

References

[1] P. A. Davies, A. Luque, Sol. Energy Mater. Sol. Cells 33, 11 (1994)

[2] Abul. K Azad, W. JM Kort-Kamp, M. Sykora, N. Weisse-Bernstein, T. S Luk, A. J Taylor, D. A. R Dalvit, and H-T Chen, Scientific Reports 6, 20347 (2016)

[3] C.-C. Chang, W. J. M. Kort-Kamp, J. Nogan, T. S. Luk, A. K. Azad, A. J. Taylor, D. A. R. Dalvit, M. Sykora, and H.-T. Chen, Nano Letters (2018) (submitted)

Session B4
9:30 - 10:00 AM Room B December 18

B12: Solar cell and photoelectrochemical properties of Cu_2ZnSnS_4 thin films fabricated by wet chemical techniques

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Abstract
Kesterite compounds of Cu_2ZnSnS_4 (CZTS) has been studied for low-cost thin film solar cells because they do not contain toxic and/or rare elements which are included in commercial photo-absorbers of CdTe and $Cu(In,Ga)(S,Se)_2$. The CZTS compound is also attractive for the solar cell because of its optimum band gap energies for sunlight absorption (1.5 eV) and high absorption coefficient ($> 10^4$ cm^{-1}). For fabrication of its thin film form, non-vacuum technologies are preferable in view of cost effectiveness. In this study, CZTS thin films with various compositions and additives were fabricated by electrodeposition and spray pyrolysis methods; their solar cell properties and applications for photoelectrochemical sunlight conversion, e.g., water splitting, were also studied [1-8].

Keywords

Kesterite Cu_2ZnSnS_4, spary deposition, solar cell properties, photoelectrochemical water splitting

References
[1] F. Jiang; S. Ikeda; T. Harada; M. Matsumura, Adv. Energy Mater., 4, 1301381 (2014). doi: 10.1002/aenm.201301381
[2] T. H. Nguyen; W. Septina; S. Fujikawa; F. Jiang; T. Harada; S. Ikeda, RSC Adv., 5, 77565 (2015). doi: 10.1039/C5RA13000J
[3] F. Jiang; C. Ozaki; Gunawan; T. Harada; Z. Tang; T. Minemoto; Y. Nose; S. Ikeda, Chem. Mater., 28, 3283 (2016). doi: 10.1021/acs.chemmater.5b04984
[4] T. H. Nguyen; T. Harada; J. Chantana; T. Minemoto; S. Nakanishi; S. Ikeda, ChemSusChem, 9, 2414 (2016). doi: 10.1002/cssc.201600641
[5] T. H. Nguyen; T. Kawaguchi; J. Chantana; T. Minemoto; T. Harada, S. Nakanishi; S. Ikeda, ACS Appl. Mater. Interfaces, 10, 5455 (2018). doi:10.1021/acsami.7b14929
[6] F. Jiang; Gunawan; T. Harada; Y. Kuang; T. Minegishi; K. Domen; S. Ikeda, J. Am. Chem. Soc., 137, 13691 (2015). doi: 10.1021/jacs.5b09015
[7] F. Jiang; S. Li, C. Ozaki; T. Harada; S. Ikeda, *Sol. RRL*. 2, 1700205 (2018) doi: 10.1002/solr.201700205
[8] D. Huang; K. Wang; L. Yu; T. H. Nguyen; S. Ikeda; F. Jiang, ACS Energy Lett., 3, 1875 (2018). doi: 10.1021/acsenergylett.8b01005

Session B4
10:00 - 10:30 AM Room B December 18

B13: A novel absorber material $ZnSnP_2$ – crystal growth and device

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Abstract
Compound semiconductor, $ZnSnP_2$ is a promising material for absorber in photovoltaic devices due to the absorption coefficient of about 10^5 cm^{-1} in the visible light region and the bandgap of 1.6 -1.7 eV, which leads to the theoretical conversion efficiency of about 30 % calculated based on Shockley-Queisser limit. Moreover, $ZnSnP_2$ consists of earth-abundant and less toxic elements compared to GaAs and CdTe.

In this talk, our recent progress on $ZnSnP_2$ solar cells will be presented. As you know, thin films are used for absorption layers in solar cells of compound semiconductors because their absorption coefficients are generally high. However, the fabrication processing of $ZnSnP_2$ thin films have not completely established yet. In our work, bulk crystals of $ZnSnP_2$ were thus utilized similar to recent studies on CdTe solar cells. [1] The bulk crystals were obtained by solution growth according to the experimentally-established phase diagram [2]. The properties of $ZnSnP_2$ bulk crystals, such as hole density and mobility, were suitable for absorber in solar cells. Another topic is the structural control of the interface between $ZnSnP_2$ and back contact. In general, Mo is used for a contact material. In the case of $ZnSnP_2$ solar cells, the contact of Mo and $ZnSnP_2$ showed high resistance and while Cu/$ZnSnP_2$ contact heat-treated led to ohmic behavior [3]. The cross-sectional TEM observation of Cu/$ZnSnP_2$ interface revealed the formation of Cu_3P due to interdiffusion at the interface. The results indicate that Cu_3P contributed to low resistance. The interface between buffer materials and $ZnSnP_2$ was also investigated using XPS measurements, which clarified that ZnS and In_2S_3 were favorable compared to CdS from the viewpoint of conduction band offset [4]. The present best efficiency is 3.44 % for $ZnSnP_2$ solar cells with the structure of Al/AZO/ZnO/(Cd,Zn)S/$ZnSnP_2$/Cu [5].

Keywords

chalcopyrite phosphide, bulk crystals, heterointerface, lattice mismatch, band alignment

References
[1] J. M. Burst et al., CdTe solar cells with open-circuit voltage breaking the 1 V barrier, Nature Energy 1, 16015 (2016). doi:10.1038/nenergy.2016.15

[2] S. Nakatsuka et al., Bulk crystal growth and characterization of $ZnSnP_2$ compound semiconductor by flux method, Phys. Status Solidi (c), 12, 520 (2015). doi: 10.1002/pssc.201400291

[3] S. Nakatsuka et al., Impact of hetero-interfaces in solar cells using $ZnSnP_2$ bulk crystals, ACS Appl. Mater. Interface, 9 33827 (2017). doi: 10.1021/acsami.7b08852

[4] S. Nakatsuka et al., Band offset at the heterojunction interfaces of CdS/$ZnSnP_2$, ZnS/$ZnSnP_2$ and In_2S_3/$ZnSnP_2$, J. Appl. Phys., 119, 193107 (2016). doi: 10.1063/1.4950882

[5] S. Akari et al., $ZnSnP_2$ solar cell with (Cd,Zn)S buffer layer: Analysis of recombination rates, Sol. Energy Mater. Sol. Cells, 174, 412 (2018). doi: 10.1016/j.solmat.2017.09.035

Session B5
11:00 - 11:30 AM Room B December 18

B14: Solar energy conversion to high-value-added reagents on nanoporous sponge photoanodes

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Abstract
Solar hydrogen production from water is an important goal for energy production; however, the current solar-to-hydrogen (STH) efficiency is still not commercially feasible. The STH efficiency should stably exceed 10–20%. Thus, we have been searching for other applications of photoelectrodes driven by sunlight. Solar hydrogen production in Photoelectrochemical (PEC) systems is a cathode reaction, and oxygen gas is obtained at the photoanodes. Oxygen gas has a market value less than several tens of percent that of hydrogen gas; therefore, few studies have focused on the other products except oxygen at photoanodes. Mi *et al*. and Sayama reported that some products, such as peroxydisulfate ($S_2O_8^{2-}$), Ce^{4+}, IO_4^-, and H_2O_2 in the WO_3 photoanode system [1,2]. These reagents have a much higher market value than oxygen. In this work, we focused on the availability of these high-value-added anode products obtained by PEC solar hydrogen production.

We prepared WO_3 nanosponge photoanodes by a nanoparticle/solution hybrid dispersion-deposition. The WO_3 nanosponge photoanodes showed a large photocurrent (3.04 $mA \cdot cm^{-2}$) in 1.0 M H_2SO_4 electrolyte under 1-Sun illumination. This high photocurrent arose from the robust inter-nanoparticle connections and preservation of the nanopores in the photoanode. The absorbed photon-to-current efficiency spectra showed a high maximum of 95.4% at 410 nm. The Faraday efficiency of $S_2O_8^{2-}$ and H_2 evolution was almost 100%, and the applied bias photon-to-current efficiency for $S_2O_8^{2-}$ and H_2 was calculated to be 2.45%, which is the highest reported value [3]. We also report a new sustainable chromic acid oxidation process (Cr^{6+} ion recycling system) for other useful organic reagents production by using this efficient WO_3 nanosponge photoanodes [4]. Obtaining this kind of high-value-added product efficiently at photoanodes in photoelectrochemical systems is important for the use of sunlight in sustainable industrial chemistry.

Keywords

Solar energy; Solar hydrogen; Photoelectrode; WO_3; Nanostructure; Photoelectrochemical reaction

References
[1] Q. Mi et al., Energy Environ. Sci., 2012, 5, 5694
[2] K. Sayama, ACS Energy Lett., 2018, 5, 5694
[3] T. Nakajima et al., J. Mater. Chem. A, 2016, 4, 17809
[4] T. Nakajima et al., J. Mater. Chem. A, 2018, 6, 110

Session B5
11:30 - 12:00 PM Room B December 18

B15: Key technologies for the novel solar driven heating and cooling systems

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Abstract
The paper addressed several key technologies that enable solar driven heating and cooling systems for buildings to operate in efficient and effective ways. In terms of the solar heating, the multiple-throughout-flowing featured panels-array in combination with micro-channel structure for individual panels are the most creative technologies that has proven to be able to achieve 10% higher solar thermal efficiency and 100% higher energy efficiency ratio compared to the existing solar thermal system. In addition, the coupled heat storage/exchanger with the double containers is able to speed up heating time and increase the heat transfer capacity of the system, and is regarded as an additional initiative. The cost balance approach is applied to determine the quantity and area of the PV panel, leading to a new way of achieving the zero-bill heating operation in an economic way. In terms of the solar cooling, the innovative super-performance dew point cooling involving advanced fibre materials, superior thermal-assisted pressing approach for bonding of the fibre material with dry side material, as well as intelligent control of the pump and fan is detailed. Furthermore, the solar driven adsorbent bed cyclic system using the solar radiation and solar based microwave energy was introduced.

Keywords

Solar; heating; cooling; multiple-throughout-flowing; micro-channel; double-container; combined heat storage/exchanger; cost-balance approach; dew-point-cooling; adsorbent bed cycling; microwave

Recent Publications
[1] Peng Xu, Xiaoli Ma*, Xudong Zhao*, Kevin Fancey. Experimental investigation of a super performance dew point air cooler. Applied Energy 203 (2017) 761–777.
[2] T. M.O. Diallo, X. Zhao*, A. Dugue, P. Bonnamy, F. J. Miguel, A. Martinez, T. Theodosiou, J. Liu, N. Brown. Numerical investigation of the energy performance of a ventilated façade system employing a smart modular heat recovery unit and a latent heat thermal energy system. Applied Energy 205 (2017) 130-152.
[3] Jinzhi Zhou, Xudong Zhao*, Xiaoli Ma, Zhenyu Du, Yi Fan, Yuanda Chen, Xinghui Zhang. Clear-days operational performance of a hybrid experimental space heating system employing the novel mini-channel solar thermal & PV/T panels and a heat pump. Solar Energy 155 (2017) 464–477.
[4] Wansheng Yang, Hao Deng, Zhangyuan Wang *, Xudong Zhao, Song He. Performance investigation of the novel solar-powered dehumidification window for residential buildings. Energies 2017, 10, 1369; doi:10.3390/en10091369.
[5] Zhiyin Duan, Xudong Zhao, Junming Li. Design, fabrication and performance evaluation of a compact regenerative evaporative cooler: Towards low energy cooling for buildings. Energy 140 (2017) 506 – 519.

Session B6
14:00 - 14:30 PM Room B December 18

B16: Silicon Photonics for 2020 and beyond

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Abstract
Silicon photonics is poised to revolutionize inter- and intra-data center communications since internet traffic continues to increase exponentially making it difficult and costly for existing switching and interconnects in data centers to cope with the fast-growing bandwidth requirement. Silicon photonics is able to contribute data centers in terms of the lower cost, higher bandwidth, and lower power consumption. As many fundamental components including the power-efficient modulators mature, silicon photonics is believed to have reached the tipping point with a surging global market. Besides the optical interconnects, silicon photonics also shows the promise in abundant applications, ranging from high performance computing and autonomous cars, to biomedical sensing and even aerospace applications.

In this invited speech, an overview of the silicon photonics as well as a potential trend for 2020 and beyond will be provided. First, the recent development of optical components including passive and active modules as well as optical circuits in silicon photonics will be presented. [1] Second, as Moore's law has been approaching the physical limitation, photonics-based high-performance computing is envisioned as a potential answer to the continuation of Moore's law. We propose and experimentally demonstrate a new photonics-assisted full adder which is capable of operating at a higher frequency than electrical counterparts while consuming less power. [2–4] This paves the way to the future integrated high-speed and power-efficient optical computing. Sensing related applications will also be addressed in the presentation. Finally, the main challenges that require technical breakthroughs for the upcoming years will be discussed.

Keywords

Silicon photonics; integrated photonics; optical interconnect; optical computing

References
[1] H. Subbaraman, X. Xu, A. Hosseini, X. Zhang, Y. Zhang, D. Kwong, and R. T. Chen, "Recent advances in silicon-based passive and active optical interconnects," Opt. Express 23, 2487–2510 (2015)

[2] Z. Ying, Z. Wang, Z. Zhao, S. Dhar, D. Z. Pan, R. Soref, and R. T. Chen, "Silicon microdisk-based full adders for optical computing," Opt. Lett. 43, 983–986 (2018)

[3] Z. Ying, S. Dhar, Z. Zhao, C. Feng, R. Mital, C.-J. Chung, D. Z. Pan, R. A. Soref, and R. T. Chen, "Electro-optic ripple-carry adder in integrated silicon photonics for optical computing," IEEE J. Sel. Top. Quantum Electron. 24, 1–10 (2018)

[4] Z. Ying, Z. Zhao, C. Feng, R. Mital, S. Dhar, D. Z. Pan, R. Soref, and R. T. Chen, "Automated logic synthesis for electro-optic logic-based integrated optical computing," Opt. Express 26, 28002–28012 (2018)

Session B6
14:30 - 15:00 PM Room B December 18

B17: Light emission effects mediated by Bloch Surface Waves

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Abstract
The management of spontaneous light emission at the nanoscale is a crucial aspect in many application domains dealing with lighting, optical communications and quantum information systems. Two widespread approaches to address this issue are based on plasmonic structures and dielectric photonic crystals, which have demonstrated a high potential in controlling spectral, angular and temporal features of the emission. Both approaches exhibit rather complementary advantages, and many efforts are nowadays undertaken to target hybrid solutions taking the best from the two sides.

In this framework, we propose a photonic device based on a dielectric multilayer, which is shown to control the spontaneous emission from organic emitters deposited on its surface [1]. Such a result is achieved by exploiting a near-field interaction of emitters to Bloch Surface Waves [2, 3] resonantly coupled within a circular cavity surrounded by a diffractive structure. A bright, monochromatic emission is then obtained, with spectral width below 1 nm, a spontaneous decay rate enhanced by a factor varying from 15 to 30, and a propagation divergence below 5 degrees in free space [4]. These findings are particularly promising for application in the technological field of integrated light sources operating in a single-photon regime.

