NanoWorld Conference
Useful Science and Technology for a Just World

April 23-25, 2018

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Nanoapproach to Cancer Based on APA Microarrays Leading Genes and a Combination of Mass Spectrometry and Nanoconductimetry

Claudio Nicolini  
Russian Academy of Sciences, Russia  
Arizona State University, AZ, USA  
Nanoworld High Tech LLC, USA  
Fondazione ELBA Nicolini, Italy  

Abstract

Nanoproteomics and Nanogenomics in nanoarrays advance the Molecular Biology, Systems Biology and Nanobiotechnologies for humans, leading to a new industrialized label free nanoapproach to cancer. According to the last available report in the literature, there were 14.9 million incident cancer cases, 8.2 million deaths, and 196.3 million disability-adjusted life years (DALYs) in 2013. Moreover, the “one-size-fits-all” axiom, which is to say the mantra for which a single medical diagnostic/therapeutic procedure would fit in all instances, has proven ineffective in properly handling and managing human disorders. For example, while one patient may not respond to a certain drug, another patient might benefit from the same treatment. The discovery of biomarkers and molecular signatures originating from Nanoproteomics and Nanogenomics contribute to fill this gap, leading to new, individualized avenues. The oncologist Leroy Hood has coined the expression of “P4 medicine”, where the four Ps stand for personalized, predictive, preventive, and participatory. This indicated a new approach to medicine, in discontinuity with the classical, conventional approach whereby diseases were diagnosed on the basis of symptoms and cured reactively, not proactively prevented, and through which drugs were administered mostly “ex adjuvantibus” and without rationale. This traditional approach resulted in failure despite enormous investment of resources. Prevention represents the core of this novel paradigm. For example, “personalized vaccinology” is emerging as a crucial component of the new framework of personalized medicine due to pathogen and host variability and the high degree of tumor heterogeneity that hinder the effectiveness of “universal” vaccines. Understanding molecular interactions, as captured by omics-based high-throughput devices and a unique combination of nanobioinformatics and label-free APA microarrays based on nanotechnologies such as Mass Spectrometry and Nanoconductimetry that enable researchers to overcome the issues of fluoresce-based and other tagged/labeled tools, may lead to new targets and drugs, drawing the diagnosis and imaging, the therapeutics and drug delivery, and the prognosis very close. This is the concept of “nanotheranostics” (a port-manteau of diagnostics and therapeutics) focused on brain tumor.

Figure 1: The shown Mass Spectrometry and QCM_D Nanoconductimetry of NAPPA and SNAP APA (Anodic Porous Allumina) micarrays lead to an effective nano approach to Cancer when combined to innovative software for Leader Genes Identification and for SPADS Characterization of dominant Protein-Protein interactions.
Biography

Dr. Claudio Nicolini’s career started as a Professor and Chair of Biophysics Department at Temple University Health Sciences Center, USA in 1976. Being an eminent scientist, he was then appointed to be the Chair of Biophysics at University of Genova, Italy. His strong contacts with large Multinational industries (FIAT, ABB, Montedison, ENI, STM, etc) in Europe led to consortia as CIREF, Technobiochip and Polo Nazioanle Bioelettronica having him at the top. He is leading the new Biochip project for USSR since 1990. He continued the USSR project at the new Russian Federation and Italy which led to the creation of Fondazione ELBA Nicolini (in 1993) through the participation of Governments of Italy, Soviet Union and European Union and several United States Institutions. In 2001, Fondazione gave birth to Nanoworld Institute involving the participation of several multinational industries and research institutions. He was elected as foreign member of Russian Academy of Sciences in 2008 and as a Honoris Causa Professor of Nanobiotechnology and Biophysics in Lomonosov Moscow State University in 2010. In 2017, he founded Nanoworld High tech LLC in Tempe (USA). He was affiliated Arizona State University as Professor Molecular Sciences in 2018. With the help of three governments and his personal involvement as advisor for science and technology; Prime Minister has provided immense support for science and technology in the key area of biotechnology and nanotechnology. He has authored more than 642 scientific publications of which more than 467 as full-length papers in international scientific journals; more than 50 book chapters, 40 WPI patents, 30 books and 45 PDB deposited protein structures. Also he has won many research grants from private and mostly public funds (beginning in USA from 1973 and continuing after 1985 in Italy, Europe and worldwide) for a total of over 60 million euro equivalent.
Time resolved structure determination of Biomolecules with X-ray Free Electron Lasers

Petra Fromme

School of Molecular Sciences and Biodesign Center for Applied Structural, Arizona State University, Tempe, AZ, USA

Abstract

The study of the dynamics biomolecules is one of the grand challenges of in the discovery of the building blocks of life as most structures determined so far only provide a static picture of the molecule. Serial Femtosecond Crystallography (SFX) provides a novel concept for structure determination, where X-ray diffraction “snapshots” are collected from a fully hydrated stream of nanocrystals, using femtosecond pulses from high energy X-ray free-electron lasers (XFELs) [1–4]. The XFEL pulses are so strong that they destroy any solid material, but a femtosecond is so short (1 fs = 10^-15 s) that X-ray damage is diminished and diffraction from the crystals is observed before destruction takes effect [3]. It opens new avenues to determine molecular movies of Photosynthesis “in action” [6–10]. In this talk we will present results from recent experiments to study the dynamic processes in Photosystem II by light-induced time-resolved femtosecond crystallography conducted at LCLS, the X-ray Free Electron Laser in Stanford and also report preliminary results from the first time resolved studies on Photosystem I from the European XFEL in Hamburg, Germany.

The talk will close with a progress report on the development of compact femto and attosecond X-ray Sources at ASU (CXLS and CXFEL) and DESY (AXSIS) [11], which will provide unique new opportunities to study the ultrafast dynamics of reactions of biomolecules with a combination of X-ray diffraction, X-ray spectroscopy and ultrafast optical spectroscopy.

References:


This work is supported by the National Science Foundation BIOXFEL STC (NSF-1231306), the Biodesign Institute at Arizona State University, the US National Institutes of Health (NIH), National Institute of General Medical Sciences grants R01 GM095583 and the European Research Council, “Frontiers in Attosecond X-ray Science: Imaging and Spectroscopy (AXSIS)”, ERC-2013-SyG 609920

Biography

Petra Fromme is Paul V Galvin Professor at the School of Molecular Sciences at Arizona State University. She was appointed by ASU President Michael Crow as the director of the Biodesign Center for Applied Structural Discovery in 2014. Her research interests are in studying the structure–to-function relationship of membrane proteins involved in bioenergy conversion and infectious diseases. She was an integral part of a team of ASU researchers and international colleagues that developed the technique of serial femtosecond nanocrystallography for analyzing proteins using high-intensity X-ray Free Electron Lasers (XFEL). Dr. Fromme’s biological research is focused on two major important fields: the study of light conversion in the process of Photosynthesis and the discovery of the structure and dynamics of membrane proteins involved in cancer and infectious diseases. Professor Fromme has published over 200 articles and is internationally recognized as a leader in photosynthesis, protein macromolecular crystallography using synchrotrons and protein serial nanocrystallography using XFELs.
Nanotechnology Enables Hot Gold Nanorods to Kill Cancer Cells and to Stop Alive Cells from Migrating and Killing More Sick People

M. A. El-Sayed
Georgia Institute of Technology, Atlanta, GA, USA

Abstract

Cancer kills many people after several years of suffering and after using a great deal of different unsuccessful treatments, like surgery, chemical and/or radiation treatments. The field of Nanotechnology showed us how different materials acquire so many different properties when their size is reduced to the nanometer scale. Gold nanoparticles having rod shape of nanometer size and a length: width ratio of 3:1 can absorb near infrared light (to which our body is transparent) and convert it into heat. If solution containing gold nanorods is injected into a cancer lump and exposed to near infrared light the hot solution (resulting from the gold nanorods upon absorbing the near infra-red light) melts the cancer cells leading to their death. This was demonstrated by our group in the photo-thermal destruction and destroying cancer cells in solution, in cancer lumps in small and in large animals [1,2,3,4].

Normally, some of the cancer cells that do not die are able to migrate to other parts of the body away from the location of their initial formation spot until they are located in a sensitive part of the body that leads to the cancer patient death. Thus, most of the cancer patients die from cancer after the cancer cells migrate by a process called metastasis to more a very sensitive part of the body.

Very recently, however, we discovered [5] that in our photo-thermal treatment, while treating cancer cells in the first cancer location with hot gold nano-rods, the cancer cell legs and arms and the motion proteins are photo-thermally destroyed. This makes it difficult for the cancer cells to migrate to new more important functional locations in the body. This treatment is thus effective in stopping cancer cell migration through the patient body and increases the success rate of the patient recovery.

References:

Biography

Professor El-Sayed received the 2007 US National Medal of Science in Chemistry from the President of the United States (2008) and the Medal of the Egyptian Republic of the First Class from the President of Egypt (2009). He was nominated by the U.S. President to the US National Medal of Science Selection Committee.

Professor El-Sayed is an Elected Member of the US National Academy of Sciences (1980), an Elected Fellow of the American Academy of Arts and Sciences (1986), an Elected Associate Member of the Third World Academy of Sciences (1984); he is an Inaugural Fellow of the American Chemical Society, the American Physical Society and an Elected Fellow of the American Association for the Advancement of Sciences. He is an Honorary Fellow of the Indian Chemical Society and the Chinese Chemical Society.

Professor El-Sayed was an Alexander von Humboldt Senior Fellow, Germany (1982), a Visiting Professor at the University of Paris, an Alfred P. Sloan as well as a Guggenheim Foundation Fellow, a Fairchild Fellow at the California Institute of Technology and a Miller Visiting Professor at U.C. Berkeley. In the past ten years, El-Sayed’s name has appeared frequently in the lists of the most highly cited scientists.
Nanomaterials for High Energy Conversion Efficiency

Zhifeng Ren  
*Department of Physics and Texas Center for Superconductivity (TcSUH), University of Houston, Houston, TX, USA*

**Abstract**

Materials in nano scale have better properties than their bulk. In this talk, I will discuss our studies on the high performance of nanostructured thermoelectric materials, enhanced oil recovery by a novel amphiphilic nanofluid, and efficient water splitting to produce hydrogen by electrolysis using outstanding nano catalysts.

**Biography**

Dr. Zhifeng Ren is currently the M.D. Anderson Chair Professor in the Department of Physics and TcSUH of the University of Houston, adjunct appointment in Mechanical Engineering, Biology and Biochemistry, Chemistry, Electrical and Computer Engineering. He obtained his PhD degree from the Institute of Physics Chinese Academy of Sciences in 1990, master's degree from Huazhong University of Science and Technology in 1987, and bachelor's degree from Sichuan Institute of Technology in 1984. He was a postdoc and then research faculty at SUNY Buffalo (1990-1999) before joining Boston College as an associate Professor in 1999. He specializes in thermoelectric materials, solar thermoelectric devices & systems, photovoltaic materials & systems, carbon nanotubes and semiconducting nanostructures, nanocomposites, bio agent delivery and biosensors, and superconductors. He is a fellow of American Physical Society, American Association for the Advancement of Science and National Academy of Inventors, a recipient of R&D 100 award and Edith and Peter O’Donnell Award in Science from The Academy of Medicine, Engineering & Science of Texas (TAMEST). He has 39 patents and published more than 400 papers with a total citation of 52,170 and an H-index of 102 and was ranked the 49th of the top 100 Materials Scientists worldwide for the past decade 2000-2010. He is co-founder of NanoLab, Inc., GMZ Energy, Inc., Solasta Inc. and APower, Inc.
Novel Two-dimensional Materials

Sokrates T. Pantelides
Department of Physics and Astronomy, Vanderbilt University, Nashville, TN, USA
Oak Ridge National Laboratory, Oak Ridge, TN, USA
University of the Chinese Academy of Sciences, Beijing, China

Abstract

The talk will describe a series of novel two-dimensional (2D) materials that have recently been fabricated and imaged by collaborators and whose properties were examined by both experimental probes and density-functional-theory calculations. Imaging was done by either scanning transmission electron microscopy (STEM) or scanning tunneling microscopy (STM). Whereas most 2D materials have a hexagonal structure, we show experimental and theoretical results on monolayers of copper oxide that has a square lattice. Whereas in virtually all cases a monolayer exfoliated from a layered bulk material retains the intrinsic structure of a single bulk layer, we show experimental and theoretical results on \( \text{Pd}_2\text{Se}_3 \) monolayers that fuse together from two layers of bulk \( \text{PdSe}_2 \) by the emission of Se atoms. We also discuss novel 2D lateral heterostructures between monolayer \( \text{Pd}_2\text{Se}_3 \) and bilayer \( \text{PdSe}_2 \). We show that the growth of Si monolayers on Ru (0001) leads to several distinct 2D structures, leading up to silicene. Finally, we unveil a unique new family of “intrinsically patterned 2D materials” that allow selective or dual functionalization.

Primary collaborators: Wu Zhou, Matthew F. Chisholm, Junhao Lin, Kazu Suenaga (STEM), Yeliang Wang, Xiao Lin, Hong-Jun Gao (STM), Yu-Yang Zhang, Sebastian Zuluaga, Shixuan Du

Biography

Dr. Pantelides received a PhD in Physics from the University of Illinois in Urbana-Champaign in 1973. After 20 years at the IBM Thomas J. Watson Research Center in New York, where he carried out research in semiconductors and served as manager, senior manager, and program director, he joined the faculty at Vanderbilt University in 1994 as the first McMinn Professor of Physics. He is currently University Distinguished Professor of Physics and Engineering at Vanderbilt, Distinguished Visiting Scientist at Oak Ridge National Laboratory (since 1995), and Distinguished Visiting Professor of Physics at the University of the Chinese Academy of Sciences in Beijing, China. His research focuses on theory in conjunction with experimental data on structural, electronic, magnetic, optical, and chemical properties of complex nanostructures.
Nanoparticles and Biomembranes

Reinhard Lipowsky
Max Planck Institute of Colloids and Interfaces, 14424 Potsdam, Germany

Abstract

The endocytosis of nanoparticles by biomembranes is essential for many processes such as biomedical imaging, drug delivery, nanotoxicity, and viral infection. In all cases, the cellular uptake of the nanoparticles starts with the adhesion of the nanoparticles to the membranes, followed by the complete engulfment of these particles. The key parameters for these endocytic processes are particle size and adhesive strength of the particle–membrane interactions as well as bending rigidity and spontaneous (or preferred) curvature of the membranes. [1,2] Under certain conditions, the nanoparticles may assemble into membrane nanotubes. [3] Complete engulfment of the nanoparticles generates an effective constriction force. [4] A sufficiently large force leads to membrane fission and particle uptake. The dependence of uptake on particle size is often nonmonotonic as observed for clathrin-dependent endocytosis of gold nanoparticles.

References:


Biography

Dr. Reinhard Lipowsky received his doctoral degree from the University of Munich in 1982 and worked as a research associate at Cornell University and at the Research Center Jülich. In 1989, he became Professor at the University of Munich. From 1990 until 1993 he was department head at the Research Center Jülich and Professor at the University of Cologne. In 1993, he became a founding director of the Max Planck Institute of Colloids and Interfaces, where he is now in charge of the department “Theory and Biosystems”. He also holds honorary Professorships at Potsdam University, Germany and Humboldt University, Berlin.
DOS Engineering for New Nano-materials

Hiroshi Kitagawa
Division of Chemistry, Graduate School of Science, Kyoto University, Japan

Abstract

The property of element is correlated directly with its electron configuration. In a solid, the density of states (DOS) at the Fermi level affects the physical and chemical properties. The method of alloying elements has been used to improve the properties of materials for many years. In particular, the solid-solution-type alloy is advantageous because tuning the compositions and/or combinations of the constituent elements can continuously control the properties. However, the majority of bulk alloys are of the phase-separated type under ambient conditions, where constituent elements are immiscible with each other. To overcome the challenge of the bulk-phase metallurgical aspects, we have focused on the nanosize effect and developed methods involving “non-equilibrium synthesis” or “a process of hydrogen absorption/desorption”. We propose a new concept of “density-of-states engineering” for the design of materials having the most desirable and suitable properties by means of “inter-element fusion”. Novel solid-solution alloys of Pd-Pt, Ag-Rh, and Pd-Ru systems in which the constituent elements are immiscible in the bulk state are presented and discussed [1]. Our present work provides a guiding principle for the design of a suitable DOS shape according to the intended physical and/or chemical properties and a method for the development of novel solid-solution alloys [2,3].

References:


Biography

Dr. Hiroshi Kitagawa received his PhD at Kyoto University in 1992. After IMS, JAIST and University of Tsukuba, he moved to Kyushu University as Professor in 2003. In 2009, he moved to Kyoto University. He held visiting appointments at RI, London. He was Science Officer, MEXT, Japan and a chair of the 5th CS3 (Chemistry Summit G5), 2013. He is now a Deputy Executive-Vice President for Research at Kyoto University. He is also engaged at JST as a Research Director, ACCEL and a Research Director of “Science and Creation of Innovative Catalysts”, PRESTO. His research fields are solid-state chemistry, coordination chemistry, nano-science, low-dimensional electron system, and molecule-based electrical conductors.
What Can We Learn from the High-Resolution Structure of the Heliobacterial Photosystem and Photosystem I of Cyanobacteria in Respect of Evolution of Photosynthesis and Nanotechnology?

Raimund Fromme  
*Arizona State University, Tempe, AZ, USA*

**Abstract**

The origin of photosynthesis is related to the first reaction centers which could convert the energy of sun light. As much our knowledge about photosystems and reaction centers has increased with structures of these membrane proteins since the mid-1980s, the trajectory of this important part of evolution is by far not understood.

With an estimated age of 4.6 billion years the planet earth had life with primitive organisms at least since 3.7 billion years ago. In these early times the earth atmosphere was strict anaerobic or oxygen free. Photosynthesis evolved from procyanobacteria which had an early branching to heliobacteria these gram-positive bacteria firmicutes are still to be found in volcanic muddy waters or even in rice paddies. The structure of the photosystem from *Heliobacterium modesticaldum* at 2.2 Å resolution gives the first insight how an ancestral photosystem has been organized.

Since around 3.5 billion years oxygen was produced which was enriched at 2.3 billion years ago to an oxygenic atmosphere. Cyanobacteria are still a major source of oxygen production on earth. The trimeric form of the cyanobacterial photosystem I has been now solved in our lab to 2.3 Å resolution which allows a direct comparison of structures and predictions about evolutionary developments. With the new structural knowledge obtained we try to translate this information to nanotechnology devices.

**Biography**

Dr. Raimund Fromme is Associate Research Professor of the Biodesign Institute at Arizona State University in the Center of Applied Structural Discovery and the School of Molecular Sciences. His work is published in more than 50 articles which have been cited 5,000 times (Google scholar).

His research has investigated the inner sanctum of photosynthesis, the structure and function of Photosystem I and II, since is master's and doctorate work. Since 2004, he has had the opportunity to work on crystal structures of various proteins in the broad field of photosynthesis, where the membrane proteins are the most interesting and challenging proteins of all. In 2017 he was the corresponding author for a study in Science about an X-ray structure of a heliobacterial photosystem.


LB Protein Nanotechnology for Synchrotron Radiation and XFEL

Eugenia Pechkova
Laboratories of Biophysics and Nanotechnology, University of Genova Medical School, Italy
Fondazione É.L.B.A. Nicolini, Pradulunga, Italy

Abstract

Langmuir-Blodgett (LB) protein nanofilm technology is a novel approach for direct “on chip” protein molecules organization into the 3D ordered diffracting arrays. The specific properties of LB protein thin films (long range order, thermal stability, ability to trigger protein crystallization in those not crystallizable by classical methods) can be exploited by the new procedures for fixed target Serial Femtosecond Crystallography (SFX). This includes diffraction data collection from nanocrystals grown by LB nanotemplate and from multilayered LB films, deposited onto ad hoc designed chips with membrane windows of submicron thickness. The novel idea for this method for XFEL is supported by previous extensive research and encouraging results obtained on LB nanofilms and nanocrystals properties by highly focused Synchrotron Radiation. SFX at X-ray free electron lasers (XFELs) has created many new opportunities for protein crystallography, including radiation damage mitigation and the study of dynamics at room temperature. This field is rapidly evolving, requiring new methods of macromolecule organization into diffracting arrays, since current methods of sample delivery are often the bottleneck which limits productivity. Indeed, the production of the protein crystals as well as their quality still remains the major problem for SFX. The combination of advanced LB nanotechnology with the XFEL has the potential to become an important tool for the structure determination of proteins that are difficult to crystallize, such as membrane proteins of life science interest and pharmaceutical industry impact.

Biography

Dr. Eugenia Pechkova, Doctoral degree in Chemistry (Moscow State University, Russia) and PhD in Biophysics (University of Genova, Italy) is an Assistant Professor in Biochemistry and Head of Laboratories of Biophysics and Nanotechnology at University of Genova Medical School, with national habilitation to the Associate Professor achieved in 2014. She serves as Board of Trustees Member of Fondazione É.L.B.A.–Nicolini, Bergamo, Italy and Associate Editor of NanoWorld Journal, USA. She has authored 90 international scientific publications (SCI), 15 chapters to books and 2 patents. She is also the author of books “Proteomics and Nanocrystallography”, Springer and “Synchrotron Radiation and Structural Proteomics”, Pan Stanford Series of Nanobiotechnology.
Targeting of Cancer Cells via Electrically-Charged Superparamagnetic Nanoparticles

Donglu Shi

The Materials Science and Engineering Program, Dept. of Mechanical and Materials Engineering, College of Engineering and Applied Science, University of Cincinnati, OH, USA

Abstract

In cancer diagnosis and therapeutics, extensive effort has been devoted to identifying cancer cells in terms of oncogenic and pathological characteristics. One of the major approaches has been the development of tumor-specific ligands for cell targeting. However, previous studies have shown that two isogenic cancer cell lines differ only by a few proteins. These commonalities between cancer and normal cells at molecular level have been the fundamental problems in any biomarker-based cancer diagnosis and therapeutics. We have recently discovered that all cancer cells are negatively charged due to the hallmark metabolic pattern associated with glycolysis. We report a close correlation between the lactate acid secreted and a net of negative electrical charges that appears on cancer cell surfaces. Superparamagnetic nanoparticles are rendered electrically charged, via surface functionalization, to strongly bind onto the cancer cells for effective and specific targeting. The charge-based targeting paves a new way for cancer cell capturing and sensitive detection in clinical settings.

Biography

Dr. Donglu Shi is currently the Chair of the Materials Science and Engineering Program at the University of Cincinnati. He received his PhD in Engineering from the University of Massachusetts at Amherst. He was the Staff Scientist in the Materials Science Division of Argonne National Laboratory between 1988 and 1995. He has so far published 270 refereed SCI journal publications including Physical Review Letters, Nature, ACS Nano, and Advanced Materials. His main interests include nanostructure design, nano biomedicine, nanophotonics, and magnetism. The most recent works pioneer several novel approaches in developing multifunctional nano carrier systems for early cancer diagnosis and therapy.
Multiplex Detection of Pancreatic Cancer Biomarkers using a SERS-based Immunoassay

Nariman Banaei¹, Byung Kim¹,²*, Yubing Sun¹,², Jean Marie Houghton³ and Anne Foley³

¹Department of Mechanical and Industrial Engineering, University of Massachusetts, MA, USA
²Institute for Applied Life Sciences, University of Massachusetts, MA, USA
³Department of Medicine, University of Massachusetts Medical School, MA, USA

Abstract

Early diagnosis of pancreatic cancer (PC) is critical to reduce the mortality rate of this disease. Current biological analysis approaches cannot robustly detect several low abundance PC biomarkers in sera, limiting the clinical application of these biomarkers. Enzyme linked immunosorbent assay and radioimmunoassay are two common platforms for detection of biomarkers; however, they suffer from some limitations. This presentation investigates a novel system for multiplex detection of pancreatic biomarkers CA19-9, MMP7, Mesothelin and MUC4 in sera samples with high sensitivity using surface enhanced Raman spectroscopy. Measuring the levels of these biomarkers in PC patients, pancreatitis patients, and healthy individuals reveals the unique expression pattern of these markers in PC patients, suggesting the great potential of using this approach for early diagnostics of PCs. Advantages and feasibility of performing this platform on an integrated microfluidic device also will be discussed.

Biography

Dr. Byung Kim is a Professor in the Department of Mechanical and Industrial Engineering at the University of Massachusetts in Amherst. His current research interests are micro/nano embossing and its application to obtain cost effective solution in the areas such as cancer detecting SERS substrate. He is on the editorial board of the Polymer-Plastics Technology and Engineering Journal. His professional affiliations include membership with the SPE, ASME, SME. He received his B.S. in Mechanical Engineering from the University of California at Berkeley in 1978 and MS and PhD from MIT in 1980 and 1983, respectively.

Novel Biodegradable Second-Generation Oxygen Release Compound in Enhancement of Dissolved Oxygen Concentration

Gordon C. C. Yang* and Sheng-Chih Huang
Institute of Environmental Engineering, National Sun Yat-Sen University, Kaohsiun, Taiwan

Abstract

The release rates of $\text{H}_2\text{O}_2$ and $\text{O}_2$ from solid peroxides are an important issue to be considered no matter they are used in environmental remediation or biomedical applications (e.g., tissue and scaffold engineering). In the field of environmental applications, solid peroxides have been encapsulated with materials like concrete and alginate. On the other hand, microfibrilated cellulose and poly (lactic-co-glycolic acid) [PLGA] have been used as the encapsulation materials to slow down and extend the period of $\text{H}_2\text{O}_2$ and $\text{O}_2$ release in medical applications. However, solid oxygen-releasing compounds still have some disadvantages or limitations in applications. To resolve these problems, a biocompatible and biodegradable nanomaterial designated second-generation oxygen release compound (2G-ORC; Taiwan patent pending) has recently been developed by the present authors. Briefly, 2G-ORC is comprised of sustained-release catalase and high-stability nanoscale sodium percarbonate. Test results showed that under neutral and alkaline pH conditions the catalytic oxygen release ability of $\text{H}_2\text{O}_2$ by sustained-release catalase outperformed other oxygen releasing biomaterials reported. By applying 0.17 g of 2G-ORC to 20 mL deionized water, the dissolved oxygen (DO) level was found to maintain at 6.24 mg/L even a test period of seven days has elapsed. Accordingly, being a bio-nanomaterial 2G-ORC has proved to be long-lasting and capable of markedly increasing the DO concentration in aqueous solutions. This feature is considered to be of great use in enhancement of DO concentration not only for in situ aerobic bioremediation of organic pollutants, but for various biomedical applications including but not limited to tissue and scaffold engineering.

Biography

Dr. Gordon Yang received his PhD from University of California, Berkeley, California, USA in 1983. After that, he worked in the industry and research labs for several years. Starting from August 1991 he began to teach at Institute of Environmental Engineering, National Sun Yat-Sen University (NSYSU) in Taiwan. He became a full Professor in 1994 and also served as the Director of that institution during 1997-2000. In 2010 he founded the Center for Emerging Contaminants Research, NSYSU and served as the Director till July 2017.
Development of a Methodology and Ionizing Radiation Device that uses Metallic Nanoparticles for the Detection and Simultaneous Treatment of Cancer

Rodolfo Figueroa¹,², Mauro Valente¹,²,³, Mauricio Santibañez¹,² and Francisco Malano¹,², Federico Geser¹ and Johnnie Lopez²
¹CFIM (Centro de Física e Ingeniería en Medicina), University of La Frontera, Temuco, Chile
²Departamento de Cs. Físicas, University of La Frontera, Temuco, Chile
³Instituto de Física E. Gaviola, Córdoba, Argentina

Abstract

A new methodology for the detection and simultaneous treatment of tumors is presented. The method is based on a 3D scanning by means of convergent X-ray beam irradiating phantom/patient containing targets with biomarker of heavy atomic number nanoparticles in certain concentration levels previously studied by other authors. Confocal detection of the point scanning allows reconstruction of a 3D image aimed at mapping tumor cells, while a second convergent beam scanning slightly out of phase operates in treatment mode to eliminate the tumor. It is proposed that simultaneity between target location and treatment irradiation may avoid the mismatches between actual and practical target. Monte Carlo simulations carried out adapting subroutines in FLUKA and PENELOPE main codes demonstrated the feasible of the proposed method. Current efforts are devoted to design and built a laboratory prototype to validate the proposed method.

