NANOMEET2022

2ND INTERNATIONAL MEET & EXPO ON NANOTECHNOLOGY

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FOREWORD

Let's Celebrate Nanotechnology: From Nano COVID-19 Vaccines to Helping Explore Space !

Welcome to NANOMEET 2022 ! This is certainly a time to celebrate Nanotechnology ! From the use of Nano materials in current worldwide COVID-19 vaccines and therapies helping us all get through the pandemic to exploring space, Nanotechnology is changing the world more today than ever. As someone who has been at the heart of Nanotechnology for over 25 years, from when we had to define what even Nanotechnology meant in the 1990s to now with hundreds if not thousands of products across all of society helping to improve the quality of life, Nanotechnology has proven to be a technology around to stay. It is clearly not "hype" but rather "ripe" for more discoveries !

Please join us for this meeting with numerous high profile speakers, discussing what is on the horizon for Nanotechnology. At a time when we can all feel isolated due to COVID and social media distorting science, let's spread some science optimism on how we can tackle the most pressing world problems with Nanotechnology.

I look forward to hearing all of your Nano discoveries !

Prof. Thomas J. Webster
Conference Chair, NANOMEET2022
Clarivate Most Distinguished Researcher
USA

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Plenary Forum

Identification of Solids for True Design and Precise Characterization of Functional Nanomaterials

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Abstract
How can we design functional solid materials, such as catalysts and photocatalysts? What are the decisive structural parameters controlling their activities, performance or properties? What is obtained as structural properties by popular conventional analytical methods, such as X-ray diffraction (XRD) or nitrogen-adsorption measurement, is limited to bulk crystalline structure and specific surface area, i.e., no structural characterization on amorphous phases, if present, and surface structure has been made so far. This is because there have been no macroscopic analytical methods to give surface structural information including possibly-present amorphous phases. Recently, we have developed reversed double-beam photoacoustic spectroscopy (RDB-PAS) which enables measure energy-resolved distribution of electron traps (ERDT) for semiconducting materials such as metal oxides [1, 2]. Those detected electron traps (ETs) seem to be predominantly located on the surface for almost all the metal oxide particles, and therefore they reflect macroscopic surface structure, including amorphous phases, in ERDT patterns. Using an ERDT pattern with the data of CB bottom position (CBB), i.e., an ERDT/CBB pattern, it has been shown that metal oxide powders, and the other semiconducting materials such as carbon nitride, can be identified without using the other analytical data such as XRD patterns or specific surface area, and similarity/differentness of a pair of metal-oxide samples can be quantitatively evaluated as degree of coincidence of ERDT/CBB patterns. In this talk, an approach of material design based on the ERDT/CBB-pattern analyses is introduced [3].

References
[1] Chem. Commun., 2016, 52, 12096–12099.
[2] Electrochim. Acta, 2018, 264, 83–90.
[3] Catal. Today, 2019, 321–322, 2–8.

Keywords
Functional Nanomaterials; Structural Characterization; Reversed Double-beam Photo-acoustic Spectroscopy; Energy-resolved Distribution of Electron Traps

Biography
The research work on photocatalysis by Professor Bunsho Ohtani started in 1981 when he was a Ph. D. course student in Kyoto University. Since then, he has been studying photocatalysis and related topics for 40 years and published more than 300 original papers (h-index: 72) and two single-author books. After gaining his Ph. D. degree from Kyoto University in 1985, he became an assistant professor in the university. In 1996, he was promoted to an associate professor in Graduate School of Science, Hokkaido University and was then awarded a full professor position in the Catalysis Research Center (presently Institute for Catalysis), Hokkaido University in 1998 and retired at the end of March 2022. He was awarded several times form the societies related to chemistry, photochemistry, electrochemistry and catalysis chemistry.

Sub-10-nm Patterning on Suspended Graphene by Using Focused He Ion Beam for Heat Phonon Engineering

Hiroshi Mizuta[*1], Guo Jiayu[1], Yoshiki Ozono[1], Shinichi Ogawa[2], Yukinori Morita[2], Afsal Kareekunnan[1], Manoharan Muruganathan[1], Fayong Liu[1]

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Abstract

Ultrafine patterning of suspended graphene by using a helium ion microscope (HIM) has been explored actively. Carving suspended graphene into single-nanometer (< 10 nm) structures using focused He+ beam milling is getting particularly interested for various advanced applications such as single-molecular detection [1] and nanoscale phonon engineering [2]. In this talk, we discuss a recent attempt of large-area patterning of sub-10-nm nanopore array in graphene (graphene phononic crystal (GPnC)) by HIM and its application to nanoscale heat phonon engineering. Thanks to excellent mechanical properties of graphene, the phononic bandgaps are formed in the THz regime with such single-nanometer GPnCs. This enables us to control thermal transport dominated by heat phonons for relatively low temperature. We successfully patterned GPnCs with nanopores of 3 - 6 nm in diameter and with a pore-pore distance down to 10 nm on suspended graphene channels with various dimensions (length of 500 nm and 1 um and width from 1.2 um to 100 nm) [3].

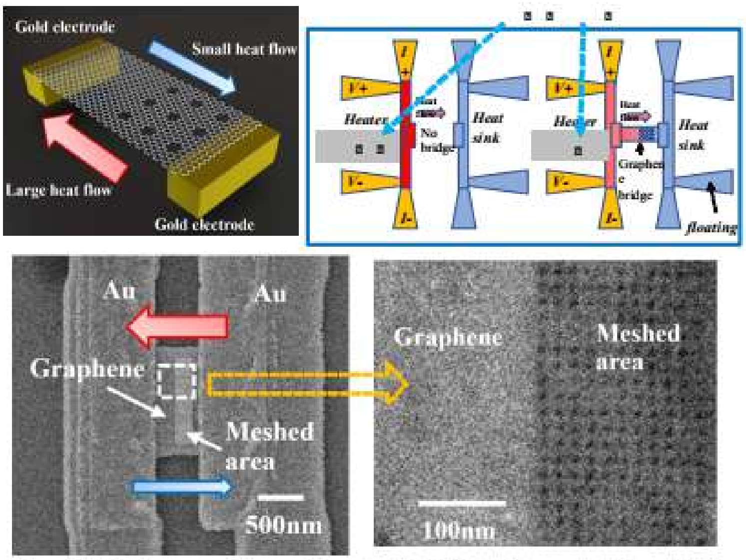

Fig. 1 Schematic of a half GPnC and the DTL methud (upper) and the HIM image of patterned asymmetric GPnC (lower).

In order to study heat phonon transport in asymmetric structures, we patterned GPnC only on half of a 500-nm-long and 1200-nm-wide suspended graphene channel (Fig. 1). The fabricated phononic devices were measured in the cryostat from 100 K to 300 K. We developed a new Differential Thermal Leakage method [4] to evaluate heat phonon transport in the asymmetric channels by switching thermal bias polarity. We observed a substantial thermal rectifying phenomenon with the rectification ratio of over 80 % at 150 K and 60 % at 250 K [5]. We also show the results for suspended trapezoidal channel and discuss the physical mechanism behind the rectification phenomena.

Acknowledgement
This research was supported by the Grant-in-Aid for Scientific Research KAKENHI 18H03861, 19H05520 from Japan Society for the Promotion of Science.

References
[1] J. Sun, M. Muruganathan, and H. Mizuta, Science Advances 2(4), e1501518 (2016).
[2] M. E. Schmidt, H. Mizuta, et al., ACS Applied Materials & Interfaces 10, 10362 (2018).
[3] F. Liu, H. Mizuta, et al., Micromachines 11(4), 387 (2020).
[4] F. Liu, H. Mizuta, et al., Ext, Abst. Int. Conf. SSDM2020, pp. 509-510 (2020).
[5] F. Liu, H. Mizuta, et al., Nano Futures 5(4), 045002 (2021).

Keywords
Graphene; NEMS; Helium Ion Beam; Phonon Engineering

Biography
Hiroshi Mizuta CPhys FInstP, received the Ph.D. degree in electrical engineering from Osaka University, Japan, in 1993. He was the Laboratory Manager at the Hitachi Cambridge Laboratory, Cambridge, UK for 1997 – 2003. He was Associate Professor at Tokyo Institute of Technology for 2003 - 2007 and Professor of Nanoelectronics at University of Southampton for 2007 – 2016. He is currently Distinguished Professor and Vice President at Japan Advanced Institute of Science and Technology (JAIST). He was awarded for 2018 Commendation for Science and Technology by the Minister of MEXT, Japan. He has published over 590 peer-reviewed scientific papers and filed over 50 patents.

Dispersion Engineering in Si_3N_4 Slot Waveguide for Different Applications

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Abstract

Photonic integrated circuits (PICs) have attracted much interest in terms of large-scale integration, small footprint, lower energy consumption and cost. Among different nonlinear platforms, Si_3N_4 is one of the primary choices to achieve broadband dispersion manipulation, due to its negligible two-photon absorption (TPA), wide transparent window, and the reasonably high Kerr nonlinearity. Slot waveguides provide an additional tuning knob to tailor various properties for on chip elements, dispersion engineering and nonlinearity manipulation.

Chromatic dispersion is of importance for a variety of applications including temporal cloaking, time lens, ultrafast optical oscilloscope, microwave photonics subsystems, true time-delay beam former. With the additionally introduced slot layer, chromatic dispersion can be efficiently tailored to be either high or low over broad bandwidth. Flat and high dispersion could be utilized to realize the broadband dispersion compensation in optical communication system. The broadband flattened low dispersion provides a good chance to generate supercontinuum and frequency comb, which have the potential applications in integrated light source, ultrashort pulse compression, and high-precision frequency metrology. In addition, dispersive wave (DW) generation is a representative effect which is sensitive to the higher-order dispersion. In general, when pumping in the anomalous dispersion, the higher-order soliton breaks into its fundamental solitons, and then the DW emits in the normal dispersion region. Additionally, some studies explored that a pump in the normal dispersion region can produce a narrowband DW in the anomalous dispersion region.

In this talk, we review our dispersion engineering for various applications based on Si3N4 slot waveguide. Firstly, we achieve a flat negative dispersion (<-600 ps/(nm•km)) over an octave-spanning bandwidth (782 to 2100 nm), which can be used as a key dispersion element in an on-chip chirped pulse amplification system. 448× temporal broadening can be achieved for a 10-fs pulse after a 5-cm waveguide propagation. Secondly, we investigate the supercontinuum generation in the Si3N4 slot waveguide with flat and low all-normal dispersion (average -15.56 ps/(nm•km)). In this condition, the proposed waveguide with a 5-mm length generates a three-octave SC range from 504 to 4229 nm when a 100-fs 90-kW hyperbolic secant pulse is launched. Thirdly, we demonstrate the ability to form two DWs, in which the long-wavelength DW can cover beyond 4000 nm by pumping in the telecommunication band. A highly efficient nonlinear conversion is realized over a fairly broad band through this approach. Finally, we investigate the four DWs radiation phenomenon and explain the underlying mechanism in details when pumping in the normal dispersion regime. The spectrum spans from visible (600

nm) to mid-IR (4500 nm), via four DWs radiation in both the anomalous and normal dispersion regions, and the spectra are shown to have a high degree of coherence.

Keywords
Dispersion Engineering; Supercontinuum Generation; Dispersive Wave

Biography
Yang Yue received the B.S. and M.S. degrees in electrical engineering and optics from Nankai University, China, in 2004 and 2007, respectively. He received the Ph.D. degree in electrical engineering from the University of Southern California, USA, in 2012. He is a Professor with the School of Information and Communications Engineering, Xi'an Jiaotong University, China. Dr. Yue's current research interest is intelligent photonics, including optical communications, optical perception, and optical chip. He has published over 200 peer-reviewed journal papers (including Science) and conference proceedings with >9,000 citations, five edited books, two book chapters, >50 issued or pending patents, >170 invited presentations (including 1 tutorial, >20 plenary and >30 keynote talks). Dr. Yue is a Senior Member of the Institute of Electronic and Electrical Engineers (IEEE). He is an Associate Editor for IEEE Access, Editor Board Member for three other scientific journals, Guest Editor for >10 journal special issues. He also served as Chair or Committee Member for >80 international conferences, Reviewer for >60 prestigious journals.

CVD Growth Frontiers of Industrial Graphene Materials

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Abstract

Chemical vapor deposition (CVD) is the most popular technique for industrial level production of high quality graphene materials. Great progress has been achieved since the first approach of catalytic CVD growth of graphene films in 2009. At the current stage, mass production of CVD graphene films toward graphene industry has been realized up to a level of millions of m2 per year. For single crystal graphene wafers, it also reaches tens of thousands of wafers per year with a size of 4 to 6 inches. Current research emphasis on CVD graphene materials is laid on three different directions, high-quality graphene films and wafers for general purpose; novel graphene materials with hierarchical structures or unique growth substrates; purpose-oriented graphene materials. The challenges for the CVD growth of general purpose graphene films and wafers include domain size, layer control, defect density, wrinkles, intrinsic surface contamination, uniformity, transferability, scalability and cost issue. Much effort are also made on the direct growth of graphene on nonmetal target substrates and it is still no way to compete with catalytic CVD graphene on metal in quality. One of the most representative examples of navel graphene materials is the graphene glass fibers developed in Beijing Graphene Institute (BGI). We have succeeded in directly growing graphene on commercially widely used glass fibers with well controlled layers and qualities. Such kinds of graphene glass fibers exhibited excellent electrical conductivities with a sheet resistance ranging from kilo-ohms down to ohms level. It has been used for deicing applications with extremely high electro-thermal conversion efficiency up to 94%. At BGI, we are also working for the purpose-oriented graphene materials and even customized graphene materials depending on the special needs and requests from customers. There is actually a great space in this area, which is particularly important before graphene films and wafers find their practical application market in next ten years.

Biography

Zhongfan Liu completed his PhD from University of Tokyo in 1990 and postdoctoral study from the same university and Institute for Molecular Science (IMS), Japan. His current research interests include the CVD growth, mass production and equipment manufacturing, and unique applications of graphene. He is the founding Director of Beijing Graphene Institute (BGI) and a BOYA chair professor of Peking University. He is the member of Chinese Academy of Sciences and the fellow of TWAS.

