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Sweden

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- Global Graphene Forum
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- Symposium on Nanoglasses

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29 - 31 March	**Advanced Energy Materials & Technology Congress**	Place: Stockholm, Sweden https://www.advancedmaterialscongress.org/energy
28 May - 04 June	**Baltic Conference Series-Spring**	Place: Kiel, Germany www.advancedmaterialscongress.org/baltic-spring
25 June - 02 July	**European Advanced Materials Congress**	Place: Genoa, Italy www.advancedmaterialscongress.org/europe
24 - 26 August	**International Conference on Nanomaterials & Nanotechnology**	Place: Stockholm, Sweden https://www.advancedmaterialscongress.org/icnano
17 - 24 September	**Advanced Functional Materials Congress**	Place: Barcelona, Spain www.advancedmaterialscongress.org/functional
01 - 08 October	**Advanced Materials World Congress**	Place: Venice, Italy www.advancedmaterialscongress.org/world
29 Oct. - 05 Nov.	**American Advanced Materials Congress**	Place: Miami, USA www.advancedmaterialscongress.org/america



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Organizer's Desk

Greetings of the day!

International Association of Advanced Materials (IAAM, www.iaamonline.org) holds enormous pleasure to welcome all of you to Advanced Nanomaterials Congress, (AMC-Nano, www.advancedmaterialscongress.org/nano) during 24 - 27 October 2021 at Central European Summer Time, GMT+2. This congress is going to be the 42nd assembly of the Advanced Materials Congress (AMC, www.advancedmaterialscongress.org) running its unique Online LIVE conference setup.

The association takes this an auspicious occasion to have the amazing opening to present all the respected delegates like you in the Online LIVE platform for the next four days from 24 to 27 October 2021. We wish that technical sessions will turn out to be a genuine inference of information, research, and knowledge on multi-inter-transdisciplinary areas of advanced nanomaterials and nanotechnology. The AMC-Nano will be a part of the Advanced Materials Lecture Series, Global Graphene Forum, Advanced Energy Materials & Technology, Nanogenerator & Piezotronics and Nano glasses to learn the advancements in the materials science, engineering & technology for study, development, and exploitation to the end-users.

The AMC-Nano will be graced by the active participation from 35 countries from all major continents. The congress assembly will run more than 30 hours with seventeen thematic sessions including opening/closing ceremony, poster session and symposium on innovations and knowledge transfer. Here, the delegates of respected research organizations, educational institutes and companies will discuss their research on the global platform and achieve invaluable advantages.

Furthermore, the AMC Nano will be graced with the announcement of Research of the Year 2021 and the Researcher of the Year Lecture by Prof. Richard Spontak from North Carolina University, USA. Dr. Spontak conducts research to improve the understanding of microstructural polymeric systems, which are of scientific interest as soft self-assembling and their commercial value as adhesives, (bio)compatibilizing agents, nanotemplates, and membranes. His lecture will highlight the strategic routes to comprehensive antimicrobial polymers: preventing the spread of diseases.

The AMC-Nano will also witness the release of the October 2021 issue of IAAM's official journal, "Advanced Materials Letters". The October issue of Advanced Materials Letters epitomizes the advancements of hydrogen energy towards a climate-neutral world. The editorial of the journal issue contains in detail and highlights the promising global trends in hydrogen energy research for achieving the net-zero goals. IAAM is working continuously in line with the United Nations' Sustainable Development Goals and synchronizes its agenda with the action plans of the European Green Deal to make Europe climate neutral.

We take away this occasion to convey our honour for all the scientific committee members, session chairs, poster jury, speakers, presenters, and attendees to make this congress grand success. We sincerely acknowledge the supports of the Institute of Advanced Materials (www.iaam.se), and the IAAM staff members who have constantly provided their excellent support to smoothly organize this event. We are confident that this assembly will make up the best of the next four days and plunge into a sea of excellent research and interdisciplinary ideas: with this association.

Welcome again and wish you all the best.

Sincerely,

International Association of Advanced Materials
Gammalkilsvägen 18, Ulrika 59 053, Sweden
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Guidelines For Activities & Instructions

Congress Time Zone: Central European Summer Time (GMT+2)

All the lectures of the congress will be recorded for publication in the open access audio video literature, Video Proceedings of Advanced Materials after the proof correction. For the broader audience, IAAM circulates the open access video article to leading researchers and members of association with its monthly newsletter. Please follow below guidelines:

- All the speakers should join the meeting 5-10 minutes in advance.
- After the lecture, there will be a discussion session with the chair & panel members.
- As the lecture will be published for open science under "Live knowledge at Web", you are advised to not use any confidential information in the presentation.
- Please find your talk time in the program with and prepare your lecture accordingly.
- Keep your device charged and ensure your internet connection is stable.
- Please download the Zoom meeting application before the meeting.
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- Any recognition is non-transferable and not returnable at any condition
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Hardwire your internet connection: This will help you avoid any issues with an unstable WiFi connection, which can affect your audio quality and the overall attendee experience.

Test the audio before your webinar begins: This will ensure your speakers and mic are working properly before the live event begins. Here's how to test your device audio.

Minimize background noise: Try to host your webinar in a quiet place. If you must be in a loud environment, using a headset with a mic often reduces background noise compared with your computer's built-in microphone. In fact, a headset is a general best practice for higher-quality audio than other built-in options.

Dress for webinar: You'll be on video, so be sure to wear business attire. We recommend solid colours as opposed to garments with patterns.

****The organizer reserves the right to make any changes, alter or modify the program at any time without prior notice.***

For more details, please visit:
www.advancedmaterialscongress.org/nano/pages/guidelines-information

Time to join the event (All day): 08.45 (CEST)

Congress Weblink:
https://us06web.zoom.us/j/83058825516?pwd=a2UxL1lhNzRCU0ltRGFIWFIweEQ3Zz09

Passcode: 975205

Webinar ID: 830 5882 5516



24 - 27 October, 2021

Scientific Program

Day - 1: Sunday, 24 October 2021, Central European Summer Time (CEST, GMT+2)

08.50 - 09.00 **Welcome Message from Organizer: Ashutosh Tiwari**, Secretary General, International Association of Advanced Materials; and Director, Institute of Advanced Materials, IAAM, Sweden

24 October, 2021

09.00-11.00 **Session 01: New Horizons in Nanomaterials & Nanotechnology**

Session Chair(s): Jian Liu and Gauthier Lefevre

09.00-09.20 **David Lewis,** ***Bottom-up synthesis of layered metal chalcogenides: Chemical routes to new 2D materials,*** University of Manchester, United Kingdom

09.20-09.40 **Xiaojun Hu,** ***A multifunctional material: nanocrystalline diamond films,*** Zhejiang University of Technology, China

09.40-10.00 **Jian Liu, Nanoreactors for sustainable catalysis,** University of Surrey, United Kingdom

10.00-10.20 **Arnaud Caron,** ***Interfaces governed mechanical properties of metallic nano-glass thin films: A nanoscopic approach,*** Korea University of Technology and Education, Republic of Korea

10.20-10.40 **Enamul Haque,** ***The active N-site for O_2 reduction over controlled N-doped carbon*** **,** RMIT University Melbourne, Australia

10.40-11.00 **Gauthier Lefevre,** ***New insight into vertical topographical selective deposition of tantalum oxide Ta_2O_5 by morphological analyses*****,** University Grenoble Alpes, CNRS, CEA/LETI-Minatec, Grenoble INP, LTM, F-38054 Grenoble-France

24 October, 2021

11.00-13.00 **Session 02: Food, Composites and Ceramic Engineering Materials**

Session Chair(s): Biaolin Peng and Laurent Sagalowicz

11.00-11.20 **Laurent Sagalowicz,** ***Lipid self-assembled structures: from nature, theory to their applications in food*** **,** Nestlé Research, Switzerland

11.20-11.40 **Biaolin Peng,** ***P-GaN-substrate sprouted giant pure negative electrocaloric effect in Mn-doped $Pb(Zr_{0.3}Ti_{0.7})O_3$ thin film with a super-broad operational temperature range*** **,** Xidian University, China

11.40-12.00 **Qingfeng Zhang,** ***Dispersion-enhanced plasmonic metamaterial for single-shot microwave imaging*** **,** Southern University of Science and Technology, China

12.00-12.20 **Yuan Shi,** ***CMC design chain from testing to modeling, characterization and simulation of mechanical behavior of ceramic matrix composites*** **,** German Aerospace Center, Germany

12.20-12.40 **Muhammad Faheem Maqsood,** ***Effect of solvent on corrosion behavior of graphene oxide coated AZ31B magnesium alloy,*** Sejong University, South Korea

12.40-13.00 **Xu-Yang Cao,** ***Research on the innovative structural retrofitting technology based on high performance materials: External SC-PBSPC BRBF sub-structures*****,** Hohai University, China

24 October, 2021

13.00-15.00

Session 03: Electronic, Magnetic and Optical Materials

Session Chair(s): Chao-Sung Lai and Denys Makarov

13.00-13.20 **Zhigang Zhu,** ***High performace gas sensors based on Mxene and MOF derived nanocomposites with low/room operating temperature*****,** University of Shanghai for Science and Technology, China

13.20-13.40 **Chao-Sung Lai,** ***Graphene and 2D materials for transistor, memristor, synaptic and light-stimulated devices*****,** Chang Gung University, Taiwan

13.40-14.00 **Denys Makarov,** ***Skin-conformal flexible and printable magnetoelectronics for human-machine interfaces and soft robotics*****,** Helmholtz-Zentrum Dresden-Rossendorf, Germany

14.00-14.20 **Haiding Sun,** ***Gallium Nitride technology for future ultraviolet light emitting, detecting and electronic devices*****,** University of Science and Technology of China, China

14.20-14.40 **Shuang Yang,** ***Surface chemistry of hybrid perovskites*****,** East China University of Science and Technology, China

14.40-15.00 **Ming Zheng,** ***Nonvolatile electric-field control of magnetic and transport properties in PMN-PT-based multiferroic heterostructures*****,** China University of Mining and Technology, China

24 October, 2021

15.00-17.30

Session 04: Materials Advances for Health, Energy and Environment

Session Chair(s): Richard Spontak and Ashutosh Tiwari

15.00-15.45 **Researcher of the Year Lecture: Richard Spontak,** ***Strategic routes to comprehensive antimicrobial polymers: preventing the spread of diseases*****,** North Carolina State University, USA

15.45-16.05 **Guihua Yu,** ***Hydrogels for energy and sustainability*****,** The University of Texas at Austin, USA

16.05-16.25 **Ajay Dalai,** ***Novel nanomaterials development for the production of jet fuel range hydrocarbons from vegetable oils*** **,** University of Saskatchewan, Canada

16.25-16.45 **Quinn Qiao,** ***Efficient solar-rechargeable lithium ion battery energy storage*****,** Syracuse University, USA

16.45-17.05 **Shu Hu,** ***A Coating strategy for photochemical production at scale*****,** Yale University, USA

17.05-17.25 **Yevgen Prokhorov,** ***Chitosan-graphene oxide nanocomposites for smart flexible electronics applications*****,** CINVESTAV del IPN, Unidad Queretaro, Mexico

Day - 2: Monday, 25 October 2021, Central European Summer Time (CEST, GMT+2)

25 October, 2021

09.00-11.00 **Session 05: Trends in Graphene and Functional Materials**

Session Chair(s): Carlos Romero-Nieto and Fang-Chung Chen

09.00-09.20 **Shlomo Magdassi,** ***New materials for 2D, 3D and 4D printing*****,** The Hebrew University of Jerusalem, Israel

09.20-09.40 **Carlos Romero-Nieto,** ***pi-Extended materials based on six-membered phosphorus heterocycles*****,** University of Castilla-La Mancha, Spain

09.40-10.00 **Sergey Polyakov,** ***Graphene model as a lattice of hydrogen-like atoms with screened ions*****,** Keldysh Institute of Applied Mathematics of RAS, Russia

10.00-10.20 **Kai Yin,** ***Femtosecond laser micro/nano-fabrication of functional surfaces for efficient solar desalination,*** Central South University, China

10.20-10.40 **Pei Zhao,** ***Mechanics of two-dimensional materials*****,** Zhejiang University, China

10.40-11.00 **Jun Zou,** ***Influence of CeO_2 / Fe_2O_3 catalyst on hydrogen production from cellulose catalytic gasification,*** Huazhong University of Science and Technology, China

25 October, 2021

11.00-13.00 **Session 06: Energy Materials and Emerging Technologies**

Session Chair(s): Genqiang Zhang and Wei Ma

11.00-11.20 **Fang-Chung Chen,** ***Emerging organic and perovskite photovoltaic devices for indoor applications*****,** National Yang Ming Chiao Tung University, Taiwan

11.20-11.40 **Wei Ma,** ***Controlling the pre-aggregation and crystallization kinetics enables high-efficiency slot-die coated organic solar cells with green solvents*****,** Xi'an Jiaotong University, China

11.40-12.00 **Meicheng Li,** ***New energy materials and devices*****,** North China Electric Power University, China

12.00-12.20 **Chol-Jun Yu,** ***Improving Cathode Performance by Intermixing Transition Metals for Sodium-Ion Batteries,*** Kim Il Sung University, DPR Korea

12.20-12.40 **Genqiang Zhang,** ***Hybrid water electrolysis for efficient H_2 production*****,** University of Science and Technology of China, China

12.40-13.00 **Hui Li,** ***Controllable synthesis of MOFs and its derivate-based catalyst for biodiesel production*****,** Shandong Jianzhu University, China

25 October, 2021

13.00-15.00 **Session 07: Battery Materials and Energy Innovations**

Session Chair(s): Marco Giorgetti and Xiankui Wei

13.00-13.20 **Haiyan Wang,** ***Interfacial design of dendrite-free zinc anodes for aqueous zinc-ion batteries*****,** Central South University, China

13.20-13.40 **Xingli Zou,** ***Liquid salt electrochemical processes for preparation of engineering/energy materials*****,** Shanghai University, China

13.40-14.00 **Xiankui Wei,** ***Atomic-scale novel ferroelectric states in energy-related materials*****,** Research Center Juelich, Germany

14.00-14.20 **Runwei Mo,** ***Structural design of high-quality graphene for fast-charging lithium-ion batteries*****,** East China University of Science and Technology, China

14.20-14.40 **Xinrong Lin,** ***Solid polymer electrolytes in solid-state lithium-metal batteries*****,** Yunnan University, China

	14.40-15.00	**Zaeem Ur Rehman, *$La_{0.75}Sr_{0.25}Cr_{0.5}Mn_{0.5}O_3$/Graphene oxide-based composite electrodes for energy storage applications*** , Institute of Metallurgy & Materials Engineering, University of the Punjab, Pakistan
25 October, 2021	**15.00-17.30**	**Session 08: Advanced Materials Research & Innovation**
		Session Chair(s): Benjamin Hsiao and **Felipe Oyarzun**
	15.00-15.20	**Benjamin Hsiao, *Advancing sustainable nanocellulose technologies for water purification*** , Stony Brook University, USA
	15.20-15.40	**Qinxiang Xia, *Research progress and frontier challenges of novel metal spinning*** , South China University of Technology, China
	15.40-16.00	**Pavle Radovanovic, *Controlling carrier polarization in transparent conducting oxide nanocrystals*** , University of Waterloo, Canada
	16.00-16.20	**Mijia Yang, *Pore structure and pore solution in alkali activated fly ash geopolymer concrete*** , North Dakota State University, USA
	16.20-16.40	**Adrian Esteban-Arranz, *Long-term performance of nanomodified coated concrete structures under hostile marine climate conditions,*** University of Castilla-La Mancha, Spain
	16.40-17.00	**Felipe Oyarzun-Ampuero, *Intranasal delivery of interferon-beta-loaded nanoparticles induces control of neuroinflammation in a preclinical model of multiple sclerosis,*** Universidad de Chile, Chile
	17.00-17.20	**Tatjana Gric, *Applications of the metamaterial formalism*** , VILNIUS TECH, Lithuania
26 October, 2021		**Day - 3: Tuesday, 26 October 2021, Central European Summer Time (CEST, GMT+2)**
	09.00-11.00	**Session 09: Biomaterials and Biodevices**
		Session Chair(s): Shin Aoki, Laurent Sagalowicz and Huaming Yang
	09.00-09.20	**Zhenyu Chu, *Regular nanomaterials based separation-sensing membrane*** , Nanjing Tech University, China
	09.20-09.40	**Li Fu, *Electrochemical sensor for phytological fingerprinting*** , Hangzhou Dianzi University, China
	09.40-10.00	**Dipak Maity, *Functionalized superparamagnetic iron oxide nanoparticles (SPIONs) in cancer theranostics*** , UPES - University of Petroleum and Energy Studies, India
	10.00-10.20	**Lei Chen, *Far-red phosphors, light source, and biomedical instrument for noninvasive treatment of neurological diseases by phototherapy*** , Hefei University of Technology, China
	10.20-10.40	**Han Jin, *Intelligent nano-electronics for implementing future med-tech*** , Shanghai Jiao Tong University, China
	10.20-10.40	**Huaming Yang, *Functionalized nanoclay for biomedical application*** , Central South University, China
26 October, 2021	**11.00-13.00**	**Session 10: Materials Engineering and Technology**
		Session Chair(s): Xiao-Yong Wang and Leonard Francis
	11.00-11.20	**Biao Zuo, *Molecular dynamics and rheology at surfaces of polymer glasses*** , Zhejiang Sci-Tech University, China
	11.20-11.40	**Xiao-Yong Wang, *Concrete with cement substitute materials-performance modelling and optimization design,*** Kangwon National University, Republic of Korea

11.40-12.00 **Jiashing Yu, *Guiding Cells with Conductive Polymer based Bioelectronics*,** National Taiwan University, Taiwan

12.00-12.20 **Zishun Liu, *Recent development of constitutive models for soft materials-(hydrogels and shape memory polymers)*,** Xi'an Jiaotong University, China

12.20-12.40 **M. Nasiruzzaman Shaikh, *Rh-Complex Supported on Magnetic Nanoparticles Catalysts for Hydroformylations and Allylic Alkylation Reactions*,** King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia

12.40-13.00 **Wing-Fu Lai, *Development of clusteroluminogenic hydrogels and films with high tunability in properties*,** The Chinese University of Hong Kong (Shenzhen), China

13.00-14.00 **Session 11: Symposium on Innovations and Knowledge Transfer**

Ashutosh Tiwari and Mikael Syväjärvi, ***Discussion on the "Future utilization of research and innovation: Knowledge transfer"*** Institute of Advanced Materials, IAAM, Sweden

About Symposium: The symposium stimulates commercialization research avenues and their translational potentials towards climate crisis, energy needs, health, etc. Discussions, exchanges of experiences, R&D practices and forming research consortium for national, international and EU calls will take place during the session.

26 October, 2021

14.00-15.00 **Session 12: Poster Presentations on Materials Engineering and Technology**

Poster Jury: Tatjana Gric, Felipe Oyarzun and Yang-hsin Shih

For online poster presentation: The attendee / delegates can write questions in the chat box/ Q&A and poster jury will discuss their questions with the poster presenters.

14.00-14.05 **Yeong Jin Chung, *Fire risk assessment of wood materials by fire preventin design*,** Kangwon National University, Republic of Korea

14.05-14.10 **Zulkarnain Jalil, *The role of natural silica from rice husk ash combined with nickel as catalyst on the hydrogen storage properties of MgH_2*,** University of Syiah Kuala, Indonesia

14.10-14.15 **Juliana Juarez, *Novel OMC by nanocasting strategy for hydrogen adsorption*,** Centro de Investigación en Nanociencia y Nanotecnología (NANOTEC) - Universidad Tecnológica Nacional, Argentina

14.15-14.20 **Ane Jimenez Zabaleta, *Heterogeneous solidification model to predict the behaviour of ceramic nano reinforcements into aluminium alloys*,** Tecnalia Research & Innovation, Spain

14.20-14.25 **Auhood Alsoihi, *Hydrothermal approach to the fabrication of TiO_2-C/NiAl-LDH coreshell hybrid photocatalyst*,** King Abdulaziz University, Saudi Arabia

14.25-14.30 **Xiaoling Luo, *Investigation and modeling of the electrical properties of poly (methyl methacrylate)/graphene nanoplatelets composite sheets with various thickness*,** Friedrich-Alexander-University Erlangen-Nuremberg, Germany

14.30-14.35 **Aditi Bhakat, *Biodegradable Nanoprobes on it's duty to improve Cancer Detection*,** NIT Rourkela, India

14.35-14.40 **Wejdan Bajafar, *Mechanochemical preparation and characterization of novel nanosized $ZnCo_2O_4$/CaO catalyst*,** King Abdulaziz University, Saudi Arabia

14.40-14.45 **Chetan Awasthi, *Electrical analysis of $PdSe_2$/$MoSe_2$ interface*,** Jamia Millia Islamia, India

14.45-14.50 **Wael Halawani, *Physicochemical characterization of copper-zinc oxides supported on Al_2O_3 and ZrO_2 catalysts*,** King Abdulaziz University, Saudi Arabia

14.50-14.55 **Manoj Sathwane, *A green approach based nanocellulose-boron nitride nanocomposite for heat spreading application*,** IIT Roorkee, India

14.55-15.00 **Salem Bamarhool,** ***A simple and rapid liquid-liquid and dispersive liquid-liquid micro extraction methods coupled with spectrophotometry for the determination of cadmium species in environmental samples,*** King Abdulaziz University, Saudi Arabia

26 October, 2021

15.00-17.00 **Session 13: Progress in Biomaterials and Biodevices**

Session Chair(s): Raymond J. Turner and Long Que

15.00-15.20 **Raymond J. Turner,** ***Using bacteria to manufacture metalloid nanomaterials for different applications*****,** University of Calgary, Canada

15.20-15.40 **Jinzhong Zhao,** ***Biomaterial scaffolds for ratotar cuff repair*****,** Shanghai Sixth People's Hospital, China

15.40-16.00 **Long Que,** ***Chip-based nanostructure-enabled biosensing and diagnostics*****,** Iowa State University, USA

16.00-16.20 **Mohd Hasmizam Razali,** ***TiO_2 Nanostructures incorporated gellan gum nanocomposite film for biomedical application and environmental remediation*****,** Universiti Malaysia Terengganu, Malaysia

16.20-16.40 **Navin Chandra,** ***Some forefront works on some bio- and nanobio- materials (involving biomolecules like DNA, RNA and proteins)*****,** Vinoba Bhave University, India

16.40-17.00 **Seda Demirel Topel,** ***Bodipy photosensitizer linked hybrid nanomaterials for photodynamic therapy*****,** Antalya Bilim University, Turkey

27 October, 2021

Day - 4: Wednesday, 27 October 2021, Central European Summer Time (CEST, GMT+2)

09.00-11.00 **Session 14: Environmental and Green Materials**

Session Chair(s): Yang-Hsin Shih and Fenglian Fu

09.00-09.20 **Yang-Hsin Shih,** ***The application of nanomaterials to degrade persistent organic pollutants in the environment*****,** National Taiwan University, Taiwan

09.20-09.40 **Fenglian Fu,** ***Synthesis, characterization and application of magnetic pyrite and CTAB intercalated molybdenum disulfide for enhanced removal of heavy metal ions*****,** Guangdong University of Technology, China

09.40-10.00 **Zhenghua Zhang,** ***2D Membrane with angstrom-confinement catalysis for water treatment*****,** Tsinghua University, China

10.00-10.20 **Khatib Farhan**, ***Nanomaterials based geopolymers, emerging sustainable green composite building material: A review***, King Abdulaziz University, Saudi Arabia

10.20-10.40 **Ru-Song Zhao,** ***New nanomaterials-based pretreament techniques of environmental samples*****,** Qilu University of Technology, China

10.40-11.00 **Cui-Yun Yu,** ***Synthesis of polysaccharides-based delivery system in aqueous media*****,** University of South China, China

27 October, 2021

11.00-13.00 **Session 15: Advanced Materials Research & Innovation**

Session Chair(s): Guoyong Wang and Kewei Zhang

11.00-11.20 **Kewei Zhang,** ***Sustainable gas sensors based on inorganic-organic hybrids*****,** Qingdao University, China

11.20-11.40 **Guoyong Wang,** ***Artificial superhydrophobic surfaces and their applications*****,** Jilin University, China

11.40-12.00 **Rukmini Gorthy,** ***Functionalizing titanium alloys using low energy, non-toxic plasma electrolytic oxidation processes*** **,** Cirrus Materials Science, New Zealand

12.00-12.20 **Asim Debnath,** ***Influence of carbon nanotubes on the dielectric and electro-optical properties of a proto-type antiferroelectric mixture used in liquid crystal based display devices*** **,** University of North Bengal, India

12.20-12.40 **Chenxiao Jiang,** ***Electro-driven in situ constructing functional layer using amphoteric molecule: The role of tryptophan in ion sieving*** **,** University of Science and Technology of China, China

12.40-13.00 **Ghada Missaoui,** ***Pt free counter electrode for DSSCs based on reduced graphene doped and codoped with heteroatoms*** **,** University of Sousse, Tunisia

27 October, 2021

13.00-15.00 **Session 16: Advanced Materials Research & Innovation**

Session Chair(s): Xiong Zhang and Himansu Nanda

13.00-13.20 **Xiong Zhang,** ***Novel carbon composite materials of MOFs grafted onto biochar: preparation and applications*** **,** Huazhong University of Science and Technology, China

13.20-13.40 **Junkuo Gao,** ***Metal-organic frameworks for efficient photocatalysis*** **,** Zhejiang Sci-Tech University, China

13.40-14.00 **Minman Tong,** ***Material genomics based porous material design for energy gas storage and separation*** **,** Jiangsu normal university, China

14.00-14.20 **Mohamad Hafiz Mamat,** ***Fabrication of resistive-type humidity sensor using metal oxide nanostructures synthesized via chemical solution process*** **,** Universiti Teknologi MARA, Malaysia

14.20-14.40 **Donia Fredj,** ***Inkjet printed transparent electrodes based on silver nanowires for flexible organic photovoltaic devices*** **,** CINaM | Centre Interdisciplinaire de Nanoscience de Marseille, France

14.40-15.00 **Faissal El Manjli,** ***From amorphous red phosphorus to 2D phosphorene nanosheets: synthesis and characterization*** **,** University of Cadi Ayyad, Morocco

27 October, 2021

15.00-17.30 **Session 17: Advanced Materials Research & Innovation**

Session Chair(s): Pamela Norris and Mikael Syväjärvi

15.00-15.20 **Pamela Norris,** ***Tuning phonon transport: from interfaces to nanostructures*** **,** University of Virginia, USA

15.20-15.40 **Anupama Kaul,** ***Layered crystallites and their heterostructures for optoelectronics and quantum-enabled devices*** **,** University of North Texas, USA

15.40-16.00 **Himansu Nanda,** ***Soft tissue polymer bioadhesives: bridging the gap in regenerative medicine*** **,** PDPM-Indian Institute of Information Technology Design and Manufacturing Jabalpur, India

16.00-16.20 **Fei Wang,** ***The construction of multidimensional nanocarrier based nanopromoters for methane hydrate formation*** **,** Qingdao University of Science and Technology, China

16.20-16.40 **Leonard Francis,** ***Structural and chemical analysis of filled nanotubes*** **,** International Iberian Nanotechnology Laboratory, Portugal

16.40-17.00 **Shawqi Al Dallal,** ***Dye enhanced quantum dot sensitized solar cell*** **,** Ahlia University, Bahrain

17.00-17.30 **Announcements of Best Oral & Poster Presentations, Feedback and Closing Ceremony**

Bottom-up Synthesis of Layered Metal Chalcogenides: Chemical Routes to New 2D Materials

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Graphical Abstract

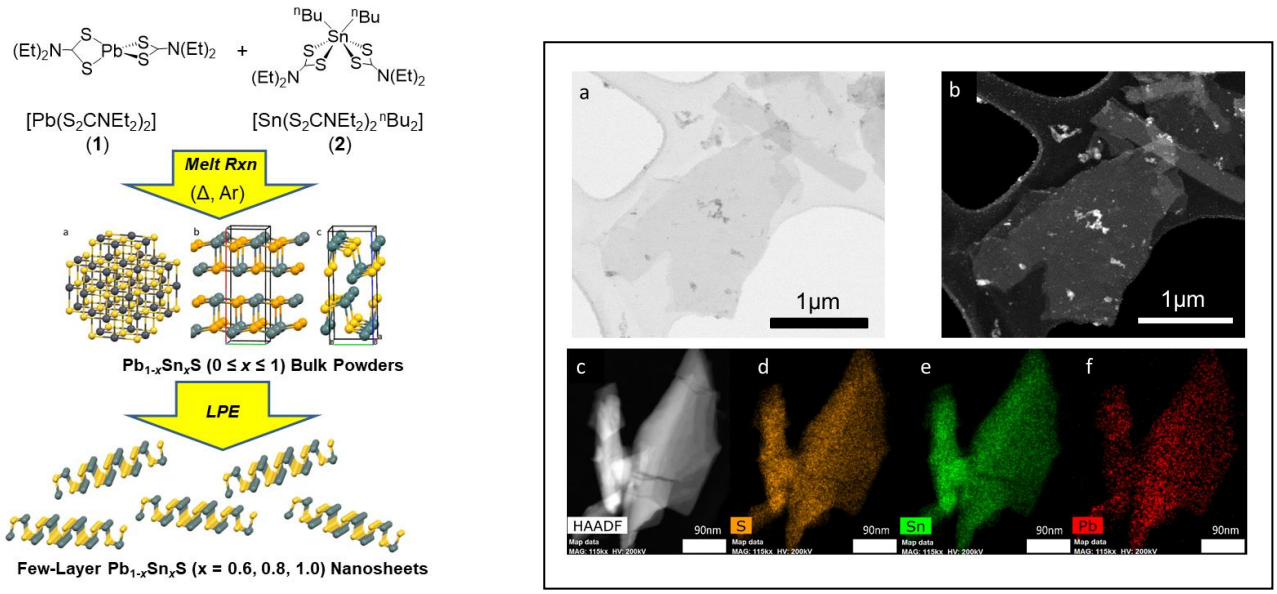


Fig. 1. Synthesis of $Pb_{1-x}Sn_xS$ bulk powders for exfoliation based on solventless thermolysis reactions from molecular precursors. Inset: **.** Characterisation of 2D $Pb_{0.2}Sn_{0.8}S$ with electron microscopy: BF-TEM, HAADF STEM imaging and EDX spectrum maps of $Pb_{0.2}Sn_{0.8}S$ nanosheets (200 kV). (a) BF-TEM image of a large nanosheet. (b) HAADF STEM image of the same $Pb_{0.2}Sn_{0.8}S$ nanosheet as found in (a). (c) HAADF STEM image of a $Pb_{0.2}Sn_{0.8}S$ nanosheet. (d) EDX spectrum image of the sulfur K_α line (2.31 keV). (e) EDX spectrum image of the Sn L_α line (3.44 keV). (f) EDX spectrum image of the Pb L_α line (10.6 keV).

Abstract

Layered bulk materials have attracted much attention for various technological applications including tribology and catalysis [**1**]. One of the most recent applications is in their study in the two-dimensional limit i.e., atomically thick materials such as graphene. Inorganic graphene analogues such as few layer molybdenum disulphide, black phosphorus and main group chalcogenides have also been the subjects of much intense research as two-dimensional semiconductors that would be complementary to graphene in a future electronics industry [**2**]. We have devised top-down routes to 2D black phosphorus [**3**] and tin(II) sulphide [**4**] both of which have layer dependent band gaps. However, these top-down

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processes suffer from a major drawback: often commercially available layered bulk crystals are used as feedstock and this inherently limits the palette of two-dimensional materials available for study without resorting to expensive processing via CVD.

As a solution to this, we have devised new routes based on solventless thermolysis of metal-organic precursors that can produce layered materials in bulk at relatively low temperatures and in relatively high purity. Because the precursors used are on the molecular scale, we can control the extent of doping or alloying of materials and this then widens range of layered materials available for exfoliation. I will present the synthesis of layered MoS_2, MoO_3 [**5**] MoWS/MoWSO alloys [**6**] and PbSnS alloys [**7**], the latter studied as post-processed 2D materials as an example of this new processing route toward bespoke 2D materials (**Fig 1**).

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Biography of Presenting Author

I am currently the Deputy Head of the Department of Materials at the University of Manchester. My group researches materials for energy generation in a broad sense, specifically targeting inorganic thin films and nanomaterials that are of use for a range of applications including thermoelectric, photocatalytic, electrocatalytic and photovoltaic power generation. To acheive this, we typically use materials chemistry to design low temperature bottom up syntheses utilising molecular precursors that allow exquisite control of the chemical composition of materials, thus allowing us to tailor them toward a specific application. We also use various top down processing techniques such as liquid phase exfoliation of layered crystals to produce thin inorganic semiconductors which are complementary to graphene. Recently we have pioneered the use of these processes in serial to produce new synthetic two-dimensional materials. In general, the use of solution phase pathways toward nanomaterials also allows us to take advantage of additive manufacturing processes, AACVD, spray coating and digital printing to assemble these inorganic materials into macroscopic structures and devices. The group collaborates internationally with a range of materials scientists, chemists, and physicists to achieve these goals.

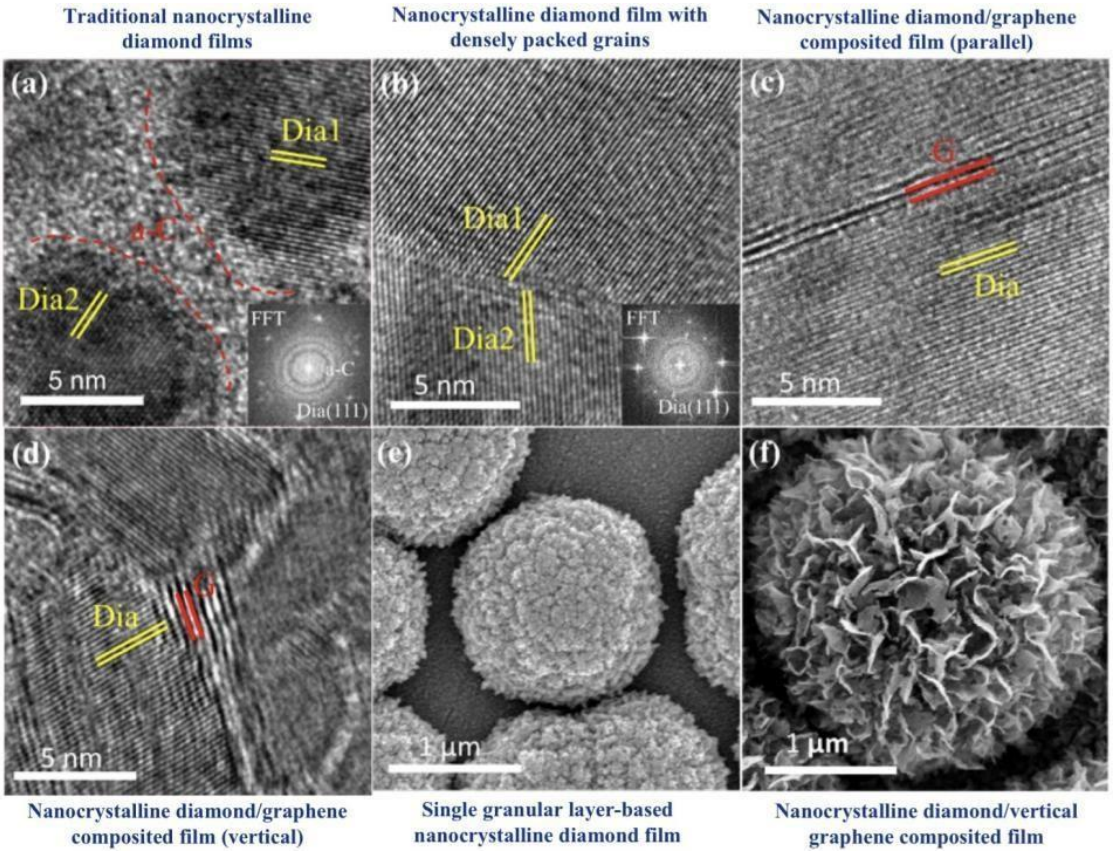
A Multifunctional Material: Nanocrystalline Diamond Films

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Graphical Abstract



Abstract

All forms of the research contribution at the conference must be accompanied by an abstract. In brief, the abstract should concisely describe the purpose of the research, indicate the experimental procedures used, summarize the key findings, and focus on the major conclusions. Abstract should be in one paragraph. Please complete your abstract here within 300-500 words.

Diamond possesses excellent physical and chemical properties, considered as a kind of multifunctional material. However, there are many problems that obstacle its realization in various fields. First, as a wide gap semiconductor, it is very difficult to prepare n-type diamond, preventing the application of diamond in the electronic related areas. Taking advantage of the unique

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microstructure in nanocrystalline diamond films composited of nanodiamond grains and amorphous carbon grain boundaries, we prepared high-mobility n-type nanocrystalline diamond films by doping and annealing. This gives important significance in the development of diamond-base pn junctions. Second, it is very difficult to control the color centers in the diamond lattice, which limits the progress of diamond-based single photon source applied in quantum information processing. By reducing the grain size of nanocrystalline diamond grains, we obtained the nanodiamonds with fewer 3 SiV color centers. This is the first time to prepare these nanodiamonds. Third, the composited characteristic of nanocrystalline diamond films normally leads to the inhomogeneous electrochemical properties. We prepared nano-diamond/graphene composited films especially the diamond grains surrounded by the ordered and small graphene. As comparing with the graphene paralleling between the adjacent grains, the films with the graphene bridging on the adjacent grain boundary, exhibit a wider potential window, faster electrochemical charge exchange and larger electrochemical active area. Vertical graphene sheets with edge carbon defects were constructed on the nano-diamond grains, forming a large number of catalytic active center positions and promoting the oxygen reduction reaction process. Forth, as an excellent coating material, researchers tend to deposit diamond films on steels to improve its hardness, abrasion performance, and corrosion resistance. However, it is very difficult to deposit diamond films on steels because large thermal expansion coefficient between diamond and steels. We designed various three-element interlayers on steel, effectively improving the adhesive force of diamond on steels. Also, the calculations based first-principle were performed to explain the inherent mechanism and design new carbon-based two dimension materials. These results have important significance in the applications of diamond in electronic industry, field emission devices, electrochemical electrodes, quantum information and high performance coating.

Keywords

Nanocrystalline diamond films; electrical properties; color center; electrochemical electrodes.

Acknowledgements

This work was supported by the key project of National Natural Science Foundation of China (No. U1809210); National Key Research and Development Program of China (No. 2016YFE0133200); International science technology cooperation program of China (No. 2014DFR51160); One Belt and One Road International Cooperation Project from Key Research and Development Program of Zhejiang Province (No. 2018C04021); the European Union's Horizon 2020 Research and Innovation Staff Exchange (RISE) Scheme (No. 734578); National Natural Science Foundation of China (Grant No. 50972129, No. 50602039 and No. 52002351) and Natural Science Foundation of Zhejiang Province (No. LQ15A040004 and LGC21E020001).

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Biography of Presenting Author



Dr. Xiaojun Hu, Professor. Vice director of College of Materials Science and Engineering in Zhejiang University of Technology. The research interest of Dr. Xiaojun Hu focuses on the preparation, electrical and photoluminescent properties of diamond films, a kind of wide band semiconductor materials, from experimental and computational view. She also developed various ways to deposit diamond films as an advanced coating on stainless steel. She designed many carbon-based two-dimensional materials by using first-principle calculations. She lead 13 projects, published more than 80 papers and authorized 22 Chinese patents as the first inventor. She acted as editorial board member in one international journal of *Functional diamond* and in two Chinese journal of *Super-hard Materials and Engineering* and *Diamond, Grinding Materials and Grinding Tools Engineering*. In 2016, she acted as the organizing committee member in the international conference of New Diamond and Nano Carbon. She organized international symposium on diamond films and functional devices as Chairman from 2015-2020. She acted as session Chair in academic conference for 12 times, and gave invited talk for 12 times and oral presentation for 27 times. She also acted as the reviewer for the journal of Advanced Materials, Diamond & Related Materials, ACS: Applied Materials and Interfaces, Carbon, Journal of Crystal Growth, J Appl. Phys., and Appl. Phys. Lett.

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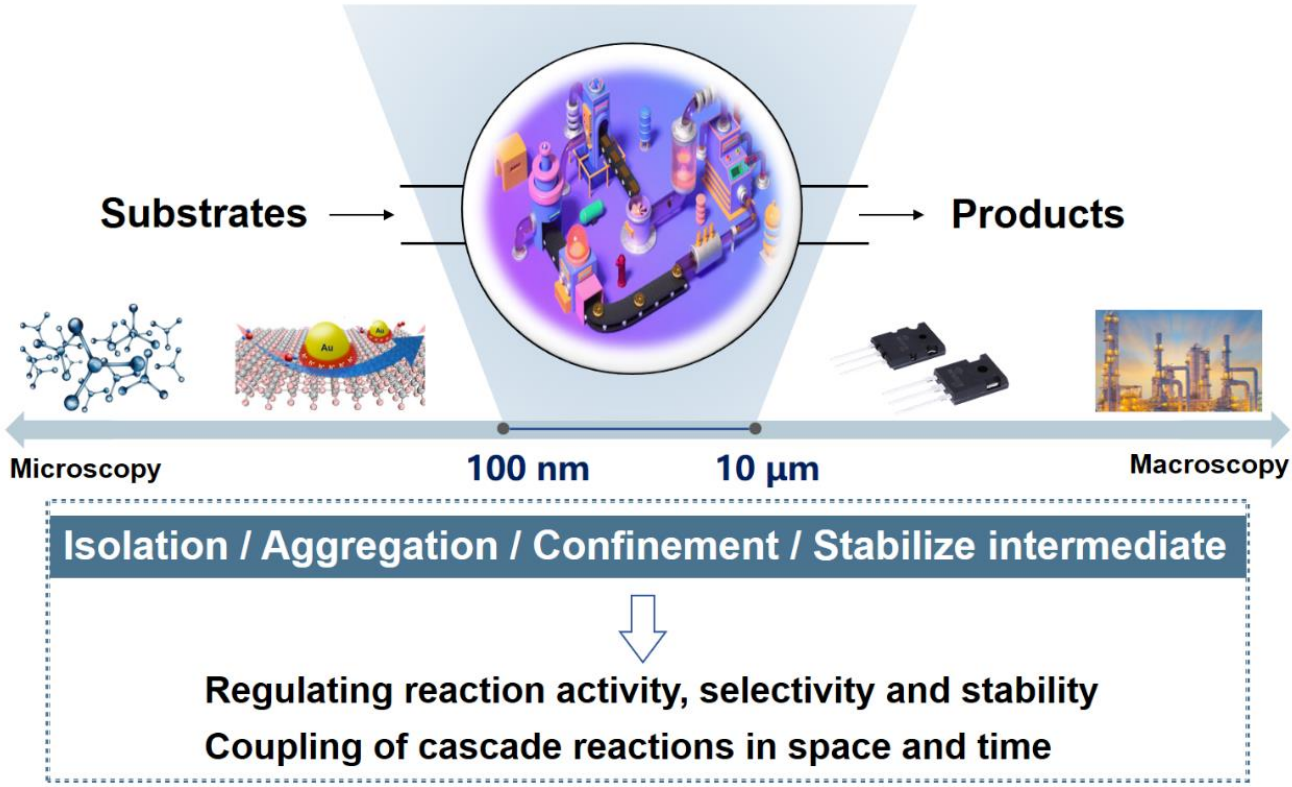
Nanoreactors for Sustainable Catalysis

Prof. Dr. Jian Liu[1,2,*]

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Graphical Abstract



Abstract

Nanoreactors as a kind of advanced materials have been widely applied in energy catalysis and biomedical application. Nanoreactors are like organelles that has special active sites for the catalytic reactions. The main characteristics of nanoreactors are such as controlling the reaction microenvironment, confinement effects, compartmentalization or accumulation of various types of elementary reactions. These characteristics would help improve the catalytic performance. Thus, the nanoreactors could be recognised as a special kind of sustainable catalytic materials. Herein, the purpose of our research is to design sustainable carbon-based nanoreactors to investigate the catalytic reactions of homogeneous catalysis in heterogeneous systems, in particularly for the

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conversion of small molecules (N_2/H_2O/CO_2) and organic molecules (e.g., nitrobenzene, phenylacetylene). A confined Fe-Cu clusters on graphitic carbon nitride as sub-nanometer reactors was fabricated for efficiently regulating the electrochemical nitrogen reduction reaction [**1**]. We provide new strategies of manipulating catalysts active centers at the sub-nanometer scale. Furthermore, a Ru/M@OG nanoreactor was designed to achieve exceptional electrochemical hydrogen evolution reaction performance, demonstrating that atomic metal species on the carbon substrate can remotely communicate with the supported metal nanoparticles, inducing synergistic electronic coupling with the nanoparticles and enabling the control of their electrocatalytic activity [**2**]. To precisely control the metal location and study the void-confinement effects, we synthesized a pair of hollow carbon sphere (HCS) nanoreactors with presynthesized PdCu nanoparticles encapsulated inside of HCS (PdCu@HCS) and supported outside of HCS (PdCu/HCS) [**3**]. It is found that hydrogenations of alkenes over PdCu@HCS are shape-selective catalysis. In addition, a yolk-shell-structured Pd&ZnO@Carbon submicroreactors are shown to be a highly selective catalyst (selectivity >99%) and superior catalytic stability for hydrogenation of phenylacetylene to phenylethylene [**4**]. The solvothermal treatment and carbonization process of uniform zeolitic imidazolate framework-8 (ZIF-8)@resin polymer core-shell structures leads to the generation of yolk–shell-structured ZnO@carbon. Therefore, the construction of artificial cells, namely carbon-based nanoreactors with tunable structure, and the composition and properties are desirable for sustainable catalysis [**5**].

Keywords

Nanoreactors; sustainable catalysis; selectivity.

Acknowledgements

Please acknowledge the funding authorities and other research supports.
Our works were supported financially by the National Natural Science Foundation of China (21905271, 11974068, 91961204, and 21905202), Liaoning Natural Science Foundation (20180510029), and the Dalian National Laboratory for Clean Energy (DNL), CAS, DNL Cooperation Fund, CAS (DNL180402), and the Supercomputing Center of Dalian University of Technology. The authors would like to thank Prof. Qihua Yang and Prof. Can Li for fruitful discussion.

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Biography of Presenting Author



Dr. Jian Liu is a Professor at Dalian Institute of Chemical Physics, Chinese Academy of Science, China, he also held an adjunct professor position in Department of Chemical and Process Engineering, University of Surrey, UK. His research focuses on the design of micro-nanoreactors, porous carbon spheres, and industrialization of homogeneous catalysis in heterogeneous systems. Dr. Liu has been PI/CI on over £4 M in sponsored research (including three ARC DP grants, one ARC LP grant, Chinese Government Funding, two international linkage grants from the Australian Academy of Sciences, and four UQ major grants) in the last ten years, and as of May 2021, has published more than 220 peer reviewed journal articles including top ranking journals such as Nature Mater., Nature Commun., Angew. Chem. Int. Ed., Adv. Mater., JACS, Chem. Sci., Chem. Soc. Rev., et al. 1 book, 10 book chapters. A recent search (May 2021) of ISI Web of Science shows his entire publications have been cited for over 17000 times. He has an H-index of 60. He was listed as 2018-2020 Highly Cited Researchers from Clarivate Analytics in Cross-Field. He is the Editor-in-Chief of Materials Today Sustainability (Elsevier), Associate Editor of Frontiers in Chemistry and Frontiers in Bioengineering and Biotechnology (2016-2019), and also as an editorial member for Materials Today, Materials Today Energy, Chinese Journal of Catalysis, etc. As recognition of his achievements in research, he was honoured with a prestigious UQ Foundation Research Excellence Award, Australian Postdoctoral Fellowship (APD), JSPS Invitation Fellowships, UQ Postdoctoral Research Fellowship, President Award (Chinese Academy of Sciences) and a Young Scientists Award of the 14th International Congress on Catalysis.

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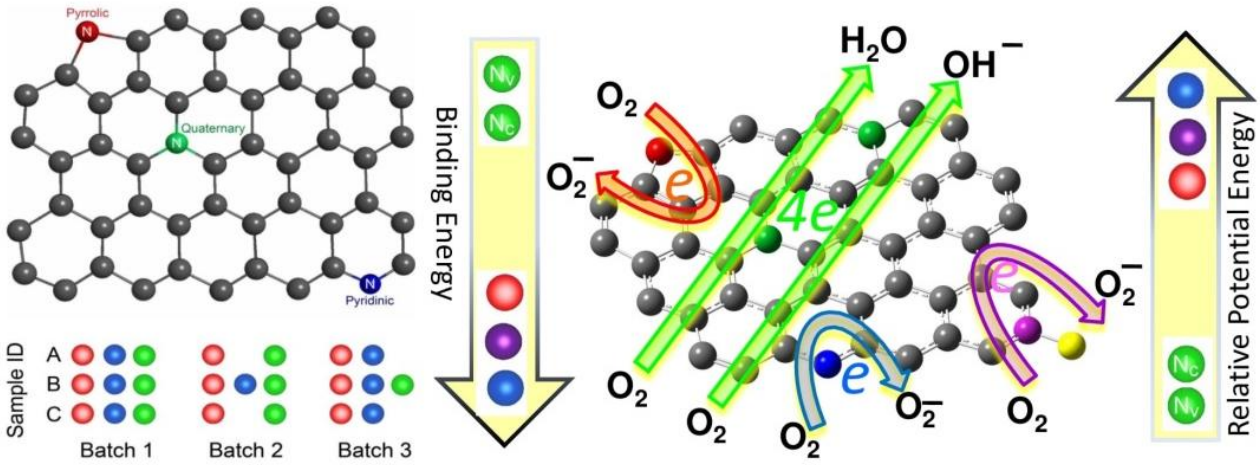
The Active N-Site for O_2 Reduction over Controlled N-Doped Carbon

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[3]School of Chemical & Biomolecular Engineering, The University of Sydney, NSW 2008, Australia

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Graphical Abstract



Abstract

N-doped carbons were synthesized by carbonizing an amino-functionalized metal–organic framework (amino-MIL-101(Al)). The types of N functionalities in the samples depended upon the pyrolysis temperature, and it was possible to prepare two samples that lacked quaternary N functionalities. This allowed us to investigate which type(s) of nitrogen groups catalyze(s) the oxygen-reduction reaction (ORR), and thus address conflicting reports regarding whether pyridinic and/or quaternary nitrogens catalyze four-electron transfer ($4e^-$) pathways for oxygen reduction. A direct experimental demonstration that the superior catalytic activity of N-doped carbon for oxygen reduction via the $4e^-$ pathway is attributable to the only quaternary N sites. The total nitrogen content was not correlated with ORR activity, and neither pyridinic nor pyrrolic N sites displayed significant electrocatalytic activity for ORR. This findings also investigated by computational simulation (DFT) using various parameters – mainly binding energy, relative potential energy, electron density and dipole moment illustrate the catalytic role of the quaternary N carbon.