Keywords

Surface Waves; Photonic Nano Cavity; Purcell effect; Directional Emission

References
[1] M. Ballarini; F. Frascella; F. Michelotti; G. Digregorio; P. Rivolo; V. Paeder; V. Musi; F. Giorgis, and E. Descrovi, Bloch surface waves-controlled emission of organic dyes grafted on a one-dimensional photonic crystal. Applied Physics Letters 99, 043302 (2011). doi:10.1063/1.3616144
[2] A. Angelini; E. Barakat; P. Munzert; L. Boarino; N. De Leo; E. Enrico; F. Giorgis; H.P. Herzig; C.F. Pirri; E. Descrovi, Focusing and Extraction of Light mediated by Bloch Surface Waves. Scientific Reports. 4, 5428 (2014). doi:10.1038/srep05428
[3] R. Badugu; K. Nowazcyk; E. Descrovi; J.R. Lakowicz, Radiative decay engineering 6: Fluorescence on one-dimensional photonic crystals. Analytical Biochemistry 442, 83 (2013). doi:10.1016/j.ab.2013.07.021
[4] U.Stella; L. Boarino; N. De Leo; P. Munzert; E. Descrovi, Enhanced directional light emission assisted by resonant Bloch Surface Waves in circular cavities, manuscript in preparation

Session B6
15:00 - 15:30 PM Room B December 18

B18: High-dimentional vectorial holographic encryption with metasurfaces

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Abstract
Holography based on metasurfaces has emerged as a promising candidate for applications in optical displays, optical storage and security by exhibiting unprecedented spatial resolution, enormous information capacity and large field of view compared to traditional methods. For exploring the full capability of the information storage/display and enhance the encryption security of metasurface holograms, smart multiplexing techniques together with suitable metasurface designs are highly demanded. Here we integrate multiple polarization manipulation channels for various spatial phase profiles into a single birefringent vectorial hologram by completely avoiding unwanted cross-talk. Multiple independent target phase profiles with quantified phase relations that can process significantly different information in different polarization states are realized within a single metasurface. For our metasurface holograms, we demonstrate high fidelity, large efficiency, broadband operation, and a total of twelve polarization channels. Such multichannel polarization multiplexing can be used for dynamic vectorial holographic display and provide triple protection to the optical security. The concept is appealing for applications of arbitrary spin to angular momentum conversion and various phase modulation/beam shaping elements.

Keywords

Holography; metasurfaces

References
[1] Zhao, R., Sain, B., Wei, Q., Tang, C., Li, X., Weiss, T., Huang, L.*, Wang, Y.*, Zentgraf, T.* Multichannel Vectorial Holographic Display and Encryption. Light: Science & Applications (2018)

Session B7
16:00 - 16:30 PM Room B December 18

B19: Applications of transferable ZTO nanospheres monolayer to optoelectronic devices

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Abstract
Zinc-tin-oxide (ZTO) has been considered as attractive optoelectronic materials due to their physical and chemical properties. [1] Recently many groups reported that the various phases of ZTO effect on their device performances in versatile applications such as anodes of battery, [2] active layer in transistor, photovoltaic devices, photodetector [3], and gas sensors based on the outstanding properties. Here, we report on the formation of transferable nano/microspheres monolayers consisting of $ZnSnO_3$ (ZTO) synthesized by fast ethanol precipitation and their application to GaN-based light-emitting diodes (LEDs) to improve the electrical and optical device performances. ZTO microspheres with different diameters of 800, 900, 1200 nm were synthesized and arrayed to form a monolayer using polydimethylsiloxane (PDMS) and simple rubbing method. The formed monolayers show the optical transmittance percentages of 94, 93, and 87 % at 460 nm, respectively. Effects of ZTO monolayers on the light extraction efficiency of LEDs were evaluated using fabricated LED chips. All LEDs with ZTO monolayer as a top-layer show improvement of light extraction efficiency about 120 ~ 145% relative to regular LEDs as well as enhanced electrical properties as evidenced by a decrease in turn on voltage. The XPS analysis indicated that the improvement in the electrical properties of LEDs with ZTO monolayers is related to the presence of graphene-like carbon bonds present in carbon residue that remains on the surface of the LED after removal of polymer. The improvement of light extraction using ZTO nano/microspheres monolayer on LEDs can be attributed to effective guiding of light generation from active regions in LEDs towards air, which was confirmed by theoretical simulations.

Keywords

ZTO nano/micro spheres; LED; Extraction efficiency; Monolayers

References

[1] Sun, S., & Liang, S. Morphological zinc stannate: synthesis, fundamental properties and applications. J. Mater. Chem. 5(39), 20534(2017)

[2] Hou, X., Cheng, Q., Bai, Y., & Zhang, W. F. Preparation and electrochemical characterization of Zn_2SnO_4 as anode materials for lithium ion batteries. Sold State Ionics, 181, 631 (2010)

[3] Bera, A., Sheikh, A. D., Haque, M. A., Bose, R., Alarousu, E., Mohammed, O. F., & Wu, T. Fast crystallization and improved stability of perovskite solar cells with Zn_2SnO_4 electron transporting layer: interface matters. ACS appl. Mater. Inter. 7, 28404(2015)

Session B7
16:30 - 17:00 PM Room B December 18

B20: Development and characterization of metallo-dielectric nanomaterials

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Abstract
This talk covers the work of rational combination from dielectric and metallic nano components. The concept of 'optoplasmonic' materials referring to the entities embracing the interaction between plasmonic fields and peripheral photonic landscape will be particularly stated in the presentation [1]. As for fabrication, template-assisted self-assembly approaches are conducted to build up nano complex with titanium dioxide and gold nano spheres. A top-bottom hybrid unit and interdigitated hybrid array are achieved [2-3]. With the characterization of the elastic and inelastic spectra of these heterogeneous materials, physical models are computed to depict the scenario of varied geometry and combination of nano particles. In sharp contrast to purely dielectric or metallic particle arrays, this artificial-material not only enhances the electric near field intensity in the cavity of metal nano cluster 'hot spots', but also expands the volume of enhanced electric field. Further research reveals that the extra enhancement and redistribution of near field are originated from the coupling between the localized plasmon resonance and the in-plane photonic mode of the companion dielectric array [4].

Keywords

2D nanomaterial; Plasmonic material; gold nanoparticle; SERS; photonic array

References
[1] Y. Hong, W. Ahn, S. V. Boriskina, X. Zhao, B.M. Reinhard, Directed Assembly of Optoplasmonic Hybrid Materials with Tunable Photonic-Plasmonic Properties, J. Phys. Chem. Lett., 6, 2506 (2015). doi: 10.1021/acs.jpclett.5b00366
[2] Y. Hong, M. Pourmand, S. V. Boriskina, B.M. Reinhard, "Enhanced Light Focusing in Self-Assembled Optoplasmonic Clusters with Subwavelength Dimensions", Adv. Mater., 25, 115 (2013). doi: 10.1002/adma.201202830
[3] Y. Hong, Y. Qiu, T. Chen, B. M. Reinhard, "Rational Assembly of Optoplasmonic Hetero-nanoparticle Arrays with Tunable Photonic–Plasmonic Resonances", Adv. Funct. Mater., 24, 721 (2014). doi: 10.1002/adfm.201301837
[4] Y. Hong, B.M. Reinhard, "Collective Photonic-Plasmonic Resonances in Noble Metal – Dielectric Nanoparticle Hybrid Arrays", Opt. Mater. Express. 4, 2409 (2014). doi:10.1364/OME.4.002409

Session B7
17:00 - 17:30 PM Room B December 18

B21: Electrons dynamics control in ultrafast laser micro/nanofabrication by spatially/temporally shaped pulses

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Abstract
An ultrafast laser pulse duration is shorter than many physical/chemical characteristic times, which makes it possible to manipulate/adjust electron dynamics, such as excitation and ionization of electrons. By spatially/temporally shaping femtosecond laser pulses, localized transient electron dynamics are actively controlled during laser-material interactions. A multiscale model is developed, which consists of the ab initio calculations for electrons dynamics, revised molecular dynamics simulation for phase change, plasma model for ionization processes, and improved two-temperature model for energy transport. Our simulation shows that it is feasible to control electron dynamics to adjust localized transient material properties, phase changes, and micro/nanostructures. Using the proposed mechanism, high-quality microholes with a diameter of 1.5 μm and an aspect ratio of 1000:1 are fabricated by a shaped single femtosecond laser pulse. It takes 42 min to fabricate 251,001 holes in a 1 cm × 1 cm area, which is very uniform in size and shape. A multiscale measurement system (from femtosecond scale to second scale) is developed for high-quality, high-aspect-ratio drilling using a femtosecond laser. It consists of a pump-probe shadowgraph imaging technique, laser-induced breakdown spectroscopy (LIBS), and an intensified charge-coupled device (ICCD) camera. For the first time, we reveal the multiple time scale fundamentals during femtosecond laser material interactions, including the femtosecond-scale propagation of a laser pulse, picosecond-scale generation/evolution of laser-induced plasma, nanosecond-scale plasma ejection/expansion, and microsecond-scale hole formation.

Keywords

Ultrafast laser micro/nanofabrication; electron dynamics; multiscale measurement

References
[1] L. Jiang, A. Wang, B. Li, T. Cui , Y. Lu, Light: Sci. & Appl., 7 (2), 174134 (2018)
[2] L. Jiang, P. Liu, X.Yan, N. Leng, C. Xu, H. Xiao, Y. Lu, Opt. Lett. 37, 2781-2783 (2012)
[3] Z. Yao, L. Jiang, X. Li, A. Wang, Z. Wang, M. Li, Y.F. Lu, Opt. Express, 26, 21960-21968 (2018)
[4] A. Wang, L. Jiang, X. Li, Y. Liu, X. Dong, L. Qu, X. Duan, Y. Lu, Adv. Mater. 27, 6238-6243 (2015)

Session B7
17:30 - 18:00 PM Room B December 18

B22: Plasmon-enhanced nanoscopy for nanoscale analysis

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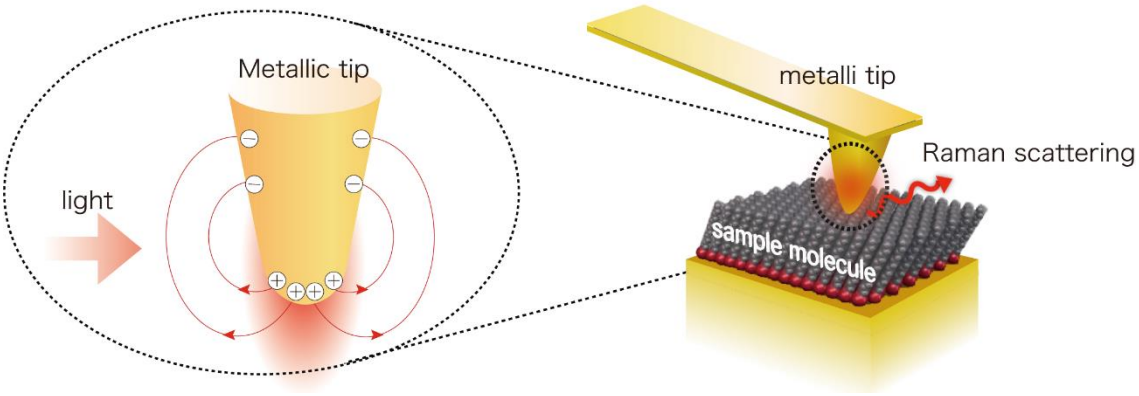
Abstract

Tip-enhanced Raman scattering (TERS) microscopy, a family of scanning probe microscopy techniques, has been recognized as a powerful surface analytical technique with both single-molecule sensitivity and nanoscale spatial resolution far beyond the diffraction limit of light. Recently, we have proposed to utilize a metallic probe tip not only to locally excite Raman scattering from sample molecules, but also to locally apply external stimuli to the molecules through the tip apex. The tip-applied stimuli including pressure, voltage, and temperature are likely to induce structural and conformational changes, band-gap tuning, and photochemical reactions in the vicinity of the tip apex. Combination of TERS microscopy with the local external stimuli has now opened up a new way to control molecular properties and functions on a nanometer scale along with the in situ nano-analysis, which can contribute to active functional control of nanodevices.

If time allows, we will extend the topic to non-plasmonic nanophotonics with the use of high-index dielectric nanostructures which have been recently regarded as an alternative to plasmonic nanostructures.



Keywords

Plasmonics; Nanophotonics; Delectric nanostructures; Field-enhanced spectroscopy

Session A8
9:00 - 9:30 AM Room A December 19

A22: Multiscale modeling of heat transfer in low-dimensional materials

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Abstract
The heat transfer in low-dimensional materials is very important and intriguing phenomena containing the following non-trivial effects: The strong boundary scattering induced thermal conductivity reduction and the low-dimensional effect induced thermal conductivity enhancement. Understanding the underlying mechanism and building reliable models for such heat transfer are critical for the applications in advanced chip cooling, high efficient thermal electrics as well as other energy related nanomaterials. Here we present our work in recent years which targeted on the multiscale modelling of nanoscale heat transfer. The first principles calculation is on the electron scale. The molecular dynamics simulation is on the atomic and molecular scale. The phonon gas model based on the thermomass theory is on the mesoscopic scale. Bridge these scales we have developed a series of fundamental understanding and engineering applicable models, which enhance our capability to harness the energy flow in nanoscale.

Keywords

Multiscale Modeling; Low-Dimensional Materials; Thermomass theory; DFT; Molecular dynamics

Session A8
9:30 - 10:00 AM Room A December 19

A23: Advanced materials and processes for Silicon based solar cells

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Abstract
The activity concerns the synthesis, fabrication and characterization of materials and solar cells based on innovative structures and advanced processes. New three dimensional architectures are chosen because they allow to improve the photoconversion efficiency of Si by increasing the light absorption or by decoupling the photons path from the photogenerated carriers collection. Si nanowires deposited in a plasma-based Chemical Vapor Deposition (CVD) system, by vapor-liquid-solid method catalysed through metallic nanodots, are integrated in the emitter of the cell as light trapping layer.

In addition to the most popular 3D architectures, such as the wires, the potential of other innovative geometries like Si Nanoholes (NH) are exploited. These have recently been proved as a promising alternative to the positive counterparts, thanks to their better mechanical robustness during process integration and to their good optical match with visible light. As a main enabling technology for the synthesis of the Si NHs the nanolithography based on self-assembling of diblock copolymers is used.
Another important technology developed in the last years and exploited in the present activity is the monolayer doping for the formation of ultra-thin and conformal silicon junctions. The research topics relate to various aspects of the formation of a solar cell: from the 3D structures synthesis to the junction formation process, to the structural and electro-optical characterization, and the devices are fabricated in-house starting from the Si substrate up to the complete device. The activity is complemented by the simulation of the advanced processes applied for the synthesis of the nanostructures. In particular, the simulation of the plasma condition in the equipment used for the growth processes aids the understanding and control of the synthesis of the positive 3D structures. Dopant atoms transfer from the molecular systems mechanism is also modeled and impurity profiles are simulated by varying the process conditions.

Another important focus is on the study of the materials synthesized by plasma based CVD. The plasma technology is particularly appreciated for its compatibility with device production lines and its flexibility in terms of throughput. We exploit the capabilities of plasma to produce advanced materials, such as Si based and C based materials, optionally doped with P or B, like amorphous Si, SiC and oxynitrides/oxycarbide SiOxNyCz, for several applications in photovoltaics.

References
[1] https://hq.imm.cnr.it/articles/silicon-solar-cells-based-advanced-architectures-and-processes

Session A8
10:00 - 10:30 AM Room A December 19

A24: Vacancy diffusion in graphene

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Abstract
The interaction between the spatially scattered vacancy defects and their kinetics drive various structural modifications, which severely alter the electronic, magnetic and transport properties. Thus, understanding the microscopic vacancy diffusion in a device setup becomes important. In this regard, we will discuss the dynamic Jahn-Teller distortion and vacancy diffusion with different carrier doping. [1] We will demonstrate that lattice relaxation perpendicular to the graphene sheet and in-plane strain relaxation play the predominant roles in predicting the correct microscopic mechanism for vacancy diffusion and thus the accurate activation barrier. We will show that the calculated activation barrier increases upon both electron and hole doping and the observed trends are explained by the differential charge density and by the hardening of the low-energy phonon modes that are responsible for vacancy diffusion. Electron doping essentially freezes the vacancy, and thus any degradation mediated by it through a dramatic decrease in diffusivity. While tracking vacancy diffusion experimentally in graphene is a difficult task, the present results will motivate new experimental efforts and assist interpretation of the results. In this talk, we will also discuss the importance of the quantum correction to the classical barrier.