Recent Verifications and Applications of the Einstein-Podolsky-Rosen Argument that "Quantum Mechanics is Not a Complete Theory"

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Abstract
Nanotechnologies have been treated since their inception via quantum mechanics which, however, is solely valid for point-like approximations of the constituents under action-at-a-distance, potential interactions. Recent experiments in various fields have established beyond scientific doubt: 1) The existence of deviations from the Copenhagen interpretation of quantum mechanics for extended particles in deep mutual entanglement; 2) The 1935 historical argument by Einstein, Podolsky and Rosen (EPR) that "quantum mechanics is not a complete theory"; and 3) Recent verifications of the EPR argument achieved via the completion of quantum into hadronic mechanics, which is based on the axiom-preserving isoproduct A*B = A T B of Hermitean operators A, B, where the positive-definite operator T represents contact non-potential interactions due to the overlapping-entanglement of the wave packet of particles. In this lecture, we report that the indicated verifications of the EPR argument appear to have significant applications in nanotechnology, such as increased rapidity of calculations, improved cyber security, and increased efficiency. Due to the dimension of the literature in the field, interested colleagues are suggested to view the references below prior to the lecture.

Ultra-high Bandwidth Applications of Integrated Kerr Optical Frequency Microcombs

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Abstract

This talk will focus on our work on ultrahigh bandwidth applications of Kerr microcombs to optical neural networks, optical data transmission and microwave photonics. Convolutional neural networks (CNNs) are a powerful category of artificial neural networks that can extract the hierarchical features of raw data to greatly reduce the network complexity and enhance the accuracy for machine learning tasks such as computer vision, speech recognition, playing board games and medical diagnosis. Optical neural networks can dramatically accelerate the computing speed to overcome the inherent bandwidth bottleneck of electronics. We use a new and powerful class of micro-comb called soliton crystals that exhibit robust operation and stable generation as well as a high intrinsic efficiency with an extremely low spacing of 48.9 GHz. We demonstrate a universal optical vector convolutional accelerator operating at 11 Tera-OPS/s (TOPS) on 250,000 pixel images. We use the same hardware to form a deep optical CNN, achieving successful recognition of full 10 digits. We also report world record high data transmission over standard optical fiber from a single optical source, at 44.2 Terabits/s over the C-band. We achieve error free transmission across 75 km of standard optical fiber in the lab and over a field trial with a metropolitan optical fiber network. Our work demonstrates the ability of optical soliton crystal micro-combs to exceed other approaches in performance for the most demanding practical optical communications applications.

Biography

David J. Moss is Director of the Optical Sciences Centre at Swinburne University of Technology in Melbourne, Australia, since 2016. He was with RMIT University in Melbourne, 2014-16, the University of Sydney 2004 - 14 and was a senior manager and scientist with JDS Uniphase in Ottawa Canada from 1998-2003. From 1994-98 he was a Senior Research Fellow with the Optical Fiber Technology Centre at Sydney University prior to which he was a visiting Scientist with Hitachi Central Research Laboratories in Tokyo, Japan,1992-94. From 1988-92 was with the National Research Council of Canada in Ottawa. He received his PhD from the University of Toronto in Physics and BSc from the University of Waterloo. He won the 2011 Australian Museum Eureka Science Prize and Google Australia Prize for Innovation in Computer Science. He is a Fellow of the IEEE Photonics Society, the OSA (now the Optica Society) and the SPIE (International Photonics Society). His research interests include optical microcombs, integrated nonlinear optics, quantum optics, microwave photonics, optical neural networks, optical networks and transmission, 2D materials including graphene oxide for nonlinear optics, optical signal processing, nanophotonics, biomedical photonics for cancer diagnosis and therapy, and other areas.

Exploring Cryogenic Treatment to Enhance Properties of Magnesium based Materials

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Abstract
Magnesium-based materials are the lightest metallic materials that are capable to cut down on fuel consumption in the transportation sector (land, air, marine and space) and can mitigate global warming. They are also the natural choice for many other applications such as in defence, sports and electronics sectors provided they display the required properties. Currently, the spectrum of properties exhibited by magnesium-based materials is limited when compared to its nearest rival aluminium, which is neuro-toxic. Efforts have therefore been made, particularly in the last 20 years, to improve the properties of magnesium using different methods that include alloy design, composite technology, nanotechnology, and secondary processing. Extremely limited efforts have been made to exploit cryogenic treatment to tailor the mechanical properties of magnesium-based materials. In particular, there has not been any work done in exploring the feasibility of cryogenic treatment on magnesium-based composites. Accordingly, the present talk will focus on presenting the initial work on the effects of a suitably designed cryogenic treatment on magnesium-based composites.

Keywords
Magnesium; Cryogenic Treatment; Non-toxic Properties

Alpha, Beta, Gamma, Delta, Omicron, What's Next? Nanomedicine for COVID-19, Tissue Engineering, and So Much More

Thomas J. Webster

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Abstract
COVID-19 has shut down the world and it is not over despite vaccines, therapeutics, and hopefully soon preventive medicine. Nanomedicine, or the use of small nanomaterials in medicine, has revolutionized drug delivery, anti-infective treatments, anti-cancer therapies, tissue engineering, medical devices, and so much more. Thus, it is not surprising that nanomedicine is also being heavily investigated and used for preventing, diagnosis, and treating COVID-19. Nanomaterials have been incorporated into masks to prevent SARS-CoV-2 spreading, used as magnetic nanoparticles to improve SARS-CoV-2 isolation and detection in bodily fluids, incorporated into current vaccines developed by Moderna and Pfizer, and has been investigated as therapeutics to passivate SARS-CoV-2 from infecting cells. This talk will cover many exciting advances for the use of nanomaterials (nanoparticles, nanofibers, self-assembled materials, and more) across numerous medical applications, including the use of nanomaterials to passivate the many emerging variants of SARS-CoV-2. It will also present how nanomaterials are well positioned as versatile materials to treat new emerging diseases and pandemics.

Keywords
Nanomedicine; COVID-19; Tissue Engineering; Regenerative Medicine; Nanomaterials

Biography
Thomas J. Webster's (H index: 111; Google Scholar) degrees are in chemical engineering from the University of Pittsburgh (B.S., 1995) and in biomedical engineering from RPI (Ph.D., 2000). He has served as a professor at Purdue (2000-2005), Brown (2005-2012), and Northeastern (2012-2021) Universities and has formed over a dozen companies who have numerous FDA approved medical products currently improving human health. He has directed numerous international centers in biomaterials and has graduated over 200 students with over 750 peer-reviewed publications. Prof. Webster is a fellow of over 8 academic societies and is a Clarivate Top 0.1% Most Influential Researcher (Pharmacology and Toxicology), SCOPUS Highly Cited Researcher (top 1% citations for materials science and mixed fields) as well as a Public Library of Science (PLoS) World Top 2% Scientist by Citations in all fields.

Biosourced Carbon Materials for Energy Transition

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Abstract
Hydrogen is an energy vector that provides new solutions, complementary to the control of energy consumption and the development of renewable sources, such as electricity storage, energy network management or cleaner travel. Hydrogen, which is rarely present in gaseous form, must be produced, stored and transported, and finally converted into electricity to power an engine or any other electrical use using a hydrogen fuel cell. In the race to decrease CO_2 emissions, and although it may seem counterintuitive, carbon materials can play a key role. In 2021, the European Chemical Society (EuChemS) released an updated version of its iconic Periodic Table, first published in 2019, of the 90 natural elements that make up everything. The main change to the 2019 EuChemS Periodic Table is to change the colour of carbon from benign green to a green, red and dark grey tricolour. Green because carbon is available in abundance in the form of carbon dioxide (too abundant), carbonate rocks and vegetation. Red because CO_2 is already a serious problem and the situation will get worse if we do not do anything to limit its production. Grey because it can come from conflicting resources. If we behave responsibly by reducing our dependence on fossil fuels and never using it from conflicting resources, we can save our beautiful and diverse planet and return carbon to its rightful green colour. Carbon materials, preferably biosourced, can be used as (i) electrodes in low-temperature electrolysers to produce hydrogen; (ii) adsorbents for adsorption storage under cryogenic conditions; (iii) adsorbents for temperature-driven adsorption-desorption compression of hydrogen; and (iv) electrodes for the hydrogen fuel cell. After a brief overview of these different applications where carbon is advantageously positioned as the material of choice, I will focus my presentation on hydrogen storage and compression on carbon materials and especially on activated carbons. Their hydrogen storage and release performances will be compared with that of well-known MOFs to conclude that similar performances can be achieved with carbon materials at a much lower cost.

Keywords
Energy Transition; Hydrogen; Carbon; Adsorption

Biography
Prof. Vanessa FIERRO pursued doctoral researches at the Institute of Carbochemistry (ICB-CSIC) and obtained her PhD from Zaragoza University (Spain). After working several years as a researcher at the French Institute of Petroleum, at the Institute of Research on Catalysis and the

Environment of Lyon (France) then at the Chemical Engineering School of Tarragona (Spain), she joined the French National Centre for Scientific Research (CNRS) in 2006. She is now a CNRS Research Professor as well as a member of the Technical Group Coal 2 of the Research Fund for Coal and Steel (RFCS). She currently works at Institut Jean Lamour (France), a joint University of Lorraine-CNRS laboratory, where she leads the Biosourced Materials Research Team. Vanessa has over 330 scientific publications in international peer-reviewed journals, an h-index of 63 (Google Scholar accessed on August 10, 2022) and extensive background in the area of porous carbon materials for energy and environmental applications. Prof. Vanessa Fierro was awarded the American Carbon Society's Charles E. Pettinos Prize in 2019 and the CNRS Silver Medal in 2020.

Keynote Forum

Integrating Artificial Intelligence and Nanotechnology for Real World Applications: Pros and Cons

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Abstract

The last decade has witnessed increased population and demands for challenging applications including environmental and medical. Such challenges require using new approaches in material science and software engineering. Nanotechnology offers a precise approach for diverse applications at a molecular scale. Nanomaterials differ from bulk material in the size ; alongside other properties related to surface morphology, charge and chemical properties. Artificial intelligence has emerged lately as a branch of software engineering that enables machines to perform tasks related to human intelligence. The combination of nanotechnology and AI offer sustainable solutions for tackling climate issues (e.g. pollution), conversion of precision agriculture, offering new drug delivery approaches and personalised therapy [1, 2]. This presentation highlights the advances in AI and nanotechnology for real world applications related to environment and healthcare. In all of the aforementioned applications, connecting AI with nanotechnology provided new generation of information and made a change in society. The enhanced computational power of AI enabled more accurate design of nanomaterials that require high precise considering their scale (at microscopic level). AI analytics such as artificial neural networks (ANNs) offer interconnected nodes that can be used for supervised or unsupervised learning. ANN are applied to complex classification, association and prediction problems within the field of nanotechnology [3]. The most commonly used AI models in nanotechnology include neural network models and probabilistic graphical models both of which require large datasets. More specifically, deep learning (DL) has become very popular lately and refers to neural networks that consist of large number of layers. By using large datasets, DL is able to find optimal solutions to optimum solutions to presented problems. Subsequently, DL and other AI analytics have been used in nanotechnology at all levels ranging from the design and fabrication of nano-materials to utilising nano-materials in real life scenarios. At design level, ANN has been used for understanding the properties of nanomaterials (e.g. carbon nanotubes). Likewise, post-synthesis of nanomaterials have be predicted accurately by combining ANN with scanning electron microscopy and Raman spectroscopy. In addition, at application-level ANN can be used to study the use of nanomaterials in different applications speeding up processes and saving cost attributed to personnel need. For instance, in precision medicine, diagnostic assays based on nano-sensors allow detection of disease biomarkers in biological fluids (e.g. saliva) down to femtomolar concentrations. Moreover, interaction of

nanomaterials with biological membranes can be predicted using AI. Nonetheless, there are still some cons related to the adoption of AI in many laboratories. These limitations relate to having (1) sufficient data sets required for deep learning, (2) automated systems that generate large datasets and (3) diverse expertise especially in the field of nanotechnology that relates to physics, chemistry, biology and medicine. Considering these challenges, areas where AI has succeeded were those relating to the availability of large datasets e.g. genetic networks where billions of parameters are used to model information. Therefore, an ideal approach for AI in nanotechnology would integrate automation with AI alongside diverse expertise from multiple disciplines.

Keywords

Nanotechnology; Artificial Intelligence; Artificial Neural Networks; Prediction

References

[1] Behgounia, F. and Zohuri, B., 2020. Artificial Intelligence Integration with Nanotechnology. Journal of Nanosciences Research & Reports. SRC/JNSRR-117. DOI: doi. org/10.47363/JNSRR/2020 (2), 117, pp.2-6.
[2] Sacha, G.M. and Varona, P., 2013. Artificial intelligence in nanotechnology. Nanotechnology, 24(45), p.452002.
[3] Hrvat, F., Aleta, A., Džuho, A., Hasanić, O. and Spahić Bećirović, L., 2021, April. Artificial Intelligence in Nanotechnology: Recent Trends, Challenges and Future Perspectives. In International Conference on Medical and Biological Engineering (pp. 690-702). Springer, Cham.

Biography

Prof Dhiya Al-Jumeily OBE, (DA) is a professor of artificial intelligence (AI) at Liverpool John Moores University. He is a senior member of IEEE, the president of eSystems Engineering Society (non-profit organisation), and the founder/general series chair of the IEEE International Conference on Developments in eSystems Engineering (DeSE). DA has extensive research experience in the application of AI in multidisciplinary research including environmental, security and medicine. He has published >300 peer-reviewed articles, 17 book chapters, and edited 17 books in multidisciplinary areas that include AI-based decision-making, Smart sensing and Internet-of-Things (IoT). Moreover, he has developed AI-based applications that have been used in real settings including environmental sensing, cyber security and medical diagnosis. Dhiya has successfully supervised over 25 PhD students' studies and has been an external examiner to various UK and international universities for undergraduate programmes, postgraduate programmes and research degrees. He has been actively involved as a member of editorial board and review committee for a number peer reviewed international journals, and acts as programme committee member or as a general chair for a number of international conferences. Dhiya is also a successful entrepreneur. He is the head of enterprise for the Faculty of Engineering and Technology. He has been awarded various commercial and research grants, nationally and internationally, over £7.5M from Overseas Research and Educational Partners, UK through British Council and directly from industry with portfolio of various Knowledge Transfer Programs between academia and Industry.