Biography

Dr. Rodolfo Gabriel Figueroa Saavedra, PhD in Physics, Full Professor, University of La Frontera (UFRO) was Director of the first Master’s Program in Medical Physics of Chile and is now the Director of the Center for Physics and Engineering in Medicine (CFIM) of the UFRO. He leads the Physics Ionizing Radiation research group. He has participated with more than 130 papers in international and national events. He has more than 50 publications and about a 10 invention patents. He has been invited to numerous Conferences in the area of Radiation, Medical Physics and XRF. He has developed a method of graphical comparisons, a new XRF spectroscopic method. Between 2008 and 2010, he developed a device capable of obtaining images of the spatial distribution of chemical elements. Since 2010, he has been developing, together with his research group, a new device and radiotherapy technique of convergent high-energy X-rays (CONVERAY®), and since 2013 he has been working on the development of a new technology for the detection and treatment of cancer.
Nanocatalyst Development for Fuels from Biomass using Si-Microreactor and Tubular Reactor


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2Department of Chemical Engineering, North Carolina A & T State University, NC, USA
3Department of Nanoengineering, Joint School of Nanoscience and Nanoengineering, North Carolina A & T State University, NC, USA
4Energy and Environmental Systems, North Carolina A & T State University, NC, USA

Abstract

The major focus of our NSF-CREST Bioenergy Center at NC A&T is to develop technology for the production of liquid transportation fuels and hydrogen for fuel cell applications. One of our main objectives is to develop robust and stable catalysts for Fischer-Tropsch (F-T) synthesis using Si-microchannel microreactor. Recently, we demonstrated a novel, modified closed channel infiltration (mCCI) method, to produce ~10 µm silica sol-gel coatings containing Ru, Fe and Co- catalysts in the microchannels [1]. While Co/SiO$_2$ at 250°C showed highest CO conversion, 90%, with highest deactivation resistance, it was followed by Fe/SiO2 and Ru/SiO$_2$ in regard to CO-conversion and stability of the catalyst. To investigate the effect of support, the Si-microchannels were coated with titania sol-gel containing Ru, Co, Fe catalysts. Preliminary studies exhibited stability and reactivity (150°C to 300°C) in the order of 12%Ru-TiO$_2$ $>$ 12%Fe-TiO$_2$ $>$ 12%Co-TiO$_2$.

The other area of research involves catalyst development for H$_2$ production from bio-derived alcohols. Our previous studies on steam reforming of methanol with different metals and MCM-41 and TiO$_2$-supports have shown that the interaction between metal and the support plays a profound role on H$_2$ production and its selectivity [2]. We have now extended our studies to steam reforming of glycerol (SRG), a byproduct of biodiesel. The SRG studies were carried out with Ni/Co-MCM-41 and Ni/Co-SBA-15 catalysts at 650 °C using a tubular reactor. Both H2 selectivity (85% vs 78%) and conversion (99% vs 88%) were better at higher glycerol to water feed ratio (1:12) for both catalysts.

References:

Biography

Dr. Debasish Kuila is the Research Director of NSF-CREST Bioenergy Center and previous Chair of chemistry at NC A&T. He was an associate Professor at Louisiana Tech and spent over 10 years at Hoechst Celanese and Great Lakes Chemical Corporations and Purdue University. He received his M.Sc. from IIT, Madras, PhD from CUNY, NY, and did postdoctoral research at The University of Michigan/Los Alamos National Laboratory and Northwestern University. His research spans from materials/biomaterials, drug delivery, cell biology to catalysis. He has 12 US Patents/applications and >60 publications and has been invited as keynote and plenary speakers for international conferences.
Life Cycle Considerations for Risk Assessment of Nanomaterials

Socorro Vázquez-Campos*, Camilla Delpivo and Alejandro Vilchez
LEITAT Technological Center, Spain

Abstract

The commercialization of nano-enabled products and their societal acceptance requires the insurability of safety at all stages of the product life cycle. Current uncertainties on the safety of such products need to be carefully addressed to avoid public fears blocking the benefits of nanotechnology. Sound scientific information must be generated to identify potential risks of nano-enabled products on human and ecosystems health and, when considered unacceptable, efficiently mitigate such risks. This has to be done in a holistic manner, taking into consideration all stages of the life cycle of these products, to protect the safety of workers, downstream users and consumers, the ecosystems, and the general population that may be exposed through the environment. Several European projects work in this direction, generating data (physic-chemical, hazard and exposure data) on exposure relevant materials that are released at different stages of nano-enabled products life cycle. This presentation will be focused on the strategy followed in several EU projects (caLIBRAt, NANOFASE, GUIDEnano) to integrate the knowledge and data generated, into risk assessment frameworks, models and tools to provide industry, regulators and society with advanced methods to evaluate the impact of ENM at any stage of their life cycle.

Biography

Dr. Socorro Vázquez-Campos leads the Human & Environmental Health & Safety research group at LEITAT Technological Centre (Barcelona, Spain). Her research aims at assessing the potential impact of nanomaterials and nanotechnology-based products on human health and the environment. Her research activity focuses on monitoring the properties (physico-chemical and biological) of nanomaterials along the life cycle of nano-enabled products combining the expertise of her multidisciplinary group on: Nanomaterial characterization in complex matrices, environmental exposure assessment, nano(eco)toxicology, risk assessment and life cycle assessment. She, in the last ten years, has coordinated and participated in numerous European and national projects in the area of nanosafety, leading to numerous papers, contributions to several book chapters, conference proceedings, and presentations in international conferences and workshops.

Inorganic, Hybridized and Living Macrocellular Foams: “Out of the Box” Heterogeneous Catalysis

Renal Backov
Centre de Recherche Paul Pascal-CRPP UPR 8641, France

Abstract

We will show how, when combining chemistry and the physical chemistry of complex fluids, we can trigger the design of highly efficient heterogeneous catalysts. We will thus focus the topic on 3D-macrocellular monolithic foams bearing hierarchical porosities and applications thereof toward heterogeneous catalysis where both activities and mass transport are enhanced. We will first depict the overall synthetic path, focusing on concentrated emulsions and lyotrope mesophases, acting as soft templates at various length. We will see how we can design cellular materials being either, inorganic, carbonaceous, hybridized or living ones where heterogeneous catalysis applications are addressed while considering respectively acidic, metallic, enzymatic or bacterial processes. Along, we will show how the fluid hydrodynamic, the low molecular hindrance and the easiest accessibility occurring within the macrocellular foams are offering advanced “out of the box” heterogeneous catalysis whatever acting in batch, on-line or when dedicated toward cascade-type chemical reactions.

Biography

Dr. Renal Backov is Professor at the University of Bordeaux since 2010. His current research is performed at the French CNRS “Centre de Recherche Paul Pascal-CRPP” UPR 8641. His main subject of research is the rational design of advanced functional materials through combining the physical chemistry of complex fluids and chemistry. As the synthetic paths employed is pleading for a strong interdisciplinary approach of chemical science, he formalized the concept of Integrative Chemistry in 2006. He was Laureate of the solid-state chemistry division of the French chemical society in 2013 while being currently invited Professor at the MIT, Cambridge MA.
Challenges in The Growth of Vertically Aligned Carbon Nanotubes: Substrate, Catalyst Layer, CVD Conditions and Much More

Klara Hernadi1, Anna Szabó1, Zsuzsanna Pápa2, Tamás Gyulavári1, Krisztián Németh1, Zsolt Tóth3 and Judit Budai2

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2Department of Optics and Quantum Electronics, University of Szeged, Hungary
3Department of Oral Biology and Experimental Dental Research, University of Szeged, Hungary

Abstract

Potential applications of carbon nanotubes (CNTs) can be significantly widen, in case CNTs form a forest–like, vertically aligned structure (VACNT). The aim of the current work was to develop a cheap and easy method for growing carbon nanotubes forests on various substrates (either conductive or non-conductive) with the CCVD (Catalytic Chemical Vapor Deposition) method. However, this growth technique is rather sensitive to synthesis parameters both during catalyst layer formation (substrate; composition; thickness; porosity; etc.) and during CCVD (gas feed – carbon source, carrier, hydrogen, water vapor; reaction temperature; reaction time; etc.). Synthesis parameters might affect not only the outer diameter, the quality and graphitization of carbon nanotubes but also the height and the density of growing forests. A systematic study proved that the catalyst layer’s morphology and amount of catalyst during the growth of carbon nanotube forests are able to control mainly the diameter of CNTs. In order to tune the height of vertically aligned carbon nanotube forest several parameters were varied during the both catalyst layer fabrication (e.g. ink concentration, ink composition, dipping speed) and the CCVD synthesis (e.g. gas feeds, reaction time). It was established that no considerable alignment occurs when CNTs are shorter than 10 µm. Above this value the orderliness of CNT forests becomes more or less independently of either reaction time or catalyst ink concentration. Authors are convinced that simple and cheap methods can open up novel applications in nanotechnology devices.

Biography

Dr. Klara Hernadi received her MSc degree in chemistry from the University of Szeged in 1983, PhD/Candidate of Chemical Science from the Hungarian Sciences in 1993, and Doctor of Chemical Science in 2004 (HAS). She had short-term employments at Texas A&M University, at Facultés Universitaires Notre-Dame de la Paix (Namur Belgium) and at Ecole Polytechnique Federale de Lausanne (Switzerland). Currently she is the leader of Research group of Environmental Chemistry as a full Professor at University of Szeged. Her current research interest covers various topics in the field of nanocrystalline materials (carbon nanotubes, hollow semiconductors, nanocomposites, etc.).

Generation of Single Molecular Species on Carbon-based Nanomaterials and their Catalytic Applications

Sungjin Park1, Sunghee Park, Yunseok Shin, and Dawoon Jang

Department of Chemistry and Chemical Engineering, Inha University, South Korea

Abstract

Chemical designing on nano–materials in molecular level would be a promising route to create new hybrid materials and to control various properties of nano- and molecular materials. Organometallic compounds have been a center of molecular catalysts with preeminent catalytic activity and selectivity in a wide range of chemical transformations. As carbon-based nanomaterials, such as graphene–based materials, carbon nanotubes, and carbon nitrides, they can dramatically tune the catalytic behavior of transition metal–based active species. Hybridization of organometallic complexes with graphene–based materials can give rise to enhance catalytic performances. In this presentation, I will discuss my recent research activities on the fundamental chemistry of carbon-based nano–materials as well as catalytic applications.

Biography

Dr. Sungjin Park has completed his PhD at the age of 28 years from KAIST, Korea and postdoctoral studies from Northwestern University, USA and University of Texas at Austin, USA. Now, he is an associate Professor at Inha University. He has published more than 85 papers in reputed journals.
Structural Functionalization of Polymeric Carbon Nitride for Efficient Photocatalytic Hydrogen Generation

Can Xue and Quan Gu
School of Materials Science and Engineering, Nanyang Technological University, Singapore

Abstract

We present a new type of metal-free photocatalyst having a microsphere core of oxygen-containing carbon nitride and self-sensitized surfaces by covalently linked polymeric triazine dyes. These self-sensitized carbon nitride (SSCN) microspheres can be prepared through a simple solvothermal approach, and exhibit high visible-light activities in photocatalytic hydrogen generation with excellent stability for more than 100 hours reaction. Comparing to the traditional g-C₃N₄ with activities terminated at 450 nm, the polymeric triazine dyes on the carbon nitride microsphere surface allow for effective wide-range visible-light harvesting and extend the hydrogen generation activities up to 600 nm. Further, the solvothermal approach allows for uniformly insertion of boron atoms into the polymeric carbon nitride framework, resulting in B-doped SSCN with reduced band-gap, enhanced charge separation efficiency and promoted surface reactivity for hydrogen generation. This new type of highly stable self-sensitized metal-free structure opens a new direction of future development of low-cost photocatalysts for efficient and long-term solar hydrogen production.

Biography

Dr. Can Xue obtained BSc degree at University of Science and Technology of China (USTC) in 2002, and received PhD degree at Northwestern University (IL, USA) in 2007. Afterwards, he moved to Singapore in 2008 as a recipient of the Lee Kuan Yew Research Fellowship, and was appointed as assistant professor in November 2009 at Nanyang Technological University, where he got promotion to tenured associate professor in September 2015.

Reservoir Interactions and Chemical Heterogeneity at the Nanoscale: Atomic Force Microscopy for Reservoir Applications

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²Physics and Biomedical Engineering Departments, Worcester Polytechnic Institute, Worcester, MA, USA
³Molecular Vista, San Jose, CA, USA

Abstract

Despite major technological advances toward improving hydrocarbon recovery, significant amounts of oil are still left behind in subsurface reservoirs. Laboratory studies of hydrocarbon recovery, fluid/material transport, and rock properties are traditionally performed on bulk samples which provide valuable information used to inform injection and production decisions. Bulk measurements, however, do not provide nanoscale measurements of parameters such as molecule–rock and nanomaterial–rock interactions at extremely high salinity which are directly relevant for designing reservoir tracers and tracer studies. In addition, when rock composition varies significantly at the nanoscale, as for source rocks, the nanoscale chemical heterogeneities that are essential to understanding the behavior and maturity of source rocks are not explained by bulk studies. Atomic Force Microscopy (AFM) has been used for petroleum applications to provide fundamental understanding of the nanoscale material properties related to molecular adhesion and mechanical properties as well as measure pores. This presentation demonstrates two applications of AFM to study reservoir rock properties. First, we demonstrate the effects of salinity on nanomaterial and molecular adhesion in reservoir fluids and show that the calcium content in these fluids affects the tip–calcite adhesion as surrogate for nanomaterial adhesion to carbonate reservoir rock. Second, we show high-resolution (20 nm/pixel) hyperspectral infrared (IR) characterization of source rocks using photo-induced force microscopy (PiFM), a recent advance in AFM-IR methodology. This technique provides a sensitive, high-resolution, and fast means of detecting nanoscale variations in mineralogy and thermal maturity of source rocks at a resolution previously unattainable by other IR techniques.
Mesomechanics of Pristine and Cross-linked Carbon Nanotube Materials

Alexey N. Volkov, Md Abu Horaira Banna and Arun B. Thapa
University of Alabama, AL, USA

Abstract

The behavior of carbon nanotube (CNT) materials subjected to mechanical loading exhibits a number of fascinating effects caused by collective interactions among individual CNTs, such as the collective or coordinate buckling and transition from viscoelastic to plastic behavior. This work is aimed at revealing the microstructural mechanisms of such collective effects and plasticity in CNT films and aerogels based on a recently developed mesoscopic model. In the mesoscopic model, nanotubes are represented in a form of chains of stretchable cylindrical segments. The mesoscopic force field accounts for stretching, bending and buckling of individual nanotubes, as well as non-bonded van-der Waals interaction between CNTs and covalent cross-links between them, and is parameterized based on results of atomistic simulations and experiments. The structures of CNT films and aerogels are found in simulations of self-assembly of initially dispersed CNTs into networks of interconnected bundle and compared with experimental data. Elastic and inelastic mechanical properties of CNT aerogels and films under compressive, tensile, and cycling loading are studied in dynamic mesoscopic simulations. The deformation-induced variations of local structural properties of the CNT materials are analyzed depending on the CNT length, material density, density of cross-links, and strain rate and used to explain the energy dissipation properties of CNT networks. For compressive loading, conditions responsible for the onset of coordinated buckling and wrinkling of CNT films are revealed.

Acknowledgment: This work is supported by the NSF CAREER award CMMI-1554589 and NASA Early Stage Innovations program (project NNX16AD99G).

Biography

Dr. Alexey N. Volkov is an Assistant Professor in the Department of Mechanical Engineering at the University of Alabama. He received his PhD degree in Fluid Mechanics from the St. Petersburg State University (Russia) in 1996. Since then he served as an Associate Professor at the Baltic State Technical University (Russia) until 2007, when he joined the University of Virginia as a research scientist. His research interests are related to problems that require multiscale computational approaches, including laser-material interaction; selective laser melting; mechanical and thermal properties of carbon nanotube-based materials and nanocomposites; and gas-assisted technologies of material production.

3D Printing Nanomaterials-Based Electrodes for Electrochemical Energy Storage and Conversion

Victor A. Beck, Todd Weisgraber, Anna N. Ivanovskaya, Swetha Chandrasekaran, Bryan D. Moran, Seth E. Watts, Dan A. Tortorelli, Juergen Biener and Marcus A. Worsley
Lawrence Livermore National Laboratory, CA, USA

Abstract

Two-dimensional (2D) nanomaterials, such as graphene and transition metal dichalcogenides, hold extraordinary promise for application in a number of electrochemical technologies. Electrochemical energy storage (EES) devices, such as lithium-ion batteries and supercapacitors, in particular, have seen 2D materials integrated into various components with exciting results. In general, EES devices are emerging as primary power sources for global efforts to shift energy dependence from limited fossil fuels towards sustainable and renewable resources. These EES devices, while renowned for their high energy or power densities, portability, and long cycle life, are still facing significant performance hindrance due to manufacturing limitations. One major obstacle is the ability to engineer macroscopic components with designed and highly resolved microstructures with optimal performance, via controllable and scalable manufacturing techniques. 3D printing covers several additive manufacturing methods that enable well-controlled creation of functional materials with 3D architectures, representing a promising approach for fabrication of next-generation EES devices with high performance. Here, we present recent work in fabricating 3D functional electrodes utilizing 3D printing-based methodologies. Specifically, 3D printing techniques such as projection microstereolithography and direct ink writing are described, as well as the details of respective feedstock development efforts. Finally, characterization of the 3D-printed electrodes and their performance in various EES applications will be presented and discussed.
Acknowledgment: This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Biography

Dr. Marcus A. Worsley received his BS at Michigan State University (2001), and PhD at Stanford University (2006) in chemical engineering. He was a Postdoctoral Fellow at Lawrence Livermore National Laboratory (2006-2008) before his current position as a Staff Scientist in the Advanced Materials Synthesis group. Currently, his research focuses on nanostructured and porous materials (e.g. aerogels and functional nanocomposites) for a wide range of applications, such as energy storage, sensing, and catalysis. This includes both the development of materials with novel properties and the development of feedstock materials for various additive manufacturing (a.k.a. 3D printing) techniques.

Accelerate Your Research Using Nature Research Group’s AI Powered Nanotechnology Platform

Prathik Roy¹, Amir Gheisi², Jessie Xiao³ and William Chiuman⁴
¹Database Research Group, Nanoscience & Technology, Springer Nature, NY, USA
²DRG, Springer Nature, Heidelberg, Germany
³DRG, Springer Nature, Beijing, China
⁴DRG, Springer Nature, HongKong

Abstract

Growing public and private investment into nanotechnology has led to a significant rise in nanotechnology data generated, with increasing research output and patents over the last decade. Nanotechnology has made a significant impact on a wide range of industries from medicine to aerospace – in developing new products and applications. However, utilizing this rapidly growing data remains a critical challenge. The increasing diversity of nanomaterials, leads to a gap between data generation and data access. Nano.nature.com known as Nano is an artificial intelligence powered research solution under the Nature Research portfolio that aims to provide highly indexed and structured information related to nanomaterials derived from peer-reviewed journals across all major publishers. These include composition, synthesis, properties, characterization methods and application information. This talk will illustrate on the impact of nanoscience around the world and how Nano can aid nanotechnology research communities to obtain fast and precise insight into the wealth of nanotechnology based scholarly knowledge.

Figure 1: Creation of curated summaries of nanomaterials

Biography

Dr. Prathik Roy is the Product manager for Nanoscience and Technology at Springer Nature, New York. He is a former MacDiarmid Postdoctoral fellow from University of Canterbury, New Zealand where he developed photodetectors and solar cells. He was also a Post-doctoral fellow in National Taiwan University where he worked on graphene-based solar cells, LEDs and photocatalytic materials. He obtained his PhD from NTU where his thesis focused on the synthesis of nanomaterials for biosensing. During his academic career, Prathik has published 30+ peer-reviewed research articles in addition to being the recipient of 6+ international research scholarship awards.
A Novel Approach to Low-temperature Synthesis of Cubic HfO2 Nanostructures and Their Cytotoxicity

Neeraj Kumar1, Blassan Plackal Adimuriyil George2, Heidi Abrahamse2, Vyom Parashar*1, Jane Catherine Ngila1 and Suprakas Sinha Ray1,3*

1Department of Applied Chemistry, University of Johannesburg, South Africa
2Laser Research Centre, Faculty of Health Sciences, University of Johannesburg, South Africa
3DST-CSIR National Centre for Nanostructured Materials, Council for Scientific and Industrial Research, South Africa

Abstract

The development of a strategy to stabilise the cubic phase of HfO2 at lower temperatures is necessary for the emergence of unique properties that are not realised in the thermodynamically stable monoclinic phase. A very high temperature (>2600 °C) is required to produce the cubic phase of HfO2, whereas the monoclinic phase is stable at ambient temperature. Here, a novel rapid synthesis strategy was designed to develop highly crystalline, pure cubic-phase HfO2 nanoparticles (size <10 nm) using microwave irradiation. Furthermore, the as-prepared nanoparticles were converted to different morphologies (spherical nanoparticles and nanoplates) without compromising the cubic phase by employing a post-hydrothermal treatment in the presence of surface modifiers. The cytotoxicities and proliferative profiles of the synthesised cubic HfO2 nanostructures were investigated over the MCF-7 breast cancer cell line, along with caspase-3/7 activities. The low-temperature phase stabilisation was significantly attributed to surface imperfections (defects and deformations) induced in the crystal lattice by the desirable presence of Na2S.xH2O and NaOH. Our work provides new insight into the stabilisation of nanoscale cubic-phase HfO2 in ambient environments; the method could be extended to other challenging phases of nanomaterials.

Biography

Dr. Suprakas Sinha Ray is a chief researcher in polymer nanocomposites at the CSIR with a PhD in physical chemistry from the University of Calcutta in 2001 and director of the DST-CSIR National Centre for Nanostructured Materials. His current research focuses on polymer-based advanced nanostructured materials and their applications. He is one of the most active and highly cited (18800 and h factor 49) authors in the field of polymer nanocomposite materials and he has recently, been rated by Thomson Reuters as being one of the Top 1% most impactful and influential scientists and Top 50 high impact chemists in 2011.

Nanosponge Cyclodextrins and their Modification with Nanomaterials (CNTs, TiO2 & Ag) for the Removal of Pollutants from Waste Water by Adsorption Process

Anny Leudjo Taka, Kriveshini Pillay* and XY Mbianda

Department of Applied Chemistry, University of Johannesburg, South Africa

Abstract

Water is a worldwide vital resource for sustaining life and due to the pollution of water by different classes of pollutants (inorganic, organic and pathogens), many ongoing studies in water purification remain a critical issue to governments, scientists and industries. The challenge is to develop a water purification technology which will be effective at removing these contaminants simultaneously and reducing their concentrations to ultra-low levels from waste water. This review article serves to give an overview on cyclodextrin nanosponge adsorbents which have already been used for water treatment. The modification of these cyclodextrin nanosponges with existing adsorbent nanomaterials and the factors affecting the adsorption capacity of these nanosorbents are discussed. The nanotoxicity of these engineered nanosorbents material is also addressed since this nanotoxicity is a major concern to the human health and environment. Therefore, having some knowledge on the prevention and detection of the nanotoxicity of these nanomaterials, will play huge role into the future of nanotechnology for sustainable clean and potable water supply.

Biography

Dr. Pillay is currently involved in two research focus areas. The first of these is Water Research in which she has been involved in several projects which have utilized modified nanomaterials and other low-cost materials for the removal of heavy metal ions and organic dyes from aqueous solution. The second of these is Forensic Research in which her research group is focusing on developing smart nanostructured and low-cost materials for forensic applications. This also involves identifying and isolating plant components which can replace toxic chemicals which are used to detect specimens at crime scenes.
**Electro-spun Si-doped Fe\(_2\)O\(_3\) anode Material for Na-ion Rechargeable Batteries**

Saveria Santangelo\(^1\), Michele Fiore\(^2\), Fabiola Pantò\(^3\), Sara Stelitano\(^4\), Patrizia Frontera\(^1\), Gianluca Longoni\(^2\), Pierluigi Antonucci\(^1\) and Riccardo Ruffo\(^2\)

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\(^2\)Milano Bicocca University, DSM, Milano, Italy
\(^3\)Mediterranea University, DIIES, Reggio Calabria, Italy
\(^4\)Calabria University, DF, Arcavacata di Rende, Italy

**Abstract**

Li-ion batteries currently represent the dominant power source for portable electronic devices, but the restricted availability of Li raw material and its growing consumption represent a serious concern. The larger abundance of Na sources has gathered increasing attention on Na-ion batteries (SIBs). Nonetheless, the development of the SIB technology requires the discovery and the investigation of new electrode materials with reversible Na\(^+\) intercalation reaction. Several oxides have been considered as electrode materials for SIBs [1,2,3]. The low conductivity and pulverization are mainly responsible for their unsatisfactory performance. Recently, high porosity and aspect ratio of the active material have been demonstrated to facilitate the electrochemical processes resulting in improved electrode stability and enhanced specific capacity [1,2]. Electro-spinning is a very simple, cheap and scalable technique for the growth of highly porous one-dimensional nanostructures [2,3].

This contribution deals with preparation, characterization and testing as anode material in SIBs of electro-spun iron oxide (Fe\(_2\)O\(_3\)) fibers. The fiber doping with silicon (Fe\(_2\)O\(_3\):Si) is proposed as a strategy to improve the electrochemical material performance. Results of half-cell tests demonstrate that undoped Fe\(_2\)O\(_3\) electrodes are able to deliver a reversible specific capacity of 100 (24) mAh\(^{-1}\) at 0.050 (2) Ag\(^{-1}\). An outstanding improvement is obtained in Fe\(_2\)O\(_3\):Si: specific capacity rises up 400 (120) mAh\(^{-1}\) at 0.050 (2) Ag\(^{-1}\), with Coulombic efficiency close to 100%.

**References:**


**Biography**

Dr. Saveria Santangelo is Associate Professor of Experimental Physics at the Dept. of Civil, Energy, Environmental and Materials Engineering of Mediterranean University of Reggio Calabria (Italy). She is active in the field of synthesis and analysis of nanostructured materials for applications in energy storage and conversion, catalysis, photo-catalysis and sensing. She is editor of 2 books and author of 140 papers published in international scientific journals ([http://www.scopus.com](http://www.scopus.com), Author Id: 7003488089).
The Phase Formation for Monodispersed Ultrathin NiPt Hollow Nanospheres

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\textsuperscript{2}School of Mathematics and Physics, University of Science and Technology Beijing, Beijing, China

Abstract

Ultrathin magnetic hollow spheres of NiPt alloy have been synthesized via a mild, green, solvothermal method. The phase formation mechanisms are studied in detail. For ultra-thin shelled hollow nanospheres, with the typical shell thickness of 2–3 nm, the phase formation can be better understood by a theoretical model proposed by Erlebacher et al.\cite{1} It involves the presence of nano-holes over the outer shell of the nanoparticles, favoring the outflow of atoms from within the particle surface exposed to the surrounding acidic environment. On the other hand, the commonly known Kirkendall effects do not apply in the present work. They are the mechanism to the phase formations of hollow nanospheres in the high temperature reaction, or in the long-time reaction at room temperature.\cite{2-4} The present work lays down an important base to understand the synthesis of ultra-thin shelled nanospheres in nanoscale.

References:


Biography

Dr. Chinping Chen obtained the PhD degree from Department of Physics State University of New York at Buffalo, US, in 1995. The area of research was the adsorption of helium–4 over the fullerite surface at low temperature. Later, he worked in particle detector as a postdoc fellow, involving the developments of transition radiation detector and the reactor neutrino detector in Institute of Physics, Academia Sinica, Taiwan. In 2002, he became a faculty member in Department of Physics, Peking University, China, working in the area of nanomagnetism and functional nanomaterials.