References
[1] Rohit Babar and Mukul Kabir, *Gate-dependent vacancy diffusion in graphene*, Physical Review B 98, 075439 (2018)

Session A9
11:00 - 11:30 AM Room A December 19

A25: Chirality Effects on an Electron Transport in Single-walled Carbon Nanotube

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Abstract
We investigate that conductivity depend on the direction of current due to the chirality of each chiral's index single-wall carbon nanotubes (SWCNTs). According to the asymmetric velocities of Dirac particles calculated by inducing curvature-induced σ-π mixing and Slater-Koster type projection for π-π and σ-π hopping integrals, we provide an analytical expression by calculating the current-current correlation function for the paramagnetic and diamagnetic current density operator. The current-current correlation function as a function of the energy for different directions of bias voltage are discussed for the chiral index.

Keywords

Carbon nanotube; chirality; the current-current correlation; the paramagnetic and diamagnetic current

References
[1] F. Qin, W. Shi, T. Ideue, M. Yoshida, A. Zak, R. Tenne, T. Kikitsu, D. Inoue, D. Hashizume and Y. Iwasa, Superconductivity in a chiral nanotube. Nature Commun. 8, 14465 (2017)

[2] Vasilii I. Artyukhov, Evgeni S. Penev and Boris I. Yakobson, Why nanotubes grow chiral. Nature Commun. 5, 4892 (2014)

[3] Van Hieu Nguyen, Bich Ha Nguyen and Ngoc Dung Dinh, Theory of Green function of free Dirac fermions in graphene. Adv. Nat. Sci.: Nanosci Nanotechnol. 7, 015013 (2016)

[4] J. Sabio, J Nilsson, and A. H. Castro Neto, f-sum rule and unconventional weight transfer in graphence. Phys. Rev. B 78, 075410 (2008)

Session A9
11:30 - 12:00 PM Room A December 19

A26: Ionic liquids assisted synthesis of porous carbon materials for energy storage devices

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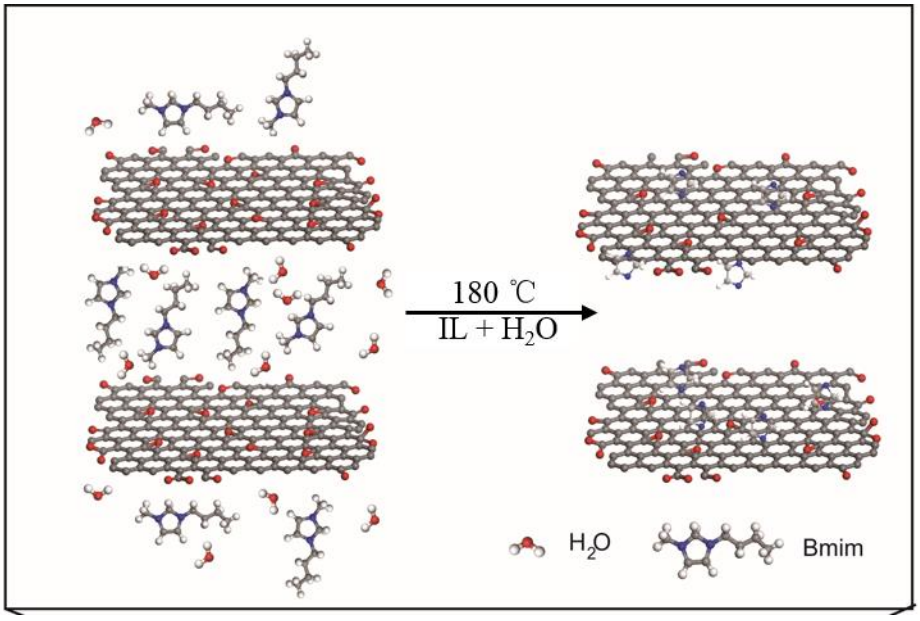
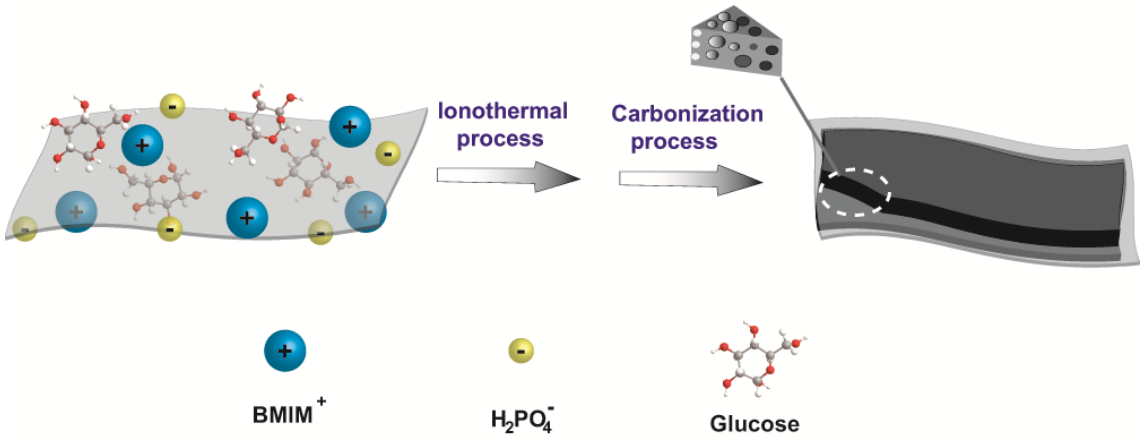
Abstract
Electrochemical energy storage with high energy density and high power density is highly demanded for portable electric devices, electric vehicles and smart grids. Rechargeable batteries and supercapacitors have been extensively studied and used in the field of electric devices. Porous carbon materials play great roles in those energy storage systems for its low cost, chemical stability and high conductivity. However, the commonly used method for synthesizing carbon materials suffers from some drawbacks, such as multistep, time consuming and pollution problems. Moreover, the widely investigated graphene-based carbon materials aggregate seriously due to the π-π stacking.

Ionic liquids (ILs), composed of cations and anions, are attracting considerable attentions due to their unique properties, such as strong dissolution, non-volatility, high thermal stability, low flash point and high polarity. Such a wide range of unique properties endow ILs as suitable alternatives for the synthesis of engineered materials by acting as advanced solvents, dopants, and templating agents.

Thus, we proposed an ionic liquid-assisted method to prepare graphene-based carbon materials for supercapacitors and rechargeable batteries. Firstly, fabricated a 3D reduced graphene oxide (ILG) by one-step ionic liquid induced self-assembly method (Scheme 1) and constructed a flexible symmetric supercapacitor with the obtained ILG. The IL plays great roles of a protector and stabilizer. The obtained ILG shows high specific capacitance (260 F g^{-1} at 0.5 A g^{-1}), superior rate capability in both 6 M KOH electrolyte and symmetric all-solid-state supercapacitor. Secondly, we synthesized a graphene-based hierarchically porous carbon (GPC) by ionothermal method and constructed supercapacitor with IL electrolyte as shown in Scheme 2. The GPC electrode exhibits a high energy density of 90.4Wh kg^{-1}, highlighting the application of IL electrolyte in EDLCs. Except for the supercapacitors, we also designed graphene-based nanocomposite (Sb_2S_3/rGO) by ionic liquid-assisted method for sodium ion batteries. The ionic liquid plays a great role in stabilizing the graphene oxide and facilitating the formation of uniform coating of Sb_2S_3 on rGO. The as-prepared IL-Sb_2S_3/rGO exhibits an impressive specific capacity of 687.7 mA h g^{-1} at a current density of 50 mA g^{-1} and a high-rate capability as an anode for sodium ion batteries.



Scheme 1. *Schematic diagrams of the ILG synthesis route*



Scheme 2. *Fabrication schematic of graphene-based hierarchically porous carbon (GPC)*

Keywords

Ionic liquid; carbon material; graphene-based; supercapacitor; batteries

References

[1] D. C. Guo, J. Mi, and A. H. Lu, Energy Environ. Sci.,2013,6,652-659
[2] S.G. Zhang, K.Dokko and M. Watanabe, Mater. Horiz., 2015,2,168-197
[3] Y. Yan, N. Cui and C. Hao, J. Alloy. Compu.,2019,776,22-30
[4] X. F. Hao, Y. Yan and C Hao. Electrochimica Acta, 2017, 241,124-131
[5] Z. Pan, Y. Yan and C. Hao, Adv. Mater. Interfaces, 2018, 1701481

Session A9
12:00 - 12:30 PM Room A December 19

A27: Dual-Functional Templated Methodology for the Synthesis of Hierarchical Porous Carbon for Supercapacitor

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Abstract
Dual-functional templated methodology was developed for synthesis of hierarchical porous carbons via direct thermal decomposition of agricultural wastes, in which dairy manure acted as low cost carbon precursor and eggshell as both hard template and activating agent source of CO_2. The dual-functional template can be easily removed by diluted HCl instead of corrosive HF. Carbonization temperature and dosage of eggshell have great influence on the porous texture of the carbon materials. Optimized temperature of 800 ^oC and mass ratio of eggshell/dairy manure (2:1) facilitate the releasing of CO_2 from eggshell thus benefitting the formation of hierarchical porous carbon. The porous carbon has maximum surface area of 543.6 m^2/g and total pore volume of 0.48 cm^3/g of which micropores account for 40%. As the electrode of supercapacitor, the obtained hierarchical porous carbons showed a relative high specific capacitance of 226.6 F/g in KOH aqueous electrolyte (6 mol/L). Besides, it exhibited outstanding cycling stability with almost 100% of specific capacitance retention after 2500 GCD cycles. The one-step template carbonization method provides a facile and sustainable route to prepare hierarchical porous carbons from the agricultural wastes.

Keywords

Dual-functional template; Eggshell; Dairy manure; Porous carbon; Supercapacitor

References
[1] K. T. Cho; B. L. Sang; J. W. Lee, Facile synthesis of highly electrocapacitive nitrogen-doped graphitic porous carbons. *Journal of Physical Chemistry C* 118, (2014), 9357. doi:10.1021/jp501742x
[2] J. Lee; J. Kim; T. Hyeon, Recent progress in the synthesis of porous carbon materials. *Advanced Materials 18*, (2006) 2073. doi:10.1002/adma.200501576
[3] L. Zhu; F. Shen; R. L. Smith; X. Qi, High−performance supercapacitor electrode materials from chitosan via hydrothermal carbonization and potassium hydroxide activation. *Energy Technology 5*, (2016), 452. doi: 10.1002/ente.201600337

Session A10
14:00 - 14:30 PM Room A December 19

A28: Intrinsic field effect and Hall mobility in multilayer III-VI 2D semiconductor InSe FETs

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Abstract

Graphene-like two-dimensional (2D) materials, not only are interesting for their exotic electronic structure and fundamental electronic transport or optical properties but also, hold promises for device miniaturization down to atomic thickness. As one material belonging to this category, InSe is not only a promising candidate for optoelectronic devices but also has potential for ultrathin field effect transistor (FET) with high mobility transport. In this work, various substrates such as PMMA, bare silicon oxide, passivated silicon oxide, and silicon nitride were used to fabricate multi-layer InSe FET devices. Through back gating and Hall measurement, the devices' field effect mobility and intrinsic Hall mobility were extracted at various temperatures to study the material's intrinsic transport behavior and the effect of dielectric substrate. Overall trend of the devices' mobility was found to increase as the temperature is reduced due to reduced phonon scattering. The sample's field effect and Hall mobilities over the range of 77-300K fall in the range of 0.1-2.0×10^3 cm^2/Vs, better than FETs made of more widely studied 2D transition metal-dichalcogenides.

Keywords

2D material; InSe; FET; mobility; thin film

Session A10
14:30 - 15:00 PM Room A December 19

A29: Nano-enabled clean water production by sunlight

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Abstract
Given the vast abundance and inexhaustibility of sunlight, tapping into solar energy to produce clean water seems a viable solution to current global challenges of water scarcity and clean energy shortage. Solar driven water evaporation, which uses photothermal materials to capture and convert sunlight to heat so to generate water vapor, is an ancient process and integral part of any solar powered clean water production. The old concept of utilizing solar-driven water evaporation to produce clean water resurfaced and was rejuvenated over the past five years because it uses only sunlight without any CO_2 emissions during the operation. The rejuvenation of the photothermal processes in the new times gains very helpful hand from nanomaterials. In this presentation, various nano-enabled photothermal materials that are able to capture whole solar spectrum and convent it to heat with almost 100% efficiency will be covered. The recent development in rationally designed photothermal structures with proper heat loss management that has led to the solar-driven water evaporation efficiency being steadily and significantly improved in the last three years, from ~50% to a near 100%, will be presented.

Session A10
15:00 - 15:30 PM Room A December 19

A30: Thin Graphite Contact for 2D-Layered Material CMOS Device and Band Gap Estimation

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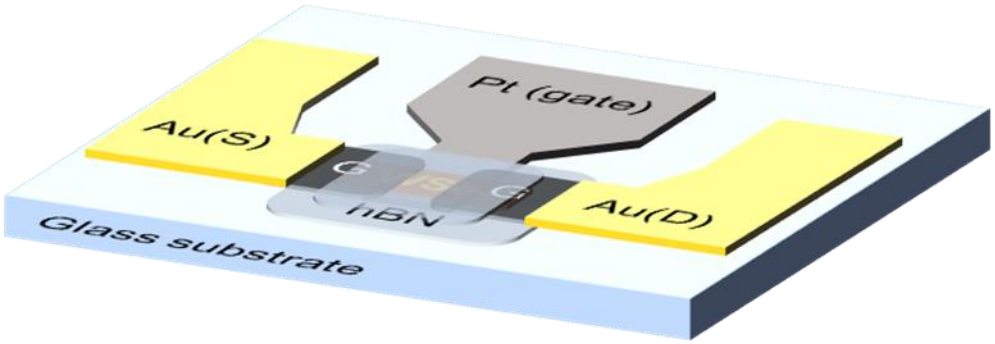
Abstract
Band gap of monolayer and few layers in two dimensional (2D) semiconductors has usually been measured by optical probing such as photoluminescence (PL). However, if their exfoliated thickness is as large as a few nm (multilayer over ~5L), PL measurements become less effective and inaccurate because the optical transition of 2D semiconductor is changed from direct to indirect mode. Here, we introduce another way to estimate the bandgap of multilayer 2D van der Waals semiconductors; that is utilizing field effect transistor (FET) as a platform. We used graphene (thin graphite) contact for multilayer van der Waals channels in FET, because graphene contact would secure ambipolar behavior and enable Schottky contact barrier tuning of FETs with the assistance of top passivation. As a result, the bandgaps of multilayer transition metal dichalcogenides and black phosphorus in unknown thickness were successfully estimated through measuring the temperature-dependent transfer curve characteristics of prepared 2D FETs with graphene contact. Futhermore, based on these thin graphite contact, we also have successfully fabricated all 2D layered material-based CMOS inverter with n-MoS_2 and p-$MoTe_2$ chjannels, and demonstrate its device properties.



References
[1] K. Choi, Y. T. Lee, J. S. Kim, S. W. Min, Y. Cho, A. Pezeshki, D. K. Hwang and S. Im, Adv. Funct. Mater., 2016, 26, 3146–3153
[2] Y. T. Lee, K. Choi, H. S. Lee, S. W. Min, P. J. Jeon, D. K. Hwang, H. J. Choi and S. Im, Small, 2014, 10, 2356–2361

Session A11
16:00 - 16:30 PM Room A December 19

A31: Energy dissipation and light emission in graphene

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Abstract
Energy dissipation in nanoscale electronics has become an important subject in modern electronic industry and energy conversion system. From this perspective, graphene with very high mobility and thermal conductivity, which are about ten times higher than silicon, is a very attractive nano-material to study energy dissipation in nano-electronics. I will present studies for the tunable Heat transport and light emission in graphene devices.