Electronic Structure and Catalytic Activity of 2D Materials

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Abstract
First, first-principles calculation indicates that $TeSe_2$ is the most stable among various $Te_{1-x}Se_x$ compounds. Different from the case of bulk Te, its bulk can equally adopt three different crystal structures as well as their chiral images. Electronic band structure calculation shows that all three phases are semiconductors, where hidden spin texture or chiral spin texture is observed. In the few-layer, on the one hand, one of them is significantly more stable than the others due to the difference in the electronegativity of two kinds of atoms. In addition, each of them exhibits interesting physical property such as large electric polarization or phase transition under hole/electron doping. Second, two non-Janus configurations of MXY (M = Mo, W; X = S/Se; Y = Se/Te) monolayers are shown to be considerably more stable than Janus configuration, displaying interesting physical properties such as giant in-plane electric polarization, giant spin splitting (160− 480 meV) at the valence band maximum, and multiferroicity. Third, our DFT calculations in collaboration with an experimental group show that the best performance of $Mo_1{-}xM'_xSe_2$ (M' = Nb, V) alloy nanosheets for electrochemical hydrogen evolution reaction is observed at a specific x value with specific crystal phase depending upon the alloy material involved, where the underlying chemical structure of the alloy is determined by Gibbs free energy including configurational entropy. Finally, highly thermally stable and transparent $WO_3{-}SiO_2$ gasochromic film formation is understood using B3LYP hybrid DFT calculation.

Keywords
Hidden Spin Texture; Non-Janus Configurations; Giant Spin Splitting; Hydrogen Evolution Reaction

Biography
Professor Hong Seok Kang obtained his BSc (Chemistry) from Seoul National University and his PhD (Physical Chemistry) from KAIST, South Korea. As a professor in Jeonju University in Korea, he has been extensively involved in research for designing and understanding electronic, optical, and chemical properties of various low dimensional nanomaterials using first-principles calculation. In collaboration with sophiscated experimental groups, his interest has been recently extended to the applications of those materials in secondary battery and photocatalytic/electrocatayltic CO_2/H_2O reduction. For his research, he was awarded three major prizes: (1) Ipjae Physical Chemistry Prize from the Division of Physical Chemistry, Korean Chemical Society (2009), Breakthrough Research Award for honouring Jeonju University (2017), and Excellent Research Award supported by Ministry of Education of Government of Korea (2018). As the corresponding author, he has published many SCI papers in renowned SCI journals such as ACS Nano, Journal of American Chemical Society, and Journal of Materials Chemistry A/C, etc. Specifically, his purely theoretical papers were selected as cover articles in Journal of Physical Chemistry C. (2019), Journal of Materials Chemistry C (2018), and

Journal of Materials Chemistry A (2017). For more details on his publications, readers are recommended to refer to his homepage at https://www.jj.ac.kr/hskang/.

Bio-inspired Skin Electronics and Optoelectronics based on 2D Materials

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Abstract
Bio-inspired devices of electronic-skins and biomimetic eyes, mimicking certain functionalities of human skin and eye, have attracted considerable interest in the past decade. Bio-inspired devicesincluding E-skins and Biomimetic eyes can be used in wearable health-monitoring de-vices and in autonomous artificial intelligence systems such as robots. Two-dimensional (2D) layered semiconductors have emerged as a highly attractive class of materials for flexible and wearable strain sensor-centric devices such as electronic-skin (e-skin). The processes for patterned 2D films including shield mask growth and soft lithography have been discussed, and optimization of electronics have been studied, and high sensitivity e-skin with excellent spatial resolution have been developed.

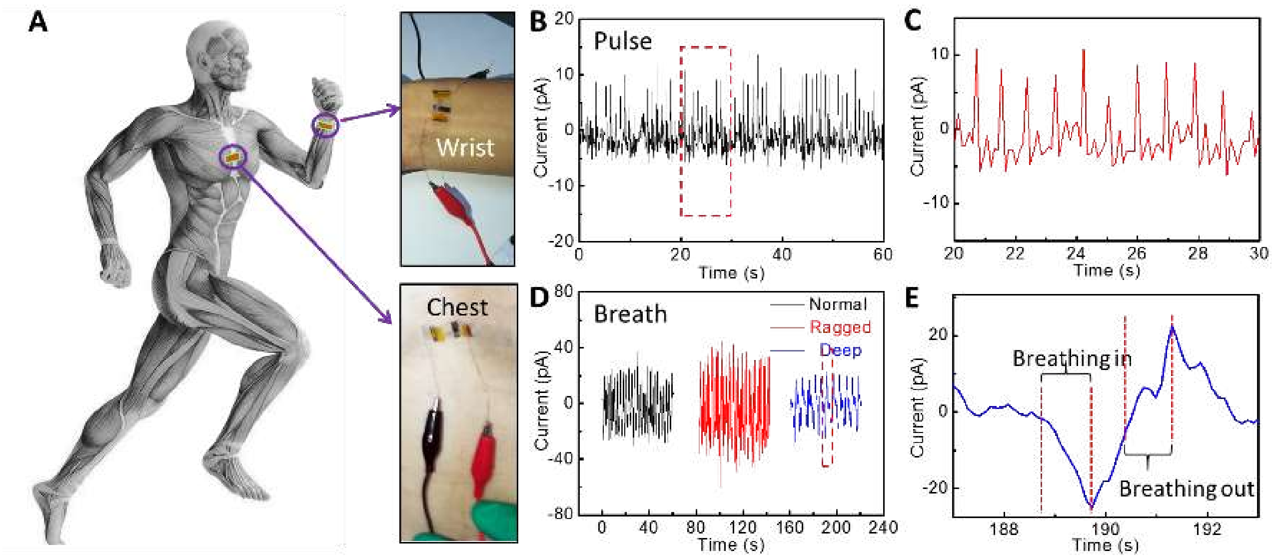

Figure 1: Wearable Electronics for Monitoring Health

References
[1] Y Hu, M Dai, W Feng, X Zhang, F Gao, S Zhang, B Tan, J Zhang, Y. Shuai, Y. Fu, and P A Hu, Ultra-low power optical synapses based on MoS_2 layers by indium-induced surface charge doping for biomimetic eyes Adv Mater, 2021,doi/epdf/10.1002/adma.202104960

[2] J Zhang, G Feng, P A Hu, A vertical transistor with a sub-1-nm channel, Nature Electronics, 2021, 325-325.
[3] Y Hu, M Dai, W Feng, X Zhang, S Zhang, B Tan, H Shang, Y Q Fu and P A Hu, Monolayer hydrophilic MoS_2 with strong charge trapping for atomically thin neuromorphic vision systems, Materials Horizons, 2020, 7 3316-3324.
[4] MJ Dai, et al, Two-Dimensional van der Waals Materials with Aligned In-Plane Po-larization

and Large Piezoelectric Effect for Self-Powered Piezoelec-tric Sensors, 2019,NanoLetter, In press.
[5] Wei Zheng, et al, Kirigami-inspired highly stretchable nanoscale devices using multi-dimensional deformation of monolayer MoS_2, Chem Mater, 2018, 30 , 6063-6070.
[6] Zhang, J, et al, Highly sensitive flexible three-axis tactile sensors based on the interface contact resistance of microstructuredgraphene. Nanoscale, 2018 10 , 7387-7395.
[7] W Feng, W Zheng, XS Chen, G Liu, T Hasan , WW Cao, P A Hu, Sensitive Electronic-Skin Strain Sensor Array Based on the Patterned Two-Dimensional α-In_2Se_3, Chem Mater, 2016, 28, 4278−4283.

High Entropy Alloy Thin Film by Atomic Layer Deposition

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Abstract
Noble metal high entropy alloy (HEA) thin film and nanoparticle as catalyst arerecently of great interest owing to the various active sites and tunable composition. In addition, the severe lattice distortion introduced by the atoms with various ratios give the catalyst high thermal and chemical stability. However, the traditional methods to synthesize bulk HEAs have severe limitations, such as uncontrollable size and morphology, costly raw material and high surface dependence. Herein, we developed two-step HEA-EJH method to achieve HEA thin film with equiatomic concentration of each noble metal. The five metallic layers were deposited in sequence by atomic layer deposition (ALD), with a thickness of 45 nm. Afterwards, electrical Joule heating (EJH) was applied to provide ultrafast ramping and cooling rate (~105/s) to alloy the noble metalswithout phase separation. XRD and STEM-EDX together showed the formation of HEA, and HRTEM shows the changes in microstructure before and after EJH. The results indicate an opportunity to fabricate HEA thin film with tunable composition and thicknesson 2D/3D surface.

$MoTe_2$ Field Effect Transistor for High-Temperature Operation

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Abstract

The two-dimensional (2D) materials-based solid-state devices are considered as the leading contenders for post-silicon electronics, optoelectronics, and memory applications [1]. The functional 2D devices are likely subjected to large thermal stress induced by high packing density in miniaturized integrated circuits along with low thermal conductivity and small heat capacity of 2D materials. In results, the large thermal stress may induce irreversible structural changes in 2D materials and affect the device performance. Therefore, in this study, we are systematically investigating the electrical and structural properties of multilayer $MoTe_2$ based field-effect transistor to high ambient temperatures (up to 673 K). We identified the optimal annealing temperature of around 500 – 525 K for the multilayer $MoTe_2$ devices, which coincides with tellurium atom dissociation temperature, suggesting permanent changes in $MoTe_2$ afterwards. Moreover, $MoTe_2$ devices surprisingly showed vanishing gate control to the degenerately p-doped characteristics at an increasing temperature to 600 K, which is caused by near range hopping transport in the defective $MoTe_2$ channel. The evolving p-type characteristics are caused by the thermally triggered oxidation of $MoTe_2$ as confirmed by XPS analysis [2]. These results will be helpful in designing practical and durable $MoTe_2$ devices.

References

[1] M.C. Lemme et al., Nature Comm. 13, 1392 (2022).
[2] F. Ahmed et al., Adv. Mater. Inter. 8, 2100950 (2021).

Keywords

2D Materials; Nanoelectronics; Field Effect Transistor

Biography

Prof. Harri Lipsanen received his PhD from Helsinki University of Technology in 1994. Since 1999 he has been a Professor of Nanotechnology in Aalto University, Finland. He has held several positions as Head of Laboratory and Department during past 20 years. In 2018 he was Nokia Foundation Visiting Professor in the University of Arizona, USA. He studies nanomaterials and nanofabrication for various applications in photonics and nanoelectronics. His current research focus on materials includes graphene and other 2D materials, compound semiconductor nanowires and their heterostructures. The nanofabrication activities extend over many methods such as atomic layer deposition, chemical vapor deposition, metalorganic vapor phase epitaxy, electron beam lithography, self-assembly etc. Prof. Lipsanen has published over 400 peer-reviewed articles.

Invited Forum

Investigation of ZnO Thin Films Doped by Rare-Earth Metals

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Abstract

Background:
One of the main problems limiting the high-efficient solar cells creation is the well-known Shockley-Queisser restriction. There are various ways which devoted increase the solar cells efficiency and circumvent mentioned constraint. One of such ways is application of up-conversion additional thin-film system attached to the solar cell with the goal to use electromagnetic waves with the large wavelength, not absorbed by the solar cell. For this goal, the large bandgap semiconductors with dissolved ionized rare-earth elements may be applied. Zinc oxide is a unique material representing a wide bandgap semiconductor of A_2B_6 group with the direct bandgap of 3.4 eV. At last time, it was found that ZnO doped by rare-earth elements can be applied as a hosting material in the thin film structures enabling anti-Stokes photoluminescence or up-conversion.

Methods:
In our work, the complex ZnO thin films with dissolved Yb and Er were prepared by magnetron co-sputtering in the pure argon atmosphere. Thin films were grown at low pressure of 3-40 mTorr and at various temperatures on different substrates: glass, silicon and gold. Prepared thin films were characterized using SEM, EDS, Raman spectroscopy, FTIR and UV-visual spectroscopy.

Results:
Basic optical properties and composition of the films in dependence on the deposition parameters were studied. Special attention was paid to photoluminescent properties of prepared samples.

Conclusions:
Provided research shows possibility creation thin film Yb and Er doped ZnO films by magnetron deposition co-sputtering method from two targets. All thin films show n-type conductivity, low resistivity, and increased band gap. Additionally, obtained films have high transmittance in the visible part of solar spectrum, and excellent adhesion to substrate.

Keywords
Magnetron Sputtering; Optical Properties; ZnO:Yb:Er; Up-conversion

Nanomaterials Exposure, Extracellular Vesicles Biogenesis and Adverse Cellular Outcomes: A Scoping Review

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Abstract

Nanomaterials (NMs) impact our daily lives due to their numerous applications, including chemistry, space, automotive, nutrition, electronics, cosmetics, textiles, medical devices, and pharmaceutical products, among others. Even though NMs offer multiple technological advantages, understanding their physicochemical properties and their interactions with the biological environment are critical elements for hazard identification, in combination with the knowledge gained on exposure scenarios necessary for risk assessment. Growing evidence demonstrates that NMs are easily accumulated and are difficult to eliminate by the human body, raising concerns about their potential harmful health effects. A plethora of studies have already revealed toxicity associated with NMs, attracting the attention of various interested entities. Emerging studies suggest that NMs alter cell communication by reshaping and altering the secretion of extracellular vesicles (EVs), leading to dysfunction in recipient cells. However, there is limited understanding of how the physicochemical characteristics of NMs alter the EVs' content and their consequent physiological functions. Therefore, in this talk the relevance of EVs in the nanotoxicology field will be explored. The current state of the art on how EVs are modulated by NM exposure and the possible regulation and modulation of signaling pathways and physiological responses will be assessed in detail. We observed that depending on the concentration and physicochemical characteristics, specific NMs promote a significant increase in EVs secretion as well as changes in their cargo, especially regarding the expression of proteins and miRNAs, which, in turn, were involved in biological processes that included cell communication, angiogenesis, and activation of the immune response, etc. Although further studies are necessary, we suggest that molecular investigations on EVs induced upon NM exposure may become a potential tool for toxicological studies since they are widely accessible biomarkers that may bridge NMs exposure with the cellular response and pathological outcome.

Deciphering Mammalian Gene Control at the Molecular Level

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Abstract
In mammalian cells, multi-protein complexes form at specific genomic regulatory elements (REs) to control expression of the associated genes and are in turn ultimately responsible for cellular identity. Consequently, insight into which proteins form part of specific regulatory complexes is of major importance for our understanding of any physiological or pathological cellular state or transition. It remains, however, extremely difficult to characterize the molecular composition of a regulatory complex formed at a specific RE using conventional approaches. We therefore developed a novel single locus isolation technique based on Transcription Activator-Like Effector (TALE) proteins termed TALE-mediated isolation of nuclear chromatin (TINC). When coupled with high-resolution mass spectrometry, TINC enables the identification and characterization of protein complexes formed at REs of interest. Targeting the Nanog promoter in mouse embryonic stem cells (ESCs) as proof of concept, TINC enabled the identification of many known and previously unknown interactors, including RCOR2. Further interrogation of the role of RCOR2 in ESCs revealed its involvement in the repression of lineage genes and the fine-tuning of pluripotency genes. This work consequently not only demonstrated the power of TINC to provide insight into the molecular makeup of specific transcriptional complexes formed at individual REs but also into the molecular basis of pluripotency maintenance of ESCs.