Vacancies vs. Magnetic Doping for Optoelectronic Properties of Lead–Halide Perovskites

Aaron Forde, Jon Vogel, Talgat Inerbaev and Dmitri Kilin\textsuperscript{*}
Department of Chemistry and Biochemistry, North Dakota State University, Fargo, ND, USA

Abstract

Nanostructures of lead-halide perovskite materials exhibit exceptional optoelectronic properties for photovoltaic and light emitting applications. Fabrication procedure can be accompanied by intentional or spontaneous formation of defects and doping. State of the art computational modeling of photo-induced processes in the defected and doped lead halide perovskite materials allows to identify favorable composition and morphologies responsible for optimal performance of perovskite-based devices. The nonadiabatic molecular dynamics is implemented in basis of non-collinear spin density function theory for the account of spin-orbit coupling for the non-radiative dynamics of photo-excited states [1]. The on-the-fly nonadiabatic couplings obtained from the trajectory provide parameters for density matrix equation of motion for electronic degrees of freedom of perovskite nanostructures. The dynamics of electronic degrees of freedom allows to assess range of key observables: rates of charge transfer at perovskite-to-contact nanointerface [2], role of quantum confinement for multi-exciton generation in perovskite quantum dots [3], and suppression of photoluminescence due to defect-induced trap states [4].
**References:**


**A Facile Root of Making Nanostructures for Fabrication of Broadband Omnidirectional Antireflective Surfaces by Self-assembly of High Molecular Weight Block Copolymers**

Parvaneh Mokarian-Tabari,1,2* Ramsankar Senthamaraikannan,1,2 Colm Glynn,2 Timothy W. Collins,2 Cian Cummins,1 David Nugent,1 Colm O’Dwyer,1,4 and Michael A. Morris1

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4Micro-Nano Systems Centre, Tyndall National Institute, Lee Maltings, Cork, T12 R5CP, Ireland

**Abstract**

Nanostructured surfaces that engineer the interaction between incident light and an object are a topic of both scientific and manufacturing significance. Nature routinely produces nanostructured surfaces with fascinating properties, such as antireflective moth eyes, self-cleaning lotus leaves, colourful butterfly wings, and water harvesting desert beetles. We now understand such properties and can mimic some of these natural structures in the laboratory. However, these synthetic structures are limited in the real industrial world since they are not easily mass produced over large areas due to the limited scalability of current technologies such as UV-lithography, the high cost of infrastructure and the inability to pattern non-planar surfaces. Here, we report a solution process based on high molecular weight block copolymers (BCP) self-assembly that allows the fabrication of sub-wavelength structures on large areas of optical and curved surfaces with feature sizes and spacings designed to efficiently scatter visible light. Si nanopillars (SiNPs) with diameters of ~115±19 nm, periodicity of 180 ± 18 nm and aspect ratio of 2-15 show a reduction in reflectivity by a factor of 100, < 0.16% between 400-900 nm at AOI 30°. Significantly, the reflectivity remains below 1.75% up to incident angles of 75°. The BCP nano-patterning capabilities avoid previous ‘inherent’ size limitations, make exceptional surfaces for improved transparency, light focusing, antireflection and for tuning photon absorption for a variety of applications on a wide range of surfaces, materials and non-planar substrates. This technique facilitates fabrication of a high density ordered array of nanopillars with tunable height, which are easily scalable and can be formed at low temperature. Compared to nanocones and other ‘black’ silicon layers, broadband antireflection coatings may now be possible for flexible PVs, solar cell technologies, and for broadband elimination of reflection of high quality glass optics.

**Biography**

Dr. Parvaneh Mokarian is a Principal Investigator at SFI Advanced Materials and BioEngineering Research Centre (AMBER) in Trinity College Dublin. She is the coordinator of an €8.3 million European Horizon 2020 project called SUN-PILOT (2018-2021). She has earned her PhD in 2009 from University of Sheffield in the UK being awarded a Dorothy Hodgkin’s scholarship. Since then she worked as a Research Fellow in University College Cork in collaboration with Tyndall National Institute and Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), before joining TCD in 2016. Her research interest is on polymer thin films, polymers at surfaces and interfaces, light- nanostructure interaction, cell-nanosurface interaction and soft nanotechnology. Her current research is focused on using block copolymers as templates for sub-wavelength nanostructures for nanofabrication, photonics applications, antireflective surfaces and functional/smart surfaces. Her team has won the 1st prize for the “Best Innovation Award” by a multilateral project or technology in SPIE, Europe’s biggest optics conference held in Brussels in April 2016. The technology is called Zeroptica.
OptiNanoPro: Novel Nanocomposites and Nanocoatings and Their Applications in Solar Panel Processing Lines
Amparo Verdu¹, David Galan¹ and Elodie Bugnicourt²
¹Bioinicia S.L., Spain
²IRIS Innovacio i Recerca Industrial i Sostenible S.L., Spain

Abstract
In terms of solar energy, contributing to the multifunctionality and efficiency of solar panels, nanocomposites and nanocoatings are of relevance either in the photoactive layers, in protective layers, or on the surface of the solar panels. The electro-hydrodynamic processing (EHDP) techniques are of particular interest as an alternative to conventional deposition and coating techniques since the latter ones require a controlled pressure and temperature environments. Compared to other deposition techniques, electrospray deposition (ESD) offers the advantage of a high deposition efficiency (up to 80%) and a reduction of the process steps. The EHDP has been applied in several fields, mostly at a lab or a pilot scale. Although there have been some industrial efforts to scale up the electrospinning process, it has only been more recently that both techniques, i.e., electrospraying and electrospraying, have been scaled up via multinozzle injectors to an industrial level through companies such as Bioinicia S.L. Through OptiNanoPro project nano-enhanced coating has been applied by electrospinning. This technology has been used to obtain both self-cleaning OPVs and product repellent surfaces (with tailored repellence to selected liquids) for easy emptying packaging. Bioinicia S.L. has achieved materials with tailored polarity including super hydrophobic properties but also amphiphobic ones, a quite peculiar behavior that is much less reported in the literature. The process required a novel multistep approach that has been patented by Bioinicia S.L. on how to use electro-hydrodynamic processes for obtaining stable layers with target characteristics.

Biography
Ms. Amparo Verdu holds a University Degree in Industrial Chemistry by the Polytechnic University of Valencia and Master of Plastics and Rubber materials. For 10 years, she developed her career as Researcher in AIMPLAS, Plastics Technology Centre. Nowadays she is the R&D Project Manager of Bioinicia S.L., experts in Nanotechnology and Electro-Hydro Dynamic Processing. She has collaborated as an Expert Member in the European Committee for Standardization CEN/TC 249/WG 7/TG 1 Biodegradable mulch films. Now she is involved in SBIOC Spanish BioCluster acting as President of the Cluster.

Interfacial Engineering of Semiconductor Hybrids for Water Oxidation
Yan-Gu Lin
Scientific Research Division, National Synchrotron Radiation Research Center, Hsinchu, Taiwan

Abstract
Sunlight is a clean, renewable and abundant energy source on the earth. Its conversion to hydrogen has been considered an ideal solution to counter the depletion and environmental problems of fossil fuels. Photoelectrochemical (PEC) water splitting is an ideal technology for the purpose, since H₂ could be produced directly from abundant and renewable water and solar light from the process. The key to the technology is photoelectrodes made of small band gap semiconductors of photocatalytic properties. The materials should have high efficiency, high stability, and low cost. In addition of the discovery of new materials, the structure and morphology of the known materials could be controlled to enhance the performance of the photoelectrodes. In this talk, the concepts of materials design and their examples will be proposed for efficient photoelectrodes of PEC cells for visible light water splitting. Particularly, We will discuss the material designs including i) p-n heterojunction photoanodes for effective electron-hole separation, ii) electron highway to facilitate interparticle electron transfer, iii) metal or anion doping to improve conductivity of the semiconductor and to extend the range of light absorption, iv) one-dimensional nanomaterials to secure a short hole diffusion distance and vectoral electron transfer, and v) loading co-catalysts for facile charge separation.

Biography
Dr. Yan-Gu Lin received his PhD degree from Materials Science and Engineering at National Chiao-Tung University, Taiwan, in 2010. After graduation, he became a Postdoctoral Fellow in Institute of Atomic and Molecular Science at Academia Sinica, Taiwan, in 2011. Thereafter, he joined Dr. Jeffrey T. Miller's group in Chemical Sciences and Engineering Division at Argonne National Laboratory, United States, as a postdoctoral researcher from 2012 to 2013. Currently, he is the assistant research scientist in National Synchrotron Radiation Research Center, Taiwan. His major research is focused on the field of energy conversion and storage application.
Molecular Engineering of Side Chain Architecture of Conjugated Polymers Enhances Performance of Photovoltaics by Tuning Ternary Blend Structures


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2Department of Chemical Engineering, Feng Chia University, Taichung, Taiwan
3Department of Material Science and Engineering, University of California, Los Angeles, CA, USA

Abstract

Here, we adopted a systemic approach of not only using the same donor chemical units in the two donor-acceptor (D/A) conjugated polymers with complementary light absorption (energy band gaps) but also varying the side chains architectures as a means of tuning the packing of these semi-planar conjugated polymers, thereby influencing the carrier transport and optimizing the PCE. We employed linear, branch and mixed linear-and-branch side-chain attached benzooxadiazole (BO) as the acceptor (A) units in poly [benzodithiophene-thiophene-benzoaxadiazole] (PBDTTBO) conjugated polymers and monitored their interactions with poly[benzodithiophene-fluorothienothiophene] (PTB7-TH), both of which featured the same benzodithiophene (BDTT) donor (D) units. We found that incorporating a minor amount (10%) of D/A conjugated PBDTTBO with such side chains into the PTB7-TH with a fullerene allowed us to tune the packing of the two polymers and, thereby, enhance the PCEs of corresponding ternary blend devices; the PCE of the ternary blend device incorporating PBDTTBO with two branched-side chains, PTB7-TH, and PC71BM increased to 11.4% from 9.0% for the device incorporating only the binary blend of PTB7-TH and PC71BM—a relative increase of more than 25%. This approach of using side chain engineering to tune the structure of a minor conjugated polymer and, thus, influence the packing of another major conjugated polymer that features the same donor chemical units appears to be an effective means of preparing highly efficient polymer cells.

Biography

Dr. Hsiu-Cheng Chen received his PhD degree in Materials Science and Engineering in 2016 from the National Chiao Tung University (NCTU), Hsinchu, Taiwan. He is currently a postdoctoral fellow (Research and Development Substitute Services) in the NCTU, Hsinchu, Taiwan. His research focuses on energy materials and high-performance organic photovoltaic devices.

NIR-Responsive Photocatalytic H2 Generation over NaYF4:Yb,Tm/C3N4 NTs

Yuxiang Zhu* and Yijiao Jiang

School of Engineering, Macquarie University, Sydney, Australia

Abstract

The generation of hydrogen from water splitting using sunlight by employing semiconductor photocatalysis is expected to be a solution of global energy and environmental issues. Recently, graphitic carbon nitride nanotubes (C3N4 NTs), a fascinating conjugated polymer, has become a new research hotspot and attracted tremendous attentions as a metal-free and visible-light-responsive photocatalyst in the field of solar-energy conversion. How to effectively utilize infrared light is challenging as it occupies about 50 % of solar irradiation. In this work, a new NaYF4:Yb,Tm/C3N4 NTs composite fabricated through a PVP-assisted surface coating was firstly applied in photocatalytic H2 production under near-infrared (NIR) irradiation. NaYF4:Yb,Tm nanoparticles with optimal doping ratio of lanthanide ions was selected based on the light absorbance of C3N4 NTs and H2 generation over C3N4 NTs under different monochromatic light. It was revealed that this nanostructure improved the upconversion UV visible energy transfer, thus enhanced H2 evolution performance. The energy transfer process between NaYF4:Yb,Tm and C3N4 were investigated to explore the nature of NIR-responsive photocatalysis of NaYF4:Yb,Tm/C3N4 NTs. Our discovery highlights the potential of developing NIR-driven structural design of photocatalysts for energy and environmental-related applications.

Biography

Ms. Yuxiang Zhu is a PhD candidate from Macquarie University, Sydney, Australia (Time period: 2015 - 2018). She completed her master research in Tianjin University of Science and Technology, China. Her research focused on heterogeneous catalysis;
Photocatalysis; hydrogen energy; green chemical synthesis, water treatment. The major objective of her PhD work is to find novel ways to inhibit electron-hole recombination, make the most of visible light and realize near-infrared responsive photocatalytic hydrogen production. Until now she has published 9 papers in journals such as Appl Catal B-Environ and Appl Catal A General.

**Photocatalytic Activity of Ce Doped ZnO Films Prepared by Sol Gel Spin Coating Technique**

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¹Department of Physics, Kanya Maha Vidyalaya, Jalandhar, India
²IKG Punjab Technical University, Kapurthala, India

**Abstract**

The aim of present study is to enhance the photocatalytic efficiency of Ce doped ZnO films. Herein, different concentrations (1.0 at.wt%, 1.5 at.wt%, 2.0 at.wt%, 2.5 at.wt%) were used as dopants. Ce doped ZnO films were synthesized by sol gel spin coating technique on to the sapphire substrates. The prepared films were annealed at 5500°C for 2.5 hours. The prepared films were characterized by various techniques in term of structural, morphological, optical and photocatalytic properties. The detailed characterization confirmed the excellent crystallinity and revealed that ZnO nanoparticles had a hexagonal wurtzite structure with preferred orientation along (101) plane. Morphology of these films was carried using FESEM images and its rods- shaped morphology has high surface to volume ratio which is related to regular growth of crystalline grains with the grain size in the range of 30-60 nm. Raman peaks indicates the tensile stress existed in Ce- ZnO films. Further, the prepared Ce-doped ZnO films were used as photocatalyst application for photodegradation of methyl orange dye. The percentage degradation of Ce-doped ZnO films were found to be improved with increased Ce concentration from 1.0%-2.0% and further increase in Ce concentration doesn't lead to enhancement in percentage degradation. The optimum concentration is of 2.0 at.wt% exhibited almost complete photodegradation in 60 min under UV illumination. Kinetic studied revealed that all the Ce doped ZnO films follow first order kinetics. The value of pseudo first order constant was found to be maximum 0.05960 (min)-1 for C3-ZnO.
Emerging Interconnect Technologies for Nanoelectronics

Krishna Saraswat
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Abstract

Modern electronics has advanced at a tremendous pace over the course of the last half century primarily due to enhanced performance of MOS transistors due to dimension scaling, introduction of new materials and novel device structures. However, while this has enhanced the transistor performance, the opposite is true for the copper interconnects that link these transistors. Looking into the future the relentless scaling paradigm is threatened by the limits of copper/low-k interconnects, including excessive power dissipation, insufficient communication bandwidth, and signal latency for both off-chip and on-chip applications. Many of these obstacles stem from the physical limitations of copper/low-k electrical wires, namely the increase in copper resistivity, as wire dimensions and grain size become comparable to the bulk mean free path of electrons in copper and the dielectric capacitance. Thus, it is imperative to examine alternate interconnect schemes and explore possible advantages of novel potential candidates. This talk will address effects of scaling on the performance of Cu/low-k interconnects, alternate interconnect schemes: carbon nanotubes (CNT), graphene, optical interconnect, three-dimensional (3-D) integration and heterogeneous integration of these technologies on the silicon platform. Performance comparison of these technologies with Cu/low-k interconnects will be discussed.

Biography

Dr. Krishna Saraswat is Rickey/Nielsen Chair Professor in Electrical Engineering at Stanford University. His research is in materials, structures, and technology of semiconductor devices and interconnects for nanoelectronics and solar cells. He has graduated over 85 doctoral students, 30 post-doctoral scholars and has published over 780 papers. He is Life Fellow of the IEEE and recipient of many awards including the Thomas Callinan Award from The Electrochemical Society in 2000, the IEEE Andrew Grove Award in 2004 and the Technovisionary Award from the India Semiconductor Association in 2007. He is listed by ISI as one of Highly Cited Authors.

ZnO Micro/Nanostructures Based Ultraviolet Photodetectors

Longxing Su and Xiaosheng Fang*
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Abstract

Benefitting from the continuous innovations in semiconductor materials and device fabricating techniques, ultraviolet (UV) photodetectors have been successfully used in advanced communications, flame detection, air purification, ozone sensing and leak detection in the past few decades.

ZnO micro/nanostructures has been paid significant attentions in ultraviolet photodetectors due to their wide bandgap (about 3.37 eV at room temperature), abundant morphologies and ease preparation methods. Typically, post prepared ZnO micro/nanostructures show intrinsic n-type property and p-type ZnO is rather difficult to be realized. In this talk, we present various researches of composite structural ultraviolet photodetectors based on composite heterostructures between ZnO and different p-/n-type materials (such as SnO₂@ZnO core-shell, ZnO@Ga₂O₃ core-shell, ZnO/BiOCl heterostructures et al.). The two different semiconductors were artfully chosen to meet the requirement of forming type-II heterojunction (i.e., staggered gap). Therefore, in all of these devices, self-powered characteristic was shown because of the photogenerated electron-hole pairs can be collected by the built-in electric filed. Our device design method would provide a new approach to realize the high performance energy saving photodetectors.
Biography

Dr. Xiaosheng Fang is currently Professor at Fudan University, China. After completing his PhD degree at the Chinese Academy of Sciences in 2006, he worked at the National Institute for Materials Science, Japan as a JSPS postdoctoral fellow, and then as an International Center for Young Scientists researcher. His research focuses on inorganic semiconductor nanostructure-based photodetectors. He has published more than 150 papers in peer-reviewed journals. The journal publications have already generated about 12500 citations, and h-index is 63. He was listed as a Highly Cited Researcher by Thomson Reuters since 2014 and has been serving as an editorial board member of 5 peer-reviewed scientific journals.

Nanotechnology and Nanosciences Session (Nano-Electronics)

Anatomy of Spin-Orbit Phenomena in Nanostructures Comprising Ferromagnetic and Nonmagnetic Materials for Advancing Spintronic Applications

Mairbek Chshiev
SPINTEC, Univ. Grenoble Alpes, CEA-INAC, CNRS, Grenoble, France

Abstract

Theoretical insights are provided into spin–orbit coupling based phenomena such as perpendicular magnetic anisotropy (PMA) [1–5] and Dzyaloshinskii–Moriya interaction (DMI) [6–9] at interfaces comprising transition metal and insulator, metal or graphene. First, the nature of PMA at Fe|MgO interfaces is unveiled by evaluating the orbital and layer resolved contributions to magnetic anisotropy in Fe/MgO interfaces and MTJs with different interfacial conditions [1–3]. Mechanisms of the optimization of the effective anisotropy as well as of its electric field control are discussed [3–5]. Next, the main features and microscopic mechanisms of DMI behavior are elucidated in Co/Pt and other Co/NM bilayers [6]. Furthermore, several approaches for DMI enhancement and manipulation will be presented including, in particular, physical mechanisms of DMI behavior in Pt/Co/MgO structures [7,8] allowing observation of room temperature skyrmions [8]. The behavior of PMA and DMI will then be addressed for nanostructures comprising Co/graphene interfaces [4,9] which may be of strong interest for graphene spintronics [10]. Finally, the mechanisms inducing the magnetism in graphene via magnetic insulators (MIs) proximity effect will be discussed including four cases of different magnetic insulators were studied: EuO, EuS, Cobalt Fe$_2$O$_4$ as well as yttrium iron garnet (YIG) [11,12].

References:

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Biography

Dr. M. Chshiev is a theoretical physicist specializing on theory of spintronic phenomena in magnetic nanostructures and electronic structure of materials for spintronics. He received his PhD degree from Moscow State University in 1997 and his Habilitation Degree from University Joseph Fourier in 2008. He was a holder of Chair of Excellence position at Nanosciences Foundation in 2008-2011 and has been a principal investigator for projects supported by French ANR and European Commission. He is Head of Theory and Modeling Group at SPINTEC and Director of European School on Nanosciences & Nanotechnology. His works are published in leading scientific journals and he has delivered numerous invited talks including at INTERMAG, MMM, APS March Meetings and Gordon Research Conferences (2010). He is an IEEE Senior Member.

Plasmonic In$_2$O$_3$ Nanocrystals as Multifunctional Materials: The Role of Dopant, Phase, and Electronic Structure

Pavle V. Radovanovic*, Penghui Yin, Hanbing Fang, Yi Tan and Manu Hegde

University of Waterloo, Canada

Abstract

Synthesis, properties, and applications of gold and silver nanostructures with tunable localized surface plasmon resonances (LSPRs) have been a subject of intense investigation over the past decade. The focus on these noble metal plasmonic nanomaterials stems from their facile synthesis, relative stability, and the visible-range LSPR. However, among other drawbacks, these nanostructures are also costly for large-scale applications and exhibit high degree of optical losses due to electronic transitions. Consequently, doped transparent semiconductor and metal oxide nanocrystals have emerged as a new class of unconventional plasmonic materials. In this talk I will present the results of our recent work on colloidal indium oxide-based plasmonic nanocrystals, including structure-dependent plasmonic properties. I will also discuss colloidal synthesis and spectroscopic properties of several new plasmonic nanocrystal systems based on In$_2$O$_3$ and comparative investigation of their electronic structure using combined Drude-Lorenz model and density functional theory. Application of these colloidal mid-IR plasmonic nanocrystals will also be discussed. I will specifically focus on our recent results on robust electron polarization in degenerately-doped In$_2$O$_3$ nanocrystals, enabled by non-resonant coupling of cyclotron magnetoplasmonic modes with the nanocrystal exciton.

Biography

Dr. Pavle Radovanovic received his PhD degree from the University of Washington, Seattle. Following his postdoctoral appointment at Harvard University, and started his independent research career at the University of Waterloo in 2006. At Waterloo he initiated a new research program in physical-inorganic chemistry focusing on the design, synthesis, and fundamental physical and chemical properties of multifunctional low-dimensional materials. His work has been recognized by number of honors and awards, including Canada Research Chair (NSERC), Early Researcher Award (Ontario Ministry of Research and Innovation), Mobility Award (French Ministry of Foreign Affairs), and CNC-IUPAC Award.
Hydrogenated Graphene for Surface Engineering and Transfer

Keith E. Whitener, Jr., Woo K. Lee, Rory Stine, Jeremy T. Robinson, Nabil D. Bassim, Rhonda M. Stroud and Paul E. Sheehan
U.S. Naval Research Laboratory, Washington, D.C., USA

Abstract

Chemical functionalization dramatically alters the chemical and physical properties of graphene. For instance, extensive hydrogenation of graphene using a dissolving metal reduction essentially eliminates the material’s electronic conductivity, but graphene can be recovered cleanly through either thermal annealing or mild chemical oxidation [1]. Partially hydrogenated graphene exhibits room temperature ferromagnetism by introducing unpaired spin centers onto the lattice [2]. Hydrogenating graphene also weakens the van der Waals force between graphene and substrate; as a result, hydrogenated graphene delaminates cleanly from a substrate, and we have used this feature to transfer chemical and physical properties of the functionalized graphene surface intact from one substrate to another. By combining this delamination with the reversibility of hydrogenation, we have developed a transfer protocol for chemical-vapor deposited (CVD) graphene that avoids polymers and chemical etchants, resulting in an ultraclean graphene surface, as corroborated by spectroscopy and optical and electron microscopy [3].

References:


Role of Anionic Surface Ligands in Photophysics of Quantum Dots

Svetlana Kilina
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Abstract

We present several examples, where calculations based on density functional theory (DFT) succeed in providing insights into photophysical properties of quantum dots (QDs) allowing for explanations of experimental observables sensitive to surface defects and ligand passivation. Thus, our calculations reveal much more complicated exchange mechanism of the native surface ligands of CdSe QDs with phenyl-dithiocarbamates (PTCs) as it was thought before. PTCs decompose during exchange with native ligands, while only a small portion of deprotonated PTCs covalently bounds to the Cd-enriched surface. Additionally, the surfaces of CdS and CdSe QDs facilitate deprotonation of thiol ligands to thiolate with proton attached to surface S or Se. However, full deprotonation results in thiolate-localized midgap trap states, while 1:1 mixture of thiols and thiolates/H on the QD surface increase intensity of the lowest energy states. Our calculations also reveal that attachment of the hydride to Se sites results in strong distortions of Cd-Se bounds leading to ‘cleaning’ out of extra Se ions from the QD surface (in a form of SeH2 gas) and eliminating Se-associated trap states. On the other hand, adsorption of H– on Cd, when the surface is enriched by metal ions, results in blue-shifted lower-energy transitions with very high oscillator strength, which likely responsible for experimentally observed emission enhancement of CdSe QDs treated by hydrides. Overall, our calculations provide insights into the surface chemistry of QDs and offering guidance for controlling optical response of nanostructures by means of ligand engineering.

Biography

Dr. Svetlana Kilina received her undergraduate education (1994) and then MS degree in Physics (1996) at Belarusian State University, Minsk, Belarus. She obtained her PhD in Chemistry at the University of Washington, Seattle, in 2007. In 2008, she was awarded the Director’s Postdoctoral Fellowship at Los Alamos National Laboratory. In 2010, she started working as an Assistant Professor at North Dakota State University (NDSU), and in 2016 was promoted to Associate Professor position. She is the recipient of Department of Energy Early Career Research Award (2012), Sloan Foundations Award (2014), and James A. Meier Professorship at NDSU (2017).
Preparation of New Core–shell Type LiYF₄:Yb⁺³/Er⁺³/Ho⁺³/Tm⁺³@LiYF₄:Yb⁺³ Upconversion Nanoparticles for Biomedical Applications

Tzong-Liu Wang, Yueh-Chi Chung and Cheng-Hsien Wu
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Abstract

In this study, the new core/shell type of the upconversion nanoparticles (UCNPs) LiYF₄:Yb⁺³,Er⁺³,Tm⁺³,Ho⁺³@LiYF₄:Yb⁺³ were successfully synthesized. By varying the composition and concentration of the activators (including Er⁺³, Ho⁺³, Tm⁺³) and the concentration of the sensitizer Yb⁺³ in the shell, the effect of the intensity of luminescence with the activators and the sensitizer could be compared. Dynamic light scattering (DLS) measurement exhibited that the particle sizes before coated with the shell was about 60-70 nm, and the size was about 90-100 nm after coated with the shell. Photoswitch tests revealed that the spiropyran molecules were successfully coordinated to the oleic acid-coated UCNPs. After irradiated with UV light, spiropyran was converted to merocyanine. It was found that the absorption band around 580 nm of merocyanine overlapped with the 540 nm emission band of the UCNPs. Photoluminescence (PL) measurements confirmed that the merocyanine form located on UCNPs could quench the green-light emission of the UCNPs through the Fluorescence Resonance Energy Transfer (FRET). In the biosensing test of the UCNPs, it was found that the fluorescence intensity of the UCNPs was quenched by the formation of electron-holes on the surface of UCNPs, hence the fluorescence intensity of the UCNPs decreased with the increase of the concentration of Hg²⁺. After adding glutathione (GSH) to the above solution, the S-Hg²⁺ complexes were formed, and the concentration of Hg²⁺ was reduced. Therefore, the intensity of the fluorescence increased with the increase of the concentration of GSH.

Biography

Dr. Tzong-Liu Wang currently is a Professor of the Department of Chemical and Materials Engineering and serves as the Dean of the College of Engineering at National University of Kaohsiung. He received his B.S. degree in chemical engineering from National Tsing-Hua University and PhD degree in materials science & engineering from University of Utah. He then joined National University of Kaohsiung in 2004. His current research interests include polymer solar cells, organic/inorganic nanohybrids, organic & inorganic optoelectronic materials, functional polyurethanes, and synthesis and characterization of functional polymers.