Keywords

N-Carbon catalyst; quaternary N; oxygen reduction, binding energy, relative potential energy.

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Acknowledgements

The authors would like to thank Australian Research Council, STEM College (RMIT University) and University of Sydney for funding and research supports.

Biography of Presenting Author



Dr. Enamul Haque, is currently affiliated as Associated Professor at RMIT University Melboune (Australia)n and honorary Associate Professor at Zhejiang Sci-Tech University (China). Dr Haque was awarded his PhD degree in Chemical & Biomolecular Engineering from the University of Sydney, which has been followed by various research positions at the University of Sydney, University of Wollongong, University of New South Wales, Deakin University and RMIT University. In this time Dr Haque has developed an international research profile in the synthesis of porous carbon materials, Metal-Organic Frameworks (MOFs), Graphene-Organic Frameworks (GOFs), graphene quantum dots and porous carbon, and more recently the application of biosensors for their study. Dr Haque's research has yielded new insights in the fields of chemistry and nanomaterials, which has already led to outstanding research publications, including in the high-impact journals, many in the top 10 % of journals in the relevant discipline, invitations to write reviews in the area, as well as several awards. Collectively, Dr Haque's research articles have been cited 4263 times (Google Scholar Citation), underpinned his impressive h-index of 24. Dr Haque's name has been listed in "World Top 2% Scientists" in the field of Nanoscience and Nanotechnology (including general chemistry and strategic technology) which was published by Stanford University, USA.

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Interfaces Governed Mechanical Properties of Metallic Nano-Glass Thin Films: A Nanoscopic Approach

Arnaud Caron[1,*], Won Seok Chae[1], Lv Limbo[2], Qing Ping Cao[2], Jianzhong Jiang[2]

[1]Korea University of Technology and Education, Republic of Korea
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Abstract

Metallic nano-glasses are a new class of materials whose amorphous structure fluctuates at the nanometer scale with dense glassy domains bounded by glass/glass interfaces. The occurrence of glass/glass interfaces opens a new perspective to tune the mechanical properties of amorphous materials. The effect of glass/glass interfaces on the mechanical response of glasses has however not been much explored yet.

In this work, we investigate the structural and mechanical properties of a $Ni_{62}Nb_{38}$ metallic nano-glass thin film surfaces prepared by magnetron sputtering with different deposition power. We use atomic force microscopy to monitor the evolution of surface morphology, hardness, and tribological performances.

Biography of Presenting Author

Arnaud Caron is a materials scientist with expertise in the multi-scale mechanical behavior of materials, surfaces, and micro-components. Since 2015 Arnaud Caron is Assistant Professor in KoreaTech – Korea University of Technology and Education, Republic of Korea. Arnaud Caron obtained his engineering degree in Materials Science in 2004 from the University of Saarland, Germany and was awarded the Schiebold Medal. In 2009, he earned his doctoral degree in Materials Science from the University of Saarland, Germany. From 2007 to 2015 Arnaud Caron worked as a research associate at the Institute of Micro- and Nanomaterials of the University of Ulm, Germany, the WPI-Advanced Institute of Materials Research at the Tohoku University, Japan, and the Leibniz – Institute for New Materials, Germany.

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New Insight into Vertical Topographical Selective Deposition of Tantalum Oxide Ta_2O_5 by Morphological Analyses

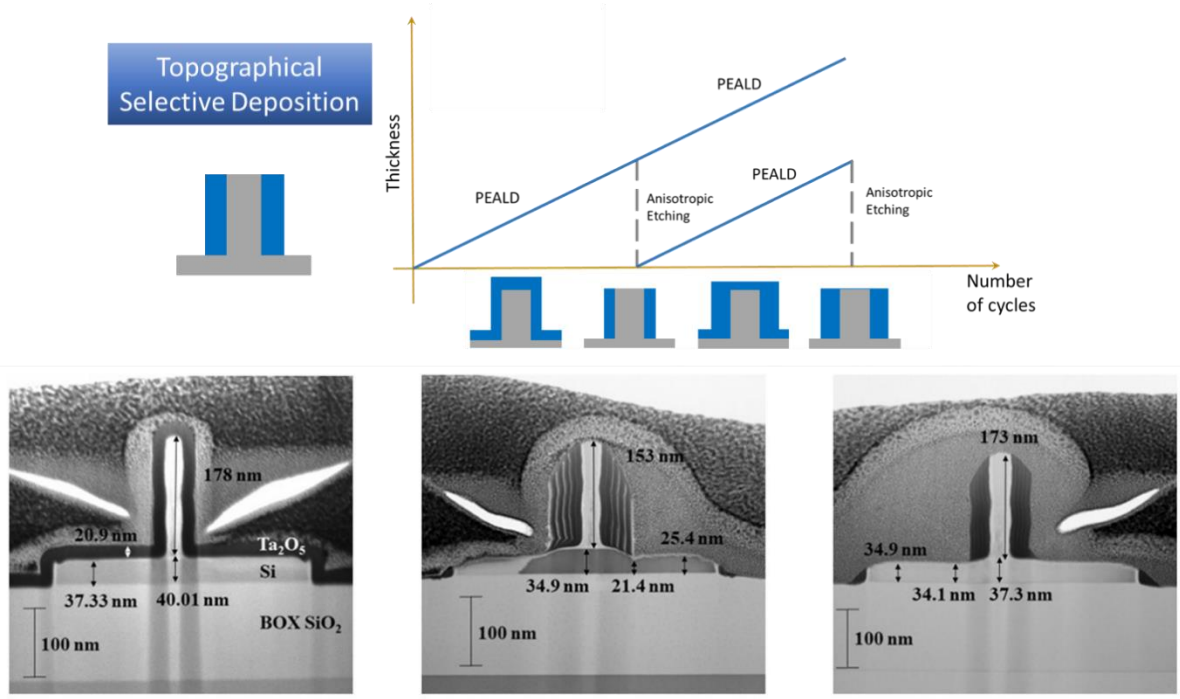
Gauthier Lefevre[1,*], Moustapha Jaffal[1], Taguhi Yeghoyan[1], Rémy Gassilloud[2], Nicolas Posseme[2], Christophe Vallee[1#], Marceline Bonvalot[1, 3]

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[2]CEA-LETI, Minatec Campus, F-38054 Grenoble, France
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Graphical Abstract

Topographical Selective Deposition (TSD) for direct vertical coating of 3D features represents a key point in miniaturization of microelectronic devices, reducing cycle time, fabrication costs and process variability.



Abstract

In the race of electronic miniaturization, current top-down processes are reaching their limits and new bottom-up techniques are evolving rapidly [**1**]. Avoiding numerous and costly fabrication process steps and placement errors, Area Selective Deposition (ASD) is attracting a lot of attention, even

though implementation, settings and shortcomings of this innovative technique remain challenging at the moment [**2**]. When dealing with 3D features, selective deposition is named Topographical Selective Deposition (TSD) and can lead to the fabrication of vertical-only coating of 3D substrates. This TSD is of particular interest for potential applications such as direct gap filling or spacer definition for instance.

In this work, we develop a Ta_2O_5 TSD process using super-cycles alternating Plasma-Enhanced Atomic Layer Deposition (PEALD) steps and two different approaches of anisotropic etching steps: quasi-Atomic Layer Etching (ALE) and argon ion sputtering [**3**]. Nanocharacterization of obtained results is presented and allows an accurate analysis of modifications in the Ta_2O_5 vertical film deposited with various ASD approaches. Results clearly show differences in terms of thickness, texture and chemical element composition. More specifically, one approach including quasi-ALE step shows better results with limited damages of the 3D features.

Therefore, morphological analysis of thin films helped to choose better selective deposition processes, as a pathway towards industrial applications of ASD.

Keywords

Nanocharacterization; topographical selective deposition; plasma-enhanced atomic layer deposition.

Acknowledgements

We acknowledge the financial support of LabEx Minos and this work was partly supported by the french RENATECH network.

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Biography of Presenting Author



Gauthier Lefevre received his PhD in 2018 while working on the synthesis and characterization of new nanomaterials for hydrogen storage. Then he moved to microelectronic devices, specializing in physical characterization of innovative processes, new materials and embedded devices. Currently, his main field of interest is atomic-scale process characterization by electron microscopy.

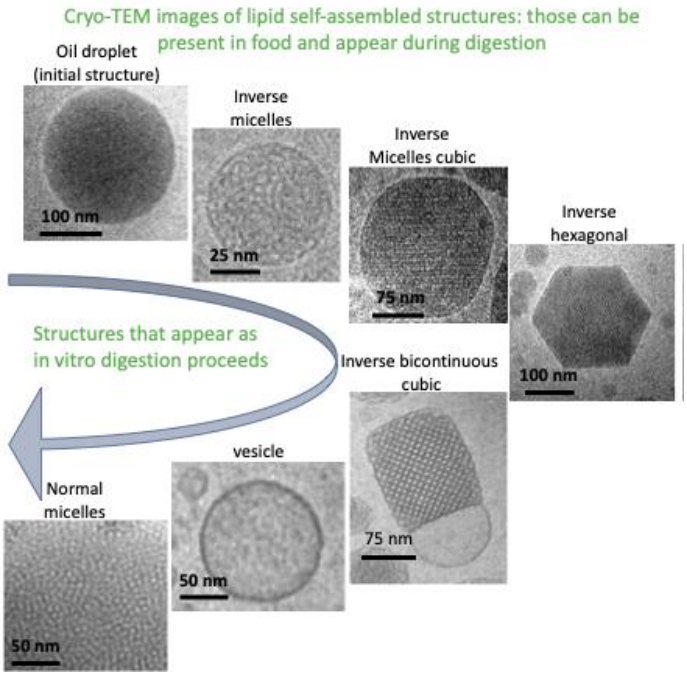
Lipid Self-Assembled Structures: From Nature, Theory to their Applications in Food

Laurent Sagalowicz*

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Graphical Abstract



Abstract

One of the main objectives in the development of new food products is to guarantee good tasting as well as bioactive efficacy. This challenge has been reinforced in recent years with the development of plant-based products for better sustainability and to account for the increasing flexitarian, vegetarian and vegan demand. Since vegan diet is inherently poor in certain micronutrients, there is a need for fortification, which could be associated with issues in term of taste and nutrient loss. For example, iron, which is very reactive leads to oxidation of other nutrients and frequently off-taste generation. Lipophilic nutrients like omega-3, vitamins A and D are often unstable and likely to degrade during food product process and shelf life. Finally, other molecules like vitamin B12 can be poorly absorbed in the human organism. Classical micro-encapsulates obtained by powder technology are outstanding for dried applications. However, they are usually not efficient in liquid products and expensive.

Lipid self-assembled structures are present in living organisms[1] and more particularly in cell membranes, mitochondrias and endoplasmic reticulums. Therefore, they are one of the primary structures existing in living matters, and research is more and more inspired by mother nature to utilize them in a similar way in fabricated products[2]. During the presentation, we will show how self-assembled structures occurs in nature and their presence in milk and in the digestive track[3] will be

outlined. The presence of sub-micrometres domains of lipophilic, amphiphilic and hydrophilic domains offers many functionalities. They can be used to control release of certain nutrients and consequently increasing their efficiency in the human body (e.g. increase of vitamin bioavailability). These structures can similarly modulate the molecular reactivity to improve oxidation stability. We will also show that they can increase the Maillard reaction yield[4]. Maillard reaction is the chemical reaction between an amino acid (present in a protein) and a sugar, which leads for example to the aroma of bread or cooked meat. Particular emphasises will be brought on the relation between structure features[5] and the obtained macroscopic properties. Finally, self-assembled structures have the advantages to be easily processed. They can be made from ingredients, such as phospholipids that are naturally present already in many food products.

Keywords

Self-assembled structures; colloids; lipids; interface; micelles.

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Biography of Presenting Author

Laurent Sagalowicz is an expert of lipids structuration and delivery systems at Nestlé Research. His main current activities include the development of new functionalities using lipid self-assemblies, crystals and aggregates. Lipids studied include triglycerides, phospholipids, and lipophilic vitamins. These assemblies are also used as delivery systems to provide stronger impact of solubilized nutrients (e.g. increase chemical stability and health efficiency of molecules such as vitamins). Recent successes include 1) Use of lipids for stabilizing lipophilic nutrients (e.g. fish oil and vitamins) and increase efficacy in human body (bioavailability of molecules) for consumer health, 2) Use of polar lipid self-assemblies to tune Maillard reaction (reaction between amino acids or proteins and sugar, leading to the desired aromas/flavours present in bread, bakery products and cooked meats) for consumer pleasure and 3) Structuration of lipids to replace palm oil and saturated fat for sustainability and consumer health.

Characterization methods include transmission electron microscopy, scanning electron microscopy, confocal microscopy, scattering techniques (X-rays and light scattering), differential scanning calorimetry, nuclear magnetic resonance and rheology.

Laurent Sagalowicz has a background and formation in Materials Science and before joining Nestlé, he worked also with ceramics, aluminium alloys and semi-conductors.

He is author or co-author of 85 scientific publications (H index of 34) and inventors of more than 30 patents. In 2015, he received the “Michel Ollivon Award” acknowledging the novelty and outstanding research of long-term work on “structure properties of lipid complex systems”.

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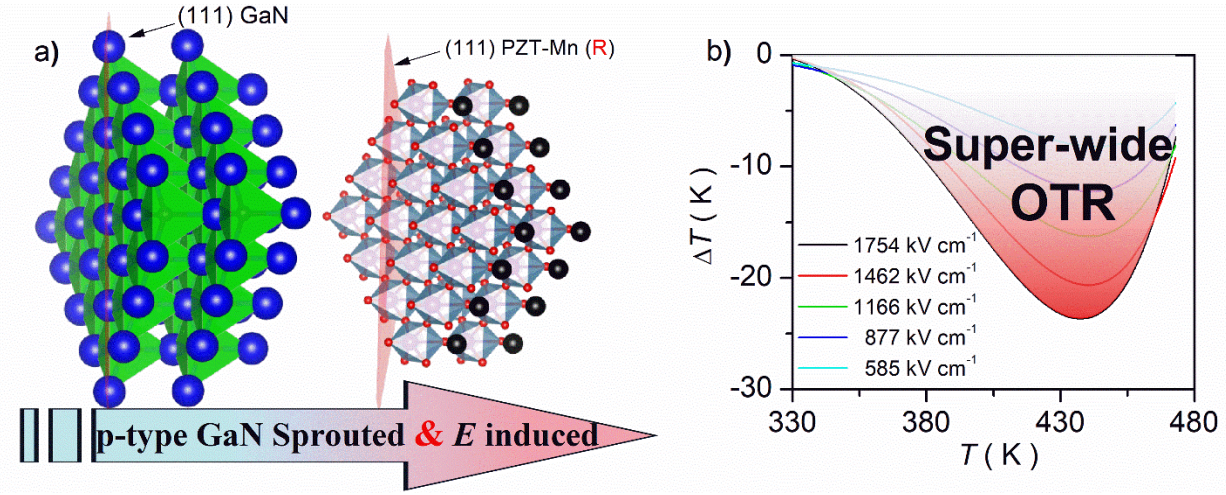
P-GaN-substrate Sprouted Giant Pure Negative Electrocaloric Effect in Mn-doped $Pb(Zr_{0.3}Ti_{0.7})O_3$ Thin Film with a Super-broad Operational Temperature Range

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Graphical Abstract



Abstract

Ferroelectric thin films simultaneously possessing large positive and negative electrocaloric (*EC*) effects are attractive to the solid-state temperature-controlled devices which can be used in many fields, such as modern electronics, communications, medical and military, etc. Here, it is demonstrated that the giant positive *EC* effect ($\triangle T_{max}$ ~ 44.5 K and $\triangle S_{max}$ ~ - 42.8 $JK^{-1}kg^{-1}$ at ~ 313 K) of the Mn-doped $Pb(Zr_{0.3}Ti_{0.7})O_3$ (PZT-Mn) thin film deposited by a sol-gel method on the $Pt/TiOx/SiO_2/Si$ can be tailored into a pure negative *EC* effect ($\triangle T_{max}$ ~ - 23.5 K and $\triangle S_{max}$ ~ 16.3 $JK^{-1}kg^{-1}$) with a recorded super-broad operational temperature range (~ 150 K) by directly depositing on the p-GaN-substrate that has a high carrier concentration ($n = 4\times10^{17}$). Under the sprouting of the p-GaN-substrate, an electric-field induced structural phase transition (nano-scaled tetragonal phase to rhombohedral phase) plays a key role in obtaining the recorded pure negative *EC* effect. It is concluded that direct deposition of ferroelectric thin film on the p-GaN-substrate can be used as a universal-simple-effective strategy to generate a pure negative *EC* effect in a broad operational temperature range (≥ 100 K).

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Keywords

P-GaN-substrate; negative electrocaloric effect; thin film; structural phase transition; PZT-Mn.

Acknowledgements

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Biography of Presenting Author



Prof. Biaolin Peng, he completed his Ph.D at Northwestern Polytechnical University and Cranfield University since from 03/2010 to 06/2013. After that, he worked as a Postdoctoral Fellow at Hong Kong Polytechnic University since from 10/2013 to 09/2017, during this time, he also worked as a Postdoctoral Fellow at Shenzhen University and as a Visiting scholar at Cranfield University. He is nominated as a distinguished Professor in Guangxi University since from 04/2016 to 03/2020. He worked as a visiting Professor at Hong Kong Polytechnic University since from 07/2019 to 09/2019, and then as a visisting professor (Cooperative Mentor : Zhong Lin Wang) at Chinese Academy of Sciences since from 09/2019 to 09/2020. And now he is a Huashan Scholars distinguished Professor in Xidian University.

More than 80 SCI papers have been published, including the Energy & Environmental Science, Advanced Functional Materials, Nano Energy, Advanced Electronic Materials, ACS Applied Materials & Interfaces, Journal of Materials Chemistry C/A, etc. More than 20 patents have been registered. Some talent program projects and rewards were won, such as the Guangxi Natural Science Outstanding Youth Science Fund, Guangxi Hundred Talents Program, Guangxi's First High-level Talent Program, Shaanxi Province Outstanding Doctoral Dissertation, Shaanxi Province Natural Science Outstanding Academic Thesis First Prize, Shaanxi Province Higher Education Science and Technology Award, the 2020 international "Eni Award" nominations.

The achievements on electrocaloric refrigeration have been widely cited by peers in journals such as Science, Nature materials, Nature Physics and Advanced Materials, etc. Many invitation reports were given by international conferences, and particularly, he was invited to give a special academic report by the National Physical Laboratory of the United Kingdom in 2015.

He has presided over more than 10 national, provincial and ministerial projects, and he served as a reviewer for more than 20 international journals. He is also the Letter review expert of the National Natural Science Foundation of China, and the standing committee member of China Electronic Components Key Materials and Devices Special Committee, and the director of China Electronic Materials and Components Industry-University-Research Collaborative Innovation Platform, and the editorial board member of Advanced Materials and Devices.

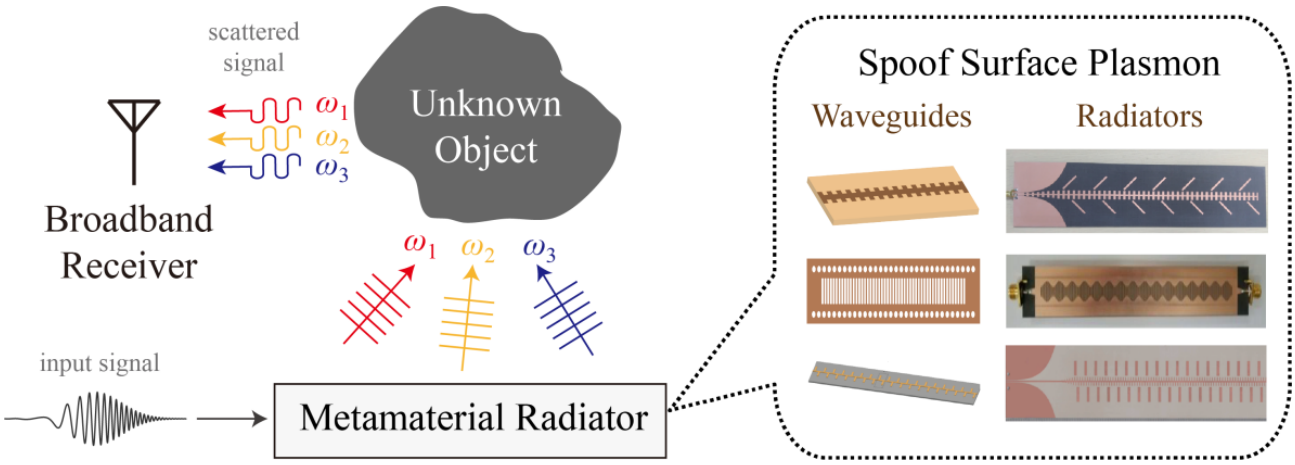
Dispersion-Enhanced Plasmonic Metamaterial for Single-Shot Microwave Imaging

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Graphical Abstract



Abstract

Frequency-diverse microwave imaging provides a new way to capture spatial information in a single shot using the frequency degree of freedom, which is very useful in capturing rapidly moving or vibrating objects. The figure above illustrates the working principle of frequency-diverse microwave imaging. As a broadband signal enters the metamaterial radiator, different frequencies excite beam radiations at different directions to shine the unknown object, and the scattered signals are collected by a broadband receiver. These different beams representing various independent measurements for the unknown objects. As long as the measurement number is sufficiently large, the unknown object can be recovered from its scattering waves. Since the metamaterial is able to offer a set of beams radiating into different directions in a single shot, it features a higher speed in data acquisition in comparison with the conventional approaches using mechanical scanning or electronic switching. High dispersion is highly preferred in the design of metamaterial for frequency-diverse microwave imaging because it is able to collect the spatial information using a narrow-spectrum signal, which, not only save the spectrum resources, but also relax the bandwidth requirement of A/D converter in the base-band hardware. Spoof surface plasmon (SSP) is an artificial metamaterial that supports a surface wave propagating along the interface between SSP and surrounding medium. This surface wave features extremely high dispersion as it operates close to the surface plasmon frequency. This talk will systematically introduce the design of dispersion-enhanced SSP structures at microwave frequencies for wave guiding and radiating. SSP waveguides cover two novel hybrid structures for

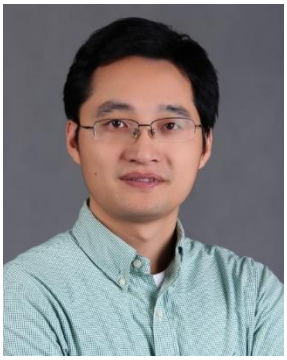
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dispersion enhancement, including substrate integrated waveguide SSP and half mode substrate integrated waveguide SSP configurations. Periodically modulating the profile of SSP waveguides or periodically loading the SSP waveguides lead to leaky wave radiations. Both of these two techniques are introduced for the design of SSP radiators. This talk will also present several frequency-diverse microwave imaging examples using SSP waveguides and SSP radiators. Frequency-diverse imaging will find wide applications in automotive radar, biomedical sensing, and security screening, etc.

Keywords

Dispersion; microwave imaging; Spoof Surface Plasmon (SSP).

Biography of Presenting Author



Dr. Qingfeng Zhang obtained the B.E. degree from University of Science and Technology of China (USTC), Hefei, China, and the Ph.D. degree from Nanyang Technological University, Singapore, all in electrical engineering. He is now a tenured associate professor at Southern University of Science and Technology, Shenzhen, China. Dr. Zhang is a Fellow of the Institution of Engineering and Technology (IET), and Vice Chair of IEEE Antennas and Propagation Society Shenzhen Chapter. His research interests are largely in emerging novel electromagnetics metamaterials where he has a special interest in dispersion engineering at microwave and millimeter-wave frequencies. He has authored/co-authored more than 200 journal and conference papers in this research area. In light of his scientific record, Dr. Zhang obtained URSI Young Scientist Award and ACES Young Scientist Award in 2018. He was elected to IET Fellow in Jan. 2020.

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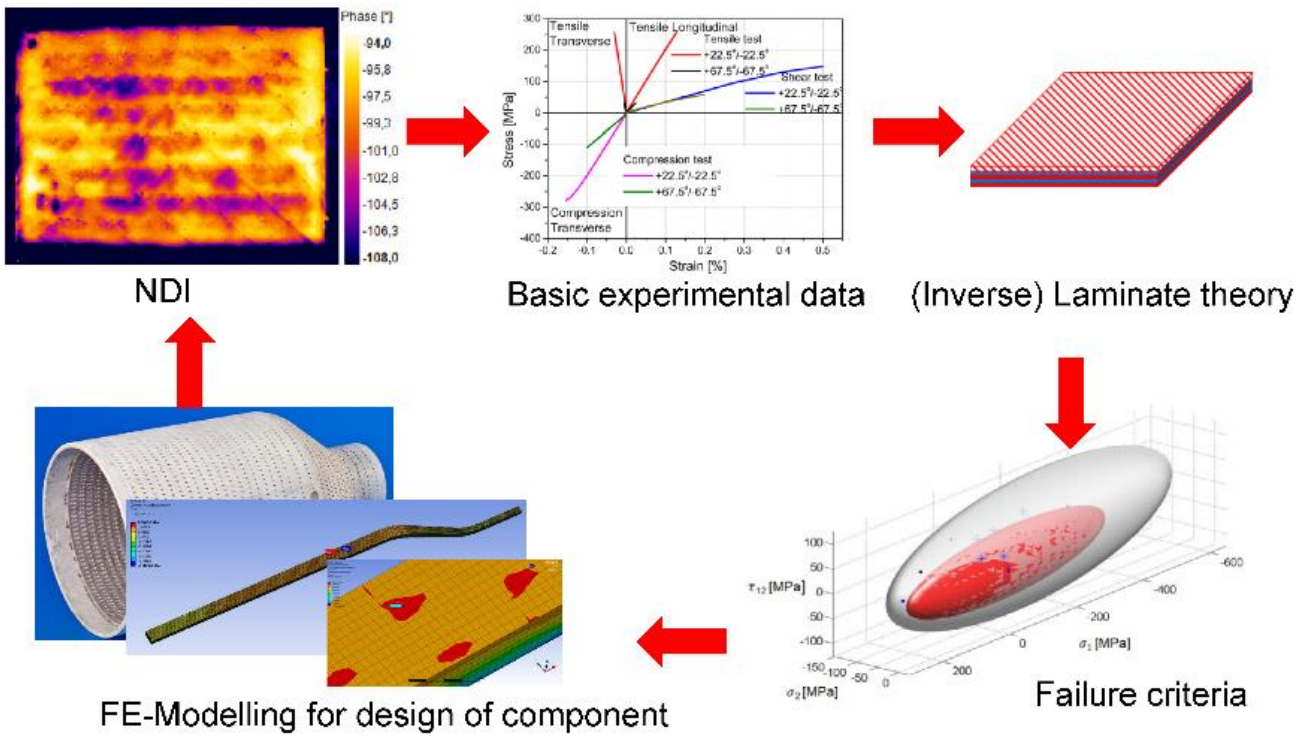
CMC Design Chain from Testing to Modeling – Characterization and Simulation of Mechanical Behavior of Ceramic Matrix Composites

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Graphical Abstract



Abstract

The application of Ceramic Matrix Composites (CMC) strongly depends on the precise prediction of the failure behaviours under real loading conditions. Therefore, a comprehensive modelling approach is necessary which describes experimental testing results dependent on microstructure and fibre orientation as well as local defects like delamination or voids. The deterministic simulation presented here is based on a design chain consisting of non-destructive investigation of microstructure, inverse laminate theory for definition of laminate properties, finite element modelling for calculation of critical stresses and strains, definition of failure criteria, and resulting failure prediction considering

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effects of defects. Experimental data from alloxide composite Whipox as well as from C/C-SiC processed via liquid silicon infiltration are used in order to proof the design chain. It is shown that in-plane strength and stiffness of Whipox can be predicted precisely considering any fiber orientation. The impact of interlaminar defects on failure prediction is shown on C/C-SiC composites. Here defects are implemented in the finite element model considering microstructural information from computer tomography and ultrasonic inspection. With use of fracture mechanical data damage evolution and valid failure prediction is possible and design and optimized engineering of CMC components is achievable.

Keywords

Ceramic matrix composites; design; fracture mechanics; modelling; laminate theory.

Acknowledgements

I want to thank Daniel Cepli and Raouf Jemmali at the DLR Institute of Structures and Design and Prof. Dietmar Koch at the University of Augsburg for the collaboration and support for this work.

Biography of Presenting Author



Dr. Yuan Shi studied Production Technology in the Aerospace Industry in University of Bremen, Germany and graduated with a Diploma degree (Diplom-Engineer). He completed his PhD study “Characterization and modeling of the mechanical properties of wound oxide ceramic composites” from the Karlsruhe Institute of Technology (KIT), Germany. Since 2011 he is working as Senior Scientist and Team Leader in German Aerospace Center (DLR), Institute of Structures and Design in Stuttgart, Germany. Furthermore, he leads the working group “Evaluation and Simulation” of department “Ceramic Composite” from Carbon Composites e.V. (CCeV). Since 2019 he is Member of DIN technical committee “Testing of advanced technical ceramic composites”. He has planned, implemented and managed several research topics and projects focusing on Ceramic Matrix Composites (CMC), e.g., financed by European Commission - Horizon 2020, Federal Ministry for Economic Affairs and Energy of German, etc. His current research focuses on the characterization and modeling of material behaviors at different temperatures for ceramic matrix composites and components, design, development and manufacture of structural prototypes, standardization. So far, he has published more than 50 papers in important academic journals such as Comp A, J. Euro. Ceram.S., applied for 4 German invention patents, and participated in the formulation of 3 new international/German standards. He has already delivered more than 30 scientific lectures about different topics of ceremic matrix composites.

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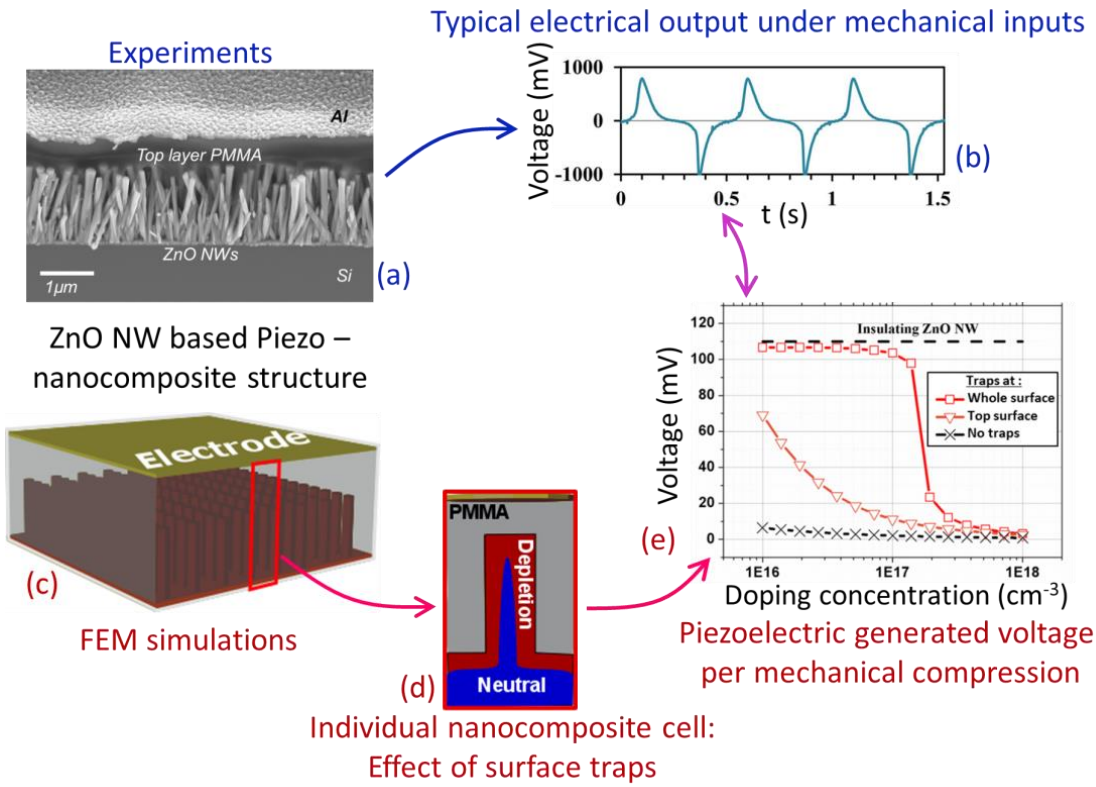
The Impact of Free Carriers and Surface Traps on Semiconducting Piezoelectric Devices

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Graphical Abstract



Abstract

Piezoelectric thin films are widely used in MEMS and NEMS actuators and resonators, as well as in mechanical sensors and energy harvesters for IoT applications or Wireless Sensors Networks (WSN) [**1**]. Nanotechnology involving piezoelectric materials has been identified by the European Community and International Technological Roadymaps as a key research direction [**2**], with benefits expected both from nanostructuring and from the replacement of toxic materials. Piezoelectric nanocomposites based on semiconducting nanowires (NWs) (see Graphical Abstract

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(a)) are an alternative to thin films with benefits expected from nanostructuration, such as low temperature fabrication (<200°C) and higher flexibility than their thin film counterparts. Higher piezoelectric coefficients have been also reported at the nanoscale [**3**]. Vertically grown piezoelectric NWs (of ZnO or GaN for instance), embedded into an insulating matrix, are a typical example of such piezoelectric nanocomposite. While ZnO has the advantage of growing in the shape of nanowires at low temperature, it normally features an N-type residual doping level. However, proof of concept sensors and mechanical energy harvesters based on ZnO NWs have featured unexpectedly high performance considering that free carriers should screen most of the piezo-potential generated under mechanical actuation (see Graphical Abstract (b)). We believe that this is due to the influence of traps at the surface of ZnO. We will discuss modeling issues, with special focus on the introduction of surface traps and free carriers in the simulation of thin films and nanocomposites of ZnO [**4**]. We will especially discus the role of slow traps, with time responses longer than mechanical load variations. The device under study is made of a nanocomposite as depicted in Figure 1a (a carpet of a few 100 nm wide, a few µm long vertical ZnO NWs immerged in PMMA) contacted on bottom and top sides. It is operated in capacitive mode, with pulses of potential generated in response to mechanical load variations. We developed a fully coupled Finite Element simulation framework to solve the equations linking mechanical, piezoelectric and semi-conducting parameters in a unit cell of the nanocomposite (see Graphical Abstract (c) and (d)). To give an example, Graphical Abstract (e) plots the maximum piezoresponse generated in open circuit conditions by an elementary device cell, and compares the results obtained with a typical trap density, taken either on the top surface alone, or on the whole NW surface, with that obtained under the assumption of negligible surface traps. It shows that slow surface traps clearly extend the range of doping level that can be tolerated for ZnO. Indeed, in thin NWs, surface traps were found to be able to deplete the core of the NW completely, preventing free carriers to screen the piezopotential. The influence of growth method (affecting doping and surface traps), geometry, as well as comparison with a thin film of same thickness, will be discussed in more details [**5**].

Keywords

ZnO; simulation; nanocomposite; energy harvesting; sensing.

Acknowledgements

This work was supported by the Federation of Micro Nano Technologies (FMNT) in Grenoble, France and the French National Research Agency in the framework of the "Investissements d'avenir" program (ANR-15-IDEX-02) through the project CDP NEED and ANR SCENIC (ANR-20-CE09-0005-04). This work has received funding from project PULSE-COM of the European Union's Horizon 2020 research and innovation programme under grant agreement No 863227.

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Biography of Presenting Author



Gustavo Ardila received his BS in electronic engineering and physics from the University of Andes, Colombia in 2002 and 2003, respectively, and his MS in microelectronic and microsystems circuit conception from the National Institute of Applied Science (INSA) in Toulouse, France in 2004. He received his PhD degree in Electrical Engineering in 2008 from the Paul Sabatier University in Toulouse. After 1 year of postdoctoral position in LAAS-CNRS laboratory in Toulouse, in 2009 he became Associate Professor at the University Grenoble Alpes (Former Joseph Fourier University) and a researcher at IMEP-LaHC in the Micro Nano Electronic Devices group, Grenoble, France. He has supervised 3 post-doctoral fellows, 1 engineer, co-supervised 6 PhD students. He is or was involved in several French and European projects related to energy harvesting or sensing applications using piezoelectric materials. These materials can be used in autonomous systems in applications like wearables, IoT, etc. His activities concern the theoretical and experimental studies of MEMS (Micro Electro Mechanical Systems) and NEMS (Nano Electro Mechanical Systems), in particular sensors and energy harvesters based on piezoelectric nano-composites (nanowires immerged into a dielectric material). He is author or co-author 9 book chapters and of more than 90 journal or international conference peer-reviewed papers and holds 1 patent. He presently leads the European team to develop the Roadmap of Energy Harvesting technologies contributing to the IEEE IRDS (International Roadmap for Devices and Systems). He is co-founder and co-organizer of the International Summer School MEMS-LATAM: Microsystems for Latin America and member of the editorial board of the “Energy” section of ISTE-Wiley publisher.

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Research on the Innovative Structural Retrofitting Technology based on High Performance Materials: External SC-PBSPC BRBF Sub-structures

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Graphical Abstract

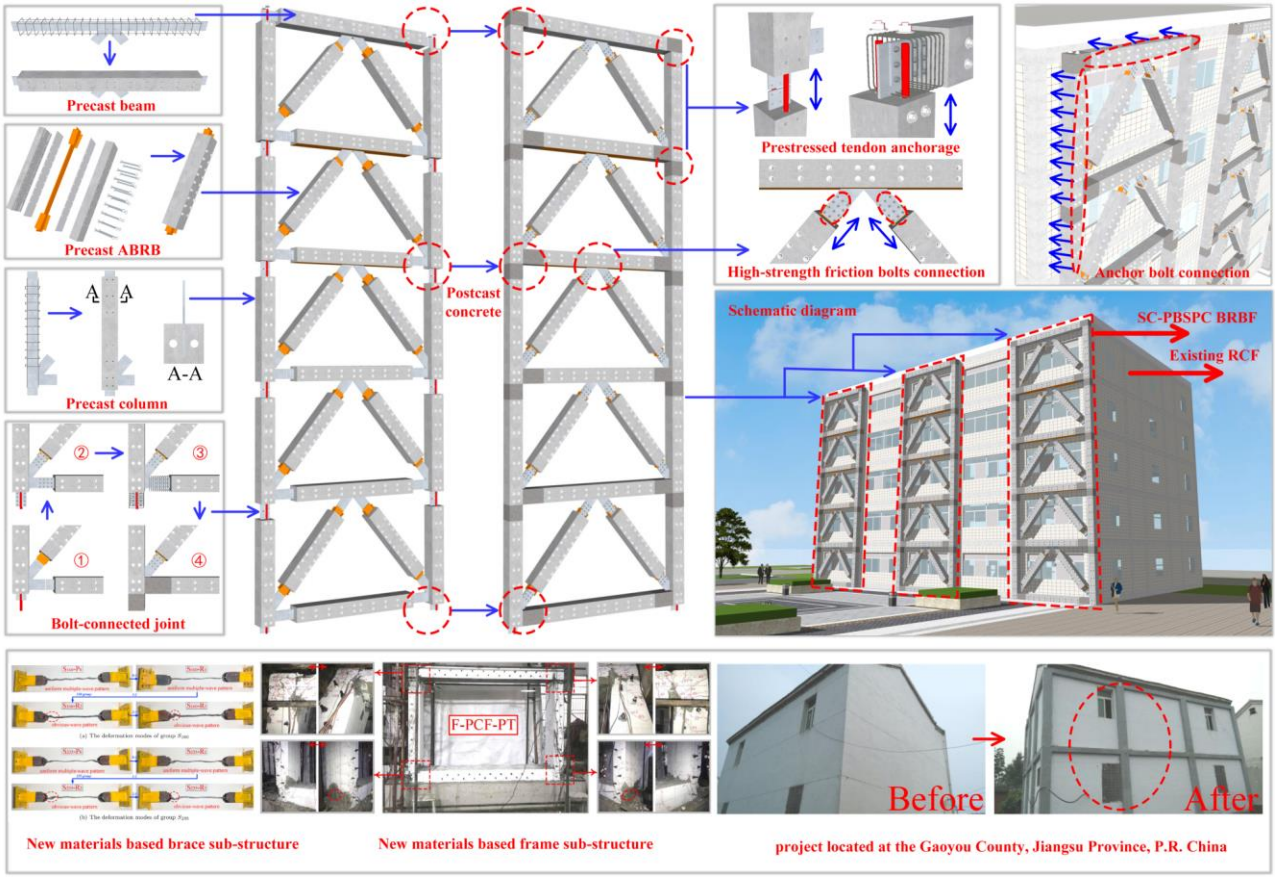


Fig. 1. Innovative high performance materials based structural retrofitting SC-PBSPC BRBF sub-structures

Abstract

A new type of external substructure based on high performance material to upgrade existing reinforced concrete frames (RCFs) is presented in this paper, namely, a self-centering precast bolt-connected steel-plate reinforced concrete buckling-restrained brace frame (SC-PBSPC BRBF). The material

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characteristics, upgrade mechanism and three-dimensional simulation model were analyzed based on relevant experiment validations. A quasistatic analysis and parameter study was conducted using 21 scenarios to compare the upgrading effects of the outside substructure. Afterwards, a stiffness-based design procedure was developed and modified for this external substructure, including macro-demand analysis, partial component design, and overall structural evaluations. Dynamic analyses were also performed on a frame building for five cases, before and after strengthening. Probabilistic seismic performance assessments are carried out for different scenarios, and the whole evaluation process is divided into four parts (i.e., hazard, demand, capacity, and risk).

Generally speaking, the proposed numerical model reflected the precast characteristics and displayed the ideal fitting accuracy. The external assembled brace provided sufficient initial stiffness and energy dissipation capacity, while the external prestressed tendon decreased residual displacements and facilitated self-centering of the whole structure. The analyses illustrated that the damage to the existing RCF was transferred and seismic demands were significantly reduced within limitations, accompanied with greater capacity reliability. The analyses illustrate that using the external retrofitting sub-structure, the structural demands are obviously reduced with lesser annual exceedance probability, the structural capacities are significantly improved with lower damage state probability, and the structural losses are sharply lessened with more controllable probability. The external SC- PBSPC BRBF is a promising retrofitting sub-structure and the research provides references for practical applications in the earthquake-prone regions. To be specific, the interesting and practical conclusions can be give as follows:

(1) Combining innovative materials, precast-assembly, self-centering, and damage transferring technologies, the SC-PBSPC BRBF works together with the existing RCF and promotes overall performance on the integrated system-level. The outside frame utilizes precast-assembly construction and equivalently enlarges the sections of the inner RCF, preventing possible premature damage under the direct attaching brace scenario. The ABRB consumes sufficient energy and the core plate can be replaced easily after hazards. The prestressed tendon provides self-centering capacity and fulfills the system recoverability. The new substructure aims at integrated retrofitting instead of new construction and provides application possibilities for large numbers of old RCFs in earthquake-prone areas.

(2) A case study is performed on an engineering project, focused on the dynamic responses of a five-span-five-story frame for five cases. The MIDRs are presented along the structural heights under DBE/MCE, and the top/residual displacement responses of four typical waves are further compared by extending the record time with zero-amplitude ground accelerations. The components of the SC-PBSPC BRBF substructure all contribute to the upgrade performance, which can be seen from the MIDR variations. The cases with ABRBs and prestressed tendons significantly decrease the top displacement and the residual displacement, respectively, demonstrating the application prospects of this substructure in the future. The demolition / collapse loss ratios also decrease while the repair loss ratio increases from case 1 to 5, and the same results can be acquired for the annual loss ratios, showing the more repairability resulting from the external retrofitting sub-structure. The resilience indexes also reflect the better functional performance after hazards in case 5, and simultaneously illustrate the more controllable factors and desired results with higher safety by the proposed external sub-structure.

Keywords

High performance materials; structural retrofitting; external sub-structures; SC-PBSPC BRBF.

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Acknowledgements

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Biography of Presenting Author



Dr. Xu-Yang Cao is a research assistant in Hohai University, Nanjing, China. His research interests include (i) innovative high performance materials based structural retrofitting and building technology, (ii) performance-based structural risk / loss analysis and resilience improving strategy, and (iii) probabilistic seismic performance assessment of complex structures and infrastructures. He has published more than 10 high-quality journal papers and has authorized 10 Chinese patents, involving novel structural materials and functional systems. He has been awarded the national scholarship of China, the merit-student of Jiangsu Province, and multiple first prizes over the national level in the field of material innovations and structural improvements. Besides, he has investigated and participated multiple research projects under provincial to national fundings, which are related to applied materials and construction technologies in practical engineering (e.g., high-performance precast bolt-connected steel-plate reinforced concrete (PBSPC), linear-elastic basalt fiber reinforced polymer (BFRP), steel fiber composite bar (SFCB)).

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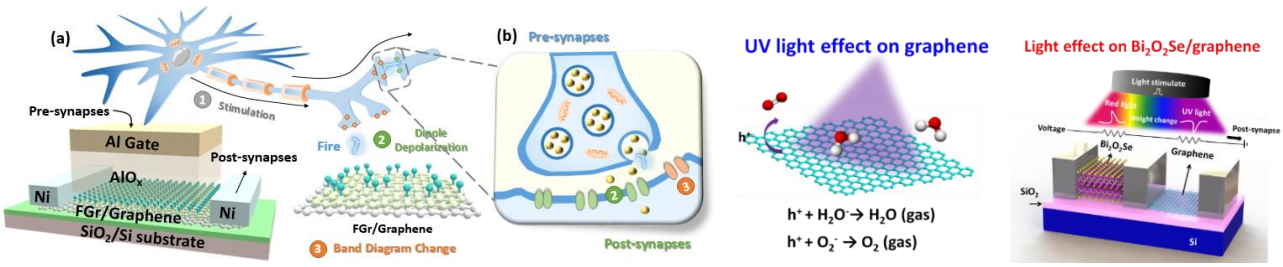
Graphene and 2D Materials for Transistor, Memristor, Synaptic and Light-Stimulated Devices

Chao-Sung Lai[1,*], Bo Liu[2], Tsung-Cheng Chen[1], Chia-Ming Yang[1]

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Graphical Abstract



Abstract

Graphene and two-dimensional material based electronic applications has been proposed and experimentally demonstrated, including transistors, memristors, and artificial synapses. Graphene is the very attractive material taking advantages of its unique lattice structure. The high carrier mobility alleviates the RC delay issue in circuit level and its weak surface van der Waals interaction enables ultra-low energy consumption in a memristor device architecture. Moreover, those surface properties lead graphene into neuromorphic devices as demonstrated in current study. A novel graphene based insulator, fluorographene, is firstly applied as gate dielectric in a field effect transistor. To identify the dielectric quality, dielectric constant, breakdown electric field and thermal stability are investigated. The scalable and one-step fabrication of single atomic-layer transistors is demonstrated by the selective fluorination of graphene using a low-damage CF4 plasma treatment, where the generated F-radicals preferentially fluorinated the graphene at low temperature (<200 °C) while defect formation was suppressed by screening out the effect of ion damage. The fluorographe was also used as decoupling for graphene as its substrate and mobility was improved much. Graphene nanodiscs (GNDs), functionalized using NH3 plasma, as charge trapping sites (CTSs) for non-volatile memory applications have been investigated. Moreover, the graphene based memristor exhibits high reliability and robustness. Inspired by its internal ion migration, a state-of-art neuromorphic operations was demonstrated to mimic human brain functions. The weak van der Waal interaction of graphene interface, graphene based neuromorphic memristor exhibit ultra-low spiking energy consumption and also demonstrate a programmable metaplasticity fashion. A fluorographene based synaptic transistor was demonstrated also. Finally, a new two-dimensional (2D) material, Bi2O2Se, and graphene have the characteristics of positive and negative light-stimulated photocurrent, respectively. Based on these properties, the light-stimulated synaptic device can be realized by a proper operation in measurement. The modulation of the light pulse on the device simulated the excitation and inhibition behavior similar as in biological synapses. A circuit level based on graphene and 2D material-electronic is the good candidate to be developed in future and combining with the concept of artificial neuron network (ANN).

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Keywords

Fluorographene; memristors; artificial synapse; Bi2O2Se; light-stimulate.

Acknowledgements

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Biography of Presenting Author



Chao-Sung Lai is the Dean of college of engineering, Chang Gung University from 2012. He received the B. S. and ph. D. degrees from National Chiao Tung University, Hsinchu, Taiwan, in 1991 and 1996, respectively. In 1996, he joined National Nano Device Laboratories, Hsinchu, where was engaged in the research of silicon-on-insulator devices. He then, in 1997, joined Chang Gung University, Taoyuan, Taiwan, as an Assistant Professor. He has been engaged in the research of the characterization and reliability of MOSFETs, Flash memory, high-k dielectrics, metal gates, and biosensors. From 2001 to 2002, he visited the Department of Electrical Engineering, University of California, Berkeley, for visiting research on fin-shaped FETs. Since 2007 to 2013, he had been the Chairman of the Department of Electronic Engineering and the Director of the Biosensor Group of the Biomedical Research Center, Chang Gung University, for the research-related bio-transistor application on ions, proteins, DNA, and biomarker analysis. From 2012, he is the Dean of Engineering College of Chang Gung University. He holds 12 U.S. patents and 60 Taiwan patents, and he is the author of more than 200 journal papers, 200 conference papers, 30 international invited talks, and 2 book chapters. Dr. Lai is the leading guest editor of the SCI journals, including Microelectronics Reliability (2010), Nano-Scaled Research Letters (2011), and Solid-State Electronics (2012), and Nano-Scaled Research Letters (2014), Chemosensors (2020), ECS Journal of Solid State Science and Technology (2021). He won Lam Research Award in 1997 and distinguished award from Electron Devices and Materials Association in 2011. He was the President, Association of Chemical Sensors in Taiwan from 2016 to 2018. He is the President of Electron Devices and Materials Association from 2019. He has served as organizing committees for several international conferences, including general chair (IEEE-INEC 2011), (IEEE-ISNE 2015) and international advisory committee (IEEE-ISNE 2016) and (IEEE-EDSSC 2017).