Nano-fertilizers as an Alternative to Chemical Fertilizers

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Abstract

The population of world is steadily increasing,in contrast to the natural resources (minerals and water reserves) which are limited and subjected to further depletion. Thisinduces pressures todevelopaneffective agricultural production systems to meet the growing demands on food and, thus, to mitigate hunger and poverty worldwide.Generally, fertilizers play a crucial role in maintaining soil fertility and improving crop quality and yield. Chemical fertilizers (primarily, N, P, and K macronutrients) are regarded as the main source to supply crops with their needs of nutrients.Proper nutrient management of crops is a major challenge worldwide as it relies predominantly on chemical fertilizers. However, chemical fertilizers are not only costly, but may be harmful and pose risk to humans health and have negative impacts on the environment. According to their perceptions, farmers usually apply large quantities of chemical fertilizers to obtain higher crop yields. However, about half of the amount of applied fertilizers is used by the crop, whereas the remaining of fertilizersis lost through leaching and gaseous emissions. These nutrients losses contribute to environmental pollution, global warming and then climate change. Moreover, high applicationrates of chemical fertilizerscan deteriorate soil fertility and raise soil salinity and thus lowercrop production and quality will occur.This creates a need to invent smartfertilizers that are friendly to the environment, particularly those of high nutrientuse efficiency and low leaching potential.Nanotechnology has a vital role in the construction of such fertilizers (called nanofertlizers).In these fertilizers, nutrients are bound to nano-dimensional adsorbents (called nanomaterials of nanoparticle size, 1 to 100 nm), which release nutrients very slowly as compared to conventional fertilizers. Nanofertilizers are nutrients coated or encapsulated with different types of nanomaterials. They have unique properties like large surface area, slow release and controlled delivery of nutrients to the targeted sites, in leaves or roots, to meet the nutrient requirements of crops. This technology not only increases nutrient-use efficiency, but also minimizes nutrient losses by leaching. Furthermore, nanofertilizers may also be used for enhancing abiotic stress tolerance, and used in combination with microorganisms (nanobiofertilizers). Nanofertilizers are emerging as a promising alternative to the conventional chemical fertilizers.These new fertilizers offer great opportunities to improve plant nutrition management to achieve reasonable yields underharsh environmentalconditions.The benefits associated with the use of nanofertilizers are definitely opening new approaches towards development of sustainable agriculture. However, further studies are needed for a sound and safe application of nanofertilizers in this vital sector which is the backbone of countries economy.In this review, researchers' attempts to produce and use nanofertilizers for sustainable crop production have been presented. The advantages and limitations of the application of these smart fertilizers have also been indicated.

Keywords
Nanofertilizers; Nanoparticles; Sustainable Agriculture; Nutrient Use Efficiency

Biography
Asad Alkhader obtained his PhD. (Horticulture and Crop Science/Plant Nutrition), MSc and BSc (Soils and Irrigation) from University of Jordan. He is the Director of Water and Soil Research Directorate at the National Agricultural Research Center (NARC). He is considered an expert researcher in plant nutrient and irrigation water management. He has published seven articles in reputed Journals, and participated in several local, regional and international conferences, workshops and forums. He reviewed many manuscripts for reputed international Journals. He conducted trainings for extension agents and farmers on plant nutrient and irrigation management issues using high fertigation technologies. He is a member of the National Fertilizers Registration Committee.

Chemical Modification of Carbon Nanomaterials and their Potential for Sustainable Technologies

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Abstract
With its ability to adopt several hybridizations, carbon is one of the most versatile elements of the periodic table of the elements. The consequent different carbon atom arrangements in the materials lead to several carbon allotropes such as diamond and graphite but also nanomaterials: carbon nanotubes and graphene. These latter are especially amazing since they possess a unique combination of remarkable properties: lightness, high accessible surface, very good chemical stability, high mechanical properties and high electronic and remarkable thermal conductivity. And they are widely known for the high potential they for a myriad of possible applications especially to develop sustainable technologies for the future. However, carbon nanomaterials are highly hydrophobic which hampers their facile processing and shaping for designing new carbon-based materials.Their chemicalmodification by either non covalent or covalent methodis hence required to improve their processability. In this paper, several examples of modified carbon-based materials in view of their respective to reduce the environmental impactwill be described and discussed. The applications targeted by these nanocarbon carbon-based nanomaterialsare biocatalysisfor green chemistry, activated graphene for CO_2 capture and graphene-based nanofluids for heat transfer.

X-ray Absorption Spectroscopy for Advanced Investigation of Energy Conversion and Conservation Materials

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Abstract
The materials scientists are devoted to searching for sustainable and clean energy in response to the global surge in demand for energy. It has never been easy to be green without developing advanced renewable energy materials. We have to approach the clean future from different angles. The universal emphasis on energy is to develop advanced functional materials for more efficient energy conversion and conservation. To improve the energy conversion or conservation efficiency of current energy materials is always a great challenge. Most of the physical and chemical properties of a material is strongly correlated to its unique atomic and electronic structures. It is difficult to better engineer the materials for a greater performance in an efficient way without knowing its atomic and electronic structures, and particularly how they adjust in the operating condition. Synchrotron x-ray spectroscopies, including x-ray absorption and x-ray emission spectroscopies are prevailing tools to study the local unoccupied and occupied electronic states. Moreover, utilization of the in situ technique that gives the opportunity to track the modulations of atomic and electronic structures of the energy material at work. The x-ray spectro-microscopic approach, scanning transmission x-ray microscopy providing the spatially resolved x-ray spectroscopy, is also gearing up for emerging energy science. This report will showcase the significances of using x-ray spectroscopies for atomic and electronic structure characterizations of several important energy material systems, such as artificial photosynthesis materials, advanced nanocatalysts, and smart materials.

Keywords
X-ray Absorption Spectroscopy; Nano-catalyst; Smart Materials; Atomic and Electronic Structures

Biography
Chung-Li Dong received his Ph.D. in Physics from Tamkang University in 2004. He conducted the postdoctoral research at the Institute of Physics, Academia Sinica, Taiwan, and Advanced Light Source, Lawrence Berkeley National Laboratory, USA during 2005-2009. In 2009-2015, he was an assistant scientist at the National Synchrotron Radiation Research Center. He is currently a professor at Research Center for X-ray Science & Department of Physics, Tamkang University, Taiwan. His research focuses on the synchrotron-based and in situ/operando spectroscopic studies of atomic and electronic structures of advanced nanostructured and energy materials.

Nanostructures for Single-protein Characterisation

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Abstract
Studying the conformation of individual proteins is essential for determining their functions within the human body, particularly in relation to both health and disease. Ideally, experiments aiming to understand the role of conformational changes for protein function proceed on the single-molecule level since averaging makes it impossible to resolve individual steps, their dynamics, and rare events. Here I will discuss two single-molecule techniques central to my research – nanopore sensing and plasmonic optical tweezers. Nanopore techniques measure the ionic current of a nanochannel as a target molecule diffuses through and relate this electrical signal directly to the physical and chemical properties of the analyte. Plasmonic optical tweezers can detect biomolecular interactions in real-time by measuring the shift in the plasmonic resonance of a nanostructure in response to the presence of a trapped protein, thereby offering a rapid, simple and non-invasive technique for studying biochemical processes in real-time.

Keywords
Single-molecule Sensing; Nanopore; Nanoplasmonic; Protein Characterisation

Biography
Dr. Cuifeng Ying is a senior lecturer at the Department of Engineering at the School of Science and Technology https://www.ntu.ac.uk/staff-profiles/science-technology/cuifeng-ying. Cuifeng has been working on designing and applying engineered nanoscale structures for biosensing applications. Specifically, her research focuses on using plasmonic/dielectric nanostructures and nanopore technology for DNA sensing and protein characterisation at a single-molecule level. She has authored/co-authored more than 30 peer-reviewed journal papers with a total citation of over 900 and an h-index of 13. She serves as a Co-guest Editor for the journal nanomaterials and a regular reviewer for several journals of the American Chemical Society (ACS) such as ACS sensors, ACS applied nanomaterials.

Tunable CNT Surfaces for THz Wave Applications

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Abstract

The research and development in the frequency region of 0.1-1.0 THz is extremely significant for the wide range of applications, such as telecommunication and imaging systems, material spectroscopy, medical imaging and treatments, etc. Despite the problems in technology and high prices for basic components (phase shifters, directional couplers, etc.), the THz systems offer higher date rates for telecommunication, high spatial resolution in the visualization of objects, small size of antennas and other elements. The state-of-the-art of the THz devices reveals serious problems with radiation sources with continuous wave semiconductor-based source, electronically tunable phase shifters, etc.

Carbon nanotubes (CNT) offer unique properties due to their natural small dimensions and outstanding electrical properties. Their tunability properties make them very attractive in application to the THz system. Integration of CNTs with the dielectric rod waveguide (DRW) technology transferred from cellulose membranes onto other substrates (sapphire DRW, optical glass, polished silicon) by direct dry transfer enables a novel technology platform for tunable THz systems.

Phase shifter can be developed by introducing the optically controlled varactor to the DRW. The phase change of 10-20 deg with almost negligible change in attenuation less than 0.1 dB can be achieved (Fig.1) in the frequency range of 75-500 GHz. Besides, DRWs have no cut-off frequency enabling broad band operation.

The effect of the dielectric constant tuning of single-walled carbon nanotubes under light illumination is observed in the very wide frequency range of 0.1–1 THz. The optical absorption spectrum is not uniform and it consists of several absorption peaks related to electron transitions. Therefore, the change of capacity and resistance under different light wavelength illumination is different at different wavelengths.

The losses are attributed to the electromagnetic absorption by the CNT layers with differences stemming from variations in nanotube densities and total lengths of the transferred samples on the DRWs. The increased absorbance at lower frequencies has also been previously observed for CNTs.

Carbon based nanomaterials are perspective materials for very wide applications in millimeter wave and THz frequency range. Phase shifter based on DRW loaded with CNT layer is a perspective candidate for ultra-wide band device application. The ultra-wide band optically

controlled CNT-based phase shifter can enable THz beam steering.

Keywords
Carbon Nanotubes; Beam Steering; THz Waves

Biography
Prof. Dmitri V. Lioubtchenko was born Gorky, Russia, in May 1971. He received B.S., M.S., and Ph.D. degrees in applied physics and mathematics from the Department of Physical and Quantum Electronics, Moscow Institute of Physics and Technology, Moscow, Russia, in 1993, 1994, and 1998, respectively. From 1994 to 1997, he was a Researcher in the Institute of Radio-engineering and Electronics, Russian Academy of Sciences, Moscow, Russia. From 1997 to 1998 he was a visiting post-doctoral researcher at The University of Liverpool, Liverpool, U.K. In 1998, he joined the Radio Laboratory of Helsinki University of Technology, now Aalto University, Finland, where he was a Docent from 2005 and from 2008 till 2013 he was Finnish Academy Research Fellow. In 2017 received a Docentship at the Department of Micro and Nano Science, KTH, Sweden. From 2019 he is Full Professor in the Institute of High-Pressure Physics, Polish Academy of Science. He was a visiting researcher at The University of Liverpool, Trinity College, University of Dublin, Chalmers University of Technology, Sweden, Universidad Carlos III de Madrid (COST VISTA program). He was a member of the EuMA General Assembly (GA) January 2016 – December 2018. He has more than 25-year experience in electrical engineering especially in the development of new materials for millimetre, microwave, and optoelectronic applications particularly, on the development of active and passive dielectric waveguides and components for the frequency above 100 GHz. He has published more than 150 papers in refereed books, journals and conferences.

β-Amyloid Fibrils Catalyze Neurotransmitter Degradation

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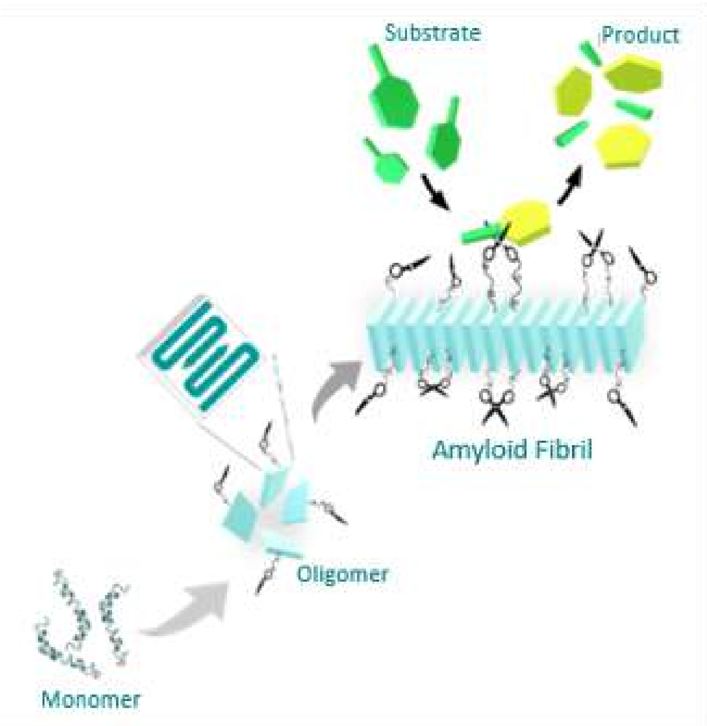
Abstract

Figure 1: β-amyloid (Aβ42) Assembles b-sheet Fibrillar Structure with Bio-catalytic Activity



Amyloid fibrils are one of the hallmarks of Alzheimer's disease (AD), although a causative link between plaque-forming amyloid fibrils and AD pathology remains to be clarified. This study demonstrates, for the first time for a naturally occurring amyloid, that fibrils comprising the 42-residue Amyloid-β peptides (Aβ42) exhibit significant catalytic properties. Aβ42 fibrils catalyzed the hydrolysis of the model ester, para-nitrophenyl acetate (pNPA), and of acetylthiocholine, a surrogate for the neurotransmitter acetylcholine. Aβ42 fibrils also catalyzed the oxidation of the prominent neurotransmitters, dopamine and adrenaline. Importantly, the catalytic activity was specifically exhibited by mature Aβ42 fibrils, as opposed to the peptide monomers, or oligomeric Aβ42, the putative neurotoxic species. Importantly, maximal catalytic activity was exerted by the full-length Aβ42 fibrils, whereas fibrillar assemblies comprising

Aβ42 sub domains exhibited significantly lower catalytic activity. The catalytic activity of Aβ fibrils may be implicated in patho-physiology pathways associated with the generation of AD amyloid plaques.