Applications of Four-dimensional Electron Microscopy in Nanomaterials

Jau Tang
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Abstract

Using 4D electron microscopy by combining the nanometer spatial resolution of electron microscopy with the femtosecond temporal resolution of fs laser pulses and electron pulses we have investigated ultrafast phenomena of nanomaterials. Our goals are to elucidate their structures, dynamics and novel physical properties for potential applications in solving important energy, environment and biomedicine related issues. In one of our Science papers, we applied ultrafast scanning electron microscopy (USEM) to study photoinduced carrier dynamics across semiconductor p-n junctions. We observed fast charge separation of electrons and holes at the p-n junction and their extremely fast ballistic dynamics, contrary to the familiar diffusive carrier transport. We attributed such observed phenomena to slow electron-phonon collision time on the surface and also to polarity-dependent gating mechanism at the junction. In our other Science and also Science Advances papers, we demonstrated novel applications of ultrafast transmission electron microscopy (UTEM) of nanoparticles in liquid solution. We have discovered very fast anomalous Brownian motion of gold nanoparticles upon fs laser excitation. Unlike the well-known Einstein’s theory of Brownian motion with linear time dependence for the mean square displacement, the observed dynamics exhibits several kinds of power time dependence, covering ballistic, super-diffusion as well as the normal diffusion regimes. Moreover, the corresponding diffusion constant is four orders of magnitude greater than same nanoparticles in the absence of laser excitation. We elucidated the impulsive driving forces on gold nanoparticles as caused by water vapor nanobubbles generated by pulsed laser heating. In another work published recently in Angew. Chemie Int. we applied the PINEM (photon-induced near field electron microscopy) technique to investigate human cancer cells. We could unfold the protein receptor conformations on the surface of cancer cell membranes which are characteristically different from the normal cells.
We have also used 4D electron diffraction, published much earlier in Nature Comm., we demonstrated that the whole crystallization processes of a TiO \textsubscript{2} thin film, from melt, via nucleation to crystal formation, could be visualized and investigated during the crystal growth.

**Glucose Sensing and Bioenergy Harnessing**

Gymama Slaughter  
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**Abstract**

We describe herein the construction of a glucose biosensor system that senses glucose without the use of potentiostat and harness usable electrical energy from glucose to power a digital electronic device simultaneously. This system is powered by a single enzymatic glucose biofuel cell comprising a highly dense mesh network of multi-walled carbon nanotubes and enzymes that results in the immobilization and direct electrical connection of the enzymes. The bioanode is functionalized with pyrroloquinoline quinone glucose dehydrogenase, while the biocathode is functionalized with bilirubin oxidase. The glucose biofuel cell assembly and its performance were investigated under physiological conditions (pH 7.4 and 37 °C) at which a maximum open circuit voltage of 548.2 mV, short circuit current density of 7.19 mA/cm\textsuperscript{2} and peak power density of 1.475 mA/cm\textsuperscript{2} were obtained in 20 mM glucose. The nominal electrical power generated from the single glucose biofuel cell (~548 mV) was amplified to 3.2 V using a two stage electrical power amplification circuit and a capacitive element functioning as a glucose transducer. The self-powered glucose biosensor exhibited a linear dynamic range of 1 mM – 45 mM and a high sensitivity of 92.51 Hz/cm\textsuperscript{2}.mM when simultaneously sensing glucose and powering a glucometer. Additionally, the system demonstrated excellent operational stability over a 53-day period.

**Biography**

Dr. Gymama Slaughter is currently an Associate Professor of Computer Engineering at the University of Maryland, Baltimore and Director of the Bioelectronics Laboratory. Her research has been supported by the National Science Foundation for diabetes research that focuses on the design and development of self-powered glucose biosensor, especially in relationship to monitoring blood glucose in diabetics. She is the recipient of the National Science Foundation’s prestigious CAREER AWARD. Her research interests are in the application of sensor-processor integration, bioelectronics design and theory, sensor interfacing and wireless networking and communications. Other research areas include bioengineering, biosensors, BioMEMS and fluidic devices.

**Sub-20 nm Corner Lithography based on Digital Etching of a-Si**

Erwin Berenschot\textsuperscript{1}, Christiaan Bruinink\textsuperscript{2}, Roald Tiggelaar\textsuperscript{2}, Han Gardeniers\textsuperscript{1} and Niels Tas\textsuperscript{1}\textsuperscript{*}

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\textsuperscript{2}NanoLab, MESA+ Institute for Nanotechnology, University of Twente, The Netherlands

**Abstract**

Corner lithography is an emerging 3D-nanopatterning technique, with demonstrated use in the wafer-scale fabrication of nanofluidic devices (e.g., fluidic probes for SPM, particle and cell traps, micro-mixers) [1-4], and potential use in NEMS, nanoelectronics and energy storage and conversion devices. In its most basic form it consists of a combination of conformal deposition and isotropic thinning of the deposited layer, leaving residues in sharp concave corners. These residues can be used as structural material, or as mask material in a subsequent etching or LOCOS based inversion step. In a self-multiplying fabrication scheme it has been used for the fabrication of octahedral 3D-fractal structures [5].

Here we introduce a procedure to scale down corner lithography to the 10 nm level, based on the LPCVD of amorphous silicon (a-Si), followed by an accurate and uniform procedure for isotropic thinning based on repeated oxidation and HF etching. The rationale behind the use of a-Si in combination with “digital etching” [6] is the need for high uniformity in composition and thickness of the deposited layer as well as its isotropic thinning. It is shown that due to the self-stopping nature of both the wet-chemical oxidation (in 69% HNO\textsubscript{3} solution at 95 °C) and subsequent 1 % HF etching of the silicon oxide formed, the thinning of the a-Si layer is uniform and well controlled, with an effective thinning of around 0.5 nm per cycle. Sub-20 nm a-Si patches created by corner lithography are used to pattern an underlying silicon nitride layer.
References:


Biography

Dr. Niels Tas received his PhD degree from the University of Twente (UT) in April 2000, based on his work on electrostatic micromotors. From 2000 – 2004 he was a post-doctoral fellow in the BIOS lab-on-a-chip group, working on surface tension effects in nanochannels. In 2004 and 2010 he was appointed as an Assistant Professor and associate Professor respectively. Since 2014, he is working in the Mesoscale Chemical Systems group at the University of Twente, on applications of innovative 3D-nanofabrication techniques in the fields of nanofluidics, NEMS, energy conversion, and nanoelectronics.

The Synthesis and Application of Highly Sensitive Fluorescent Probes

Feifei Sun and Jin Ouyang*

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Abstract

Fluorescent probes have attracted great attentions for merits of photostability, biocompatibility and selectivity. To further improve the sensitivity of fluorescent probes, we constructed series of core-shell nanostructures for biosensing and bioimaging. With the strategy of plasmon-enhanced fluorescence (PEF), fluorescence emission can be highly enhanced owing to the larger and stronger electromagnetic fields at sharp tips of nanostructures. The nanostructures we constructed include the cores of nanorods, nanobipyramids, nanoprisms, and nanocubes, etc., with different “hot spots”, and applied them to the detection of pyrophosphate, microRNA, single nucleotide polymorphisms, and real-time monitoring of polymerase chain reaction products [1-3]. Besides, we developed a PEF-based single-molecule probe to avoid the limitation of the average effect and reflected the single molecular message directly [4]. Moreover, we explored a molecular beacon sensor based on plasmonic-enhanced single molecular fluorescence and realized in situ imaging of intracellular telomerase. To develop environmentally friendly fluorescent probes, we also studied DNA-sequence-dependent fluorescent copper nanoparticles and designed a smart DNA three-way junction to achieve fast, direct, label-free, enzyme-free and versatile detection of SNPs at room temperature [5]. The highly sensitive fluorescent probes we synthesized show potentials in biological detections.

Acknowledgment: The authors gratefully acknowledge the support from the NNSFC (21675014, 21475011) and the Fundamental Research Funds for the Central Universities.

References:


Biography

Dr. Jin Ouyang received her PhD degrees from Ghent University, Belgium. She is now working as a Professor at Beijing Normal University. She received several Natural Science Foundation of China and published over 100 papers on the peer-reviewed journals such as Anal. Chem., Adv. Funct. Mater., Chem. Commun., Nano lett., Small, etc..

A High-integration Sensor Array Sensitive to Oxynitride Mixture

Zhang Yong*, Cheng Zhenzhen and Pan Zhigang
State Key Laboratory of Electrical Insulation and Power Equipment, Xi’an Jiaotong University, Xi’an, China

Abstract

There are many methods to detect mixed gas components at present, including metal oxide semiconductor sensor arrays, nanomaterial based adsorptive sensor arrays, gas chromatographs, and spectrometers and so on, but they are limited by high operating temperature, low integration, slow response and serious overlap of characteristic absorption spectrum of different components. Here, we report on a high-integration carbon nanotubes sensor array with two different electrode separations. The array is comprised of a large carbon nanotube array cathode, two extracting electrodes and two collecting electrodes and worked at non-self-sustaining discharge state, which was determined by the study on current-voltage characteristic of a double-electrode structure sensor. Through studying the relationship between gas concentration of oxynitride mixture and discharge currents at 1 atm, we obtained the distinct sensitivities of a binary mixture in the concentration ranges of 0–1166 ppm NO and 0–712 ppm NO2 using the array at low operating voltages and 60°C. Collecting currents of the two sensors decreased with increasing NO and NO2 concentration in the gas mixture. The repeatable characteristics and dynamical response tests of the sensors were also conducted. The proposed sensor array has potential for the direct detection of a mixture without separating the mixed gases.

Biography

Dr. Y. Zhang received Bachelor Degree, Master Degree and Doctor Degree in 1990, 1993 and 2004 from Xi’an Jiaotong University, respectively, and focuses on research fields of micro and nano mechanical system based sensors and intelligent detection technology.

She is a Professor in the School of Electrical Engineering of Xi’an Jiaotong University, a fixed member of the State Key Lab of Electrical Institute and Power Equipment of Xi’an Jiaotong University, a senior member of the Institute of Electrical and Electronics Engineers (IEEE), and an expert committee member of Energy Equipment of China Energy Society. She has published 43 papers in international well-known publications (Scientific Reports of the Nature Publishing Group, Sensors and Actuators B: Chemical, and so on) with 17 indexed by SCI and 23 indexed by EI. 26 patents have been authorized and 7 patents have been accepted by the Patent Office of China. She won the first class prize of Science and Technology Award of Shaanxi province in 2013.
Innovation of Magnetic Properties using Au Nanoparticles

Yukiko Yasukawa
Department of Electrical and Electronic Engineering, Faculty of Engineering, Chiba Institute of Technology, Japan

Abstract

An enhancement of magneto-optical (MO) characteristics in the magnetic materials is one of the promising ways to develop novel physical applications in functional materials. In this study, our target material is TbFeCo magnetic thin film, which is known to be one of the conventional MO materials. By utilizing self-organized Au nanoparticles as an underlayer of TbFeCo thin film, we attempted to enhance MO characteristics of TbFeCo. We confirmed that self-organized Au nanoparticles exhibit localized surface plasmon resonance (LSPR) phenomena, such that an increase in the electric field in the vicinity of each Au particle can be expected. As a consequence, enhancement of MO characteristics of TbFeCo could be possible due to strong electric field between TbFeCo/Au interfaces.

We formed self-organized Au nanoparticles on Si substrates. Afterward, TbFeCo thin film was prepared on the Au nanoparticles. The samples were prepared through the magnetron-sputtering technique. In the present study, we formed Si$_3$N$_4$ (10 nm: capping layer)/TbFeCo (various thickness: MO layer)/self-organized Au nanoparticles (5 to 10 nm in diameter: LSPR layer)/Si substrate structures.

The magnetic properties and polar-Kerr characteristics were compared concerning the samples with/without Au nanoparticle underlayers. The properties were largely affected by Au nanoparticle underlayers. Coercivity of TbFeCo thin film was decreased when the Au nanoparticles were used as an underlayer of TbFeCo, whereas MO angle was drastically increased. Magnetic domain structures of the samples with/without Au nanoparticle underlayers were different. We consider that these results are owing to interaction between TbFeCo magnetic thin film and self-organized Au nanoparticles.

Biography

Dr. Yukiko Yasukawa, Doctor of Engineering, now is an Associate Professor of Department of Electrical and Electronic Engineering, Faculty of Engineering, Chiba Institute of Technology, Japan.

She got a Doctor's degree in functional-oxide materials, i.e., magnetic- and superconducting-oxide materials, from Tokyo Institute of Technology in 2006. After she received the PhD, she learned nanofabrication techniques. Her current interests are nanostructured magnetic materials as well as modification of physical properties of nanomagnetic materials. She established her own laboratory in 2014 in Chiba Institute of Technology. Her group has active collaborations with The National Institute and other Universities.

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3National University of Science and Technology MISiS, Russia
4National Institute for Materials Science NIMS, Japan
5High Energy Accelerator Research Organization, Japan

Abstract

Due to the extraordinary properties such as high carrier mobility, weak spin-orbit coupling and unique band structure of graphene, graphene-based spin transistor, magnetic random access memory and magnetic field sensor were proposed for ultrafast, low-power consumption spintronic devices for next generation. In those reported graphene-spintronic device, conventional ferromagnet such as Ni, Co, Fe with low spin polarization have been used due to the well-established synthesis method of graphene on them. However, the low spin signal and tiny magnetoresistance effect reported in those system are very disappointing and makes the graphene still far from being considered for real spintronic device application. Adopting highly spin-polarized material such as half-metal can be the most effective way to improve the performance of graphene spintronics device, the experimental demonstration, however, is still lacking.

This study, for the first time, presents a successful synthesis of graphene by high-vacuum chemical vapor deposition on a half-metallic Co2FeGe0.5Ga0.5 (CFGG) Heusler alloy whose half-metallicity has been confirmed experimentally. We confirmed the high-quality epitaxial growth of single layer graphene directly on CFGG. strikingly, a detail investigation of the electronic structure of the graphene/CFGG heterostructure reveals the physical nature of the interface between graphene and CFGG, which makes the graphene/Co2FeGe0.5Ga0.5 heterostructure unique from other graphene/ferromagnet (Ni, Co, Fe, Permalloy) heterostructure with a chemical interface bonding so far. The features of high spin polarization of CFGG Heusler alloy together with the quasi-freestanding nature of graphene make the graphene/CFGG heterostructure extremely promising for high-performance spintronic devices.

Biography

Dr. Songtian Li received his Ph. D degree from the Faculty of Engineering in Shinshu University, Japan in 2012. He had a post-doctoral fellowship in National Institute for Materials Science, Japan, from 2012 to 2017. Since then he joined National Institutes for Quantum and Radiological Science and Technology, Japan. His current interest is developing next-generation high-performance spintronic devices by using graphene and half-metallic Heusler alloy.

A Discrete Resistance Change in the 3D Nanostructured Metal Oxide due to the Nano-confinement Effect

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2JST-PRESTO, Japan

Abstract

Functional oxides with strongly correlated electron system, such as vanadium dioxide, manganite, and so on show first-order metal-insulator phase transition (MIT) with a change in conductivity by several orders magnitude. Since a discovery of the phase separation during MIT process, many researchers have been trying to capture a nanoscale electric domain and investigate its exotic properties. To understand exotic nanoscale electronic domain properties and utilize their superior properties as device functionalities, the three-dimensional (3D) nano-structuring is one of the most effective approaches. We report the construction of the well-defined 3D metal oxide nanowall wire (nw), which allows the direct investigation of its insulator-metal transition (IMT) at the single domain scale. A single electronic nanodomain exhibited an intrinsic first-order IMT with an unusually steep single-step change in its magnetoresistance and temperature-induced resistance. The special confinement effect is discussed in terms of the reduction in the number of elements due to an IMT.
Biography

Dr. Azusa N. Hattori (PhD-Science), now is an Assistant Professor in the Institute of Scientific and Industrial Research, Osaka University, and a PREST researcher in Japan Science and Technology Agency. Her research interests are nanofabrication in atomic resolution and novel nanoscale physical property typically for transition metal oxides.

ZnO-based Low Dimensional Structures for Ultraviolet Photodetectors and Light Emitting Devices

Longxing Su* and Xiaosheng Fang
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Abstract

Low dimensional ZnO structures, such as nano/micro-wires and quantum dots, have been paid considerable attentions during last decades due to their facile preparation processes, abundant morphologies and superior photoelectronic properties. Here, we report the fabrication and characterization of UV photodetectors and light emitting devices based on ZnO low dimensional structures. Self-powered UV photodetectors was fabricated through combining ZnO nano/micro-wires with $p$-Te microwire or $p$-PANI. Heterojunctions were formed and then contributed to the separation of photogenerated electron-hole pairs under 0 bias. Thanks to the heterojunction, the self-power device shows fast response speed with rise time $<$ 0.1 ms and decay time $<$ 1 ms, which is much faster than that of ZnO based photoconductive one. In additionally, deep UV random lasers were realized based on MgZnO nano-crystals. The grain sizes are in the range of 130~300 nm. This kind of morphology facilitates effective light scattering for the formation of random laser cavities. The lasers are operated with continuous current mode at room temperature and the shortest wavelength reaches 284 nm with very low threshold current densities of 33 A/cm$^2$. Our results demonstrate that ZnO low dimensional structures have promising applications in UV optoelectronic devices.
**Acoustic Nanofluidics**

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**Abstract**

Acoustic waves have found new utility in microfluidics in recent years, providing an enormously powerful ability to manipulate fluids and suspended particles in open and closed fluid systems. In this talk, we cover some fundamental and powerful concepts of acoustic wave generation and propagation often overlooked in the literature and follow it with exploration of new phenomena observed at the nanoscale, terming it acoustic nanofluidics. The utility of acoustic waves at the micro-scale is even more compelling at the nano-scale, in many ways not predicted by classical theory. Particle deagglomeration, fluid pumping, pattern formation, and other curious physical phenomena will be shown in the context of potentially useful nanoscale applications. Along the way, the fascinating underlying physics tying together the acoustics, fluid dynamics, and broader physical phenomena appearing in these systems will be described.

**Biography**

Dr. James Friend is a Professor in the Center for Medical Devices and Instrumentation at the University of California, San Diego, leading the Medically Advanced Devices Laboratory. His research interests are principally in exploring and exploiting acoustic phenomena at small scales. He currently supervises a team of 7 PhD students, has over 260 peer-reviewed research publications (H-factor = 41) and 27 patents in process or granted, completed 33 postgraduate students and supervised 18 postdoctoral staff, and been awarded over $25 million in competitive grant-based research funding.

**Alzheimer's Disease and Nanotechnology. Novel Drug Treatment Strategies**

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**Abstract**

Alzheimer’s disease (AD) inflicts more than 5 million Americans for which no suitable therapeutic strategy is available till today. Recent evidences show that neprilysin (NPL), the rate-limiting enzyme for amyloid-beta peptide (AbP) play key roles in the pathogenesis of AD. In this investigation we explored the role mesenchymal stem cells (MSCs) and cerebrolysin (CBL, a combination of neurotrophic factors and active peptide fragments) in relation with NPL in AD. We used TiO2-nanowired of MSCs and CBL on NPL content and brain pathology in AD using a rat model comprising intraventricular (i.c.v.) administration of AbP (1-40) in the left lateral ventricle (250 ng/10 µl, once daily) for 4 weeks. Co-administration of TiO2 nanowired MSCs (10^6 cells) with 2.5 ml/kg CBL (i.v.) once daily for 1 week after 2 weeks of AbP infusion significantly increased the NPL in hippocampus (400 pg/g) from untreated control group (120 pg/g; Control 420±8 pg/g brain) along with significant decrease in the AbP deposition (45 pg/g
from untreated control 75 pg/g; saline control 40±4 pg/g). Neuronal damages, gliosis and myelin vesiculation were also markedly reduced by the combined treatment of TiO$_2$, MSCs and CBL in AD. However, these changes were significantly less evident with MSCs or CBL treatment given alone. These observations suggest that co-administration of TiO$_2$-nanowired CBL and MSCs induces superior neuroprotection in AD through increasing the brain NPL level effectively. Further studies are needed to explore clinical value of these findings.

Biography

Dr. Hari Shanker Sharma, Director of Research (International Experimental Central Nervous System Injury & Repair, IECNSIR), University Hospital, Uppsala University is Professor of Neurobiology (MRC), Docent in Neuroanatomy (UU) and is currently affiliated with Department of Surgical Sciences, Division of Anesthesiology and Intensive Care Medicine, Uppsala University, Sweden. He received the prestigious Distinguished International Scientists Collaboration Award (DISCA) by National Institute on Drug Abuse (NIDA), Baltimore, MD (2006–2008). His research on nanoparticles in Neurodegeneration and Neuroprotection is supported by US Air Force Research & Development, Dayton, OH, USA. Dr. Sharma published over 400 peer reviewed research papers (H-index 41).

The Forthcoming Renaissance for Calcium Phosphate Nanoparticles in Biomedicine

Vuk Uskoković

Abstract

Calcium phosphate was selected throughout the evolution for the mineral component of the vertebrate skeleton. Its comprising the foundations of our bodies has served as an invaluable inspiration for materials scientists who have attempted to discover in this material more potential than meets the eye. Efforts are currently being made to expand the application repertoire of calcium phosphates beyond their use as traditional bone fillers or tissue engineering construct components that impart osteoconductivity and high compressive strength. The application of calcium phosphates for sustained drug delivery, gene and anticancer therapies, antibiofilm coatings and hard tissue regeneration has been intensely explored recently. In this talk I will show that calcium phosphate nanoparticles could be chemically designed to take on the role of bone growth factors, antibiotics for prophylactic or anti-infective purposes, bisphosphonates as antiresorptive compounds, viral vectors to enable the intracellular delivery of therapeutics, and magnetic hyperthermia agents. Correspondingly, nanoparticulate calcium phosphates could: (a) produce tunable drug release profiles; (b) take the form of viscous and injectable, self-setting pastes; (c) be naturally osteoinductive and inhibitory for osteoclastogenesis; (d) intracellularly deliver bioactive compounds; (e) accommodate an array of functional ions; (f) be processed into macroporous constructs for tissue engineering; and (g) be naturally antimicrobial. All in all, calcium phosphates possess a protean nature whose therapeutic potentials have been barely tapped into.

Biography

Dr. Vuk Uskoković is a Professor of bioengineering at the University of Illinois in Chicago and a Professor of biomedical and pharmaceutical sciences at Chapman University in Orange County, California. He is the director of Advanced Materials and Nanobiotechnology Laboratory whose goal is the development of nanotechnological innovations in the field of biomedicine. Formerly he was with various departments at University of California at San Francisco, Clarkson University at Potsdam, New York and Jožef Stefan Institute in Ljubljana, Slovenia. He has authored around 100 peer-reviewed research articles and reviews and has given more than 50 invited talks worldwide.
Nanomaterials: From Fiction to Reality. Examples of Liposomes as Drug Nanocarriers and Polymer based Nanocomposites.

Djafer Benachour
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Abstract

The fast and large developments of nanotechnology over the last three decades, have led to: production of nanomaterials that are now being used in different fields. Indeed; the new approach to materials science, i.e.: the “bottom-up” approach and the development of new synthesis pathways and techniques, allowed production of “tailor-made” molecules that could be designed for specific applications… “These nanomaterials spread out to many scientific and technologic fields, notably in materials science, in catalysis and in medicine. The examples of two types of nanomaterials based on polymers will be discussed:

1-smart nanocarriers used for drugs delivery and targeting. These nanocarriers ranging from liposomes, to polymeric nanospheres and micelles, are now used for cancer treatment. These drugs nanocarriers helped the emergence of what is now called “Nanomedicine”. Polymeric materials are suitable for the design of many drug nanocarriers because of the ease of their synthesis; the versatility of their particle forms, and the soft conditions of their processing. Typical polymer examples will be presented to illustrate this type of nanomaterials.

2- polymer nanocomposites are now industrially produced and used for high performance applications. Carbon nanotubes and clay nanoparticles are widely used as reinforcing agents to enhance mechanical and thermal properties of polymer composites. For instance, It has been found that a load of 5% /wt. of clay, will induce an increase of 50°C of the melting temperature of some polyolefin based composites (such as Polyamide and Polypropylene). Other examples of polymer nanocomposites will be presented.

Biography

Dr. Djafer Benachour, presently a full time Professor of Macromolecular Science and Engineering at Ferhat ABBAS University SETIF1 (ALGERIA), holds an Engineer degree (National Polytechnic School of Algiers, June 1976), a Master of Science (May 1980) and a PhD (August 1982) degrees in Macromolecular Science (both from CWRU, USA). Since July 2000, he chairs a research laboratory on “Multiphase Polymeric Materials” (LMPMP). His works deal with polymer blends, nanocomposites, recycling and reactive processing. Over the last 30 years, he supervised 32 Master and 26 PhD theses; and authored/co-authored 80 scientific publications.

Impact of Cerium Oxide Nanoparticles Shape on their in vitro Cellular Toxicity

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5UCP, ENSTA ParisTech, Université Paris-Saclay, 828 bd des Maréchaux, 91762 Palaiseau cedex France

Abstract

Cerium oxides (CeO2) nanoparticles, also referred to as nanoceria, are extensively used with a wide range of applications. However, their impact on human health and on the environment is not fully elucidated. The aim of this study was to investigate the influence of the CeO2 nanoparticles morphology on their in vitro toxicity. CeO2 nanoparticles of similar chemical composition and crystallinity were synthesized, only the shape varied (rods or octahedrons/cubes). Macrophages from the RAW264.7 cell line were exposed to these different samples and the toxicity was evaluated in terms of lactate dehydrogenase (LDH) release, Tumor Necrosis Factor alpha (TNF-a) production and reactive oxygen species (ROS) generation. Results showed no ROS production, whatever the nanoparticle shape. The LDH release and the TNF-a production were significantly and dose-dependently enhanced by rod-like nanoparticles, whereas they did not vary with cubic/octahedral nanoparticles. In conclusion, a strong impact of CeO2 nanoparticle morphology on their in vitro toxicity was clearly demonstrated, underscoring that nanoceria shape should be carefully taken in consideration, especially in a “safer by design” context.
Biography

Dr. Jérémie Pourchez received his PhD in Chemical and Process Engineering in 2006. He is Professor since 2012 in the Center for Health Engineering at Ecole Nationale Supérieure des Mines de Saint-Étienne in France. His research interest and teaching include the understanding of inhaled nanoparticles fate within the organism to highlight toxicity, biodistribution and biopersistance of nanoparticles in living systems. His fields of expertise are: anatomic and cell targets of nanosized aerosol, physico-chemistry of nanoparticles and in vitro analysis of biological effects.

Clickable’ Recombinant Spider Silk and its Healthcare Applications

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1University of Nottingham, School of Chemistry, Centre for Biomolecular Sciences, Nottingham, UK
2University of Nottingham, School of Life Sciences, Nottingham, UK

Abstract

Spider silk including recombinant forms is a biomaterial of significant interest for medical and other applications due to both its mechanical properties (tensile strength and toughness) and its biocompatibility. We have recently reported the preparation of antibiotic and fluorophore functionalized silk fibres self-assembled from the miniaturized major spidroin protein 4RepCT derived from the dragline silk of the South African nursery web spider, Euprosthenops australis [1]. This has been achieved through the site-specific incorporation of the un-natural, bio-orthogonally functionalized amino acids L-azido-homoalanine (Aha) and L-homopropargylglycine (Hpg) in the mini spidroins. The Aha residues can be selectively and efficiently modified with ligands bearing alkyne groups using either a copper (I) catalysed azide alkyne cycloaddition (CuAAC) or strain promoted azide alkyne cycloaddition (SPAAC) ‘click’ reaction.

We have demonstrated that we can functionalize the silk proteins with fluorophores, pep-tides and with the broad spectrum antibiotic levofloxacin. The antibiotic has been attached via a glycerol ester that is cleaved either through a drop in pH or by esterases released by E. coli as they grow. The 4RepCT3Aha proteins can be modified either prior to or after silk fibre assembly and the tensile strength of the resulting fibres is unaffected. This has allowed fibres decorated with two or more different ligands in defined ratios to be prepared. The antibiotic functionalized silk fibres prevent E. coli growth for at least 5 days demonstrating good potential for future use in medical dressings. Additional applications of the functionalized silks in re-generative medicine will also be presented.