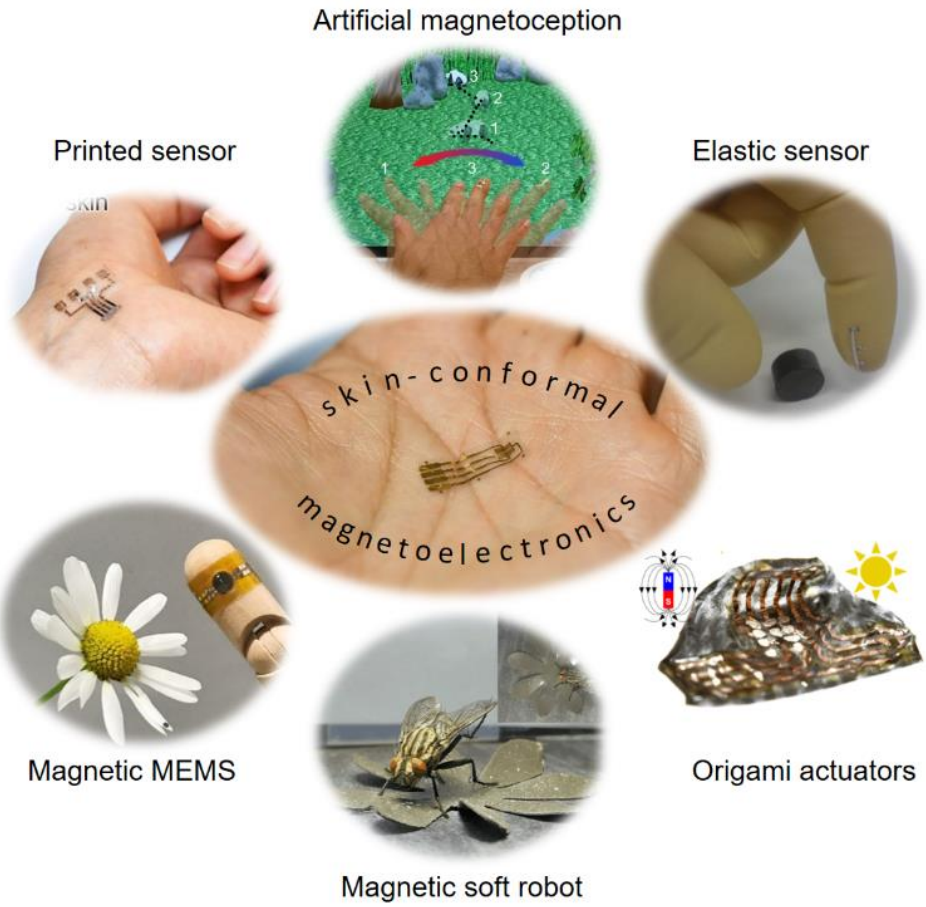
Skin-conformal Flexible and Printable Magnetoelectronics for Human-Machine Interfaces and Soft Robotics

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Graphical Abstract



Abstract

Motion sensing is the primary task in numerous disciplines including industrial robotics, prosthetics, virtual and augmented reality appliances. In rigid electronics, rotations, displacements and vibrations are typically monitored using magnetic field sensors prepared on flat and rigid substrates. Extending 2D structures into 3D space relying on the flexible and printed electronics approaches allows to enrich

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conventional or to launch novel functionalities of spintronic-based devices by tailoring geometrical curvature and 3D shape. We developed shapeable magnetoelectronics [**1**] – namely, flexible, stretchable [**2**] and even printable [**3**] skin-conformal magnetosensitive elements. The technology platform relies on high-performance magnetoresistive and Hall effect sensors fabricated on ultrathin polymeric foils based on thin film technologies or printing methods. These mechanically shapeable magnetosensitive elements enable touchless interactivity with our surroundings based on the interaction with magnetic fields, which is relevant for smart skins, soft robotics and human-machine interfaces. With these activities, we extended the use of high quality magnetic thin films to new research and technology fields. This topic is gaining visibility in the interdisciplinary community of physicists, chemists, mechanical and electrical engineers working on the fabrication of 3D shaped magnetic functional membranes, develops methods for their characterisation and theoretical frameworks for their description as well as puts forth concepts for the technological implementation of shapeable magnetoelectronics in different application fields. Here, we will review technological platforms allowing to realize mechanically imperceptible electronic skins for interactive electronics, which enable perception of the geomagnetic field, but also enable sensitivities down to ultra-small fields of sub-50 nT. These devices allow humans to orient with respect to earth's magnetic field ubiquitously. Furthermore, biomagnetic orientation enables novel interactivity concepts for virtual and augmented reality applications. We showcase this by realizing touchless control of virtual units in a game using omnidirectional magnetosensitive skins [**2**]. This concept was further extended by demonstrating a flexible magnetic microelectromechanical platform (m-MEMS), which is able to transduce both tactile (via mechanical pressure) and touchless (via magnetic field) stimulations simultaneously and discriminate them in real time [**4**]. This is crucial for smart home applications, interactive electronics, human-machine interfaces, but also for the realization of smart soft robotics with highly conformal integrated feedback system [**5**] as well as in medicine for physicians and surgeons. In 2019, we brought these research activities to the next level in the frame of the Helmholtz Innovation Lab *FlexiSens*. *FlexiSens* bridges fundamental and application-oriented activities with the focus on the transfer of the thin film fabricated sensor technologies for flexible and printable electronics to the market. For this purpose, together with Scia Systems GmbH, we establish a 300 mm grade production line (thin film deposition, lithography, chemical processing of 300 mm wafers) to bring the our sensor technologies to the industry-relevant scale. Flexible magnetic field sensors are offered to industry partners either directly via the HZDR or via the company HZDR Innovation GmbH and already bring financial benefit to the group. The fundamental and application-oriented aspects of this technology will be discussed in the presentation.

Keywords

Flexible electronics; printed electronics; magnetic field sensing; human-machine interfaces; soft robotics.

Acknowledgements

These developments benefited from the direct contribution of and insightful discussions with current and former members of the group as well as numerous fruitful cooperations with research teams worldwide. This work was financed in part via national and European projects including German Research Foundation (DFG) Grants MA 5144/9-1, MA 5144/13-1, MA 5144/28-1, and Helmholtz Association of German Research Centres in the frame of the Helmholtz Innovation Lab *FlexiSens*.

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Biography of Presenting Author



Born and raised in Ukraine, I obtained my Master Degree (2005) at the Taras Shevchenko National University of Kyiv in Ukraine, followed by a Ph.D. (2008) from the University of Konstanz in Germany, working on hard magnetic materials for data storage applications. From November 2010 until September 2015, I was leading a group *Magnetic Nanomembranes* at the Leibniz Institute for Solid State and Materials Research Dresden (IFW Dresden). Since October 2015, I work at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and currently assume position of the head of department *Intelligent materials and systems* and lead the technology transfer activities at the Helmholtz Innovation Lab *FlexiSens*. With our activities, we made a decisive contribution to the development of the field of curvilinear magnetism and stimulated research on spintronics on flexible, bendable and stretchable surfaces. Mechanically flexible and skin-conformal magnetic field sensors enable new application scenarios for human-machine interfaces, eMobility and medicine. The development of this novel research field is supported in the frame of 18x national and 5x European projects including European Research Council, EU Information and Communication Technologies, Federal Ministry of Education and Research, German Research Foundation (total third party funding exceeds 15.5 MioEUR). The research of my group is visible and well accepted by the material science and flexible electronics communities. This is reflected in numerous high-profile publications (more than 160 publications; H-index: 45; i10-index: 120) including Nature Physics; 2x Nature Electronics, 6x Nature Communications, Science Advances, 12x Advanced Materials, 6x Nano Letters, and invitations to key conferences in the field (more than 100 invited talks). Furthermore, our publications are featured as 26 cover pages of the top journals of the material science community including 1x Nature Electronics, 6x Advanced Materials. I am a Senior Member of the IEEE and a Fellow of the Young Academy of Europe.

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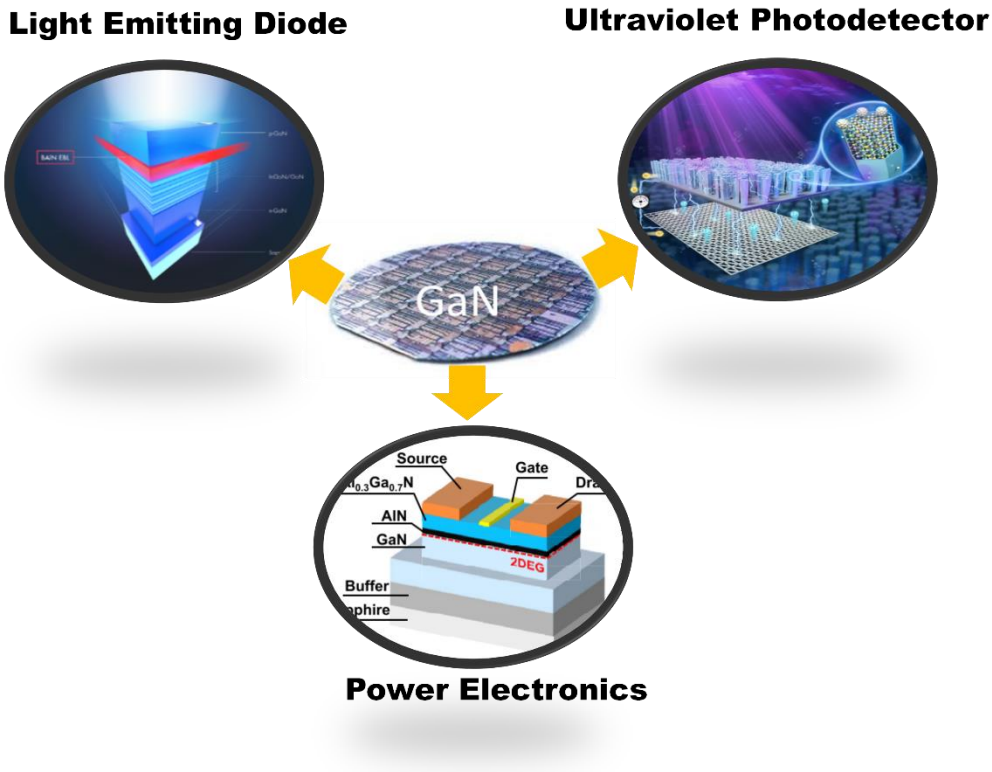
Gallium Nitride Technology for Future Ultraviolet Light Emitting, Detecting and Electronic Devices

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Graphical Abstract



Abstract

The III-nitride family (AlN, GaN, InN, and their alloys) has been regarded as one of the most significant semiconductors, and has therefore been heavily investigated in the past two decades for both optoelectronics (light emitting diodes, photodetectors, etc.), and power electronics applications (high mobility electron transistor, etc) [**1**]. Excitingly, the InGaN-based light emitters have revolutionized the lighting industry, promoting energy-efficient and eco-friendly modern solid-state lighting and lasing technologies. Similarly, by alloying GaN with AlN, we can synthesize AlGaN ternary alloys with tunable direct bandgaps from 3.4 eV (GaN) to 6.1 eV (AlN), corresponding to a wide UV spectral range from 360 nm to 210 nm, for a broad range of applications including air/water purification, UV curing, data storage, optical communication, etc. Hence, the AlGaN alloys have attracted enormous attention in the nitride community for use in efficient AlGaN-based UV LED [**2,3**], lasers and photodetectors [**4**]. In the field of power electronics, AlGaN alloys possess superb material

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properties including large critical electric fields, high electron mobility, and an excellent power figure of merit, making them very suitable for developing power electronic devices [**5**]. In this presentation, we will focus on the development of AlGaN-based high efficient UV LEDs, UV lasers, UV detectors as well as AlGaN/GaN heterojunction based HEMTs. Particularly, we will discuss the successful demonstration of the high efficient deep-ultraviolet light-emitting diodes grown on large misoriented sapphire substrates, ultraviolet lasers in the form of graded index separated confinement heterostructure (GRINSCH), the high photoresponsive solar-blind photodetectors in the form of AlGaN-based nanowires, as well as the high performance of HEMT. In the first part, high quality Al1-xGaxN/Al1-yGayN multiple quantum wells (MQWs) with sharp interfaces and emitting at ~280 nm was successfully grown on sapphire substrate with a misorientation angle as large as 4°. Wavy MQWs are observed due to step bunching formed at the step edges of the highly misoriented substrate. A significantly enhanced photoluminescence intensity (at least 10 times higher), improved internal quantum efficiency over 90%, and a much longer carrier lifetime were achieved for QWs grown on 4° misoriented sapphire substrate when compared with that grown on 0.2° misoriented sapphire. Importantly, the wafer-level output power of the ultraviolet light emitting diodes on 4° misoriented sapphire substrate were nearly doubled. In the second part, we will discuss about the UV lasers in the form of GRINSCH. In the third part, we will discuss the research on the solar-blind PDs based on self-assembled defect-free wide bandgap AlGaN nanowires on the low cost, large-scale silicon substrate, demonstrating superior photoresponse capability with high reproducibility, reliability and scalability. And in the last part, we will cover recent progress of development of high performance AlGaN/GaN based HEMT devices.

Keywords

Gallium nitride; light emitting diode; ultraviolet photodetector; power electronics, HEMT.

Acknowledgements

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Biography of Presenting Author



Prof. Haiding Sun received his Ph.D. in Electrical Engineering from Boston University. He is a Professor in the School of Microelectronics at University of Science and Technology of China. He has published more than 85 peer-reviewed SCI-index journal papers including Nature Electronics, Advanced Functional Materials, Nano Letters, IEEE Electron Device Letters, Applied Physics Letters etc. He has written 4 book chapters and holds 4 US, 4 PTC and 20 Chinese Patents. His research interests include the investigation of the physics, MBE and MOCVD epitaxy, fabrication, and characterization of wide bandgap semiconductor materials for both optoelectronics and electronic devices. This includes nanostructures and low-dimensional structures (quantum wires, dots, wells) for nanoelectronics and nanophotonics, based on group III-Nitrides and III-Oxides. His work has been highlighted by more than 100 times in many media outlets including Compound Semiconductors, Semiconductors Today, Phys.org, Nanowerk etc. He is a IEEE Senior Member.

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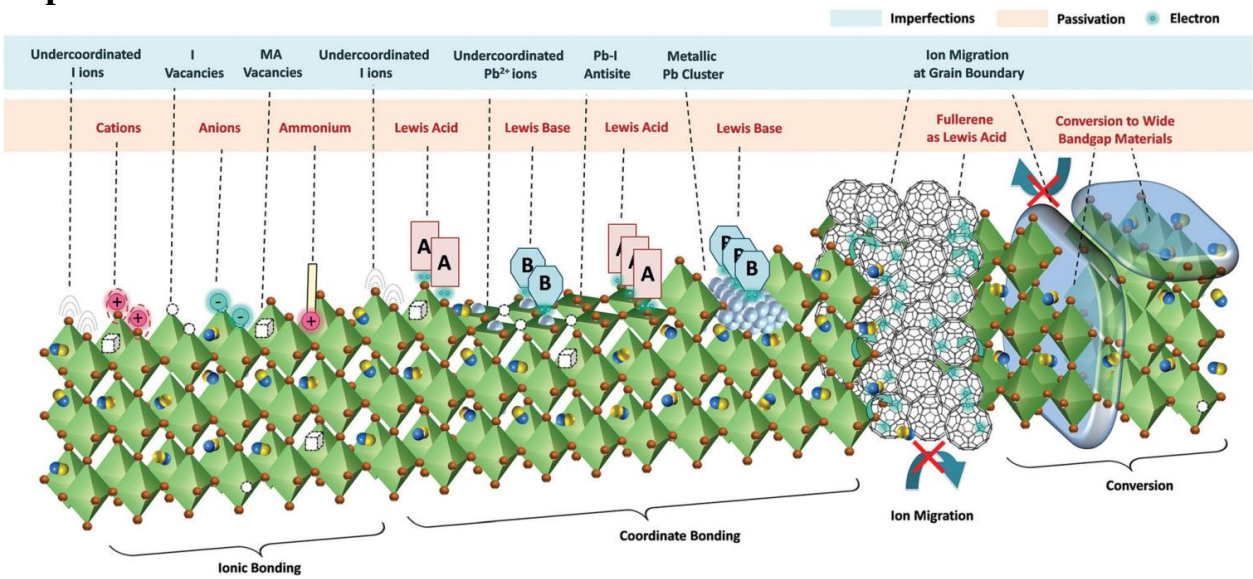
Surface Chemistry of Hybrid Perovskites

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Graphical Abstract



Abstract

Organic-inorganic perovskite solar cells have attracted extensive attention in scientific research in recent years. Now its certificated efficiency has exceeded 25%, exceeding the standard of commercial thin-film solar cells. However, the major obstacle to the commercialization of perovskite solar cells is its stability, that is, the degradation of materials under humid, light, high temperature and other environments. In view of the above problems, we have carried out a series of works. Firstly, we proposed the concept of functionalization of perovskites: a new type of ammonia molecules with hydrophobic alkyl groups are assembled to A sties on perovskite surface and established a monolayer waterproof coating. Through the optimization of surface molecular structure, this method can effectively improve the humidity stability of perovskite, enabling excellent stability (>30 days) under the relative humidity of 90%, while traditional perovskite material was completely decomposed within 10 days under this condition. Secondly, We show that converting the surfaces of lead halide perovskite to water-insoluble lead (II) oxysalt through reaction with sulfate or phosphate ions can effectively stabilize the perovskite surface and bulk material. These capping lead oxysalt thin layers enhance the water resistance of the perovskite films by forming strong chemical bonds. The wide-bandgap lead oxysalt layers also reduce the defect density on the perovskite surfaces by passivating undercoordinated surface lead centers, which are defect-nucleating sites. Encapsulated devices stabilized by the lead oxysalt layers maintain 96.8% of their initial efficiency after operation at maximum power point under simulated air mass (AM) 1.5 G irradiation for 1200 hours at 65°C. Then, a perovskite photovoltaic high-energy radiation stability test system is designed and built. The

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perovskite active layers are shown to retain 96.8% of their initial power conversion efficiency under continuous irradiation of gamma-rays and light for 1535 h, where gamma-rays have an accumulated dose of 2.3 Mrad. In striking contrast, a glass substrate shows obvious loss of transmittance under the same irradiation conditions. The excellent stability of the perovskite solar cells benefits from the self-healing behaviour to recover its efficiency loss from the early degradation induced by gamma-ray irradiation. These results demonstrate the prospects of perovskite materials in applications of radiation detectors and space solar cells.

Keywords

Perovskite; surface; stability.

Acknowledgements

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Biography of Presenting Author



Shuang Yang received his Bachelor degree from Tsingtao University of Science & Technology in 2011, and got his PhD degree at East China University of Science and Technology in 2016. He then joined Nanyang Technological University, University of Nesbraka- Lincoln, University of North Carlina, Chapel Hill as a postdoctoral researcher. Currently he is a professor at East Chin University of Science &Technology. His research focus on the chemistry and physics of semiconducting materials and photo-electric devices. He has published more than 50 research papers, including Science, Nat. Energy, Nat. Common., J. Am. Chem. Soc., Angew. Chem. Int. Ed., Adv. Mater. etc. His current research interests focus on semiconducting materials and next-generation photovoltaics.

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Nonvolatile Electric-field Control of Magnetic and Transport Properties in PMN-PT-based Multiferroic Heterostructures

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Graphical Abstract

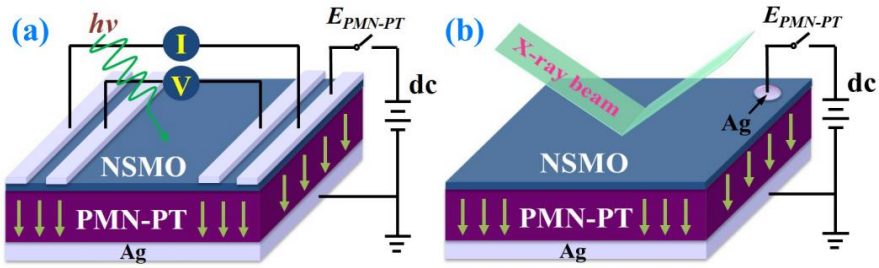


Fig. 1. Schematic of the experimental setups for in situ measurements of (a) film resistance and (b) out-of-plane strain of the PMN-PT-based heterostructures, respectively.

Abstract

The integration of magnetic functional thin films (e.g., metals/alloys, ferrites, and manganites) with perovskite ferroelectrics offers an exciting opportunity to control magnetism by electric field (instead of magnetic field and electric current) through a strong magnetoelectric coupling effect, which is promising for developing dense, high-speed, ultralow-power tunable electronic and spintronic devices. Progress has been made toward electrically controlling nonvolatile tuning of magnetic states in these multiferroic heterostructures for information storage industry, which is usually attributed to ferroelectric polarization switching-induced interfacial charge effect. In this work, we propose a design principle that the electrically induced ferroelastic domain engineering in PMN-PT ferroelectric single-crystal substrates can be used to achieve robust nonvolatile tuning of magnetic and transport properties in elastically-coupled perovskite manganites and $SrRuO_3$ thin films in a reversible way. Such a nonvolatile and reversible response is striking, which stems from the intermediate lateral-polarization-induced stable strain state in the substrate during domain switching. Based on the piezoelectric response of the substrate, the quantitative determination of the resistance change and the lateral strain of the film can be obtained. These results demonstrate that lattice strain and physical properties of functional thin films epitaxially grown on PMN-PT substrates can be in situ, dynamically and reversibly modulated via ferroelectric poling, converse piezoelectric effect, polarization rotation, and ferroelastic effect. This method can be further extended to study the intrinsic strain effects of other functional thin films. Moreover, for manganite films the magnetically (optically) tunable strain effect, together with the strain-tunable magnetoresistance (photoresistance) effect, demonstrates strong mutual coupling between the strain and the magnetic field (light), which is essentially mediated by the electronic phase separation. Our findings are instructive for realizing ferroelastically driven nonvolatile manipulation of lattice-coupled magnetic and electrical properties in hybrid correlated oxides/ferroelectric systems and

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designing next-generation reconfigurable, high-frequency, ultralow-power nonvolatile electronic devices.

Keywords

PMN-PT crystals; correlated oxides; magnetoelectric effect; strain effect.

Acknowledgements

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Biography of Presenting Author



Ming Zheng obtained his Ph.D. degree in Materials Physics and Chemistry from Shanghai Institute of Ceramics, Chinese Academy of Sciences in 2015. After working at National University of Singapore, The University of Hong Kong, and The Hong Kong Polytechnic University, Dr. Zheng was awarded Japan Society for The Promotion of Science (JSPS) Fellowship in the field of multiferroics and joined the Department of Physics in Nagoya University, Japan, in 2018. In 2019, he was invited to join China University of Mining and Technology as a faculty member through high-end talents program. His current research interests include functional (multiferroic, ferroelectric, magnetic and luminescent) thin-film materials and devices. He has authored or co-authored more than 30 papers published in international reputed journals including NPG Asia Mater. (2), Adv. Funct. Mater., Nano Energy, ACS Appl. Mater. Interfaces (2), J. Mater. Chem. C, Appl. Phys. Lett. (8), Phys. Rev. Applied (2), Phys. Rev. B. The paper published on Phys. Rev. Applied (2018) was selected as key scientific article by Advanced in Engineering (AIE), a famous global science and technology media organization. He also served as an Editorial Board Member for the journals Current Applied Materials, Current Chinese Science and TPC member for AMEE2020 and the referee for well-known journals, such as NPG Asia Mater., ACS Appl. Mater. Interfaces, J. Mater. Chem. C, Adv. Electron. Mater., Appl. Mater. Today, etc.

Novel Nanomaterials Development for the Production of Jet Fuel Range Hydrocarbons from Vegetable Oils

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Abstract

In this study, the synergistic effect of Fe on the monometallic Cu/SiO_2-Al_2O_3 catalysts of variable Cu loadings (5–15 wt. %) was ascertained by varying Fe contents in the range of 1–5 wt. % on the optimized 13 wt. %Cu/SiO_2-Al_2O_3 catalyst. At 340 °C and 2.07 MPa H_2 pressure, the jet fuel range hydrocarbons yield and selectivity of 51.8% and 53.8%, respectively, were recorded for the Fe(3)-Cu(13)/SiO_2-Al_2O_3 catalyst. To investigate the influence of nature of acid sites of support on cracking of oleic acid, ZSM-5 and HZSM-5-supported 3%Fe-13%Cu were also evaluated at 300–340 °C and 2.07 MPa H_2 pressure. XPS analysis revealed the existence of Cu^{1+} phase in the Fe(3)-Cu(13)/SiO_2-Al_2O_3 catalyst while Cu metal was predominant in both the ZSM-5 and HZSM-5-supported FeCu catalysts. The lowest crystallite size of Fe(3)-Cu(13)/SiO_2-Al_2O_3 was confirmed by XRD indicating high metal dispersion and corroborated by the weakest metal-support interaction revealed from the TPR profile of this catalyst. CO chemisorption also confirmed high metal dispersion (8.4%) for the Fe(3)-Cu(13)/SiO_2-Al_2O_3 catalyst. The lowest and mildest Bronsted/Lewis acid sites ratio was recorded from the pyridine-FTIR analysis for this catalyst. The highest jet fuel range hydrocarbons yield of 59.5% and selectivity of 73.6% were recorded for the Fe(3)-Cu(13)/SiO_2-Al_2O_3 catalyst evaluated at 300 °C and 2.07 MPa H_2 pressure, which can be attributed to its desirable textural properties, high oxophilic iron content, high metal dispersion and mild Bronsted acid sites present in this catalyst. Also, the synergistic effects of 1 wt.% Ti, 1 wt.% Zr, and Sn in the range of 0.5-2 wt.% on Fe(3)-Cu(13)/SiO_2-Al_2O_3 catalyst were ascertained through extensive characterization and their subsequent evaluation for the production of aviation turbine fuel (ATF) range hydrocarbons (C_8-C_{16}) via hydroprocessing of oleic acid. The largest surface area (571 m^2/g) and pore volume (0.65 cm^3/g) were obtained from the N_2 physisorption analysis of 1 wt.% Sn-promoted catalyst. Cu_2O and CuO were identified in the X-ray diffractograms (XRD) of all the catalysts except for catalyst containing 1 wt.% Sn, which revealed only the peaks of Cu_2O owing to the small particle size of CuO below the threshold of detection of XRD. X-ray photoelectron spectroscopy (XPS) analysis revealed the presence of both oxidized and reduced phases of Cu, Fe, Ti, Zr and Sn in their respective catalysts, with the highest and lowest atomic compositions of reduced Fe and CuO, respectively, detected in catalyst containing 1 wt.% Sn; corroborating findings from XRD analyses. The relatively homogeneous dispersion of phases present in this catalyst (revealed by its smallest crystallite size of 5.1 nm) was also evidenced by the weakest metal-support interaction from the H_2-TPR analysis of the same catalyst. Hydroprocessing of oleic acid using catalyst containing 1 wt.% Sn at T=320°C, H_2 pressure = 2.1 MPa, and time = 8 h, resulted in the highest ATF range hydrocarbons selectivity of

76.8% and yield of 71.7%; probably due to its high metal dispersion, desirable textural properties and high oxophilic reduced iron content.

Biography of Presenting Author



Dr. Ajay K. Dalai obtained his B.Sc. Tech. in Petro-Chemical Engineering from LIT, Nagpur, and M.Tech. in Chemical Engineering from IIT Kanpur. Then he served as Petroleum Production Engineer at ONGC, Ahmedabad for about two years and then joined the University of Saskatchewan for his Ph.D. After obtaining his experiences as a PDF at Texas A&M University at College Station in Texas and as a Research Associate at the University of Calgary, Alberta, Canada, he joined the University of Saskatchewan as an Assistant Professor in 1996, and then he was promoted to Associate Professor in 1998 and to Full Professor in 2002. He was promoted to Distinguished Professor at the University of Saskatchewan in 2020. Professor Dalai worked as Tier 2 Canada Research Chair at the University of Saskatchewan from 2001 to 2009 and then was promoted to Tier 1 Canada Research Chair in 2009 which he currently holds. He has served as Head of Chemical Engineering from 2007 to 2009 at the University of Saskatchewan and as Associate Dean, Research and Partnership from 2009 to 2014 in the College of Engineering. In 2012, Professor Dalai worked as Special Adviser to VP Research Signature Areas of Energy and Mineral Resources.

Dr. Dalai's research focus is the novel catalyst development for gas to liquid technologies, biodiesel production, hydrogen/syngas production, hydroprocessing, value-added products from biomass, and pollution control. He has supervised over 150 M.Sc., Ph.D., and Post-doctoral Fellows and has received over 35 million dollars for his research over the past 25 years. Dr. Dalai has published over 550 research papers mostly in heterogeneous catalysis and catalytic processes in international journals and conference proceedings. He has submitted several patent applications. His ground-breaking research has led to over 31500 citations of his work and H-index of 82. He serves in Editorial Board of several prestigious journals. Professor Dalai has received fellowship from different societies such as Royal Society of Canada, Royal Society of Chemistry in UK, International Association of Advanced Materials, American Institute of Chemical Engineering, Canadian Academy of Engineering, Chemical Institute of Canada, Engineering Institute of Canada, and Indian Institute of Chemical Engineers. Professor Dalai is also a Fulbright Fellow from USA, DAAD Fellow from Germany and JSPS Fellow from Japan. Professor Dalai has received several national and international awards. Recently, he has received Indian Institute of Chemical Engineers DRC Life Time Achievement Award, Canadian Society of Chemical Engineering R.S. Jane Memorial Award for outstanding contributions to Chemical Engineering Profession, Royal Society of Canada's Miraslow Romanoswki Medal for Outstanding Contribution to Environmental Science, and University of Saskatchewan's George Ivany Internationalization Award.

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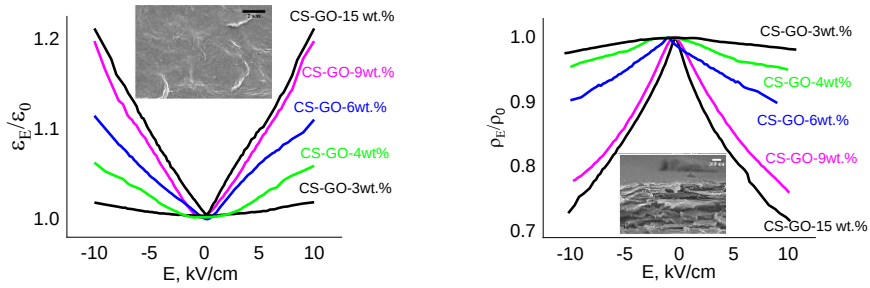
Chitosan-graphene Oxide Nanocomposites for Smart Flexible Electronics Applications

Yevgen Prokhorov*

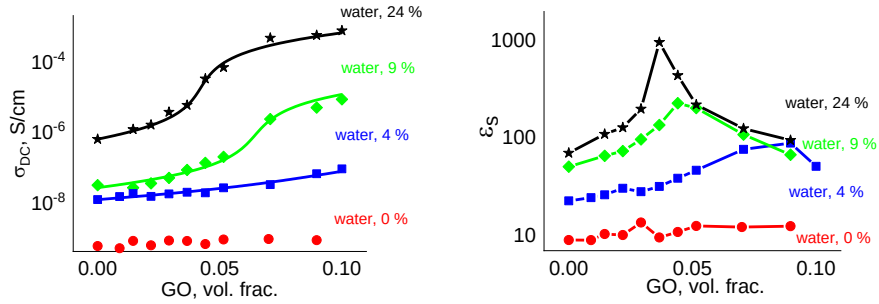
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Graphical Abstract



Tunability of capacitance and resistivity obtained in CS–GO films with different weight % of GO.



Dependences of conductivity and dielectric constant as a function of GO volume fraction for films with different water content indicate on graphs.

Abstract

Chitosan-graphene oxide (CS-GO) nanocomposites have attached great attention due to various applications in the flexible electronic as field-effect transistors, smart functional devices, sensors, supercapacitors, etc. The performance of such devices depends upon their dielectric constant, conductivity, humidity, and application of an external electrical field. Despite of intensive research, the effect of sorbed water on the conductivity and dielectric behavior of nanocomposite has not been fully addressed and demonstrate controversial results. In this regard, reported electrical properties (conductivity σ and dielectric constant ε) show large dispersion: for example, at room temperature values of σ varied between 10^{-5}-10^{-2} S/cm and ε between 2-10^4. Therefore, the aim of this work is to investigate the conductivity and dielectric constant of neat GO (GO paper) and CS-GO nanocomposites in wide range of GO concentrations and under different water content. Additionally, FTIR, Raman, XRD, weight and impedance measurements were carried out to shed light on properties of CS-GO nanocomposites for different applications.

Our findings reveal that σ and ε of GO strongly depends upon the frequency range and moisture content. We found 3 frequency regimes: in the low frequency range dominated Wartburg pseudocapacitance; in the frequency range 10^2-10^5Hz dominated water interface layer and at frequency higher than 10^5Hz dominated bulk GO properties.

In CS-GO flexible films new phenomena has been observed: electrical tunability and percolation effects. It was shown that nanocomposites capacitance exhibits negative tunability (dielectric constant increase with applying DC electrical field). Concomitantly, the resistivity revealed positive tunability (by increasing electrical field the resistivity decreases). The mechanism of such anomalous tunability can be traced as a reversible transformation of GO into rGO ($CS–NH^{+}_{3}–GO–H^{+} \Leftrightarrow CS–rGO$). In this transformation H^{+} from water or GO side groups and those from protonated NH^{+}_{3} groups of CS participate in the reduction process. Due to the presence of additional protons from CS, this process is relatively quick with excellent reproducibility.

Dependences of DC conductivity and dielectric constant have been investigated versus GO concentration and water content. In the case of CS-GO films annealing before measurements in a vacuum, DC conductivity and dielectric constant do not dependent on the GO concentration. At water content higher 5% the percolation effect has been observed. The values of critical exponents obtained in wet CS-GO films allow us to conclude that nanocomposites are a three-dimensional percolation system. Results of fitting of DC conductivity using a model which includes conductivity of CS, GO and interface layer between them have shown that with increasing of water content in CS-GO films, conductivity, and thickness of interfacial layer increase. Moreover, the conductivity of the interfacial layer in wet films is higher than the conductivity of CS and neat GO, and the thickness of the interfacial layer increases with water content. For an explanation of experimental results, the new model of percolation phenomena in wet CS-GO nanocomposites has been proposed: due to the interaction of GO with CS and water molecules at the interface between CS and GO appear high conductivity interface phase, which supports proton transfer and is responsible for the percolation properties of wet nanocomposites. Additionally, increasing water content increases the conductivity and thickness of the interface layer that led to shifting the percolation threshold to lower GO concentration.

Results presented may be of great importance in the applications of such nanocomposites in different areas, as proton exchange membranes, sensors, flexible electronics, biomedicine.

Keywords

Chitosan; graphene oxide; tunability; percolation.

Acknowledgements

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Biography of Presenting Author



Prof. Yevgen Prokhorov received his PhD degree from Odessa State University (Ukraine) in 1979. In 1990, he was promoted to Heard of Department at Institute of Mechanic of Ukraine Academy of Science. Since 1998 he works at the Center for Research and Advanced Studies of the National Polytechnic Institute (Mexico) as research Professor at Material Science Department. The current focus of his research is on nanocomposites comprising polymers with conductivity and dielectric inorganic nanoparticles, characterization their structure and electrical properties. Besides, he is interested in the application of nanocomposites for flexible electronic and biomedical applications. Prof. Yevgen Prokhorov is author or co-author more than 120 papers on ISI journals, of more than 60 full papers published in peer-reviewed international and national conferences proceedings, 11 patents, 2 books and 8 books' chapters. He participated as the director more than in 20 national and international scientific projects.

Hydrogels for Energy and Sustainability

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Abstract

Hydrogels are highly crosslinked networks of polymers saturated with water. Conventional hydrogels have found significant applications in biomedical fields such as tissue engineering and drug delivery, owing to their stimuli responsiveness and biocompatibility. We have developed a novel class of 'energy hydrogels' based on versatile gelation chemistries with highly tunable molecular building blocks and rational integration with micro-/nano-structured materials, to achieve a number of appealing new functionalities that enable them as an emerging material platform for advanced energy and sustainability technologies.

In this talk, I will illustrate how to design 'structure-derived multifunctionality' of this special class of materials and to transform the current development of hydrogel materials into sustainable energy and water technologies, from high-energy batteries and supercapacitors, electrocatalysts, to solar-driven water desalination and atmospheric water harvesting

Keywords

Hydrogel; energy storage; electrocatalysis; energy technology.

Biography of Presenting Author



Guihua Yu is a Mike Walker Professor of Materials Science and Mechanical Engineering at University of Texas at Austin. He received Ph.D. from Harvard University followed by postdoc at Stanford University. His research has focused on creative synthesis and self-assembly of functional organic and hybrid organic-inorganic nanomaterials, and fundamental understanding of their chemical/physical properties for advanced energy and environmental technologies. Yu has published over 230 scientific papers in many prominent journals such as Science, Nature, Nature Reviews Materials, Nature Materials, Nature Nanotechnology, Nature Catalysis, Nature Sustainability, with total citations over 44,000 times and H-index ~113. Yu is an elected fellow of Royal Society of Chemistry (FRSC) and Institute of Physics (FInstP), and he is ranked as one of Top Highly Cited Researchers in Materials Science by Web of Science since 2017. He is the recipient of a number of prestigious awards/honors, to name a few: Blavatnik National Awards Honoree, O'Donnell Award in Engineering by Texas Academy of Medicine, Engineering, and Science (TAMEST), TMS Brimacombe Medalist Award, IAAM Medal Award, Polymer International-IUPAC Award for Creativity in Applied Polymer Science, US Department of Energy's Early Career Award, ACS ENFL Emerging Researcher Award, Caltech's Resnick Young Investigator, Camille Dreyfus Teacher-Scholar Award, Sloan Research Fellowship, *MIT Technology Review* '35 Top Innovators Under 35', IUPAC Prize for Young Chemists. Yu currently serves as Associate Editor of *ACS Materials Letters* (a new flagship materials science journal by American Chemical Society) and is Advisory/Editorial Board Member of over 20 prestigious international journals.

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Strategic Routes to Comprehensive Antimicrobial Polymers: Preventing the Spread of Diseases

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Graphical Abstract

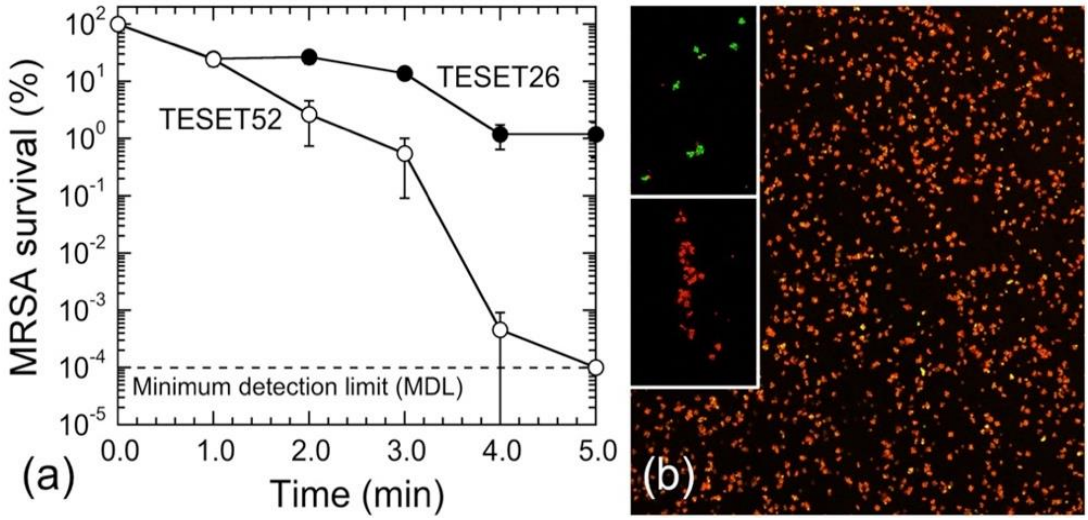


Fig. 1. (a) Survival kinetics of methicillin-resistant *S. aureus* (MRSA) on two polyacids differing in their degree of functionalization. (b) Live/dead assay of methicillin-susceptible *S. aureus* after 5 min of exposure.

Abstract

Some of the challenges currently facing the global health community are becoming increasingly life-threatening. For instance, infectious microbes such as SARS-CoV-2, *C. difficile* and methicillin-resistant *S. aureus* (MRSA) constitute major healthcare concerns as invisible predators that primarily, but necessarily, stalk the elderly and immune-compromised. In response, various materials-related antimicrobial surfaces involving metal (oxide) nanoparticles or surface functionalization have been proposed to combat this growing menace by preventing the spread of infectious diseases, but many are either limited to specific microbes or promote environmental contamination. In this work, we introduce two promising antimicrobial surface strategies in which several polymer films and coatings are utilized as exemplars to demonstrate their potential. The first focuses on embedding photosensitive dye molecules capable of generating singlet oxygen, a strong oxidizing agent, into a nonpolar thermoplastic elastomer (TPE), [**1**] as well as coatings on polymer fibers [**2,3**] and other substrates. In the presence of molecular oxygen and incoherent visible light, this system inactivates at least 99.9999% of two Gram-positive bacterial strains, as well as at least 99.9% of three Gram-negative bacterial strains, three virus strains and a fungal strain, in *ca*. 1 h under the conditions employed. Alternatively, a vastly different method employs an anionic TPE represented by a pentablock polymer

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that, upon hydration, is inherently capable of promoting a dramatic pH jump at the polymer/pathogen interface, [**4**] resulting in a highly acidic environment that rapidly causes inactivation and kills at least 99.99% of the pathogens tested (including 3 drug-resistant bacteria such as MRSA, as well as *C. difficile* and SARS-CoV-2[5]) in 5 min or less. These methods afford effective and unexplored pathways to broad-spectrum self-disinfecting materials that function continuously.

Keywords

antibacterial; antiviral; photoinactivation; polyacids; COVID-19

Acknowledgments

This work was financially supported by the Nonwovens Institute at North Carolina State University, Halyard Health, Kraton Corporation, and the National Science Foundation.

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Biography of Presenting Author



Dr. Richard J. Spontak is a Distinguished Professor of Chemical & Biomolecular Engineering and Professor of Materials Science & Engineering at North Carolina State University. He received his B.S. from Penn State University in 1983 and his Ph.D. from UC Berkeley in 1988. He then pursued post-doctoral research at the University of Cambridge (U.K.) and the Institute for Energy Technology (Norway) before joining the Procter & Gamble Company in 1990 and North Carolina State University in 1992. He has published over 300 peer-reviewed journal papers, and his work has been featured on 31 journal covers and cited over 14,000 times. His research interests focus on the phase behaviour and morphology/property development of nanostructured polymers, polymer nanocomposites and coatings, electron microscopy, and stimuli-responsive soft materials. In recognition of his research achievements, he has received (inter)national awards such as the ACS (PMSE Division) Cooperative Research Award in Polymer Science & Engineering, the German Society for Electron Microscopy Ernst Ruska Prize, the ACS (Rubber Division) Chemistry of Thermoplastic Elastomers Award, the IOM3 Colwyn Medal, the NTNU Lars Onsager Medal, and the SPE International Award. A fellow of the American Physical Society, IOM3 and the Royal Society of Chemistry, he is a member of the Norwegian Academy of Technological Sciences.

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Efficient Solar-Rechargeable Lithium-Ion Battery Energy Storage

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Abstract

Use of energy storage devices such as lithium-ion batteries (LIBs) can help to mitigate the problem of intermittent photovoltaic (PV) power to achieve higher PV penetration into the electric grid. Also, the benefit of deployment of electric vehicles for energy sustainable future seems rather irrelevant unless they are charged using electricity generated from renewables. In addition, large scale practical applications of battery based electric vehicles is still challenging because of the inflexibility it has with the charging stations. All these issues can be addressed by use of solar cells as a viable energy source to charge lithium-ion batteries. Here we demonstrate simple, efficient and cost-effective photo-charging design approach where the use of promising low-cost solar cells such as perovskite solar cell or dye sensitized solar cell with the help of DC-DC power conversion can efficiently charge a $Li_4Ti_5O_{12}$-$LiCoO_2$ LIB.

Biography of Presenting Author



Dr. Quinn Qiao is Professor in Mechanical and Aerospace Engineering at Syracuse University. Current research focuses on lithium-ion batteries, lithium metal batteries, polymer photovoltaics, dye-sensitized solar cells, and Perovskite solar cells. He has published more than 200 peer reviewed papers in leading journals including Science, Nature Communications, Energy and Environmental Science, Journal of the American Chemical Society, Advanced Materials, Advanced Energy Materials, Advanced Functional Materials, Nanoscale, and Nano Energy, etc. He has received NSF CAREER Award from US National Science Foundation, and Bergmann Memorial Award from the US-Israel Bi-national Science Foundation.

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A Coating Strategy for Photochemical Production at Scale

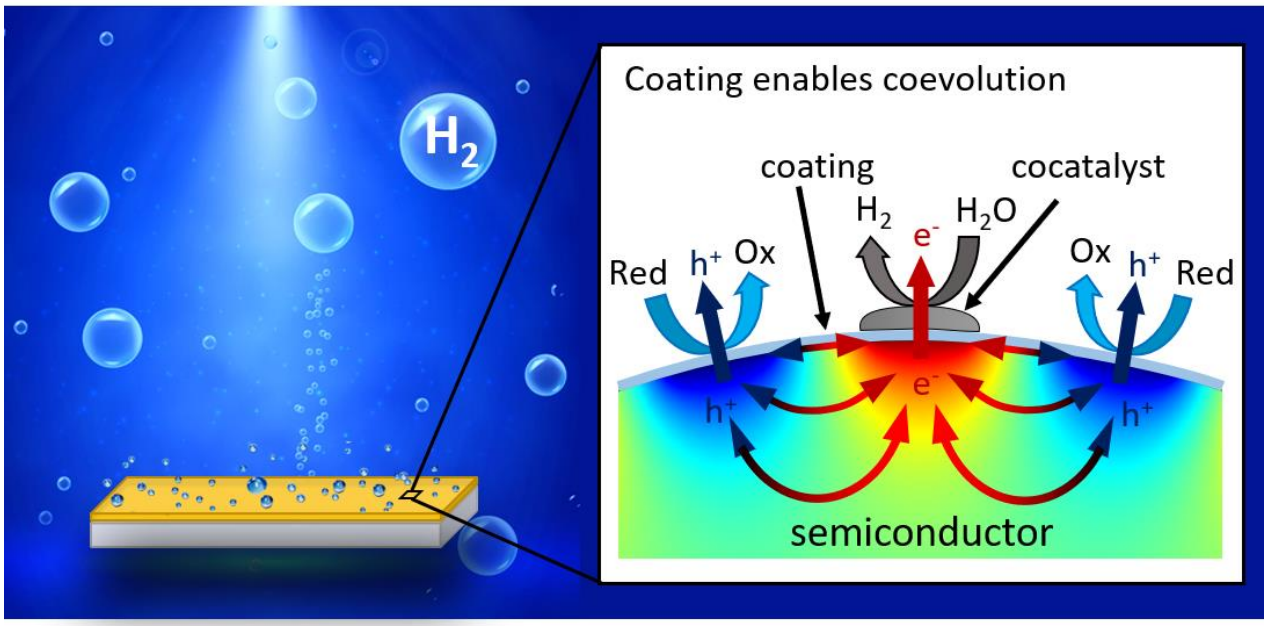
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Graphical Abstract

A conformal protective coating enabled a semiconductor particle film stably performing H_2 photocatalysis for >100 hours.



Abstract

Stable operation for over 10,000 hours has been the challenge hindering the direct use of nanoscale semiconductors for photochemical production of chemicals. I will first discuss a road map for coating-protected photoelectrochemical panels towards 20% solar-to-chemical conversion. The chemical bonds can convert the stored solar energy back to electricity or heat, desirable for the urgently needed long-duration storage. I will then discuss an emerging coating strategy to stabilize particulate photocatalysts in a photo-reactor that promises solar energy utilization at an agricultural scale. Those photocatalysts coevolve reductive and oxidative reactions in close proximity, and they potentially overcome the scale-up challenge by photoelectrochemical panels. Based on the holistic understanding of the photophysical, electrocatalytic, and transport processes coupled at the nanoscale, we employ stabilization coatings to coevolve H_2 at a record rate of 48.5 $mmol \cdot h^{-1} \cdot g^{-1}$ or 2.5 mL $H_2 \cdot h^{-1} \cdot cm^{-2}$ under 1-sun solar illumination in ambient air. I will show the combination of advanced coating design and

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in situ characterizations to visualize the multi-scale coupled processes at the semiconductor/liquid interfaces. Additionally, the discovery of new coatings offers the opportunity to tune the local energetics, kinetics, and reaction environments of supported co-catalysts.

Keywords

Photocatalysis, solar energy conversion, coating, nanoscale semiconductors.