References

[1] A. Arad, A.Baruch Leshem, H. Rapaport and R. Jelinek Chem Catalysis (2021),1,4.

Role of Critical Coupling for Extreme Enhancement of the Quality (Q)-factor and Mode Field Intensity in CRIGF Devices

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Abstract
Resonant planar dielectric gratings incorporated in a Bragg mirror box, known as Cavity-Resonant Integrated-Grating Filters, are numerically optimized to achieve extremely high quality factors by adjusting the cavity in/out-coupling rate and by introducing apodizing mode-matching sections to reduce the scattering losses at the boundaries between the different constitutive grating regions. Q-factors gradually ranging between 0.1 and 50 million are obtained and two different domains are distinguished as a function of the perturbation parameter. In the first case where the coupling Q-factor, Q-coupling, is lower than the one resulting from the other cavity losses (referred hereafter as Fabry-Perot (FP) Q-factor, QFP), and which corresponds to the over-coupling regime, the reflectivity response exhibits a high resonance maximum. On the contrary, in the under-coupling regime (with QFP< Q-coupling), the resonant reflectivity maxima are much weaker since the scattering at the grating boundaries becomes the predominant loss channel. Between these two domains, the so-called critical coupling condition leads to very strong field enhancement inside the device reaching up to 104 times the incident field amplitude. This numeric-theoretical work paves the way towards the practical implementation of CRIGFs with much higher Q-factors than currently demonstrated, potentially reaching performance on a par with other resonators such as photonic crystal cavities or whispering gallery mode resonators.

Keywords
Diffraction Gratings; Resonant Waveguides; Critical Coupling

Biography
Evgeny Popov (1956) has obtained his PhD (1988) and ScD (1991) for the works on anomalies of diffraction gratings in the Institute of Solid State Physics (Bulgarian Academy of Sciences, Sofia) where he worked as a researcher, assistant and full professor till 2000. Since then he is a full professor in Aix-Marseille University, Marseille, France, teaching physics and mathematical

methods of physics at undergraduate and graduate level. His research in the Institute Fresnel covers different topics of electromagnetic optics, scientific optical instrumentation, and diffraction modelling using spectral methods such as Fourier modal method, differential and surface integral methods, coordinate transformation, and modal method. Evgeny Popov is a senior member of Institut Universitaire de France and Fellow of Optical Society of America.

Synthesis of Graphene Films towards Industrial Production

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Abstract

Since its invention in 2009, Cu based chemical vapor deposition (CVD) method has been the main technology for preparing large-area and high-quality graphene films, both in academia and industry. Here, I will introduce our recent work in the development of graphene film synthesis to industrial production from the aspects of materials, equipment, and process. We have found that oriented graphene domains can grow on Cu substrates with a large surface crystallographic structure tolerance and attributed it to the single lowest energy state of graphene nucleation. Carbon impurity in Cu substrate is a crucial issue disturbing the epitaxial growth of graphene on Cu, which can be suppressed by oxygen pre-treatment. Carbon impurity from the background atmosphere, e.g, from the oil vapor when an oil pump is used for a low-pressure CVD process, may also contaminate the reaction chamber and disturb graphene growth. The effect of oxygen is nonmonotonic, i.e., with the increase of oxygen, graphene adlayers are etched without damaging the top layer, then shift to growth, and finally all layers are etched. An oxygen-assisted exchange penetration model is proposed. On the other hand, the uncontrolled oxygen contamination may affect the reliability of the equipment. A typical example is the Cu deposition on the quartz tube at the regions corresponding to the two ends of the furnace heating zone. The accumulated Cu deposits are inevitably oxidized to form Cu2O and CuO, which result in an introduction of water either due to the desorption of water adsorbed on the rough surface or the reduction of oxides by hydrogen and methane and therefore lead to a non-steady state for graphene growth and significantly reduce the system reliability. The loading configuration of Cu substrate may also affect the growth of graphene adlayers. Equivalent carbon concentration on both sides of Cu foils is preferred so as to avoid adlayer growth due to backside diffusion. At the end, I will introduce a breath CVD method for large-area low-cost production of graphene films. A Cu foil substrate can be rolled into a spiral to increase the substrate loading density. Graphite mat strips are placed between the Cu layers at the two ends of the spiral to avoid Cu layer adhesion at high temperature while leaving enough space inside the Cu spiral for gas exchange. Reactant gases are introduced in a way similar to breathing by repeatedly increasing and decreasing the pressure inside the reactor as well as the Cu spiral, which assists gas exchange. In addition, in order to avoid the collapse of the middle Cu layers due to high temperature softening and gravity, the Cu spiral is placed vertically. With this method, both the size and throughput of graphene films can be an order of magnitude larger than conventional methods.

Keywords
Graphene; Chemical Vapor Deposition; Epitaxial; Industrial Production

Biography
Dr. Fangzhu Qing is an associate professor at the University of Electronic Science and Technology of China (UESTC). She received her PhD degree in materials science from Sichuan University and then joined UESTC in 2015. She worked as a visiting scholar in the Microelectronics Research Center at the University of Texas-Austin in 2019. Her current research interests focus on the synthesis and application of graphene and other 2D materials.

Tailor-made Drug and Gene Delivery Nanosystems to Mediate Antitumor Strategies

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Abstract
Cancer is one of the major causes of death worldwide, highlighting the urgent need for the development of new therapeutic approaches, such as those involving gene therapy and chemotherapy mediated by nanosystems, that present higher therapeutic efficacy and lesser side effects than conventional treatments. In this regard, one of our main goals is to develop nanosystems that have the ability to efficiently deliver the therapeutic agents into target cells.

We have developed several lipid- and polymer-based formulations. Regarding the lipid-based nanosystems, our results showed that the association of ligands such as asialofetuin to cationic liposomes, promotes a substantial increase in their transfection activity in hepatocellular carcinoma cells both in vitro and in vivo. Regarding the polymers-based nanosystems, our data demonstrated that the best mixtures between PDMAEMA and PβAE homopolymers presented a much higher transfection activity, in the presence of serum, than that obtained with bPEI-based or block copolymer-based polyplexes. Moreover, PEGylation of PAMA-based polyplexes showed that PEG-b-PAMA-based polyplexes exhibited much better biological activity/cytotoxicity relationship than the corresponding non-PEGylated nanocarriers. Regarding the physicochemical properties, the developed nanosystems presented high protection of genetic material and reduced sizes, which are suitable features for in vivo applications.On the other hand, new hybrid nanosystems consisting of a polymericcore coated by a lipid bilayer, containing a specific ligand to the asialoglycoprotein receptor, presented high drug loading capacity as well asgreat specificity and antitumor activity in target cells. The new hybridnanosystems exhibited suitable physicochemical properties for in vivo applications.

Our data show that the developed nano-formulations present a noticeable ability to efficiently deliver genetic material and drugs into target cells, consequently constituting new nanoplatforms to mediate novel antitumor strategies.

Biography
Henrique Faneca obtained his Ph.D. degree in Biochemistry in 2005 at University of Coimbra. He is Principal Investigator, at Center for Neuroscience and Cell Biology (CNC), University of Coimbra, since November 2016, leading the research group: Nanosystems and targeted antitumor strategies. The activity of his research group is focused on the development and characterization of nanosystems that allow an efficient and specific delivery of therapeutic agents into target cells, and on the generation of new multitarget antitumor strategies, such as those involving the combination of gene therapy and chemotherapy.

Keywords
Nanosystems for Drug and Gene Delivery; Gene Delivery; Drug Delivery; Cancer Therapy

High Mobility Emissive Organic Semiconductors and Devices

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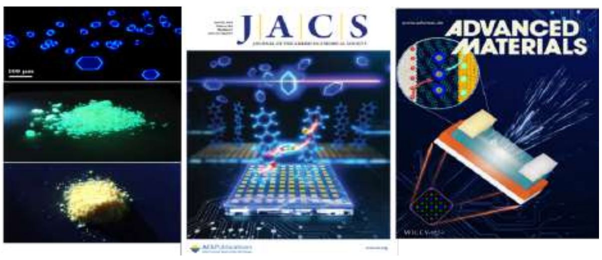
Abstract

The integration of high charge carrier mobility and high luminescence in an organic semiconductor is challenging and has been mutually exclusive due to their different requirements of the inherent nature of molecular structures and aggregate states. However, there is highly need of such materials for organic light-emitting transistors and organic electrically pumped lasers. Aiming at this scientific question, currently we have carried out systematical investigation in this field and developed a series of high mobility emissive organic semiconductors from the aspects of molecule design and crystal engineering. For instance, we developed a novel organic semiconductor, 2,6-diphenylanthracene (DPA), which exhibits not only high blue emission with single crystal absolute florescence quantum yield of 41.2% but also high charge carrier mobility with single crystal mobility of 34 $cm^2 V^{-1} s^{-1}$ [1]. Furthermore, a series of anthracene-based high mobility emissive organic semiconductors are successfully synthesized with different color emissions by rationally adjusting the molecular conjugation and structures [2]. Inspired by the above investigation, an important development has been further achieved for high mobility organic laser semiconductors based on fluorene building blocks [3]. 2,7-diphenyl-9H-fluorene (LD-1) as an representative laser molecule exhibited state-of-the-art integrated optoelectronic properties with a high mobility, a high photoluminescence quantum yield, and also superior deep-blue laser characteristics (low threshold of Pth = 71 μJ cm^{-2} and Pth = 53 μJ cm^{-2} and high quality factor (Q) of ~3100 and ~2700 at emission peaks of 390 and 410 nm, respectively) [4]. Based on these superior integrated optoelectronic organic semiconductors, we explored their applications in light-emitting transistors based on planar and vertical device geometries. Based on DPA semiconductor, we successfully realized high performance single-component OLET devices which demonstrated typical ambipolar electroluminescence characters with tunable light emission positions in the conducting channel [4, 5]. In this talk, I will give a brief introduction for these progresses.

Keywords

Organic Semiconductor, High Mobility; Strong Emission; Light-emitting Transistor



References

[1] J. Liu, et al., High mobility emissive organic semiconductor. Nat Commun, 6, 10032 (2015).
[2] Z. Xie, et al., Recent Advances on High Mobility Emissive Anthracene-derived Organic Semiconductors, Chem. J. Chinese U.6, 1179 (2020).
[3] Z. Qin, et al., High-Efficiency Single-Component Organic Light-Emitting Transistors. Adv Mater, 31, e1903175 (2019).
[4] D. Liu, et al., Organic Laser Molecule with High Mobility, High Photoluminescence Quantum Yield, and Deep-Blue Lasing Characteristics. J Am Chem Soc, 142, 6332 (2020).
[5] Z. Qin, H. Gao, H. Dong, W. Hu, Organic Light-Emitting Transistors Entering a New Development Stage. Adv Mater, 33, e2007149 (2021).

Biography

Prof. Dr. Huanli Dong is a professor of Institute of Chemistry, Chinese Academy of Sciences. She received her Ph.D. degree from the institute in 2009 after she got her M.S. degree from Fujian Institute of Research on the Structure of Material, CAS, in 2006. Her current research focuses on organic semiconductor crystals including organic small molecules and conjugated polymers by material science and growth technology and their applications in OFETs, integrated optoelectronic devices, and circuits.

Hybrid Graphene/Silicon Integrated Photodetectors

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Abstract

Two-dimensional (2D) materials and van der Waals (vdW) heterostructures have shown tremendous potential for light detection applications, opening new avenues in developing novel, high-performance and broadband photodetectors (PDs) beyond state-of-the-art. A variety of high-performance 2D, hybrid-2D and vdW PDs with ultra-high responsivity, sensitivity and ultra-broad spectral response have been reported so far based on graphene, transition metal dichalcogenides (TMDs), III-VI group layered semiconductors, black phosphorous, and more, covering the visible, infrared and terahertz spectra. Nevertheless, the field is far from reaching its saturation. Quite the opposite, the rich portfolio of 2D materials and newly emerging physical phenomena in vdW heterostructures, together with favourable heterogeneous integration of 2D systems with silicon technology, CMOS read-out electronics and flexible platforms, set new horizons for the development of innovative 2D integrated PDs. In this talk, I will focus on graphene integration with silicon photonics for telecom applications and multispectral photodetection. Key aspects related to device physics, material properties, fabrication process development and system performances will be discussed.

Biography

Dr. Ilya Goykhman is an Assistant Professor at the Faculty of Electrical and Computer Engineering and Head of Laboratory for Nanoscale and Quantum Optoelectronics at Technion. Prior to joining Technion, Dr Goykhman was a Senior Research Associate at the Cambridge Graphene Centre (CGC) and a Lecturer at the Centre for Doctoral Training at the University of Cambridge. He is a task leader on Broadband PDs in the optoelectronics work package in the EU Graphene flagship project. His main research interests span the integrated 2D optoelectronics, device physics, technology development of graphene and 2D materials, 2D/3D hybrid systems for applications in communication, light generation, quantum optics and sensing.

Modification of Montmorillonite as a Reinforcing Filler for Nanocomposites with Various Polymeric Matrices

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Abstract
Selected results will be presented of our over 20 years lasting investigations of nanocomposites with polymeric or elastomeric matrices, filled with various types of organomodified montmorillonite (MMT). First important outcome is related to a development of a method of fast determination of the optimal surface modification of the MMT using rheological measurements. Generally, the organomodification of MMT for reinforcing of a particular polymer is tested by measurements of physical, mainly mechanical properties of MMT mixed with the polymeric matrix. However, observation of dispersions of organomodified MMT in various solvents is much easier and faster since no presence of polymer is needed. Visual observation may identify four main forms of the dispersion, first is quickly sedimenting suspension corresponding to incompatibility, second is slowly sedimenting dispersion, third is stable dispersion and the fourth manifests itself as a gel with certain mechanical strength. Each form may be determined by a typical rheological behaviour clearly distinguishable according to records of G’ and G’’ curves with changing frequency. The prediction of behaviour of any surface organomodification of MMT is based on the comparison of Hildebrand solubility parameters of particular solvents with those of selected polymers. If the solubility parameters of a solvent and the polymer are similar, the behavior of the MMT-filled polymer is supposed to correspond with the compatibility / incompatibility of the pair modified MMT – solvent.