Reference


Biography

Dr. Neil Thomas is currently a Professor of Medicinal & Biological Chemistry in the School of Chemistry, University of Nottingham, UK having undertaken his BSc(Hons) Chemistry degree (1987) and PhD (1990) at the University of Southampton, UK. He was then awarded a NATO/SERC postdoctoral research fellowship (1990-92) to work in the group of Stephen J. Benkovic at the Pennsylvania State University, USA on catalytic antibodies, before taking up a Royal Society University Research Fellowship in the School of Chemistry at Bath University UK (1992-95) before moving to Nottingham. Research interests: Mechanistic enzymology; generating proteins with new functions; developing new biological probes.
Multifunctional Scaffold Based on Hydrogel-Incorporated Nanofiber
Won-Gun Koh, Minsu Kim, Kanghee Cho, Hye Jin Hong, Du Yeol Ryu, and Ji Hong Min
Department of Chemical & Biomolecular Engineering, Yonsei University, Seoul, South Korea

Abstract

In this study, we describe a simple method for fabricating micropatterned three-dimensional polymeric fibrous scaffolds that are capable of controlling the spatial positioning of mammalian cells and proteins. Photopatterning of poly(ethylene glycol)(PEG) hydrogel on the electrospun nanofibers produced micropatterned nanofiber matrices made of hydrogel microwells filled with a nanofibrous region, which is capable of generating cell and protein micropatterns due to the different interactions that cells and proteins have with PEG hydrogels and nanofibers as shown in Figure 1. Different proteins could be immobilized onto resultant micropatterned nanofiber scaffold, carrying out cell patterning, metabolite.

Biography

Dr. Won-Gun Koh was born in Seoul, Korea. He received B.S. and M.S degree in Department of Chemical Engineering at Yonsei University, Korea. He received PhD in 2004 from Department of Chemical Engineering at Penn State University under the guidance of Professor Michael V. Pishko. After PhD, he was appointed as postdoc scholar at Stanford University, where he made relationship with Professor Curtis W. Frank. He became the Assistant Professor in Department of Chemical & Biomolecular Engineering at Yonsei University in 2005. Currently he is Professor in same Department and Director of Yonsei Center for Research Facilities. His research interests include polymer-based tissue engineering and biosensor.

Nanomaterial Based Drug Delivery Systems for Local Immunomodulation in Pancreatic Cells Transplantation
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2Department of Biomedical Engineering, University of Miami, FL, USA
3Università degli Studi di Padova, Italy

Abstract

We aim to deliver immunomodulatory drugs locally and in a sustained manner in pancreatic islet grafts to target macrophages and cytotoxic T cells and improve graft outcomes. We previously developed amphiphilic block copolymers made of poly (ethylene glycol)-poly (propylene sulfide) (PEG-PPS) and poly (ethylene glycol)-oligo (ethylene sulfide) (PEG-OES) that self-assemble into micelles and nanofibers able of loading hydrophobic drugs without chemical conjugation. Here, we are applying those nanomaterials as drug delivery systems (nDDS) to improve solubility, stability, and absorption of the antiinflammatory dexamethasone (Dexa) and of the immunosuppressant cyclosporine A (CsA). We found that PEG44-PPS20 micelles and PEG44-OES5 nanofibers can load both CsA and Dexa allowing controlled drug release with an efficiency and at a rate that is dependent on the chemical composition and on the density of the nDDS hydrophobic cores. Dexa can be released over a period of 6-8 hours, while CsA can be released within 7-14 days. Furthermore, we found that nDDS/Dexa and nDDS/CsA decrease macrophage viability (and cytokine production) and cytotoxic T cell activation, respectively without affecting islet viability and glucose-stimulated insulin secretion. Tunable drug release demonstrates the versatility of our nanomaterials as drug delivery systems for decreasing macrophage-mediated inflammation in the first hours after cell transplantation and for dampening T cell activation and proliferation during the first 7-14 days after islet transplantation, when T-cell mediated rejection occurs. Therefore, our nDDS platform can address the current challenges of islet transplantation in type 1 diabetes by providing local immunomodulation that could reduce the need of chronic immunosuppression and improve graft outcome.

Biography

Dr. Velluto obtained her PhD in Pharmaceutical Sciences from the School of Pharmacy at the University of Chieti (Italy). She worked as postdoctoral fellow with Prof. J. Hubbell at EPFL (Switzerland) and she obtained the Marie Curie Intra-European Individual Fellowship at Queen Mary University (London, UK). She is specialized in design, synthesis and characterization of bio-nanomaterials for therapeutic applications. Currently Associated Scientist at the Diabetes Research Institute of the University of Miami, she is developing nanomaterials as drug delivery systems for immunotherapies localized to the vicinity of transplanted pancreatic islets. She aims to translate those nanomaterials into clinical practice.
Plasmonic Nanogaps: Sensing Metabolites as Signatures of Biological Processes

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Abstract

Nanoparticles from colloidal solution – with controlled composition, size, and shape – serve as excellent building blocks for plasmonic devices and metasurfaces. However, understanding hierarchical driving forces affecting geometry of oligomers and interparticle gap spacings is still needed to fabricate high density architectures over large areas. Here, I will present how electrohydrodynamic (EHD) flow is used as a long-range driving force to enable carbodiimide crosslinking between nanospheres yielding control of gap spacing in oligomers with sub-nanometer precision over mm² areas. Plasmonic nanogaps produce uniform surface enhanced Raman scattering (SERS) response with billion-fold enhancements at low integration times and laser power.

This enables incorporation of nanogaps into in-line microfluidic devices for early detection of bacterial biofilms. During biofilm formation, density-dependent gene expression is regulated; a mechanism called quorum sensing (QS). Once developed, bacterial biofilms often exhibit resistance mechanisms such as efflux pumps, which specifically pump out antibacterial molecules and can withstand up to 1000 times higher doses of antibiotics than their free floating planktonic counterparts. While new antimicrobial strategies are being developed to combat antibiotic resistance, here we investigate a promising parallel strategy, sensing QS molecules for early detection of biofilm formation at a stage where antibiotic treatment has higher efficacy. Here we show that by analyzing SERS response with machine learning algorithms, we are able to differentiate bacterial metabolites in the complex soup of biological media at concentrations down to pg/mL and detect the presence of pyocyanin in supernatant from Pseudomonas aeruginosa cultures as early as three hours after seeding due to high signal enhancements by plasmonic nanogaps. Surface-attached bacteria exposed to a bactericidal antibiotic were differentially less susceptible after 10 h of growth, indicating that these devices may be useful for early intervention of bacterial infections.

Nanodelivery of Drugs and Antibodies for the Novel Treatment Strategies of Parkinson’s Disease

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2Dept. of Biomedical Engineering, University of Arkansas, Fayetteville, AR, USA
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5RoNeuro Institute for Neurological Research and Diagnostic, Romania
6LaNCE, Dept Neuroscience, University of the Basque Country (UPV/EHU), Leioa, Bizkaia, Spain
7School of Biomedical Engineering, Dept. of Biomaterials, Indian Institute of technology, Varanasi, India
8COMAMO Consulting & Services. Mondsee, Oberösterreich, Österreich

Abstract

Parkinson’s disease (PD) induced afflicts more than several million Americans for which no suitable therapeutic strategies has emerged so far. Intraperitoneal injections of 1-metyl-4-phenyl-1,2,3,6-tetrahydropyridin (MPTP, 20 mg/kg) daily within 2-h intervals for 5 days in mice induce PD-like symptoms on the 8th da showing significant decrease in dopamine (DA), 3,4-dihydroxyphenylacetic acid (HVA) as well as decrease in tyrosine hydroxylase (TH) positive cells in the Substantia Nigra Pars Compacta (SNpc) and striatum (STr) is seen. We used timed release of cerebrolysin CBL-a well-balanced composition of several neurotrophic factors and active peptide fragments) with titanate nanospheres (TiNS) together with antibodies of alpha synuclein (α-SNL) for treating PD in mouse model. TiNS-CBL (3 ml/kg, i.v.) given after 2-days of MPTP administration for 5 days resulted in a marked increase in TH-positive cells in the SNpc and STr and enhanced DA, DOPAC and HVA levels in SNpc and STr. This effect was further potentiated when co-administration of TiNS-CBL and antibodies to α-SNL (1:20, 25 µg in 50 µl) was given together indicating its therapeutic value in clinics.
Biography

Dr. Aruna Sharma, MD is Secretary of Research International Experimental CNS injury & Repair (IECNSIR) at Uppsala University Hospital, Sweden. She is experimental Neurpathologist Karl Marx University Leipzig (1987-1988); Semmelweis University Medical School, Budapest (1988-1989), Free University Berlin, (1989-1991) and Neuropathology Institute Uppsala (1992-1995). Her research on nanotechnology include Indian/Chinese Medicine on the CNS toxicology, neurorepair and. She received Top 15 % technology Award at Global Innovation Summit & Showcase from US Govt. Washington DC, May 22-25, 2016 for Nanowired-delivery of Cerebrolysin with MSH in sleep deprivation. She published over 140 reviewed research papers in Reputed Neuroscience Journals (H-index = 19).

Chitosan/imipenem based Nano-constructs to Combat Resistant Clinical ISOLATES: Fabrication and in-vitro Study

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6Department of Biosciences, COMSATS Institute of Information Technology, Park Road, Islamabad, Pakistan

Abstract

The global emergence of metallo-β-lactamase (MBL) producing bacterial pathogens has rendered the current therapeutic options ineffective. This perturbing situation requires an inventive strategy to stop the dissemination of MBL producers and their associated infections. The present investigation reports the fabrication and evaluation of bio-based nano-carrier system carrying imipenem, a carbapenem representative, as a therapeutic tool against resistant pathogens. Empty chitosan nanoparticles (CSNPs) and drug loaded CSNPs were generated by ionic gelation method. Both nano-dispersions had mean particle size of less than 100 nm as confirmed by Atomic Force Microscopy (AFM) based analyses. The stability of nano-colloidal system was affirmed by positive zeta potential of more than +50 mV. Encapsulation efficiency of imipenem varied from 45-64% as a function of drug concentration at the time of ionic gelation. FTIR studies confirmed that the drug was entrapped inside CSNPs by simple electrostatic interactions between active molecule and polymer. The imipenem loaded CSNPs displayed a significant activity in vitro against the MBL producing pathogens including Escherichia coli, Klebsiella pneumonia and Pseudomonas aeruginosa for at least five days, whereas the ordinary drug fails to control them.

Biography

Dr. Bushra Jamil holds a bachelor degree in pharmacy from University of the Punjab, Lahore; M Phil in Microbiology from Quaid-i-Azam University, Islamabad; and has a doctorate from COMSATS Institute of Information Technology, Islamabad. Her title of research during PhD was “Nano-antibiotics: Nano Encapsulation of Natural and Synthetic Antimicrobials to Combat Multi Drug Resistant Pathogens”. She has over seven years of work experience. She is experienced in pharmaceutical microbiological, medical microbiology and Nanotechnology.

Right now she is serving as Assistant Professor at National University of Medical Sciences (NUMS). It is pertinent to mention here that NUMS is a Federal Public-Sector University envisioned to grow as a research led institution providing opportunities of undergraduate and post graduate education in Medicine, Dentistry, Nursing, Allied Health and Animal Husbandry. She has written over ten peer reviewed papers and technical articles relating to nanotechnology and microbiology. She has also delivered invited lectures and papers to multiple national conference.
Fluorescence Lifetime Imaging Microscopy (FLIM) for Monitoring Mitochondrial Protein Localization and Shuttling with Sub-diffraction Resolution

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2University of Göttingen, Germany
3University of Münster, Germany

Abstract

Cellular metabolism is highly compartmentalized. This prevents interference of opposing biochemical pathways and therefore enables the maintenance of specific physicochemical environments. Especially mitochondria, placed center stage in many aspects of cell biology and medicine, provide numerous microcompartments. Trafficking of proteins in response to specific stimuli is essential for mitochondrial function and hence for cellular vitality. For instance, the quality control enzyme PTEN induced putative kinase 1 (PINK1) shuttles between the cytosol as well as the outer mitochondrial (OMM) and inner mitochondrial membrane (IMM). However, due to the small size of mitochondria (0.5-1 µm), protein localization in different mitochondrial microcompartments, as well as protein translocation over time, is not accessible by conventional microscopy. Here, we demonstrate that time-correlated single-photon counting (TCSPC) fluorescence lifetime-imaging microscopy (FLIM) of monomeric fluorescent proteins (FPs) classifies not only mitochondria but protein localization in different mitochondrial and cellular compartments. We found that membrane-associated FPs have a shorter fluorescence lifetime than soluble forms. In mitochondria, localization of mCitrine in the matrix as well as in the OMM and IMM could be distinguished by significant differences in fluorescence lifetime t. The method was sensitive enough to monitor shifts in protein location between mitochondrial microcompartments. We suggest that FLIM is a versatile and non-invasive method to monitor spatiotemporal events in mitochondria. Time domain sensitivity allows for gaining substantial information about sub-mitochondrial localization overcoming diffraction limitation.

Biography

Ms. Anna-Carina Söhnel, born in 1987, studied food chemistry at the University of Münster, Germany. During her study she established a determination method of the mycotoxin fusaric acid via high-performance liquid chromatography tandem-mass spectrometry. In 2014, she started her PhD at the Institute of Molecular Cell Biology (Karin B. Busch, Münster/Germany). Here, her research focuses on mitochondrial dynamics and intracellular mitochondrial trafficking. In an actual project she wants to clarify possible abnormalities in mitochondrial transport and exchange in Alzheimer’s Disease model cells by advanced fluorescence microscopy techniques. This summer she will complete her doctoral thesis, looking forward to new challenges.

Enhancing Immunity and Disease Resistance in Fish by Chitosan-Selenium Nanoparticles

Ivan Fan Xia1,2*, Kwong-Sen Wong1, Hang-Kin Kong3, Jacky Siu-To Cheung2, Xiao-Ting Zheng3, Ka-Hing Wong1,2 and Kevin Wing-Hin Kwok1,2

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2Department of Applied Biology and Chemical Technology, The Hong Kong Polytechnic University, Hong Kong SAR, China
3Key Laboratory of South China Sea Fisheries Resources Exploitation & Utilization, Ministry of Agriculture, Guangzhou, China

Abstract

Selenium nanomaterials are attracting increasing attention due to unique bioactivity and low toxicity compared with traditional selenium species. In this work, chitosan stabilized selenium nanoparticles (CTS-SeNPs) was developed using controlled reduction of sodium selenite at room temperature with food grade materials. Suitability of CTS-SeNPs as an immunostimulant was explored. Zebrafish (Danio rerio) were exposed to 0, 2, 5, 10 and 20 µg/g of dietary CTS-SeNPs for 9 days. Their immune response and resistance to bacterial infection were determined. At 5 µg/g and 10 µg/g CTS-SeNPs, these fish showed improved survivorship when challenged by a common aquaculture pathogen Aeromonas hydrophila. Moreover, lysozyme activity (1.8-fold) and respiratory burst (2.4-fold) were all significantly enhanced at 10 µg/g CTS-SeNPs. In term of adaptive immune responses, lymphocyte (T cell and B cell) proliferation and immunoglobulin M expression were also improved at 10 µg/g CTS-SeNPs. CTS-SeNPs showed better immunostimulant properties than chitosan and selenite. These results showed that CTS-SeNP is a good immunostimulant for fish species.
Novel fibroin-based Nanoparticles for Cancer Chemotherapy: Development and Characterization

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Abstract

Fibroin, a silk human-biocompatible protein, has demonstrated remarkable properties including toughness, elasticity, as well as biodegradability. Taking these advantages, we conducted a study to formulate and determine the properties of novel fibroin nanoparticles (FNP) as a potential drug delivery system for cancer chemotherapy. Using coacervation method, with the addition of the crosslinker 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC), three FNP formulations namely FNP, FNP-EDC\textsubscript{low}, and FNP-EDC\textsubscript{high}, were fabricated by varying the content of EDC. Interestingly, all formulations showed nanosize spherical particles of approximately 300 nm, with the charge ranging from $-15$ mV, FNP and FNP-EDC\textsubscript{low}, to $+30$ mV as the amount of EDC increased, FNP-EDC\textsubscript{high}. Using transmission electron microscope, the FNP-EDC\textsubscript{high} particles were tighter packed due to extensive crosslink reactions as compared to the FNP-EDC\textsubscript{low}. Also, FNP with no EDC demonstrated some aggregation between particles. In addition, utilizing FT-IR, the shift of characterized amide I peak at 1646 cm\textsuperscript{-1} in raw fibroin to 1622 cm\textsuperscript{-1} was observed in all formulations, suggesting a transformation from silk I (random coils and $\alpha$-helices amorphous structure) to silk II structures (anti-parallel $\beta$-sheet crystalline structure). The results from DSC and XRD methods were in agreement with FT-IR. In addition, the degree of crystallinity was increased as follows; FNP $<$ FNP-EDC\textsubscript{low} $<$ FNP-EDC\textsubscript{high}. Finally, combine all data, the possible structures of the novel nanoparticles have been proposed.

Biography

Mr. Duy Toan Pham is currently a PhD candidate in the field of nanopharmaceutical technology, at the faculty of Pharmaceutical Sciences, Naresuan University, Thailand, under the supervision of Assoc. Prof. Waree Tiyaboonchai and Asst. Prof. Nuttawut Saelim. He graduated as a pharmacist in Vietnam and worked for one year as a lecturer before pursuing doctoral study. He is interested in developing novel nanocarrier systems from natural products for drug delivery, especially in cancer area.
Hydrogen Production from Methanol Photolysis in Aqueous Solution Using Bimetallic Zinc Indium Sulfide Catalysts

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Abstract

Water or light alcohols decompositions through the photochemical reaction for hydrogen production are advantageous in that the reaction can proceed using only the sunlight without any additional energy. However, there is required at least 0.7-1.2 eV of voltage to photolysis of water or light alcohols. Therefore, semiconductor materials such as TiO₂ containing a band-gap exceeding this voltage and redox potential ranges for hydrogen and oxygen are need. In recent years, many researchers attention shifted to some semiconductors absorbing visible light, and more attention was focused on semiconductors with sulfur counter ions from oxygen.

This study focuses on hydrogen production by methanol photolysis using zinc indium sulfide. The X-ray diffraction peaks which assigned to hexagonal ZnInS₂₅ structure are shown in the synthesized ZnInS₂₅ and ZnInS₄ samples, however, a perfect hexagonal ZnInS₂₅ structure is observed when In of twice amount against Zn is coexisted. The results of ultra-violet absorption and X-ray photoelectron spectroscopy-edge analysis confirm that the band-gaps of ZnInSₓS₁₋ₓ particles decrease depend on the coexistence of In. However, the photocurrent which related to the life time of excited electrons is no correlation with the Zn/In molar ratio, and it is higher in ZnInS₂₅ particle with a ratio of Zn:In=1:1. Consequently, the hydrogen production by methanol decomposition in aqueous solution is the best in ZnInS₂₅ catalyst. This result gives ultimately relevant that the recombination between electrons and holes during photocatalytic methanol decomposition is suppressed over bimetallic ZnInS₂₅ than pure single metallic ZnS.

Biography

Since 2006, Dr. Kang is working as a Professor at department of chemistry of Yeungnam University in Korea. Her research interests are in the area of renewable energy, particularly focused on hydrogen production from photo- and thermal-catalysis using various nanomaterials. So far, she has published more than 250 papers for the energy and environment-related materials in peer-reviewed journals. She was awarded numerous academic divisions including the gyeongbuk science and technology best award in 2015. She served as a member of the editorial board of the JIEC from 2008 to 2014. Currently, she acts as a financial director in the KSIEC.

Ion Beam Sputter Deposition Technique for Direct Growth of Ge Quantum Dots on a Graphene/SiO₂/Si Substrate

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²Institute of Optoelectronic Information Material, School of Materials Science and Engineering, Yunnan University, China

Abstract

The quantum dots (QDs)/graphene hybrid structure shows excellent photoreponse abilities in photodefectivity devices due to the unique QDs quantum confinement and the ultrahigh carrier mobility of graphene. Thus, this project invented the ion beam sputtering deposition technique (IBSD) to realize the directly growth of Ge quantum dots (QDs) on single-layer graphene on a SiO₂/Si substrate.

The morphology results illustrate that the Ge QDs size and morphology on graphene can be modulated via tuning the Ge coverage by IBSD technique. The results also indicate that increasing the sputtering time of Ge, the density of Ge dots increased, but the sizes (both diameter and height) of Ge dots tend to decrease. All morphology evolution route of Ge islands agrees well with the Zinsmeister theory. Secondly, the existence of interaction like doping effects at the interface of Ge QDs with graphene has been demonstrated. The strength of the interaction can be enhanced remarkably by reducing the Ge coverage in a certain scope, which indicates that the interaction can be modulated via controlling the coverage of Ge. The charge transfer behaviour at the interface of Ge/graphene has been demonstrated also. Comparing with traditional methods for Ge dots grown on Si substrate, the IBSD treatment changes the positions of corresponding photoluminescence (PL) peaks of Ge QDs/ graphene hybrid structure undergo a large red-shift, which was attributed to the lack of atomic intermixing and the existence of surface states in this hybrid material. According to the first principle calculation, the Ge growth on the graphene follows the Volmer– Weber mode instead of the traditional Ge QDs/Si system Stranski–Krastanow mode. The theoretical study also suggests that decreasing the Ge coverage enhances the interaction between Ge and graphene layer, which highly agree with the experimental results.

The final products were applied in a FET photodetectors, the device demonstrates the responsivity of 4.3 AW⁻¹ at 808nm infrared light irradiation and relatively large values (0.92) of β in absolute. The optoelectronic features indicate that the device using IBSD fabricated Ge QDs/graphene improves the efficiency
of carrier transfer and overcome the limit of ligand barrier at the interface of Ge/graphene. This project supplies a new technique for fabricating hybrid nanostructure QDs/graphene for novel optoelectronic devices application.

**Charge Transport, Interfacial Interactions and Synergistic Mechanism in BiNbO$_4$/MWO$_4$ (M = Zn and Cd) Heterostructures for Hydrogen Production: Insights from a DFT+U Study**

Francis Opoku$^1$, Krishna Kuben Govender$^2$, Cornelia Gertina Catharina Elizabeth van Sittert$^1$ and Penny Poomani Govender$^{1*}$

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$^*$Research Focus Area for Chemical Resource Beneficiation: Laboratory of Applied Molecular Modelling, North-West University, Potchefstroom, South Africa

**Abstract**

In the 21st century, the growing demand of global energy is one of the key challenges. The photocatalytic generation of hydrogen has attracted extensive attention to discuss the increasing global demand for sustainable and clean energy. However, hydrogen evolution reaction normally uses the economically expensive rare noble metals and the process remains a challenge. Herein, low-cost BiNbO$_4$/MWO$_4$(010) heterostructures are studied for the first time to check their suitability towards photocatalytic hydrogen production. A theoretical study with the aid of density functional theory (DFT) is used to investigate the synergistic effect, ionisation energy, electron affinity, charge transfer, electronic properties and the underlying mechanism for hydrogen generation of BiNbO$_4$/MWO$_4$(010) heterostructures. The experimental band gaps of bulk ZnWO$_4$, CdWO$_4$ and BiNbO$_4$ are well reproduced by the DFT+U method. The calculated band edge position shows a type-II staggered band alignment and the charge transfer between BiNbO$_4$ and MWO$_4$ monolayers results in a large interfacial built-in potential, which will favour the separation of charge carriers in the heterostructures. The effective mass of the photoinduced holes is higher compared to the electrons, making the heterostructures useful in hydrogen production. The BiNbO$_4$/MWO$_4$(010) heterostructures are more suitable for photocatalytic hydrogen production due to its strong reducing power relative to the H$_2$/H$_2$O potential. This study sheds insight on the less known BiNbO$_4$/ZnWO$_4$(010) heterostructures and the fully explored electronic and optical properties will pave way for future photocatalytic water splitting applications.

**Biography**

Dr. Penny Poomani Govender is an Associate Professor in the Department of Applied Chemistry, University of Johannesburg. Professor Govender received her PhD in 2013 at the University of Potchefstroom, South Africa. She has extensive experience in academia and is currently the Molecular Modelling Group leader and Head of Department, Applied Chemistry. Her research areas include bioinorganic, computational chemistry, numerical modelling, quantum chemistry and material science.

**The Magnetic and Electrocatalytic Properties for NixPt$_{1-x}$ Nanoalloys**

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**Abstract**

We have synthesized bimetallic NiPt$_x$ nanoalloys via a simple one-pot wet chemical method. They are sub-7 nm monodispersed single-crystal with the morphology of truncated octahedrons in the alloying state of disordered atomic arrangements. The effective magnetic moments exhibit two unusual properties. Firstly, an anomalous temperature dependency is observed, increasing from approximately 0.9 µB/atom at 15 K to 1.9 µB/atom at 300 K. Secondly, the magnitude of the average effective moment for the Ni atoms increases by a factor of more than three compared with bulk counterpart at room temperature. To understand these intriguing properties, we have carried out experiments by X-ray absorption near-edge spectroscopy (XANES) of the L3 edge for Pt and numerical calculations by density functional theory. The observed novel enhancement in magnetism and its anomalous temperature dependency are attributable to the electron transfer arising from the thermal-activation effects. The electron transfer might play important roles in the material functionalities not only for magnetic but also for electrocatalytic properties. To investigate the electrocatalytic properties, we have also synthesized Ni$_x$Pt$_{1-x}$ nanoalloys with controllable shape, size and compositions. Their electrocatalytic properties for the oxidation of methanol are apparently better than that the commercial Pt/C catalyst. This makes the Ni$_x$Pt$_{1-x}$ nanoalloys potential candidates as fuel cell catalysts.

**Biography**

Dr. Aixian Shan obtained her PhD in 2015 from Beihang University, and then she went to the department of physics of Peking University as a postdoc. Since October 2017, she is a lecturer in University of Science and Technology Beijing. Her main research interests focus on the bimetal magnetic nanomaterials.
Preparation of Ge Quantum Dots on Graphene/SiO$_2$/Si Substrates by Sputtering Deposition

Anran Chen$^{1,2}$, Jin Zhang$^{1,2}$ and Yu Yang$^{1,2}$

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$^2$Institute of Optoelectronic Information Material, School of Materials Science and Engineering, Yunnan University, China

Abstract

Graphene-based hybrid materials combined with nanometer materials has gained a great research interests due to its novel promising applications. Here, we fabricate a composite of Ge Quantum dots (QDs) grown on graphene/SiO$_2$/Si substrate by self-assembled ion beam sputtering deposition (IBSD) technique with growth interrupt. All the samples were grown under 500 oC and the interrupt time was all set as 10 minutes with different deposition time. The evolution behavior and the doping effect were investigated by atomic force microscope (AFM) and Raman spectra. The size and density of Ge QDs increase first and then decrease with the increase of deposition time. When deposition time is 180 s, the density of Ge QDs can reach to 109/cm$^2$, and its morphology and size are the most uniform. At the same time, Red shift of G peak in Raman spectra indicates charge doping effect between Ge and graphene. Our research provides preliminary study for preparation of Ge QDs/graphene composites and use for optoelectronic devices to improve photoelectric properties.

Synthesis of Molybdenum Sulphide Nanostructures for the Treatment of Pollutants in Water

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Abstract

Water pollution is a major hazard for humankind; the subsequent effect is the scarcity of clean drinking water. These effects are experienced both in South Africa and in the world at large, thus the demand for clean drinking water has posed a challenge for researchers. The commonly found pollutants in water are the dyes Methyl Blue (MB) and Rhodamine (RhB) as well as the heavy metals, such as Chromium (VI). These are found to be the major contributors to pollution in water. The aim of this research is to fabricate nanostructured compounds for the removal of these dyes and heavy metals from water. In this regard, molybdenum sulphide and its nanostructure composites are synthesized to evaluate its photocatalytic properties for optoelectronic devices to improve photoelectric properties.