Acknowledgements

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Biography of Presenting Author



Shu Hu received his Ph.D. (2011) from Stanford University in Materials Science and Engineering. Between 2012 and 2015, he did postdoctoral work with Professor Nathan S. Lewis at California Institute of Technology, where he discovered tunable atomic layer deposition coatings that enabled efficient and durable photochemistry. Starting the independent career at Yale, his group develop new materials and interfaces for an emerging class of photocatalysts: his work include adjusting coating energetics for selectivity and tuning coating porosity for stable membrane separation. He has won a number of awards, including the Journal of Materials Chemistry Young Investigator Award (2018), ECS Energy Division Young Investigator (2019), Scialog Fellow for Negative Emission Science (2020), and DOE Early Career Award (2021).

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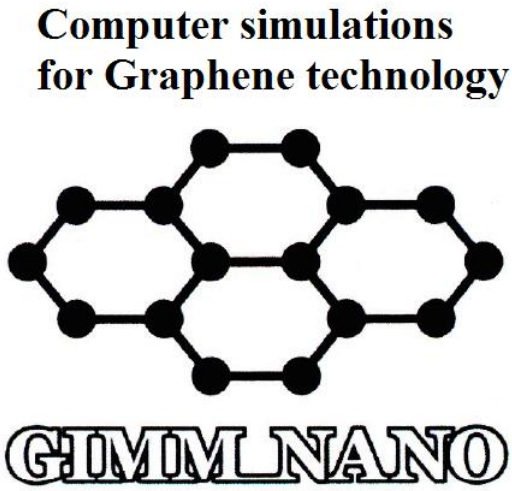
Graphene Model as a Lattice of Hydrogen-like Atoms with Screened Ions

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Graphical Abstract



Abstract

The simplest model of many-electron atoms is the model of independent electrons [**1**]. Among such models, the models of hydrogen-like and helium-like atoms are often used. In [**2**], on the basis of the Thomas-Fermi theory, the distribution of electrons in atoms with a screened ion was obtained for an arbitrary nuclear charge. This distribution of electrons was used in [**3-5**] as a model of the carbon atom in order to calculate the emission characteristics of graphene. It was assumed that out of the four valence electrons, three electrons in bond have little effect on the emission process. Under these conditions, the emission is determined by the fourth weakly bound electron, which strongly interacts with the field of the environment.

It was shown in [**4,5**] that the centrally symmetric field of the screened ion is inhomogeneous along the radius. Therefore, in the variational calculation of the electron energy, the total energy operator was modified. For this operator, the degeneracy condition was obtained and the energy of the ground state was calculated. It was shown that taking into account the interaction of a weakly bound electron with the field of the environment leads to the splitting of the ground state into two: having, respectively, dipole and quadrupole moments. In [**5**], this model of a hydrogen-like atom, taking into account the Coulomb interaction of an electron with a shielding shell, was used to calculate the photoionization energy of light atoms from the ground state. The results of these calculations are shown in **Fig. 1**.

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In this work, the distribution of screening electrons is obtained taking into account their Coulomb interaction with a weakly bound electron and the field of the nearest lattice atoms. From the condition of the maximum binding energy with the ion of all electrons of the atom, the physical conditions for the delocalization of a weakly bound electron are calculated.

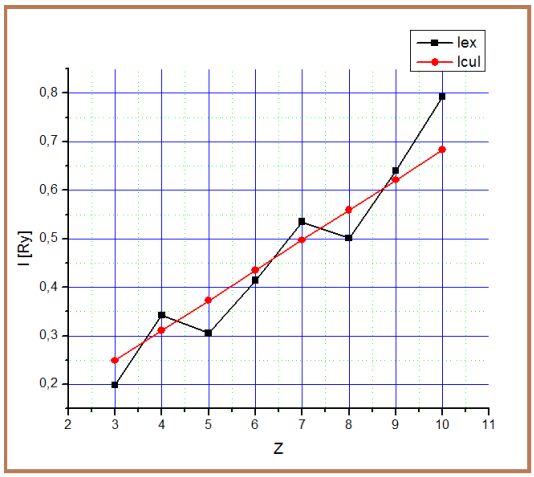


Fig. 1. Comparison of the calculated and experimental values of the single ionization potential of atoms with the nuclear charge Z.

Keywords

Computing simulation; graphene lattice; equilibrium states.

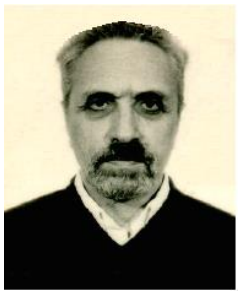
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Biography of Presenting Author



Freinkman, Boris Grigorievich was born on October 2, 1939 in Moscow. Graduate in mechanical engineer, Bouman's Moscow Higher Tech, Moscow, 1963. Graduate in applied mathematics, Moscow Engineer-Physical Institute, 1976. Doctor of Philosophy, All Union Research Institute, Moscow, 1986.
From engineer to lead engineer special design office Moscow Production Union "Melz", 1964-1981, chief specialist, 1992-1996. Lead engineer to senior science staff All Union Research Institute of Optical-Physical Measurements, Moscow, 1981-1986. Team leader Soft-Tec Ltd., 1996-1999. Senior science staff Institute Microelectronics Technology and High Purity Material, 1999-2016. Boris Grigorievich Freinkman has been listed as a noteworthy mechanical engineer by Marquis Who's Who. Recently, he has been working within the framework of grants at the Keldysh Institute of Applied Mathematics of RAS.

New Materials for 2D, 3D and 4D printing

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Abstract

Additive manufacturing which is based on printing processes is considered the next industrial revolution. Functional printing brings the additional performance of printed patterns, beyond the conventional graphic output, and the main bottleneck in this field is the lack of suitable materials. The synthesis and formulations of novel nanomaterials and inks will be presented, with their utilization in printed devices, responsive and 3D objects. New approaches for achieving conductive inks for printed plastic electronics will be presented, as well as new materials and processes for 3D and 4D printing. Utilization of 3D and 4D printing technologies for fabrication of objects composed of ceramics, shape memory polymers, elastomers and hydrogels will be demonstrated, for applications such as soft robotics, drug delivery systems, responsive connectors and Internet of Things (IoT), dynamic jewelry and medical devices.

Keywords

3D Printing, nanomaterials, soft robotics, inkjet.

Biography of Presenting Author



Shlomo Magdassi is a professor at the Institute of Chemistry of The Hebrew University of Jerusalem. He is the Director of the Center for Functional and 3D Printing, and holds the Enrique Berman Chair in solar energy. His research focuses on micro and nanomaterials and their applications in functional inks such as printed electronics, 2D, 3D and 4D printing. He is the author over 300 publications and the editor of 4 books. He also has more than 80 inventions (38 US granted patents, ~300 PCT applications), which are related to applications of dispersed systems in various industries. Based on his inventions, many commercial activities evolved, which led to licensing, worldwide sales and establishing new start-up companies.

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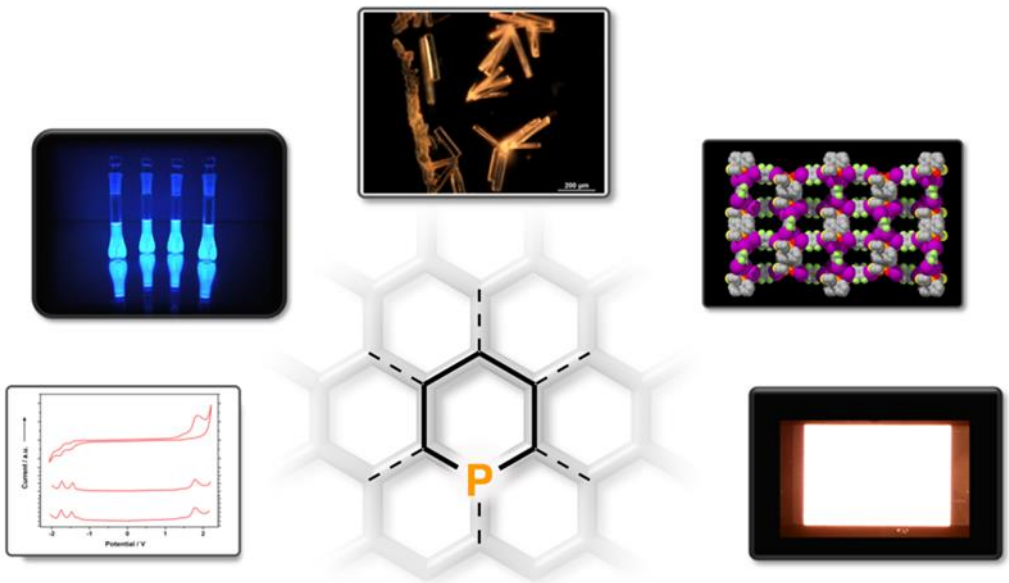
π-Extended Materials Based on Six-Membered Phosphorus Heterocycles

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Graphical Abstract



Abstract

π-Extended architectures are a fascinating class of compounds that plays a fundamental role in the materials science. The efficient overlap of atomic orbitals along an extended net of polyaromatic systems enables outstanding properties such as strong luminescence and high charge mobilities. An efficient strategy to modulate the latter optoelectronic properties consists in embedding heteroatoms into the carbon scaffold. To that end, phosphorus atoms are particular interesting. They present an electron lone pair that is readily available for a variety of reversible post-functionalization reactions with transition metals, Lewis acids, oxidizing and alkylating agents, [**1**] which may serve to modulate the structural and electronic properties of the systems they are embedded in. Thus, incorporating phosphorus centers into p-systems prompts unique electronic characteristics that are inaccessible from any other heteroatom [**2,3**]. Herein, I will provide an overview of our research on π-extended six-membered phosphorus heterocycles (6M-PHs). In particular, I will describe our investigations on the

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synthesis and multifunctional applications of novel organophosphorus materials. Our results demonstrate that π-systems based on 6M-PHs are remarkably stable and may be applied in light-emitting diodes, photoelectrochemical cells, fluoroelectrochromic devices, biomarkers, self-assembled materials and chemotherapeutic agents. Thus, all-in-all, I will describe the benefits of embedding 6M-PHs into π-extended polyaromatic hydrocarbons.

Keywords

π-extended molecules; multifunctional materials; organophosphorus materials; phosphorus heterocycles

Acknowledgements

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Biography of Presenting Author



Carlos Romero-Nieto obtained his PhD in organic chemistry from the University of Castilla-La Mancha (Spain). During his PhD, he joined the group of Prof. Thomas Baumgartner in Canada for one year. In 2010, he joined the group of Prof. Dirk Guldi at the Department of Physical Chemistry of the University of Erlangen-Nuremberg (Germany) for a postdoctoral position. In 2013, he was awarded with the Liebig Fellowship, which allowed him to start his independent career at the University of Heidelberg (Germany). In 2019, he obtained the Venia Legendi from the University of Heidelberg. In 2016, he was awarded with the Hengstberger Prize for Young Researchers from the University of Heidelberg, in 2018 with the National Award for Young Researchers by the Spanish Royal Chemical Society and in 2020 with the Award for Young Researchers from the Spanish Royal Chemical Society of Castilla-La Mancha. His research interests include the synthesis of novel phosphorus- and boron-based functional molecules for the development of new material applications and cancer research.

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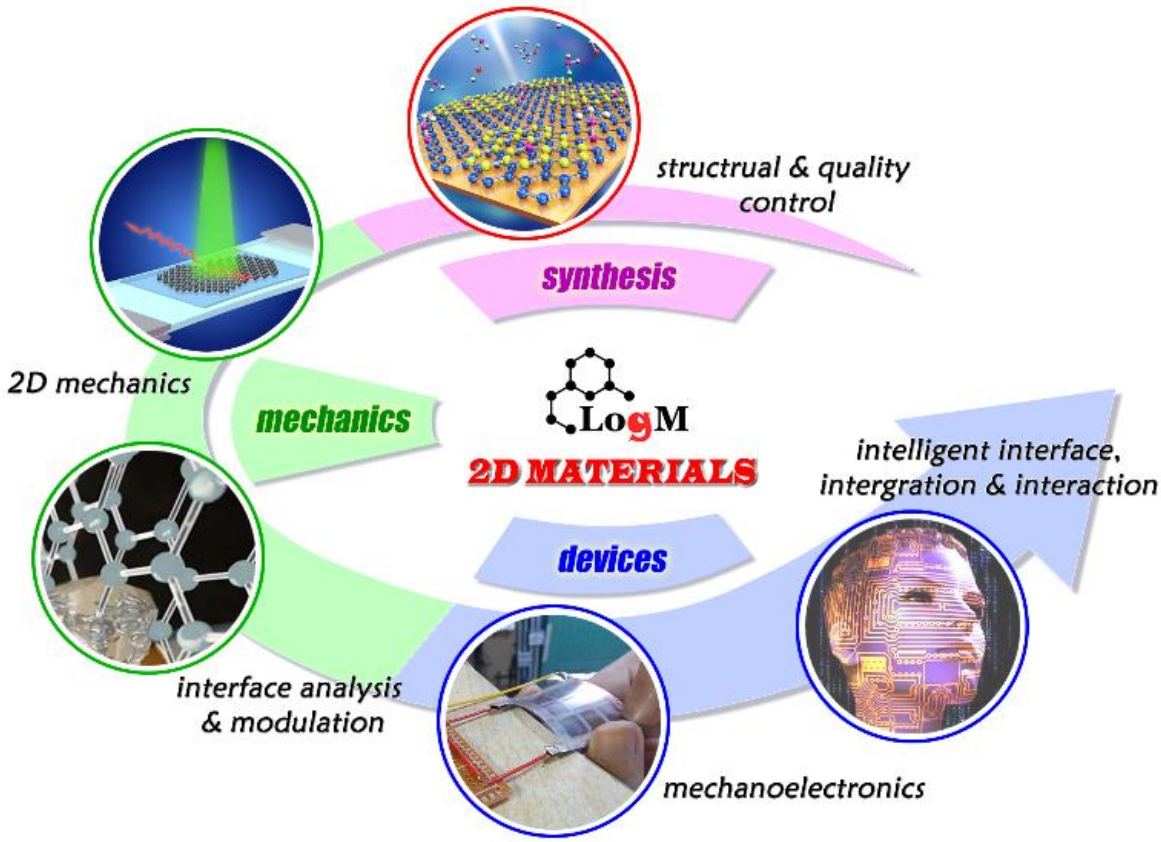
Mechanics of Two-Dimensional Materials

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Graphical Abstract



Abstract

In two-dimensional materials the assumption of continuity is no longer valid, so the applicability of continuum mechanics is questionable. The development of solid-state mechanics theory needs the support of experimental data, but the experimental research on the mechanical properties of two-dimensional materials is progressing slowly. Due to the intrinsic relationship between the characteristic peaks of the material's Raman spectrum and its strain, it has become an important means of mechanical experiments in two-dimensional material layers. Here I introduce the work related to strain measurement and decoupling of two-dimensional materials represented by graphene and their

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stacking structure using Raman spectroscopy in recent years, the crack propagation behaviour and fracture in graphene's plane, and the damage between graphene layers. The results obtained in the solution of toughness and the size effect of interlayer failure behaviour and interlayer shear strength provide data support for the basic mechanical properties of two-dimensional materials and the multi-scale performance of macroscopic parameters in mechanics.

Keywords

Graphene; mechanics; Raman spectroscopy.

Acknowledgements

This work was financially supported by the National Key Scientific Instruments and Equipment Development Project of China (61427901).

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Biography of Presenting Author



Associate professor and doctoral supervisor of Zhejiang University. He received the Ph.D. in Mechanical Engineering from the University of Tokyo, Japan, in 2011. His research directions include micro-nano mechanics, new methods and new technologies of experimental mechanics, robotic tactile sensors, etc. He has published 57 papers in scientific journals such as Nature Communications, ACS Nano, Physical Review B, Nanoscale, and Carbon, with an H-index of 18.

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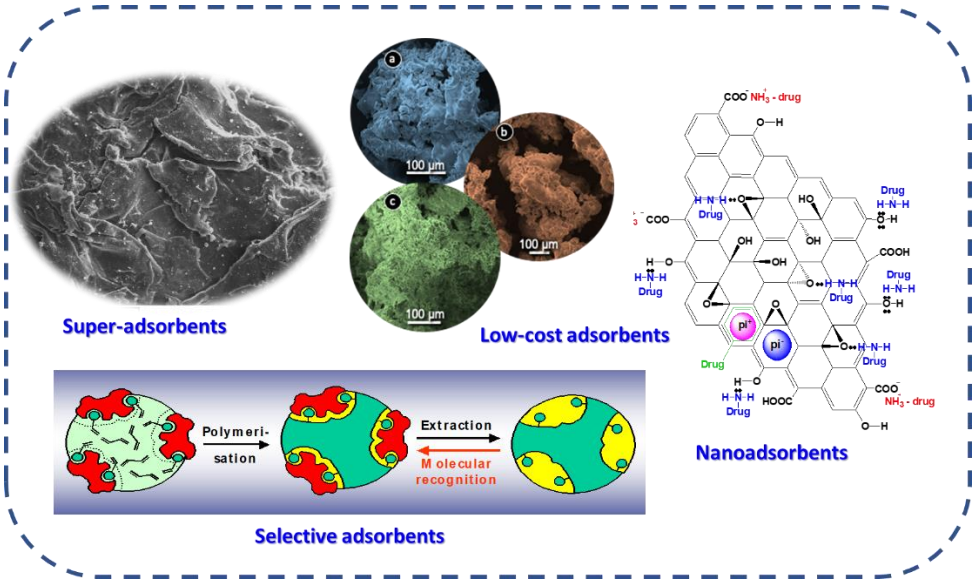
Effective Materials in Wastewater Treatment: Low cost-, selective-, super- and nano- adsorbent Materials

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Graphical Abstract



Abstract

Sorption is a physical and chemical process by which one substance becomes attached to another. A specific case of sorption is the adsorption; Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. Adsorption is considered to be a very promising separation technique especially for the removal of pollutants in liquid-phase (dyes, heavy metals, phenols, etc.). However, the economic crisis of the 2000s led researchers to turn their interest in adsorbent materials with some special characteristics: (i) super-adsorbent materials of high capacity; (ii) selective adsorbent materials (Molecular Imprinted Polymers – MIPs); (iii) low-cost adsorbent materials; (iv) nano-adsorbent materials. All above can include materials with significant properties beginning from the low-cost and reaching the super-properties. The first class contains many materials as activated carbons, agricultural wastes, modified polymers, graphenes, etc. In the present presentation, experimental data are presented from work of Prof. Kyzas, including the synthesis, characterization and adsorptive evaluation of those materials applied to wastewater treatment. Some indicative classes of materials are: (i) MIPs which

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are used for specific binding of highly-added value pollutants as precious metals (silver, gold) or drugs for recovery, etc., (ii) activated carbons of high surface area, (iii) polymers (i.e. chitosan) of high capacity; (iv) agro-food wastes of almost low-cost synthesis; (v) nanomaterials (graphenes) of significant properties. In this lecture, a recent summary of this type of works will be presented analyzing in details the next-generation adsorbent materials, discussing many different (maybe in some occasions doubtful) topics such as: (i) adsorption capacity; (ii) kinetic modeling and (iii) desorption/reuse potential.

Keywords

Adsorption; graphene; polymers; nanomaterials.

Acknowledgements

The data presented are a collage of published works which were funded by National (Greek) and European Projects as described here.

Biography of Presenting Author



Dr. George Z. Kyzas is Associate Professor at the Department of Chemistry at the International Hellenic University (IHU). He was born in Drama (Greece) and studied Chemistry at the Department of Chemistry at the Aristotle University of Thessaloniki (AUTh). He obtained his BSc, MSc, and PhD degrees from the Department of Chemistry (AUTh) expertised in Chemical Technology. He then worked as a PostDoc Researcher at the Department of Chemistry (AUTh) in many research projects. He is now working at the Department of Chemistry (International Hellenic University, Kavala, Greece), being the Head of the Department (since 2019). His research interests include the synthesis and characterization of various (majorly adsorbent) materials (inorganic, aluminates, polymers, graphenes, agro-food residues, nanomaterials, CNTs, etc.) for environmental applications (i.e., treatment of wastewaters).

His scientific work has been published in more than 190 Papers in international journals with a high impact factor (IF, ave 5.5), while he published 8 Books, 36 Chapters in scientific Books and holds 3 Patents. He was also 8 times Guest Editor at Special issues of journals and has more than 90 Announcements (Invited) in International Conferences. His work is widely recognized with 7,500 Citations based on Scopus database (h-index 54) and 10,000 Citations based on Google Scholar database (h-index 56).

His name is included in the list of World Top 2% Scientists for 2019, which is compiled by the Stanford University (USA) based on standardized citation indicators. He has been awarded with scholarships from the Research Committee of the Aristotle University of Thessaloniki (2009, 2013), the Greek State Scholarship Foundation (2013) and the Stavros Niarchos Foundation (2016). He has also participated in about 25 research projects. He is a Reviewer in more than 200 scientific journals of prestigious Publishers (Nature, American Chemical Society, Elsevier, Springer, Wiley, Taylor & Francis) and participates as an Assessor/Evaluator/Reviewer in National, European and International research proposals/calls/projects.

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Hybrid Water Electrolysis for Efficient H_2 Production

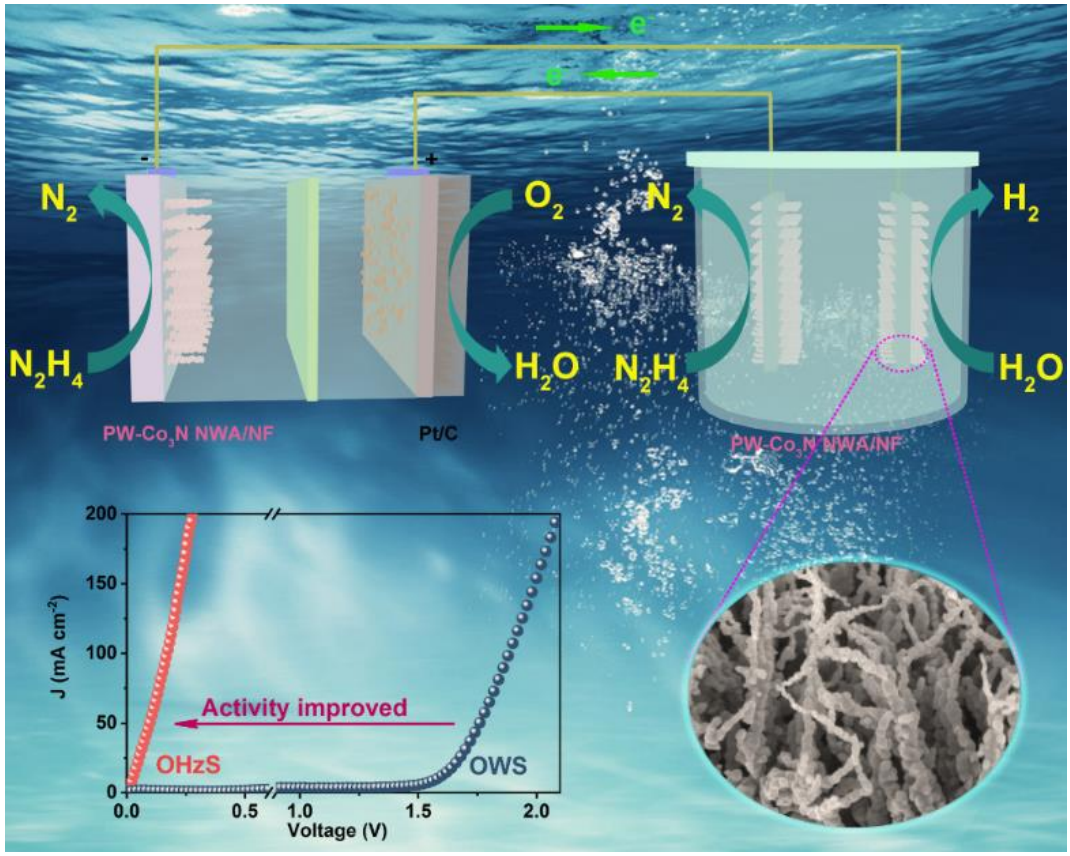
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Graphical Abstract

The concept of hybrid water electrocatalysis by replacing sluggish OER with HzOR is achieved for energy-saving H_2 production with developed bifunctional electrocatalysts involving rational design strategies.



Abstract

The rapidly increasing energy consumption and the deteriorating global environmental concerns have compelled the stringent demand on clean and sustainable energy sources. Hydrogen (H_2), as the energy carrier with the highest energy density and zero carbon emission, has been placed much expectation as one of the most fascinating candidates to change the current fossil fuel dominated energy structure.

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Electrocatalytic water splitting is deemed as the suitable technique for green yet efficient H_2 production, while the key challenge originates from the intrinsically sluggish kinetics of anodic oxygen evolution reaction (OER, 4OH− → O2 + 2H2O + 4e−, 1.23V vs. RHE) involving four-electron-transfer process, which not only leads to the energy wastage, but also further increases the cost due to the utilization of noble metal based electrocatalysts, thus highly limits its large-scale application. Recently, the concept of hybrid water electrocatalysis has been proposed by replacing sluggish OER with thermodynamically more favourable hydrazine oxidation reaction (HzOR), which has been considered as a more energy-efficient strategy than water splitting. However, the relatively high cell voltage in two-electrode system and the required external electric power hinder its scalable applications, especially in mobile devices. We recently developed several strategies that can achieve outstanding bifunctionality towards both hydrogen evolution and hydrazine oxidation catalysis, including heteroatom doping in transition metal nitrides, rational design of artificial heterointerfaces and constructing partially exposed RuP_2-carbon hybrid structures. In these works, the possible origins of the bifunctional catalytic activity were unraveled by DFT calculations combined with experimental evidences, which could benefit the fundamental understanding of the underlying mechanisms. The overall hydrazine assisted hybrid splitting (OHzS) measurement within the homemade two-electrode electrolyzer suggested that the required cell voltage can be largely lowered compared with overall water splitting, indicating the potential for energy-saving H_2 production. Moreover, the possibility of the extended applications was also demonstrated by powering the OHzS through the commercial solar cell and waster AAA battery as well as the direct hydrazine fuel cell, where a decent H_2 production rate can be achieved. These works could provide an alternative energy-saving H_2 production system with rational design of advanced electricatalysts based on unique micro-/-nanostructures, which could potentially contribute to the advancement of large scale electrocatalytic H_2 production.

Keywords

Electrocatalysis; hydrogen production; hydrazine oxidation reaction; hydrogen evolution reaction; bifunctionality.

Acknowledgements

We acknowledge the financial support from the National Natural Science Foundation of China, the Recruitment Program of Global Experts and the Fundamental Research Funds for the Central Universities. The numerical calculations in this paper have been done in the Supercomputing Center of University of Science and Technology of China and TianHe-2 at LvLiang Cloud Computing Center of China.

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Biography of Presenting Author



Genqiang Zhang is a Professor of Material Science at the University of Science and Technology of China in Hefei, Anhui, P. R. China. Dr. Zhang received his bachelor's degree and Ph. D degree in 2004 and 2009, respectively, both from University of Science and Technology of China. After 6 years of post-doctoral research experience in Purdue University, Nanyang Technological Unviersity and Los Alamos National Laboratory, Dr. Zhang got back to his Alta Mater and started independent research at 2016. His major research focuses on the exploration of the environment-friendly, cost-effective and scalable chemical synthesis methods to manipulate the size, morphology and microstructure for the construction of unique micro-/nano-structures of functional materials including multi-component transition metal compounds and their complex hybrid nanostructures, as well as the transition metal compounds/carbon hybrid structures in order to realize their promising practical applications as high performance electrodes/electrocatalysts on energy storage and conversion devices including rechargeable batteries, water electrolyzer and fuel cells. He has published more than 90 journal papers in the field of materials science and energy related applications, including high profile journals such as Science Advances, Nature Communications, Advanced Materials and so on. Dr. Zhang has served as Editorial Board Member for Nanomaterials and Young Advisory Board member for InfoMat.

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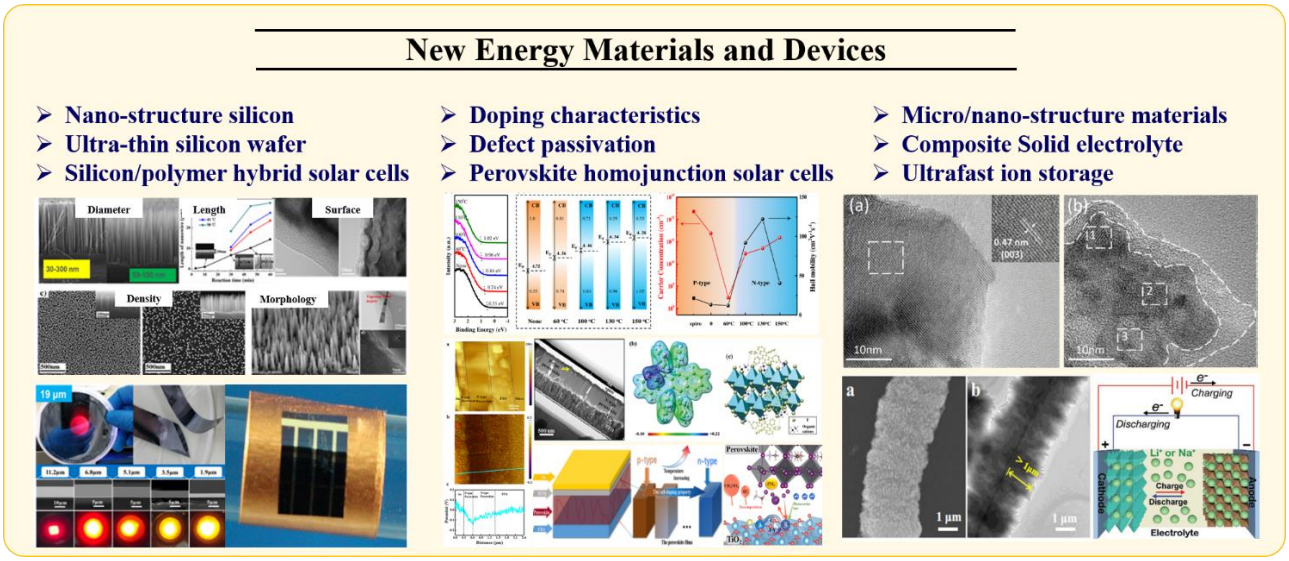
New Energy Materials and Devices

Meicheng Li*, Xiaojun Lv, Yingfeng Li, Bing Jiang, Lihua Chu, Peng Cui, Lehao Liu, Haifang Li

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Graphical Abstract



Abstract

Efficient energy conversion and storage are the keys to the development and utilization of new energy, especially solar energy. Silicon-based hybrid solar cells and perovskite solar cells (PSCs) are two kinds of attractive energy conversion devices. To improve the photoelectric conversion efficiency (PCE) of devices, the micro/nano structures, doping characteristics, and defect suppression of solar cell materials have been explored based on the detailed consideration of device structural design. First, we verify the length, diameter, and array density of the silicon nanowire (SiNW) are key parameters in SiNW solar cells, as they dramatically decide the light-harvesting and carrier recombination. The method of discrete dipole approximation simulation has been developed to determine the optimal size, morphology, and porosities of SiNW for photovoltaic devices. We have prepared high-quality ultrathin silicon wafers with adjustable thickness from 100 μm to 2 μm, and uniform, large-area silicon nanowire arrays with controllable length, diameter, filling rate, surface quality, and morphology. Second, carrier lifetime and doping property of the perovskite materials have been managed by precursor composition and preparation process, and the underlying mechanisms governing their effects on the PCE of PSCs have been investigated. From this, we have fabricated highly efficient electron-selective layer free PSCs and perovskite homojunction solar cells, whose built-in electric field promotes oriented transport of the photo-induced carriers, thus reducing carrier recombination losses. Further, we have discovered the degradation process of PSCs, especially TiO_2-based devices

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under ultraviolet irradiation, and proposed blocking the transformation of Ti^{3+}-V_O states to improve the stability. The supramolecular interaction materials (like rubrene, cyclodextrin, F4TCNQ, etc.) have also been employed to inhibit defect formation and ion migration, thus enhancing the performance and stability of PSCs. On the other hand, for electrochemical energy storage, the rate-determining process is largely determined by the ion transport occurring in electrode materials and the composite electrolyte design. We have designed a simple low-temperature solution approach to synthesize the anode material of Zn_2GeO_4/g-C_3N_4 hybrid structure, improving Li-ion storage and diffusion pathway and preventing the formation of unstable solid electrolyte interphase. Also, we have proposed an enhanced ion transport mechanism for ultrafast energy storage by the localized electron that can be induced by intrinsic defects, leading to an enhancement of Li/Na ion diffusivity by two orders of magnitude. Moreover, by using aramid nanofibers (ANFs) as multifunctional nano-additives, comprehensively-upgraded polyethylene oxide LiTFSI electrolytes with 3D ANF network frames have been achieved through the hydrogen-bond interactions between the 1D ANFs, achieving an 8-fold increase in ionic conductivity and a three-fold (0.5C) increase in the capacity.

All forms of the research contribution at the conference must be accompanied by an abstract. In brief, the abstract should concisely describe the purpose of the research, indicate the experimental procedures used, summarize the key findings, and focus on the major conclusions. Abstract should be in one paragraph. Please complete your abstract here within 300-500 words.

Keywords

Silicon nanostructures; perovskite homojunction; solar cells; solid electrolyte; ultrafast ion storage.

Acknowledgements

This work is supported partially by National Natural Science Foundation of China (Grant nos. 51772096, 51972110 and 52072121), Beijing Science and Technology Project (Z181100005118002), Par-Eu Scholars Program, Science and Technology Beijing 100 Leading Talent Training Project, the Fundamental Research Funds for the Central Universities (2020MS023, 2020MS028) and the NCEPU "Double First-Class" Program.

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Biography of Presenting Author



Prof. Meicheng Li currently is Yangtze river scholars Distinguished Professor of Ministry of Education, the Director of New Energy Materials and Devices Research Center, and the Dean of the School of New Energy, North China Electric Power University. He obtained his PhD at Harbin Institute of Technology in 2001. He joined Harbin Institute of Technology as Lecture and Associate Professor from 2001 to 2004. He worked in University of Cambridge as Research Fellow from 2004 to 2006. He went back Harbin Institute of Technology and worked as Professor at 2006. He won the Excellent Talents in the New Century by the ministry of education in 2006. From 2010, he worked in North China Electric Power University. He has carried out academic exchange visiting in many famous international universities, such as UC Berkeley, Stanford University, the University of Manchester, National University of Singapore, Nanyang Technological University, University of New South Wales, etc. His current research topic is the New Energy Materials and Devices, focusing on the nanostructures of silicon, carbon and oxide etc., and the relative novel device applications in energy harvesting, conversion, and storage. Till now, he contributed more than 200 journal articles (including Nature Energy, Energy & Environmental Science, Advanced Materials, Advanced Science, Nano Energy etc.) and performed the review services for about 100 SCI journals. He got almost 20 items of awards for the science and technology success. He served more than 30 academic conferences as the chair, track co-chair or session chair. He is an executive fellow of the China Energy Society, fellow of Chinese Society for Optical Engineering, executive fellow of China of Instrument Materials Society, executive fellow of Photoelectric Technology Professional Committee, Chinese Society Astronautics, a member of the Materials Research Society, and senior member of Chinese Institute of Electronics. He is also the editorial board member of 10 international peer review journals, such as: IET Renewable Power Generation, Carbon Energy, Journal of Materiomics, Energy Storage Science and Technology, Journal of Energy and Power Engineering, Journal of Advances in Nanomaterials, Advances in Condensed Matter Physics.

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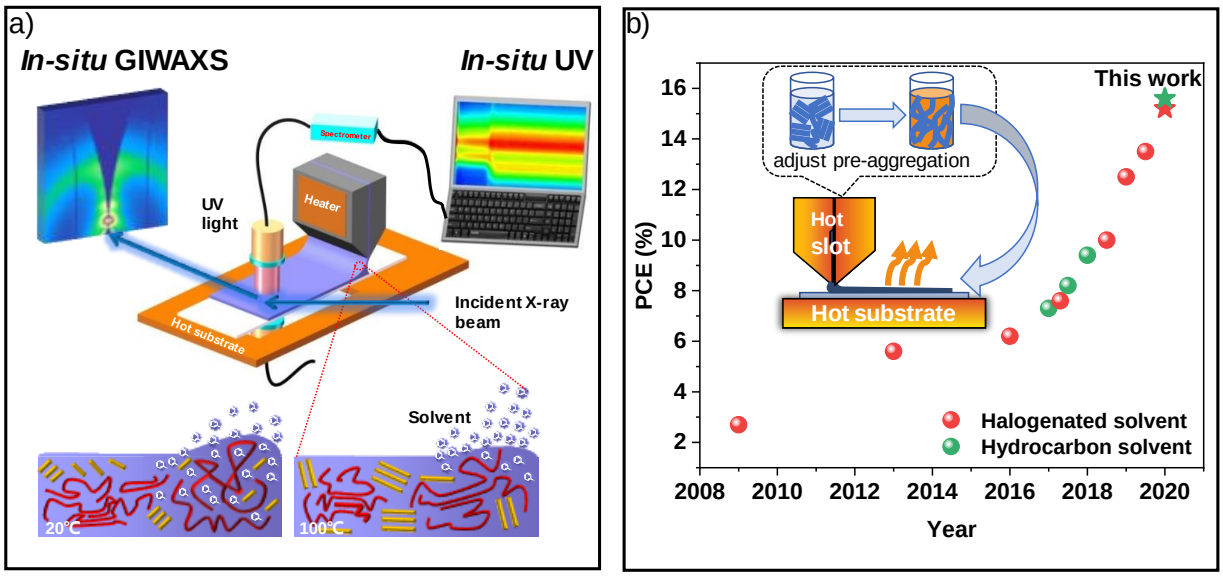
Controlling the Pre-aggregation and Crystallization Kinetics Enables High-efficiency Slot-die Coated Organic Solar Cells with Green Solvents

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Graphical Abstract



a) Schematic of in-situ GIWAXS and in-situ UV absorption measurements. b) Statistics of progress in the efficiency of halogenated and hydrocarbon solvents prepared devices.

Abstract

Slot-die coating method, which is compatible with continuous roll-to-roll processing, is regarded as the most suitable technology for large-area processing of organic solar cells (OSCs). However, the efficiency of devices processed by slot-die coating is much lower than that of spin-coating devices. Improving device performance prepared by slot-die coating is quite essential for the large-area application of OSCs, and the optimization of the active layer morphology is the top priority to improve the efficiency of OSCs. In-depth study of the film forming kinetics during slot-die coating is of great significance. Here, in-situ UV-vis absorption and in-situ GIWAXS are performed to reveal the aggregation and crystallization evolution process during the slot-die coating. The effect of processing

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temperature (substrate and solution temperature) on morphology evolution and device performance are systematically studied. The results have shown that the aggregation rate of the donor and receptor in PM7:IT4F is balanced by 60 °C solution and substrate processing, as well as the nucleation and growth rate of the crystal of the donor and receptor, thus increasing the crystallinity and promoting the transport of carriers. Furthermore, in the PM6:Y6 system, by adjusting the solution and substrate temperature, a similar pre-aggregation state and film-forming kinetic process can be obtained for both halogen solvents and green solvents, so as to obtain the highest power conversion efficiency (15.6%) of the green solvent printing OSCs. The strategy of controlling pre-aggregation/crystallization kinetics may pave the way for the large-area printing processing in the future.

Keywords

Slot-die coating; organic solar cells; pre-aggregation; crystallization kinetics; green solvents.

Acknowledgements

We acknowledge the support from Ministry of science and technology (No. 2016YFA0200700), NSFC (21704082, 21875182, 21534003), China Postdoctoral Science Foundation (2017M623162), the Natural Science Foundation of Shaanxi Province (2020JQ-015), 111 project 2.0 (BP2018008).

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Biography of Presenting Author



Wei Ma was born in Ningxia, Wuzhong, China (1983). He has been a full Professor in the School of Materials Science and Engineering at Xi'an Jiaotong University since 2014. He obtained his Ph.D. degree in Chemical Physics from the University of Pierre Marie Curie (Paris 6, France) in 2010 before moving to the Ecole Normale Superieure (Paris), France (2010–2011) and North Carolina State University (NCSU) as Postdoc Fellow. His research interests include the use of soft/hard X-ray based techniques to unravel the relationship between organic thin film microstructure and device performance.

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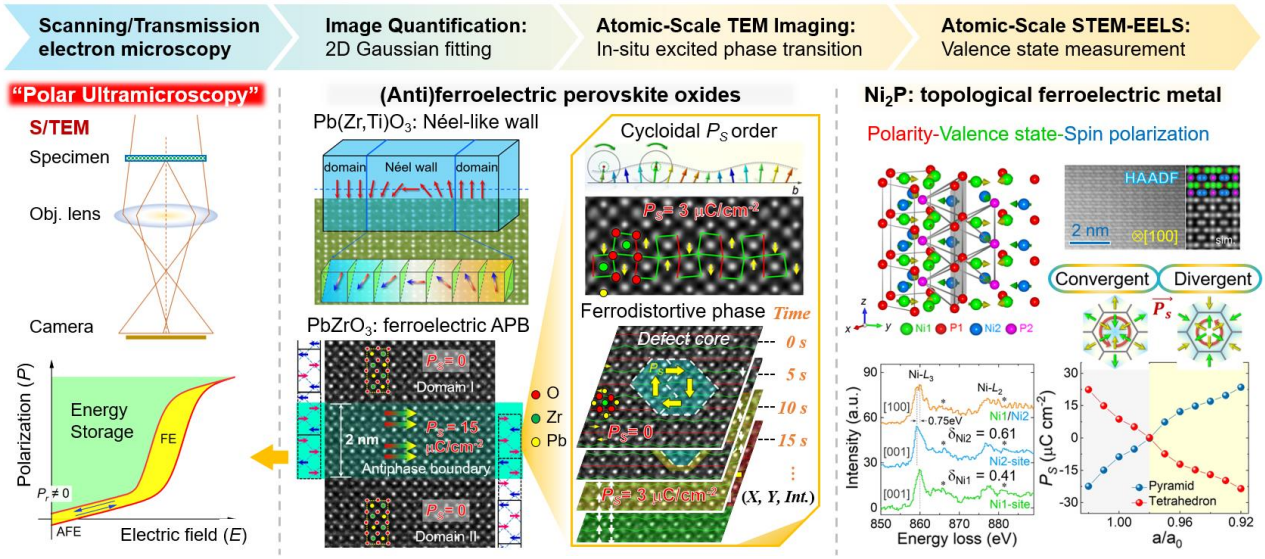
Atomic-scale Novel Ferroelectric States in Energy-Related Materials

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Graphical Abstract



Abstract

Collection and storage of green energy through advanced material development is a cutting-edge research direction given their great importance for the future life of human society. Alongside macroscopic material design, atomic-scale microstructural characterization provides an unprecedented approach of clarifying the fundamental principles about energy storage and conversion, thus offering an alternative and practical strategy towards maximizing the effectiveness of energy materials. Aberration-corrected **scanning/transmission electron microscopy** (**S/TEM**), with unparalleled spatial and energy resolution and powerful characterization capabilities, provides a powerful platform to acquire multiscale and multi-dimensional structural information about functional materials. However, realizing direct and even *in-situ* detection of light elements remains a challenge due to their low scattering power. **In this lecture, we will report on the discovery of novel ferroelectric (FE)**

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states in energy-related $Pb(Zr,Ti)O_3$, antiferroelectric (AFE) $PbZrO_3$ and nonpolar Ni_2P catalyst. Our research theme "**Polar Ultramicroscopy Structure**" starts from developing **quantitative negative spherical-aberration (C_S) imaging (Q-NCSI) technique**, which delivers picometer-precision measurement based on iterative image simulations and 2D Gaussian fitting to atomic positions. With this, Néel-like domain wall, intriguing ferroelectric antiphase boundary (APB) and phase-transition frustration are unveiled in (anti)ferroelectric perovskite oxides [**1-3**]. On this basis, electron-beam-irradiation-based **time- and atomic-resolution (TAR) NCSI technique**, allowing **direct and *in-situ* imaging of light and heavy elements**, is developed to perform structurally coupled energy storage study in dielectric insulators. By slowing down the phase-transition speed from milliseconds to seconds, our TAR-NCSI study on $PbZrO_3$ discloses **a novel transient ferrodistortive phase, characteristic of a cycloidal order of polarization** [**4**], during the AFE-to-FE transition. Application of the TAR-NCSI technique on point-defect-doped $PbZrO_3$ further reveals defect-core-induced unit-cell-scale phase-transition pathway, which is accompanied with formation of charged domain walls during the energy storage process [**5**]. In the study of nickel phosphide catalysts, motivated by their seemingly ambiguous valence states, an intimate relationship between topological polyhedral polarity, elemental valence state and spin polarization is determined in Ni_2P through establishment of symmetry equations of polarity, valence state measurement using quantitative electron energy loss spectroscopy (**Q-EELS**) and first-principles calculations. The unprecedented coupling between these physical quantities triggers definition of a new material category - **topological ferroelectric metal** [**6**]. **Overall, our research findings present new territories of exploring novel polar matter of states, under either equilibrium or non-equilibrium conditions**. Along with the developed microscopy techniques, this not only provides an atomic- or spin-level avenue to understand structural mysteries about energy storage and energy conversion processes, but also highlights the importance of unfolding polar ultramicroscopy structure study in advanced functional and energy-related materials.

Keywords

Polar ultramicroscopy structure; *in situ* atomic resolution; ferroelectric ferrodistortive phase; topological ferroelectric metal; energy materials.

Acknowledgements

The research works were funded by the European Union's Horizon 2020 research and innovation program through the CritCat Project under grant agreement No. 686053 and supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy – Cluster of Excellence Matter and Light for Quantum Computing (ML4Q) EXC 2004/1 – 390534769.

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Biography of Presenting Author



Dr. Xian-Kui Wei is a scientific staff member at Ernst Ruska Centre (**ER-C**) for Microscopy and Spectroscopy with Electrons in Forschungszentrum Jülich (**FZJ**), Germany. After receiving his Ph.D. in 2011 from Institute of Physics, Chinese Academy of Sciences (**CAS**), he started his academic research career in Swiss Federal Institute of Technology Lausanne (**EPFL**) until 2016 and then moved to **FZJ** until the present day. In the past 10 years, he has been engaged in application and method development of **aberration- corrected scanning/ transmission electron microscopy** (**S/TEM**), and **his work has a primary focus on quantitative and *in-situ* dynamic structure characterization under ultrahigh resolution**.

In the study of functional and energy-related materials, his research interests in ultramicroscopy and polarity prompt him to initiate a new research direction: "**polar ultramicroscopy structure**". Among ~40 scientific papers, his leading contribution made a number of them publish in ***Nature Materials* (1), *Nature Communications* (4), *Advanced Materials* (2), *Advanced Functional Materials* (1), *Nano Energy* (1), *Nano Letters* (1), *ACS Catalysis* (1)**, etc. Out of his contribution in relevant fields, he was invited to serve as a peer reviewer for some international journals (e.g., ***Nat. Commun.*, *Nano Lett.*, *Adv. Funct. Mater.*, *ACS Cent. Sci***., etc.), act as a **guest editor** for **Frontiers in Materials**, and write review papers about the theme of polar ultramicroscopy structure.

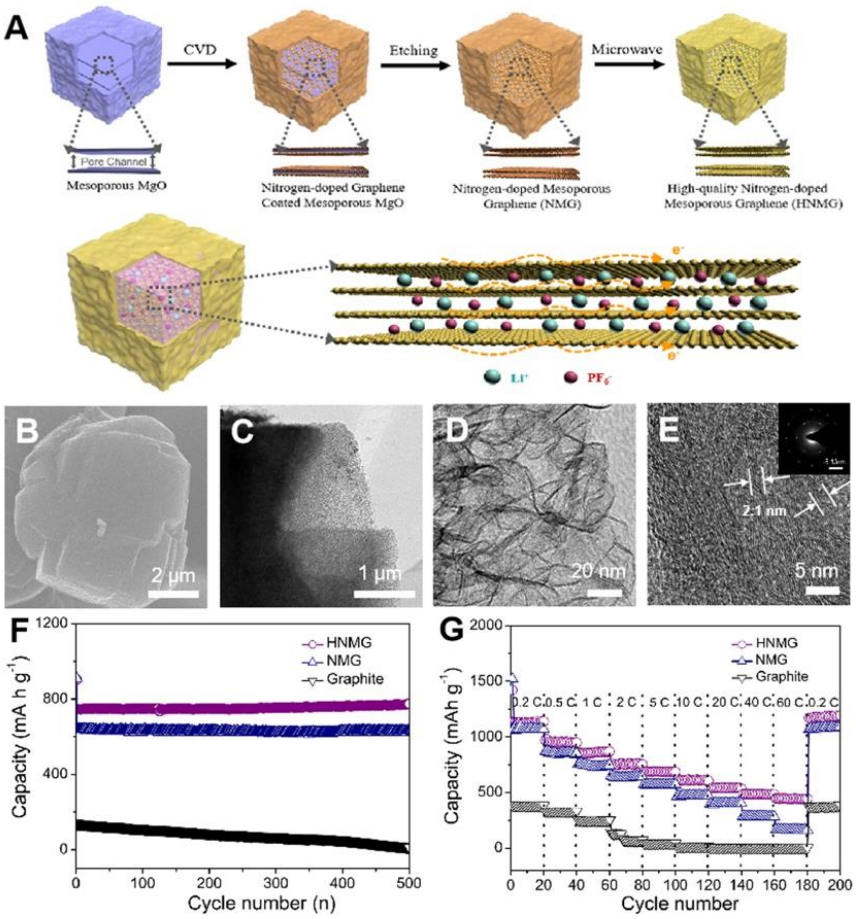
Structural Design of High-Quality Graphene for Fast-Charging Lithium-Ion Batteries

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Graphical Abstract



Abstract

There are increasing demands for lithium-ion batteries with both high-energy density and power density for electric vehicles and mobile device applications. Such performance characteristics, in the context of their electrochemical process, are generally governed by the capacity and voltage of the electrodes, as well as the transport of electrons and ions. The application of graphene for electrochemical energy storage has received tremendous attention; however, challenges remain in synthesis and other aspects. Here we report the synthesis of high-quality, nitrogen-doped, mesoporous

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graphene particles through chemical vapor deposition with magnesium-oxide particles as the catalyst and template. Specifically, using mesoporous magnesium oxide (MgO) as the template and catalyst, nitrogen-doped graphene is grown within the MgO particles by chemical vapor deposition using acetonitrile as the precursor. Removal of the template leads to the formation of nitrogen-doped mesoporous graphene particles. It is believed that the growth of graphene on MgO is achieved through by free-radical condensation of hydrocarbons. Compared with metallic catalysts, MgO generally leads to graphene materials with higher defect density, which can be reduced by subsequent microwave radiation and enables the synthesis of high-quality, nitrogen-doped, mesoporous graphene (HNMG) particles. Such particles possess excellent structural and electrochemical stability, electronic and ionic conductivity, enabling their use as high-performance anodes with high reversible capacity, outstanding rate performance (e.g., 1,138 mA h g^{-1} at 0.2 C or 440 mA h g^{-1} at 60 C with a mass loading of 1 mg cm^{-2}), and excellent cycling stability (e.g., >99% capacity retention for 500 cycles at 2 C with a mass loading of 1 mg cm^{-2}). Interestingly, thick electrodes could be fabricated with high areal capacity and current density (e.g., 6.1 mA h cm^{-2} at 0.9 mA cm^{-2}), providing an intriguing class of materials for lithium-ion batteries with high energy and power performance. The unique architecture of the HNMG particles affords several major advantages leading to high performance. At first, the low defect density of the HNMG particles affords outstanding electronic conductivity and electrochemical stability, improving power performance and cycling stability. Moreover, the three-dimensional graphene scaffolds provide the HNMG particles with structural stability, avoiding irreversible stacking of the graphene layers during the charging and discharging, which also prolongs the cycling stability and improves the Coulombic efficiency. It is also worth mentioning that the mesoporous structure provides the HNMG particles with a large number of lithium-storage sites, effective ion-transport pathways, as well as space to accommodate the volume change that may occur during charging and discharging. Finally, nitrogen doping improves the electrode-electrolyte interactions, provides lithiophilic surface moieties, and offers uniform nucleation sites with small nucleation overpotential, which has advantages in high-energy density and fast-charging capability. Importantly, this work opens a pathway to develop the high-quality graphene microstructure with real-life applications in high performance electrochemical energy storage and conversion and beyond.