Session A11
16:30 - 17:00 PM Room A December 19

A32: Unexpectedly Promoting Effect of Carbon Nanotubes Grown During the Non-oxidative Coupling of Methane over Copper Catalysts

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Abstract

One of the challenges for the non-oxidative coupling of methane (NOCM) is to effectively remove the deposited coke over catalysts owing to the over-dehydrogenation of methane. Herein, we show that an in-situ growth of carbon nanotubes (CNTs) instead of coke were observed during NOCM over a $CuSO_{4/\gamma}$-Al_2O_3 catalyst. The as-grown CNTs depict an unexpected promoting effect for NOCM with a highest activity of 0.48 mol kg $cat^{-1}\cdot h^{-1}$, and maintained 85% activity after 200 h running time. The equilibrium methane conversion is 9.8 % with a selectivity of 78.2 % for C_2 (C_2H_4 + C_2H_6) products. Highly dispersed Cu nanoparticles distributed on the top of CNTs measured by transmission electron microscopy is proposed to result in high catalyst stability during NOCM for 200h instead of deactivation in several hours. Here, we firstly prove that the as-grown CNTs can promote the catalytic activity of NOCM instead of deactivation by coking over catalysts.

Keywords

Carbon nanotube; Non-oxidative coupling of methane; Copper catalysts; Promoting effect; Catalytic activity

Session B8
9:00 - 9:30 AM Room B December 19

B23: Micro and nanocoatings for biomedical applications improving Ti50Zr alloy performance

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Abstract

The presentation contains new results regarding the properties of micro and nanocoatings fabricated on Ti50Zr in the context of the new trend to extend Zr alloys use for restorative works especially in the oral cavity. According to investigations of TiZr with various Zr content, Ti50Zr was a better choice to reach performance taking into acount that TiZr stability is increasing with Zr content only until 50%. For higher Zr content, its stability in bioliquids is decreasing [1]. The Ti50Zr was coated via various procedures obtaing micro and nano architectures as a function of fabrication method. Microstructures were fabricated via electrochemical deposition of a mixture of chitosan and hydroxyapatite [2]. Nanocoatings were fabricated via one [3] or two steps anodizing [4] protocols and by changing anodizing conditions and posttreatments. The structure, morphology, topography, hydrophilic character, and biological aspects were evaluated and discussed. The AFM investigations developing more knowledge about adhesive and nanomechanical properties were used as a tool in understanding the interface. The mainly evidenced biological aspects were cell viability, NO and ROS levels. The biological assays were completed with the investigation of the antibacterial ability of the coatings. The results were correlated with the coatings properties and discussed as an expression of bioperforrmance.

Keywords

Performance of bionic coating of chitosan and hydroxyapatite; Surface properties of Ti50Zr nanotubes; AFM nanomechanical properties; Biological assays: cell viability, NO, ROS, antibacterial effect

References

[1] T. Akimoto, T. Ueno, Y. Tsutsumi, H. Doi, T. Hanawa, N. Wakabayashi, Evaluation of corrosion resistance of implant-use Ti-Zr binary alloys with a range of compositions. Journal of Biomedical Materials Research Part B: Applied Biomaterials. 106, 73 (2018). doi: 10.1002/jbm.b.33811

[2] M. Vardaki, D. Ionita, A. B. Stoian, I. Demetrescu, Increasing corrosion resistance of a ZrTi alloy with a bioinspired coating with low porosity. Materials and Corrosion. 68, 988 (2017). doi: 10.1002/maco.201609408

[3] A. B. Stoian, M. Vardaki, D. Ionita, M. Enachescu, M. Prodana, O. Brancoveanu, I. Demetrescu, Nanopores and nanotubes ceramic oxides elaborated on titanium alloy with zirconium by changing anodization potentials. Ceramics International. 44, 7026 (2018). doi: 10.1016/j.ceramint.2018.01.137

[4] S. Grigorescu, C. Ungureanu, R. Kirchgeorg, P. Schmuki, I. Demetrescu, Various sized nanotubes on TiZr for antibacterial surfaces. Applied Surface Science. 270, 190 (2013). doi: 10.1016/j.apsusc.2012.12.165

Session B8
9:30 - 10:00 AM Room B December 19

B24: Plasmonic semiconductors for photothermal therapy in the NIR-II window

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Abstract
Self-doped copper chalcogenide nanocrystals show broad plasmonic resonances covering NIR-II window [1], where optical transmission through tissue is optimal and higher maximum permissible exposure to laser irradiation is allowed. They are strong candidates for photothermal theranostic applications. By developing a facile aqueous phase synthetic route, monodisperse $Cu_{2-x}Se$ nanocrystals with controlled size and surface properties have been prepared [2], and their plasmonic absorption was found to depend strongly on the physicochemical attributes. Through size and surface optimizations, these $Cu_{2-x}Se$ nanocrystals have been applied to photoacoustic imaging guided photothermal therapy, along with their cytotoxicity and blood circulation properties investigated. Furthermore, through an in situ deposition of a thin MnO_2 shell on $Cu_{2-x}Se$, they display enhanced MRI signal in response to acidic pH, H_2O_2, and reducing environment, without compromising photothermal property of the inner $Cu_{2-x}Se$ core [3]. This serves as a new method of constructing photothermal theranostic probes with tumor microenvironment responsive light-up MRI contrast enhancing capability.

Keywords

copper chalcogenide; theranostic; NIR-II; photothermal; photoacoustic imaging

References
[1] J. M. Luther, P. K. Jain, T. Ewers, A. P. Alivisatos, Localized Surface Plasmon Resonances Arising from Free Carriers in Doped Quantum Dots. Nat. Mater. 10, 361 (2011). doi: 10.1038/nmat3004

[2] X. Ding, D. Fu, Y. Kuang, Y. Zou, X. Yang, L. Feng, X. Sun, H. Wu, J. Jiang, Seeded Growth of $Cu_{2-x}Se$ Nanocrystals and Their Size-Dependent Phototherapeutic Effect. ACS Appl. Nano Mater. 1, 3303 (2018). doi: 10.1021/acsanm.8b00516

[3] D. Fu, X. Ding, J. Wu, C. Li, Q. Wang, J. Jiang, Cationic Polyelectrolyte Mediated Synthesis of MnO_2-Based Core–Shell Structures as Activatable MRI Theranostic Platform for Tumor Cell Ablation. Part. Part. Syst. Charact. 35, 1800078 (2018). doi: 10.1002/ppsc.201800078

Session B8
10:00 - 10:30 AM Room B December 19

B25: Janus Drug-Drug Conjugate Nanocapsules for enhancing Cancer Therapeutic Efficacy

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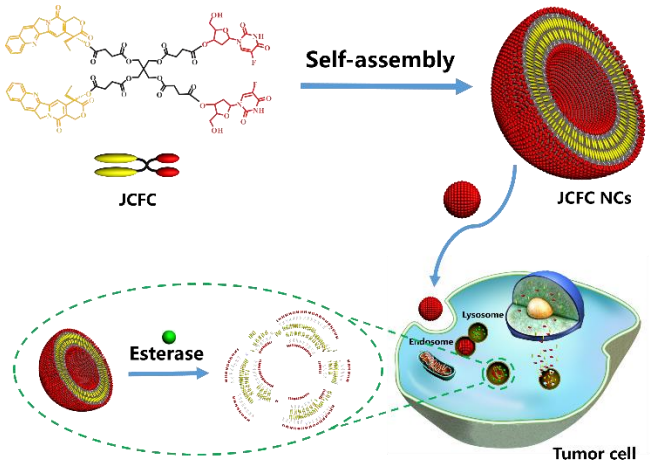
Abstract
A novel uniform liposome-like nanocapsule (NCs) was self-assembled for the first time from an amphiphilic Janus camptothecin-floxuridine conjugate (JCFC). JCFC NCs represent a strategy to deliver and preserve a fixed 1:1 molar ratio of the two drugs in a liposomal manner that can suppress premature burst release and coordinate the pharmacokinetics of the different drugs after i.v. administration. Our results demonstrate that the long blood retention time of the JCFC NCs facilitates the high tumorous accumulation of anticancer drugs via EPR effect and the subsequent cellular internalization into tumor cells. Owing to the esterase and acid hydrolysis of the ester bond in tumor cells, both camptothecin and floxuridine can be coordinately released from the JCFC NCs, resulting in higher apoptotic rate and synergetic anticancer activity than the individual free drugs and the mixture of camptothecin and floxuridine. We believe that JCFC NCs will soon begin to reach their full potential as an important class of therapeutic liposomal formulations and will contribute to remarkable advances in cancer treatments due to their unique features including clever use of JCFC itself as active liposomal building units, significantly high drug loading content, highly stable co-delivery drug combinations compared with competing conventional liposomes.



Scheme 1. *Self-assembly of Janus camptothecin-floxuridine conjugate into the liposome-like nanocapsule for cancer combination therapy.*

Related Recent Publications

[1] Liang X, Gao G, Cui L, Wang S, Wang J, Dai Z(2018) Self-assembly of Amphiphilic Janus Camptothecin-Floxuridine Conjugate into Liposome-like Nanocapsules for More Efficacious Combination Chemotherapy in Cancer. Adv Mater 1703135

[2] Liang X, Xu Y, Gao G, Zhou Y, Zhang N, Dai Z(2018) Ultrasound contrast agent microbubbles with ultrahigh loading capacity of camptothecin and floxuridine for enhancing tumor accumulation and combined chemotherapeutic efficacy. NPG Asia Mater, in press

[3] Chen M, Liang X, Gao G, Zhao R, Zhang N, Wang S, Chen W, Zhao B, Wang J, Dai Z(2018) Ultrasound Triggered Conversion of Porphyrin/Camptothecin-Fluoroxyuridine Triad Microbubbles into Nanoparticles Overcomes Multidrug Resistance in Colorectal Cancer. ACS Nano 2018, 12 (7), 7312–7326

[4] Xu Y, Liang X, Bhattarai P, Sun Y, Zhou Y, Wang W, Chen W, Ge H, Wang J, Cui L, Dai Z (2017) Enhancing therapeutic efficacy of combined cancer phototherapy by ultrasound-mediated in situ conversion of near-infrared cyanine/porphyrin microbubbles into nanoparticles. Adv Funct Mater 1704096

Session B9
11:00 - 11:30 AM Room B December 19

B26: Formation of micro/nano wrinkles on polymeric surfaces

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Abstract
Micro/nano wrinkled surfaces have excellent characteristics, such as significantly enlarged surface area and enhanced adhesion. These characteristics have recently used as surface platforms for many emerging applications in electrical, mechanical, and biological processes. In particular, nano-wrinkles offer additional physical features, such as superhydrophobicity and enhanced Raman scattering. Although serval fabrication techniques have been successfully developed to generate wrinkles at micro/nano scales, they are mostly limited to simple planar surfaces. Creating controllable multiscale wrinkles on multi-planar surfaces has remained challenging. We develop a simple pathway to form spatially tunable wrinkles at micro/nano scales on non-planar polymeric surfaces. In this texturing method, we make PEG (polyethylene glycol) microstructures, for instance, microposts using non-uniform photopolymerization in a PDMS channel. After a controllable washing step to remove the excess unpolymerized PEG, the partially cured top layer spontaneously forms wrinkles upon plasma treatment. We can simply control wrinkle wavelength by controlling the thickness of the partially cured top-layer.

Session B9
11:30 - 12:00 PM Room B December 19

B27: A Novel "Micro-capillary ELISA" for Detecting Salivary Biomarkers Aiming for POC Applications

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Abstract

We developed a novel immunoassay system in a micro-scale capillary tube aiming to apply for point-of care environment. In particular the "μ-capillary ELISA" was designed to detect stress biomarkers in saliva. C-reactive protein (CRP) and cortisol had been reported to be related with psychological stress, and also are secreted in saliva [1-2]. Conventionally measuring the level of cortisol necessitates a tedious collection process in which a person is required to spend a whole in a hospital to amass urine sample. The concentration of CRP and cortisol is decided by ELISA which is composed of multi-steps and processed by an experienced personnel. However use of "μ-capillary ELISA" in assaying the stress biomarkers in saliva not only simplifies the assay process but also has added advantage of being a non-invasiveness.

Surface chemistry is one the major factors that decides the performance of the "μ-capillary ELISA". We developed a vapor-phase surface modification in immobilizing aminopropyl triethoxysilane (APTES). The efficiency of the vapor-phase amination was confirmed by comparing with that of the solution method through attaching gold nanoparticles on the two amine surfaces. Using the "μ-capillary ELISA" prepared via vapor-phase amination, at least 0.1 ng/mL of CRP could be detected [3]. In devising a "μ-capillary ELISA" for cortisol, in order to overcome problems caused by the small molecular weight of cortisol, four different types of surface chemistries for competitive immunoassays were compared. Choosing the best resulting process in which cortisol was immobilized with (3-trimethoxysilylpropyl) diethylenetriamine (TMPED), the "μ-capillary ELISA" system could detect cortisol as low as 50 pg/mL in artificial saliva. Also we developed a nanoparticle system to enhance detection performance in "μ-capillary ELISA" [4].

In conclusion, use of the novel "μ-capillary ELISA" system in detecting salivary biomarkers, together with added technical development in surface chemistry and nanoparticles, is likely to make useful applications in POC environments. The future research is focused on installing the "μ-capillary ELISA" system to hand-held sensors equipped to wirelessly communicate with a mobile-phone.

Keywords

Micro-capillary; immunoassay; saliva; stress biomarkers and nanoparticles

References

[1] M. K. Wium-Andersen; D. D. Ørested; S. F. Nielsen; B. G. Nordestgaard, Elevated C-Reactive Protein Levels, Psychological Distressm and Depression in 73131 Individuals, Jama Psychiatry 70, 176 (2013). doi: 10.1001/2013.jamapsychiatry.102

[2] D. H. Hellhammer; S Wust; B. M. Kudielka, Salivary Cortisol As a Biomarker in Stress Research, Psychoneuroendocrinology. 34, 163 (2009) doi:10.1016/j.psyneuen.2008.10.026

[3] W.-J. Kim, S. H. Hyun, H. Y. Cho, S. Byun, B. K. Kim, C. Huh, K. H. Chung, Y. J. Kim, Sensitive "capillary ELISA" via vapor-phase surface modification, Sensors and Actuators B 233, 281 (2016) doi:10.1016/j.snb.2016.04.072

[4] W.-J. Kim, H. Y. Cho, B. Jeong , S. Byun, J.D. Huh, Y. J. Kim, Synergistic Use of Gold Nanoparticles (AuNPs) and "Capillary Enzyme-Linked Immunosorbent Assay (ELISA)" for High Sensitivity and Fast Assays, Sensors 18, 55 (2018), doi:10.3390/s18010055

Session B9
12:00 - 12:30 PM Room B December 19

B28: Surface Modification of ZnO Nanoparticles by Core-Shell Nanoparticles Decreased Cytotoxicity towards HeLa Cancer Cells: A facile Approach for Safer Nanomaterials