Abstract

Stable and high-surface-area zirconia oxide nanoparticles have been synthesised by means of the hydrothermal method. The BET results show a high surface area of 543 m$^2$/g was obtained in the hydrothermal process, having a high porosity in nanometre range. The hydrothermal method was operated at 120°C, under autoclave with a Teflon liner at ambient pressure for 48 hours. High resolution Scanning Electron Microscopy (HRSEM) shows the different morphologies of zirconia nanoparticles, which could be categorised as one-dimensional (1D) and zero-dimensional (0D), as it had a high crystalite orientation, which was also confirmed by the X-ray diffraction (XRD). The mixture of two types of cubic phase in one sample was obtained from XRD and confirmed by the zirconia nanostructure, which shows the stable phase of fluorite, which has full cubic symmetry (Fm-3m) and also an Arkelite zirconia nanostructure that shows the stable phase of fluorite, which has full cubic symmetry (Fm-3m). The XRD results also shows the different structure orientations of face-centred cubic (FCC) and body-centred cubic (BCC) in one sample.
Biography

Ms. Sigwadi is a Lecturer in the Department of Civil and Chemical Engineering, College of Science, Engineering and Technology (CSET), University of South Africa (UNISA). She is doing research in the area of Nano-composite membrane for fuel cell application. She has formerly held positions as Metallurgist at the SGS, under Hydrometallurgical department, Mintek as Tech-trainee (In-service training) under Mineral Processing.

Bonding Strength of Vertically Aligned CNTs Grown on Cu Substrates: Effect of Buffer Layer

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2Air Force Research Laboratory (AFRL), WPAFB, OH, USA

Abstract

Direct growth of vertical aligned carbon nanotubes (VACNTs) onto bulk copper (Cu) substrates is a promising application of utilizing CNTs as novel thermal interface materials (TIMs) for electronics packaging. The previous study’s results demonstrated that buffer layer plays a key role in the growth of CNTs on Cu structure, and by introducing appropriate controlled buffer layers, VACNTs with good alignment and high quality can be synthesized reproducibly on Cu substrates via chemical vapor deposition. However, one of the more fundamental issues, effect of buffer layer on CNT/Cu interfacial property, especially on bonding attachment strength, is not fully understood. In the present study, the effect of buffer layer, including materials (Al2O3, SiO2 and Al), thickness and deposition method, on CNT/Cu interfacial bonding strength was investigated using a uniaxial force testing system. The interface morphology of CNT/Cu substrates after pull-off testing was characterized using SEM. The experimental results indicated that buffer layer not only dictated CNT/Cu substrate bonding strength, but also affects CNT/Cu fracture location and interface morphology. This quantitative evaluation and fundamental understanding of the effect of buffer layer on CNT/Cu substrate interface bonding strength would ultimately lead to development of well-bonded VACNT nanostructured devices for a real-life electronics applications.

Biography

Dr. Qiuhong Zhang, as a senior research scientist, works in University of Dayton Research Institute. Principal areas of research include: Synthesis, characterization and application of carbon nanotubes (CNTs); nanomaterials modification/ fabrication/ characterization; high temperature polymer synthesis, modification, analysis and applications; composite materials design, processing and properties testing, failure analysis. Currently, he is involved in a CNT research project that addresses basic scientific issues related in growing CNTs directly onto various alternative unconventional substrates to create a micro-carbon composite layer as a thermal interface materials (MIT) for thermal management applications.

Mechanical Properties of BN Nanosheets

Alexey Falin*, Ying Chen and Luhua Li
Deakin University, Australia

Abstract

With occurrence of graphene in 2004, two-dimensional (2D) materials have received significant interest from both academic and industrial communities. The non-carbon 2D nanosheets, such as boron nitride (BN), molybdenum disulfide (MoS2) also attracted a lot of attention due to their unique physical properties. In spite of extensive studies on the properties of 2D materials, the mechanical properties of various nanosheets and factors affecting them have not been studied experimentally. These properties have considerable importance not only from the fundamental point of view but also for future applications of nanosheets.

This work is a short review of the mechanical properties of BN nanosheets. It has been shown that Young’s modulus and fracture strength of monolayer (1L) BN are close to those of graphene. However, with the increasing number of the layers, the mechanical properties of graphene started to deteriorate up to 30% while BN nanosheets were as strong as 1L BN. According to the theoretical calculations, the interlayer interaction in BN increased with increasing in-plane strain and out-of-plane compression. The interlayer interaction in graphene at the same conditions decreased which led to the interlayer slide. Also, the mechanical properties of nanosheets were highly influenced by defects and temperature.

The study of mechanical properties of BN nanosheets showed their high potential to substitute graphene nanosheets in various application almost without sacrificing the required strength and stiffness. The high-temperature stability of BN nanosheets also can be used for composite production in the areas where graphene fillers may cause rapid oxidation at elevated temperatures.

Biography

Mr. Alexey Falin obtained his Bachelor and master’s degrees in engineering from MSUT STANKIN, Russia. Currently, he is completing his doctoral degree at Deakin University, Australia. His PhD study is mainly focused on the mechanical properties of BN nanosheets and factors affecting them.
Role of MoS$_2$ and WS$_2$ Monolayers on Photocatalytic Hydrogen Production and The Pollutant Degradation of Monoclinic BiVO$_4$: A First-principles Study

Francis Opoku$^1$, Krishna Kuben Govender$^2$, Cornelia Gertina Catharina Elizabeth van Sittert$^1$ and Penny Poomani Govender$^1$

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$^2$Council for Scientific and Industrial Research, Meraka Institute, Center for High Performance Computing, Cape Town, South Africa

Abstract

The global dependence on exhaustible fossil fuel resources has made the search for an alternative renewable and sustainable fuel more urgent. Fabricated $m$-BiVO$_4$-based heterostructures have shown improved photocatalytic activity for hydrogen evolution and pollutant degradation; however, a deeper understanding of the photocatalytic mechanism and the role of the monolayers is still lacking. In the present study, the roles of MoS$_2$ and WS$_2$ monolayers loaded onto an $m$-BiVO$_4$ surface for active photocatalytic hydrogen production and pollutant degradation are explored using first-principle studies. Herein, hybrid density functional calculations are used to investigate the charge transfer, electronic properties, photocatalytic activity and mechanism of the MS$_2$/m-BiVO$_4$(010) heterostructures. The results showed a narrow band gap, built-in potential and a type-II band alignment for the MS$_2$/m-BiVO$_4$(010) heterostructures compared to pure $m$-BiVO$_4$ which favour the separation and transfer of charge carriers and visible-light-driven activity. The MoS$_2$/m-BiVO$_4$ heterostructure showed a suitable band edge for hydrogen production and pollutant degradation compared to the WS$_2$/m-BiVO$_4$ heterostructure. This improvement is attributed to the role of the MoS$_2$ monolayer as an electron donor, the many reactive sites on the MoS$_2$ surface and the enhanced electron/hole pair separation of charge carriers at the MoS$_2$/m-BiVO$_4$(010) interface. Based on the analysis of the electronic properties, the MS$_2$/m-BiVO$_4$(010) heterostructures are shown to fit within the acceptable band gap and built-in potential range. The proposed theoretical design paved a way for the effective and large-scale fabrication of $m$-BiVO$_4$-based photocatalyst for solar energy conversion and environmental remediation applications.

Biography

Mr. Francis Opoku received his BSc. (Hons) Chemistry (2010) and M.Phil. Inorganic Chemistry (2014) degrees from the Kwame Nkrumah University of Science and Technology, Ghana. He is now pursuing a PhD degree in Chemistry under the supervision of Dr. Penny Poomani Govender, Dr. Krishna Kuben Govender and Dr. Cornelia Gertina Catharina Elizabeth van Sittert in the Department of Applied Chemistry, University of Johannesburg, South Africa. His research interests include the design of efficient semiconductor-based photocatalyst materials and their applications in water splitting as well as degradation of pollutants in wastewater/water resources.

Synthesis of Hollow-structured Metal Oxide Nanomaterials Formed from Nanostructured Metal Chalcogenide and their Application to Lithium Ion Battery

Gi Dae Park* and Yun Chan Kang

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Abstract

Hollow-structured nanomaterials with various morphologies, including nanospheres, nanoplates, and nanorods, have attracted significant attention because of their widespread applications in energy storage, catalysis, drug delivery, and gas sensors. In particular, when it is applied as anode materials for lithium-ion batteries, the large portion of void space in hollow-structured nanomaterials has been used to accommodate large volume changes during cycling, to provide short path length for lithium-ion transport. Hollow-structured nanospheres have been widely synthesized by various method with use of template. However, templates with 1D or 2D structured nanorod and nanoplate have not been well developed. Therefore, hollow-structured 1D and 2D nanomaterials were prepared via the Kirkendall effect without the use of templates. In recent, hollow structured 1D and 2D metal chalcogenides have been reported by using 1D and 2D structured metal oxide nanomaterials via the Kirkendall effect. However, metal chalcogenides materials rarely transformed into their metal oxide materials with unique morphology. In this study, the transformation of nanostructured metal sulfides and selenides into uniquely structured metal oxides via the Kirkendall effect is studied. Hollow SnO$_2$ nanoplate and hierarchically structured SnO$_2$ microspheres comprising hollow SnO$_2$ nanoplate are synthesized by spray pyrolysis applying a Kirkendall diffusion process. The uniquely structured metal oxide hollow nanoplates have extremely superior cycling and rate performances for Li-ion storage.

Biography

Mr. Gi Dae Park received his B.S. degree from the Department of Chemical Engineering, Konkuk University, Korea in 2014. He is currently a PhD candidate in the Department of Materials Science and Engineering, Korea University, South Korea. His research focuses on the development of nanostructured electrode materials for rechargeable batteries (lithium and sodium ion, lithium-sulfur batteries) and hydrogen evolution reaction using spray pyrolysis and spray drying processes.
Presence of Valence Sulfide and Oxide Impurities in MoS₂ and WS₂ can Dramatically Change their Hydrogen Evolution Reaction Activities

Naziah Mohamad Latiff¹, Lu Wang¹, Carmen C. Mayorga-Martinez¹, Zdeněk Sofer², Adrian C. Fisher³ and Martin Pumera¹

¹Nanyang Technological University, Singapore
²University of Chemistry and Technology Prague, Czech Republic
³University of Cambridge, UK

Abstract

Hydrogen evolution reaction (HER) is important for the clean production of hydrogen gas for a hydrogen economy. Currently, platinum is known to be the best HER electrocatalyst. However, its high price and limited abundance impedes the progress of this technology. This has motivated an intensive search for alternative HER electrocatalysts. Molybdenum disulfide (MoS₂) and tungsten disulfide (WS₂) are touted as promising future replacements of platinum in electrolyzers. However, there is significant discrepancy in the HER onset potentials of MoS₂ and WS₂ reported. In this paper, we show that the presence of their valence sulfide and oxide impurities namely MoS₃, MoO₂, MoO₃, WS₃, WO₂ and WO₃ can contribute to the HER performances of MoS₂ and WS₂.

Biography

Upon completing her degree in Chemistry and Biological Chemistry from Nanyang Technological University (NTU) in 2014, Ms. Naziah Mohamad Latiff joined Prof. Martin Pumera’s group as PhD student under the Cambridge Centre for Advanced Research and Education in Singapore (CARES) programme. That choice had sparked her interest in exploring toxicity and applications of layered materials in energy related fields. It has been an exciting research journey with many discoveries waiting to be unravelled.

PtTe₂ as a Safe Alternative Electro catalyst for Oxygen Reduction Reaction (ORR)

Nur Farhanah Binte Rosli¹, Carmen C. Mayorga-Martinez¹, Naziah M. Latiff¹, Nasuha Rohaizad¹, Zdeněk Sofer², Adrian C. Fisher³ and Martin Pumera¹

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Abstract

Oxygen reduction reaction (ORR) is an important reaction for fuel cells. Platinum on carbon (Pt/C) is a typical electrocatalyst for ORR in industrial applications. There is a constant search for a replacement for Pt/C with better ORR electrocatalytic performance but thus far, most materials show poorer electrocatalytic activity than Pt/C. Herein, we present electrocatalytical and cytotoxicity studies of platinum (Pt) dichalcogenides and we have found PtTe₂ to have similar electrocatalytic ORR performance to Pt/C but with significantly lower toxicity. Hence, PtTe₂ can be denoted as a safer alternative electrocatalyst for ORR. In summary, these studies can allow better understanding of electrocatalytic performance and toxicological profiles and of Pt dichalcogenides in comparison to Pt/C to aid future mass application and commercialisation in clean energy reactions such as ORR.

Biography

Ms. Nur Farhanah Binte Rosli is a year 2 PhD student in Nanyang Technological University (Singapore), her research interest is geared towards studying the toxic implications of new layered materials which has promising potential as electrocatalyst in clean energy applications. She hopes to extend the research further by studying methods of improving the safety of the material or venturing into possible applications of toxic materials.
The Influence of Spin Speed Effect on ZnO Seed Layers on ZnO Nanorods-based Perovskite Solar Cells

Wei-Shuo Li*, Yun-Hao Chen, and Huang-Chung Cheng
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Abstract

Perovskite solar cells have drawn significant attention due to the outstanding efficiency and low-cost fabrication process. In this study, ZnO nanorods is chosen as the electron transport layer (ETL) due to its 3D structure and low temperature process. While depositing perovskite layer, we used two-step coating method to improve the surface coverage and the uniformity of the perovskite layer. To further improve the performance of the solar cells, we tune the spin speed of the ZnO seed layer which can control the density of ZnO nanorods. The power conversion efficiency of 9.50 % is achieved with the spin speed of 4500 rpm.

Biography

Mr. Wei-Shuo Li, who majored in nano electronics and materials, received the B.S. degree in department of Communication Engineering from I-SHUO University, Taiwan, in 2013. He received the MS degree in department of Applied Material and Optoelectronic Engineering from National Nan University, Taiwan, in 2015. He is currently working toward the PhD degree in the Department of Electronics Engineering of National Chiao Tung University in Taiwan. His research is mainly on metal oxide based perovskite solar cells.

Synthesis and Application of a Sustainable N-doped TiO$_2$/CdS Nanohybrid Composite for Photocatalytic Degradation of 4-chlorophenol

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Abstract

Titanium dioxide (TiO$_2$), a semiconducting metal oxide, has gained much attention for its potential application as a photocatalyst over the past few decades. However, TiO$_2$ is characterized by a wide optical bandgap (E$_g$ ~3.2 eV) that requires UV irradiation, leading to limited visible solar light application [1]. Doping with nitrogen and combining with a narrow bandgap semiconductor such as CdS (E$_g$ ~2.48 eV) has the potential to resolve these issues [2]. CdS, however, undergoes photocorrosion with photogenerated holes. Hole scavengers, such as S$_2^-$ ions, may suppress this process. In this work, we propose an alternative approach involving the protection of CdS deposited on TiO$_2$ with a thin film of conducting polymer. Nitrogen-doped TiO$_2$ (N-TiO$_2$) nanostructures were synthesized on FTO glass using a sol-gel method. Sequentially, CdS nanoparticles were deposited via SILAR, and poly(1,8-diaminocarbazole) (PDACz) [3] was synthesized on their surface to form the full hybrid photocatalyst. The bandgap energy of the N-TiO$_2$/CdS/PDACz hybrid determined from UV-Vis reflectance spectra was 2.26 eV, close to that of CdS. The synthesized TiO$_2$ nanostructures, along with N-TiO$_2$, N-TiO$_2$/CdS and N-TiO$_2$/CdS/PDACz composites were applied to visible light photodegradation of 4-chlorophenol. The N-TiO$_2$/CdS system yielded the highest photocatalytic reaction rate (k = 0.00360 min$^{-1}$) compared to bare TiO$_2$ (k = 0.00140 min$^{-1}$). Despite this, significant photocorrosion of CdS was confirmed by UV-Vis reflectance spectra taken post-photocatalytic measurement. The N-TiO$_2$/CdS/PDACz hybrid showed a middle value of photocatalytic rate constant (k = 0.00201 min$^{-1}$) and dissolution of CdS was significantly inhibited by the presence of the polymer, making this system attractive for practical applications.

References:


Abstract

Comparative Study of H₂ Adsorption on Na Doped SiC and SiGe Monolayers

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²Instituto de Física, Universidad Nacional Autónoma de México, Ciudad de México, México

The silicon carbide monolayer (SiC-M) has recently attracted considerable attention due to its outstanding properties such as high mechanical strength, saturated carrier mobility, high thermal stability, and high thermal conductivity. Compared with graphene, SiC-M has a much higher chemical reactivity towards foreign adsorbates, rendering it a potential metal-free catalyst. The siligene monolayer (SiGe-M) is stable and free from imaginary frequency in the phonon spectrum. The Ge and Si atoms in SiGe-M exhibit different tendencies in binding with hydrogen atoms, making sublattice-selective hydrogenation and consequently electron spin-polarization possible. The SiC-M and SiGe-M with metal atoms have been recognized as promising materials for the storage of hydrogen. In the present study we report the molecular hydrogen adsorption in SiC-M and SiGe-M both doped with Na. The calculations have been performed density functional theory. For the SiC-M, the Na adsorption favors the “top” site, conversely, the SiGe-M favors the “hollow” site. The interaction of the Na-doped monolayers with molecular hydrogen suggests that each Na atom can bind up to four hydrogen molecules with average adsorption energy of 0.79 eV for the SiC-M, and of 0.25 eV for the SiGe-M. All these observations suggest that a large storage capacity can be obtained for the SiC-M and SiGe-M. Then, these materials can be considered for the storage of hydrogen.

Acknowledgment: This work was partially supported through the multidisciplinary projects 2016-1770 and 2016-1771, and the SIP-2017-0885 project. Likewise L.G.A. F.S. would like to thank the CONACYT and BEIFI-Instituto Politécnico Nacional for their scholarships.

Green Solar Cell

Dev R Udata
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Abstract

Solar cells convert sunlight into electrical energy, and they have a large role to play in boosting solar power generation globally. But the cost of solar power is still high and not everyone can afford it in many parts of the world. Currently, materials used to make solar cells are environmentally harmful and toxic to human beings. To overcome the above challenges, I have developed a type of solar cell that can convert a wide range of sunlight into usable electrical energy at very low cost and also with environmentally safe materials.

This green solar cell design and principle mimics the natural photosynthesis in plants and produces electricity through electron transfer. When the sunlight hits the conductive glass with the plant extract it absorbs the sunlight there. With the help of the carbon layered slide and electrolyte solution it will produce current.

I used numerous combinations of natural plant materials such as raspberry, blueberry, blackberry, grapes, spinach, henna, and cilantro to find out efficient natural material which can take up light and excite the electrons to produce electricity over the period of 15 days. The plant extract of spinach produced the most current out of all the natural plant extracts.

To further improve cost efficiency and better performance of solar cells in a greener way, I would like to explore more natural materials to substitute to Titanium Dioxide. Also, would like explore alternative natural materials like cuticle, plant wax etc. to replace anti reflective glass.
Biography

Mr. Dev R Udata is an enthusiastic independent research scholar. As he grew up in one of the greenest state of US, Oregon, he is always passionate about studying on producing green energy. His ultimate goal is to make every house hold should be able to make their own solar cells with green materials to overcome their energy needs. During this research investigation he has visited multiple labs at Oregon State University, Portland State University and Andhra University to discuss and conduct the research experiments.

Utilizing Quantum Key Distribution within Nanotechnology

Gretchen Farrow and Danny Barnes
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Abstract

New technologies are emerging yearly with every enhancement. With technology getting faster and smaller, security is needed at a much higher rate due to privacy issues. Nanoscience and nanotechnology are both the now and the future. Nanotechnology can be the vanguard of innovations for security. Often times, security has the lowest priority when implementing new ideas. This lack of thought could cause a host of vulnerabilities in the implementation, thus creating a negative stigma for the technology. Quantum Key Distribution is a method of using quantum states to establish a random secret key for encryption and is a subset of Quantum Computing. Quantum Key Distribution promises unconditional security in data communication and is currently being placed in commercial applications. Nanotechnology is evolving and creating the need to evolve Quantum Key Distribution. This research will utilize online quantum computer simulators to implement common Quantum Key Distribution protocols. Furthermore, this research will investigate the possibility of quantum computing systems being transferred to nano-science/nanotechnology. Also, the research will include how quantum computing can enhance the security of nanotechnologies without hindering the capabilities.

Acknowledgment: This research is supported by grant from NSF HRD-1238838.

Characterization of CuS@CuInS₂:In₃S₃ Particles for Effective Hydrogen Production from Water/ Methanol Photo Spitting

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Abstract

Since industrialization, humanity faces environmental pollution and energy depletion, and hydrogen energy is attracting attention as a next-generation clean energy resource that can solve this problem. The most environmentally friendly and economical way to produce hydrogen is through the use of photocatalysts, and it is essential to develop highly efficient photocatalysts. Titanium dioxide (TiO₂), which is a typical photocatalyst, has various advantages such as low cost, high oxidation potential and non-toxicity, but has little optical activity in the visible region and is difficult to commercialize due to high recombination rate of photo-generated charge carriers. Accordingly, a sulfide catalyst, which is effective for charge separation and excellent in response in the visible light region, has recently been attracting attention.

In this study, we tried to produce hydrogen from water/methanol photo-splitting using a core-shell structure catalyst. In particular, we proposed a CuS@CuInS₂:In₃S₃ catalyst with an interface between the core and the shell by controlling the structure and shape of the catalyst, this interface can act as a site where the catalyst can adsorb more reactants, thereby increasing the activity of the catalyst. The performance of CuS@CuInS₂:In₃S₃ catalyst containing sulfur vacancies due to structural defects was significantly higher than that of pure CuS and In₃S₃. As a result of H₂O-TPD, it was found that CuS@CuInS₂:In₃S₃ catalyst having interface can adsorb more reactants. In addition, PL and photocurrent measurements showed that the recombination between the photo-generated electrons and hole pairs of the CuS@CuInS₂:In₃S₃ catalyst was inhibited.

Biography

Ms. Jeong Yeon Do entered the Department of Chemistry at Yeungnam University, South Korea in 2010 and obtained her master's degree in 2017. She is currently working towards a PhD degree in Prof. Misook Kang's group, department of Chemistry, Yeungnam University. Current research interests include nanocrystalline materials, Photocatalysts, materials for solar energy conversion and fuel generation, CO₂ capture and conversion. She has published several papers and attended various domestic and international conferences. She has been consistently presenting her research at the institute and has won three best papers and an excellent poster presentation.
Revolutionizing Enhanced Oil Recovery: Prospects of Magnetized Water in Surfactant and Polymer Flooding

Marwan Y. Rezk*, Soha E. Anwar and Nageh K. Allam
Energy Materials Laboratory (EML), American University in Cairo (AUC), Egypt

Abstract

Polymers and surfactants are the most widely used chemical flooding methods to enhance oil recovery. However, the high cost of chemicals is a growing barrier as the oil prices are decreasing. Nowadays, water can be magnetized at low cost to alter some of its properties including surface tension, pH, viscosity, and scale formation. The use of magnetized water under such altered properties would enhance the oil recovery through chemical enhanced oil recovery. In the work done, water has been magnetized by passing it through a high magnetic field (MF). Magnetized water has been characterized to compare it to distilled/deionized water as a reference by UV-Vis and Raman spectroscopy. Subsequent to magnetization, guar gum polymer has been dissolved in magnetized water and compared to another batch that is dissolved in the reference water. The thermal stability of guar gum polymer was evaluated by thermogravimetric (TGA) analysis. On the other hand, magnetized water has been used versus oil to evaluate the interfacial tension reduction in comparison with the normal case in the presence of surfactant. The results have shown that the use of magnetized water can enhance the polymer's stability and reduce interfacial tension. The results promote magnetized water to be a good candidate for cheaper enhanced oil recovery.

Effects of Milling Parameters on the Mechanical Properties of Multiwalled Carbon Nanotubes (MWCNTs) Reinforced Ti64 Nanocomposite Fabricated via Spark Plasma Sintering (SPS)

Oluwaniyi Ajiteru¹, Thato Thshephe¹, Moses Okoro² and Peter Olubambi²
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²Centre for Nanoengineering and Tribocorrosion, South Africa

Abstract

The discrete attributes of MWCNTs as related to their thermal, mechanical, and electrical behaviors has made them a suitable reinforcement for use in producing metal matrix composites (MMCs). The metal matrices can be Copper (Cu), Titanium (Ti), Magnesium (Mg), Aluminium (Al) and/or their alloys. Extensive research have shown that the produced composites possesses outstanding properties such as high corrosion resistance, high modulus of elasticity, high specific weight and strength which has made them to be employed in different applications for example in aerospace, marine, biomedical, petrochemical, and power amongst others. However, in the course of dispersing MWCNTs in metal matrices, it has been reported that several problems are being encountered some of which includes agglomeration of MWCNTs, breakage in the sp² structure of MWCNTs and formation of unwanted intermetallic compounds. Consequently, this adversely affects the properties of the nanocomposites. In this work, the synthesis technique used in dispersing MWCNTs of varying concentration (0.5 wt%, 1.0 wt% and 1.5 wt%) in Ti64 is high energy ball mill (HEBM). A batch (i, ii and iii) was formed for the dispersion using different milling parameters e.g. impact energy, ball-to-powder ratio (BPR), ball sizes, milling speed and time. The admixed powders were then fabricated via SPS with a pre-compaction force of 10kN and at constant heating rate of 100 °C/min. The applied pressure and holding time utilized during the operation was 50 MPa and 5 min respectively in vacuum. The sintering temperature was varied between the range of 850 and 1000°C. After investigation, it was observed that the mechanical properties of the produced nanocomposite depend greatly on the milling parameters.

Biography

Mr. Oluwaniyi Ajiteru is a 25 years old enthusiastic researcher. He studied Materials Engineering at the prestigious Obafemi Awolowo University, Nigeria where he finished among the top 1% of his class and won the award for the student with the highest mark in Production Metallurgy. He is currently a scholar under Global Excellence Stature Scholarship at the University of Johannesburg, South Africa to pursue a Master's degree in Metallurgy. In addition, he is also a Project Management Professional, PMP.
The Influence of Oxygen Plasma Treatment on the Supercapacitors Characteristics of Sprayed-carbon Nanotube Thin Films

Shuo-Yang Weng*, Yi-Chieh Li and Huang-Chung Cheng
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Abstract

In this study, our goal is to fabricate a high-performance electrode based on CNTs for supercapacitors. We are using the ultrasonic spraying methods to fabricate the carbon nanotube-based supercapacitors. In order to increase the performance, the oxygen-containing functional groups acted as the redox reactions sites for extra capacitance. Hence, the increased amounts of these functional groups by increasing plasma treated time resulted in the improvement of the $C'_{sp}$. In the end, an optimal condition was found at treatment time for 60s because the degree of oxygen-containing functional groups could be increased dramatically from 26.88% to 41.32% without over-damage on CNTs, resulting in the $C'_{sp}$ raising from 23.7 F/g to 49.3 F/g. The improvement ratio of $C'_{sp}$ was 2.1x in 1M Na$_2$SO$_4$ solution at a scan rate of 100 mV/s.

Biography

Mr. Shuo-Yang Weng, who majored in nano electronics and materials and received the B.S. degree from the Undergraduate Honors Programs of Nano Science and Engineering, National Chiao Tung University, Taiwan, in 2016. He is currently working toward the Master degree in the Department of Electronics Engineering of National Chiao Tung University in Taiwan. His research is mainly on carbon nanotube-based supercapacitors.