Keywords

High-quality graphene; structural design; fast-charging; thick electrodes.

Acknowledgements

We are grateful to the funding support from the UCLA ENN Center for Nanomedicine and Energy Conversion and Shanghai Pujiang Program (20PJ1402500).

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Biography of Presenting Author



The speaker received his Ph.D. from Harbin Institute of Technology in 2015, and has been engaged in scientific research at Singapore University of Technology and Design and University of California, Los Angeles from 2015 to 2020, and will be a professor at East China University of Science and Technology in 2020. Focusing on the scientific problems that are difficult to balance between high energy density, high power density and high cycle life in electrochemical energy storage batteries, the speaker developed a new energy storage mechanism based on interface regulation to explore the integration of "surface energy storage + bulk energy storage". Electrode materials is obtained by structural design with both optimal electronic structure and high electrochemical activity. And combined with theoretical calculations and in-situ characterization methods to reveal the internal relationship between interface regulation and structural design and electrochemical performance. The speaker explored new schemes for energy storage applications that take into account the characteristics of high energy and fast charging. This injects new vitality into the research and development of advanced energy storage devices, and promotes the development of high-efficient energy storage science and technology in the future. The speaker has so far written 1 monograph (chapter) and published 30 papers, including 16 papers with IF>10, and 19 of which were published as the first or corresponding author on Nat. Commun (3), Adv. Mater (1), ACS Nano (2), Nano Lett (1), Adv. Funct. Mater (1), Energy Storage Mater (3), etc. Currently, 2 CN invention patents have been authorized. The speaker hosts a Shanghai Overseas High-level Talent Introduction Project and a Shanghai Pujiang Talents A-type Project in 2020.

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Solid Polymer Electrolytes in Solid-state Lithium-metal Batteries

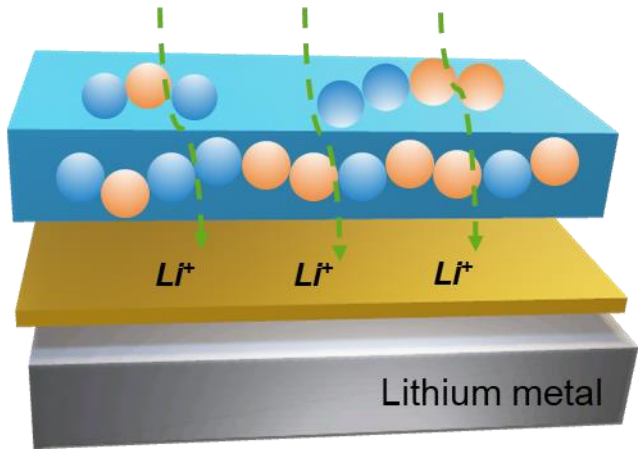
Peng Wen, Minyi Jia, Xia Qing, Xinrong Lin*

Key Laboratory of Medicinal Chemistry for Natural Resource, Ministry of Education; Yunnan Provincial Center for Research & Development of Natural P roducts; School of Chemical Science and Technology, Yunnan University, Kunming, 650091, P. R. China

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Graphical Abstract

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Abstract

Solid polymer electrolytes (SPEs) could offer flexible processability, highly tunable chemical functionality and cost effectiveness, and are therefore regarded attractive alternatives to conventional liquid electrolytes (LE) to access all-solid-state batteries (ASSBs), which would solve the safety and energy density limitations of state-of-the-art lithium-ion batteries. Meanwhile, lithium metal anodes are being increasingly explored to combine with SPEs to further increase the energy of ASSBs because of their ultrahigh theoretical specific capacity (3860 mAh g^{-1}) and low reduction potential (-3.04V vs. SHE). Unfortunately, it is well recognized that the uneven lithium deposition at the surface of metallic lithium would generate electrically disconnected dendrites during repeated charge-discharge cycles, which would lead to large interfacial resistance, low coulombic efficiency, internal short-circuit and therefore premature cell failure, severely hindering the development of lithium-metal based batteries. Therefore, developing functionalized SPEs to chemically regulate the electrode-electrolyte interaction, stabilize interfacial SEI and suppress lithium dendrites proliferation remains a significant challenge and is highly desired. Herein, we designed different types of polymer electrolytes and in-situ battery assembly technique to address the interfacial problems in ASSBs based on the fundamental root causes

of lithium dendrites growth, which facilitated the homogeneous ion transport in the bulk SPE, stabilized the solid electrolyte interface (SEI) formation, and enhanced the poor contact between solid electrolyte and electrode. Nuclear magnetic resonance (NMR), Fourier-transform infrared spectra (FTIR), electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) were used to characterize the structural, physicochemical and electrochemical properties of the SPEs. Li plating-stripping test in Li||Li symmetric lithium cell and Li||Cu cells were employed to investigate the dendrites formation behavior and coulombic efficiency. Charge-discharge cycling in ASSBs coupled with various cathodes was carried out, which enabled stable cycling, high coulombic efficiency and better SPE-lithium compatibility as high-performance all-solid-state batteries with safety. In-depth structure-property relationships were also probed to elucidate that rational employment of appropriate functional groups, polymer backbones and such would dramatically change the lithium deposition compositionally and morphologically, eventually influencing the performance of the SPEs. These studies demonstrate that the rational design of polymer electrolytes and the development of in-situ synthetic technique would efficiently and effectively suppress lithium dendrites, which might shed light on future design of high energy and high safety energy storage devices.

Keywords

Solid-state batteries; solid polymer electrolytes; lithium-ion batteries; lithium dendrites.

Acknowledgements

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Biography of Presenting Author



Prof. Dr. Xinrong Lin received her Ph.D. in Polymer Chemistry from Boston University where she centered on the synthesis and characterization of macromolecules and understanding their structure-property relationships. Her Ph. D training was also received from MIT (2011-2013), where she started to investigate at the interface of polymer science and energy storage. She then worked as a Postdoctoral Associate at Boston University (2014–2016) and joined BASF as a Team Leader/Scientist to work on cathode materials and solid-state batteries in 2017. Since 2019, she joined Yunnan University as an Associate Professor, focusing her research on the design of synthetic methods and novel polymeric materials for energy storage applications, and employing state-of-the-art characterization and simulation methods to understand/regulate the ion/electron conducting behavior of polymers.

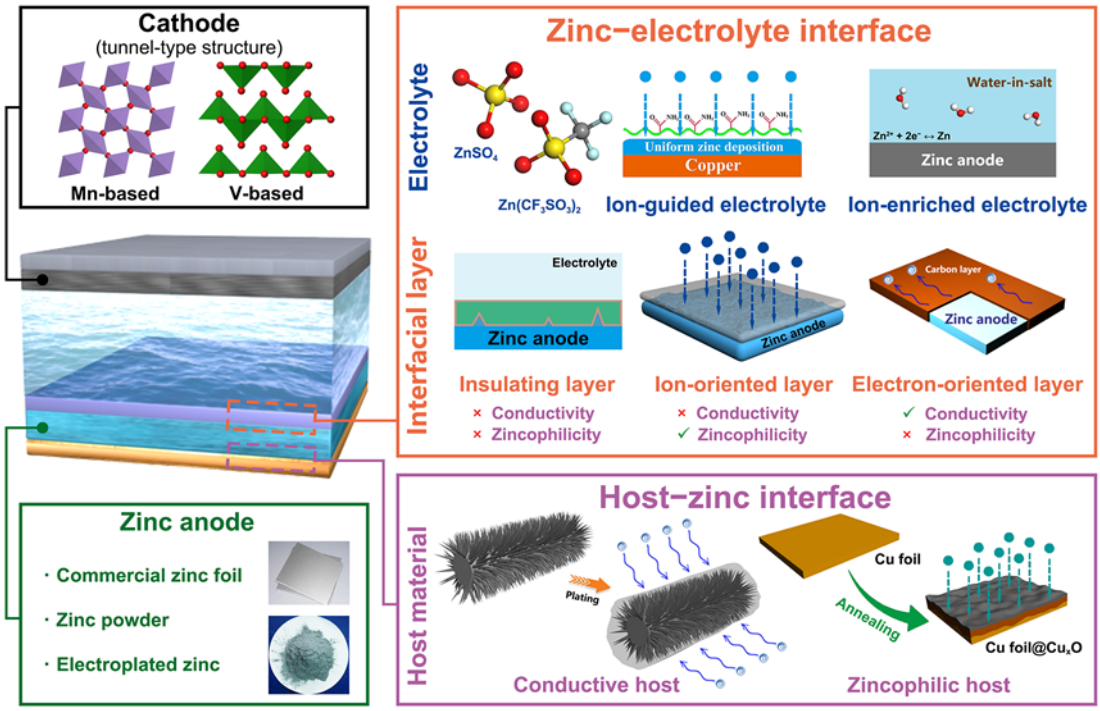
Interfacial Design of Dendrite-Free Zinc Anodes for Aqueous Zinc-Ion Batteries

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Graphical Abstract



Abstract

Aqueous zinc-ion batteries have been developed rapidly recently as promising energy storage devices in large-scale energy storage systems owing to their low cost and high safety. The research on suppressing zinc dendrite growth has meanwhile attracted widespread attention in order to improve the lifespan and reversibility of batteries. Herein, design methods for dendrite-free zinc anodes and their internal mechanisms are reviewed firstly from the perspective of optimizing host-zinc interface and zinc-electrolyte interface. Then, several design strategies will be introduced to homogenize zinc deposition by regulating the interfacial electric field and ion distribution during zinc nucleation and growth. For example, a synergistic method combining Cu-Zn solid solution interface on copper mesh skeleton with good zinc affinity and polyacrylamide electrolyte additive was used to modify the zinc anode, which could greatly reduce the overpotential of the zinc nucleation and increase the stability of zinc deposition. The as-prepared zinc anodes show a dendrite-free plating/stripping behavior in a wide

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range of current densities. High-performance Zn anode without external dendrite growth was fabricated by coating TiO_2 with highly exposed (001) facet on commercial Zn foil. Benefiting from the specific crystal orientation of TiO_2 with abomination to Zn absorption, Zn^{2+} transferred by the electric field was enriched on the anode surface. Thus, the increased interfacial Zn^{2+} concentration could induce uniform nucleation and the further Zn deposition was guided to grow laterally. The as-prepared Zn anode exhibited superior Zn plating and stripping performance with a long lifespan (460 h at 1 mA cm^{-2} for 1 mAh cm^{-2}).

Keywords

Zinc metal anode; aqueous zinc ion batteries; interfacial design strategies; zinc dendrites.

Acknowledgements

This research was financially supported by the National Nature Science Foundation of China (No.21975289 and No. U19A2019), and Hunan Provincial Science and Technology Plan Project of China (No. 2017TP1001 and No. 2018RS3009).

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Biography of Presenting Author



Dr. Haiyan Wang earned Ph.D degree in Applied Chemistry at Central South University in 2012. In 2010, he once joined Prof. Peter G Bruce's group in University of St. Andrews (UK) as a visiting Ph.D. student. Starting at 2016, he joined Prof. Minhua Shao's group at Hong Kong University of Science and Technology as a Hong Kong Scholar. Now he is a full Professor in College of Chemistry and Chemical Engineering at Central South University. His current research interests are mainly focused on the new energy materials and devices, including Li/Na ion batteries and aqueous metal batteries (Al/Zn). He has published over 110 refereed papers with him as the first or corresponding author, including Nat Commun, Angew. Chem. Int. Ed, Energy & Environmental Science, Advanced Materials, Advanced Energy Materials, ACS Nano (over 5500 citation times, H-index 45, so far). He is a principal inventor of 12 Chinese authorized patents. He serves as the vice director of Hunan Provincial Key Laboratory of Chemical Power Sources and the Applied Chemistry Major. In recent years, he has made important progress in sodium ion batteries and zinc ion batteries in fundamental researches and is pushing forward to the industrialization. He has received some important awards, for examples, The First Chongqing Science and Technology Progress Award and The Second Hunan Science and Technology Progress Award. He is also the winner of Distinguished Young Scholar of Hunan Natural Science Fund, Young Talents in Hunan Province, HongKong Scholar, My Favorite Young Teacher in Hunan Province, and Top Ten Youth Award in Central South University.

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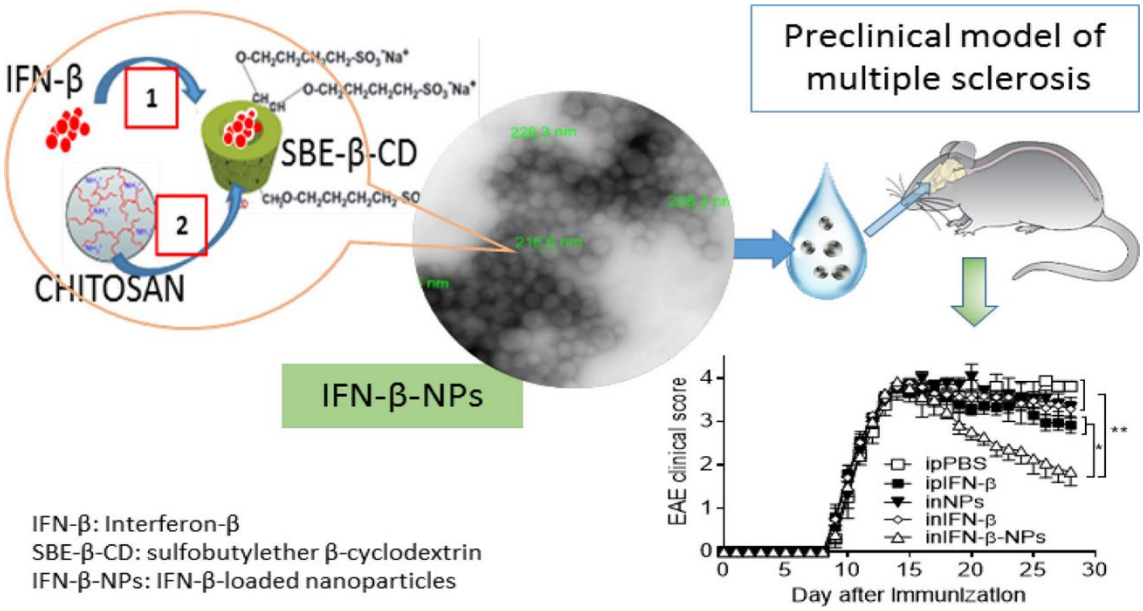
Intranasal Delivery of Interferon-beta-loaded Nanoparticles induces Control of Neuroinflammation in a Preclinical Model of Multiple Sclerosis



L.F. Gonzalez[1], E. Acuna[1], G. Arellano[1], P. Morales[2], P. Sotomayor[1], F. Oyarzun-Ampuero[3,4,*], R. Naves[1]

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Graphical Abstract



Abstract

Multiple sclerosis (MS) is an autoimmune disease affecting the central nervous system (CNS). Interferon (IFN)-β constitutes one of the first-line therapies to treat MS but has limited efficacy due to the: injectable systemic administration, short half-life, and limited CNS access[1]. To address these limitations, we developed IFN-β-loaded chitosan/sulfobutylether-β-cyclodextrin nanoparticles (IFN-β-NPs) for delivery of IFN-β into the CNS via the intranasal (i.n.) route. The nanoparticles (NPs)

(≈200 nm, polydispersity ≈0.1, and zeta potential ≈20 mV) were prepared by mixing two aqueous solutions and associated human or murine IFN-β with high efficiency (90%). Functional *in vitro* assays showed that IFN-β-NPs were safe and that IFN-β was steadily released while retaining biological activity. Biodistribution analysis showed an early and high fluorescence in the brain after nasal administration of fluorescent probe-loaded NPs. Remarkably, mice developing experimental autoimmune encephalomyelitis (EAE), an experimental model of MS, exhibited a significant improvement of clinical symptoms in response to intranasal IFN-β-NPs (inIFN-β-NPs), whereas a similar dose of intranasal or systemic free IFN-β had no effect. Importantly, inIFN-β-NPs treatment was equally effective despite a reduction of 78% in the total amount of weekly administered IFN-β. Overall, inIFN-β-NPs represent a potential, effective, non-invasive, and low-cost therapy for MS[1].

Keywords

Nanoparticles, interferon-beta, multiple sclerosis, drug delivery, nanomedicine.

Acknowledgements

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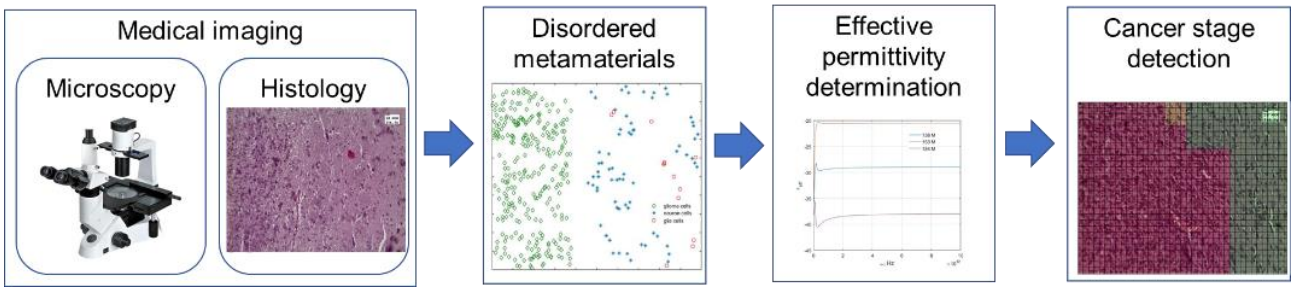
Applications of the Metamaterial Formalism

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Graphical Abstract



Early detection of a tumor makes it more probable that the patient will, finally, beat the cancer and recover. The main goal of broadly defined cancer diagnostics is to determine whether a patient has a tumor, where it is located, and what is its histological type and severity. The major characteristic of the cancer affected tissue is the presence of the glioma cells in the sample. Current approach in diagnosis focuses mainly on microbiological, immunological, and pathological aspects rather than on the "metamaterial geometry" of the diseases. The determination of the effective properties of the biological tissue samples treating them as the disordered metamaterial media has become possible with the development of the effective medium approximation techniques. The advantage of them lies in the capability to treat the biological tissue samples as the metamaterial structures, possessing the well-studied properties. Here, we present, in the first time to our knowledge, the studies on metamaterial properties of biological tissues to identify healthy and cancerous areas in the brain tissue. The results show, that the metamaterial properties strongly differ depending on the tissue type, if it is healthy or unhealthy one. The obtained effective permittivity values were dependent on various factors, like the amount of different cell types in the sample and their distribution. Based on these findings, the identification of the cancer affected areas based on their effective medium properties was performed. These results proved the metamaterial model capability in recognition of the cancer affected areas. The presented approach can have a significant impact on the development of methodological approaches toward precise identification of pathological tissues and would allow for more effective detection of cancer-related changes. We suggest the highly effective recognition of the cancerous specimens in stained brain biopsies.

Abstract

Cancer is one of the leading causes of death worldwide, and its diagnosis is critical to initiate therapies [**1**]. The apoptosis of cancer cells plays a pivotal role in shaping of organs in tandem with cell proliferation, regulation, and the removal of defective as well as excessive cells in immune system.

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Hence, it is imperative to develop sensitive detection technologies that allow to figure out if the biological tissue is cancerous.

The rapid development of machine learning and particularly deep learning opens the wide avenues for the medical imaging community's interest in applying these techniques aiming to improve the accuracy of cancer screening [**2**]. Machine learning algorithms can analyse large amounts of data and solve complex tasks in a very short time. The former can provide the fertile ground for helping physician to improve the accuracy and efficiency of making cancer diagnoses, selecting personalized therapies and predicting long-term outcomes. Artificial intelligence (AI) describes a subset of machine learning that can identify patterns in data and take actions to reach pre-set goals without specific programming. Convolutional neural networks (CNNs) represent multiple inter-connected layers of AI algorithms that have learnable weights and can classify data with minimal pre-processing. Convolution is a mathematical operation that expresses the amount of overlap of one function as it is shifted over another function. The primary function of convolution in medical image processing is to extract features from input data. The CNN translates raw image pixels on the input end to scores at the output. When many CNN layers are stacked, they are called deep-CNNs. Deep CNNs exhibits several benefits in comparison with standard image reconstruction algorithms [**3**]. Despite all the advantages offered by the above described techniques, the main disadvantage of them is the tremendous computer resources required to fulfil the tasks. Doing so, the application of metamaterial based approaches will enable a more effective detection and identification of cancerous tissues with much less computer resources.

Recent studies of metamaterials [**4**] have created a large knowledgebase showing the importance of the metamaterial formalism in solving different types of biological problems. Electromagnetic radiation in THz frequency range has provided a fertile ground for sensing, chemical and biomedical applications. THz metamaterials are made of periodically arranged sub-wavelength metal structures. It is worthwhile pointing out the similarity between the disordered metamaterials [**5**] and biological tissues and hence the applicability of the metamaterial formalism to treat the biological processes.

Calculation of effective permittivity of biological tissue has received tremendous attention during the past years. It is worthwhile noting that measurement of permittivity of biological tissue possessing nonlinear characteristics in frequency domain is quite a challenging task. From the contents of the above-mentioned literatures, there is no study applying metamaterial formalism for treating if the biological tissue is cancerous. This work deals with the effective permittivity in biological system, especially brain, represented by the metamaterial formalism. Herein, we demonstrate a theoretical analysis on several typical models of effective permittivity in materials. We intend to explore the acceptability of the models in bio-tissues. The determination of the effective permittivity of the tissue samples allows for recognition of cancerous tissues.

Keywords

Metamaterial, disorder, cancer.

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska Curie grant agreement No 713694 and from Engineering and Physical Sciences Research Council (EPSRC) (Grant No. EP/R024898/1).

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Biography of Presenting Author



Dr. Gric's research career has been focused on the investigation of waveguide devices, namely on proposing their electrodynamical analysis. Applied research includes the design of microwave frequency selective structures, waveguide modulators, filters. Fundamental research is primarily concerned with developing rigorous computational methods for the electrodynamical analysis of the waveguide structures. Another major goal of her studies is plasmonics as the examination of the interaction between electromagnetic field and free electrons in a metal. The optically-active nanostructures have been simulated and their fundamental photonic properties have been explored. Moreover, the broad scope of research carried out by Dr. Gric has included investigations into the new fascinating properties of novel materials. Dr. Gric is involved in development of unusual materials and structures that can manipulate the flow of light in ways that are useful in optical sensing, photovoltaics, solid state lighting, fiber optics and other applications. Dr. Gric also has a record of effective teaching in the rank of Full Professor. She has been conducting independent research projects for the past eight years. Dr. Gric has published extensively in her field of investigation with more than 70 peer-reviewed papers in top journals in physics, electrodynamics, and optics and has written several books and book chapters.

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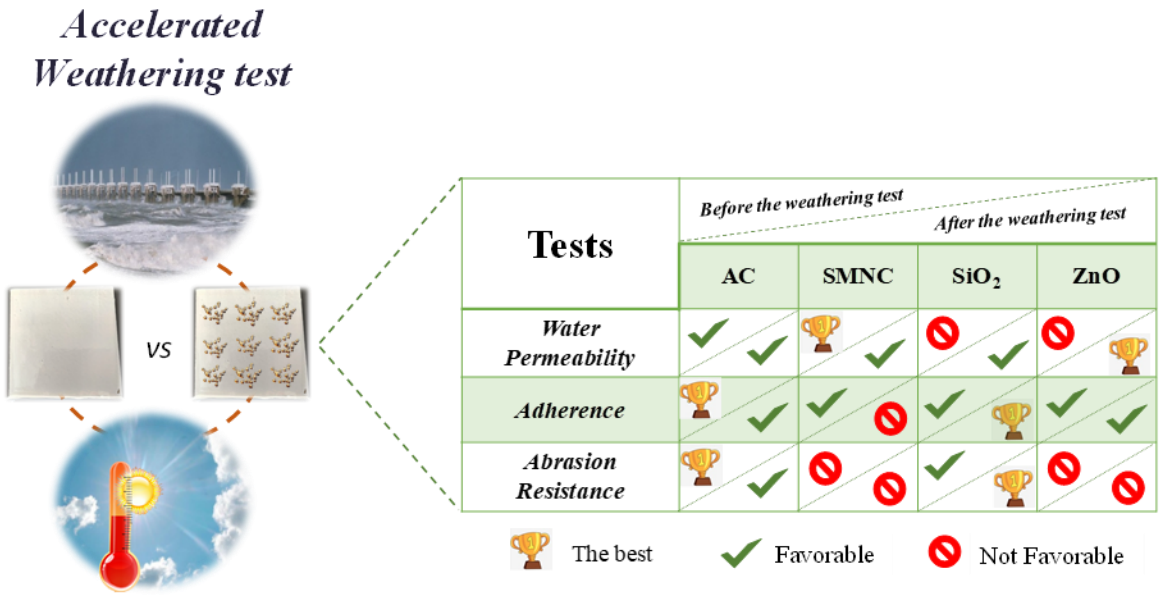
Long-term Performance of Nanomodified Coated Concrete Structures under Hostile Marine Climate Conditions

Adrián Esteban-Arranz[1,*], Ana Raquel de la Osa[1], Wendy Eunice García-Lorefice[1], Javier Sacristan[2], Luz Sánchez-Silva[1,*]

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Graphical Abstract



Abstract

Epoxy resin coatings are commonly used to protect reinforced concrete structures due to their advantageous properties such as excellent chemical and corrosion resistance and strong adhesion capacity. These resins reduce the water penetration and prevent from the incorporation of harmful species such as CO_2 or chloride anions. However, these coatings are susceptible to get damaged by surface abrasion and erosion, generating localized defects that deteriorate their appearance and mechanical strength. These defects lead to the incorporation of water and other dangerous species into the structures, minimizing the protection of the concrete [**1**]. Previous reports have demonstrated the positive effects of the incorporation of some particles into epoxy coatings [**2**]. However, a more thorough study on the effect of different nanoparticles incorporation to the final coating results must be done. Therefore, the aim of this study is to optimize cement, bisphenol-A and polyol epoxy resin

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coatings, by functionalising the selected one with different nanoparticles (activated carbon, surface modified nanoclay, zinc oxide, activated carbon and silica), and test their behaviour in hostile climate conditions. Coated concrete structures are subjected to 3 weeks in a spray salt chamber and 3 weeks in a QUV chamber. Before and after this test, their adhesion, water permeability, and abrasion resistance are established. Their water permeability is ruled by the nature of the nanocomposites, being the non-modified resin, which shows the worst result. The best adherence and abrasion resistance properties are found with activated carbon and silica composites, due to their thermal stability and curing degree after the ageing test [**3**].

Keywords

Nanoparticle; nanocomposite; epoxy system, weathering test.

Acknowledgements

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3. A. Esteban-Arranz, A. R. de la Osa, W. E. Garcia-Lorefice, J. Sacristan, L. Sanchez-Silva, *Nanomaterials*, **2021**, 11(4), 869.

Biography of Presenting Author



Dr. Adrian Esteban-Arranz obtained his Ph.D in chemical engineer in October 2017 with distinctions. His research was focused on the synthesis, characterization and application of carbonaceous materials, especially graphene-based, for their use as adsorbents and catalyst supports to eliminate emerging pollutants from treated wastewater. He conducted two predoctoral stayments at the Helmholtz Centre for Environmental Research in Leipzig, Germany, under the supervision of Prof. Kopinke and Dr. Georgi. In July 2017, he moved to Manchester, UK and started working at the Nanomedicine lab group under the supervision of Prof. Kostarelos between the University of Manchester and the National Graphene Institute. For the next two years, he worked on the synthesis, characterization and functionalization of graphene based materials with different biomolecules (lipids, peptides, proteins and RNA) for nanomedicine applications in the European projects Graphene Flagship, BIORIMA and 2D Health. In October 2019, he started working in the chemical engineering department of UCLM, under the supervision of Prof. María Luz Sánchez Silva in the European project OASIS. Since then, he has been working in the synthesis and optimization of aerogel-based materials by freeze-drying pilot line for construction applications. He has also developed important contribution in modified coatings with nanoparticles for construction applications.

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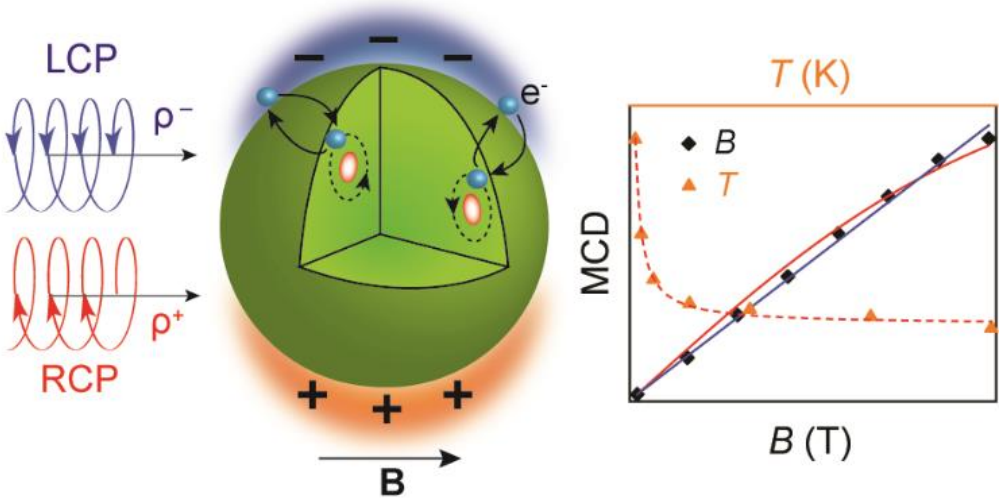
Controlling Carrier Polarization in Transparent Conducting Oxide Nanocrystals

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Graphical Abstract



Abstract

Point defects, both extrinsic and native, critically determine functional properties of metal oxides. As an example, aliovalent dopants or oxygen vacancies could result in the formation of shallow donor states which give certain transparent metal oxides a robust n-type conductivity. This class of metal oxides is known as transparent conducting oxides (TCOs). TCO nanocrystals exhibiting localized surface plasmon resonance (LSPR) as a result of free conduction band electrons have attracted significant attention in recent years due to their unique optoelectronic properties [**1**]. Unlike noble metal nanoparticles, colloidal plasmonic metal oxide nanocrystals have LSPR frequencies tunable in the infrared region, which makes them appealing for terahertz imaging, heat-responsive devices, and surface-enhanced infrared spectroscopic measurements. Besides expanding the LSPR frequency range, plasmonic metal oxide nanocrystals could potentially bring about numerous other opportunities related to single-phase plasmon-exciton interactions. However, non-resonant nature of the LSPR and exciton in semiconductors has been a major obstacle toward realizing such opportunities. In this talk I will discuss the results of our recent work on the structure and composition dependent plasmonic properties of colloidal metal oxide nanostructures [**2**]. I will particularly focus on generating robust excitonic splitting in TCO nanocrystals, enabled by coupling between plasmon-related carriers and excitonic states in an external magnetic field [**3**]. This phenomenon allows for controlling carrier polarization in semiconductor nanocrystals at high temperature. Furthermore, the ability to control carrier localization allows for spin-induced splitting of the excitonic states and further manipulation

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of the carrier polarization in these non-magnetic semiconductor nanostructures [**4**]. Possible applications of this emerging class of multifunctional materials for new electronic and quantum information technologies will also be discussed.

Keywords

Transparent conducting oxide nanocrystals; defects; localized surface plasmon resonance; zeeman splitting; magnetic semiconductors.

Acknowledgements

This research was undertaken thanks in part to funding from the Canada First Research Excellence Fund. We acknowledge the financial support by the Natural Sciences and Engineering Research Council of Canada and Canada Foundation for Innovation.

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Biography of Presenting Author



Pavle Radovanovic received his B.Sc. equivalent degree in chemistry from the University of Novi Sad, Serbia, and an MSc degree from Georgetown University. He subsequently obtained his PhD degree from the University of Washington, Seattle in 2004. Following a postdoctoral fellowship at Harvard University, he started his independent career at the University of Waterloo (Canada) in 2006 and became a full professor in 2017. His research program focuses on the design, physical and chemical properties, and possible applications of multifunctional low-dimensional inorganic and hybrid materials. His research combines a range of complex spectroscopic measurements, structural characterization, and theoretical simulations to formulate quantitative models of structure-function and function-function correlations. This research aims to elucidate fundamental principles governing the coexistence of and interactions between different degrees of freedom, leading to possible applications in lighting, photocatalysis, and quantum technologies. His work has been recognized by a number of honours and awards, including 2019 Keith Laidler Award (by Canadian Society for Chemistry) for outstanding early-career contributions to physical chemistry in Canada, Canada Research Chair, Early Researcher Award (by Ontario Ministry of Research and Innovation), Mobility Award (by French Ministry of Foreign Affairs), and CNC-IUPAC Award. He was a Visiting Professor at the University of California-Berkeley.

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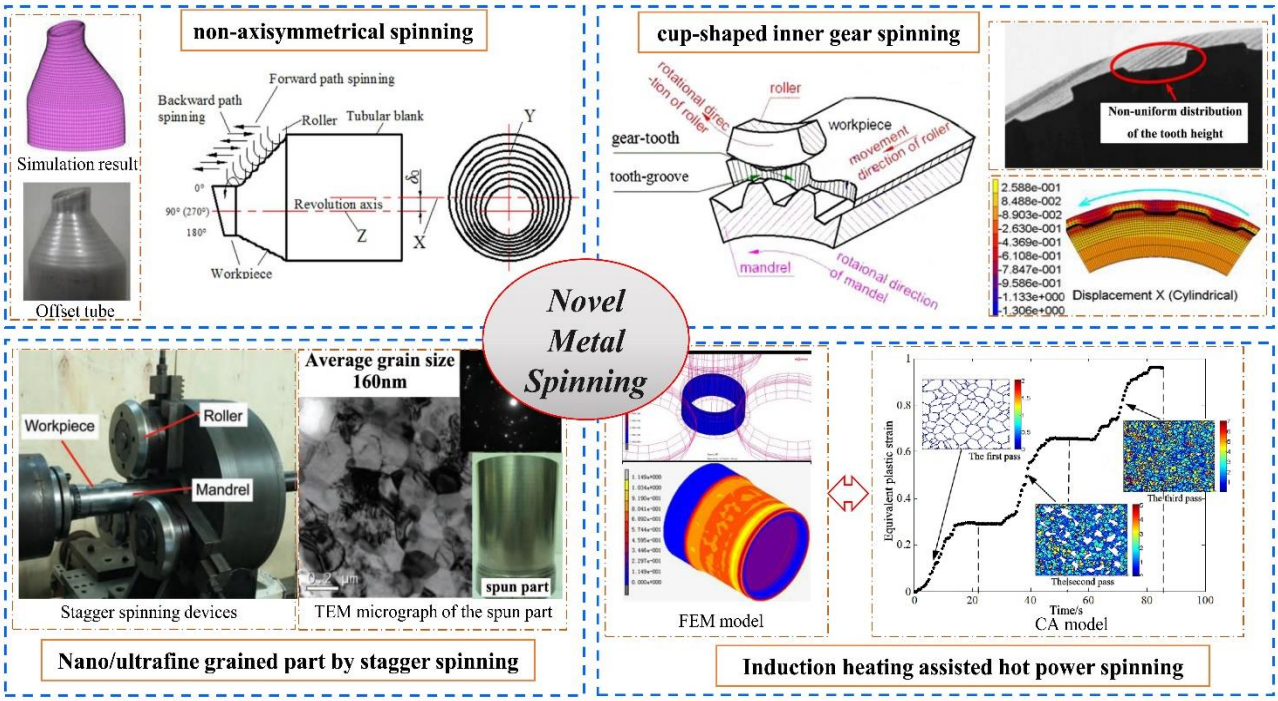
Research Progress and Frontier Challenges of Novel Metal Spinning

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Graphical Abstract



Abstract

Metal spinning is one of the near-net shape forming processes widely used for manufacturing axisymmetric, thin-walled and hollow circular cross-section parts. In recent years, novel spinning processes, such as the non-axisymmetrical spinning, toothed spinning, nano/ultrafine grain spinning, and induction-heating spinning, have been developed for manufacturing the non-axisymmetrical and toothed parts, parts with nano/ultrafine grain structures, and difficult-to-deform metals. To manufacture the asymmetric parts with a partial axis paralleling or being a certain inclined angle to the original axis of the workpiece, a 3D non-axisymmetrical spinning method was proposed, where the workpiece was free from the rotational motion during processing and the roller set was installed on the main spindle and rotated together with the main spindle of the machine; a thin-walled hollow

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asymmetric parts can be produced without the need of using subsequent welding processes. For realize the less chip or chipless manufacturing, a cup-shaped inner gear spinning process was proposed, where the three rollers were 120° equally positioned along the circumference of the workpiece and there was a certain distance between rollers along both the axial and radial directions of the workpiece; the method has been successfully used to form various cup-shaped thin-walled inner gears with high dimensional accuracy and mechanical properties. The nano/ultrafine grained structures refer to the materials with grain size ranged from 1 nm to 100 nm and from 100 nm to 1000 nm, respectively. It has attracted significant interests in scientific research and industry application due to its unique mechanical, physical and chemical properties. A power spinning method based on small plastic strains for manufacturing cylindrical parts with nano/ultrafine grained structures was proposed, which consists of quenching, power spinning and recrystallization annealing; the equiaxial ferritic grains with an average size of 160 nm are generated by subsequent recrystallization annealing at 480 °C for 30 minutes in the spun parts made of ASTM 1020 steel. Conventional spinning processes are typically performed at room temperature, but for parts made of difficult-to-deform metal materials, such as Ni-based superalloys, which exhibits large deformation resistance and severe work hardening when forming at room temperature, heating is generally applied to the blank in order to decrease the forming force and increase the material plasticity. The electromagnetic induction-heating assisted spinning method was proposed because of the essence of the blank self-heating under induction heating, the numerical model coupled with the finite element and cellular automata was constructed to realize the integrated control of the shape & property of Haynes 230 cylindrical parts during hot backward flow spinning. Additionally, the future development trend of spinning technology, such as the online measurement of spinning quality based on machine vision and the development of big data analysis systems for spinning forming, were also prospected.

Keywords

Novel metal spinning; non-axisymmetrical spinning; cup-shaped inner gear spinning, stagger power spinning, hot power spinning.

Acknowledgements

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Biography of Presenting Author



Qinxiang Xia is a professor in Mechanical Engineering, group leader of the Metal Forming and Die CAX technology at the South China University of Technology. She received her Ph.D. degree from the South China University of Technology in 2006 and served as a visiting Scholar at the Department of Mechanical, Materials and Manufacturing Engineering, University of Nottingham, the UK in 2009. Her research interests are plastic forming theory, technology & equipment, and die CAX technology.

Prof Xia has been actively publishing more than eighty papers in international journals (e.g. J Mach Tool Manu, Int. J. Plast, and J. Mater. Process. Technol) and sixty conferences papers (e.g., ICTP, ICMMP, and ISP). She was awarded a second-class award for the science & technology machinery industry of Guangdong province (2020) and a third-class award for the science & technology progress of Guangdong province (2014, 2015). She is currently a reviewer of Int J Mach Tools Manuf, J Mater Process Technol, Int J Adv Manuf Technol, etc. She now is also serving as a committee member of Chinese society for technology of plasticity (CMES).

Prof Xia's projects have been supported by the National Natural Science Foundation of China, Guangdong Province Key Field Research & Development Program Project, and Guangdong Province Basic and Applied Basic Research Fund Project, etc. She is currently engaged in the research of hot power spinning forming & property control, the strength and toughness mechanism of complex components based on spinning, and the development of intelligent integrated system during the die manufacturing process.

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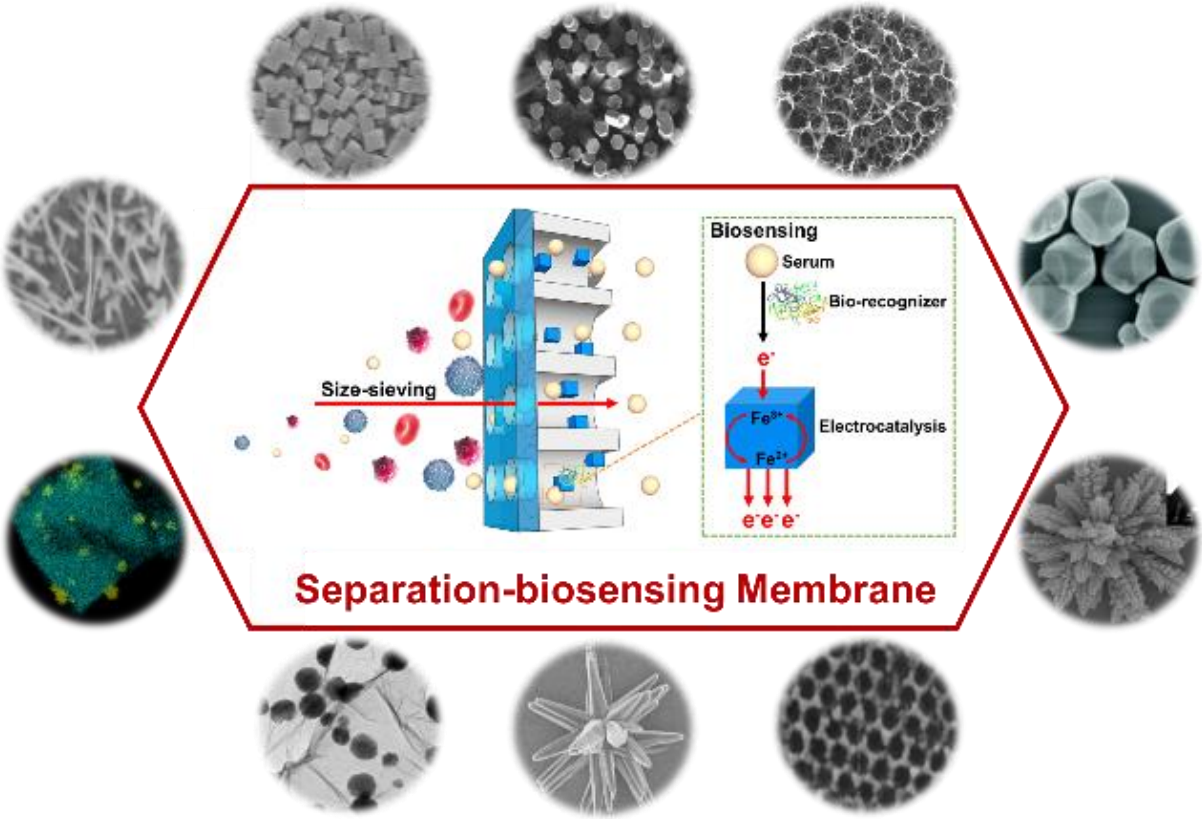
Regular Nanomaterials based Separation-Sensing Membrane

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Graphical Abstract



Abstract

Dynamic and on-site analysis of serum from human blood is crucial especially for making decisions during clinical surgery and emergency treatments. However, state-of-the-art blood assay methods can only collect single or discrete data of physiological analytes; thus, remaining a great challenge in the online reports of the dynamic fluctuation of key analytes. In order to address above issue, we have proposed a new-concept membrane to integrate principles of membrane separation and electrochemical biosensor together, achieving the serum collection and analysis from whole blood simultaneously. Relying on our developed various methods of nanostructure control, the membrane material can be exactly built to form porous separation layer and electroanalytic biosensing layer

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which realizes the blood sieving and key indices detection. This membrane achieved accurate and online glucose and lactate monitoring in patients with a variety of medical conditions within 1 min, which is one order of magnitude faster than the state-of-the-art techniques. Furthermore, this technique has been successfully transferred to commercial products which have already been applied in more than 10 fermentation companies.

Keywords

Separation-biosensing membrane; blood sieving; dynamic detection; clinical online monitor.

Acknowledgements

This work was financially supported by the National Natural Science Foundation of China (Nos. 21727818, 21706116 and 22078148).

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Biography of Presenting Author



Dr. Zhenyu Chu received Ph.D degree from Nanjing Tech University in 2013. He became an associate professor in 2018. He was a visiting professor in Curtin University, Australia from 2017-2018. He is the member of Medical, Biological Membrane Committee in Chinese Industry Association, and the membrane of Anesthesiology Committee of Chinese Research Hospital.

Chu's research interest is focused on Separation & sensing membranes for biosensors. He developed various novel methods of nanostructure control on biosensing materials to obtain a series of regular nanostructures for the performance enhancement. He combines the principles of membrane separation and electrochemical biosensing together to propose a separation-biosensing membrane, achieving the dynamic and real-time blood sieving and serum analysis simultaneously in clinical surgery. The membrane has then been miniaturized as a novel flexible microchip to construct a commercial bioanalytical instrument for the quality check in more than 10 fermentation companies.

Chu has published 54 SCI papers in *Angewandte Chemie International Edition, Advanced Materials, ACS Nano, Advanced Functional Materials, Chemical Communications, Biosensors and Bioelectronics, Journal of Materials Chemistry, Nanoscale* et al., with over 1670 citations and H-index 22 (Google Scholar); 10 international conference papers with winning excellent presentation awards; 6 granted patents and 9 pending patent including 1 European patent.

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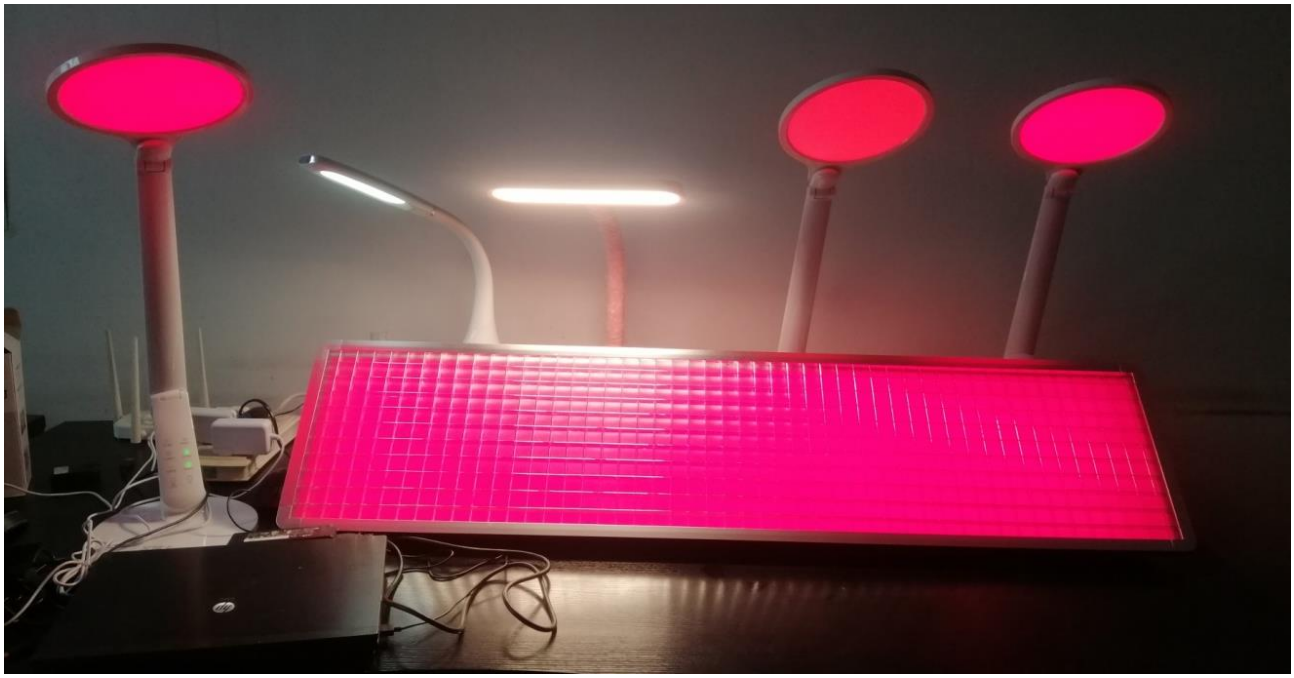
Far-red Phosphors, Light Source, and Biomedical Instrument for Noninvasive Treatment of Neurological Diseases by Phototherapy

Lei Chen[1,5,*], Zhuming Cheng[1], Yabing Wu[1], Xinyu Li[2], Xiaole Li[2], Mei Zhu[2*], Yuqin Zhang[3], Yong Wang[4], Changchun Chen[3*]

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Graphical Abstract



Abstract

For a long time, people have been suffering from the neurological diseases, such as the Parkinson's disease, Alzheimer's disease, depression and anxiety, for which there is no good treatment. Moreover, the myopia (or named with near sightedness) which is a global problem plagues young children and teenagers. The common characters for these diseases are affected by neurotransmitters, like dopamine and melatonin, which are secreted by neutrons. Typically, both the Parkinson's disease and myopia

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are considered due to the deficiency of dopamine [**1,2**]. Eyes are part of a brain, while our understanding on brain is very limited. "As humans, we can identify galaxies light years away and we can study particles smaller than an atom, but still haven't the mystery of the 3 lbs of the mater sits between our years.", as said by the American president Barack Obama on the ceremony to launch the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative in April 2013 [**3**]. Besides photons, however, there is no a better tool to interact with neutrons by turning on or turning off the pathway to secrete neurotransmitters. In 2020, a comment paper published on Science suggested a new weapon against Parkinson's disease by using light [**4**]. The phototherapy was pioneered by Niels Ryberg Finsen and the Nobel Prize in Physiology or Medicine 1903 was awarded him in recognition of his contribution to the treatment of diseases, especially lupus vulgaris, with concentrated light radiation. Eye doctors always encourage children spend enough time outdoors to reduce the prevalence of myopia in children. In practice, this is a kind of phototherapy to myopia. Phototherapy has also been proposed as a treatment for major depressive disorder [**5**]. However, the ordinary indoor light is not sufficient to treat this condition. Our studies show that the difference between outdoor and indoor light that benefits for neurons is far red component. To compensate the deficiency of indoor light in far red wavelength range of 650-950 nm, the far-red phosphors, light sources, and biomedical instrument for noninvasive treatment of neurological diseases were developed in our group. The photoactivites of the far red light on plants (rice and wheat seedling), animals (mice), bacteria, and cells was demonstrated. Furthermore, the intensified gene expression in plant hormone metabolism pathway by far red light was observed through transcriptome gene sequencing in rice seedling, which provided solid basis for future experiments on human neurons using the far-red light.