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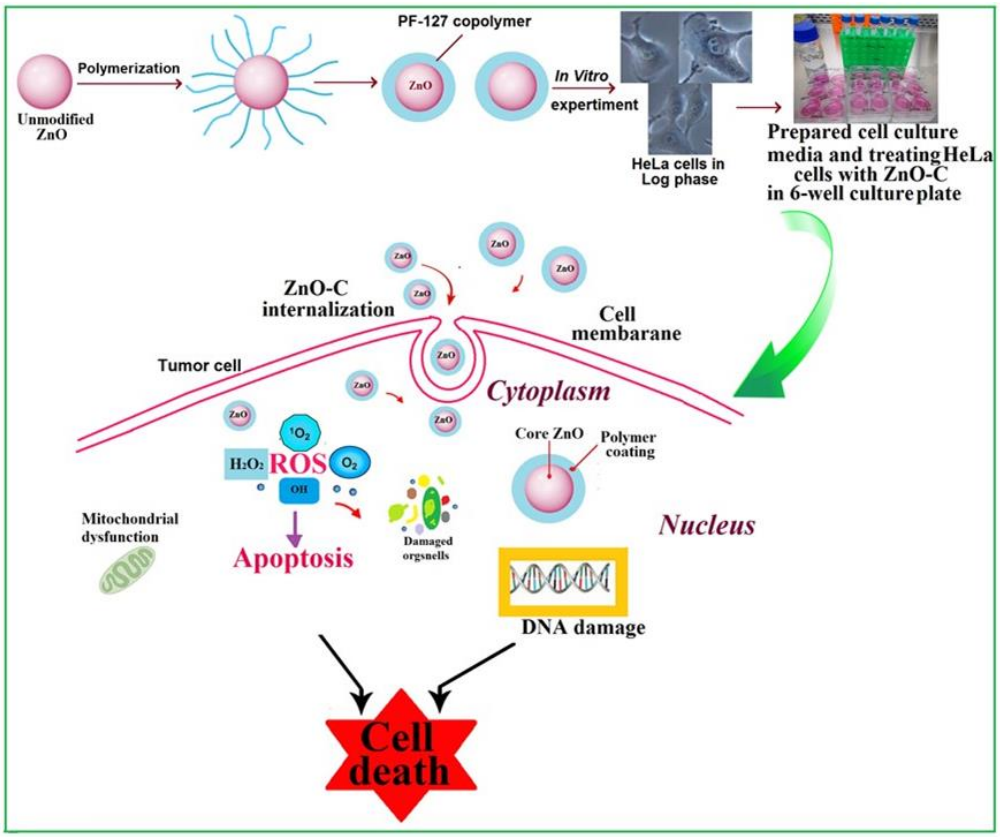
Abstract
This study was designed to develop an effective strategy of a core-shell nanoparticle structure as a distinctive formula to achieve decreased toxicity of nanomaterials. The structure was fabricated through surface modification by introducing Pluronic F-127 copolymer (PF-127) as a shell coating ZnO nanoparticle (ZnO-NPs) core. Employing a simple solution process. Two equally sized ZnO-NPs samples were synthesized, the stabilized coated ZnO-C (representing the core/shell), and the as-purchased sample ZnO-A. The cytotoxicity was studied on the human cervix cancer cells (HeLa) and was much reduced by ZnO-C, whereas its unique properties were preservative, as evidential by the structural and morphological investigations through XRD, TEM, and FESEM. These characterizations revealed similarities in crystal structure, high purity, identical morphologies and average cores sizes (60nm) in the two samples. Conversely, FTIR spectroscopy exhibited significant dissimilarities in their surface chemistry showing varied surface functional groups. Subsequently, zeta potential measurements as well showed big differences in their surface charges (36.3mV and 24.3mV). Importantly, these improvements in the physiochemical properties resulted in major differences in their cytotoxicity to HeLa cells, which is a vital aim of this study. The obtained IC50 values 25mM by ZnO-C and 0.2mM by ZnO-A, indicated selective reliable doses and biocompatibility due to ZnO-C colloidal stability that led to a controlled release into HeLa cells and prolonged action. Therefore, the cytotoxicity was definitely tailored. Additionally, trypan blue exclusion assay (TBEA), showed a dose-dependent fashion cytotoxic effects that ZnO-A effectively reduced HeLa cell viability (37%, and 18.4%, at 0.25 and 0.35mM respectively), while ZnO-C exhibited higher cell viability (94% and 79% at 15 and 20mM respectively). Furthermore, reactive oxygen species (ROS) were much generated by ZnO-A (45%) than ZnO-C (30%) and induced higher apoptosis (49.70%, 40.20% respectively) indicative by the morphological changes (FESEM images) visualized by microscopic means. Moreover, the toxicity was found to depend on the coating level, more PF-127 coating layers caused substantial decrease in ZnO-NPs toxicity. Based on these findings, ZnO-NPs in such a core-shell design can be a promising approach presenting a safer nanomaterial in biomedical applications as well as in other industries.

Keywords

ZnO nanoparticles; Core/shell Nanoparticles; Pluronic F-127 copolymer; Surface modification; HeLa cancer cells; Toxicity

Graphical abstract



Session B10
14:00 - 14:30 PM Room B December 19

B29: Shape memory fibrous scaffolds for bone tissue engineering

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Abstract
In bone tissue engineering, a significant challenge remains in the design and fabrication of ideal biomaterial scaffolds that are capable of recapitulating the cellular microenvironments, both biologically and biomechanically. While electrospinning has been well-documented for enabling to biomimetically construct the cell-residing extracellular matrix, how to exert in situ mechanical stimuli upon post-implantation of the scaffolds is an issue to be addressed. Having the biodegradable scaffolds integrated with shape memory functionality [1] may offer a solution to this problem. This presentation gives a brief overview of our recent works [2-4] in developing electrospun biomimicking fibrous scaffolds with shape memory effects for potential use towards in situ bone regeneration. We demonstrated that shape memory capable scaffolds hold a great potential in achieving enhanced efficacy in physiologically repairing various bone defects with the bone tissue engineering approach.

Keywords

Shape memory effects; Electrospinning; Fibrous scaffolds; Bone tissue engineering

References
[1] M. Bao; Q.H. Zhou; W. Dong; X.X. Lou; Y.Z. Zhang, Ultrasound-Modulated Shape Memory and Payload Release Effects in a Biodegradable Cylindrical Rod Made of Chitosan-Functionalized PLGA Microspheres. Biomacromolecules. 14, 1971 (2013). doi: 10.1021/bm4003464
[2] M. Bao; X.X. Lou; Q.H. Zhou; W. Dong; H.H. Yuan; Y.Z. Zhang, Electrospun Biomimetic Fibrous Scaffold from Shape Memory Polymer of PDLLA-co-TMC for Bone Tissue Engineering. ACS Applied Materials & Interfaces. 6, 2611 (2014). doi: 10.1021/am405101k
[3] M. Bao; X.L. Wang; H.H. Yuan; X.X. Lou, Q.H. Zhao; Y.Z. Zhang, HAp Incorporated Ultrafine Polymeric Fibers with Shape Memory Effect for Potential Use in Bone Screw Hole Healing. Journal of Materials Chemistry B. 4, 5308 (2016). doi: 10.1039/c6tb01305h
[4] Y. Zhou; X.L. Wang; B.C. Yi; Z.P. Yu; S.Y. Yang; Y.B. Shen; Y.Z. Zhang, Engineering Shape Memory Enabled Composite Nanofibers for Bone Tissue Engineering. Chemical Journal of Chinese Universities-Chinese. 39, 1554 (2018). doi: 10.7503/cjcu20170838

Session B10
14:30 - 15:00 PM Room B December 19

B30: Capped gold and silver clusters as efficient contrast agents for bio-imaging? Exploring new routes to enhance their emission properties

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Abstract
Functional ligand-protected noble metal cluster nanomaterials [1] with enhanced two-photon absorption and two-photon excited emission may lead to new technologies in the fields of bio-imaging applications. In this contribution, I will review experimental and theoretical methodologies allowing detailed investigation and analysis of two-photon absorption/emission properties of ligand-protected silver and gold metal clusters, coined “ligand-core” NLO-phores. [2, 3] Then I will thoroughly analyze physical phenomena and trends leading to large two-photon absorption/emission responses of a few series of model nanoclusters [4, 5] focusing on the effects of the relaxation pathways in the linear and nonlinear optical regime, as well as innovative strategies aiming at enhancing their two-photon emission responses. [6-8]

References
[1] R. Antoine and V. Bonačić-Koutecký, Liganded silver and gold quantum clusters. Towards a new class of nonlinear optical nanomaterials, Springer International Publishing, 2018
[2] Russier-Antoine I, Bertorelle F, Calin N, Sanader Z, Krstic M, Comby-Zerbino C, et al. Ligand-core NLO-phores: a combined experimental and theoretical approach to the two-photon absorption and two-photon excited emission properties of small-ligated silver nanoclusters. Nanoscale. 2017;9(3):1221-28
[3] Sanader Z, Krstic M, Russier-Antoine I, Bertorelle F, Dugourd P, Brevet P-F, et al. Two-photon absorption of ligand-protected Ag_{15} nanoclusters. Towards a new class of nonlinear optics nanomaterials. Physical Chemistry Chemical Physics. 2016;18:12404-08
[4] Bertorelle F, Russier-Antoine I, Calin N, Comby-Zerbino C, Bensalah-Ledoux A, Guy S, et al. $Au_{10}(SG)_{10}$: A Chiral Gold Catenane Nanocluster with Zero Confined Electrons. Optical Properties and First-Principles Theoretical Analysis. The Journal of Physical Chemistry Letters. 2017;8(9):1979-85
[5] Russier-Antoine I, Bertorelle F, Hamouda R, Rayane D, Dugourd P, Sanader Z, et al. Tuning Ag_{29} nanocluster light emission from red to blue with one and two-photon excitation. Nanoscale. 2016;8(5):2892-98
[6] Bertorelle F, Moulin C, Soleilhac A, Comby-Zerbino C, Dugourd P, Russier-Antoine I, et al. Bulky counterions: enhancing the two-photon excited fluorescence of gold nanoclusters. ChemPhysChem. 2018;19:165-68
[7] Shen D, Henry M, Trouillet V, Comby-Zerbino C, Bertorelle F, Sancey L, et al. Zwitterion functionalized gold nanoclusters for multimodal near infrared fluorescence and photoacoustic imaging. APL Materials. 2017;5(5):053404
[8] Waszkielewicz M, Olesiak-Banska J, Comby-Zerbino C, Bertorelle F, Dagany X, Bansal AK, et al. pH-Induced transformation of ligated Au_{25} to brighter Au_{23} nanoclusters. Nanoscale. 2018;10(24):11335-41

Session B10
15:00 - 15:30 PM Room B December 19

B31: Peptide-Modified PLL-coated Aligned PEDOT:PSS Fibers Promotes the Growth of PC12-derived Nerve Cells

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Abstract

Preceding researches have shown that PC12-derrived neural cells cultivated on aligned PEDOT:PSS fibers show a longer neurite outgrowth and increased neural-markers gene expression upon electrostimulation [1]. However, the resulting cell viability of such treatment is considerably lower when compared to the control group cultivated on TCPS. In this experiment, we try to investigate the possibility of adhering anionic laminin-derived peptide (DCDEGYIGSR) on the electrospun material so as to increase both of the cell viability and corresponding gene expression of the said neural cells [2].

Poly-L-Lactide has been shown to be a good candidate as a bio-linker [3]. Upon contact with PLL solution, PEDOT:PSS will adsorb the polymers unto its surface. The peptides will be attached by means of EDC/NHS coupling. The modified surface will be tested for its hydrophilicity (contact angle), surface morphology (AFM and SEM) and its surface energy (XPS). Fluorescamine staining will be conducted on PLL coated PEDOT:PSS. BCA Assay will be conducted as to determine the grafting ratio of the peptide onto the surface.

After the electrostimulation, the cell culture will be assessed for its growth characteristics. Alamar Blue staining will be used to determine its cell metabolism rate curve for the selected time points. Live and Dead staining will also be carried out at the end of the culture. RT-PCR will be conducted on Nestin, Tuj-1 and MAP2 gene to reveal the cell's gene expression for the groups with and without peptide modification. Immunostaining on Nestin and Tuj-1 will be conducted and confocal imagery will then be obtaining so as to visualize the resulting culture of its neurite outgrowth and cell morphology.

Generally, this show that our effort may be promising and particularly a novel work in this scope, since there has been no study conducted on how to make an aligned PEDOT:PSS fiber and have its surface modified at the same time. Furthermore, such study may give a good insight on how the effect of these two variables interact with each other and how they may be concerted together so as to bring out a better method to be further applied in clinical settings.

Keywords

Aligned nanofibers; surface modification; functionalization of peptides; PEDOT; PSS; PLL

References

[1] Chang YJ, Hsu CM, Lu MS, Chen L. Electrical Stimulation Promotes Nerve Growth-Factor Induced Neurite Outgrowth and Signalling. Biochim Biophys Acta. 1830(8):4130-6 (2013). doi: 10.1016/j.bbagen.2013.04.007

[2] Green, et.al. Cell Attachment Functionality of Bioactive Conductive Polymers for Neural Interfaces. Biomaterials 30 (2009):3637-3644. doi: 10.1016/j.biomaterials.2009.03.043

[3] Yu J, et.al. Electrospun PLGA Fibers Incorporated with Functionalized Biomolecules for Cardiac Tissue Engineering. Tissue Engineering 20 (2014):1896-1907. doi: 10.1089/ten.TEA.2013.0008

Session B11
16:00 - 16:30 PM Room B December 19

B32: Bio-Hybrid Hydrogel Comprising Animal and Plant Sources Embedded with Protein Capped Silver Nanoparticles for Accelerated Tissue Regeneration in Chronic Tissue Defects

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Abstract
The clinical management of a variety of tissue defects resulting from a traumatic insult (superficial and chronic wounds), oncological resection or progressively degenerative diseases (such as diabetic foot ulcer and many others), is a formidable challenge to the current standard of treatment aiming at structural and functional reconstruction. Hydrogel-based drug delivery system has emerged as a promising platform for chronic tissue defects due to their inherent ability to facilitate the moist microenvironment with better biocompatibility and accelerated tissue regeneration. Here, we have synthesized the aminated xanthan gum and the biomimetic silver nanoparticles by treating the xanthan gum with ethylene diamine and by employing the aqueous collagen as a reducing and stabilizing agent, respectively. We have also developed a stable bio-hybrid hydrogel system comprising of collagen (C) as a biocompatible polymer, aminated xanthan gum (AXG) as a biodegradable polymer and gelling agent, biomimetic silver nanoparticles (AGNP) as an antimicrobial agent and melatonin (MELT) as an antioxidant and anti-inflammatory agent. The prepared C-AXG-AGNP-MELT hydrogel system exhibits better gelation, surface morphology, rheology and degelation properties. In vitro antibacterial studies demonstrate that the C-AXG-AGNP-MELT hydrogel system remarkably inhibited both gram-positive and gram-negative bacterias namely Bacillus subtilis, Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa. The in vitro cell culture assessment of the prepared hydrogel system showed excellent biocompatibility when cultured with the NIH 3T3 fibroblast cell lines. We also evaluated the wound healing efficiency of the prepared C-AXG-AGNP-MELT hydrogel system in a full-thickness open excisional skin wound model in Wistar albino rats. The results indicate that the application of C-AXG-AGNP-MELT hydrogel system enhances re-epithelialization of epidermis and collagen deposition in the wound tissue owing to its excellent antimicrobial, antioxidant and anti-inflammatory properties. Our findings suggest that the developed C-AXG-AGNP-MELT hydrogel system can be used as a promising wound dressing material for treating infected burn and chronic tissue defects.

Keywords

Collagen; Silver Nanoparticles; Aminated Xanthan Gum; Antimicrobial; Tissue Regeneration; Wound Healing

Session B11
16:30 - 17:00 PM Room B December 19

B33: Multifunctional Plasmonic and Luminescent Nanomaterials for Smart Biosensors and Theranostics Applications

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Abstract
Inspired by Natural biomineralization processes in creating functional nanostructured materials under benign conditions from the bottom up, our research focuses on the development of biogenic nanomaterials for a vast plethora of biomedical applications. Firstly, I will talk about the rational design of peptide- and nucleic acid-based biomolecular templates for the synthesis of multifunctional metallic and carbon-based nanoparticles with tunable optical properties (i.e., plasmon absorption and light emission) and biofunctionalities for sensing, imaging, delivery and therapy [1-9]. For example, we have designed self-assembly DNA templates to form redox-responsive silver nanoclusters (NCs < 2 nm in size) for two-way color change detection of free radicals and antioxidants in real time. Using bi-functional peptide templates, AuNCs with tunable emission color from visible to near-infrared wavelength have been successfully synthesized for targeted gene delivery and bioimaging applications [5]. We have also employed this bioinspired approach to 'turn' the native protein into bioactive fluorescent sensors for small molecule drug screening [6] and photodynamic therapy [7]. More recently, we have uncovered the first design principles of amino acid-derived photoluminescent bio-dots with tailored-made structure-properties to improve their photostability, intracellular uptake capability and biocompatibility [8]. Inspired by the natural antimicrobial peptides, benign antimicrobial biodot that possesses both the unique photochemical properties of nanoparticles and biomaterials has been developed for combating broad spectrum multi-drug resistant bacteria [9]. The second part of my presentation will focus on the bio-functionalization strategies of noble metal nanoparticle for biosensor development, which can convert the 'invisible' biological responses into easily measurable and observable colorimetric outputs [10,11]. By exploiting the plasmonic coupling, fluorescence and/or light scattering properties of the nanometals, we have developed a series of label-free nanosensors to detect a wide range of bio-analytes such as drugs, biomarkers, pathogens, etc., and for studying important biomolecular interactions such as gene transcription, DNA mutation and enzymatic reaction [12-16]. These bioassays are versatile, efficient and low-cost with high throughput sensing capability. These smart nanobiosensors are versatile, efficient and low-cost, which could culminate into tangible products useful for biomedical research and diagnostics. The fundamental understanding on the intertwined relationships of biological processes and nanochemistry can contribute on tailoring multifunctional biocompatible and smart nanomaterials towards theranostics and personalized medicine in the future.