The Benzodithiophene-based Small Molecule for Ternary Organic Solar Cells with Non-fullerene Acceptors

Yi-Ju Lu*, Yu-Che Lin, Hsiu-Cheng Chen and Kung-Hwa Wei
Department of Materials Science and Engineering, National Chiao Tung University, Taiwan

Abstract

Non-fullerene materials are new promising candidates for future application of organic solar cells. However, their low short-circuit current density ($J_{sc}$) limit the performance of power conversion efficiency (PCE). In this study, we replaced PC$_{71}$BM with non-fullerene materials (m-ITIC-OR) and introduced a simple concept of ternary blend system for organic solar cells. Small molecules (SM-4OMe) with complementary absorption spectrum were blended into the binary system (PTB7-TH:m-ITIC-OR) to successfully broaden the range of absorption spectrum and improve the $J_{sc}$ of the non-fullerene ternary organic solar cell device. The molecule structure of SM-4OMe is composed of a benzodithiophene (BDT) unit as the donor, which also in PTB7-TH leading to good morphology compatibility by blending PTB7-TH, SM-4OMe and m-ITIC-OR together to form desired packing orientation in the ternary blend films. Furthermore, fluorescence resonance energy transfer (FRET) effect is found between PTB7-TH and SM-4OMe, generating more carriers to diffuse to the interface so that the higher short-circuit current is collected and eventually the device was optimized. The best PCE of a device incorporating a ternary blend of PTB7-TH:SM-4OMe:m-ITIC-OR (0.9:0.1:1.5, w/w/w) as the active layer in chlorobenzene, was 8.61%. It is approximate 20% higher than the value 7.26% of the corresponding device incorporating binary blend of PTB7-TH:m-ITIC-OR (1:1.5, w/w). The ternary blend films with only a few amount of SM-4OMe ensuring the desired packing orientation for a better transportation of carriers. The result shows that the PCE for the single junction organic photovoltaics could be successfully enhanced by a facile procedure of ternary solar cells.
Tunable High Responsivity of Graphene-Si Field Effect Photodetector

Siapwan Srisonphan
Department of Electrical Engineering and ELeclots and Semiconductor Applications (ELSA) Laboratory, Faculty of Engineering, Kasetsart University, Bangkok, Thailand

Abstract

Carrier transport in two dimensional systems such as graphene and well-defined nanostructures can provide exceptional electronic characteristics. Due to the unique and remarkable physical properties, such as a high transparency to light and excellent carrier mobility, graphene has received considerable attention for future nanoelectronic and photonic applications. However, graphene-based photodetectors demonstrate low responsivity ($\sim 6-10 \text{ mA/W}$) in the visible wavelength due to their weak optical absorption ($\sim 2.3\%$) and extremely short carrier lifetime. Herein, we present a photodetector based on graphene/SiO$_2$/Si (GrOS) field effect structure with an embedded nanoscale trench, allowing two devices (graphene/Si heterojunction and nanoscale vacuum based GrOS capacitor) combined at the same platform. The responsivity of the hybrid platforms based on p-Si and n-Si is fully and finely tunable up to 1.2 and 0.45 A/W, respectively, which correspond to external (internal) quantum efficiencies of 235% (350%) and 88% (132%), respectively. The multiple exciton generations (MEG) in the proposed device originate from the impact ionization initiated by photo-excited carrier injection into the self-induced localized electric field in Si. The primary mechanism of photoelectron transport is governed by ballistic electrons transport, which is emitted from the Si edge to graphene via a nanoscale air gap. We present both electrostatic current-voltage ($I-V$) characteristic and the transient response of hybrid photodetector. The integrated photodetector is architecturally Si-compatible and thus highly promising for ultrafast, low-power, and tunable responsivity for photonic applications.

Biography

Dr. S. Srisonphan obtained his PhD in Electrical Engineering from University of Pittsburgh, USA in 2013. Since July 2013, he has been a lecturer at the Kasetsart University, Thailand. His main research interests are modeling and simulation, self-assembly and nanochannel device, and dielectric and insulation including plasma technology.

A Flexible Pressure Sensor with Double-layered Structure

Jinyoung Lee*, Dongkyun Shin, Gieun Kim and Jongwoon Park
Korea University of Technology and Education, South Korea

Abstract

The pressure sensor is used in various fields such as touch interface, health monitoring, artificial skin, etc. It should maintain the original function even in the bending or stretching state. In the case of devices that sense pressure through physical deformation by pressure, they can be easily damaged by soft contact. Therefore, it is necessary to maintain constant response characteristics to the change of the surrounding environment or repeated contact. Many studies have been made on capacitive pressure sensors since they have high sensitivity and stability. However, the production process of capacitive sensors is complicated and the cost is high. In contrast, the resistive pressure sensors are simple to fabricate and more cost effective. Even so, resistive pressure sensors show very poor sensitivity in the low pressure.

In this study, we have fabricated flexible resistive pressure sensors with nanometer-thick layers by spray coating using AgNWs and analyzed the electrical response. AgNWs are spray coated directly onto uncured polydimethylsiloxane (PDMS) such that AgNWs penetrate into the uncured PDMS, enhancing the adhesion properties of AgNWs. However, the AgNW sensor shows unstable electric response and low pressure sensitivity. Because of those issues, the conductive polymer, poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate) (PEDOT:PSS), was coated on AgNWs to enhance the sensitivity and obtain stable electrical response. Such a double-layered sensor ensures a stable electric response because the PEDOT:PSS layer tellingly suppresses the protrusion of AgNWs from PDMS when pressure is applied.

Biography

Mr. Jinyoung Lee is a doctoral student at Korea University of technology and education. He conducted a study on stretchable electrodes when he studied for a master’s degree. He has studied cross-link organic material, roll-to-roll system for OLED panel during a doctoral course. He is currently studying on pressure sensors.
Tunable Work Function of Metal Gate Stack by In-situ Atomic Layer Lamellar Doping of AlN in TiN

Kuei-Wen Huang, Po-Hsien Cheng, Yu-Shu Lin, Chin-I Wang and Miin-Jang Chen
Department of Materials Science and Engineering, National Taiwan University, Taipei, Taiwan

Abstract

The work function of the Pt/Ti\textsubscript{1-x}Al\textsubscript{x}N\textsubscript{y} bilayer metal gate electrode on the gate oxide was tailored by introducing a thin AlN-doped TiN interlayer using the in-situ atomic layer lamellar doping technique. With the increase of the nominal AlN lamellar doping percentage (\(DP_{\text{AlN}}\)) from 0% to 6.25%, the work function of the bilayer metal gate decreases from 4.49 eV and reaches a minimum of 4.19 eV. Then the work function increases to 4.59 eV as the \(DP_{\text{AlN}}\) increases to 50%. The Auger electron spectroscopy (AES) analysis reveals the linear dependence between the Al/(Ti+Al) concentration ratio and \(DP_{\text{AlN}}\), indicating the capability of precise and digital control of the doping concentration and work function by the in-situ atomic layer lamellar doping technique. A low work function of 4.19 eV was achieved in the Pt/Ti\textsubscript{1-x}Al\textsubscript{x}N\textsubscript{y} bilayer metal gate, which is appropriate as the low-work-function metal gate for n-MOSFET devices.

Biography

Mr. Kuei-Wen Huang received the B. S. in materials science and engineering from National Taiwan University, Taipei, Taiwan, in 2015. He is currently working toward the PhD degree in the graduate institute of materials science and engineering, National Taiwan University. His research interests include atomic layer deposition (ALD), high-K/metal gate, and electron/ion beam lithography for silicon-based process integration.

Patterning of Metallic Nanolines Based on Electron Beam Induced Deposition Accompanied with Selective Growth of Atomic Layer Deposition

Kuei-Wen Huang*, Po-Shuan Yang and Miin-Jang Chen
Department of Materials Science and Engineering, National Taiwan University, Taipei, Taiwan

Abstract

Patterning of nanoscale metallic structures is realized by the combination of electron beam induced deposition (EBID) and atomic layer deposition (ALD) techniques. Selective growth of the desired metallic material (Pt) on the seeding layer prepared by EBID is achieved by optimizing the ALD conditions. The electron dose required for the deposition of seeding layer is much lower, and the material quality of Pt nanolines is much improved by the selective ALD growth, as compared with those of the direct EBID. The method based on the EBID patterning and ALD selective growth provides an alternative way to improve the spatial resolution and material quality of the electron beam lithography.

Biography

Mr. Kuei-Wen Huang received the B. S. in materials science and engineering from National Taiwan University, Taipei, Taiwan, in 2015. He is currently working toward the PhD degree in the graduate institute of materials science and engineering, National Taiwan University. His research interests include atomic layer deposition (ALD), high-K/metal gate, and electron/ion beam lithography for silicon-based process integration.
Study on Organic Thin Film Coating for AMOLED Panel using Diluted Solution

Dongkyun Shin*, Jinyoung Lee, Gieun Kim and Jongwoon Park
Korea University of Technology and Education, Korea

Abstract

On the surface of the AMOLED, an insulator material such as a photo-resistor forms a bank for pixel defining. A capillary phenomenon occurs between ink and bank due to surface tension and adhesion force. It brings a concave thickness profile in which the pixel’s center thickness is thin and the rim is thick. And degradation of emission uniformity within pixels.

With an attempt to suppress concave profile, we have performed slot-die coating with different concentration of aqueous PEDOT:PSS solution. In this work, we found that the dilution of solution affect to thickness uniformity by decreased film thickness of near bank edge. PEDOT:PSS was diluted with different ratio of DI water (de-ionized water) at 10:0, 7:3, 5:5, 3:7, respectively (PEDOT : water). As a result, thickness uniformity was measured as 51% using un-diluted PEDOT:PSS. As the concentration of PEDOT decreased, the in-pixel thickness uniformity gradually increased. The thickness uniformity of the 7:3 dilution and the 5:5 dilution was 67% and 69%, respectively. In the case of 3:7 diluted solution, the thickness uniformity was measured as 84%, which is the best result. When the solution is diluted, the drying time becomes relatively longer and the amount of the movable solution becomes larger. This micro fluid improves the thickness uniformity while reducing the thickness of the edge. In addition, the thickness uniformity can be controlled by the drying method. It was confirmed that the light emission of the AMOLED device is affected by the uniformity of the thickness with diluted solution.

Biography

Mr. Dongkyun Shin is majoring in electronics and he started studying OLED from his master’s degree. Particularly, he concentrated on the field of solution process including slot die coater. He is currently studying the coating on the pixel pattern substrate and the multilayer coating of three layers or more through the doctoral course. In addition, he is also interested in finding out the problems in the experiments and finding improvement methods by fluid flow simulation.

Investigating the Optical Properties of Boron Nitride Nanotubes

Justin Anderson* and Lyons
Hampton University, Hampton, VA, USA

Abstract

This research paper presents developments in the investigation of the optical properties of boron nitride nanotubes such as emission wavelengths and absorption peak. The experiment is designed to perform ultraviolet and Raman spectroscopy on an approximate isolated nanoliter of boron nitride nanotubes in an optical fiber sample tube. Over the course of the experiment, a simple, low-cost technique to isolate nanoliter samples of Boron Nitride nanotubes was created. Boron nitride nanotubes have already been investigated for their profound properties of high thermal conductivity, excellent mechanical strength, the emission of UV light and a tunable band gap that is stable regardless of small variations in diameter. The predetermined properties of boron nitride nanotubes and this experiment extend its field of applications.

Biography

Mr. Justin Anderson is senior Computer Information Systems Major, Nanoscience Minor. He is from Washington D.C. and attend Hampton University. His research interests are bio-inspired algorithms and nanomaterials.
Graphene Quantum Sheets with Multiband Emission: Unravelling the Molecular Origin of Graphene Quantum Dots

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Energy Materials Laboratory (EML), School of Sciences and Engineering, The American University in Cairo, New Cairo, Egypt

Abstract

The dependence of the fluorescence in graphene quantum dots on the excitation wavelength has been the focus of several studies recently. While some studies attributed their multichromophoric behavior to core and surface states, others related it to the differently-sized nanodomains of sp2-hybridized carbon in an amorphous matrix. Herein, colloidal graphene quantum sheets and nanoflakes were directly synthesized via low temperature catalytic chemical vapor deposition (CVD). These graphene nanostructures were found to exhibit well-resolved multi-emission bands in the visible region. Based on the X-ray photoelectron, FT-IR and Raman spectroscopies as well as density functional theory (DFT) calculations, the role of polycyclic aromatic hydrocarbons (PAHs) was identified as the building blocks of graphene quantum dots.

Biography

Ms. Radwa Adel Shedeed is a graduate student at The American University in Cairo, Physics Major. She is working on graphene quantum dots and has published a paper in J. Phys. Chem. C. She, also, participated by a poster in MRS (Materials Research society) Spring Meeting & Exhibit, Phoenix, AZ, USA, Spring 2016. Now, she spends the summer at Laser Dynamics Lab (LDL), Georgia Institute of Technology, Atlanta, GA, USA, to finalize her research thesis.

Flexible and Sensitive Humidity Sensor System based on Hydrophilic PTFE Thin Film for Real Time Detection

Uihyun Jung*, Heekyeong Park, Seok Hwan Jeong, Muhammad Naqi, Na Liu and Sunkook Kim
School of Advanced Materials Science & Engineering, Sungkyunkwan University, Suwon, South Korea

Abstract

Recently, flexible electronics have attracted much more interests in versatile areas of fundamental sciences and industries. Flexibility is essential in many applications, where the sensor must be curved or subjected to repeated bends. Considering the flexible humidity sensor, it has multivariate impact on humans as well as on environment. Focusing on plant science, the relative humidity (RH) is most important for continuous monitoring of plant disorders during various process like photosynthesis, water absorbing. For this application, the sensor should have higher sensitivity, flexibility, and stability.

Figure 1. Capacitance variation of PTFE sensor with respect to RH.

In this work, we report on humidity sensing capability of flexible polytetrafluoroethylene (PTFE) sensor and the application to smart monitoring system. First, we presented a capacitive humidity sensor fabricated by using nanoporous PTFE substrate as sensing and frame material. The flexible humidity sensor exhibits a linear behavior in the range of 50 to 90 RH (%), shown in Figure 1. Flexible nature of PTFE film gives our sensor robust tolerance against mechanical stress, which was reinforced by adapting co-planar interdigitated electrodes. As a result, it shows no apparent degradation of device performance after up to 3,000 times of cyclic upward bending. Second, we demonstrated a real-time wireless monitoring system based on flexible PTFE humidity sensor as data acquisition component. Bluetooth module connected by sensor enable wireless communication to smartphone. We demonstrated the functionality of our sensing system by attaching the flexible humidity sensor to a cylindrical surface and collecting data in real time.
Abstract

Superparamagnetic of iron oxide nanoparticles (SPIONs) may be an alternative for replacing gadolinium-based contrast agents (GBCAs), since they could cause nephrogenic fibrosis in patients with kidney problems according to FDA. Our research group is focused on studies for synthetize SPIONS coated by biomaterials and investigate features as negative CAs for helping to the detection of the early breast cancer. Then, we compared the SPIONS coated by polyethylene glycol (PEG) – (A01 and A02) with a type of melanin, named pheomelanin (C01). The infrared of A01 and A02 identified chemical group of Fe₃O₄, respectively (595.2 cm⁻¹ and 575.3 cm⁻¹) and peaks characteristic of PEG (-C-O-C at 1135 cm⁻¹ (A01) and 1124 cm⁻¹ (A02), CH₃ at 1400.5 cm⁻¹ (A01 e A02), also O-H at 3399.9 cm⁻¹ (A01) and at 3434.8 cm⁻¹ (A02)). Besides, for C01, the infrared indicated a band at 612 cm⁻¹ attributed to γ-Fe₂O₃, and other peaks corresponding to pheomelanin (O-H at 3138.8 cm⁻¹, C=O at 1621.7 cm⁻¹, C-O at 1001 cm⁻¹ and C-S at 617, 75 cm⁻¹). The DLS analysis indicated hydrodynamic sizes for all samples (less than 180 nm) and the EDS exhibited percentage indexes of iron and coating materials, confirming the formation of NPs. VSM analysis pointed out that the SPIONS A01 (22.2), A02 (65.0) and C01 (37.8) emu/g samples indicated superparamagnetic profile. Finally, for the measurements of MRI in T₂ weight, the effect of signal reduction for iron concentrations, respectively for Rₓ(1/T₂), the slope value of samples C01, A01 and A02 was 217.8 ± 20.9, 198.2 ± 18.1 and 304.0 ± 22.1 (M⁻¹.s⁻¹), respectively. In conclusion, all samples as coating materials for SPIONS used as negative CAS were confirmed.

Biography

Mr. Uihyun Jung is a second-year graduate student in the school of Advanced Materials Science and Engineering at Sungkyunkwan University. He holds a bachelor’s degree in Electronics and Radio Engineering from KyungHee University. He is currently working as a researcher in Multifunctional Nano Bio Electronics Lab in Sungkyunkwan University. His research interests include flexible sensors, bio-sensors and devices based on two-dimensional materials.

Water-Soluble Iron Oxide Magnetic Nanoparticles (NPs) Coated by Biomaterials as Potential Negative Contrast Agents in Magnetic Resonance Imaging (MRI)

Alexandre D’Agostini Zottis¹, Eduardo Sant’Ana Ricardo¹, Brena Beatriz Pereira Ribeiro¹, Jeovandro Maria Beltrame³, Mayara da Silva¹ Luiz Felipe Nobre², Lucas Freiberger de Souza² and Rozangela Curi Pedrosa¹

¹Federal Institute of Education, Science and Technology of Santa Catarina – IFSC, Campus Florianópolis, Brazil
²DMI Clinic – São José, Brazil
³Federal University of Santa Catarina – UFSC, Florianópolis, Brazil

Abstract

Contrast Agents in Magnetic Resonance Imaging (MRI)

DNA samples are commonly frozen for storage. However, freezing can compromise the integrity of DNA molecules. Considering the wide applications of DNA molecules in nanotechnology, changes to DNA integrity at the molecular level may cause undesirable outcomes. However, the effects of freezing on DNA integrity have not been fully explored. To investigate the impact of freezing on DNA integrity, samples of frozen and non-frozen bacteriophage lambda DNA were studied using optical tweezers. Tension (5 to 35 pN) was applied to DNA molecules to mimic mechanical interactions between DNA and other biomolecules. The integrity of the DNA molecules was evaluated by measuring the time taken for single DNA molecules to break under tension. Mean lifetimes were determined by maximum likelihood estimates and variances were obtained through bootstrapping simulations. The lifetimes of frozen DNA molecules are significantly reduced, implying that freezing compromises DNA integrity.

Freezing Decrease the Integrity of DNA Molecules

Ian C. Hsu

Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, Taiwan

Abstract

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Biography

Dr. Alexandre D’Agostini Zottis, is Professor of the Department of Health and Services from Federal Institute of Santa Catarina since 2006, and is member of the Professional Masters on Radiation Protection at Federal Institute of Santa Catarina. Graduated and Bachelor’s in Physics (1996 and 2004), MsC in Biotechnology (2005), and PhD in Inorganic Chemistry (2015) from Federal University of Santa Catarina. He is currently head of NANOTEC Research Group at the Federal Institute of Santa Catarina. The main interests are the development of nanomaterials applied in the following fields: nanomedicine, environmental, nano dosimetry and radiological protection purpose.

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RNA Nanotechnology for Specific Delivery of Anti-miRNA for Suppression of Breast, Prostate and Brain Cancer

Dan Shu1, Daniel Binzel1, Tae Jin Lee1, Hongran Yin1, Yi Shu5,6, Hui Li1, Ren Xu6,7, Bin Guo8, Carlo M. Croce4 and Peixuan Guo1,2,3

1Pharmaceutics and Pharmaceutical Chemistry, College of Pharmacy, The Ohio State University, Columbus, OH, USA
2Department of Physiology & Cell Biology, College of Medicine, The Ohio State University, Columbus, OH, USA
3Dorothy M. Davis Heart and Lung Research Institute, The Ohio State University, Columbus, OH, USA
4Department of Cancer Biology and Genetics, College of Medicine, The Ohio State University, Columbus, OH, USA
5College of Pharmacy, University of Kentucky, Lexington, KY, USA
6Markey Cancer Center, University of Kentucky, Lexington, KY, USA
7Department of Molecular and Biomedical Pharmacology, University of Kentucky, Lexington, KY, USA
8Department of Pharmaceutical Sciences, North Dakota State University, Fargo, ND, USA

Abstract

MicroRNAs (miRNAs) are non-coding RNA molecules that regulating post-transcriptional gene expression and cellular differentiation, proliferation and apoptosis. The oncogenic microRNA-21 gene (miR-21) has been identified commonly overexpressed in solid tumors such as breast, lung, prostate, colon, brain cancers etc. Knocked down miR-21 expression by anti-miR21 has been proposed to treat solid tumors by up-regulating tumor suppressors, PTEN and PDCD4. However, delivery of anti-miR21 to the tumor without collateral damage requires an efficient and robust platform. Here, we report the application of RNA nanotechnology using three-way-junction (3WJ) nanoparticles derived from phi29 DNA packaging motor for specific delivery of anti-miR21 and to inhibit the growth of breast cancer, prostate cancer and brain cancer. Utilizing the thermodynamic ultra-stable 3WJ motif, multivalent RNA nanoparticles were constructed incorporating target ligands (such as Folate or PSMA and EGFR RNA aptamers) and high thermodynamic stable anti-miR21 seed as therapeutic module. The RNase resistant and thermos-dynamically stable RNA nanoparticles remained intact after systemic injection in mice and strongly bind to tumors with little accumulation in healthy organs eight hours’ post-injection. The use of 20nM RNA nanoparticles with 54nt 3WJ, 8nt anti-miRNA seed and 30-40nt RNA targeting aptamers will enhance tumor regression effect. RNA nanotechnology exhibits clinical potentials as a platform for targeted cancer treatment.

Design and Evaluation of Self-assembled Scaffolds using Biodegradable Polymer Microparticles

Akansha Singh*, Prasad Admane, Robin Kumar and A. K. Panda
National Institute of Immunology, New Delhi, India

Abstract

Scaffold fabrication method is momentous as it helps in defining the porous architecture and mechanical strength of the scaffold. The major problem associated with scaffold manufacturing techniques is loss and degradation of incorporated biostimulatory molecules, such as growth factors, drug or enzymes. A new method of scaffold fabrication using PDLA polymer was designed earlier in our lab. This method ensures limited loss of functional ability of the entrapped molecules. The labile biomolecules stay encased inside the fused particles and can be delivered through the scaffold in a controlled fashion. We have successfully entrapped antibiotics like Gentamycin and Neomycin inside scaffold particles. Antibiotic released from the scaffolds was found to be bioactive as tested against Staphylococcus aureus and the release pattern was biphasic over a period of one week. We have prepared scaffolds with different mechanical properties using nano-sized, micro-sized and macro-sized polymeric particles. The scaffolds were found to be non-toxic to murine fibroblasts cultures in vitro as well as to mice upon subcutaneous implantation. This method provides a novel and easy way of fabricating antibiotic loaded polymer scaffolds for various of applications. Furthermore, these scaffolds can be used for targeted delivery of drugs and growth factors encapsulated in polymeric nano- or micro-particles fused to form a membrane.

Biography

Ms. Akansha Singh is a graduate student working in the field of tissue engineering under the guidance of Dr. Amulya K. Panda from National Institute of Immunology, New Delhi, India. She is trying to make scaffolds using nano- and Microparticles suitable for different tissue’s mechanical properties such as bone, cartilage, skin, cornea, etc. Presently she is on student exchange program with University of Toronto, working on skin regeneration in the lab of Dr. Marc Jeschke, Sunnybrook Health Science Centre, Toronto, Canada.
Ultrastructure of the Gut and Testis in *Acheta domesticus* after Exposure to Graphene Oxide in Food

Marta Dziewięcka¹, Barbara Flasz²*, Julia Karpeta-Kaczmarek¹, Magdalena Rost-Roszkowska² and Maria Augustyniak¹
¹Department of Animal Physiology and Ecotoxicology, University of Silesia in Katowice, Katowice, Poland
²Department of Animal Histology and Embryology, University of Silesia, Katowice, Poland

Abstract

Market analysis unambiguously shows that materials of graphene family will be more and more often employed in industry, medicine and food production. Defining potential threats of new substances for organisms on an early stage of their production and implementation is a primary task of modern medicine, toxicology and ecotoxicology.

The main research problem of our project is assessment of influence of graphene oxide (GO) on the selected vital parameters of a model insect species *Acheta domesticus*.

In this research we attempted to investigate short-term *in vivo* toxicity of graphene oxide. The nanoparticles were administrated to *Acheta domesticus* with food during ten days of adult individuals.

The total oxidative stress was checked at the beginning and at the end of the experiment using flow cytometry. A histological assessment of the gut and male gonad (testis) was performed after ten days of treatment using Transmission Electron Microscopy (TEM). The results reported intensification of oxidative defense and numerous degenerative changes in the tissues of *Acheta domesticus* (especially in the midgut and testis). We can therefore assume that graphene oxide can migrate via the epithelium to hemolymph, and then can be distributed throughout the whole organism.

Acknowledgment: The research was supported by the National Science Centre (NCN) on the basis of Agreement No. UMO-2016/23/N/NZ7/01977.

Electrically Controlled Drug Release from Drug Loaded Polymer Nanocomposite Films

Christian Chamberlayne¹*, Ephraim Neumann²* and Richard Zare¹
¹Stanford University, CA, USA
²Leibniz University Hannover, Germany

Abstract

Medical implants capable of releasing quantitative amounts of drugs on demand open many possibilities in medical devise applications. Toward this goal, we have developed drug loaded polymers that release drugs upon electrical stimulation. The polymer acts both as a drug reservoir and a release mechanism for medical implants. The ease at which electronics can be miniaturized as well as the quantitative control on amount of released drug through the voltage and current are two large advantages for electrically stimulated drug release.

Two issues facing the field of electrically stimulate drug release are: loading sufficient quantities of drug, and releasing said drug with low voltages. We demonstrate drug loadings above 40% by weight as well as drug release at low voltages (less than 1.5V). Our system is also quite versatile, allowing electrically stimulated drug release of a variety of drugs, spanning from small molecules up to small polypeptides like insulin.

Biography

Christian Chamberlayne: 3rd year chemistry graduate student in Dr. Richard Zare’s lab at Stanford with a concentration in chemical physics. Undergraduate education at The College William and Mary, majoring in chemistry with a minor in physics.

Ephraim Neumann: 2nd year material- and nanochemistry masters student in Dr. Caro’s lab at Leibniz University Hannover and Visiting Researcher in Dr. Zare’s lab at Stanford through DAAD scholarship. Undergraduate education at Leibniz University Hannover in chemistry.
Nanoprobes Displaying Surface Enhanced Raman Scattering Signals for the Multiplexed Detection of Protein Biomarkers

In-Jun Hwang*, Jin-Kyoung Yang, Tae Woog Kang and Jong-Ho Kim
Department of Chemical Engineering, Hanyang University, Ansan, South Korea

Abstract

It is of importance to detect protein biomarkers in a sensitive and multiplexed manner for the early and accurate diagnosis of diseases. Herein, we present an approach for designing surface-enhanced Raman scattering (SERS) nanoprobes with various optical signals for the sensitive and multiplexed detection of the potential biomarkers of Alzheimer’s disease (AD). For the synthesis of the SERS nanoprobes, silver nanoshells (AgNSs) were rapidly formed on the surface of silica nanoparticles via the Raman labels-assisted reduction of Ag ions under very mild conditions (25°C and 60 min). As-prepared SERS nanoprobes had uniform AgNS with a 50 nm of thickness and a 2 nm of nanogaps for electric filed enhancement. The SERS nanoprobes exhibited strong Raman signals with the enhancement factor of 1.7x10^7. In addition, each SERS nanoprobe displayed its own Raman signal without overlapping. The SERS nanoprobes conjugated with antibodies were then applied for the sensitive and multiplexed detection of Alzheimer’s disease (AD) biomarkers, such as Aβ40, Aβ42, and total tau proteins. It was found that the SERS nanoprobes were capable of detecting all the proteins at concentrations as low as 1 pg/ml in a multiplexed manner.

Graphene Oxide can Cause Multigenerational Harmful Effects

Marta Dziewiecka1*, Barbara Flasz1, Julia Karpeta-Kaczmarek1, Jolanta Kwasniewska2 and Maria Augustyniak1
1Department of Animal Physiology and Ecotoxicology, University of Silesia in Katowice, Katowice, Poland
2Department of Plant Anatomy and Cytology, University of Silesia in Katowice, Katowice, Poland

Abstract

Graphene oxide (GO) – an oxidized derivative of graphene, has been acclaimed a “superstar” in the area of nanomaterials in recent years. It draws researchers’ attention with a number of its unique physicochemical properties which determine its potentially widespread use in industry, science and medicine. Therefore, potential influence of graphene and its derivatives on environment is a burning issue nowadays. It seems obvious that nanoparticles can penetrate to the organism via many different ways. But still, knowledge about effects of long-term exposure of organism to nanoparticles, including GO, is rudimentary. In the long-term perspective the knowledge will influence progress of the civilization through determining potentially unfavorable consequences and contribution in assessing risk associated with use of graphene oxide, both for human and other organisms.