Keywords:

Far red light; phosphor; phototherapy; neurological diseases; myopia.

Acknowledgements

The authors acknowledge the funding by the National Natural Science Foundation (21875058), the Key Research and Development Plan of Anhui Province (202004a05020179), the Open Foundation of National Joint Engineering Research Center for Abrasion Control and Molding of Metal Materials of Henan University of Science and Technology (HKDNM2019015), and the Nurturing Project for Science and Technology Achievements Aided by Intelligent Manufacturing Institute of HFUT (IMIPY2021025), China.

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Biography of Presenting Author



Dr. Lei Chen is professor at Hefei University of Technology. He received his Ph.D. from University of Science and Technology of China in 2007 with major in Nuclear Science and Applications. He was engaged in postdoctoral research at National Taiwan University in China Taiwan and took visiting-professor research at University of Alberta in Canada. His research interests focus on inter-disciplines on luminescence, optics, optometry, neuroinformatics, and brain science, in addition to his previously main research on condensed-mater physics, solid-state inorganic chemistry, solid-state luminescence, crystal and electronic structures, synchrotron radiation technology and application, phosphors for light-emitting diodes (LED), and quantum dots display. He has published 74 peer-reviewed papers, with representative papers published on top journals like Materials Today, Chemistry of Materials, Advanced Science, Nano Energy, Chemical Engineering journal, etc. His H-index is 21 and i10 index is 41. He has filed 1 USA patent, 2 Australia patents, 4 PCT patents, and 25 invention patents of China. Due to his great contribution on LED phosphors, LED package skills and LED lamps, he was awarded with the first prize of Science and Technology Progress Award of China Light Industry Federation in 2020, the second prize of Science and Technology Progress Award of Anhui Province in 2018, and the second prize of Science and Technology Progress Award of Guangdong Province in 2019. He was awarded with the Distinguished Scientist Award on the International Scientist Awards 2021 On Engineering, Science and Medicine by the VDGOOD Professional Association, India.

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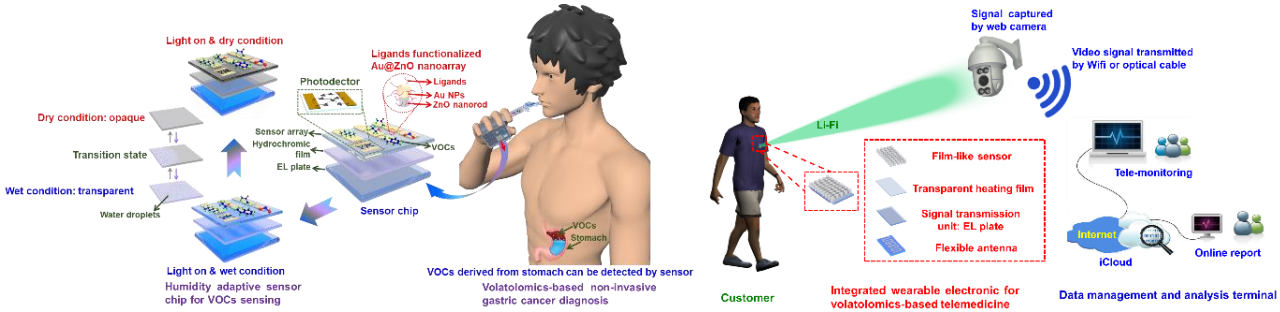
Intelligent Nano-Electronics for Implementing Future Med-Tech

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Graphical Abstract



Abstract

Chronic non-communicable diseases, such as diabetes and cancer are global public concerned health issues and has been emphasized as the “leading killer” by World Health Organization over the past decade. An effective way to prevent chronic disease is to establish a healthcare model based on tele-monitoring system which offers a cost-effective medical approach for victims coming from low-income countries. Herein, we report intelligent nano-electronics for potentially evaluating human heath state. Through integrating gas sensor, heating film, signal transmitting unit and bendable battery, the developed stacking electronic is adopted to continuous monitoring of the level of important volatile markers derived from human skin/breath. Furthermore, light fidelity hybrid image recognition technology is employed in the research, allowing informative data to be quickly captured by a high resolution camera and uploaded to server for further health status evaluation. Notably, the nanosensor-based electronic demonstrates high specificity, quick response rate ($t_{90\%}$ = 4.5 s), and desirable low detection limit (down to 0.117 ppm) in continuous tele-monitoring chronic-disease-related volatile marker (*e.g.*, acetone). Particularly, the concept of humidity self-adaptability is created for the intelligent nano-electroics which enables volatile markers to be high-performance tracked, even at high humidity condition. Assisted by the power saved light fidelity (Li-Fi) communicating technology, a clinic proof on the specifically designed electronic for noninvasively and uninterrupted assessing potential health risk (*e.g.*, diabetics) is successfully implemented, with the accuracy of around 81%. A further increase in the accuracy of prewarning is predicted by excluding the impact of individual differences such as the gender, age, and smoking status of the customer. These promising pilot results indicate a bright future for the tailor-made nanosensing-device-supported volatolomics-based telemedicine in preventing chronic diseases and increasing patients’ survival rate.

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Keywords

Volatolomics-based telemedicine, light fidelity, wearable electronic, image recognition, nanosensor.

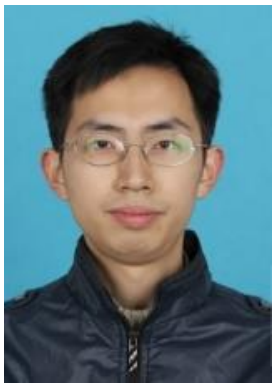
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2. Y. Zhou *et.al.*, *Chemical Engineering Journal*, **2021**, 130543.

Biography of Presenting Author



Han Jin received his Ph.D. in Molecular and Materials Sciences from Kyushu University (Japan) in 2012. Then, he furthered his postdoctoral research in Israel-Institute of Technology, focusing on the development of novel nanosensors for detecting volatile organic compounds. Currently, he is an A/Professor in Shanghai Jiao Tong University (China), in the meanwhile, he is also a guest Professor in National Engineering Research Center for Nanotechnology (China). He received "Chemistry Award of Foreign Researcher" (Japan) due to his contribution to sensor community. His research interests include nanomaterial-based chemical (flexible) sensors, electronic skin, nanoarray devices for screening, diagnosis, and monitoring of disease, breath analysis, volatile biomarkers, and molecular electronic devices.

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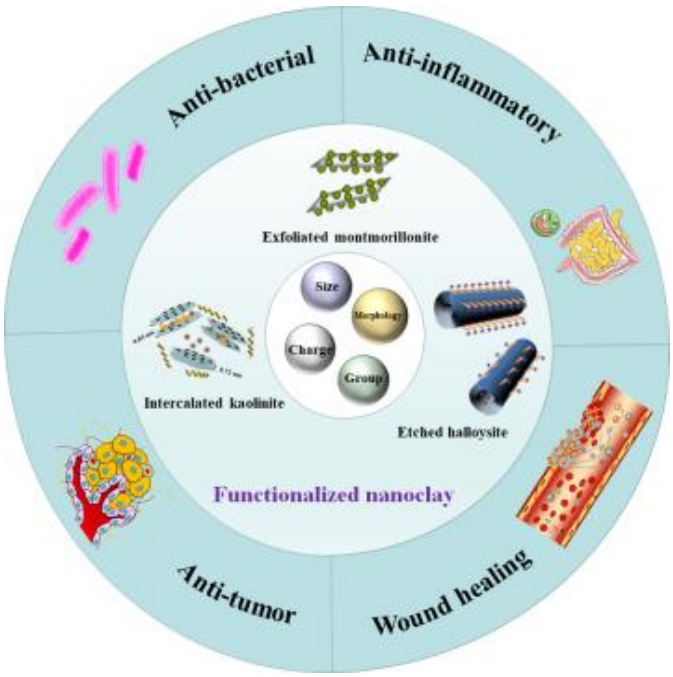
Functionalized Nanoclay for Biomedical Application

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Graphical Abstract



Abstract

Nanoclay plays an important role in biomedical application, including anti-bacterial, anti-inflammatory, wound healing, anti-tumor, etc. [**1**] due to its high porosity, large specific surface area, rich surface functional groups, good dispersion, and good biocompatibility [**2**]. Natural attributes of nanoclay on its biological effects have been studied. Nanoclay has an anti-inflammatory effect on ulcerative colitis. Among them, Kaolinite (Kaol) and montmorillonite (MMT) have a better anti-inflammatory effect. Kaolinite with thin small flakes and loosely piled up has a better hemostatic effect. Similarly, halloysite could promote cellular internalization due to electrostatic adsorption. Functionalized nanoclay was obtained to explore the biomedical application. The anti-bacterial performance of Fe_2O_3/Kaol composite can be enhanced by controlling the distribution density of Fe_2O_3 nanoparticles on the surface of kaolinite to generate more hydroxyl radicals. The higher hemostatic performance of the α-Fe_2O_3/Kaol compound is mainly due to the synergy between kaolinite and iron trioxide. The iron trioxide particles can promote the aggregation of red blood cells and form a blood

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cap on the wound. The α-Fe_2O_3 works together with Kaol to quickly adsorb water molecules in the blood, promote the endogenous coagulation pathway, and the activation and aggregation of platelets to enhance the hemostasis effect. Furthermore, ZnO-Fe_2O_3/Kaol/PG with three effects (hemostasis, antibacterial, and promoting healing) was prepared through electrospinning technology. The anti-tumor effects of functionalized nanoclay are assessed. Fe_3O_4 and DOX are loaded on the dodecyl amine intercalated kaolinite matrix. then, KI is coated to construct a multifunctional drug-carrying system integrating targeted therapy, drug delivery, diagnosis, and treatment. Montmorillonite is exfoliated and followed by DOX loaded. It shows that DOX-MMT exhibits enhanced DOX uptake capacity and cancer cell inhibitory effect. Similarly, halloysite nanotubes (HNTs) with different lumen diameters are functionalized, followed by the anti-cancer agent loaded. The anticancer efficacy (cell viability less than 52%) of HNTs-PTX increased and is attributed to the lower interfacial energy on both inside and outside the tubes that improves tube loading. These findings indicate that the property of biomedical application could be regulated by the functionalized nanoclay.

Keywords

Functionalized nanoclay; biomedical application; attributes; biological effects.

Acknowledgements

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Biography of Presenting Author



Huaming Yang is a professor at China University of Geosciences, and Central South University, China. He completed his Ph.D. at Central South University of Technology in 1998, and went to the University of Bristol as a visiting professor from 2008–2009. He was elected a leading talent of the National "Ten Thousand Talents Program", and awarded the National Science Fund for Distinguished Young Scholars in China. His research interests involve the synthesis and design of biomedical, environmental and energy materials from nanoclay minerals, and the functional strategy and interfacial structure of advanced functioanl materials at atomic-molecular level.

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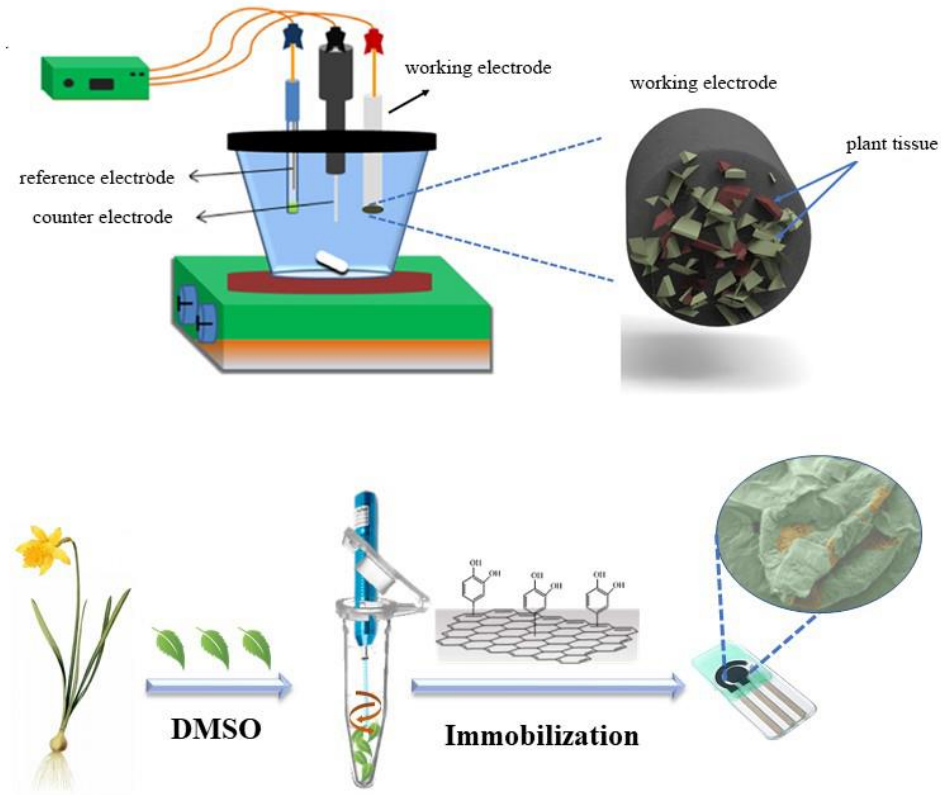
Electrochemical Sensor for Phytological Fingerprinting

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Graphical Abstract



Abstract

Plant identification and phylogenetic studies based on electrochemical fingerprinting is a cross-analytical technique that has emerged in recent years between electroanalytical chemistry and phytochemistry. Plant tissues contain a large number of electrochemical active compounds, such as phenols, ketones and alkaloids. Many of them can be oxidized at low potentials, providing specific electrochemical fingerprints of the plant. Unlike mass spectrometry/chromatography-based chemotaxonomy, electroanalytical chemistry provides a convenient way to present fingerprints of all electrochemically active substances in plant tissues. Theoretically, the difference in electrochemically

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active substances in plants is also largely controlled by genes. Therefore, the electrochemical fingerprint of plant tissues is "big data" that can be used for taxonomic research without qualitative analysis. In this presentation, I will outline our work in the development of electrochemical fingerprinting for plant identification and phylogenetic investigation.

Keywords

Electroanalysis; biosensor; phylogenetics; plant identification; surface modification; pattern recognition.

Acknowledgements

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Biography of Presenting Author



Dr. Fu is an Associate Professor of College of Materials and Environmental Engineering, Hangzhou Dianzi University. Dr. Fu received his PhD in Chemistry at Swinburne University of Technology (Australia) in 2017. He has author or co-author of more than 100 peer reviewed journal papers in the field of Bioelectroanalysis and Biosensor. His work has been cited > 4000 times with an H-index of 37. He also published 8 book chapters with several books/translation books. His research focuses on various aspects of electrochemistry, analytical chemistry, environmental chemistry and food chemistry. His current interests include innovation of electroanalytical chemistry methodology, sensor design and fabrication, phytochemistry and electrochemical fingerprinting.

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Rh-Complex Supported on Magnetic Nanoparticles Catalysts for Hydroformylations and Allylic Alkylation Reactions

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Abstract

The hallmark of designing a successful catalyst is higher efficiency, economical, operational simplicity, extensive reusability, higher environmental credential, and potential use in multiple industrial applications. Herein, we describe a facile protocol for the phosphine complexes of Rh and Pd anchored on the ultrasmall magnetic nanoparticles for transfer hydrogenations reactions. A diphenylphosphino-ferrocenylethyl amine (PPFA) is conjugated with dopamine hydrochloride to form dop-PPFA and then anchored this ligand on the magnetic nanoparticles' surface to produce Fe_3O_4/dop-PPFA. The prepared materials are complexed with the Rh precursor as a catalytic center. XRD, FTIR, SEM, TEM, and XPS were used to investigate the structure and its reactivity. Rh-complexes of Fe_3O_4/dop-PPFA were used to convert terminal olefin to the aldehyde using *syn gas* ($CO:H_2$ 1:1) pressure. Styrene is quantitatively converted to aldehyde with the insertion of CO molecule into the olefin skeleton with 99% branched aldehyde selectivity. The robustness of the catalyst has been tested by reusing the catalyst for multiple cycles. The Rh catalyzed allylic alkylation reactions are carried out using cinnamyl acetate and dimethylmalonate as nucleophile to produce the regioselective alkylated product.

Keywords

Magnetic nanoparticle; hydrogenations; styrene; ferrocene; alkylations.

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Biography of Presenting Author

M. Nasiruzzaman Shaikh received his Ph.D. in 2009 from Kyungpook National University, South Korea, under Prof. T.-J. Kim. He worked as a post-doctoral fellow for a year in Medical College Hospital in the same university. Then he moved to Saudi Arabia as a post-doctoral fellow at the department of chemistry in King Fahd University of Petroleum and Minerals (KFUPM) and then joined the Center of Research Excellence in Nanotechnology (CENT), Research Institute (RI), as Research Scientist-III. Then, he is promoted to Research Scientist-II in the year 2019. He has received a medal for the best inventor award in Saudi Arabia in the year 2018. His current research interest focuses on designing advanced functional metal nanoparticle materials for heterogeneous catalytic applications. He developed numerous superparamagnetic iron-oxide nanoparticles (SPIONs) and MOF-based reusable nanomaterials for hydrogenation, coupling reactions and applications. He was also working as Lab Manager of the CENT in KFUPM.

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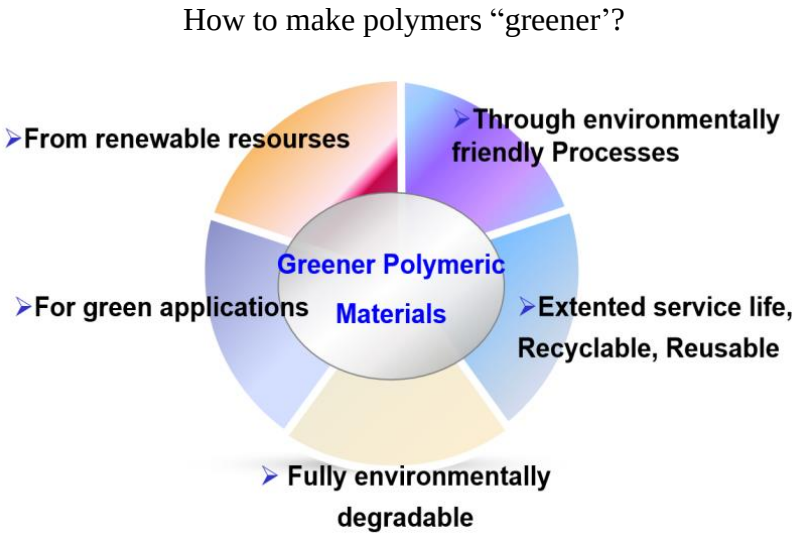
Advanced Polymeric Materials from and For Greener Processes

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Graphical Abstract



Abstract

To support our ever growing needs, we are continuously increasing intake from and discharge into Mother Nature. Polymeric materials under variety of forms, including fibers, films, foams, membranes, rubbers, engineering plastics, glues, gels, composites and even foods, had be invented to meet variety of essential structural and functional needs to improve our life quality. However, the production and disposal of such growing amount of polymeric materials had caused diminution of natural resources and pollution of environment. How to make and use polymers from and for greener processes had been the goal of my professional career. It is believed that polymeric materials from renewable sources, produced from environmentally friendly processes, used for greener applications, can be reusable, recyclable with extended service lives, and/or fully environmentally degradable should be explored across the scope of nanoscience, engineering and technology. In this presentation, I will review and highlight the works I was involved in the areas of syntheses, green processing and applications of fluorinated polymers, high performance membranes for green applications, and environmentally friendly processing and applications of polymers. Our recent progress in using super-critical CO_2 assisted extrusion systems to lower processing temperature and avoid decomposition of polymers, advanced surface modification methods to make super wetting membranes, PTFE composite hollow fiber membranes for long lasting water treatment processes, and the development and applications of lower cost high performance ionic conducting polymers, high selective composite membranes, reversible nano-encapsulation based on weak chemical bonding, low resistance fluid filtration media based on shaped fibers will be covered to promote further discussion and cooperation.

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Keywords

Polymer; green processing; green application; environmentally friendly; nano-science.

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In addition to thank colleagues and students from all the organizations I have worked for, I am also grateful for the financial supports from the private companies, and government agencies including US National Science Foundation (CHE-9133028. CHE-9207230. and OSR-9108772), the Department of Energy (Cooperative Agreement DE-FC02-91ER-75666, "DOE/EPSCoR Research Implementation Plan"), the SBIR projects, the key and general projects of National Science Foundation of China, and the International Cooperation Project and Industrial Support Project of National Ministry of Science and Technology of China.

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Biography of Presenting Author



Professor Lixin Xue received his PhD degree in 1996 from Clemson University and had been project and program leaders for several major US companies, including AlliedSignal (Honeywell) Inc, PhilipMorris USA (Altria Corporataion), and Celanese Corporation, in the development of new technologies and new products. He has led the development of the core technologies for world-renowned branded products, involving indoor air quality control, waste water treatment, green energy production and storage, engine oil life extension, automotive filter development, flagrant control release, biodegradable material processing, fiber spinning process optimization, shaped fiber design and applications, and super-critical fluid assist polymer processing, supporting the sales of *FRAM$^{(R)}$ filters*, *Marlboro$^{(R)}$ consumer products* and *Celanese Advantage$^{(R)}$ Tow*. He is named inventors for 270+ published patents (including 58 issued US/ PCT patents, and 130+ issued Chinese patients;) and authors for 90+ papers published in the top international Journals, keynote speaker chairing and co-chairing 80+ international conferences. Served as reviewers and named to editorial boards for over 10 international journals, he is also serving as board directors for industrial and academic organizations, providing technical and policy suggestions for government agencies and variety of industries, promoting transfer and transformation of technologies. He is winner of various prizes including *Hong Kong Yilida Experimental Science Award* (1986), *Philip Morris Awards for Outstanding Technical Contribution* (2003 and 2006), *First Prize of Science and Technology Advancement* of Chinese Association for Membrane Industry (2018), *Outstanding Reviewer Award* from《J. of Mem. Sci.》(2018), *Gold Invention Award* for Ningbo City (2018), *and Excellent Invention Award* of Chinese Patent and Trade Office (2019).

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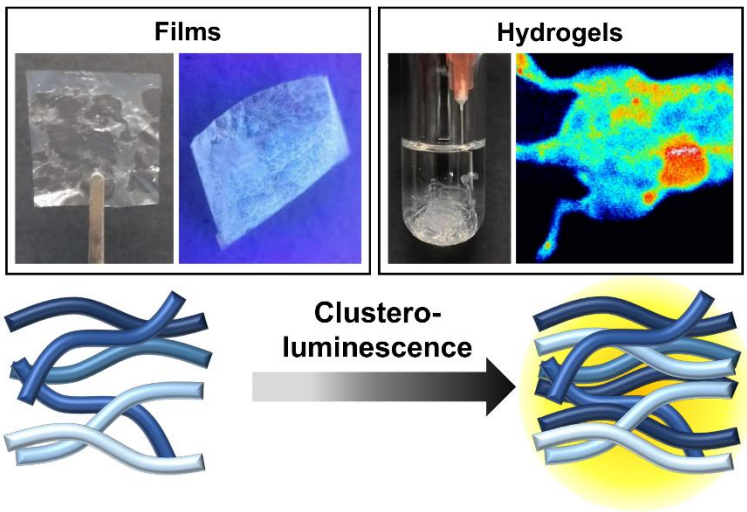
Development of Clusteroluminogenic Hydrogels and Films with High Tunability in Properties

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Graphical Abstract



Abstract

Luminescence from polymeric luminogens is conventionally thought to be caused by the availability of π-conjugated systems. Since the turn of the last century, clusteroluminogenic polymers, which show intrinsic luminescence despite the absence of conjugated electronic structures, have been identified. These polymers possess aggregation induced emission (AIE)-like properties caused by through-space nonbonding interactions among electron-rich heteroatoms. They do not experience aggregation-caused quenching as conventional luminescent polymers do. To exploit the potential of this unique mechanism of luminescence in food and biomedical applications, we have generated a range of clusteroluminogenic hydrogels and films with high tunability in properties. For instance, we have synthesized a biocompatible and clusteroluminogenic cellulose-based polymer which can serve as a depot system for enhancing *in vivo* antitumor efficacy and enabling the location and gelation process of the polymer to be tracked in real time upon injection into an animal model, with the agent release sustainability of the gel formed being able to be tuned simply by changing the concentration and molecular weight of the polymer. By crosslinking chitosan with low-molecular-weight poly(ethylenimine) via urethane linkages, we have also fabricated a positively-charged clusteroluminogenic polymer that can complex with sodium carboxymethyl cellulose to obtain a bioinspired, sustained-release material for biphasic chemical sensing. In a preclinical trial on a dermal punch model of tissue repair, our material has been found not only to increases the rate of wound

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closure, but also to sense internal chemical signals in itself during wound therapy and relay those signals into changes in luminescence to enable the prevention of skin hyperpigmentation caused by minocycline hydrochloride. Apart from applications in therapy, we have generated a range of clusteroluminogenic films for food packaging. One example is the hypromellose-graft-chitosan-based polyelectrolyte complex films, which show high efficiency in post-production agent loading and hence can be incorporated with different agents by end users to address the needs of different situations during food protection. By using frozen chicken breasts as a model, they enable real-time monitoring of the status of the frozen food due to the property of clusteroluminescence. Another example is the UV-shielding cellulose-based films whose wettability and water vapour permeability can be changed upon manipulation of the molecular weight and concentration of the polymer. The films are also dually self-indicating in a way that, by displaying changes in the intensity of clusteroluminescence, they can reveal their barrier properties and the status of the packaged food. All these works of ours demonstrate the high potential of incorporating clusteroluminescence into materials design to extend the functionality and versatility of hydrogels and films for food and biomedical applications.

Keywords

Clusteroluminescence; hydrogels; films; food packaging; sustained release

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Biography of Presenting Author



Wing-Fu Lai received his MSc with distinction in Materials Engineering and Nanotechnology from City University of Hong Kong, and earned his PhD in Chemistry from the University of Hong Kong. He was credentialed as a Chartered Biologist in 2014, a Chartered Chemist in 2018 and a Certified Food Scientist in 2021. He was also accredited in 2018 as “Overseas High-caliber Personnel” (Category B) by Shenzhen Municipal People's Government in China. Currently he is a Presidential Young Fellow and a Principal Investigator at the Chinese University of Hong Kong (Shenzhen), holding an adjunct faculty appointment in Department of Applied Biology and Chemical Technology at the Hong Kong Polytechnic University. His research interest lies in the development and engineering of polymeric materials for food and biomedical applications. One of his works was selected in 2016 as the “Best Paper on Materials” by the Hong Kong Institute of Engineers. He is also the author of *Delivery of Therapeutics for Biogerontological Interventions: From Concepts to Experimental Design* (Academic Press, 2019), and has edited several books on materials science. Besides serving on the editorial boards of various journals, he is an *ad-hoc* reviewer for more than 70 scientific journals in areas ranging from food technology and bioactive agent delivery to materials engineering.

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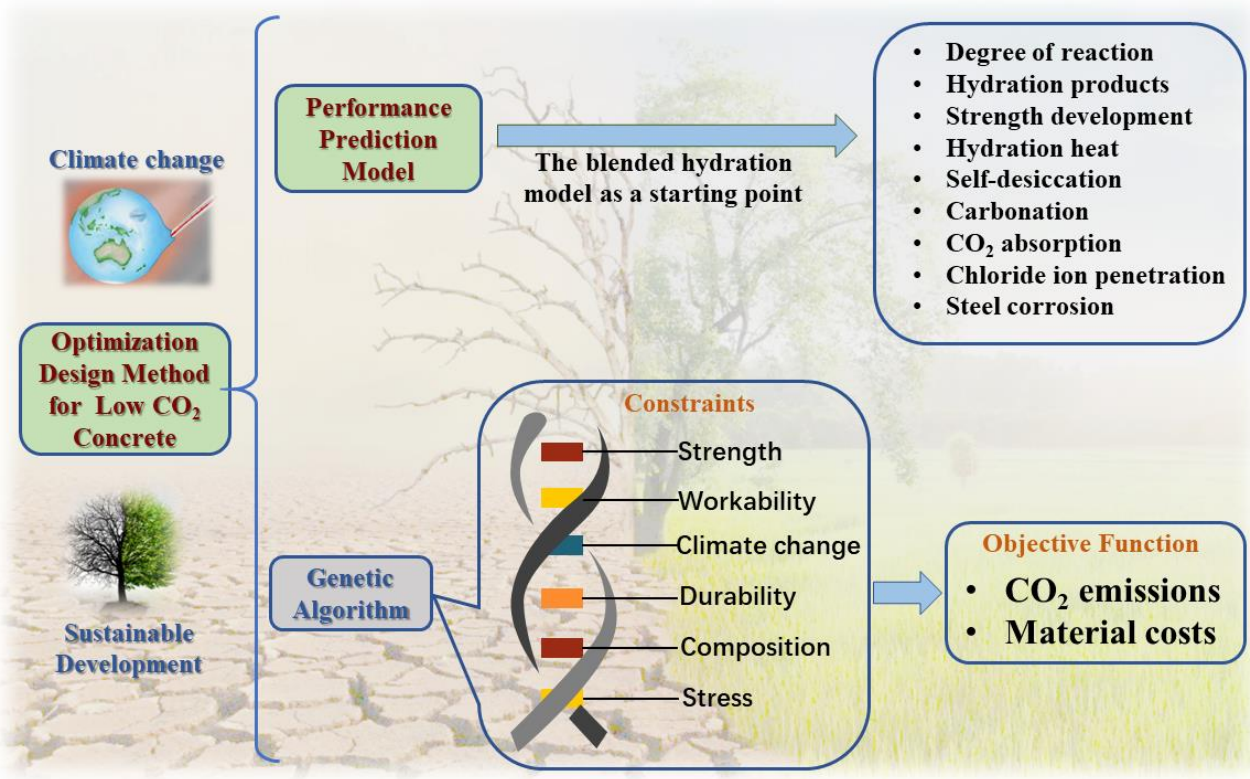
Concrete with Cement Substitute Materials-Performance Modelling and Optimization Design

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Graphical Abstract



Abstract

Cement substitute materials, such as fly ash, silica fume, blast furnace slag, limestone powder, and other mineral admixtures, are widely used in concrete production. At present, there are many experimental studies on composite concrete, but theoretical research is relatively lacking. This study proposes a performance prediction model and an optimization design method for concrete containing cement substitute materials. This study mainly includes two parts. The first part is the performance prediction model of concrete containing cement substitute materials, and the second part is the

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optimization design method. In the performance prediction model part, an integrated model that can predict the properties of concrete containing cement substitute materials is proposed. This integrated model uses the blended hydration model as a starting point to predict the degree of reaction, the phase assemblage of hydration products, strength development, hydration heat and temperature distribution of hardening concrete, self-desiccation and moisture diffusion of concrete, carbonation, CO_2 absorption, chloride ion penetration, and steel corrosion. The performance prediction model has the following characteristics: First, it is suitable for concrete of different mixtures and strengths (from ordinary strength to ultra-high-strength concrete). Second, it is suitable for different admixture substitution ratios (general substitution rate and high substitution rate). Third, it is suitable for different curing conditions, such as constant temperature and humidity conditions in laboratories, variable temperature and humidity conditions in construction sites, and adiabatic temperature rise conditions for mass-volume concrete. Fourth, the interaction between the cement hydration reaction and the admixture reaction is considered. For different concrete mix ratios, the parameters of the model remain unchanged, which has good usability. In the part of the optimization design method, through the combination of genetic algorithm and performance prediction model, a low-carbon concrete mix design method is proposed. This design method takes CO_2 emissions or material costs as an objective function and takes strength, workability, and carbonization durability under climate change as constraints. The optimization design method has the following characteristics: First, it distinguishes the control factors (strength control and carbonization durability control) of the concrete mix design. Second, different sustainability indicators can be considered, such as CO_2 emissions, resource consumption, energy consumption, material prices, etc. Third, different climate change scenarios are considered, such as Representative Concentration Pathway (RCP)2.6, RCP 4.5, RCP 6.0, or RCP 8.5. For each climate change scenario, a corresponding optimal mixture can be obtained. Fourth, it has good portability and can be easily used in Design codes of different countries, such as codes with different strength, carbonization durability, and workability calculation formulas. In short, based on the performance prediction model and optimization design method proposed in this study, concrete researchers, users, and producers from all over the world can find suitable cement substitute materials, find concrete mix proportions that meet engineering requirements and reduce environmental impact, and realize the sustainable development of the concrete industry.

Keywords

Cement substitute materials; Performance prediction model; Optimization design method; Climate change; Sustainable development.

Acknowledgements

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Biography of Presenting Author



Dr. Xiao-Yong Wang is a professor at Kangwon National University, Korea. He received his Ph.D. in construction material in the year 2010 from Hanyang University, Korea. Professor Wang's research direction is the performance simulation of composite concrete and the optimal design of composite concrete. Compared with ordinary Portland cement concrete, composite concrete contains one or more mineral admixtures. Replacing part of cement with mineral admixtures can not only reduce the amount of cement, but also improve some of the long-term properties of concrete. Composite concrete is a practical means for the concrete industry to deal with climate change.

Since 2006, Professor Wang has proposed a series of composite concrete performance prediction models, including hydration model, heat release model, strength model, carbonation and chloride ion penetration model, steel corrosion model, etc. The model proposed by Professor Wang has been recognized and widely cited by researchers worldwide. In recent years, Professor Wang has devoted himself to the design of low-carbon concrete materials. Based on his performance prediction models and genetic algorithm, he proposed a low-carbon concrete material design method that comprehensively considers the impact of strength, workability, durability, climate change, and load. The design method proposed by Professor Wang not only considers the current engineering needs but also meets the future sustainable development needs of civil engineering.

Professor Wang has published more than 90 refereed journal papers on composite concrete and presided over several special issues to find practical and feasible paths for low-carbon concrete.

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Recent Development of Constitutive Models for Soft Materials - (Hydrogels and Shape Memory Polymers)

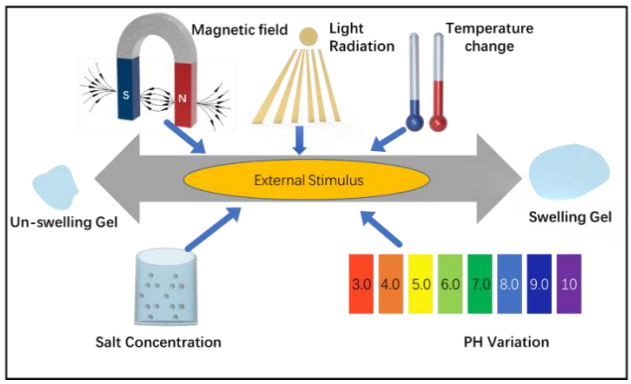
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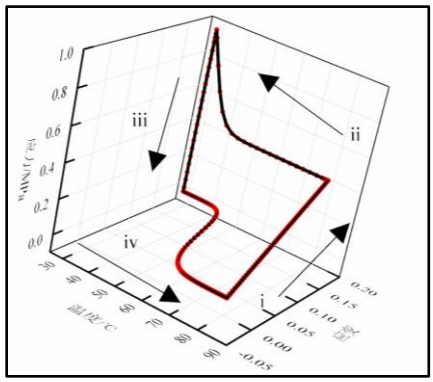
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Graphical Abstract

(a) Schematics of hydrogels under different external stimuli
(b) Temperature-stress-strain curve of thermal sensitive shape memory polymer.



(a)



(b)

Abstract

With development of soft machines, the mechanics of soft materials (hydrogels, shape memory polymers) becomes an emerging field in applied mechanics. Hydrogel is a type of synthetic polymers composed of cross-linked polymer network and water. A polymer network can imbibe copious amounts of water and swell, which can be used in many potential applications, such as stretchable conductors, tissue engineering and fire resistance materials. On other hand, shape memory polymers (SMP) are also a type of smart materials that can keep a temporary shape after pre-deformation at a higher temperature and subsequent cooling to a lower temperature. When they are reheated, their original shape can be recovered. Such special characteristic of SMPs makes them widely used in different structures and devices. Before these applications, hydrogels and SMPs should be studied carefully. In last decade, computational methods have become main approaches to study mechanics of soft materials and to predict deformation behavior of soft materials. In order to predict the deformation behaviors of soft materials correctly, it is critical to develop proper constitutive models. Since the constitutive models of soft materials are still in under development. Therefore, it is very imperative to assess and discuss the advances of new constitutive models for soft materials.

In this presentation, we will review some of the recent works aligned with the direction of providing a better understanding of new development of constitutive models of soft materials. Since last decade, we have proposed different constitutive models for neutral and environmentally sensitive (temperature, pH-value, magnetics and light) hydrogels. These constitutive models have successfully incorporated into FEM. For the SMPs study, we have established series new constitutive models for SMPs. To validate the proposed models, simulated and predicted results are compared with experimental results. As many

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issues related to the deformation behaviors of hydrogel and SMPs still remain open, we will provide some outlines for plausible future directions in the research of constitutive models in soft materials. Finally, we will overview the recent development of computational mechanics in the study of soft materials; especially, the advances of constitutive models for soft material in different research groups over the worldwide will be discussed and reviewed.

Keywords

Hydrogel; shape memory polymer; constitutive models.

Acknowledgements

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Biography of Presenting Author



Dr. Zishun Liu is a Professor of Xi'an Jiaotong University (XJTU) and Executive Director of International Center for Applied Mechanics. He is also the General Secretary of Int. Association of Applied Mechanics (IAAM) and the Honorary President of Singapore Association of Computational Mechanics (SACM). He is IAAM fellow and SACM fellow. He served on the faculty of XJTU between 1986 and 1994, and as Senior Scientist, Capability Group Manager at Institute of High Performance Computing, Singapore (IHPC), and Associate Professor of NUS at various points from 1999 to 2012. As a visiting scientist, he worked in Max Planck Institute for Metals Research, Stuttgart, Germany and University of Glasgow, UK in 2005 and 2006 respectively. His research interests are in the areas of Mechanics of Soft Materials, Solid Mechanics & Biomechanics, Nanomechanics. He has published more than 200 SCI referred research papers and many of his research articles were awarded Most Cited Author Award.

Dr Liu is an active member of various leadership roles in editorial boards and professional communities as follow: Dr. Liu is an Editor-In-Chief of Int. Journal of Applied Mechanics and Int. Journal of Computational Materials Science and Engineering, and Editor of Journal of Mechanics of Material and Structures, Associate Editor of Journal of Applied and Computational Mechanics. He also serves on the editorial boards of Int. Journal of Computational Methods, Int. Journal of Structural Stability and Dynamics, Acta Mechanica Sinica, Acta Mechanica Solida Sinica. Guest editor of Computational Materials Science; Guest editor of special issue of Structural Engineering and Mechanics; Dr Liu is a General Committee Member of Association of Asia-Pacific Computational Mechanics (APACM) and General Member of the International Association for Computational Mechanics (IACM). As a Chairman, Dr. Liu has organized more than 20 Int. Conferences in the field of computational mechanics & applied mechanics.

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Molecular Dynamics and Rheology at Surfaces of Polymer Glasses

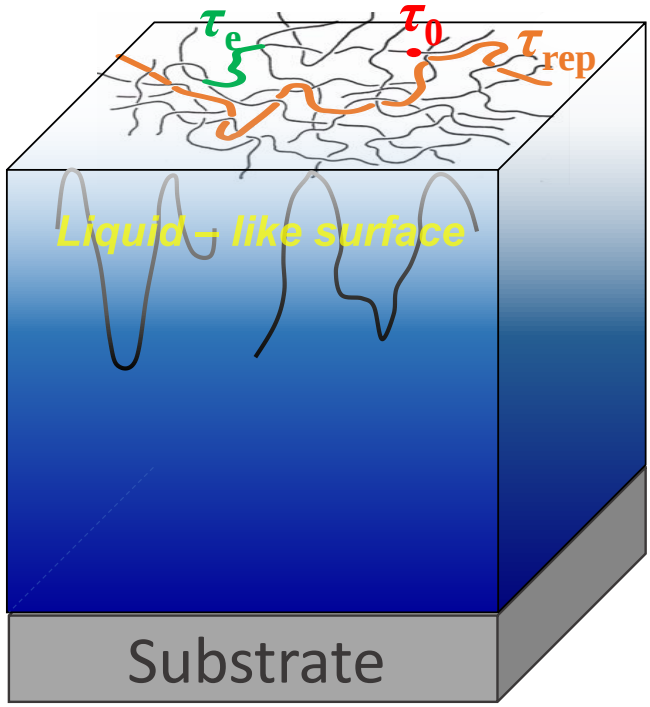
Zhiwei Hao[1,†], Asieh Ghanekarade[2,†], Ningtao Zhu[1], Katelyn Randazzo[3], Keiji Tanaka[5,6], David S. Simmons[2], Rodney D. Priestley[3,4], Biao Zuo[1,*]

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Graphical Abstract



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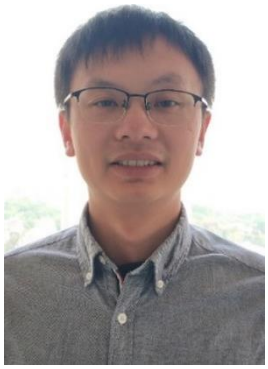
Abstract

The discovery of enormous changes in molecular dynamics near interfaces in glass-forming liquids is one of the major developments in soft condensed matter in the recent decades. Here, we report a nano-creep experiment to probe time-dependent relaxation of nanometer-thick layers at polymer surfaces. Time-resolved nano-rheological data, combined with molecular dynamics simulations reveal a new dynamic mode at polymer surfaces, arising from the intrinsic nature of gradient in segmental dynamics near surface, that retards the surface chain diffusion. This causes unentangled chains to exhibit surface mechanical response and dynamics that are characteristic of entangled polymers, i.e., emergence of a transient rubbery surface behavior. For entangled chains, the phenomenon prolongs and stiffens the entangled response. In both cases, the breadth of the entangled response grows on cooling, leading to a breakdown of time-temperature-superposition at the surface; i.e., thermorheological complexity. Counterintuitively, this new mode of slow surface dynamics emerges precisely because surface dynamics are accelerated relative to bulk.

Keywords

Surface dynamics; rubbery state; nano-rheology; polymer glasses.

Biography of Presenting Author



Biao Zuo received a B.S. (2008, Chemistry), M.S. (2011, Polymer Physics and Chemistry) and Ph.D. (2014, Textile Materials Physics and Chemistry) from Zhejiang Sci-Tech University and subsequently joined at the same university as a lecturer (2014 ~ 2017). He was an associate professor from 2017 to 2021, and just get promoted to a full professor, and started the Polymer Surface and Interface Groups (PSI). His primary research interests are the physics and chemistry of polymers at surfaces & interfaces and under nanometer confinement.

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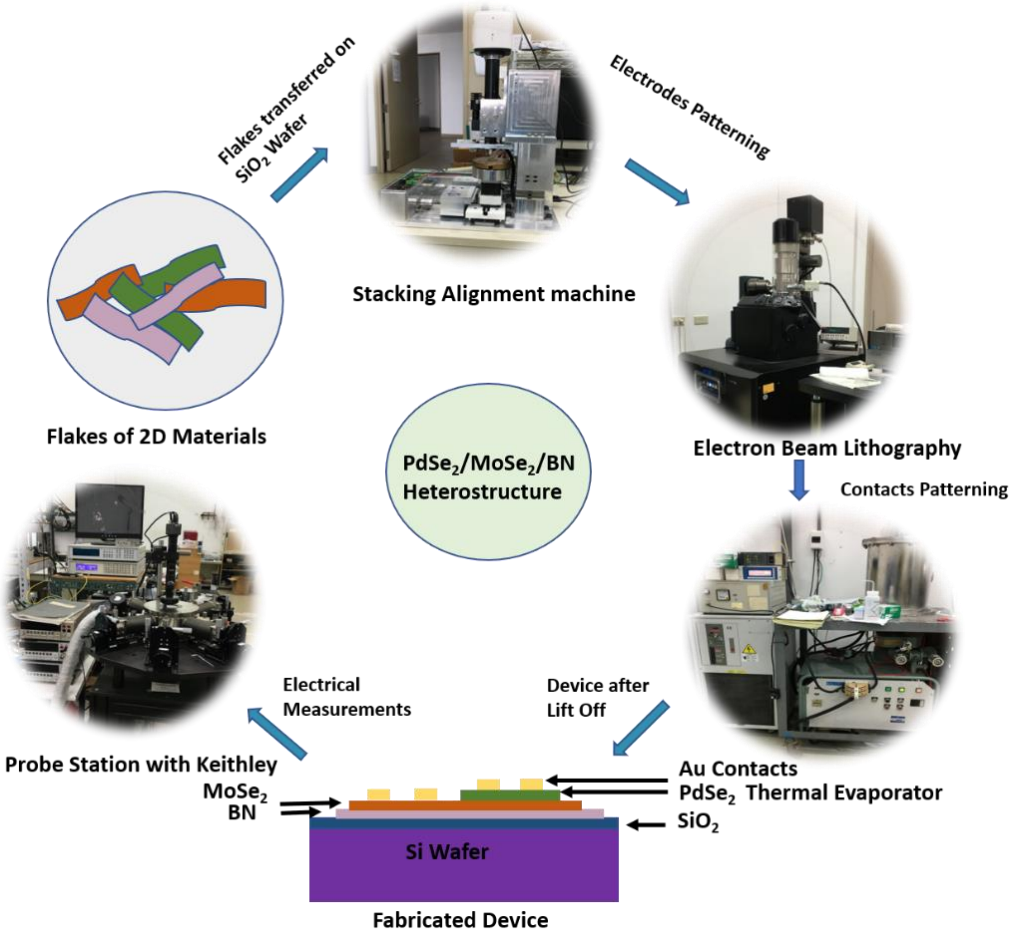
Electrical Analysis of $PdSe_2/MoSe_2$ Interface

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Graphical Abstract



Abstract

Transition Metal Dichalcogenides stand out for their unusual structure and electrical properties as the scientific community's interest in two-dimensional materials grows. The field effect transistor is a fundamental component of semiconductors and the electronic industry. High On-current and mobility with layer dependant features are required for outstanding FET channel material. Because of their layer dependent bandgap, improved carrier mobility, and high ambipolar stability, TMDs have proven to be a promising choice. The substrate should be free of extrinsic disorder and dangling bonds in

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order to test inherent behaviour. therefore, hexagonal boron nitride has been chosen as the substrate for back gated transistor fabrication. TMDs flakes are deposited on a Silicon substrate using a normal dry transfer process, then 100nm thick gold connections are formed using electron beam lithography, followed by thermal evaporation and acetone lift-off to create the $PdSe_2/MoSe_2$/BN heterostructure. The Probe station and Keithley are used to perform electrical characterization on the fabricated device. Performance can be separated into three categories based on device configuration and electrical response.

(i) $MoSe_2$
(ii) $MoSe_2$ and $PdSe_2$ heterostructure
(iii) $PdSe_2$ on $MoSe_2$

Type 2 heterostructures are seen in $MoSe_2/PdSe_2$, which have better electrical properties such as On/Off ratio and mobility than $MoSe_2$. Because of the difference in the work functions of $MoSe_2$ and $PdSe_2$, the back gate voltage can be used to regulate carrier concentration and thus current. When $PdSe_2$ is transferred over $MoSe_2$, the On current increases due to a reduction in trap states and dopants and an increase in carrier concentration. The N-type behaviour is also improved, as evidenced by the right shift in threshold voltage.

From our experiments, it can be concluded that thickness dependent bandgap of $PdSe_2$ fermi level and carrier concentration can be tuned in a wide range. Hence, due to the quick passage of charge carriers between interface layers, $MoSe_2$ and $PdSe_2$ based heterostructures are a promising solution for electrical and photonics-based applications.

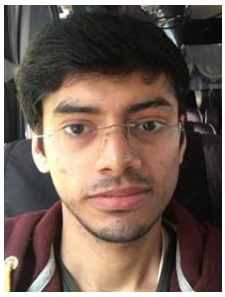
Keywords

$MoSe_2$; $PdSe_2$; Hexagonal Boron Nitride (BN), heterostructure, field effect transistors.