Further on, three interesting results related to preparation and testing of selected polymers reinforced with various organomodified MMTs will be discussed. None of the modified MMTs was of commercial origin; all modifiers were synthesized and consequently attached to the MMT surface. First, several different MMTs were compared as fillers in various polymers, especially in polyolefins, biodegradable poly(butylene adipate terephthalate), and few others, second, quite detailed investigation was made on nanocomposites with elastomeric matrices, especially natural rubber, as well as SBR and EPDM, where interesting and somewhat surprising results were found, different id compared to the thermoplastic matrices, and third, investigation of a possibility of reinforcing thermoplastic starch (TPS) by modified MMT aimed to modification of TPS properties to reach higher strength parameters and increased resistance towards moisture. The third investigation was aimed mainly to the increase of physical properties of mixtures TPS / biodegradable biopolymers in mixtures where the TPS served mainly as an inexpensive filler but also an option was followed to the application of TPS as the matrix for low-cost environmentally friendly polymeric materials with increased application range.

Acknowledgement
Projects of Slovak grant agencies APVV 20-0593, APVV 18-0420, APVV 19-0487 and the project ERANET EnACTIVEtics.

Keywords
Nanocomposites; Montmorillonite; Polymeric Matrix; Thermoplastic Starch

Biography
Prof. Ivan Chodak is a senior scientist, former head (1982 – 2009) of Department of Composite Materials in Polymer Institute of the Slovak Academy of Sciences, Bratislava. He is the author and co-author of over 170 scientific papers, H-index = 33. His scientific interests are aimed to multiphase polymeric systems, mainly to electroconductive composites with polymeric matrices, polymer nanocomposites and biodegradable polymer blends. In the latter topic, besides number of publications as well as several patents (one being commercialized in Slovakia), he participated for 12 years as a member of the expert group in workshops organized by ICS UNIDO Trieste on biodegradable plastics all over the world (2-4 workshops each year in e.g. Brazil, Egypt, Indonesia, Qatar, Bahrain, Uganda, Korea, UAE, Serbia, Poland, Slovakia, etc.). Recently his activities are also aimed to development and application of biomaterials based on thermoplastic starch as major component of the polymeric systems. In the period 2005 - 2009 he served as a member of Presidium of the Slovak Academy of Sciences (elected position), for almost 20 years he lectured Polymer Physics as external teacher at two universities, namely Slovak Technical University and Trencin University of Alexander Dubcek. From 2012 he is the elected member of the Slovak Learned Society.

Efficient Thermo-chromic VO_2 Thin Films Formed After a Two-step Process

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Abstract

Thanks to its metal-to-insulator transition (MIT) temperature not so far from the ambient one, thermochromic VO_2 exhibits great potentiality in smart coatings devoted to energy purposes. Among different methods to synthesize VO_2 films, reactive sputter deposition remains one of the most suitable for cost-effective industrial-scale production. For a few decades, increasing attention has been paid to a fast and relatively simple approach based on two steps to produce thermochromic VO_2 thin films: in the first stage, a vanadium (V) thin film is sputter deposited, and in the second one, a subsequent air-oxidation of the metallic film at moderate temperatures (often less than 500 °C) is performed to form the VO_2 phase. Recently, it has been revealed that oxidation of vanadium nitride (VN) thin films also give rise to the formation of thermochromic VO_2. This work aims to compare the thermochromic properties of VO_2 films achieved after thermal air oxidation of V and VN thin films prepared by sputtering deposition from an elemental vanadium target. For both precursors, short-time air annealing (from 60 to 300 seconds) was performed at 550 °C. X-ray diffraction and Raman spectroscopy depicted that the thermal oxidation domain allowing the formation of the thermochromic VO_2 phase was enlarged for VN as compared to V precursor films. These results were confirmed by electrical measurements of the resulting oxides in the temperature region that encompass the MIT of thermochromic m-VO_2. Finally, a particular focus was made on the oxides of the VN series in terms of their infrared properties. The results indicate that the oxidation of VN precursor allows the synthesis of monoclinic VO_2 films displaying good thermochromic properties with narrower hysteresis widths (< 9.3 °C) as compared to those obtained by vanadium film's oxidation, making VN precursor of particular interest for industrial upscaling.

Biography

Dr. Jean-François PIERSON was born in 1971, he is full Professor at the University of Lorraine. He is currently the head of the department Chemistry and Physics of Solids and Surfaces (approx. 150 people) of the Institut Jean Lamour (UMR CNRS 7198). His research is dedicated to the elaboration by magnetron sputtering and the characterization of thin films (oxides, nitrides and metallic glasses) for energy, optical and electrical applications. He has published more than 150 papers in international journals and he is co-author of 6 international patents.

Synthesis and Characterization of Carbon Quantum Dots (CQD) Derived from Waste Biomass

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Abstract
In the present study, carbon quantum dots (CQD) derived from waste rapeseed extrudate were synthesized. Carbon nanoparticles were obtained in a microwave radiation field, with no other external stabilising agents; the processes were conducted in an aqueous environment. Three input parameters were applied, at three levels of variation. These were microwave (MW) process temperature (120, 180 or 240°C), microwave process time (1, 2 or 3 h) and ultrasound homogenisation time (0, 90 or 180 sec) of the samples before processing. Only the processes conducted at the lowest temperature were successful. UV-Vis spectroscopy was applied to the identification of desired products and the characterisation of their morphology was performed by the TEM-EDS technique. The size of CQD measured with the DLS technique was less than 10 nm. Carbon quantum dots may be applied in many industrial and scientific applications such as in vitro imaging of cell structures, synthesis of optoelectronic materials, creation of energy storage devices and biosensors.

Keywords
Nanotechnology; Carbon dots; Nanoparticles; Rapeseed

Biography
Jolanta Pulit-Prociak, PhD, Eng., received her MSc degree in Light organic technology from Cracow University of Technology (Poland) and also PhD degree in Chemical Technology from the same University. Currently, she works as an assistant professor in the Faculty of Chemical Engineering and Technology at the Cracow University of Technology. Her research of specialization includes development of new, pro-ecological methods of obtaining metallic and metal oxides nanoparticles, and checking the possibility of their use in consumer products, with consideration of their impact on the natural environment. She is a co-author of over 50 publications in a number of scientific journals. She has been leading scientific project on development of nontoxic nanometric drug carriers.

To Manipulate Energy Gap of Lead-free Double Perovskite

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Abstract

The organic-inorganic hybrid perovskite ABX_3 solar cell has developed very rapidly, and its efficiency has increased rapidly, which is close to the photoelectric conversion efficiency of monocrystalline silicon cell, but it contains lead which is toxic to human body. At present, the photovoltaic efficiency of tin based materials in non-lead perovskite is the highest, which has exceeded 14%, but Sn^{2+} is easy to be oxidized to Sn^{4+} [1]. Non-lead double perovskite structure, such as $Cs_2AgBiBr_6$, is very stable. In our previous research, we took the lead in obtaining high-quality $Cs_2AgBiBr_6$ film without pinholes [2], but the highest photovoltaic efficiency reported in the literature is only 3%, which is mainly limited by its optical energy gap of nearly 2 eV (too wide), resulting in insufficient optical absorption. Therefore, it is necessary to study how to regulate the energy gap of double perovskite.

Herein, Fe^{2+} is chosen as the dopant to alloy into $Cs_2AgBiBr_6$ single crystals, and results in an absorption range broadening to ≈1350 nm, which is the longest near-infrared (NIR) response recorded among lead-free perovskites. About 1% of Fe ions are alloyed into the $Cs_2AgBiBr_6$ lattice to cause lattice shrink age. Instead of narrowing the bandgap, Fe doping would introduce a new intermediate band inside the pristine bandgap of $Cs_2AgBiBr_6$ to strongly absorb NIR light, as confirmed by third harmonic generation results. Moreover, considerable photo generated carriers are produced in Fe doped $Cs_2AgBiBr_6$ crystals with NIR irradiation. This work has provided a new way to extend the optical response of lead-free perovskites for NIR photodetectors and intermediate band photovoltaics [3].

Keywords

Perovskite; Lead free; Energy gap; Near IR

References

[1] Cuncun Wu et al. From Pb to Bi: A Promising Family of Pb-Free Optoelectronic Materials and Devices, Adv. Energy Mater. 2019, 1902496.
[2] Wu, Cuncun et al. The Dawn of Lead-Free Perovskite Solar Cell: Highly Stable Double Perovskite $Cs_2AgBiBr_6$ Film, Adv. Sci. 2018, 5(3), 1700759.
[3] Ganghong Liu et al. Extending Absorption of $Cs_2AgBiBr_6$ to Near-Infrared Region (≈1350 nm) with Intermediate Band. Adv. Funct. Mater. 2021, 2109891.

Biography

Lixin Xiao is a full professor at Department of Physics, Peking University. He is a Fellow of the Royal Society of Chemistry. He received his PhD from The University of Tokyo in 2000. He has been working on OLED and solar cell.

Integrated Optical Sources and Optical Links with Nano-dimensioned Si AM LED's and Si Ge Detectors in a 0.35µm IC Process

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Abstract
A series of on-chip optical sources and links, operating at 650 – 850 nm propagation wavelengths, have been designed and realized, with a 0.35µm Si-Ge radio frequency bipolar integrated circuit process. Micron- and nano-dimensioned optical sources, waveguides and detectors were all integrated on the same chip to form complete on-chip optical -links. Si Avalanche mode LEDs (Si AM LEDs) technology has been developed in the 650 - 850nm wavelength regime. Correspondingly, small micro-dimensioned detectors with pW/µm^2 sensitivity have been developed for the same wavelength range utilizing Si-Ge detector technology with detection efficiencies of up to 0.85, and with a transition frequency of up to 80 GHz. Avalanche based Silicon Light Emitting Diode, Schottky contacting, TEOS densification strategies, silicon nitride based waveguides, and state of the art Si-Ge bipolar detector technologies were used as key design strategies. Best performances op the optical sources show nano dimensioned emission spots operating at .1 mW and nWatt emission power. Best performances show optical coupling of up to 5 GHz and - 40dBm with total optical link budget loss of -30dB. The results show a potential transition frequency coupling of up to 40GHz. The technology is particularly suitable for application in Nano-technology applications where micro and nano spot illuminations are applicable Realization of on-chip optical links on chip and low-cost optical interconnects utilizing side surface waveguide-to-optical fiber coupling is also possible. The application of these optical sources and links can be applied in futuristic bio and analyte sensors, advanced intensity sensitive detectors, and microsite to environment communications.

Keywords
Nanotechnology; Electroluminescence; Bio and Analyte Sensors; Light Emitting Diodes; Silicon; CMOS Integrated Circuitry; Optical Wave-guiding; Optical Detectors; Optical Communication

Biography

Lukas W. Snyman received the B.Sc., B.Sc Hons., M.Sc. and PhD degrees, in South Africa. He is currently Research and Innovation Professor at the NanoWs Institute at the University of South Africa in Johannesburg, South Africa. He has to date published 120 research outputs in international conference proceedings and journal articles in the field of silicon photonics and CMOS Optoelectronics. He is author and co-author of two scholarly book chapters on Integrating Micro-Photonic Systems and MOEMS into Standard Silicon CMOS Integrated Circuitry. He is currently the main inventor and co-inventor of eight granted U.S.A patents, two European Patents, two Korean patents, one Chinese patent, and eleven granted SA patents.

Controlled Growth of High-quality Graphene Films: Manipulating the Crystal Orientation via Chemical Vapor Deposition

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Abstract
Graphene has garnered widespread interest and confer remarkable potential for next-generation technological applications, which relies on the controllable preparation of high-quality graphene films. Chemical vapor deposition (CVD) is considered the most promising method, and great progress has been achieved over the last decade. Currently, this field is being pushed to new heights that pursuit structure control (e.g. orientation, layer, stacking order, contamination, doping, etc.) and low-cost production (e.g. increasing the production capacity and growth rate) [1, 2]. In this talk, I will introduce our recent works on controlled growth of high-quality graphene films via CVD approach, especially on controlling the crystallographic orientation of graphene. By designing and preparing single-crystal Cu(111) foils, we have opportunities in realizing the epitaxial growth of large-area single-crystal graphene film [3]. We designed and constructed a pilot-scale CVD system suitable for producing A3-size graphene films, which works well and output high-quality graphene films with high capacity. In another hand, we also explore the possibility on controlling the layer number and stacking order, which is motivated by the emerging twistronics. Here I will present our state-of-the-art hetero-site nucleation method for growing twisted bilayer graphene (tBLG) [4]. Gas-flow perturbation and switching of the graphene edge termination play crucial roles in triggering the formation of interlayer twist. The growth mechanism is carefully investigated by using an isotope-labelling technique. The as-obtained tBLGs show high crystalline quality, which is confirmed by the Raman spectra, atomically clear Moiré patterns in TEM image and ultrahigh carrier mobility (68,000 $cm^2 V^{-1} s^{-1}$ at room temperature).

Keywords
Chemical Vapor Deposition; Single-crystal Graphene; Twisted Bilayer Graphene

References
[1] L. Sun, G. Yuan, L. Gao, J. Yang, M. Chhowalla, M. H. Gharahcheshmeh, K. K. Gleason, Y. S. Choi, B. H. Hong, Z. Liu, Nat. Rev. Methods Primers 2021, 1, 5
[2] L. Sun, L. Lin, Z. Wang, D. Rui, Z. Yu, J. Zhang, Y. Li, X. Liu, K. Jia, K. Wang, L. Zheng, B. Deng, T. Ma, N. Kang, H. Xu, K. S. Novoselov, H. Peng, Z. Liu, Adv. Mater. 2019, 31, 1902978.
[3] L. Sun, B. Chen, W. Wang, Y. Li, X. Zeng, H. Liu, Y. Liang, Z. Zhao, A. Cai, R. Zhang, Y. Zhu, Y. Wang, Y. Song, Q. Ding, X. Gao, H. Peng, Z. Li, L. Lin, Z. Liu, ACS Nano 2022, 16, 285.
[4] L. Sun, Z. Wang, Y. Wang, L. Zhao, Y. Li, B. Chen, S. Huang, S. Zhang, W. Wang, D.

Pei, H. Fang, S. Zhong, H. Liu, J. Zhang, L. Tong, Y. Chen, Z. Li, M. H. Rümmeli, K. S. Novoselov, H. Peng, L. Lin, Z. Liu, Nat. Commun. 2021, 12, 2391.