Keywords

Bioinspired Synthesis; Plasmonic nanoparticles; Photoluminescence; Biosensor; Nanomedicine

References

[1] X. T. Zheng; V. H. Xu; Y. N. Tan*, Bioinspired Design and Engineering of Functional Nanostructured Materials. Advances in Bioinspired and Biomedical Materials Vol. 2, American Chemical Society (ACS) Book, 1253, 123-152 (2017)

[2] Y. Yu; B. Y.L. Mok; X.J. Loh; Y. N. Tan*, Rational Design of Biomolecular Templates for Synthesizing Multifunctional Noble Metal Nanoclusters towards Personalized Theranostic Applications. Advanced Healthcare Materials (2016). DOI: 10.1002/adhm.201600192

[3] V. H. Xu; X. T. Zheng; B. Y.L. Mok; S.A. Ibrahim; Y. Yu; Y. N. Tan*, Molecular Design of Bioinspired Nanostructures for Biomedical Applications: Synthesis, Self-Assembly and Functional Properties." Journal of Molecular and Engineering Materials, 04, 1640003-1640036 (2016)

[4] Y. N. Tan; J. Y. Lee; Daniel. I. C. Wang*, Uncovering the Design Rules for Peptide Synthesis of Metal Nanoparticles. Journal of American Chemical Society, 132, 5677-5686 (2010)

[5] Y. Yu; J. C. Yi; Y. N. Tan*, Microwave-Assisted Synthesis and Mechanistic Study of Multicolor Emissive Au Nanoclusters using Thiol-Containing Biomolecules. Adv. Mater. Lett. 9 (9), 647-651(2018).

[6] Y. Yu; S. Y. New; J. Xie; X. Su; Y. N. Tan*, Protein-Based Fluorescent Metal Nanoclusters for Small Molecular Drug Screening. Chemical Communications, 50, 13805-13808 (2014).

[7] Y. Yu; J. Geng; E.X.O, Yong; V. Chellappan; Y. N. Tan*, Bovine Serum Albulmin Protein-Templated Silver Nanocluster (BSA-Ag13): An Effective Singlet Oxygen Generator for Photodynamic Cancer Therapy", Advanced Healthcare Materials. (2016). DOI:10.1002/adhm.201600312.

[8] H.V. Xu; X. T. Zheng; Y. Zhao; Y. N. Tan *, Uncovering the Design Principle of Amino Acid-Derived Photoluminescent Biodots with Tailor-Made Structure–Properties and Applications for Cellular Bioimaging." ACS Applied Materials and Interfaces, 10, 19881–19888 (2018).

[9] H.V. Xu; X. T. Zheng; C. Wang; Y. Zhao; Y. N. Tan*, Bioinspired Antimicrobial Nanodots with Amphiphilic and Zwitterionic-like Characteristics for Combating Multidrug-Resistant Bacteria and Biofilm Removal." ACS Applied Nano Materials 1, 2062–2068 (2018).

[10] W. L. P. Goh; J. F. Ghadessey; D. P. Lane; X. T. Zheng; E. Assah; Y. N. Tan*, Transcription Factors As Detection And Diagnostic Biomarkers In Cancer. Next Generation Point-Of-Care Biomedical Sensors Technologies for Cancer Diagnosis. Springer Nature Book, DOI: 10.1007/978-981-10-4726-8 (2017).

[11] Y. N. Tan*; X. T. Zheng; Y. Yu, Metallic Nanobiosensor for Biological Analysis and Medical Diagnostics. Nanobiosensors for Personalized and Onsite Biomedical Diagnostics. The Institution of Engineering and Technology Book, 537-559 (2015).

[12] J. Song; Y. N. Tan*; D. Jańczewski; M. A. Hempenius; J. W. Xu; H. R. Tan; G. J. Vancso*, Poly(ferrocenylsilane) Electrolytes as Gold Nanoparticle Foundry: Two-in-One Redox Synthesis, Electrosteric Stabilization, and Sensing Applications", Nanoscale DOI: 10.1039/C7NR04697A (2017)

[13] E. Assah; W. L. P. Goh; X. T. Zheng; D. P. Lane; J. Li; T. X. Lim; J. F. Ghadessey; Y. N. Tan*, Rapid Colorimetric Detection Of P53 Protein Function Using DNA-Gold Nanoconjugates with Applications For Drug Discovery and Cancer Diagnostics. Colloids and Surfaces B: Biointerfaces, 169, 214-221(2018), DOI.org/10.1016/j.colsurfb.2018.05.007

[14] X. T. Zheng; W. L. P. Goh; P. Yeow; D. P. Lane; J. F. Ghadessey; Y. N. Tan*, Ultrasensitive Dynamic Light Scattering Based Nanobiosensor For Rapid Anticancer Drug Screening. Sensors and Actuators B: Chemical, 279, 79-86 (2018). Doi.org/10.1016/j.snb.2018.09.088

[15] N. J. Seow; Y. N. Tan*; X. Su; Lanry Yung*, DNA-Directed Assembly of Nanogold Dimers: A Unique Dynamic Light Scattering Sensing Probe for Transcription Factor Detection, Scientific Report, 5:18293 (2015). DOI: 10.1038/srep18293.

[16] Y. N. Tan; X. Su; Y. Zhu; J. Y. Lee, Sensing Of Transcription Factor Through Controlled-Assembly of Metal Nanoparticles Modified With Segmented DNA Elements. ACS Nano, 4, 5101–5110 (2010)

Session B11
17:00 - 17:30 PM Room B December 19

B34: T1/T2 Dual functional iron oxide MRI contrast agent with super stability and low hypersensitivity

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Abstract

Clinical acceptable safety and efficacy are the most important issues for the design and synthesis of iron oxide MRI contrast agent. To meet the requirements we developed a kind of low molecular weight PAA-coated Fe_3O_4 nanoparticles (CS015) with super colloidal stability and low hypersensitivity benefited by ultrahigh carboxyl group density. The constitution and physicochemical properties of the particles were characterized by TEM, XRD, FTIR and TGA. Ultrahigh density of COOH on the particles (33 COOH/nm^2) was verified while core size (5.1 nm) and dynamic diameter (41 nm) with narrow distribution were also achieved. The particles showed excellent dispersity and stability even after re-dissolving spry-dried and freeze-dried samples, at high temperature sterilized conditions and long-term storage. The nanoparticles could quickly capture iron ions in bulk solution from ITC results and bioactive iron of CS015 was greatly decreased (0.54±0.05 mg/L) compared to commercial available Ferumoxytol, Iron Sucrose and VSOP. Free iron ions release was 1120 times lower than iron toxic concentration. An excellent low cytotoxicity and less risk of hypersensitivity of CS015 had been manifested by cytotoxicity experiments and passive cutaneous anaphylaxis test. T1 and T2-weighted MRI contrast effects both in vitro and in vivo had been verified made CS015 a potential dual MRI contrast agent. Theoretical calculated conformation was speculated and all the advantages mentioned above were benefited by the three dimensional brush-like texture of CS015. Therefore, these merits of CS015 exhibited great potential in MRI contrast agent for diagnostic applications.

Keywords

Superparemagnetic nanoparticles; MRI contrast agent; Stability; Hypersensitivity

Session B11
17:30 - 18:00 PM Room B December 19

B35: Nanotechnology and Environmental Application: Future with Electrospinning

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Abstract

Nanotechnology is providing novel opportunities and solutions to guarantee sustainable energy and environments for the future. Materials of nanofiberous morphology are attractive to solve numerous energy and environmental issues. Nanofibers can be effectively produced by electrospinning, which is a simple and low cost technique. In addition, electrospinning allows the production of nanofibers from various materials e.g. organics and inorganics in different configurations and assemblies. The nanofibers used in filtration membranes for environmental remediation, minimize the pressure drop and provide better efficiency than conventional fiber mats. The large surface area-to-volume ratio of nanofiber membranes allows greater surface adsorption of contaminants from air and water, and increases the life-time of the filtration media. This review highlights the potential and application of electrospun nanofiberous materials for solving critical environmental issues. The main aim of this review will be to discuss the application of electrospun nanofibers for air and water filtration and to introduce the high-throughput electrospinning machine as well as the products for air and water filtration. This review will be equally important for scientists, professors, policy makers, industrialists and the students to understand the electrospinning process and its importance for environmental applications.

Overall the following will be discussed in this abstract:

- Reviews the recent advances in development of functional electrospun nano fibers
- Comprehensively introduces the environmental applications of electrospun nano fibers
- Provides a versatile strategy for design and development of functional nanomaterials towards environmental issues

Keywords

Electrospinning; Environmental Nanotechnology; Ultra-filtration; Nanofibers; Air-filtration

Acknowledgment

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Reference

[1] Thavasi, V., Singh, G., Ramakrishna, S., Electrospun nanofibers in energy and environmental applications, Energ. Environ. Sci., 1, 205-221, 2008

[2] Deshpande, T. D., Yogesh R. G. S., Patil S., Sharma, A., To study surface and sub-surface nanomechanical properties of electrospun polyacrylonitrile (PAN) nanofibers/polydimethylsiloxane (PDMS) composites, Soft Matter. 14, 7829-7838, 2018

Poster Session
Room C, December 18 2018

P1: Dimension-dependent optoelectronic properties of perovskite-metal oxide core-shell nanocrystals

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Abstract

Recently, halide-perovskite materials are promising for various applications including optoelectronic devices such as solar cells, photodetectors and phototransistors due to their high absorption density, carrier diffusion length and easy solution process. [1-2] Thus, lots of methods have been developed to change the composition and morphology of the perovskite nanocrystals to modulate the optophysical properties. [3, 4] Especially, dimension of nanocrystals such as nanodots, nanorods, nanowires, nanosheets, and nanoplatelets confines the photogenerated charge carrier and change the charge transport performances.

However, the practical application of perovskite nanocrystals is still limited due to their unstability toward the oxygen, humidity, and light irradiation. Because the perovskite nanocrystals have the ionic properties and are passivated by labile ligands after solution synthesis via hydrogen bond. [5] Therefore, ligand exchange of synthesized nanocrystals into polymers and metal oxides, are suggested for the stability of perovskite nanocrystals. Titanium dioxide (TiO_2), one of n-type metal oxide semiconductors, could protect the perovskite nanocrystals against environment and transfer the photogenerated electrons.

Here, we synthesize the perovskite nanocrystals with different dimension including 0D and 2D via hot injection methods and passivate the perovskite nanocrystals with TiO_2 to generate perovskite-metal oxide core-shell nanocomposite. The dimension-dependent optical and electrical properties of theses nanocomposite are analyzed using HRTEM, XRD, UV-vis absorption and PL spectroscopy.

Keywords

Perovskite nanocrystals; colloidal synthesis; core-shell; charge transfer

References

[1] Q.A. Akkerman, G. Rainò, M.V. Kovalenko, L. Manna, Genesis, challenges and opportunities for colloidal lead halide perovskite nanocrystals, Nature Materials, 17 (2018) 394-405

[2] N.-G. Park, Perovskite solar cells: an emerging photovoltaic technology, Materials Today, 18 (2015) 65-72

[3] S. Bai, Z. Yuan, F. Gao, Colloidal metal halide perovskite nanocrystals: synthesis, characterization, and applications, Journal of Materials Chemistry C, 4 (2016) 3898-3904

[4] M.V. Kovalenko, L. Protesescu, M.I. Bodnarchuk, Properties and potential optoelectronic applications of lead halide perovskite nanocrystals, Science, 358 (2017) 745-750

[5] H. Huang, M.I. Bodnarchuk, S.V. Kershaw, M.V. Kovalenko, A.L. Rogach, Lead Halide Perovskite Nanocrystals in the Research Spotlight: Stability and Defect Tolerance, ACS Energy Letters, 2 (2017) 2071-2083

Poster Session
Room C, December 18 2018

P2: Continuous degradation of toxic molecules through in-situ reduction of CO_2 using metal doped B-TiO_2 photocatalysts

Hee Min Hwang[1,2], Simgeon Oh[1,2], Jinjoo Lee[3], Yesel Hong[3], G. Hwan Park[3], Chang-il Shin[3], Yerin Park[3], Hyoyoung Lee[1,2,3,]*

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Abstract

Up to now, complete water splitting reaction under sunlight for the continuous photo catalytic processes will be one of the most attractive methods to solve the future energy problems in the world. However, the problem of this reaction for the complete water splitting reaction requires sacrificial agents for hole scavenger such as methanol at the valence band (VB) and for electron scavenger such as $AgNO_3$ at the conduction band (CB) [1]. For the complete degradation of organic molecules using photocatalytic semiconducting materials such as TiO_2 [2], both activities at the valence band and conduction band sites are quite necessary for the continuous degradation process without using any scavengers.

In this report, we provide new continuous photo-catalytic processes through in-situ degradation of organic compounds at CB site and simultaneously conversion of CO_2 at VB site. B-TiO_2 was disordered rutile/ordered anatase TiO_2 phase-mixed structure via litium-ethylenediamine (Li-EDA) treatment. The methyl paraoxon (MPO) is one of sarin simulants which are organophosphorus materials and toxic to human body. Degradation of MPO occurred on VB of B-TiO_2 to CO_2 and the resulting CO_2 was gradually converted to CO on CB of B-TiO_2. We achieved 100 % degradation of nerve agent at CB and 72.09 % of conversion from CO_2 to CO (922.86 μmol/g) at VB of TiO_2. It is first time to report for CO_2 reduction from nerve agents by using TiO_2-based materials. As a whole, our concept can be applied for various environmental, military and energy conversion fields.