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Biography of Presenting Author



Chetan Awasthi is a Ph.D. student at Centre for Nanoscience and Nanotechnology, Jamia Millia Islamia, New Delhi India. He is working on 2D materials (Transition Metal dichalcogenides and its composites) and its application in various areas like Temperature Sensing and Thermoelectrics under the supervision of Prof. S.S. Islam. He received his Bachelor's degree in Electronics from University of Delhi and Master's degree in Electronics from Jamia Millia Islamia.

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Heterogeneous Solidification Model to Predict the behaviour of Ceramic Nano Reinforcements into Aluminium Alloys

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Abstract

In recent years, many researchers have tried to predict the solidification process of reinforced materials in order to minimize the expensive and time-consuming experimental work. The present work is based on the development of nanoreinforced aluminium composites and studied the variation on the solidification behaviour due to the introduction of nanometric particles. Previous existing models are focused on spherical particles and the innovative work is to predict the effect of introducing pyramidal and cubic shaped particles. The model predicts the grain size by studying the critical Gibbs energy and radius. After comparing obtained results with the experimental ones, it is concluded that, if the subcooling is considered, both, cubic and pyramidal particle reinforced alloys present better properties. By contrast, if the subcooling is not considered, spherical particles present the best results. The model has been validated experimentally with Al_2O_3 and TiC nanoparticles incorporation to an Al alloy.

Biography of Presenting Author

Ane Jimenez Zabaleta (Donostia, 1994). MSc in Mechanical Engineering from the School of Engineering of the University of Navarra in Spain (2017). She started her research career in Tecnalia while accomplishing her Master´s Degree final project that was awarded with the Euroguss Talent Award (2020). In 2018, she received a grant from the University of the Basque Country to conduct a PhD study in collaboration with Tecnalia. Her research is focused on nano-reinforced aluminum alloys with the aim to improve the mechanical properties and reduce the overall weight of structural components. In addition, she conducted a research stay in the Metallurgy and Materials Science Institute in Krakow, where she increased her knowledge on microstructural characterisation. She accomplished a virtual research stay with the Metallurgy and Materials Department of the University of Birmingham that was focused on the study of molecular dynamics.

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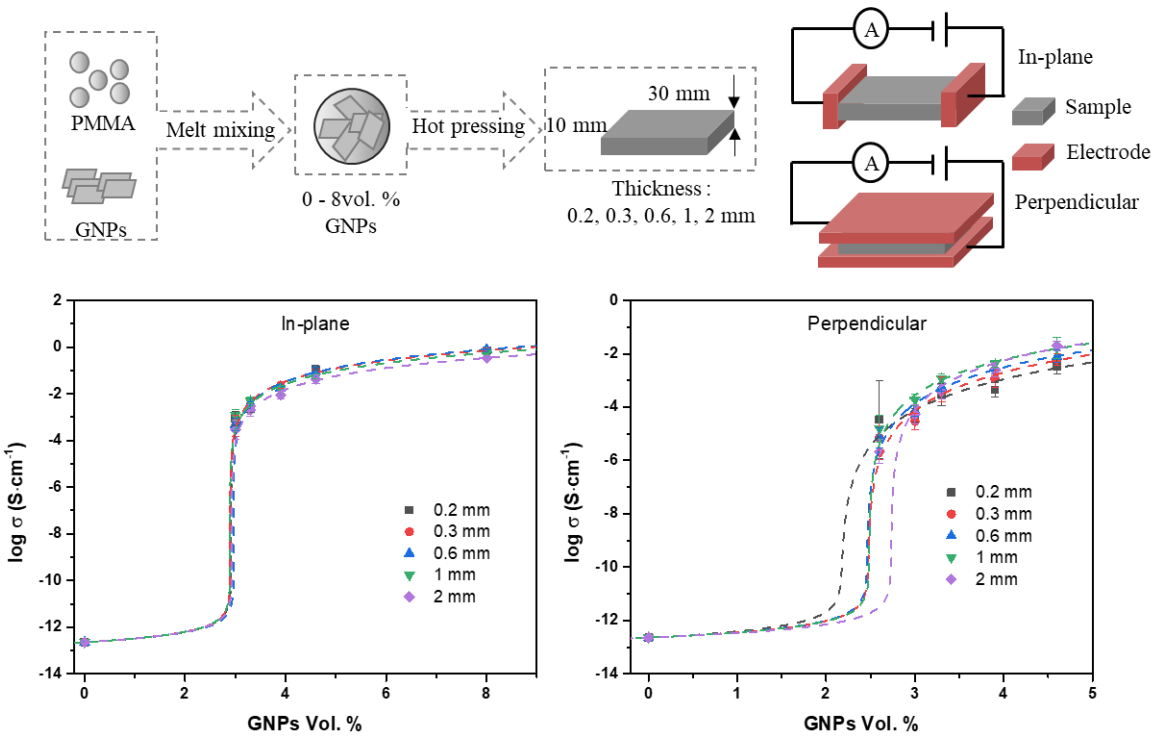
Investigation and Modeling of the Electrical Properties of Poly (methyl methacrylate)/Graphene Nanoplatelets Composite Sheets with Various Thickness

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[1]Institute of Polymer Materials, Friedrich-Alexander-University Erlangen-Nuremberg, Martensstr. 7, Erlangen, 91058, Germany
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Graphical Abstract



Abstract

Poly(methyl methacrylate) (PMMA) composites containing graphene nanoplatelets (GNPs) at various concentrations were melt mixed and hot pressed into rectangular sheets with a variety of thickness. The conductivity σ in the in-plane and perpendicular directions were investigated and modeled using McLachlan general effective medium (GEM) equation [**1**]. In the in-plane direction, the values of the

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parameter t and the resultant percolation thresholds $\Phi_{c,\,I}$ of composite sheets were almost constants of 2.90 vol. % and 2.0 (universal value), respectively, regardless of the sample thickness. In the perpendicular direction, the exponent t decreased from 3.5 to 2.8 as the thickness increased from 0.2 mm to 2 mm, while the percolation threshold $\Phi_{c,\,P}$ increased from 2.12 vol. % to 2.72 vol. %. The lower $\Phi_{c,\,P}$ reveals an easier formation of the percolated network within thinner samples. This is likely due to the large aspect ratio (AR) of GNPs, the lower $\Phi_{c,\,P}$ values relative to $\Phi_{c,\,I}$ also confirm the dependence of sample geometry. The parameter t could be termed the "shape factor", a higher value indicates more tunneling effect or/and more tortuous networks [**2**]. From the point view of tunneling effect, it is considered that more electron tunneling occurred in the perpendicular direction for composite sheets with lower thickness, which was resulted from more thin layers of insulating polymer between the graphene sheets. The finding is opposite to that of the previous study on PMMA/carbon fibers (CF) composites [**3**], which might be ascribed to the different shapes of GNPs and CF. Flake-like GNPs were more prone to construct direct conductive pathways in long-distance transport than rod-like CF.

Keywords

Graphene nanoplatelets; electrical properties; thickness; modelling.

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Biography of Presenting Author



2010- 2014 Study at the Department of Polymer Science and Engineering at Sichuan University, China, degree: Bachelor.
2014-2017 Study at the Department of Polymer Science and Engineering at Sichuan University, China, degree: Master.
Since October 2018 Research at the Institute of Polymer Materials of the Friedrich Alexander University Erlangen-Nuremberg
Field of work: Conductive polymer composites

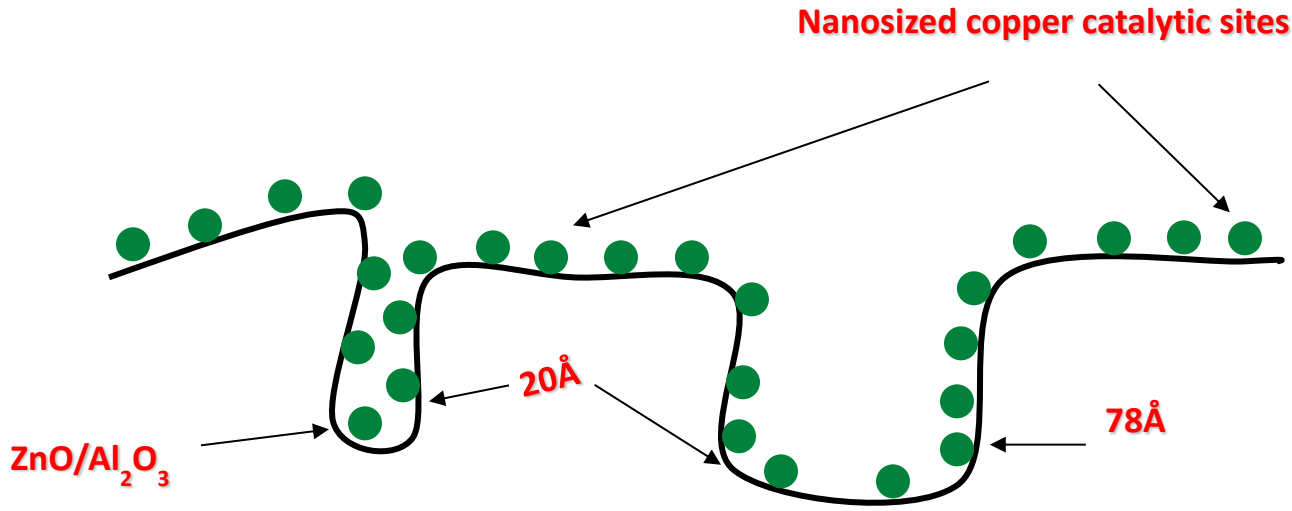
Physicochemical Characterization of Copper-Zinc Oxides Supported on Al_2O_3 and ZrO_2 Catalysts

Wail Halawani*, Abdulmohsen Ali Alsherhri, Mohamed Mokhtar

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Graphical Abstract



Dispersion of nanosized copper catalytic active sites on the surface of different supports

Abstract

Copper zinc oxide catalysts supported on different supports find potential applications in the field of heterogeneous catalysis for methanol production [1], CO-oxidation [2], biodiesel production [3], photocatalysis [4]. The chemical composition and preparation conditions play an important role on the synthesis of the supported catalysts. The dispersion of the active species on the surface of the support and the metal support interaction affects the catalytic performance of the synthesized catalyst. In the present study 5 mol% of Al_2O_3 and ZrO_2 were selected as supports for copper-zinc mixed oxide catalyst with nominal composition varied between 30 to 70 mol% of copper: zinc. The thermal behaviour of as-synthesized materials was studied using TGA analyses. All the solid specimens were calcined in air at 500°C for 5h prior to physicochemical characterization using different techniques such as FTIR, DR-UV-Vis, XRD, SEM and N_2 physisorption at -196°C. TGA thermograms displayed three main steps of thermal decomposition for all the investigated samples at ~200°C, 450°C and above 800°C. Metal oxides were formed at 500°C as depicted by XRD data which complements the TGA results. The crystallite size of all the calcined catalysts was ranged 11-20 nm as calculated using Sherer

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equation. Therefore, nanosized catalyst specimens were successfully attained, which could have superior catalytic activity in the anticipated catalytic reaction.

Keywords

Copper-zinc; biodiesel; physicochemical; heterogeneous catalysis

Acknowledgements

Please acknowledge the funding authorities and other research supports.

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Biography of Presenting Author



Mr. **Wael Halawani** born in Makkah, Saudi Arabia and got his BSc. degree from Umm Al-Qura University, Saudi Arabia in 2011. He started to study the master degree at King Abdulaziz University in 2017. The title of his thesis is “copper-zinc supported on different supports for biodiesel production” under supervision of Prof. Mohamed Mokhtar.

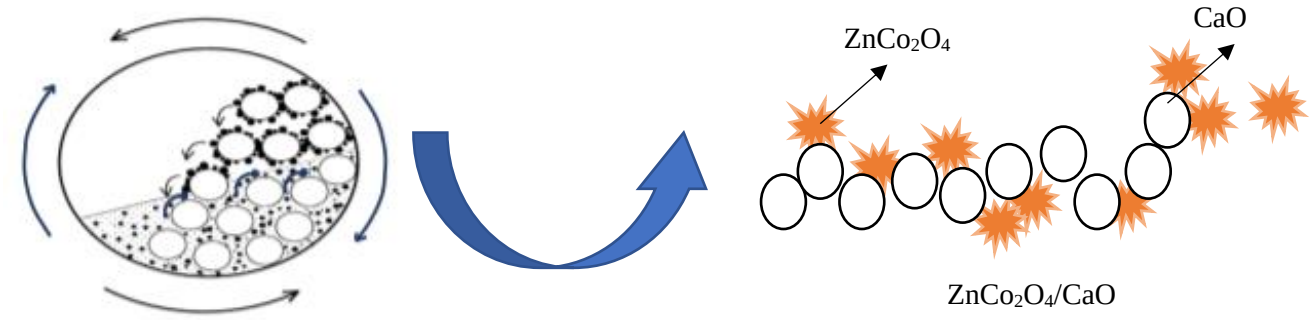
Mechanochemical Preparation and Characterization of Novel Nanosized $ZnCo_2O_4$/CaO Catalyst

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Graphical Abstract



Manual grinding between $ZnCo_2O_4$ and CaO powder

Abstract

Novel $ZnCo_2O_4$/CaO nanoparticles catalysts were successfully prepared via mechanochemical reaction of synthesized $ZnCo_2O_4$ and CaO powder mixture. This particular composite could be used in potential fields of heterogeneous catalysis such as photocatalysis [**1**] , electroreduction application [**2**], and transesterification- esterification reactions for biodiesel production [**3**]. The catalyst was characterized by a series of techniques including x-ray diffraction (XRD), CO_2 temperature-programmed desorption (CO_2-TPD), x-ray photoelectron spectroscopy (XPS), Fourier-transform infrared spectroscopy (FTIR). The average crystallite size of catalyst was 16.58 nm as estimated from the Sherer equation. From the CO_2-TPD of $ZnCo_2O_4$/CaO catalyst, a broad desorption peak was observed from 600 ^oC to 850 ^oC, which was ascribed to the strong basic sites of O^{2-} anions. The basic property of the catalyst enhances its catalytic activity, especially in transesterification reactions to produce biodiesel. The unique characteristics of $ZnCo_2O_4$/CaO catalyst provide a wide scope application in different catalytic reactions.

Keywords

$ZnCo_2O_4$/CaO; nanosized catalysts; heterogeneous catalysis.

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Biography of Presenting Author

Wejdan Bajafar master student at King Abdelaziz University, Jeddah, Saudi Arabia. She got his BSc. degree from the same university in 2015 (excellent with first honor). Her MSc. thesis focused on the synthesis of biodiesel by novel heterogeneous catalysts under the supervision of Prof. Mohamed Mokhtar. She is interested in physical chemistry, heterogeneous catalysis, sustainable energy, green chemistry, and nanomaterials.

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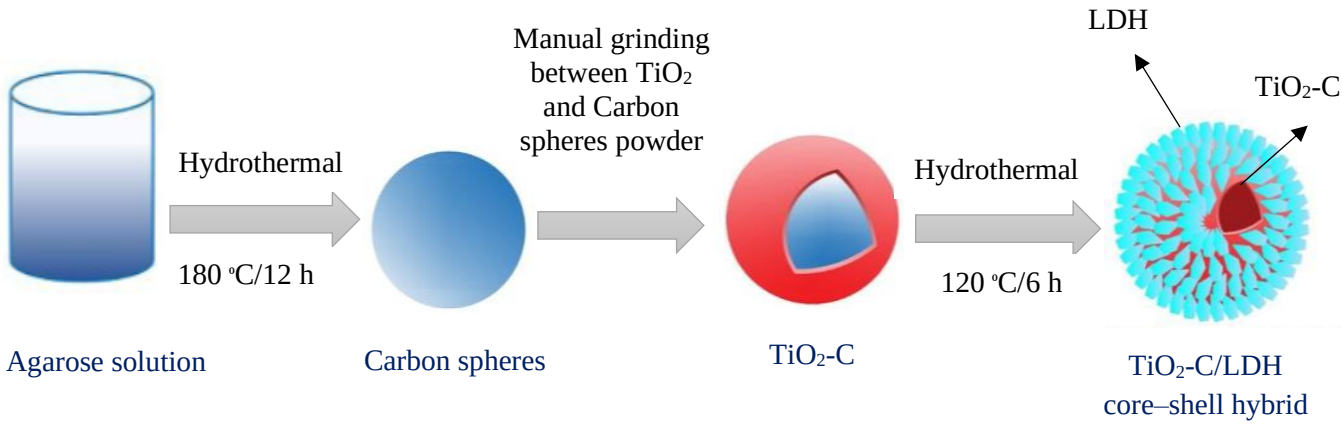
Hydrothermal Approach to the Fabrication of TiO_2-C/NiAl-LDH Core–shell Hybrid Photocatalyst

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Graphical Abstract



Abstract

Novel TiO_2-Carbon sphere / layered double hydroxide nanohybrid (CTL) catalysts were successfully prepared via a hydrothermal method. They are considered promising photocatalysts with high efficiency and selectivity for CO_2 reduction holds paramount significance for resolving the energy crisis and various environmental problems associated with traditional fossil fuels [**1**], and this particular composite could be used in potential fields of heterogeneous catalysis such as photocatalysis [**2**]. The hybridization of TiO_2 with LDHs would provide an effective way to enhance the charge separation and photo- catalytic efficiency [**3**]. The catalyst was characterized by a series of techniques including x-ray diffraction (XRD), CO_2 temperature-programmed desorption, NH_3 temperature-programmed desorption, H_2 temperature-programmed reduction, Scanning electron microscopy (SEM), diffuse reflectance spectroscopy (DRS-UV), x-ray photoelectron spectroscopy (XPS) and Fourier-transform infrared spectroscopy (FTIR). From CO_2-TPD of CTL-Ni catalyst, a significant peak which corresponded to basicity phase at 351 ºC (medium base). Therefore, this work offers a promising approach to the rational design and fabrication of core–shell hybrid photocatalysts with potential applications. The decomposition efficiency of methyl orange was chosen as the test reaction to investigate the synthesized powders' photocatalytic activity.

Keywords

Solar energy, semiconductor photocatalyst, TiO_2/LDH, water treatment.

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Biography of Presenting Author

Auhood Alsoihi Master student at King Abdelaziz University, Jeddah, Saudi Arabia. She got her BSc. degree from the Umm Al-Qura University in 2012, Mecca Saudi Arabia (excellent with first honor), and she works as teaching assistant at the same university. Her MSc. thesis focused on the synthesis of photocatalysts by novel heterogeneous catalysts under the supervision of Prof. Mohamed Mokhtar. She is interested in physical chemistry, heterogeneous catalysis, sustainable energy, green chemistry, and nanomaterials.

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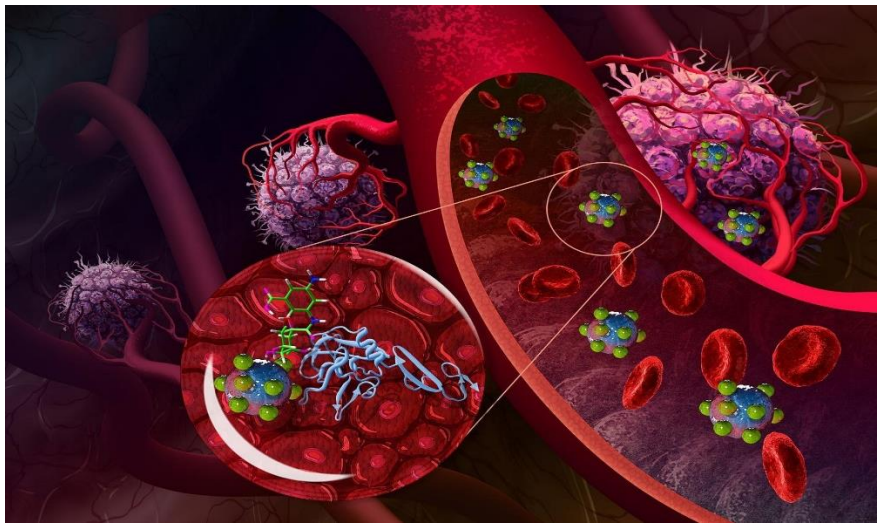
Biodegradable Nanoprobes on it's Duty to Improve CANCER Detection

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Graphical Abstract



Abstract

Recent studies say that we can detect cancer more accurately than before by using biodegradable nanoprobes. This can also further help in diagnosis and therapy of cancer in future. Nanoprobes absorb light of a specific color, like blue, and then emit back light of a different color, like green. This fluorescent property of nanoprobes help doctors to easily detect tumors as these tiny optical probes light up the areas when they attach to the tumors and they can also identify the shape and size of the cancers as well.

As some tissues emit light as well, to prevent wrong identification of cancer a new nanoprobe named **bioharmonophores** are introduced. This new type of nanoprobes emit light with a new type of glowing technology known as **Second Harmonic Generation** (SHG).

Bioharmonophores are modified to spot target cancer cells only and highlight tumors more brightly than those fluorescent nanoprobes. These bioharmonophores are biocompatible and biodegradable as they are prepared using the same peptides which are present in the body and they will be metabolised within 48 hours naturally.

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A Simple and Rapid Liquid-Liquid and Dispersive Liquid-Liquid Micro Extraction Methods Coupled with Spectrophotometry for the Determination of Cadmium Species in Environmental Samples

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Abstract

The submitted report is mainly emphasis on the detailed study with wet lab experiment for the enumeration and extraction of cadmium from the lab tap water (King Abdul-Aziz University, Jeddah) as a sample. The method used was selective simple and with maximum extractant yield with help of spectrophotometric method, involving classical liquid –liquid extractive (LLE) and dispersive liquid-liquid micro-extraction (DLLME) spectrophotometric methods for trace determination and speciation of cadmium from tap water samples. The established LLE and DLLME methods for trace determination and chemical speciation of Cadmium (II) was based upon using reagent Di-Phenayl Carbazone (DPC) and solvent used was Chloroform in liquid –liquid extractive (LLE) and Chloroform & Methanol mixture in dispersive liquid-liquid micro-extraction (DLLME). The two methodology found to be more precise and with high accuracy as DLLME method uses less amount of solvent with more selective and efficient result when compared to LLE. In the process of extraction, NaOH used to prevent the unreacted excess reagent from moving to the organic solvent. Selection of concentration of NaOH was done on the basis of number of trails with different concentrations and the most effective concentration was selected having more yield of extractant. At last the Result of the experiment was calculated at 03 different Concentration of Cadmium with most lower values considered as (0.1M, 0.25M.0.3 M) with their absorbance (0.048, 0.09, & 0.101) respectively and finally Recovery percentage was found to be 100.25% with relative Standard Deviation (1.22%). The whole process was maintained as an Environment friendly set of standard.

Keywords

Cadmium; LLE, DLLME; *SPECTrometer*; Di-Phenayl Carbazone.

Acknowledgements

My Sincere acknowledgement to below mentioned funding authorities and other research supports.

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Biography of Presenting Author



I am Salem Bamarhool a student at King Abdul-Aziz University perusing last semester of Masters in Analytical Chemistry, for fulfillment of the Master's Degree this is my Thesis work and it is the last part in completion my Masters Course.

Currently I am living at Jeddah with my family and trying the best of me to achieve highest success in coming future.

My future plan to do higher education after attaining Masters and do research in the same field and the outcome of which may helpful to the mankind.

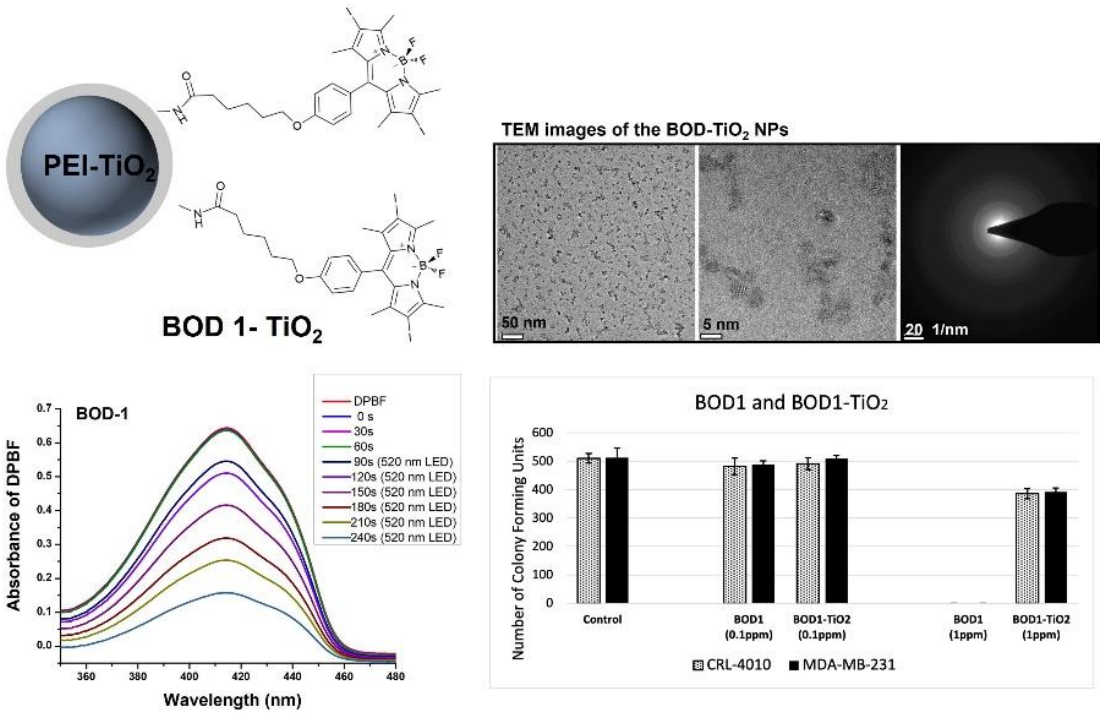
Bodipy Photosensitizer Linked Hybrid Nanomaterials for Photodynamic Therapy

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[2]Antalya Bilim University, Department of Electircal and Electronics Engineering, Antalya, 07190, Turkey

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Graphical Abstract



Abstract

Photodynamic therapy (PDT) is an alternative clinically approved treatment method to obliterate the cancerous lesion by producing reactive oxygen species (ROS) via activated a photosensitiser (PS) molecule at a certain wavelength[1]. In recent years, Bodipy (4,4-difluoro-4-bora-3a,4a-diaza-s-indacene) as a photosensitizer molecule has been extensively investigated in PDT[2,3]. However, the use of many Bodipy PS in PDT has been limited due to their insolubility in aqueous solution. Therefore, nanotechnology offer tremendous solutions to build up nano-carrier systems for insoluble molecules. We have herein developed a stable formulation of hybrid Bodipy PS via conjugation of TiO_2 nanoparticles to the Bodipy PS. In this study, a heavy metal substituted Bodipy PS molecule has been synthesized and linked to polyethyleneimine (PEI) functionalized TiO_2 nanoparticles to increase the stability and biocompatibility of the photosensitizer in physiological conditions (pH:7.4) as a potential photodynamic therapy agent. PEI-TiO_2 nanoparticles have been prepared by a hydrothermal method

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which yields anatase phase crystals with an average diameter of 5 nm. Singlet oxygen studies reveal that the pure Bodipy derivative (BOD 1) has been resulted to 85% decrease in the absorbance of trap molecule, DPBF (diphenyl benzoisofuran), in 180 seconds under 532 nm LED light. Furthermore, the cytotoxicity for the hybrid photosensitizer has been tested against CRL-4010 and MDA-MB-231 cancer cell lines under UV light exposure at a certain time. BOD1-TiO_2 nanoparticles have been found to be effective on both cell lines. IC_{50} value has been calculated as 0.16 ppm and 0.23 ppm for pure BOD 1 on CRL-4010 and MDA-MB-231 cells, respectively, after 5 minutes LED light irradiation. However, IC_{50} values have been raised to 115.60 and 99.53 ppm on CRL-4010 and MDA-MB-231 cell lines, respectively, when BOD1 was functionalized with PEI-TiO_2 nanoparticles. Colony forming experiments show that BOD1 at a concentration of 1 ppm in DMSO has been completely inhibited the colony formation for both cancel cell lines. When BOD1 conjugated to TiO_2 nanoparticles, it has been revealed that it has not superior effect like bare BOD1 on colony formation, however exhibited approximately 20 % inhibition for both cancer cells due to the low conjugation effect of BOD1 to TiO_2 nanoparticle. Nevertheless, the resultant BOD1-TiO_2 hybrid formulation has been exhibited a stable dispersion in physiological solution to apply as a singlet oxygen generator for PDT.

Keywords

Photodynamic therapy; TiO_2; Bodipy; CRL-4010 cells; MDA-MB-231cells.

Acknowledgements

The authors are acknowledged to Antalya Bilim University and Necmettin Erbakan University for their financial support.

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Biography of Presenting Author



Seda Demirel Topel has received her PhD degree in Organic Chemistry (2013, Akdeniz University, Turkey). In the first years of her PhD, she joined the Natural Products group as a researcher at Lund University, Sweden, then continued her PhD studies at National Nanotechnology Research Center (UNAM), Bilkent University, Turkey in the field of organic-hybrid nanoparticles for photodynamic therapy (2010-2013). Then she continued her studies as a post-Doc fellow at the Department of Molecular Sciences, SLU, Sweden in 2013-2014. Currently, she is working as Assist. Prof. at the Department of Electrical & Electronics Engineering at Antalya Bilim University, since 2017. Her research interests include the synthesis and characterization of various types of nanoparticles such as silicon dioxide, titanium dioxide, superparamagnetic iron oxide and upconversion nanoparticles and their hybrid forms with organic ligands for biological applications such as theranostics, bio-imaging and controlled drug delivery.

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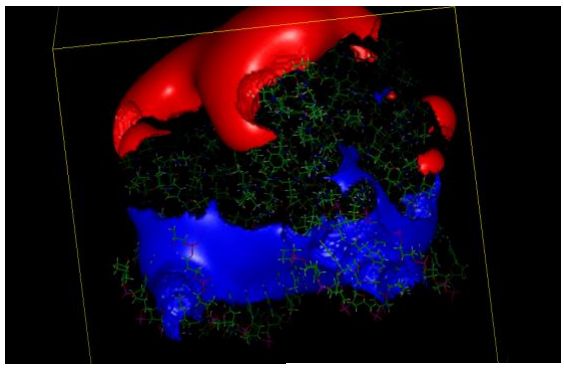
Some Forefront Works on some Bio- and Nanobio-Materials (Involving biomolecules like DNA, RNA and Proteins)

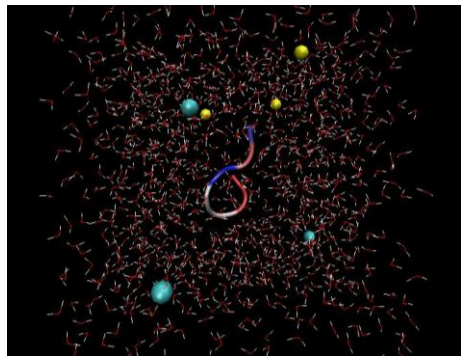
Navin Chandra*

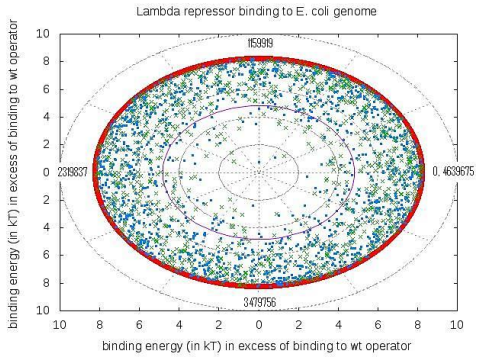
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Graphical Abstract







Abstract

In the present talk the speaker will talk about (some of) the works done by him on some Bio- and Nanobio- materials-- which involve biomolecules like DNA, RNA and proteins-- and interactions among them. The works are computational which include 1. Electrostatics of Protein-Nucleic Acid Interactions, [**1**] 2. Molecular Dynamics simulation studies of a biologically important peptide [**2**] and 3. Simulation of the Energetics of the process of (so-called) 'Target search' by a Protein over a Genome [**3**] (by writing Fortran programmes). Our results obtained from above mentioned computational calculations shed new light on the mechanism of (Nano-)biomolecular interactions (specially exploring the roles of electrostatics and salt therein), which are vital for cell functioning. One of the works will also be helpful for workers trying to design anti-HCV (HCV- Hepatitis C Virus) drug [**4**] in laboratory. These works are on the forefront of the recent advances in 'Theoretical Molecular Bio-Physics' and are providing new directions and dimensions to the application of Physics (including that of Mathematics and Computation) in Biology. Works are interdisciplinary and involve

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multiple disciplines like Physics, Chemistry, Mathematics and Computation apart from Biology. Though the works the speaker will talk about are involved ones and might require knowledge and expertise in multiple disciplines, however, the speaker would only use them to introduce the charm of doing 'Interdisciplinary researches in Science'-- specifically exploring the scope of research in fields of Biology by a student of Physics or Mathematics thereby contributing to the scientists' understanding of life. Feynman had once opined that everything in Chemistry not only has to be consistent with but is explained by the principles and laws of Physics. And also, now the attempts are on to explain everything in Biology on the basis of Molecular structures and their interactions (that is, Scientists are looking for a Chemical basis of life). Our works attempt to proceed in that direction

Keywords

Biomolecules; biomolecular interactions; electrostatic; molecular dynamics simulation; genome.

Acknowledgements

NC acknowledges research supports provided by S. N. Bose National Centre for Basic Sciences (SNBNCBS), Kolkata. NC also acknowledges Prof. Siddharths Roy and Prof. Gautam Basu for providing scientific insights in doing above works.

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Biography of Presenting Author



Dr. Navin Chandra is an Assistant Professor in Physics at Vinoba Bhave University (VBU), Hazaribag, India. He completed his M. Sc. and Ph. D. from S. N. Bose National Centre for Basic Sciences (SNBNCBS), Kolkata under the Post-B. Sc. Integrated Research program. He has more than 13 years of teaching experience at Post-Graduate (P.G.) level and more than 10 years of post-Ph. D. research experience in the capacity of Assistant Professor of Physics. Dr. Chandra has taught several hundreds of students for their M. Sc. He is currently guiding three Ph. D. students. He has published some good research papers in reputed journals. His area of current research interests are:

- Computational Molecular Bio-Physics and Bioinformatics
- Electrostatic Interactions among Biomolecules
- Molecular Dynamics Simulation of Biomolecules
- Programming (Simulating) Biomolecules using FORTRAN and other computer programming language

Dr. Chandra has delivered several lectures and invited talks in many conferences, seminars and webinars. He is a life member of the Indian Association of Physics Teachers and the Indian Science Congress Association. He was a member of Senate of Vinoba Bhave University from 2017 to 2020 as nominated by the Government of Jharkhand.write a brief biography of presenting author. The text should not be more than 200 words long.

TiO_2 Nanostructures Incorporated Gellan Gum Film for Biomedical Applications and Environmental Remediation

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Abstract

TiO_2 incorporated gellan gum (GG) film was fabricated by solvent casting. Prior to that, a series of TiO_2 nanostructures such as nanoparticle, nanotubes and nanrods were synthesized using hydrothermal method. The fabricated GG + TiO_2 were characterized using Fourier transform infrared (FTIR), X-ray diffraction (XRD), and scanning electron microscopy (SEM) to study their physiochemical properties. FTIR was used to investigate the intermolecular interactions in the film. The crystal structure was determined by bulk analysis using XRD and SEM for microstructure observation of film surfaces. The performance of synthesized GG + TiO_2 film was evaluated for biomedical applications. The film possessed antibacterial properties towards staphylococcus aureus and escherichia coli bacteria and also induces the cell growth, thus offering a good candidate for biomedical applications. On top that, the delevoped film shows good photocatalytic activity for air and water pollution treatment.

Keywords

TiO_2, gellan gum, film, biomedical.

Biography of Presenting Author



Mohd Hasmizam Razali has a PhD degree in Materials Engineering (Nanomaterials) from Universiti Sains Malaysia (USM), MSc. in Chemistry (Catalyst) and B.Sc (Hons) in Chemical Industry from Universiti Teknologi Malaysia (UTM). Currently he is an Assoc. Prof. at Faculty of Sciences and Marine Environment, Universiti Malaysia Terengganu (UMT), Malaysia. He has published more than 50 technical papers in journals and conference proceedings locally and internationally related to the nanomaterials and functional materials research. Owing to their significant impacts to the science, economy and society, his innovative research and inventions have attracted global and national interests, enabling him to secure financial support from both private and government agencies. He has been awarded Who's Who in the World for 3 years in a row 2013, 2014 and 2015 by The Marquis Who's Who Publications Board. In 2014, the Cambridge Biographical Centre listed him as one of 2000 Outstanding Intellectuals of the 21st Century, due its ability to produce nanomaterials with tremendous improvement compared to conventional commercial materials. On top of that, he is also the recipient of the MAWHIBA Award and GENEVA Gold Medal Award in 1999.

Research Interest: Functional Nanomaterials for renewable energy generation and biomedical application.

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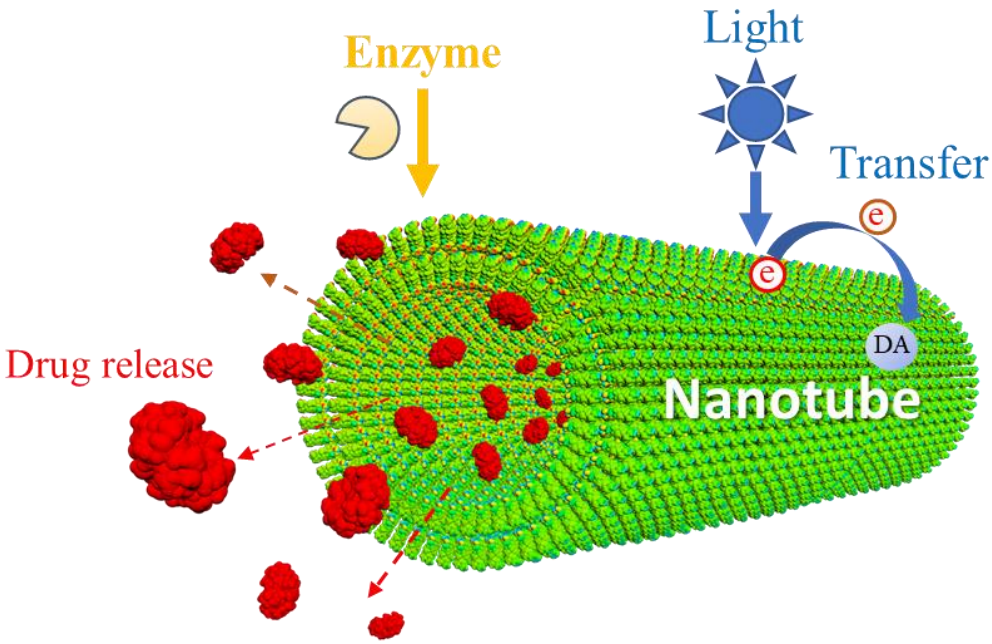
Stimuli-Responsive Nanotubes for Biomedical Applications

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Graphical Abstract



Abstract

Molecular self-assembly is becoming increasingly popular as a “bottom up” approach in the synthesis of supramolecular materials with molecular precision. In this lecture, I will discuss our efforts in the design and synthesis of stimuli-responsive nanotubes for biomedical applications. First, I will focus on the enzyme-responsive nanotubes formed by the self-assembly of chiral lipids, which are capable of releasing both hydrophobic and hydrophilic drugs in a controlled manner. A single dose of drug-loaded lipid nanotubes administrated to the inflammatory sites of arthritic rats can significantly inhibit the degree of joint swelling and suppress the content of proinflammatory cytokines in inflamed tissues for a long period of time. Second, I will focus on light-harvesting J-aggregate nanotubes by the co-assembly of chiral bile acids and cyanine dyes, which can efficiently transfer the excited electrons to dopamine (DA) due to the delocalized excitation. A portable sensor platform is formed by integrating the J-aggregate nanotubes into an agarose hydrogel film. I will show that the integrated J-aggregate

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nanotubes can be used as a photo-induced electron transfer probe for highly sensitive and selectively detecting DA in biological fluids.

Keywords

Self-assembly, chiral molecules, nanotubes, drug delivery, biosensing.

Acknowledgements

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Biography of Presenting Author



Jiyu Fang is the Director of Advanced Materials Processing and Analysis Center at the University of Central Florida (UCF), where he is also a Professor and Associate Chair of Department of Materials Science and Engineering. He received his Ph.D in Biomedical Engineering from Southeast University, China and completed postdoctoral fellowships at Iowa State University and University of California at Los Angeles. Prior to joining the faculty of UCF in 2003, he was a researcher in the Center of Bio/Molecular Science and Engineering at Naval Research Laboratory. His research falls within the general domain of soft materials. Specifically, he utilizes the self-assembly of molecules to synthesize stimuli-responsive materials for biosensor and drug delivery applications. He has published more than 140 journal papers. He received 2009 UCF Distinguished Researcher Award, 2010 UCF Research Incentive Award, 2015 UCF Research Incentive Award, and 2019 UCF Luminary Award. Currently, he is an Editor-in-Chief of Journal of Materials Science and Chemical Engineering and serves as an editorial board member of several journals including International Materials Reviews.

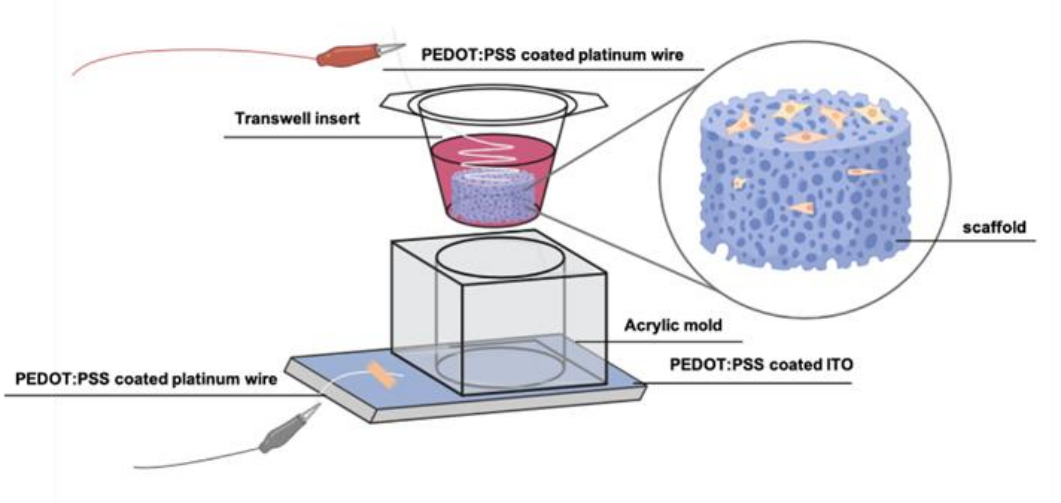
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Guiding Cells with Conductive Polymer based Bioelectronics

Fang-Jung Chen[1], I-Hsiang Liao, Chun-Ting Liu, Yu-Sheng Hsiao[2]*, Jiashing Yu[1]*

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Graphical Abstract



Abstract

Conductive polymers (CPs) have received increasing attention as promising materials for studying electrophysiological signal in cell and tissue engineering. The combination of CPs with electrical stimulation (ES) could possibly enhance neurogenesis, osteogenesis, and myogenesis. To date, research has been prioritized on capitalizing the CPs as a two-dimensional (2D) structures for guiding the differentiation. In contrast, relatively little is conducted on the implementation of 3D conductive scaffold. We reported the synergic assembly of poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate) (PEDOT: PSS) and multi-walled carbon nanotube (MWCNT) as a biocompatible, electrically conductive, mechanically robust and structurally porous 3D scaffold. PEDOT: PSS based scaffolds fabricating by ice-templating method not only present high porosity but also demonstrate enhanced mechanical strength and conductivity, allowing human adipose stem cells (hASC) to adhere and differentiate into osteoblast under the electrical stimulation. To showcase the bioelectrical utilization, a proof-of-concept demonstration of electrical-stimulated cell culture under the ES is demonstrated. The ES effects coupled with the 3D scaffold show promise on pheochromocytoma 12 (PC12), a neuronal cell line and further studied the ES effect on osteogenesis of human adipose-derived stem cell (hASC). PC12 cultured on this PEDOT: PSS/MWCNT 3D scaffolds were induced to differentiate toward more mature neuronal phenotype with the treatment of ES. Furthermore, hASC osteogenesis could be highly promoted in this conductive scaffold with ES. Calcium deposition concentration and osteo-differentiated gene markers were significantly higher

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with ES. The facile assembly of 3D conductive scaffold sheds light on tissue engineering for both in vitro platform for investigating the 3D microenvironment for electrophysiological simulation of cells and tissue under ES treatment of in vivo tissue engineering.

Keywords

Conductive polymers, stem cell differentiation, electrical stimulation.

Acknowledgements

The research was supported by Ministry of Science and Technology, Taiwan.

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Biography of Presenting Author



Dr. Yu received her B.S. in Chemical Engineering in 2003 from National Taiwan University, Taiwan, R.O.C and Ph.D. in 2008 from UC Berkeley/UC San Francisco Joint Graduate Group in Bioengineering. Dr. Yu worked as a postdoctoral researcher at UCSF Medical School and Cardiovascular Research Institute from 2008-2010. She relocated back to her alma mater in 2010 and was an Assistant Professor from 2010-2015 and Associate Professor from 2015-2019. Dr. Yu was promoted to full Professor from Aug. 2019

Dr. Yu's group focus on customized and functional modification of biomaterials including surface modification of biomaterials to enhance cell and extracellular matrix (ECM) interaction. Antibody and peptides conjugated nanoparticles as biosensors and drug delivery vehicles for cancer therapy, cell encapsulation and 3D culture of hASCs (human adipose-derived stem cell) in alginate-based microspheres and various porous scaffold and hydrogel for stem cells differentiation. The group has representative publications in Biomaterials, Tissue Engineering, ACS Applied Materials and Interfaces, Journal of Materials Chemistry B and Biomaterials Sciences etc.

Selected Awards and Fellowships of Dr. Yu include: Young Investigator Award 2012. ISOMRM International Symposium of Materials on Regenerative Medicine. Young Investigator Award, Certificate of Excellence, 2014 World Congress on Preventive and Regenerative Medicine (WCPRM). Recipient, Best Advisor Award (2016), National Taiwan University. Recipient, International Lectureship of the 97th Annual Meeting of The Chemical Society of Japan (March 2017). Recipient, Outstanding Achievement and Contribution. Asia Pacific Society for Materials Research 2017 (July 2017). Young Investigator Award 2017. 3th ISOMRM International Symposium of Materials on Regenerative Medicine

Using Bacteria to Manufacture Metalloid Nanomaterials for Different Applications

Raymond J. Turner[1,*], Elena Piacenza[1], Alessandro Presentato[1], Greta Baggio[2], Alessandra Bulgarini[2], Giovani Vallini[2], Silvia Lampis[2], Roberto Borghese[3], Martina Cappelletti[3], Davide Zannoni[3]

[1] Department of Biological Sciences, University of Calgary, Calgary, Canada
[2] Department of Biotechnology, University of Verona, Verona, Italy
[3] Department of Pharmacy and Biotechnology, University of Bologna, Bologna, Italy

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Abstract

Understanding mechanisms of metal or metalloid ion interactions with bacteria and the toxicity/resistance in bacteria is important for biomedical applications to metal/loid pollutant bioremediation. Recently we see a conversation to move beyond bioremediation of metal/loids by biosorption to bioconversion to value added production of novel compounds. The oxyanions of the chalcogens Selenium and Tellurium are bioavailable and toxic to most bacterial species. However, now several species have been isolated that are able to tolerate these oxyanions and convert them to the less toxic and less bioavailable elemental forms of Se^0 and Te^0 as precipitates that are on the nanoscale. Thus, the field has moved to see if such strains as able to bioconvert these toxic metalloids into nanomaterials of specific structures. This would then simultaneously having potential for bioremediation of chalcogen contaminated sites as well as being an eco-friendly alternative for the synthesis of Se and Te nanomaterials. My group, and in collaboration with others, have explored a number of different bacterial strains for their capacity to produce Se and Te nanomaterials including: *Escherichia coli*, *Bacillus mycoides* SeITE01, *Stenotrophomonas maltophilia* SeITE02, *Rhodococcus aetherivorans* BCP1, and *Rhodobacter capsulatus*. The nanomaterials that these strains produce are nanoparticles and nanorods of various sizes, dimensions, and crystalline structures. The physicochemical characteristics of the nanomaterial forms are dependent on a combination of the strain and different culturing conditions. In some cases, the nanomaterials are either secreted or produced extracellularly, for others the nanomaterials are found intracellularly. The Se and Te nanomaterials that are produced are remarkably stable, a feature of natural biochemicals as 'capping' agents from the microbes. The nanomaterials obtained to date have displayed promising electronic, fluorescent and antimicrobial properties.

Keywords

Nanomaterial; selenium, tellurium, bacteria.

Acknowledgements

R.J. Turner thanks the funding agency Natural Sciences and Engineering Research Council of Canada (NSERC).

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Biography of Presenting Author



Raymond J. Turner is a multi-ethnic multi-generational Canadian. Academic career began with a B.Sc. (1985) in Biochemistry / Chemistry followed by a Ph.D. (1990) in Biophysical chemistry. Post-Doctoral training (1990-1994) was obtained in Molecular and Microbial Biochemistry. In January 1998, was recruited to the University of Calgary and is presently appointed as Faculty Professor of Science. Has held the post as Associate Department Head and Graduate program director and chair of various research cluster units between. He has also served on Dean's and vice-presidents' advisory committees. Research funding from the Canadian funding councils of NSERC, CIHR, Genome Canada, and MITACS as well as a number of industrial partners. Has received awards of excellence in research and excellence in graduate student supervision from the University of Calgary. Received visiting professorship appointments from the University of East Anglia, England, University of Bologna and University of Verona, Italy, as well as receiving a number of Fellowships from the Instituto di Studi Avanzati, Italy. Awarded the Western Universities Speaker Lectureship from the Canadian society of Chemistry in 2015. Research interests are multi-disciplinary from metal toxicity/sensitivity and resistance/tolerance mechanisms in bacteria, to Biofilm physiology and biochemistry, to protein transporters and translocases.