In our study we focused on long-term in vivo toxicity of graphene oxide. Two generations of house cricket (Acheta domestica) were intoxicated with different concentrations of GO during the whole life cycle. We have confirmed important cellular changes (low energy budget, DNA damage, decreased cell viability), and reduced fecundity in insects after consumption of food with graphene oxide. Moreover, the second generation of A. domestica presented significantly lower cell vitality compared to the first (parental) generation. We can presume that GO can cause multigenerational negative consequences.

Acknowledgment: The research was supported by the National Science Centre (NCN) on the basis of Agreement No. UMO-2016/23/N/NZ7/01977.

Biography

Ms. Marta Dziewiecka is a PhD student working on “Advanced methods in biotechnology and biodiversity” in Department of Animal Physiology and Ecotoxicology at University of Silesia in Katowice, Poland. Her scientific project is based on nanoparticles toxicity study (especially graphene oxide). She is the author and co-author of eight scientific publications (Total Impact Factor = 33,7) and one popular science publication. She participated in many national and international scientific meetings (a total of 34 conferences). Currently, She is a project manager (UMO-2016/23/N/NZ7/01977) financed by National Science Centre (Poland).
Innovative Strategy to Control the Functionalization of Nanoparticles

Maurice Retout1, Hennie Valkenier1, Pascale Blond2, Ivan Jabin2 and Gilles Bruylants1
1Engineering of Molecular Nanosystems, Université Libre de Bruxelles, Belgium
2Laboratoire de Chimie Organique, Université Libre de Bruxelles, Belgium

Abstract

Intense research in the field of nanomedicine, especially the development and optimization of nanomaterials, has paved the way to a wide range of potential diagnostic and/or therapeutic applications. Nanoparticles of noble metals or magnetic materials are expected to allow major achievements in this field thanks to their respective optical or magnetic properties. In this context, nanoparticles require a perfect colloidal stability and robustness towards physiological conditions (pH, ionic strength, protein adsorption...). In addition to that, many applications require a strict control of the ligand density on the nanoparticles, which is a real challenge when these latter are grafted via the commonly used thiol groups [1].

In order to overcome these issues, we are developing an innovative and versatile strategy to robustly functionalize nanoparticles in a controlled way, based on the use of calixarene-diazonium salts.

We report here the proof-of-concept of this strategy on gold nanoparticles (GNPs), on which we have shown that it is possible to obtain a monolayer of calixarenes via the formation of a covalent bond Au-C leading to highly stable and robust GNPs [2]. We have also achieved the grafting of mixed layers of two calixarenes around the GNPs and demonstrated that their proportions at the surface can be tuned [3]. On this basis, it is thus possible to functionalize GNPs with a defined number of reactive functional groups, allowing their controlled post-functionalization with organic ligands.

Efforts are now on going to demonstrate the applicability of this strategy to other types of nanoparticles. Preliminary but promising results indicate the versatility of our strategy.

References:

Biography

Mr. Maurice Retout studied Engineering in life sciences and biotechnologies at the Université Libre de Bruxelles (ULB, Belgium) and graduated in 2015 in Bioengineering sciences. He is currently a PhD student at the Engineering of Molecular NanoSystems laboratory (ULB) under the supervision of Prof. G. Bruylants. His research activities mainly focus on the development of convenient biosensors based on the optical properties of plasmonic nanoparticles for the in vitro detection of cancer biomarkers. In this context, the development of a new functionalization strategy of these particles represents a major and important part of his research.

Smart Assembly of Mn-Ferrites/Silica Core-Shell with Fluorescein and Gold Nanorods: A Robust and Stable Nanomicelle for in vivo Triple Modality Imaging

Mirko Maturi1, Ilaria Monaco1, Paolo Armanetti2, Erica Locatelli1, Alessandra Flori1, Serena del Turco1, Luca Menichetti1 and Mauro Comes Franchini1
1Department of Industrial Chemistry “Toso Montanari”, University of Bologna, Italy
2Italian National Research Council (CNR), Pisa, Italy

Abstract

Lately, the attention towards multiple modality imaging with nanostructured contrast agents have rapidly grown thanks to the remarkable properties displayed by metallic nanostructures. Herein we report the synthesis of a resilient nanosystem based on silica-coated magnetic MnFe2O4 nanoparticles conjugated to fluorescein and PEGylated gold nanorods embedded in polymeric micelles (MnFe2O4@SiO2@GNRs@PMs), for magnetic-photoacoustic-optical triple-modality imaging. The magnetic relaxivity of the nanosystem has been evaluated, revealing high r1/r2 ratios that suggests the effectiveness of the nanosystem as T1-contrast agent with MRI instrumentations commonly implemented at clinical stage. In addition, contrast-based fluorescence imaging has been tested both in vitro and ex vivo, showing that the nanosystem owned the suitable optical
properties of fluorescein, with contrast intensities comparable with previously reported results. Finally, photoacoustic performances of the nanosystem have been evaluated, revealing good linearity between concentration and photoacoustic response in the 25 – 250 nM concentration. Furthermore, the performances of MnFe₂O₄@SiO₂@GNRs@PMs for PA imaging have been tested ex vivo and in vivo with irradiation at 690 nm. The results showed a contrast-to-noise ratio (CNR) as high as 60 in a mouse leg subcutaneously injected with the nanosystem. The inner Mn-Ferrite core allowed for efficient MRI, the conjugation to fluorescein guaranteed sensitive detection by optical imaging and the presence of gold nanorods ensured enhanced photoacoustic contrast in the first biological window of the NIR spectrum, both in vitro and in vivo. Biocompatibility studies revealed no hemolytic effect induced by the nanoconstruct, revealing the applicability of the studied diagnostic tool for medical studies at the clinical stage.

Biography

Mr. Mirko Maturi received his Bachelor degree in Industrial Chemistry at the University of Bologna (October 2015) and an Erasmus Mundus double Master degree in Advanced Spectroscopy in Chemistry between the University of Bologna, Italy and the University of Lille 1, France (July 2017) with a thesis titled “Chitosan-Coated Gold Nanorods for Hyperspectral Photoacoustic Imaging of Marine Bladder Cancer”. In November 2017 he started the PhD Program in Chemistry at the University of Bologna. His current research interests include synthesis, engineering and characterization of nanoparticles for applications in drug delivery, biological imaging and smart materials.

Two-dimensional Nanosheet Biosensors for the Optical Detection of Pathogens

Tae Woog Kang*, Juhee Han, Sin Lee, In-Jun Hwang, Su-Ji Jeon, and Jong-Ho Kim
Department of Chemical Engineering, Hanyang University, South Korea

Abstract

It is of great interest to modulate the dimension of nanomaterials for their biological applications. Herein, we present an effective approach for the exfoliation and functionalization of transition metal dichalcogenides (TMDs) such as WS₂, MoSe₂, and WSe₂ with a recognition chemical element in an aqueous solution, and the application of exfoliated TMD monolayers for the selective detection of bacterial pathogens. Bulk TMDs were effectively exfoliated into TMD monolayers using a polysaccharide polymer in water via a pulse sonication process. The obtained TMD monolayers exhibited characteristic excitonic absorption and strong fluorescence in a visible range, as compared with their bulk counterparts. The TMD monolayers displayed their characteristic Raman scattering signals and the vibrational modes of the polymer in the Raman and FT-IR spectra, indicating that the exfoliation and functionalization of the TMD monolayers in an aqueous solution were successfully achieved. The TMD monolayers were then applied for the selective detection of bacteria without the use of antibodies. The WS₂ monolayers were able to selectively detect E. coli at concentrations as low as a single copy.

Cytotoxic Evaluation of HDAC Inhibitor Conjugated Prodrug Micelles for Doxorubicin Delivery Against Lung Cancer

Bolutito Alade¹*, Ying Xie² and David Oupicky¹
¹Hampton University, Hampton, VA, USA
²University of Nebraska Medical Center, Omaha, NE, USA

Abstract

Colon cancer is the third most prevalent cause of cancer-related death and the second most common form of cancer in the United States. In colon cancer, as well as many other cancer types, the tumor suppressing gene p53 is typically subject to inactivation or mutation. Suppression of p53 leads to the dysregulation of the different classes of microRNAs. Among them, the upregulation of mi-34a induces cell apoptosis and/or cell cycle arrest in both cancerous and defective cells. The goal of this study was to characterize a newly developed hydroxychloroquine-conjugated polycation (HQ-P) in comparison with the parent polycation (P), as well as study each one’s ability to deliver miRNA in HCT116 human colon cancer cells. The hypothesis for this study was that both delivery systems will have relatively similar physiochemical properties (size, ζ potential, miRNA loading capacity), but the HQ-P-based systems will demonstrate higher endosomal escape activity and cell apoptosis in cultured HCT116 cells.

Biography

Mr. Bolutito Alade is in third year at Hampton University, and his first in the School of Pharmacy. His research background is primarily in nanomedicine and pharmaceutical sciences. Most of his research was done in the lab of Dr. David Oupicky, at the University of Nebraska Medical Center, where he spent two consecutive summers as a research intern. After taking this past fall semester off from research in order to adapt to pharmacy school, he is now looking start doing more research related to biopharmaceutics and pharmacokinetics this spring semester.
**RNA Nanoparticles Delivering Therapeutics for Thyroid, Prostate, Breast and Brain Cancer Treatment**

**Congcong Xu**, Peixuan Guo, Sissy Jhiang and Dan Shu

*The Ohio State University, OH, USA*

**Abstract**

With the effective treatment of most thyroid cancer by total thyroidectomy and radioiodine ablation, 10% - 20% of the cases remain challenging due to the resistance to conventional chemotherapy and radioiodine therapy. New strategies with enhanced and prolonged therapeutic efficacy are urgently needed. Herein, we developed RNA nanotechnology-based system for therapeutic RNA delivery into thyroid cancer cells for effective cell inhibition. Specifically, a three-way junction (3WJ) motif derived from the packaging RNA (pRNA) of phi29 DNA packaging motor was engineered to harbor EGFR aptamer and anti-miRNA 21 for targeted delivery. Flow cytometry analysis showed the specific binding of RNA nanoparticles to the thyroid cancer cells and the q-RT PCR results suggested the successful gene regulation. We envision that this 3WJ-based therapy platform holds great promises for radioiodine- and chemotherapy-refractory thyroid cancer.

**RNA-based Micelles: A Novel Platform for Paclitaxel Loading and Delivery**

**Yi Shu**, Hongran Yin*, Mehdi Rajabi*, Hui Li, Mario Vieweger, Sijin Guo, Dan Shu and Peixuan Guo

*1Center for RNA Nanobiotechnology and Nanomedicine, College of Pharmacy, Division of Pharmaceutics and Pharmaceutical Chemistry, College of Medicine, Dorothy M. Davis Heart and Lung Research Institute and James Comprehensive Cancer Center, The Ohio State University, Columbus, OH, USA

*2Nanobiotechnology Center, Markey Cancer Center and Department of Pharmaceutical Sciences, University of Kentucky, KY, USA*

**Abstract**

RNA can serve as powerful building blocks for bottom-up fabrication of nanostructures for biotechnological and biomedical applications. In addition to current self-assembly strategies utilizing base pairing, motif piling and tertiary interactions, we reported for the first time to build RNA based micellar nanoconstruct with a cholesterol molecule conjugated onto one helical end of a branched pRNA three-way junction (3WJ) motif. The resulting amphiphilic RNA micelles consist of a hydrophilic RNA head and a covalently linked hydrophobic lipid tail that can spontaneously assemble in aqueous solution via hydrophobic interaction. Taking advantage of the feature of pRNA 3WJ branched structure, the assembled RNA micelles are capable of escorting multiple functional modules. As a proof of concept for delivery for therapeutics, Paclitaxel was loaded into the RNA micelles with significantly improved water solubility. The successful construction of the drug loaded RNA micelles was confirmed and characterized by agarose gel electrophoresis, atomic force microscopy (AFM), dynamic light scattering (DLS), and fluorescence Nile Red encapsulation assay. The estimate critical micelle formation concentration ranges from 39nM to 78nM. The Paclitaxel loaded RNA micelles can internalize into cancer cells and inhibit their proliferation. Further studies showed that the Paclitaxel loaded RNA micelles induced cancer cell apoptosis in a Caspase-3 dependent manner but RNA micelles alone exhibited low cytotoxicity. Finally, the Paclitaxel loaded RNA micelles targeted to tumor in vivo without accumulation in healthy tissues and organs. There is also no or very low induction of pro-inflammatory response. Therefore, multivalence, cancer cell permeability, combined with controllable assembly, low or nontoxicity nature, and tumor targeting are all promising features that make our pRNA micelles a suitable platform for potential drug delivery.

**Protease-Activatable Polymersomes for Diagnostics and Treatment of Cancer Cell**

**Hyun-Ouk Kim**, HyeYoung Son*, Jong-Woo Lim*, Jihye Kim*, Haejin Chun*, Geunseon Park, Yong-Min Huh and Seungjoo Haam

*1Department of Chemical and Biomolecular Engineering, Yonsei University, Seoul, South Korea

*2YUHS-KRIBB Medical Convergence Research Institute, Seoul, South Korea*

**Abstract**

Metastasis-associated proteases, such as MT1-MMP, play decisive roles during malignancy and have been used as biomarkers for diagnosis, prognosis, and drug targeting. Protease-activatable polymersomes have great potential as cancer theragnosis platform due to the high selectivity of the activating proteases. Here we report a highly modular design for the efficient and simple synthesis of amphiphilic block polymer-peptide and copolymer-peptide based on methoxy-poly (ethyleneglycol)-b-polyleucine (mPEG-b-pLeu) and MT1-MMP antagonist peptide-b-polyleucine (MT1-peptide-b-pLeu), respectively. These amphiphilic self-assemble in water into polymersomes that can disassemble and release encapsulated imaging agent, gene and drug upon enzymatic activation. Importantly, this system was found to prevent the initiation and progression of cancer metastasis. Consequently, this study may also provide new strategy in the development of nanomedicine for diagnosis and therapy of cancer metastasis.
Silver Nanoparticles as Antibacterial Against Fish Bacterial Diseases

Julio César Meneses¹, Aida Handam¹, María del Carmen Monroy² and Jorge Castro²

¹Laboratorio de Microbiología y Biología Molecular del Departamento de Atención a la Salud, Universidad Autónoma Metropolitana Unidad Xochimilco, Mexico
²Laboratorio de Alimento Vivo y Análisis Químico del Departamento del Hombre y su Ambiente, México City, Universidad Autónoma Metropolitana Unidad Xochimilco, Mexico

Abstract

Nanotechnology is a field of research of the nanoparticles due to their noble properties within that highlight its antimicrobial effect, in particular silver nanoparticles [1]. The use of silver as an antibacterial has been since ancient times. In aquaculture, the ornamental fish have expressed bacterial diseases, which have resistance to the different types of antibiotics [2]. The aquaculture industry are looking for new alternatives for the control of these diseases [3]. The aim of this work is to determine the antibacterial effect of silver nanoparticles (AgNPs) against *Vibrio fluvialis*. The AgNPs were synthesized at different concentrations (180 and 90 ppm) using sodium citrate as a reducing agent. The Turbidimetric assay [4] results shown that AgNPs could inhibit the grown of *V. fluvialis*, in concentration depended manner. The minimum inhibitory concentration (MIC) of AgNPs against *V. fluvialis* was 45 ppm. Toxicity results [5] prove that AgNPs are not toxic to Angel fish (*Pterophyllum scalare*). There was no harm in eyes, fins and scales. This study concluded that the AgNPs showed antibacterial activity against *V. fluvialis*. However, future studies of the effect of AgNPs are necessary in other pathogenic microorganisms, which affect the health of the ornamental fish.

References:


Identifying the Critical Amino Acids within Immunoglobulin Domain of Human Peroxidasin Necessary for Crosslinking of Basement Membranes

M. Gaines-Smith¹, T. Maitre and I. Ero-Tollive

Hampton University, Hampton, VA, USA

Abstract

Assembly and integrity of collagen IV networks is essential for the integrity of basement membranes. An integral component of collagen IV is the sulfilimine bond (S=N), between methionine-93 and hydroxylysine-211 within the NC1 domains. This bond was identified as important for stabilization of basement membrane networks. Peroxidasin has been identified as the multi-domain peroxidase responsible for catalyzing sulfilimine bond formation by using its peroxidase and n-terminus of the immunoglobulin (Ig) domain. Previously, we identified the peroxidase and immunoglobulin domain as the domains necessary for crosslinking the basement membrane. Therefore, our current work focuses on investigating and identifying the critical amino acids within the immunoglobulin domain of peroxidasin responsible for catalyzing sulfilimine bond formation. To this end, we are designing primers to introduce specific mutations into our target Ig site within peroxidasin. These mutants will later be transfected into HEK293T cells that are overlayed on uncrosslinked basement membrane generated by PFHR-9 cells. Using SDS-PAGE, western blots and commassie staining we will assess the amount of crosslinking to determine the critical amino acids of the immunoglobulin domain of peroxidasin that is necessary and sufficient for crosslinking the basement membrane. These findings will provide insight into the mechanism for crosslinking/sulfilimine bond formation within the basement membrane.
Self-assemble Dynamics and Nanostructural evolution of a Novel Amphiphilic Chitosan for Drug Encapsulation and Release Upon Anti-Cancer Treatment

Min-Chin Chang*, Wei-Ting Huang, Ming-Chia Li and Dean-Mo Liu
Department of Materials Science and Engineering, Nano-Bioengineering Lab, National Chiao Tung University, Taiwan

Abstract

Self-assembly has been an interesting and important dynamic behavior for a materials possessing amphiphilic nature, and this is frequently observed in nature. What is more critical and also a need to explore while its association with drug molecule(s), for encapsulation and release in order to achieve a better-than-ever medical efficacy, compared with conventional free-drug medication protocol. Here, we employ a novel amphiphilic biodegradable and biocompatible materials, carboxymethyl-hexanoyl chitosan (termed as CHC), which has been successfully synthesized from this lab. The self-assemble dynamics and nanostructural evolution of the CHC in the presence and absence of hydrophobic drug were intensively explored through the use of H-NMR, C-NMR, FTIR, DLS, TEM, circular dichroism (CD) and small-angle electron diffraction. The stability of the self-assembled nanostructure was measured and was found to become dynamic with drug presence, suggesting drug release lead to a nanostructural variation over a certain extent. A corresponding drug release dynamic was then characterized in this work and a full explanation on nanostructure-associated drug elution from a given nanocarrier was proposed, which will be important with respect to nanomedicinal design from molecular consideration. This work also confirmed a nanostructural stability and minimized critical micellar concentration, and high encapsulation efficiency for anti-cancer drug, ensuring a potential benefit for the CHC in biomedical applications.

Non-aqueous Type Biosensor Based on Double Gate MoS₂ Field-effect Transistor for High Sensitive and Reproducible

Seok Hwan Jeong*, Heekyeong Park, Uihyun Jung and Sunkook Kim
School of Advanced Materials Science and Engineering, Sungkyunkwan University, South Korea

Abstract

Label-free, high sensitivity, and rapid detection are utmost valuable advantages of biosensors based on field-effect transistor (FET). Among various semiconductor channel materials, two dimensional materials, such as graphene and transition metal dicalcogenizes (TMDs), have great potential for ultrahigh sensitive biosensor due to their large surface to volume ratio. Compared with graphene based FETs, TMDs based FETs are more effectively controlled by binding of biomolecules due to the existence of bandgap.

In this work, a molybdenum disulfide (MoS₂) FET based biosensor was used for high sensitive prostate specific antigen (PSA) detector. The detection of PSA was occurred on surface of MoS₂ passivated with Al₂O₃ top dielectric layer. This top layer was coated with high dense and well-oriented anti-PSA. Non-aqueous measurement process was selected for enhancement of both sensitivity and reproducibility. The pH memory theory, the proteins maintain their ionization state after removing aqueous, is a great theoretical tool of our detection systems. Non-specific binding between Al₂O₃ above MoS₂ surface and other molecules was perfectly suppressed with casein blocker for high reliability. The ultrahigh sensitivity of our MoS₂ biosensor was proved with much low limit of detection of 100 fg/mL. Finally, theoretical simulation suggested that optimization of device parameter such as thickness of Al₂O₃ layers offers the more enhanced performance of biosensor such as sensitivity and power-efficient.

Biography

Mr. Seok Hwan Jeong was graduated in electronic engineering from Kyunghee University in 2017, Korea. And he is now attending a master’s degree at material science and engineering of Sungkyunkwan University, South Korea under Prof. Sunkook Kim. His research areas are bio-nano electronics based on MoS₂ FET and deposition of high-k dielectric such as Al₂O₃ onto the surface of TMDCs materials.

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Abstract

The uses of gold nanoparticles (GNPs) as radiosensitizers have been widely explored during the last years. In vitro and in silico experiments have demonstrated a significant dose enhancement in the GNP vicinity and reduction in cell survival under X-ray irradiation. The dose enhancement due to GNPs is attributed to a large photoelectric cross section of gold at the K-shell, which leads to the increase in the number of lethal lesions in critical cell structures. Although the physical mechanisms of the energy deposition are understood, at present the reasons for the biological outcomes are not clear.

The GNP distribution in a cell is the most important factor that determines the dose delivered to the cell nucleus and the probability of the cell survival. In this work, we use an analytical framework for the assessment of the cell survival proposed in [1], which is based on the Local Effect Model, allowing us to take into account the effects of highly inhomogeneous dose distribution in the nucleus due to the intracellular distribution of 20 nm GNPs. The survival fraction curves and the RBE of MDA-MB-231 cell structure irradiated with 100 keV X-rays were calculated using the published radial dose distributions around the GNPs and specific distributions of GNPs in cells. As a result, a set of survival curves and corresponding RBE were obtained that reasonably coincides with the data available in literature.


Biography

Mr. Wilmer Melo-Bernal is a PhD student at the University of Sonora (Unison), Mexico. His work focuses on analytical and numerical modeling of survival curves of irradiated cells with embedded nanoparticles. Prior to this he completed his Master’s degree in Physics with Honors at the Unison in 2014. His MSc thesis title is “Nanoscale dose distribution in critical structures of X-ray irradiated cell with embedded gold nanoparticles: an analytical framework for the assessment of the cell survival”.

In–planta Quantum Dots Translocation via Rolling

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Abstract

This work is focused to identify and confirm the translocation of the quantum dots within the citrus plant vascular tissue. This will be achieved by inducing pores in the stem region via roller, to permit the entrance of the quantum dots to the inside tissue. Plant branches were brought and treated as follows: rolled/ covered with quantum dots, rolled/ covered with water and non-rolled/ covered with quantum dots. Plants were dissected at the stem region and one section was obtained from each plant. Sections were examined by fluorescence lifetime imaging (FLIM), time correlated single photon counting (TCSPC) and optical microscopy imaging. It was found that the rolled sample with quantum dots acquired the quantum dots through the induced pores and translocated through the tissue. This is clearly appeared from the fluorescence lifetime values, TCSPC decay curves and the optical images (Fig.1). In conclusion, the induction of pores via roller with adding sufficient amount of quantum dots solution and prevent its dryness, ensures the quantum dots uptake and translocation into the plant instead of the gauze/ Swiffer® quantum dots treated plants only.

Fig.1: The optical microscope images (10X) for a)- rolled / covered with water sample (Control) and b)- rolled/covered with quantum dots sample. The blue arrow shows the quantum dots.
Enhanced Synergistic Therapeutic Efficacy Using Dual-drug Co-delivery to against Non-Small-Cell Lung Cancer: From In-vitro to In-vivo

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Abstract
A novel dual-drug co-delivery nanosystem was successfully developed using carboxymethyl-hexanoyl chitosan (CHC) as a nanocarrier, through self-assembly co-encapsulation process designed in this work, for the treatment of advanced non-small-cell lung carcinoma (NSCLC, A549). A combination therapy with co-dosing of two drugs simultaneously with different mechanisms of action toward the disease site renders a synergistic therapeutic performance feasible. This has been confirmed in our work where a combination of chemo-drug, gemcitabine (dFdC), which effectively inhibit DNA formation, leading cell death, and a Chinese herbal drug, demethoxycurcumin (DMC), which is able to downgrade NF-kB expression and reduce largely the multi-drug resistance (MDR) mechanism, gave rise to a synergistic cell-killing performance, in terms of a measure of combination index. The same protocol was designed for in-vivo evaluation with a further modification with targeting moiety, EGFR antibody, on the co-delivery nanocarriers and a significantly enhanced inhibition on tumor growth was observed in a mice model, which further justified the co-delivery efficacy proposed in this work. Co-encapsulation and associated self-assembly behavior of the CHC nanocarrier were systemically explored and an optimized synthesis protocol for this dual-drug co-loaded system was experimentally determined in full. It is believed, from this work, optimization of the co-delivery nanosystem largely enhance therapeutic efficacy compared to either free drug or sequentially-delivered (one drug after another) dosing protocols. Our finding can then envision a future development on the use of anticancer drugs, either chemotherapeutic or possibly immunotherapeutic drugs, with optimal combination strategy in treating advanced tumor progression with greater performance and is highly feasible in clinical translation.

Design and Synthesis of Amphiphilic Acrylic-chitosan Macromolecule and its Association with Hydrogel Lens for Anti-glaucoma

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Abstract
This work aimed at designing amphiphilic acrylic-chitosan macromolecule with self-assembly and water affinity properties to associate with hydrogel-based contact lens to treat glaucoma with enhanced efficacy and bioavailability. A newly-formed carboxymethyl-hexanoyl chitosan (termed as CHC) has been successfully developed from this lab for years. Its amphiphilic nature permitted a self-assembly nanostructure to evolve in aqueous media, and in the meantime, allows bioactive drug(s) to be encapsulated and delivered in a controlled, sustained manner for medication purpose. Combining the CHC, also a mucoadhesive biomaterials, with contact lens brings a new therapeutic strategy to treat eye disease, in particular, glaucoma. However, the lack of interfacial bonding between CHC and contact lens, either Poly-HEMA hydrogel or silicone-based hydrogel, reduced its mechanical integrity, water affinity (retention capability), and even optical clarity. Therefore, an attempt was made to link acrylic molecule with CHC via a chemical bonding, and from our work, it is being successfully synthesized a HEMA-conjugated CHC nanostructure (termed as H-CHC), without changing self-assembly nature and water affinity as of original CHC. Further association with poly-HEMA results in a high-clarity hydrogel lens, with much improved mechanical behavior, and high water retentionability. Encapsulating anti-glaucoma drug (with both single- and dual- drug protocols), a sustained release of the drug(s) from the resulting contact lens ensures a long-term control of intraocular pressure to a healthy level, between 15-20 mmHg and it is highly expecting the resulting drug-eluting contact lens can be successful in clinical translation.
Improving the Hydrogen Production in Water Splitting by a Simple Hot-press Process and Spontaneous Spatial Charge Separation Effect

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Abstract

In this study, a spontaneous charge spatial separation (SCSS) and simple hot press process (HPP) has been adopted to enhance the efficiency of photocatalytic water splitting. Originally, the photocatalytic activity of hematite is limited by its relatively poor absorptivity, very short excited-state lifetime, and a short hole diffusion length. To address these issues, pseudocubic polyhedral α-Fe2O3 photoelectrode was fabricated and achieved the spontaneous charge spatial separation in water splitting process. The intrinsic charge spatial distribution has to be taken into account when selecting the facets, as it results in accumulation of photoexcited electrons and holes on certain semiconductor facets. Furthermore, we develop a new technology of using a simple hot press process to improve carrier transport, charge separation and longtime stability for photocatalytic water splitting. Without complicated nanostructure fabrication, this hot press process demonstrated a 2-fold enhanced photocurrent under A.M. 1.5 solar simulator irradiation. The enhancement is attributed to the improvement of carrier transport properties in TiO2-Fe2O3 matrix due to significant reduction of the film thickness after the hot press process. In addition, Tin (Sn) from the FTO substrate was diffused and doped into these polyhedral α-Fe2O3 and hot press TiO2-Fe2O3 during the sintering process to serves as an electron donor and increases the carrier density. In addition, plasmonic gold nanoparticles were incorporated into these two systems, which would provide the strong field and hot electrons, resulting in the enhancement of visible light absorption efficiency and inhibit charge recombination, this leads the photocatalytic water splitting to achieve a further stage.