Biography

Dr. Luzhao Sun is a research fellow in Beijing Graphene Institute, China. He received his B.S. in Information Display and Opto-Electronic Technology from University of Electronic Science and Technology of China (UESTC) in 2015, and his Ph.D. degree in physical chemistry from Peking University in 2020. Dr. Sun's current research interests focus on chemical vapor deposition (CVD)-based graphene film, especially on controlled growth of graphene regarding domain size, layer number, stacking order, doping and strain. He has issued over 20 patents, published over 30 peer-reviewed journal papers and authored several book chapters. The number of citations is over 1200 times and his present h-index is 20 (Google Scholar). He is an Advisory Board Member with Materials Today Electronics.

Effect of Quantum Confinement on Electrical Properties in GaInP Semiconductor Laser Diode Structures

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Abstract
In this study, we have investigated the effect of quantum confinement on electrical properties in GaInP semiconductor laser diode structures. The GaInP semiconductor laser was grown on GaAs substrate using metal organic vapour-phase epitaxy (MOVPE) technique. The devices structures, which are used in this study, contain either bulk, quantum well or quantum dot layers that all made of GaInP material and the variation between these structures are found in the degree of confinement for the carriers in these structures. The electrical parameters such as series resistance (Rs) and ideality factor (n) are calculated depending on the measurements of the current-voltage characteristic (I-V) at the temperature range of 77 K to 400 K with stepping of 25 K.

The change of Rs and n with temperature for the three structures are plotted in Figure 1. From this figure, Rs and n are both generally decrease with increasing temperature.

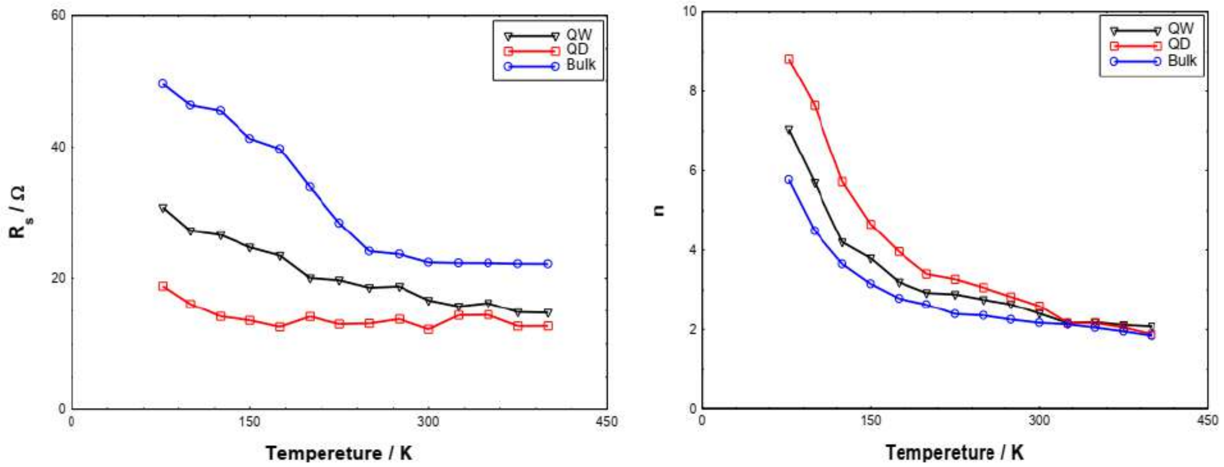

Fig.1: (Left) The series resistance R_s versus temperature T. (Right) The ideality factor n versus temperature T.

The effect of quantum confinement cause a decrease to Rs due to high carrier transition efficiency and increase to n due to the existence of barrier walls that account for the carrier's field emission. This is the main reason for high n in the structure.

Keywords
Quantum Confinement; Semiconductor Laser; Electrical Properties; Laser Diode Structures

Biography
Mohammed Al-Ghamdi has completed his PhD at the age of 35 years from Cardiff University, UK. He is an Associate professor at King Abdul Aziz University, Saudi Arabia. He has over 35 publications that have been cited over 300 times, and his publication h-index is 12. He is a member of IEEE and OSA societies.

Photonic Polymerase Chain Reaction with Plasmonic Gold and Silver Nanotriangles

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Abstract
Plasmonic nanoparticles (NPs) with different shapes are well known for their excellent optical absorbance in the broad range of electromagnetic spectrum. The combination of these NPs with photons can give a photothermal effect via photon-electron-phonon coupling. In this study, we report the synthesis of triangular gold and silver NPs and designed a nano heater system for photonic polymerase chain reactions (PCR). The photothermal properties of NPs were evaluated using different concentrations of NPs, temperatures and power of photonic source to design a nano thermal cycler for variable-temperature PCR. This study reports a cost-effective machine-free PCR setup using the triangular gold and silver NPs with high efficiency compared to the commercial PCR. The high yield PCR efficiency was observed due to the high heat-conducting properties of NPs and surface adsorption of DNA to the NPs at the nanoscale as suggested by real-time PCR, circular dichroism and UV spectroscopy methods. These findings provide cost-effective solutions to develop robust machine-free modules which can be used in various photonic applications and diagnostics.

Keywords
Nanoplasmonics; Gold; Silver; Polymerase Chain Reaction; Photo-thermal effect

Biography
Pradeep Kadu has completed his Masters in Applied Chemistry from the Visvesvaraya National Institute of Technology (VNIT) Nagpur, India. In June 2016, he qualified the junior research fellowship exam conducted by Council of scientific and industrial research (CSIR), India, and joined as a Research Scholar (Ph.D. student) in the Department of Biosciences and Bioengineering, IIT Bombay under the supervision of Prof. Samir Maji. His research work is mainly focused on shape-controlled synthesis of highly plasmonic metal nanoparticles and their interaction with biomolecular scaffolds using amyloids and their applications in bioassays. Besides work, he loves vector designing and art illustration for scientific articles.

Adhesion Improvement of Polymeric Nanofibers on Nitinol for Stent Applications

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Abstract
Polymeric nanofibers have promising properties for medical applications and Tissue Engineering. High specific surface area, adjustable pore size, and scale of extra-cellular matrix are the most interesting. These properties bring benefits to stent applications when used as a coating or cover. Some of the benefits could be in decreasing in-stent thrombosis and restenosis rates for patients. Under current conditions textile covers mostly are attached by sewing, which is not feasible for nanofiber nonwovens. Furthermore, direct coating of nanofibers onto stents lowers manual labour and quality control efforts. But the integration and attachement of nanofibers onto stent materials lacks sufficient adhesion and has not been sufficiently re-searched until today. Therefore, this study aims to find a method to evaluate the adhesion between a metal substrate and polymeric nanofibers from electrospinning and develop methods for improving the adhesion to a sufficient level.

Nanofibers from thermoplastic polyurethane (TPU) were produced using the solution electrospinning method. Electrostatic forces are used to draw fibers with diameters on the nanometer scale from a polymer solution and produce nonwovens out of it in this technology. The nanofibers were directly spun on a cleaned and prepared Nitinol plates. The samples were tested in a 180° peel test according to DIN EN ISO 11339 and mean peel forces calculated from the stress-strain curves. The results for bare Nitinol plates were set as the baseline. Additionally, methods for adhesion and bonding improvement were tested. Heat treatment and solvent vapor treatment as a post-treatment, film coating with TPU, and argon plasma treatment as a pre-treatment were used.

All methods were able to increase peel forces significantly. The untreated coated samples have a peel force/width of 99.8 ± 29.5 mN/cm and the highest measured peel force/width appears for the pre-coated samples of 556.6 ± 211.7 mN/cm. Hence, the maximal increase of peel force/width in this study was around 5.5 times.

Keywords
Electrospinning; Nanofibers; Stents; Coating

Biography
Thomas Schneiders is a project manager and PhD student at the Institut fuer Textiltechnik of RWTH Aachen University in Aachen, Germany. He has a Master’s degree in Polymer and Textile Technology from the RWTH Aachen University as well and has 5 years of expertise

in electrospinning and development of medical textiles and products. His research focus is in machinery, process and product development for electrospinning and the production of polymeric nanofibers. Especially for Tissue Engineering applications and stent coatings.

References

[1] Ballarin, F.M., Blackledge, T.A., Capitos Davis, N.L., Frontini, P.M., Abraham, G.A. and Wong, S.-C. (2013), Effect of topology on the adhesive forces between electrospun polymer fibers using a T-peel test. Polym Eng Sci, 53, 2219-2227.
[2] Hellert C, Wortmann M, Frese N, Grötsch G, Cornelißen C, Ehrmann A. Adhesion of Electrospun Poly(acrylonitrile) Nanofibers on Con-ductive and Isolating Foil Substrates. Coatings. 2021; 11(2):249.

Biostatic Properties of Metal Oxides-Chitosan Nanohybrids

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Abstract
Growing international problem with pathogens acquiring resistance to antibiotics is the reason for the search for bactericidal substances against which microorganisms cannot become resistant. The aim of this study was to synthesize inorganic-organic nanohybrids and obtain materials with antimicrobial effects. Chitosan (CS) was deposited on nanocomposite carriers such as calcium oxide with titanium dioxide ($CaO-TiO_2$), magnesium oxide with titanium dioxide ($MgO-TiO_2$) and copper(II) oxide with titanium dioxide ($CuO-TiO_2$). The efficiency of the process was examined at varying concentrations of chitosan and temperature. The parameters for nanohybrids synthesis were selected based on the highest amount of nano-chitosan deposited on the nanohybrids – for each carrier, the process conditions were as follows: chitosan solution at 5 g/L and 20°C. The materials were obtained using these parameters and were used for microbiological tests against *E. coli, S. aureus* and *C. albicans*. The growth inhibitory activity of the obtained materials was qualitatively defined. These results suggest that the synthesized nanohybrids and nanocomposites exhibit biostatic action. The material with the broadest effect was the $CuO-TiO_2$-CS hybrid, which had biostatic properties against all tested strains at a minimal concentration of 1250 µg/mL.

Keywords
Inorganic-organic Hybrid; Nanohybrid Materials; Chitosan; Bacteriostatic; Fungistatic Effect

Biography
Wiktoria Matyjasik received her BSc and MSc degree in Industrial and Environmental Biotechnology from Cracow University of Technology (Poland) and currently is studying as a PhD student of Chemical Engineering in the same University. Her research interests include bionanotechnology, green synthesis of nanoparticles, potential application of nanomaterials in medicine, diagnostics, and environmental analytics.

Synaptic Transistor based on a-In_2Se_3 Nanosheets with Ultralow Power Consumption

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Abstract

Modern computers are based on von-Neumann architecture in which the processing and memory units are separated physically. Such separation induces large power consumption, high circuitry complexity, and difficulty in miniaturization. To overcome this bottleneck, neuromorphic computing has been proposed, which can work in an ultralow power consumption with no need of the bus for transferring data. Synaptic transistor is the fundamental part of neuromorphic system, which can integrate signal processing and storage. Specially, synaptic transistor can perform signal transmission and synaptic weight training simultaneously. Most of the reported synaptic transistors use special dielectric layers to modulate the state of the channel and mimic the synaptic behavior. These special dielectric materials make the device difficult to be miniaturized and integrated. α-In_2Se_3 nanosheet is a special two-dimensional (2D) ferroelectric semiconductor with correlated out-of-plane and in-plane polarizations. We demonstrate for the first time a novel type of synaptic transistor using 2D ferroelectric semiconductor (α-In_2Se_3 nanosheet) as the channel material and normal dielectric layer (SiO_2) as the gate dielectrics. The synaptic behaviors including single-spike response, paired-spike response, and multispike response are experimentally demonstrated. In addition, by using ultrathin α-In_2Se_3 nanosheet of less than 10 nm as the channel and high-k HfO_2 as the gate dielectric layer, we demonstrate an electric synaptic transistor with ultralow power consumption (only 3.36 fJ per spike) and large dynamic range of 158. Nearly symmetric long-term plasticity (LTP) and long-term depression (LTD) with good linearity are also obtained through adopting incremental voltage spikes, and high pattern recognition accuracy in an ANN simulation is realized. Furthermore, based on the broad range (ultraviolet to short-wavelength infrared (SWIR)) photo-response and the ferroelectric property of α-In_2Se_3 nanosheet, photonic synaptic device in visible-SWIR range is demonstrated for the first time. Specially, using p-n heterostructure based on 2D ferroelectric α-In_2Se_3 nanosheet and p-type 2D material, photonic synapse with energy consumption per spike in fJ level is realized.

Keywords

Synaptic Transistor; Two-dimensional Materials; Ferroelectric Semiconductor; Low-Power Consumption

Biography

Prof. Chen is a full professor in School of Electronics, Peking University. She received PhD degree in Department of Materials Physics, University of Science and Technology Beijing in 1994. She was a visiting student in Department of Materials Science, Cambridge University from 1991-1993. She was a COE research fellow in Institute of Metal Materials, Japan in

1997-1998 and a postdoc in Department of Physics, Arizona State University in 1998-2000. She has published more than 210 journal papers with more than 12,000 other citations. Her current research interests include developing novel nanodevices based on 2D materials and III-V nanowires, and characterizing nanostructures by in situ TEM and in situ SEM.

Magnetically Separable Nano-catalysts and Their Applications

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Abstract
Homogeneous and heterogeneous catalysis are key techniques in modern synthesis and play a central role both in academic and industrial research. Homogeneous catalysts have the advantages of being selective and reactive, but their separation from the reaction mixtures is a difficult process. In contrast, heterogeneous catalysts are less selective and reactive, but they can be easily separated from the reaction medium and recycled. Selective, reactive and recyclable catalyst can be considered as an ideal catalyst and very attractive for various applications. In order to achieve such ideal catalysts, there is a quest to develop new catalytic systems that can bridge between homogeneous and heterogeneous catalysis.

In this talk, magnetically separable catalysts that combine the advantages of homogeneous and heterogeneous catalysts will be described. The preparation methods, the characterization and the application of these catalysts in various important organic transformations such as hydroformylation, hydroaminomethylation, hydrogenation and one-pot reactions, will be presented.

Keywords
Magnetic Nanoparticles; Metal Nanoparticles; Immobilized Catalysts; Organic Transformations

Biography
Prof. Abu-Reziq completed his doctorate at the Hebrew University in catalysis and sol-gel chemistry. After receiving his Ph.D. degree in 2004, he moved to Ottawa University, Canada, to do his postdoctoral research in the field of nanocatalysis. In 2006, he joined the company Sol-Gel Technologies as Senior Researcher and spent two years in developing micro and nano-encapsulation systems based on sol-gel process as drug delivery systems. In 2008, He was appointed as Senior Lecturer at Casali Center for Applied Chemistry and Institute of Chemistry and on 2015 he was promoted to Associate Professor. His research focuses on nanocatalysis, magnetic materials, green chemistry and developing micro and nanoencapsulation methods.