Keywords

TiO_2; degradation; CO_2 reduction; nerve agent; photocatalyst

References

[1] S. R. Lingampalli, and C. N. R. Rao. Recent Progress in the Photocatalytic Reduction of Carbon Dioxide.ACS Omega. 2017, 2, 2740−2748

[2] Lizandra M. Zimmermann, Faruk Nome, Degradation of Methyl Paraoxon in the Presence of Mg^{2+}-Al^{3+} Mixed Oxides. J. Phys. Chem. C 2013, 117, 49, 26097-2610

Poster Session
Room C, December 18 2018

P3: Ultraviolet photodetector using pn junction of p-CuO hollow nanospheres and n-ZnO nanorods

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Abstract
Zinc oxide (ZnO) is a most well-studied n-type semiconductor for application of ultraviolet (UV) photodetectors due to its direct and wide energy band gap (~3.37 eV at room temperature). [1] But, UV photodetectors using ZnO show the low rising and falling time compare to other metal oxide materials. In order to improve these performances, we suggest new pn junction structure using p-CuO and n-ZnO for UV detector. At first we synthesize the p-CuO nanospheres by using polymer spheres template methods. The synthesized Cu-ion incorporated polymer spheres loaded on the top of n-ZnO nanorods (NRs) grown on n-Si substrate by hydrothermal method. The thermal annealing process changed monolayer of Cu-ion incorporated polymer spheres into CuO hollow nanospheres. In addition, the shrinkage of diameters of CuO occurred during the thermal annealing process resulting in formation of spacing between each sphere. To compare the effects of coverage of CuO nanospheres on device performance, we added another layer of CuO nanospheres with same process. The current-voltage (I-V) and time-related photocurrent (T-I) curves show that the fabrication of CuO nanospheres on ZnO could improve the detector performances. In addition, the sensitivity of 2-times transferred of CuO on the surface of n-ZnO NRs shows about 3 times higher than that of 1-time transferred CuO layer based detector. Our suggested p-CuO nanospheres covered n-ZnO NRs can improve the performance of UV photodetector which show the faster electron-hole separation and the suppression of recombination by the mutual transfer of the photo-generated electrons or holes. [2]

Keywords

CuO hollow nanospheres; pn junction; UV photodetector; Photo sensitivity

References
[1] Anderson Janotti, Chris G Van de Walle, Fundamentals of zinc oxide as a semiconductor. Rep. Prog. Phys., 72, 126501 (2009)

[2] Sheng-Bo Wang, Chih-Hung Hsiao, Shoou-Jinn Chang, Senior Member, IEEE, Z. Y. Jiao, Sheng-Joue Young, Shang-Chao Hung, and Bohr-Ran Huang, ZnO branched nanowires and the p-CuO/n-ZnO heterojunction nanostructured photodetector. IEEE Trans. Nanotechnol., 12, 263 (2013)

Poster Session
Room C, December 18 2018

P4: Highly carbon-doped TiO_2 derived from MXene boosting the photocatalytic hydrogen evolution

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Abstract
The effective in situ carbon doping of titanium dioxide can greatly improve the lifetime of photogenerated carriers and widen the optical absorption range for photocatalytic reactions. [1] Here, highly carbon-doped TiO_2 (HC-TiO_2) with a hierarchical structure and good crystallization was synthesized by using the exfoliated MXene at low temperature. [2] It was found that the high-content carbon doping induced a valence band tail state that promoted photogenerated carriers' effective separation and reduced bandgap, which greatly improved the utilization of light for photocatalytic reactions. This band tail was attributed to the strong electron withdrawing carboxylate groups from carbon doping. [3-4] The photocatalytic hydrogen production rate of the hierarchical HC-TiO_2 was 9.7 times that of the commercial P25 without cocatalyst under simulated sunlight. This work enriched the synthesis method of C-doped TiO_2 and the application of MXene based materials.

Keywords

Photocatalyst; Hydrogen evolution; C-TiO_2; MXene; Hierarchical structure

References
[1] Tian, J.; Zhao, Z.; Kumar, A.; Boughton, R. I.; Liu, H. Recent progress in design, synthesis, and applications of one-dimensional TiO_2 nanostructured surface heterostructures: a review. doi: 10.1039/C4CS00180J
[2] Jia, G.; Wang, Y.; Cui, X.; Zheng, W., Highly carbon-doped TiO_2 derived from MXene boosting the photocatalytic hydrogen evolution. doi:10.1021/acssuschemeng.8b03406
[3] Niu, P.; Wu, T.; Wen, L.; Tan, J.; Yang, Y.; Zheng, S.; Liang, Y.; Li, F.; Irvine, J. T. S.; Liu, G.; Ma, X.; Cheng, H. M. Substitutional carbon-modified anatase TiO_2 decahedral plates directly derived from titanium oxalate crystals via topotactic transition. doi: 10.1002/adma.201705999
[4] Tao, J.; Luttrell, T.; Batzill, M. A two-dimensional phase of TiO2 with a reduced bandgap. doi: 10.1038/nchem.1006

Poster Session
Room C, December 18 2018

P5: Hexagonal $FeIn_2S_4$: Layer Dependent Band Structure of Ternary Metal Chalcogenides

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Abstract
From the development of graphene, two dimensional nanomaterials have been widely studied due to their exotic characteristics. Among the several 2-dimensional materials such as graphene derivatives, hexagonal boron nitride, and phosphene, transition metal chalcogenides (TMDs) have received considerable attention due to their electrical characteristics, chemical stability and suitable band gaps for applications. [1] However, still there are only few studies for layered structure of ternary metal chalcogenides, which consists of two metal cations and one chalcogenide anions. Here, the layer dependence band gap the possibility of layer dependence of ternary metal chalcogenides was suggested with the hexagonal $FeIn_2S_4$ (h-FIS) which was generally known as a spinel structure. [2] The investigation of formation of h-FIS was followed by comparison with cubic phase $FeIn_2S_4$ (c-FIS) and hexagonal $ZnIn_2S_4$. The thickness of h-FIS was obtained by controlling the dissociation rate of sulfur radicals from sulfur precursor, [3] and then different band structure of each of h-FIS samples were investigated through the optical bandgap and redox potentials from cyclovoltammetry. This research will contribute to developing new applications of ternary metal chalcogenides and exploring their unveiled characteristics.

Keywords

layered structure; iron indium sulfides; metal chalcogenides; two dimensional materials

References
[1] Butler SZ, Hollen SM, Cao L, Cui Y, Gupta JA, Gutiérrez HR, Heinz TF, Hong SS, Huang J, Ismach AF, Johnston-Halperin E, Kuno M, Plashnitsa VV, Robinson RD, Ruoff RS, Salahuddin S, Shan J, Shi L, Spencer MG, Terrones M, Windl W, Goldberger JE; Progress, challenges, and opportunities in two-dimensional materials beyond graphene. ACS Nano. 7(4), 2898 (2013). doi:10.1021/nn400280c

[2] Kim H, Tiwari AP, Hwang E, Cho Y, Hwang H, Bak S, Hong Y, Lee H. Fein2s4 nanocrystals: A ternary metal chalcogenide material for ambipolar field-effect transistors. 5(7), 1800068 (2018). doi:doi:10.1002/advs.201800068

[3] Yoo D, Kim M, Jeong S, Han J, Cheon J. Chemical synthetic strategy for single-layer transition-metal chalcogenides. Journal of the American Chemical Society. 136(42), 14670-14673 (2014). doi:10.1021/ja5079943

Poster Session
Room C, December 18 2018

P6: Ligand-exchanged colloidal WSe_2 and its counter cation dependent HER study

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Abstract
Hydrogen evolution reaction (HER) which involves the electrolysis of water molecules has been emerged as a clean synthesis of hydrogen, which is an alternative to steam methane reformer widely used in industry [1]. Promising candidates among earth-abundant catalysts are transition-metal dichalcogenides (TMDs), which are two-dimensional (2D) layered materials. They can reach high current densities at low over-potentials [2]. Commonly, these materials have been synthesized by vacuum-involving method like chemical vacuum deposition (CVD), while a colloidal synthesis has been less focused in spite of its scalable, less energy-intensive and cost-effective advantages [3]. The main reason is the presence of the surface ligands on the materials, resulting in the intrinsic limitation for use as catalysts.

In this study, we demonstrate the effectiveness of ligand-exchanged colloidal WSe_2 as a catalyst for HER. Up to now, it has been reported that the surface ligands can inhibit the catalytic reactions on the surface [3]; on the other hand, some other ligands have shown the lack of the inhibition effects [4] or even an increase in the reactivity [5]. As a layered material, WSe_2 has a potential to intercalate small molecules between its layers, and we found that after ligand exchange, this results in incorporation of charge-balancing counter cations into its layers which increases the current density. In this presentation, we like to introduce the study on HER activity by electrochemical measurement, XRD and XPS etc.

Keywords

Hydrogen evolution reaction (HER); Transition metal dichalcogenides (TMDs); Colloidal synthesis; Ligand exchange; Intercalation

References
[1] N. Udengaard, Hydrogen Production by Steam Reforming of Hydrocarbons. Prepr. Pap.-Am. Chem. Soc., Div. Fuel Chem. 2004, 49, 906−907.

[2] C. G. Morales-Guio; L.-A. Stern; X. Hu, Nanostructured Hydrotreating Catalysts for Electrochemical Hydrogen Evolution. Chem. Soc. Rev. 43, 6555 (2014). doi: 10.1039/C3CS60468C

[3] D. A. Henckel; O. Lenz; B. M. Cossairt, Effect of Ligand Coverage on Hydrogen Evolution Catalyzed by Colloidal WSe_2. ACS Catal. 7, 2815 (2017). doi: 10.1021/acscatal.7b00074

[4] H. Borchert; D. Fenske; J. Kolny-Olesiak; J. Parisi; K. Al-Shamery; M. Baumer, Ligand-Capped Pt Nanocrystals as Oxide-Supported Catalysts: FTIR Spectroscopic Investigations of the Adsorption and Oxidation of CO. Angew. Chem., Int. Ed. 46, 2923 (2007). doi:10.1002/anie.200604460

[5] Enhanced electrocatalysis of the oxygen reduction reaction based on patterning of platinum surfaces with cyanide. Nat. Chem. 2, 880 (2010). doi: 10.1038/nchem.771

Poster Session
Room C, December 18 2018

P7: The Fabrication of ZnO Nanoarrays and Its Applications for Photoelectrochemical Water Splitting and Protein Microarray based Biosensing

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Abstract
Nanostructured ZnO materials have received broad attention due to their distinguished performance in electronics, optics and photonics [1]. In this work, we designed and fabricated two ZnO nanoarrays composites including: CuO/ZnO nanoarrays heterojunction and ZnO NRs/Au film substrate. Here, we simultaneous improved of the carrier separation and light harvesting by constructing P-N heterojunctions in CuO/ZnO nanoarrays composites. The CuO/ZnO nanoarrays heterojunction photoanode exhibited a significant negative shift of 150 mV for the onset potential and an approximately 4-fold enhancement in the photocurrent at 1.23 V vs RHE compared with those of pristine ZnO NRs. This work offers a facile strategy for preparing oxide-based P-N heterojunction photoanodes for enhanced PEC water splitting [2]. Moreover, we present the fabrication of a kind of novel plasmonic protein microarrays using nanostructured ZnO nanorod arrays (ZnO NRs) on 50 nm Au film that exhibits an enhancement of fluorescence up to 200-fold. The as-prepared plasmonic protein microarrays were used for the detection of the carcinoembryonic antigen (Carcinoembryonic Antigen, CEA) cancer biomarker. The plasmonic enhancement resulted in a detection limit of 27 pg ml^{-1} in 0.01 M PBS and a dynamic range of 100 pg mL^{-1} to 100 μg mL^{-1}. The ZnO NRs/Au substrates can be mass-manufactured, which is highly promising for the development of low cost, sensitive, and high-throughput protein assay platform for applications in clinical diagnosis [3, 4]. These two ZnO nanoarrays composites would be further used in the field of PEC water splitting and protein microarray based biosensing.

Keywords

Zinc Oxide Nanoarrays (ZnO NRs); Photoelectrochemical Water Splitting; Heterojunction; Protein Microarray; Biosensing

References
[1] W. Zhong Lin, Zinc oxide nanostructures: growth, properties and applications. Journal of Physics: Condensed Matter. 16, R829 (2004). doi:10.1088/0953-8984/16/25/R01
[2] M. G. Walter; E. L. Warren; J. R. McKone; S. W. Boettcher; Q. Mi; E. A. Santori; N. S. Lewis, Solar Water Splitting Cells. Chemical Reviews. 110, 6446 (2010). doi:10.1021/cr1002326. doi:10.1002/adhm.201600414
[3] C. Liu; F. Meng; B. Wang; L. Zhang; X. Cui, Plasmonic Nanograting Enhanced Fluorescence for Protein Microarray Analysis of Carcinoembryonic Antigen (CEA). Analytical Methods. 10, 145 (2018). doi:10.1039/C7AY02232H
[4] C. Liu; F. Meng; W. Zheng; T. Xue; Z. Jin; Z. Wang; X. Cui, Plasmonic ZnO Nanorods/Au Substrates for Protein Microarrays with High Sensitivity and Broad Dynamic Range. Sensors and Actuators B: Chemical. 228, 231 (2016). doi:10.1016/j.snb.2016.01.019

Poster Session
Room C, December 18 2018

P8: Electrochemical fabrication of hierarchical pseudocapacitive electrode for supercapacitor

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Abstract
Graphene has been received great attention as electrode materials for supercapacitor due to its high electrical conductivity, large surface area and perfect porosity effects. However, low capacitance of carbon-based materials limits their applications. In addition, pristine graphene is easy to restack. Incorporation of pseudocapacitive materials with graphene sheets is a good way to fabricate high performance supercapacitor electrode materials. However, in the composites made by in situ deposition of conducting polymers or inorganic oxides in suspensions of graphene sheets, connections between graphene sheets might be blocked by aggregations of the pseudocapacitive materials, so its effect on improving electric conductivity for the composites may be weakened.

A facile electrochemical method was designed by our group to prepare functionalized exfoliated graphite (FEG) with functionalized graphene sheets anchoring on the graphite substrates via a two-step partial exfoliation [1]. Nanostructed pseudocapacitive materials, such as MnO_2 and Ni-Co double hydroxide (Ni-Co DH), were electrochemically in situ grown on surfaces of graphene sheets in FEG to fabricate hierarchical pseudocapacitive electrodes [1-2].

Keywords

functionalized exfoliated graphite; MnO_2; Ni-Co double hydroxide; supercapacitor

Acknowledgments

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References
[1] Y. Song, D.-Y. Feng, T.-Y. Liu, Y. Li, X.-X. Liu, *Nanoscale*, 2015, 7, 3581–3587
[2] Y. Song, X. Cai, X.-X. Xu, X.-X. Liu, *J. Mater. Chem. A*, 2015, 3, 14712-14720

Poster Session
Room C, December 18 2018

P9: Energy Band Modulation of Phase-selectively Disordered Pt-TiO_2 for Highly Active Photocatalysts

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Abstract
P25 is a famous phase mixed TiO_2 with well lattice connected interface between anatase and rutile phase. This phase junction structure separates photo-exciton smoothly and its high photocatalytic performance reported by a number of papers.[1] And the continuous studies of P25 TiO_2 discovered that the outstanding charge separation performance of P25 occurred by low-energy electron transfer in type-I heterojunction energy band configuration between anatase and rutile phase TiO_2.[2] In this study, we reduced Pt co-catalyst consumption for photocatalytic hydrogen evolution reaction (P-HER) by phase selective energy band modulation in P25 which has anatase and rutile two-phase mixed TiO_2 through our TiO_2 phase-selectively reduction method. An ordered anatase / disordered rutile and the disordered anatase / ordered rutile phase mixed P25 (OA/DR P25 TiO_2 and DA/OR P25 TiO_2) synthesized and the type-II heterojunction energy band configuration achieved with OA/DR P25 TiO_2. As a result, P-HER performance of OA/DR and DA/OR P25 TiO_2 samples showed improved performance and OA/DR P25 TiO_2 showed best performance than other TiO_2 samples due to it has only type-II heterojunction energy band configuration. Especially, P-HER performance test of OA/DR P25 TiO_2 with Pt deposition showed impressive P-HER performance with extremely low amount of Pt metal support. The Pt deposited OA/DR P25 TiO_2 (Pt-OA/DR P25 TiO_2) performed higher hydrogen evolution rate with below 0.05 wt% Pt co-catalyst than Pt deposited P25 (Pt-P25) under simulated 1 sun irradiation whereas pristine P25 performed comparable hydrogen evolution rate with 0.5 wt% Pt co-catalyst. Consequently, Pt consumption of Pt-OA/DR P25 TiO_2 was 10 times lower than the Pt-P25 with energy band alignment. From the various band alignment measurements, we expected that the improper type-I heterojunction energy band alignment between anatase and rutile phase in pristine P25 hindered charge separation and carrier transfer process. [3] Whereas, the energy band modulated OA/DR P25 TiO_2 which has type-II heterojunction structure between anatase and rutile phase effectively separated photo-excited carriers and improved P-HER performance.