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Nanomaterials based Geopolymers, Emerging Sustainable Green Composite Building Material: A Review

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Abstract

The enormity of the pollution from cement production can be gauged from the fact that cement, whose production results in 650–920 kg of CO_2/ ton, is produced at the rate of 1ton /human being/year and is currently the second biggest reason for greenhouse gases emission. One of the major goals in achieving sustainable construction materials is to reduce CO_2 emission and limit overuse of virgin materials for cement production. Among different methods, the synthesis of geopolymer composite, using alkali-activated aluminosilicate industrial by-products, has been at the forefront of current global research, which is to limit the use of cement and .to provide sustainable alternative to OPC based construction. The current impetus is to shift the micro-structural and hydration based chemical processes of conventional cement to a more novel, durable, environmentally / economically sustainability binders (SCMs) and binding processes. Through the development of geopolymers different modifications has been done for synthesis of strong and sustainable building material and one such option is to add prospective materials such as nanoparticles. Incorporation of nanomaterials like nano-SiO_2 , nano-Al_2O_3, nano-TiO_2, nano-Fe_2O_3, nano-ZnO_2, nano-clay, carbon nano-tubes, carbon nano-fibers etc. in geopolymers or partially incorporated industrial by-product based cement composites has had dual impact of enhanced pozzolanic activity and densified microstructure due to filler effect. The nano-particles of small size that fill up the pores in the composite, induce physico-mechanical behavioural changes, which eventually lead to increased micromechanical properties of N-A-S-H gel and enhanced durability (reduced Permeability). The reduction in stretching band for nanomaterial incorporated geopolymer specimens, depicted by FTIR results, indicate the reduction of Si/Al ratio, which is essential for the development of high performance geopolymer. The nano-particle dispersion which is positively influenced by alkaline activating solution is generally sized more than 10nm.

Besides the comprehensive review on the pros and cons of nano-materials incorporation in the geopolymers and partially incorporated industrial by-products based cement composite, this study also looks forward to different possibilities that can be explored with the aid of nanomaterial and technology. Enhancement of aggregate–paste bond strength, improvement of composite performance using nanoporous thin film technology at ITZ, self-healing of microcracks with the use of chemistry and microbes self-healing polymers, nanomaterials CNTs for electrical conductivity and stress-sensing of geopolymer composite, self-cleaning composite and self-sensing and self-powered material composites are few possibilities that need to be worked on with nanomaterials and nano-technological aids. The possible development of intelligent and need based geopolymer composite with the integration of nanotechnology-based self-sensing, self-powered materials and cyber infrastructure technologies can revolutionise the base line of built environment.

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Functionalizing Titanium Alloys using Low Energy, Non-Toxic Plasma Electrolytic Oxidation Processes

Fengyan Hou[1], Rukmini Gorthy[1,*], Ian Mardon[1], Da Tang[1, 2], Chris Goode

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Graphical Abstract

The team at Cirrus Materials Science has been working on using sustainable plasma electrolytic oxidation (PEO) processes to produce coatings on light metals with visible light functionality. Cirrus PEO technology produces adherent, textured bluish-grey coatings on T1 titanium alloys (a & b) utilizing <120 V of energy (c). The coatings are composed of titanium oxides, silicates, carbides, and nitrides.

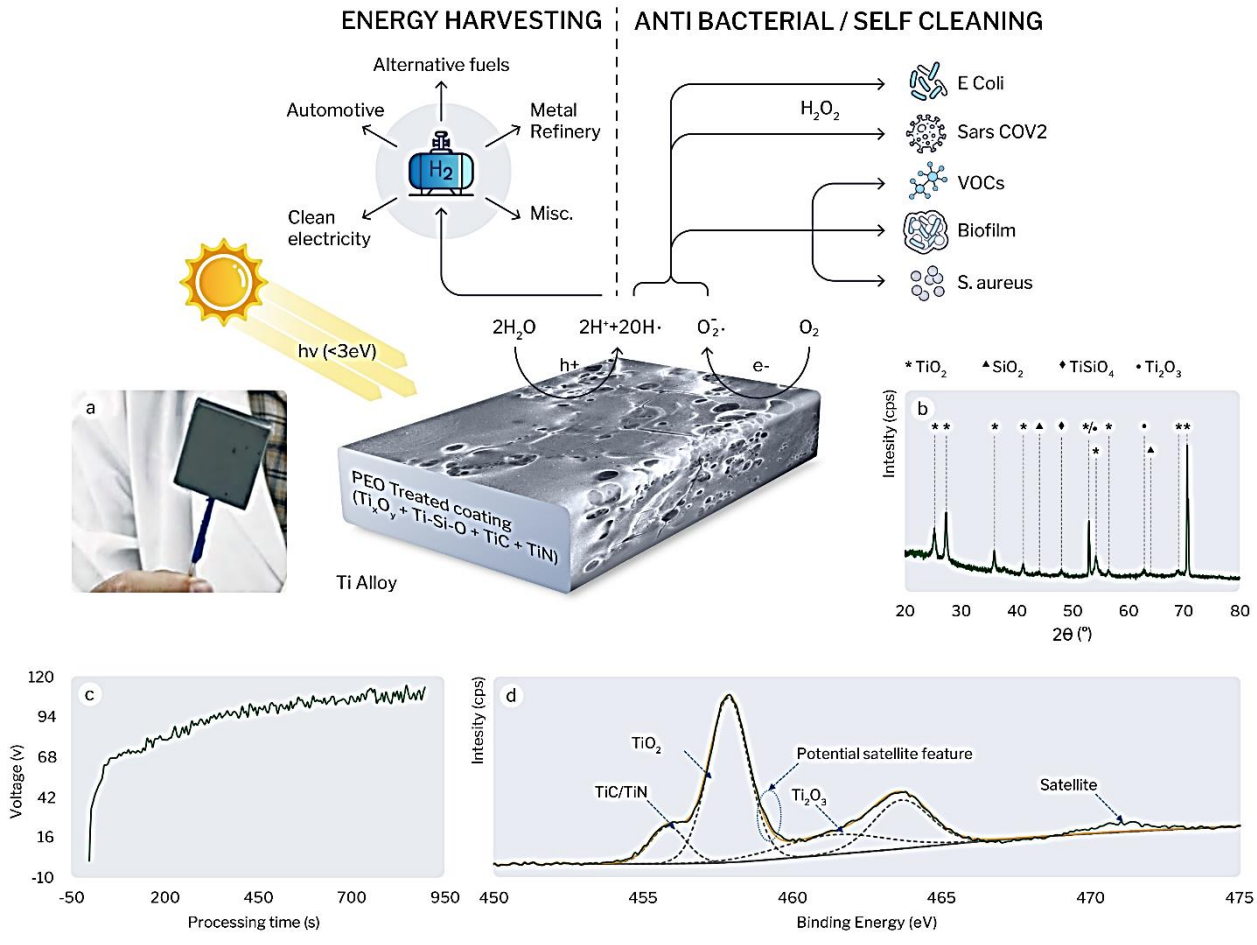


Fig. 1. Schematic illustrating the potential applications of PEO treated titanium alloys using Cirrus technology. (a) Bluish-grey coatings on Ti substrates. (b) XRD pattern exhibiting the high texture of resultant coatings. (c) Voltage-time curve depicting the low energy usage of Cirrus PEO technology. (d) XPS core-level spectrum for Ti 2p showing the chemical composition of the coatings.

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Abstract

Plasma electrolytic oxidation (PEO) is a surface-treatment process that protects metallic or metal-based substrate by applying high direct current (DC), pulsed DC or alternating current (AC) between a stable cathode and the target substrate in an electrolyte. Micro-arc discharge points on the substrate, formed due to plasma thermochemical interactions, induce bidirectional formation of ceramic oxide coatings. Light metals such as Mg, Al and Ti are commonly subjected to PEO treatment for a wide range of applications [**1**]. However, PEO surface-treatment is primarily used to incorporate wear and corrosion resistance characteristics to the target substrate.

Titanium and its alloys possess high specific strengths, low densities and are easy to machine for a broad scope of applications in aerospace, chemical, biomedical and semiconductor industries [**2**]. T1 titanium alloys are of particular interest for scientific (photocatalytic) applications [**3**] but they as they are not reactive with oxygen and do not respond to standard thermal hardening processes, their functionalization requires advanced materials engineering. Of the available T1 alloy surface treatment techniques, PEO is one of the few commercially viable processes that can produce thick, adherent, robust, and durable coatings. Cirrus aimed to improve existing PEO treatment methodologies to produce oxidized Ti coatings with functional properties in addition to the characteristics previously listed. Efficient functionalization of Ti–O-based materials also requires them to be responsive under visible light.

PEO surface treatments generally use high potentials (> 400 V) to electrochemically modify the passivating surface oxide layer [**4**]. Additionally, the processes often require toxic chemicals such as chromic acid and fluorides to treat the alloy surfaces [**5**]. Here, we report a PEO surface treatment methodology that can produce functional ceramic coatings on T1 Ti alloys using low voltages (~120 V) and environmentally friendly silicate-containing organo-alkaline baths. Nitrogenation of the coatings is achieved by introducing nitrogen-containing polymers into the PEO electrolyte. The resultant coatings are composites of titanium oxides, carbides, nitrides, and silicate compounds. X-ray diffraction analysis indicates that the coatings possessed high-texture in A [220] direction. We were particularly interested in analyzing the influences of carbide and nitride compounds on the functionality of the ceramic coatings. This is the first ever report of producing TixOy, Ti-Si-O, TiC, and TiN textured composite coatings using a single PEO bath without carbide/nitride nanoparticles. The bandgaps of the coatings suggest visible light functionality. The use of nitrogen-based compounds in the PEO baths also improves the hardness of the oxide coatings.

Keywords

Low-energy PEO; photocatalytic surface; textured coatings; carbide inclusion; nitridation.

Acknowledgements

We thank Catherine Hobbis and Colin Doyle of Research Centre for Surface and Materials Science at The University of Auckland (UoA). We also thank Tianping Zhu for assisting with potentiodynamic testing of the coatings. We are grateful to Prof. Wei Gao for providing us with access to the characterization facilities at UoA. This work was partly funded by grants from Callaghan Innovation.

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Biography of Presenting Author



Rukmini is a Materials Process Engineer at Cirrus since January 2020. She has a PhD in Materials Engineering from the University of Canterbury, NZ and an M.S. in Mechanical & Materials Science Engineering from University of Cincinnati, USA. Her primary research interest is in applying forensic investigative principles for materials analysis and characterization. She has published original articles in high-impact journals such as Scientific Reports, Surface & Coatings Technology and Materials. Rukmini currently works on nanostructured coatings with target applications in photocatalysis, semiconductors and lightweight engineering.

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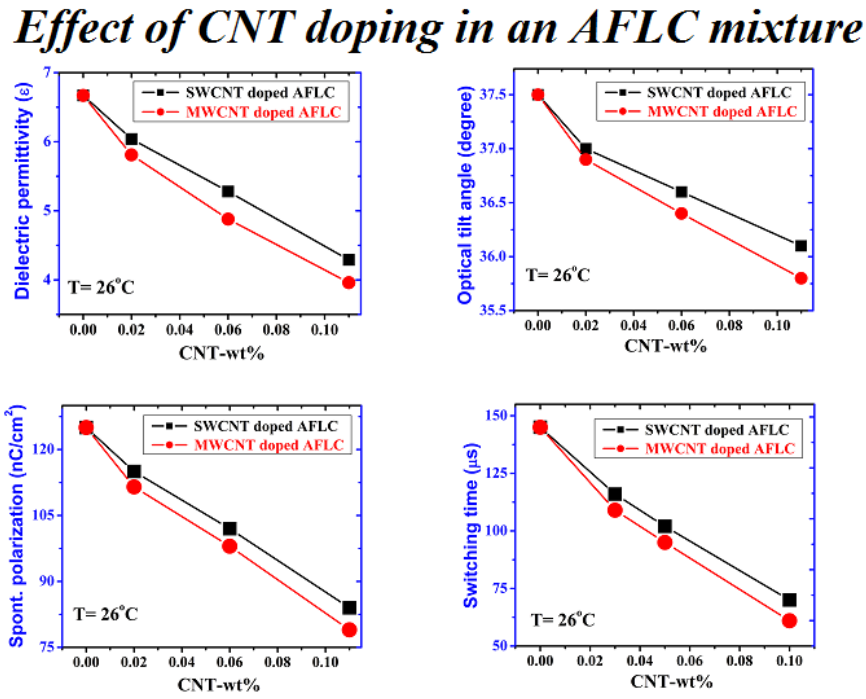
Influence of Carbon Nanotubes on the Dielectric and Electro-optical Properties of a Proto-type Antiferroelectric Mixture used in Liquid Crystal based Display Devices

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Graphical Abstract



Abstract

We have investigated the effect of doping of different concentrations of single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs) on the dielectric and electro-optical properties of a room temperature antiferroelectric liquid crystal (AFLC) mixture, a proto-type of the mixtures used in an actual liquid crystal display (LCD) device. CNT doping result in quite substantial improvements of several parameters of the AFLC mixture like dielectric permittivity, conductivity, spontaneous polarization, and switching time which are important for display and other applications. In most cases, nearly similar effects are observed in SWCNTs and MWCNTs doping (see Graphical Abstract). A slight difference in observed results may be due to their different

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dimensions and surface area. Although the dimensions of the CNTs are much larger than the dimensions of the liquid crystal molecules, doping of CNTs slightly decreases the phase transition temperatures of the pristine mixture signifying that the dispersions of CNTs affect the molecular ordering only marginally. It is also confirmed from the observation that the maximum decrement in the optical tilt angle, the primary order parameter of the antiferroelectric phase, is only 1.7^{o} at the highest doping concentration (0.11wt%) of MWCNTs. Spontaneous polarization of the CNT doped FLC mixture decreases due to the screening of the molecular dipole moment by the π–π electron system of CNTs. The real part of dielectric permittivity and absorption strength decrease remarkably due to the trapping of ions by the CNTs. Trapping of ions by the dispersed CNTs increases the effective electric field inside the AFLC display cell which in turn decreases the switching time of the CNT composites significantly making it more suitable for AFLC-based practical applications. Trapping also decreases the ac and dc conductivities of the AFLC mixtures.

In brief, doping of CNTs traps the mobile ions present in the AFLC mixture that may minimize the negative effects of an LCD device such as slower response time (high switching time), high operating voltage, image sticking, image flickering, and non-uniformity of the images and can be useful for developing improved AFLC based electro-optical devices.

Keywords

Antiferroelectric liquid crystal (AFLC); Carbon nanotubes (CNTs); AFLC-CNT nanocomposite; dielectric properties; switching time.

Acknowledgments

PKM acknowledges funding from the University of North Bengal: Grant No. 164/R-2018(SF17). We acknowledge Prof. Roman Dabrowski, Military University of Technology, Poland for supplying liquid crystal compounds.

Biography of Presenting Author



Dr. Asim Debnath presently works as a post-doctoral researcher in the Department of Physics, University of North Bengal, Siliguri, West Bengal, India. Dr. Debnath obtained his Ph.D. degree on 20th March 2019 from the University of North Bengal. Dr. Debnath formulated several room temperature ferroelectric, antiferroelectric, and electroclinic liquid crystal mixtures and their nano-composites first time by any Indian groups, which have properties suitable for FLC-based display devices and at par with mixtures used in the industry. He has also experience in writing research proposals for synchrotron beam time and carrying out experimental work at Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany. Till now he has published 18 research articles in journals of international repute, which has achieved 126 citations and of h-index: 08

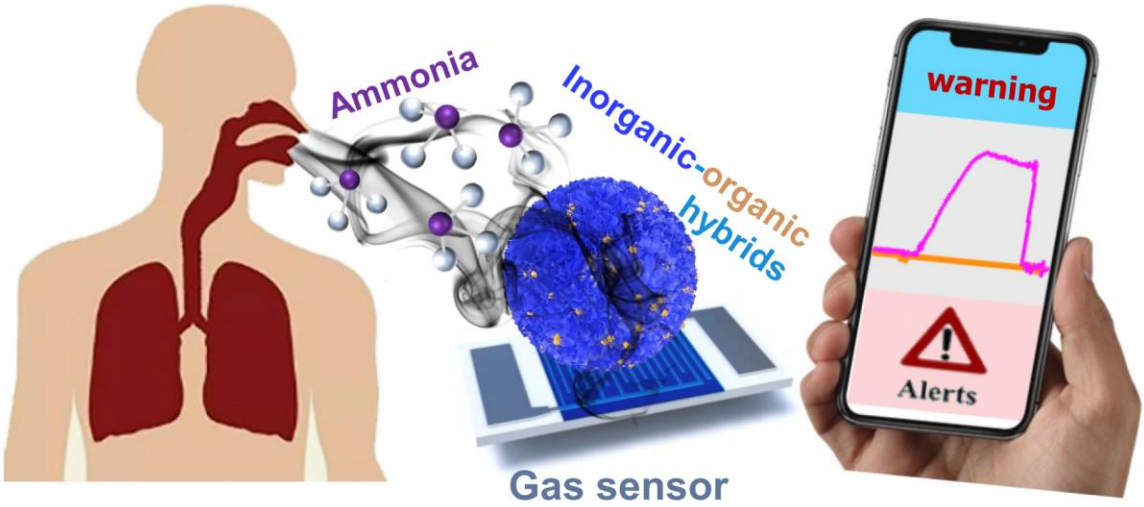
Sustainable Gas Sensors Based on Inorganic - Organic Hybrids

Kewei Zhang*

State Key Laboratory of Bio-Fibers and Eco-Textiles, Collaborative Innovation Center of Shandong Marine Biobased Fibers and Ecological Textiles, College of Materials Science and Engineering, Institute of Marine Biobased Materials, Qingdao University, Qingdao 266071, P. R. China

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Graphical Abstract



Abstract

With rapid development of smart city, the accurate detection of hazardous gases is urgently needed for environmental safety and human health. Among various gas-sensing materials, hierarchical metal oxides and their nanocomposites with hetero-oxides are highly desirable because of their high surface-to-volume ratios and well-defined mesoporous channels, while the related sensors still suffer from drawbacks of baseline drift, high-power consumption and limited response and recovery. It is thus necessary to exploit novel gas-sensing materials for satisfying the requirement of low-temperature gas detection. Inorganic-organic hybrids present great potential in advancing sensor performance with special emphasis on the promotion of adsorption-desorption kinetic and charge-transfer ability. We have recently developed a "game changer" to enhance the performance of traditional gas sensors by creatively adopting oxide/polymer/carbon heterostructure with abundant defects. Also, a novel type of flame-retardant and flexible gas sensor has been established based on metal oxide endowed seaweed fabric that derived from renewable marine polysaccharide. In this talk, I will present a glance view of our recent work on the sustainable gas sensors based on inorganic-organic hybrids: the synthesis of materials, fabrication and integration of device, adsorption-desorption kinetic of sensing process, as well as potential applications.

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Keywords

Sensors; heterojunctions; hazardous gases; flexible electronics.

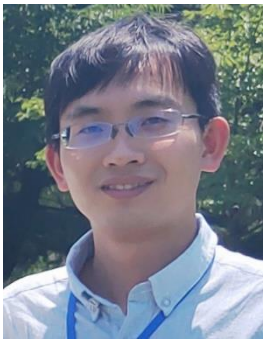
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This work was supported by the National Natural Science Foundation of China (Nos. 51973099, 61604012), the Taishan Scholar Program of Shandong Province (No. tsqn201812055), and the State Key Laboratory of Bio-Fibers and Eco-Textiles (Qingdao University) (Nos. ZKT04, GZRC202007).

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Biography of Presenting Author



Dr. Kewei Zhang is a professor at Qingdao University, China. He received his B.S. in Chemical Engineering and Technology from Shandong University of Science & Technology and Ph.D. in Chemical Engineering and Technology from Beijing University of Chemical Technology. He then worked as assistant professor at Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences. Currently, he is a professor at State Key Laboratory of Bio-Fibers and Eco-Textiles, College of Materials Science and Engineering, Qingdao University, China. His research interests focus on functional semiconductor materials, bio-based flexible electronics, and micro/nano energy and self-powered sensing technology. He has authored and co-authored over 50 peer reviewed journal articles, edited and co-edited 2 textbooks and 1 research monograph, and held over 10 patents. He is the recipient of Taishan Scholar in 2018 and Young Chemist Award for IYPT by Chinese Chemical Society in 2019.

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Pt Free Counter Electrode for DSSCs based on Reduced Graphene Doped and Codoped with Heteroatoms

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Abstract

The search for highly efficient carbon materials with high electrocatalytic activity for the counter electrode (CE) use in Dye Sensitized Solar Cells (DSSCs) is still indispensable. The aim of this research is the synthesis and characterization of Nitrogen and Boron mono-doped and co-doped reduced graphene oxide (rGO) as a Platinum free catalyst for CE in DSSCs. We report that, Boron-doped rGO and nitrogen-doped rGO have been respectively synthesized by facile Hummer's method reaction of Graphene Oxide (GO) with Boric Acid and Urea as B and N precusors respectively and GO reducer. The successful preparation of doped rGO samples was confirmed by Fourier Transform infra-Red spectroscopy, X-ray diffraction, Raman spectroscopy, X-ray photoelectron spectroscopy, Scanning Electron Microscopy and transmission electron microscopy. The FTIR and XPS analysis confirmed the presence of different functional groups such as B–C, B-O, C-N as well as C=N bonds confirming the effective doping of B and N into the rGO matrix. Furthermore, the insertion of N and B atoms in the crystal structure of rGO effectively reduced defects in GO by substituting the sp^3C defect sites (caused by Oxygen functional groups) in the forms of pyridinic N, quaternary N and BC_3 as confirmed by XRD and Raman spectroscopy analysis. The electrochemical activity of the N, B co-doped rGO counter electrode has improved due to the introduction of B and N containing functional groups at the electrode surface, which accelerate the charge transfer rate across electrode/solution interface. Additionally, the B, N co-doped rGO sample exhibit the lowest R_{ct} indicating that the synergistic effects of co-doping with B and N atoms helps enhancing the electrical conductivity and catalytic activity of graphene oxide electrode. Finally, the prepared B, N co-doped rGO is promising for application as a counter electrode for platinum-free dye-sensitized solar cell (DSSC).

Biography of Presenting Author



Ghada Missaoui in currently institute Ecole Supérieur des Science et de Technologie de Hammam Sousse – University of Sousse, Tunisia. Degree in Master of Science in Nanoscience**.** Grade: 15.02 /20

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Promising Ti-based Metal-organic Frameworks for Photocatalysis

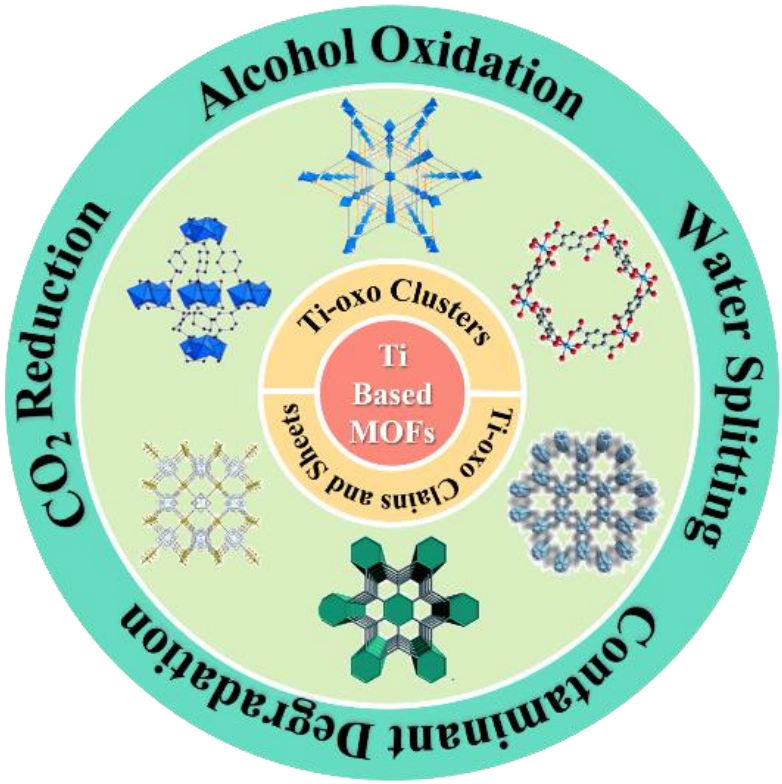
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Graphical Abstract

Ti-carboxylate MOFs demonstrated promising applications in photocatalytic H_2 generation, photocatalytic reduction of CO_2, dye photodegradation.



Abstract

Metal-organic frameworks (MOFs) have emerged as a significant class of porous crystalline materials constructed from metal nodes and multidentate linkers. Many researches have shown the promisng applications of MOFs in gas adsorption and separation, electrocatalysis, photocatalysis and biomedicine etc., mainly due to the advantages of high porosity, large surface areas and easily tunable optical and electronic structures. Particularly, light-sensitive Ti-oxo clusters in Ti-based MOFs result in promising photocatalytic activity [**1-3**]. Here, we summarize our recent works on the design and

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synthesis of Ti-based MOFs for improved visible-light driven photocatalysis for water purification and H_2 generation. As the first pure Ti-salicylate MOF, our group used 2,5-dihydroxyterephthalic acid (H_4DOBDC) and Ti(i-OPr)$_4$ as starting materials in glacial acetic acid to synthesize a new Ti-MOF named as NTU-9, which is a red, hexagonal prism crystal. This is the first example of Ti-MOFs with the single crystal structure [**4**]. Interestingly, acetic acid as a solvent can slow the reaction between the titanium salt and the organic ligand, so that much larger single crystals can be obtained. NTU-9 demonstrated high efficiency for the photodegradation of organic dyes in water. Recently, infinite 1D Ti-O rod-based MOFs are promising photocatalysts for water splitting due to their high optical response, favourable photo-redox properties and stability, but were rarely explored. Three isoreticular porous 1D rod-based Ti-MOFs **ZSTU-1**, **ZSTU-2** and **ZSTU-3** are successfully constructed from infinite $[Ti_6(\mu_3\text{-}O)_6(\mu_2\text{-}OH)_6]_n$ secondary building unit (SBU) and tritopic carboxylate linkers 4,4',4''-nitrilotribenzoic acid (H_3TCA), 1,3,5-(4-carboxylphenyl)-benzene (H_3BTB) and tris(4′-carboxybiphenyl)amine (H_3BTCA), respectively [**5**]. Their porosities systematically increase with the larger and longer organic linkers. The two MOFs **ZSTU-1** and **ZSTU-3** build from the triphenylamino-based ligands can absorb visible light, exhibiting much better photocatalytic performance than **ZSTU-2**, as shown in the H_2 production rate of 3-4 times. The photocatalytic H_2 production rates for **ZSTU-1**, **ZSTU-2**, **ZSTU-3** are 1060 μmol g^{-1} h^{-1}, 350 μmol g^{-1} h^{-1} and 1350 μmol g^{-1} h^{-1}, respectively. The extraordinary photocatalytic activity of **ZSTU-3** is attributed to its visible light absorption, large surface area, and favorable charge separation. In conclusions, our works on Ti-MOFs might open up the new sight to fabricate highly effective visible-light photocatalysts for H_2 evolution in the future.

Keywords

Metal-organic frameworks; photocatalysis; band gap modulation; hydrogen evolution; water purification.

Acknowledgements

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Biography of Presenting Author



Junkuo Gao is professor at Zhejiang Sci-Tech University, China. He obtained his PhD in Zhejiang University, China in 2010. Then, he worked with Prof. Hans Agren at Royal Institute of Technology (KTH, Sweden) and Prof. Qichun Zhang at Nanyang Technological University (Singapore) as a postdoctoral fellow (2010-2013). In 2013, he joined the School of Materials Science and Engineering at Zhejiang Sci-Tech University as Distinguished professor of Zhejiang Province, director of Institute of New Energy Fiber Materials. He is now an Academic Editor of PeerJ, PeerJ Inorganic Chemistry and PeerJ Materials Science, guest editor of Current Organic Chemistry. His research interest is metal-organic frameworks-based nanomaterials for clean energy and green chemistry applications. He has published more than 130 articles in peer-reviewed journals in J. Am. Chem. Soc., Angew. Chem. Int. Ed., Coord. Chem. Rev., Small, J. Mater. Chem. A etc. with over 6800 citations, including 7 ESI hot papers and 17 ESI highly cited papers. He is invited as reviewers for more than 90 scientific journals, including Nature Communications, Journal of American Chemical Society, Advanced Materials, Angewandte Chemie International Edition, ACS Catalysis, Small, Green Chemistry etc. He is awarded the 2019 Publons top peer reviewer (top 1% reviewers in Chemistry and Cross-Field). He was selected as the 2020 emerging investigators of Journal of Materials Chemistry A.

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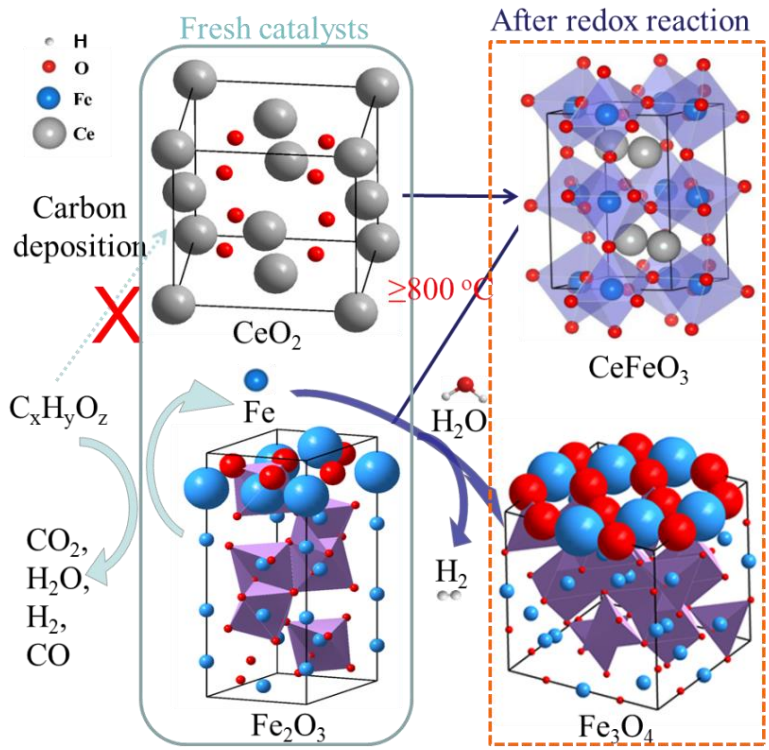
Influence of CeO_2/Fe_2O_3 Catalyst on Hydrogen Production from Cellulose Catalytic Gasification

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Graphical Abstract



Abstract

In this study, Ce/Fe bi-metallic catalysts were used to promote hydrogen production from cellulose steam catalytic gasification. The effect of different Ce/Fe ratios on the catalytic performance of hydrogen production was studied. The distribution of products, gas composition, carbon deposition and the stability of the catalyst were analyzed with variant approaches. Results show that the catalytic performance of the CeO_2/Fe_2O_3 catalyst in relation to hydrogen production was much better than pure CeO_2 or Fe_2O_3. When the ratio of Ce:Fe was 3:7, the maximum yield of the H_2 was 21.63mmol/g

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cellulose at 800 °C. $CeFeO_3$ could be generated at 800 °C or higher temperature after redox reactions without forming CeO_2/Fe_2O_3 clathrate, and the existence of $CeFeO_3$ enhanced the thermal stability of CeO_2/Fe_2O_3 catalyst. The presence of CeO_2 not only improved the oxidative ability and stability of the catalysts, but also was in favour of the oxidation of possible deposited carbon on the surface of the used catalysts, reduces the production of deposited carbon.

Keywords

Hydrogen; catalytic gasification; cellulose; biomass.

Acknowledgements

This work gets financial support from the National Key R&D Program of China (Project No. 2018YFB1501403).

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Biography of Presenting Author

Zou Jun's research is focused on biomass thermochemical conversion. So far he has published 13 SCI/EI papers in prestigious international journals like Energy conversion and management, Bioresource technology, International journal of hydrogen energy and so on. He participates in several research projects such as National Key Research and Development Program of China, National Natural Science Foundation, Open projects of Hubei provincial key laboratory for control of industrial smoke pollution and Open project of key laboratory of renewable energy and natural gas hydrate. He participates several domestic and international conferences and gives oral reports in 2020 Yunnan International Forum on Green Energy, 1st chemical looping conference of China, 5th International conference on biomass energy & exhibition, 4th international symposium on gasification and its application and so on.

With the development of economy and increasing of human life, the amount of organic solid wastes increasing largely. Organic solid waste represented by agricultural and forestry waste and urban domestic waste has caused serious environmental pollution and waste of resources, and it is in urgent need of efficient resource utilization. The nominee uses organic solid wastes as raw materials and calcium-based absorbent as a catalytic tar reforming catalyst for staged catalytic gasification of hydrogen-rich gases. In this context, his work is consistent with international circumstances such as "Pilot Work Plan for the Construction of "No Waste City"", "promote agricultural green production, promote the full utilization of major agricultural wastes" and "practice green life, Ways to promote the reduction and resource utilization of domestic waste sources". He uses carbide slag to adsorb CO_2 which not only benefit for greenhouse gas emission, but also provides clean and efficient utilization for Calcium-contained solid wastes.

Fabrication of Resistive-Type Humidity Sensor Using Metal Oxide Nanostructures Synthesized via Chemical Solution Process

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Abstract

In the past decade, humidity sensors have been widely studied and considered in the various applications including agriculture, food industries, climate monitoring, chemical storage, healthcare, and semiconductor industries. The studies have been focused to prepare humidity sensor with good humidity sensing performance and low cost, which required for large-scale volume and to fulfil the rigorous performance obligations of the emerging areas. In this research, resistive-type humidity sensors were fabricated using zinc oxide (ZnO), titanium dioxide (TiO_2) and nickel oxide (NiO) nanostructures. These nanostructures were produced and grown on substrates using solution immersion method. This method is cost-effective fabrication process, which could produce nanostructure films in large scale. The results obtained in this research show that metal oxide nanostructures in form of ZnO nanorod arrays, flower-like TiO_2 nanorod arrays and NiO nanoball/nansoheet structures are good candidates for humidity sensing applications. These nanostructures produce high humidity sensing sensitivity and could provide potential humidity sensing applications in the emerging areas.

Keywords

Humidity sensor; Metal oxide; Nanostructures; Chemical Solution

Biography of Presenting Author



Associate Professor Ir. Ts. Dr. Mohamad Hafiz Mamat graduated from Department of Electrical& Electronic Engineering and Information Engineering, Nagoya University, Japan in 2005 and received both MSc degree and PhD degree in Electrical Engineering from Universiti Teknologi MARA (UiTM) Shah Alam, Malaysia. His research area is in the field of nanoelectronics, which focuses on nanomaterial syntheses and fabrication of electronic devices such as sensors and solar cells. He was awarded both Professional Engineer (Ir.) and Professional Technologist (Ts.) in 2018. He was assigned as a visiting scientist at BSA Rahman Crescent Institute of Science and Technology, Chennai India in 2018. He was accorded ASEAN-India Research and Training Fellowship in 2018 and attached at BSA

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Rahman Crescent Institute of Science and Technology for 6 months from August 2018 to January 2019. Currently, he is the Head of NANO-ElecTronic Centre (NET), Faculty of Electrical Engineering, UiTM. He has published over 370 papers in the journals and conference proceedings. His H-index is 24 based on Scopus database. He has 2 Malaysian patents and more than 24 copyrights granted, which related to nanomaterials syntheses and device fabrications. He has joined several conferences and symposia in international and national level as participant, invited speaker or keynote speaker. He also serves as head of technical committee of NANO-SciTech Conferences from 2010 to 2020. He has supervised 8 PhD theses and 5 MSc theses. Currently, he is supervising 10 PhD and 8 MSc students. He has received more than 70 awards at national and international levels. These include Malaysian Solid State Science and Technology Society (MASS) 2014 Award for "The Most Promising Researcher Award", The Best Award and Gold Medal at the Malaysia Technology Expo (MTE) 2014, UiTM Academic Award 2015 for "The Most Promising Academician Award", Gold Medal at International Invention and Innovation Expo (ITEX) 2017, UiTM Academic Award 2018 for "The Best Supervisor Award", The Best Award and Gold Medal at the Malaysia Technology Expo (MTE) 2019, Gold Medal at the International Conference and Exposition on Inventions by Institution of Higher Learning 2019 (PECIPTA'19), and Gold Medal at the Malaysia Technology Expo (MTE) 2020.

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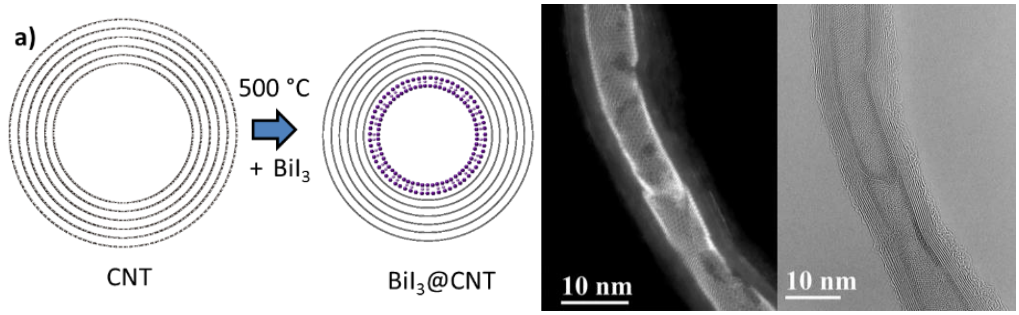
Structural and Chemical Analysis of Filled Nanotubes

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Graphical Abstract



Abstract

The hollow interiors of nanotubes could host the growth or filling of foreign elements/compounds to obtain hetero-structures. The growth of these materials in the confined one dimensional space lead to novel properties. There are different routes to obtain the filling of nanotubes. Among these capillary filling serves as a suitable method to enable filling of carbon nanotubes (CNTs) and inorganic nanotubes including those of BN and WS_2 [**1,2**]. In this talk the synthesis, structure and novel properties/applications of such 1D vdW heteronanostructures will be discussed. Various suitable examples will be highlighted. These include our recent work on the filling of Gd and Bi-based compounds within CNTs and WS_2 Nanotubes which enable the formation of Single-Walled Nanotubes of GdI_3 and BiI_3 [**3,4**]. The formation of Inorganic Single-Walled Nanotubes is especially interesting since it enables the exploration of new materials which are at the interface of 1D and 2D [**5**]. In such complex heterostructures, the precise determination of the structure and composition is detrimental in its further application. Thus the investigation of the structure, morphology and chemical composition of filled nanotubes investigated using aberration corrected scanning/transmission electron microscopy and associated spectroscopic techniques (EELS and EDS) will be outlined. The three dimensional structure of such systems can be elucidated using electron tomography [**6**]. The experimental observations in these systems are adequately supported by carrying out theoretical calculations in order to elucidate and understand the difference in behavior of the various compounds towards their affinity to fill the interior of the Nanotubes [**7,8**].

Keywords

One-dimensional; nanotubes; vdW heterostructures, inorganic single-walled nanotubes, advanced electron microscopic techniques.

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Biography of Presenting Author



Leonard Deepak Francis is a group leader of the Nanostructured Materials Group at the International Iberian Nanotechnology Laboratory (INL). His broad area of research is focused on the use of advanced electron microscopic techniques for the study of materials/nanomaterials for various applications, as well as in the study of fundamental physical phenomena and dynamics at the nanoscale. He also employs the Focused Ion Beam (FIB) technique extensively towards the investigations of nanodevices.

Leonard received his Ph.D. in 2005 from Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India. Subsequently, he was a postdoctoral fellow (2006–2008) at the Weizmann Institute of Science, Israel. Leonard has published more than 100 papers and 8 review articles in major international journals. In addition, he has three book chapters. Several of his articles have made it to the cover page of journals. He served as the guest editor for a special issue of the Journal of Nano Materials: Nanomaterial Properties: Size and Shape Dependencies. He has participated in two major European projects: NANOHVAC and NANoReg and three regional projects. Currently he is involved in several national projects (funded by the Portuguese Science Foundation: Fundação para a Ciência e a Tecnologia (FCT) and the ERDF through COMPETE2020). In addition, he is an acting referee for various ACS, RSC and Elsevier journals among others. More recently he has edited two books entitled "Advanced Transmission Electron Microscopy – Applications to Nanomaterials" - Springer (2015) and "Metal Nanoparticles and Clusters: Advances in Synthesis, Properties and Applications" - Springer (2018). Leonard also holds 3 joint patents. He has a h-index of 30.

Dye Enhanced Quantum Dot Sensitized Solar Cell

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Abstract

There is great interest in third generation solar cells, such as dye and quantum dot sensitized solar cells. In this work we investigate the role of dye extract on the enhancement of the photovoltaic properties of quantum dot sensitized solar cells. Lead sulfide quantum dots of different diameters have been used to sensitize titanium oxide based nanoparticles. Towards this end, we compare the open circuit voltage, the short circuit current, and efficiency of quantum dot-sensitized solar cells with the same quantities as obtained for dye-enhanced system using pomegranate dye extract. An open circuit voltage of 166 mV, a short circuit current of 0.1 mA, and an efficiency of 0.32% were obtained for 2.4 nm radius lead sulfide quantum dot sensitized solar cells. Using pomegranate dye extract reveals a considerable enhancement of the above characteristics. The combined dye-quantum dot system produces an open circuit voltage of 300 mV, a short circuit current of 0.55 mA, and an efficiency of 3.4%. A model describing the structure and processes leading to the above enhancement of the solar cell characteristics is presented. In this model we explain the interplay between the transfer of electrons between the dye, quantum dots, and subsequent injection in the wide band gap titanium dioxide semiconductor.

Biography of Presenting Author

Prof. Shawqi Al Dallal of physics at Ahlia University. Received the BSc. Degree in Electrical Engineering from Baghdad University (1967). Engineer at Bapco, Bahrain (1968-1971). DEA in Solid State Electronic and Particles from The University of Pierre et Marie Curie, Paris, France (1973). Doctorate in Engineerig from the same University (1976), and then a doctorate d'Eta in Physics from the same University (1981). Chairman, Deparrtment of Physics, Bahrain University (1985). Academic visitor to Imperial College, London (1990). Dean, College of Science, Bahrain University, (1991-1995). Dean of Graduate Studies and research, Ahlia University (2010-2015). Emeritus professor, Ahlia University (2019-present). Published over 115 research work in reputed International Journals and conferences. Published many books including "Encyclopedia of Astronomy, Astrophysics, and Space Science". Organized many International workshops and conferences. Founder of Bahrain Astronomical Society, and Arab Union on Astronomy and Astrophysics. Member of many local, regional, and international scientific societis.

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The Construction of Kinetic Nanopromoters for Methane Hydrate Formation

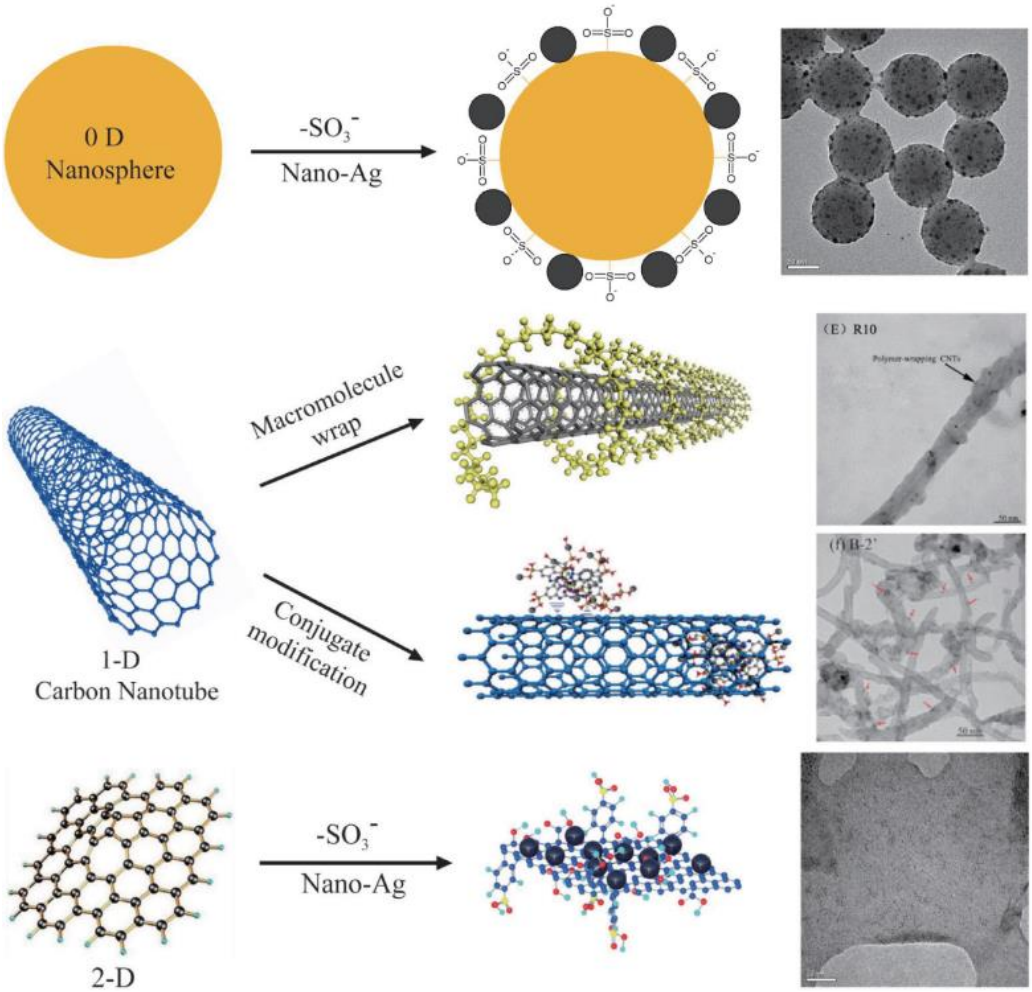
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Graphical Abstract

Novel nanopromoters were constructed by fixing functional groups and/or metal nanoparticles on multidimensional nanocarriers, which could achieve the rapid formation of methane hydrates with high storage capacity.



Schematic diagram of the construction of novel nanopromoters

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Abstract

Gas hydrates have been endowed with great potential in natural gas storage and transportation, and achieving the rapid hydrate formation is critical to utilize this technology. Even surfactants have been confirmed as the most efficient promoters for gas hydrate formation, the foam generation during hydrate dissociation seriously impacts the application. In our on-going studies, we have developed a series of novel nanopromoters by fixing traditional promoters, such as, surfactant molecules (or functional groups) and metal nanoparticles on multidimensional nanocarriers, as shown by the Graphical abstract. Firstly, 0-dimensional nanospheres were used as the carriers to prepare nanopromoters, including, nanosphere-carried sodium dodecyl sulfate (SDS), SDS & nano-Ag, $-SO_3^-$, $-SO_3^-$ & nano-Ag.[1] Fixing on the nanospheres could not only improve the stability of surfactants (or functional groups) and metal nanoparticles in the aqueous phase, but also enable them to contact with water and gas molecules more efficiently, and therefore endowed the nanopromoters with much better promotion efficiency to methane hydrate formation. In addition, with nanosphere as the carrier, we achieved the coupling of different hydrophilic (e.g. $-SO_3^-$ & $-COO^-$) on the carrier surface and for the first time achieved the synergic regulation of both the hydrate formation kinetics and hydrate density under non-mechanical disturbance.[2] Secondly, nanopromoters with 1-dimensional carbon nanotubes as the carriers were prepared, consisting of, carbon nanotube-carried $-SO_3^-$ and nano-Ag/Cu.[3] The carbon nanotube-based nanopromoter produced very efficient promotion to methane hydrate formation by enhancing the mass and thermal transfer during hydrate formation process. Thirdly, nanopromoters with 2-dimensional graphene nanosheets as the carriers were constructed, including, graphene nanosheets-carried $-SO_3^-$ and $-SO_3^-$ & nano-Ag, which also produced excellent acceleration to gas hydrate formation.[4] Finally, 3-dimensional porous materials (e.g. activated carbon) have also been used as the carrier and nano-Ag particles were fixed on the carrier to construct micro-space for methane hydrate formation, which produced great potential for serving as the media for methane hydrate formation.[5] Above all, the nanocarrier-based promoters produced much better promotion to methane hydrate formation compared with the traditional surfactants or metal nanoparticles. Moreover, as the surfactants existed not as free molecules but as an assembly in the liquid phase, the foam generation during hydrate dissociation were almost removed.

Keywords

Natural gas hydrates; natural gas storage & transportation; nanopromoter; multidimensional nanocarrier.

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Biography of Presenting Author



Prof. Fei Wang currently works as the leader of Hydrate-based Energy Research Group in Qingdao University of Science & Technology, China. He earned his PhD in Chemical Engineering from the University of Chinese Academy of Sciences in July 2016 and then continued with his postdoctoral research in Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences, until Aug 2018 with the research topic of hydrate-based natural gas storage and transportation. In September 2018, he was designated as high-level personnel and joined as a professor in Qingdao University of Science and Technology, where he built the Hydrate-based Energy Research Group, with the research scope of hydrate-based natural gas/hydrogen storage & transportation, CO2 capture, and seawater desalination, etc. Currently, the research group consists of one Professor, four associated Professor, and over 20 graduate students, and the featured achievements including the development of novel nanopromoters for gas hydrate formation and facilities those can achieve the continuous preparation of natural gas hydrates. Prof. Fei Wang has published over about 40 SCI papers as the first/corresponding author in the journals, such as, AIChE Journal, Chemical Engineering Journal, Chemical Engineering Science, and Journal of Materials Chemistry A, etc. Moreover, Prof. Fei Wang was granted as the IAAM Fellow (JR) in June 2021. His achievements show promising potential of bringing hydrate-based natural gas/hydrogen storage and transportation toward industrial applications.

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