Keywords

Photocatalyst; TiO_2; Energy band modulation; Hydrogen evolution reaction

References
[1] B. Ohtani, O. O. Prieto-Mahaney, D. Li, R.Abe, What is Degussa (Evonik) P25? Crystalline composition analysis, reconstruction from isolated pure particles and photocatalytic activity test. J Photochem Photobiol A Chem, 216, 179 (2010). doi: 10.1016/j.jphotochem.2010.07.024
[2] D. C. Hurum, A. G. Agrios, K. A. Gray, Explaining the Enhanced Photocatalytic Activity of Degussa P25 Mixed-Phase TiO_2 Using EPR. J. Phys. Chem. B, 107, 4545 (2003). doi: 10.1021/jp0273934
[3] A. D. Paola, M. Bellardita, L. Palmisano, Brookite, the Least Known TiO_2 Photocatalyst. Catalysts., 3, 36 (2013). doi:10.3390/catal3010036

Poster Session
Room C, December 18 2018

P10: The effects of Ga_2O_3 interlayer on the emission of n-In_2O_3 nanorod/p-GaN heterojunction light emitting diode

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Abstract
The In_2O_3 has been used for various opto-electrical devices such as photodetector, gas sensor, , transistor, and transparent conducting electrode [1] due to its large band gap (3.4 eV at room temp) and high mobility (160 $cm^2/V{\cdot}s$). Despite of its optical and structural merits, light emitting diode using In_2O_3 nanostructure has not yet been reported [2]. In this study, we report on the effects of formation of Ga_2O_3 on p-GaN surface by O_2 plasma treatment on morphological property of post-grown In_2O_3 nanorods(NRs) to fabricate n-In_2O_3/p-GaN pn heterojunction based light emitting diode. After formation of Ga_2O_3 layer on p-GaN surface, the transformation of surface property from hydrophobic to hydrophilic property makes possible to grow of uniformed $In(OH)_3$ NRs on p-GaN surface by using hydrothermal method [3]. Through the calcination process conducted at 600 ℃ in air ambient, $In(OH)_3$ NRs were changed to In_2O_3 NRs without the severe morphology changes. After fabrication of LED devices using the general photolithography and electrode deposition method, the current-voltage (I-V) measurements are conducted. The obtained I-V curve of n-In_2O_3 NRs/p-GaN with Ga_2O_3 interlayer shows rectified diode characteristics and turn-on voltage of 12.6 V at forward bias condition with green light emission (λ ~ 554 nm). As a possible green light emission mechanism from our suggested structures, the various defects energy states mediated green emissions were considered.

Keywords

Surface treatment; Green emission; Ga_2O_3; In_2O_3 nanorods

References
[1] J.H.W. De Wit, G. Van Unen, M. Lahey, Electron concentration and mobility in In_2O_3. J. Phys. Chem. Solids 38, 819 (1977). doi: 10.1016/0022-3697(77)90117-2
[2] D. Shao, L. Qin, S. Sawyer, High Responsivity, Bandpass Near-UV Photodetector Fabricated From PVA-In_2O_3 Nanoparticles on a GaN Substrate, IEEE Photon. J. 4, 715(2012). doi:10.1109/JPHOT.2012.2195485
[3] R. Su, H. Liu, T. Kong, Q. Song, N. Li, G. Jin, G. Cheng, Tuning Surface Wettability of $In_xGa_{(1-x)}N$ Nanotip Arrays by Phosphonic Acid Modification and Photoillumination, Langmuir 27, 13220(2011). doi:10.1021/la203072n

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P11: Impacts of Zr-doping into crystalline lattices of bismuth vanadate powder and thin film on their photocatalytic and photoelectrochemical properties

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Abstract

Bismuth vanadate ($BiVO_4$) has been studied extensively as a potential photocatalyst and/or photoanode for oxygen (O_2) production through water-splitting using sunlight [1]. $BiVO_4$ possess two doping sites, Bi and V. So far, doping with molybdemun (Mo) or tungsten (W) at the V site has shown to be effective to enhance activity for water oxidation [2]. Since hexavalent form is the most stable phase for Mo and W, doping with these elements at the pentavalent V site should introduce excess electrons. Hence increasing in n-type conductivity would be effective for the enhancement of the activity. In accordance with the study of density functional theory (DFT) reported by Yin et al., group IVB elements such as Zr and Hf can substitute the Bi site in $BiVO_4$ because of its low formation energy [3]. Since replacements of trivalent Bi with tetravalent Zr and Hf should induce increments of n-type conductivity, these electrostructural changes would be beneficial for the improvement of photocatalytic water oxidation. In the present study, therefore, effects of zirconium (Zr) doping into the $BiVO_4$ powder on its structural and photocatalytic activity for O_2 evolution were examined. The formation of the $BiVO_4$ powder crystallized in the monoclinic scheelite structure (*ms*-$BiVO_4$) was achieved when the sample doped with relatively small amount of Zr. The photocatalytic activity of the Zr-doped *ms*-$BiVO_4$ powder showed much higher than that of non-doped *ms*-$BiVO_4$. However, further doping induced structural alterations into tetragonal scheelite and tetragonal zircon structures, leading to lowering photocatalytic activity for O_2 evolution. Similar effects of Zr doping were also confirmed by the photoelectrochemcal (PEC) system based on the $BiVO_4$ thin film doped with various amounts of Zr. Thus, the Zr doping was confirmed to be effective for improvements of photocatalytic/(PEC) functions of $BiVO_4$ for water oxidation.

Keywords

Zr-doping, photocatalytic water oxidation, crystalline structure.

References

[1] A. Kudo, K. Omori, H. Kato, J. Am. Chem. Soc. 121 (1999) 11459.

[2] H. S. Park, K. E. Kweon, H. Ye, E. Paek, G. S. Hwang, A. J. Bard, J. Phys. Chem. C, 115 (2011)

[3] W.-J. Yin, S.-H. Wei, M. M. Al-Jassim, J. Turner, Y. Yan, Phys. Rev. B 83 (2011) 15510

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P12: Silver-incorporated Cu_2ZnSnS_4 thin film as an absorber for solar cells and a cathode for photoelectrochemical water splitting

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Abstract
Cu_2ZnSnS_4 (CZTS) is a promising absorber material for photovoltaic (PV) solar cells as well as a photocathode for photoelectrochemical (PEC) water splitting and carbon oxide fixation [1-4]. We have recently demonstrated successful fabrication of CZTS film with sufficient qualities for PV and PEC applications by using a facile spray pyrolysis method [5-7]. For further improvements of PV and PEC properties, impacts of silver (Ag) incorporation into the crystalline lattice of CZTS on its structural, optical, and electric properties were examined.

Crystallographic analyses indicated successful incorporation of various amounts of Ag up to an Ag / (Ag + Cu) ratio of ca. 0.1 into the crystal lattice of CZTS without formation of other impurity compounds. Appreciable enhancements of PV properties and PEC water splitting performances were obtained by the Ag incorporation. Electrostructural analyses of the devices suggested that the Ag-incorporated film in the device achieved reduction in the amounts of unfavorable copper on zinc antisite defects in comparison with those in the bare CZTS film. Moreover, the use of an Ag-incorporated film improved band alignment at the CdS(buffer)-CZTS interface.

Keywords

Cu_2ZnSnS_4 thin films; Ag incorporation; defect concentrations

References

[1] H. Katagiri, K. Jimbo, W. S. Maw, K. Oishi, M. Yamazaki, H. Araki, A. Takeuchi, Thin Solid Films, 517 (2009) 2455

[2] F. Liu, C. Yan, J. Huang, K. Sun, F. Zhou, J. A. Stride, M. A. Green, X. Hao, Adv. Energy Mater., 6 (2016) 1600706

[3] S. Kamimura, Y. Sasaki, M. Kanaya, T. Tsubota, T. Ohno, RSC Adv., 6 (2016) 112594

[4] K. Iwashina, A. Iwase, Y. H. Ng, R. Amal, A. Kudo, J. Am. Chem. Soc., 137 (2015) 604

[5] T. H. Nguyen, W. Septina, S. Fujikawa, F. Jiang, T. Harada, S. Ikeda, RSC Adv., 5 (2015) 77565

[6] T. H. Nguyen, T. Harada, J. Chantana, T. Minemoto, S. Nakanishi, S. Ikeda, ChemSusChem, 9 (2016) 2414

[7] T. H. Nguyen, T. Harada, S. Fujikawa, S. Nakanishia, S. Ikeda, ECS Trans, 75 (2017) 15

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P13: Graphene quantum dots decorated graphene as an enhanced sensing platform for sensitive and selective detection of copper(II)

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Abstract

It is essential to develop high sensitive and selective methods for monitoring and measuring of the trace Cu(II). [1-3] Based on this urgent demand, we designed a simple and efficient electrochemical sensing platform based on the hybrid of two carbon nanomaterials for the sensitive and selective detection of trace Cu(II) by using differential pulse anodic stripping voltammetry (DPASV) analysis. The GQDs/graphene/GCE exhibited enhanced electrochemical responses because of a fast electron transfer from graphene and a high affinity to Cu(II) from graphene quantum dots (GQDs). Under the optimal conditions, a good linear response in the range of 0.015 – 8.775 μM with correlation coefficient of 0.9995 and a detection limit of 1.34 nM (S/N = 3) were obtained. The developed method was further validated and successfully applied to the detection of Cu(II) in real water samples. The simple preparation and efficient selectivity of the proposed modified electrode show the promising potential for applications in sensing of Cu(II).

Keywords

Electrochemical senor; Graphene; Graphene quantum dots; Copper(II)

References

[1] A. Ambrosi, C.K. Chua, N.M. Latiff, A.H. Loo, C.H.A. Wong, A.Y.S. Eng, A. Bonanni, M. Pumera, Graphene and its electrochemistry–an update, Chem. Soc. Rev. 45, 2458 (2016). doi: 10.1039/c6cs00136j
[2] Z. Zhang, J. Zhang, N. Chen, L. Qu, Graphene quantum dots: an emerging material for energy-related applications and beyond, Energ. Environ. Sci. 5, 8869 (2012). doi: 10.1039/c2ee22982j
[3] Y. Wang, S. Zhao, J. Qi*, X. Cui*, Graphene quantum dots decorated graphene as an enhanced sensing platform for sensitive and selective detection of copper(II), J. Electro. Chem. 797, 113 (2017). doi: 10.1016/j.jelechem.2017.05.031

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P14: Elastic nanoscale spongy graphene-functionalized silicon as excellent stability anode in Li ion battery

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Abstract
Silicon can make alloy with lithium in the form of $Li_{22}Si_5$ to deliver a highest theoretical gravimetric capacity of ~4200 mAh g^{-1}, and thus is considered to be one of the most promising anode materials for next generation Li ion battery. However, those advantages are seriously offset by a great challenge of large volume expansion during lithiation, which causes a serious damage to the electrode structure and thus gives rise to a fast decay of the specific capacity [1]. In this work, novel 3D spongy grapheme (SG)-functionalized silicon is for the first time demonstrated by chemical vapor deposition for a LIB anode, which can overcome the common silicon anode issues such as poor conductivity and volume expansion of Si as well as transfer of Li ion towards the Si. The elastic feature of graphene has excellent function to self-adaptively buffer the volume variation during charge-discharge process. In addition, different from traditional graphene or carbon shells (core-shell and yolk-shell), the spongy 3D graphene networks provide much improved unique functions with excellent long-cycle stability and rate capability. The Si@SG electrode exhibits excellent cycling performance with high reversible specific capacity [2]. A superior 95% capacity retention is achieved after 510 cycles.

References
[1] M. Zhou, X. Li, B, Wang, Y, Zhang, et al. Nano Lett. 15 (2015) 6222-6228
[2] C. Zhang, T.-H. Kang, J.-S. Yu, Nano Research, 11(2018) 233-245

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P15: Structure and visible-light induced photocatalytic activity of metal cyanamide composites

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Abstract

Photocatalytic technology can utilize solar energy as induced light to degrade various organic pollutants and produce hydrogen from water splitting, which shows broad prospect applications in the development of new energy and environmental pollution treatment [1]. Metal cyanamide is a new type of photocatalysts. Theoretically, cyanamide ion ($[NCN]^{2-}$) is a linear ion composed of three atoms, which can form metal-metal bridged compounds. And the delocalized π conjugation can be formed by atoms C and N through SP^2 hybridization, which electronic structure in HOMO and LUMO orbitals is more similar with that of carbides or sulfides, and therefore exhibits good visible light response and photocatalytic activity [2]. In this study, some single metal cyanamide such as ZnNCN, Ag_2NCM, $Ni(HNCN)_2$ and CdNCN have been synthesized by a simple ligand exchange method. Their photo response, band structure and photocatalytic activity are studied respectively. These metal cyanamide were then hybridized with traditional inorganic conductors, such as TiO_2 and $BiVO_4$, and the charge transfer at the interface of hetero structure and photocatalytic mechanism have been proposed too. Compared to the single metal cyanamide, the nanocomposites of Ag_2NCN/TiO_2 [3], Ag_2NCN/ZnNCN and $Ni(HNCN)_2/BiVO_4$ all exhibit enhanced photocatalytic activity owing to the effective charge separation because of the matched energy bands of hetero components.

Keywords

Visible-light induced photocatalysis; Metal cyanamide; Nanocomposites; Interface control; Photocatalytic mechanism

References

[1] A. Fujishima; K. Honda K, Electronchemical Photolysis of Water at Semiconductor Electrode. Nature. 238, 37 (1972). doi:10.1038/238037a0

[2] W. Zhao; Y. Liu; J. Liu; P. Chen; I. W. Chen; F. Huang; J. Lin, Controllable Synthesis of Silver Cyanamide as a New Semiconductor Photocatalyst under Visible-light Irradiation. Journal of Materials Chemistry. 1, 7942 (2013). doi:10.1039/C3TA10868F

[3] H. Meng; X. X. Li; X. Zhang; Y. F. Liu; Y. Xu; Y. D. Han; J. L. Xu, Fabrication of Nanocomposites Composed of Silver Cyanamide and Titania for Improved Photocatalytic Hydrogen Generation. Dalton Transactions. 44, 19948 (2015). doi: 10.1039/c5dt03869c

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P16: Nanoporous Sulfur-doped Copper Oxide ($Cu_2O_xS_{1-x}$) for Overall Water Splitting

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Abstract

Developing active and bifunctional noble metal-free electrocatalysts is crucial for both the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) in the full water splitting process. [1-3] A ternary nanoporous sulfur doped copper oxide ($Cu_2O_xS_{1-x}$) was successfully synthesized on Cu foam. The obtained $Cu_2O_xS_{1-x}$/Cu shows robust electrocatalytic activity towards HER with a low overpotential of 40 mV at 10 mA cm^{-2}, a Tafel slope of 68 mV dec^{-1}, and exhibits long-term stability in acid solution. [4] Moreover, the $Cu_2O_xS_{1-x}$ shows excellent electrocatalytic activity for OER, HER, and overall water splitting as a bifunctional catalyst in 1.0 M KOH electrolyte. The sulfur doping strategy implemented here can greatly improve the catalytic performance and stability in both acidic and alkaline water electrolyzers and presents an efficient catalyst for overall water splitting.

Keywords

$Cu_2O_xS_{1-x}$; sulfur doping; hydrogen evolution reaction; oxygen evolution reaction; overall water splitting

References

[1] Wang, J.; Xu, F.; Jin, H.; Chen, Y.; Wang, Y., Non-Noble Metal-based Carbon Composites in Hydrogen Evolution Reaction: Fundamentals to Applications. Advanced Materials 2017, 29 (14), 1605838. doi: 10.1002/adma.201605838

[2] Wang, J.; Cui, W.; Liu, Q.; Xing, Z.; Asiri, A. M.; Sun, X., Recent Progress in Cobalt-Based Heterogeneous Catalysts for Electrochemical Water Splitting. Advanced Materials 2016, 28 (2), 215-230. doi: 10.1002/adma.201502696

[3] Du, P.; Eisenberg, R., Catalysts made of earth-abundant elements (Co, Ni, Fe) for water splitting: Recent progress and future challenges. Energy & Environmental Science 2012, 5 (3), 6012-6021. doi: 10.1039/c2ee03250c

[4] Zhang, X.; Cui, X.; Sun, Y.; Qi, K.; Jin, Z.; Wei, S.; Li, W.; Zhang, L; Zheng, W.; ACS Applied. Materials. Interfaces, 2018, 10, 745–752. doi:10.1021/acsami.7b16280

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