Relation between Structure and Nonlinear Optical Response in Nanostructured Materials

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Abstract

Nanostructured materials have attracted considerable attention for their optical properties, inparticular for their large nonlinear response, and their potential for different applications such as information processing, and biological and chemical sensing, to name a few. The main reason for this is the ability to tune the optical properties by manipulation of the composition, structure and symmetry of the composites. For second-order, and to a lesser extent also for third-order nonlinear processes, the response is highly dependent on the symmetry of the material structure. It is this dependence of the response on material symmetrythat makes nonlinear optics itself an interesting tool for probing the nanoscopic structure of the materials by means of merely macroscopic measurements.

In this work we present results for the study of the structure of different materials employing nonlinear measurements. On one hand we present a study of second harmonic generation in elongated metallic nanoparticles embedded in glass, which have random positions but are aligned in a preferential direction. On the other hand, we also present second harmonic generation and nonlinear absorption studies in hexagonal arrays of metallic nanoprisms. In all cases the polarization dependence of the response observed is related to the structure and symmetry of the materials, through modelling of the nonlinear response, finding that we can indeed relate the observed response to the nanoscopic structure of the materials studied.

Aerosol Nanocomposite Systems Capable of Overcoming the Pulmonary Epithelial Barrier

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Abstract

The lungs are an attractive route for drug delivery with advantages such as a large surface area, high blood flow, and limited enzymatic activity. There is increasing interest in aerosol administration of nanoparticles (NP) to achieve controlled delivery of drugs via the lungs. In this study, the ability of NP with varying surface properties to cross an in vitro pulmonary epithelial barrier was evaluated. NP coatings included lung cell membranes, lipids, and polymers, which were characterized for their ability to internalize in or penetrate cell monolayers. NP were encapsulated into inhalable nanocomposite microparticles (nCmP) via spray drying. nCmP are capable of depositing in different regions of the lungs and upon deposition, the NP disassociate into their original form. These NP then have the potential to internalize in or be transported across the pulmonary epithelial barrier via a variety of mechanisms. The NP involved a drug-loaded biodegradable polymercore and the NP shells were pulmonary cell membranes, lipids (cationic or anionic), or polymers (PEG or polyvinyl alcohol). The morphology of the NP and nCmP were evaluated using scanning electron microscopy. The core and shell of the NP were evaluated using transmission electron microscopy. The size, size distribution and zeta potential of NP were measured by dynamic light scattering. Cytotoxicity of the NP and release profiles of CUR from the NP were determined. Internalization and transport of NP were conducted in presence and absence of pharmacological inhibitors. The water content and aerosol dispersion performance of the nCmP was quantified.

Biography

Dr. Samantha Meenach is currently an associate professor at the University of Rhode Island with joint appointments in Chemical Engineering and Biomedical and Pharmaceutical Sciences. She is originally from Kentucky and obtained her degrees in chemical engineering from the University of Kentucky. Dr. Meenach was a NIH NCI Cancer Nanotechnology Postdoctoral Trainee, where her research focused on the development of aerosol nanotherapeutics for the treatment of lung cancer. The work of the Meenach group has focused on the development of aerosol therapeutics for the treatment of pulmonary diseases and nanoparticles capable of penetrating physiological barriers. Outside of academics, Samantha is an avid reader and loves playing games, traveling, kayaking, and yoga.

Separation of Cellulose Nanocrystals from Natural Fibers using Ionic Liquids based on Hidrogensulphate Anion

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Abstract

Due to the environmental appeal that has grown in recent years, the use of agricultural waste and plant fibers to develop new biogradable materials are desirable. In this context, nanocomposites reinforced with cellulose nanocrystals (NCCs) obtained from different natural fibers have stood out as promising materials. NCCs used to be separated with acid hydrolysis from cellulosic matrix, a new trend is the use of ionic liquids [1] besides being less corrosive than the sulfuric acid, and the ionic liquids can be reused. [BMIM] [HSO_4] was proposed in different works as alternative media [2]. In a previous work, the [2-HEA] [HSO_4] was proven to be useful to obtain NCCs from microcrystalline cellulose [3] and it has the advantage of having a lower cost and is less toxic than [BMIM] [HSO_4]. In this work, NCCs were separated from the isolated cellulose of different fibers as bromelia (Neoglaziovia variegate) and rambutan fruit (Nephelium lappaceum) etc.). Through the hydrolysis process in sulfuric acid, aprotic [BMIM] [HSO_4] and protic ionic liquid [2-HEA] [HSO_4]. The obtained NCCs materials characterized by termogravimetric analysis (TG), infrared spectroscopy (FTIR), X-ray diffraction (XRD), zeta ELS and different microscopy techniques (SEM, TEM and AFM). They presented thermal stability that allowed the incorporation in polymeric matrix by extrusion, using a morphology with rod and spherical shapes that allow the versatility in new applications. To test the obtained NCCs, bromelia based NCCs were incorporated in the proportion of 0.01g/g in a polymeric matrix based on Ecovio®/ PBAT/lignin (from palm Elaeis Guineensis), generating three Nanocomposites confirmed by the TEM analysis, with nanoscale particles dispersed in the polymer matrix. The samples presented tensile strength of 7.36-7.58 MPa and specific deformation of 8.18-12.26%, with potential application in the agricultural packaging sector. Rambutam based NCCs were tested in nanopaper production. The nanostructures have presented a good stability in water, and better thermal behavior than the commercial nanocrystals evaluated and polymorphism type I, despite the low crystallinity verified. The ionic liquid was successfully recycled in a high yield, being and was able to undergo new hydrolysis.

References

[1] Li; Zhao. Adv. Synth. Catal., 349 (2007) 1847–1850.
[2] Tan et al.. Biomass Bioenergy, 81 (2015) 584–591.
[3] Gonçalves et al. Separation and Purification Technology, 196 (2018) 200–207.

Keywords

Cellulose Nanocrystals; Ionic Liquids; Nanopapers; Natural Fibers

Biography

S. Mattedi got a Chemical engineering degree from Federal University of Bahia, a master's degree and a PhD degree in Chemical Engineering from Federal University of Rio de Janeiro (COPPE/UFRJ) in 1993 and 1997. She worked as visiting scholar at FederalUniversity of São Carlos, São Carlos-SP, Brazil in 1999-2000 and 2003, at Universidade de Santiago de Compostela in 2009-2010, and in Monash University, 2017-2018. She has experience in Sustainable ProcessingChemical Engineering, focusing on Applied Thermodynamics, Operations of Separation and Mixture, acting on the following subjects: equations of state, phase equilibria, ionic liquids and experimental data. She is now afull professor at Federal University of Bahia, where she began to work in 1994.

Size-Selected Clusters: From Heterogenous Catalysis to Electrocatalysis and Li-O_2 Batteries

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Abstract
In this presentation, we will provide an overview of recent results which emerged from the studies of the performance of supported size-selected clusters in a variety of reactions, from heterogeneous to electrochemical and batteries, discussing the effect of cluster size and composition along the role of the support and reaction conditions.

While the main focus of the paper will be on (electro)catalysts made of monodisperse subnanometer clusters, unexpected propensities of under reaction conditions dynamically formed nano-assemblies will be discussed as well. In the last part of the paper, as time shall allow, we will highlight the opportunities provided by atomic precision design of bimetallic clusters in fine-tuning their performance and their bifunctionality in industrially relevant reactions.

Biography
Stefan Vajda is currently the head of the recently established Department of Nanocatalysis of the J. Heyrovský Institute of Physical Chemistry of the Czech Academy of Science located in Prague. He is also the ERA Chair holder at the Institute. Stefan pioneered the studies of atomically precise size- and composition selected subnanometer size cluster-based catalyst under realistic reaction conditions of temperature and pressure in industrially relevant processes. Stefan received his Diploma (MSc) degree in Physical Chemistry and his PhD in Chemistry from Charles University in Prague, and habilitated from Experimental Physics at the Freie Universität Berlin. His awards include a Fulbright Fellowship spent at the University of Chicago. Before returning to Prague in 2019, Stefan was active at the Freie Universität Berlin and Argonne National Laboratory US. During his career, Stefan published over 120 peer-reviewed articles and book chapters, has 7 issued US patents and presented over 80 invited talks at international conferences.

Highly Efficient Optical II-VI Diluted Magnetic Nanostructures Grown Directly on Silicon (111) Substrates

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Abstract

CdMnTe is a diluted magnetic semiconductor compound that has been studied for a long time due to its optoelectronic and magnetic properties and application as solar cells, x-ray detectors and other magneto optic devices. Most of these studies have used GaAs(001) as substrates since good quality II-VI substrates are rare and very expensive. In this work we describe the growth and characterization of CdMnTe thin films and CdTe/CdMnTe heterostructures deposited directly on Silicon (111) substrate. The samples were grown by molecular beam epitaxy using a homemade MBE system with CdTe and Mn effusion cells. The obtained samples were characterized by high resolution x-ray diffraction (HR-XRD), high resolution transmission microscopy (HR-TEM), atomic force microscopy (AFM) and photoluminescence (PL). With a huge lattice mismatch of almost 19% between CdMnTe and Si, this system follows the Volmer-Weber growth mode and the tri-dimensional nucleation islands grown epitaxialy, completely relaxed with the lattice mismatch being probably accommodated by a Tellurium interfacial layer. However, these islands have a high in-plane mosaicity which causes a lot of defects at the interface and originate a layer with very high surface roughness. The heterostructures studied were CdTe quantum wells (QW) with thickness from 3 to 20 nm between 120 nm thick CdMnTe barriers, with 11% Mn content. Despite the big interfacial roughness, the samples investigated showed a remarkably intense photoluminescence signal composed by a main peak assigned to QW confined state and low intensity shoulder, attributed to defects. The main PL peak has a FWHM of about 0.02 eV but shows a fine structure with very narrow lines with FWHM ten times smaller. The position and intensity of these lines change when the incident laser beam moves to different positions and are probably caused by 3D confined structures formed during the QW growth, due to surface roughness.

Keywords

CdMnTe; MBE; Lattice Mismatch; Characterization

Advanced Modeling of Emerging Magneto-resistive Memory

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Abstract

Spintronics based magneto-restive random access memory (MRAM) is an emerging technology, showing great promise for replacing conventional standalone and embedded memories in the near future. While being scalable and nonvolatile, MRAM offers long endurance and fast, low power switching between logical states. The main component of MRAM is the magnetic tunnel junction (MTJ), a structure consisting of two ferromagnetic layers separated by a tunnel barrier (TB). The two logical states are encoded by the relative magnetization of the two magnetic layers being either parallel or anti-parallel. Switching between these states is achieved by the transfer of angular momentum from a spin-polarized current to one of the magnetic layers. Reading is carried out by measuring the state dependent resistance across the MTJ.

There are two types of spin based MRAM named after the source of the torques acting on the magnetic layer. Spin transfer torque (STT) MRAM is an already well-established type of MRAM with first commercial products available. Spin orbit torque (SOT) MRAM is an emerging type of MRAM, which promises even higher endurance and sub-nanosecond switching at the cost of having a larger footprint.

MRAM introduces many new design challenges to be overcome. To facilitate and accelerate the development and optimization of MRAM, versatile software capable of simulating the dynamics in such devices is essential. Modeling advanced, single-digit shape-anisotropy MRAM cells require accurate evaluations of spin currents and torques in MTJs with elongated free and reference layers. For this purpose, we extended the approach for computing the torque, successfully applied to nanoscale metallic spin valves, to MTJs.

The charge current is evaluated by modeling the TB as a poor conductor with a local resistance dependent on the relative orientation of the magnetization. This way, the expected dependence of the current flow on the magnetization state is reproduced. However, we show that this approach must be supplemented by appropriate boundary conditions at the TB interfaces, in order to take into account the interfacial spin current polarization. The correct dependence of the torque on the relative angle between the magnetization vectors is then reproduced. Moreover, we can introduce a nonlinear bias dependence of the torque by making the interface polarization parameters dependent on the voltage. The observed voltage dependence of both the damping-like and field-like torques is thereby properly reproduced.

As the magnetization in elongated free layers of ultra-scaled MRAM cells is highly nonuniform during switching, the formation of domain walls creates additional torques acting in the bulk of the layers usually modeled with an expression derived by Zhang and Li. We show that, in the presence of an MTJ, the Slonczewski and Zhang-Li torques are not independent, so that a unified treatment of the MTJ and free layer magnetization texture is needed to accurately describe the torque in the presence of elongated magnetic layers.

Finally, we analyze the magnetization dynamics in cells of small diameter with several TBs. Our predictions agree well with the recent experimental demonstrations of switching of ultra-scaled MRAM cells.

Keywords
Spin Transfer Torques; Magneto-resistive Memory; Modeling; Finite Element Method

Biography
Viktor Sverdlov received his Master of Science and PhD degrees in physics from the State University of St. Petersburg, Russia, in 1985 and 1989, respectively. From 1989 to 1999, he worked as a staff research scientist at the V.A. Fock Institute of Physics, St. Petersburg State University. During this time, he visited ICTP (Italy, 1993), the University of Geneva (Switzerland, 1993-1994), the University of Oulu (Finland, 1995), the Helsinki University of Technology (Finland, 1996, 1998), the Free University of Berlin (Germany, 1997), and NORDITA (Denmark, 1998). In 1999, he became a staff research scientist at the State University of New York at Stony Brook. He joined the Institute for Microelectronics, Technische Universität Wien, in 2004 and he is currently on a tenure-track position. His scientific interests include device simulations, computational physics, solid-state physics, and nanoelectronics.

Molecular Switches Acting in Tandem with Nano Cages

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Abstract

Molecular switches are entities that can be toggled between two or more forms upon exposure to an external stimulus, such as light.This toggling event often requires conformational freedom and space to isomerize between the forms. Confining these molecules to volumes only slightly larger than the molecules themselves can profoundly alter their properties.The confining cage shouldbe flexible enough to adapt to the shape of the guest, and allow it enough freedom to successfully switch between the different conformers. In the absence of the cage the photoswitching can be either suppressed or the guest can be excluded from the solubilizing medium.

Current work focuses on a very flexible, water soluble coordination cage encapsulating molecule such as spiropyran and azobenzene derivatives. Single crystal X-ray diffraction analysis reveals a relatively large unit cell, containinga cage, one or two guests and numerous counter ions and solvent molecules. The cage undergoes significant structural changes to adapt when binding the guest or guests.

These newly synthesized materials are a novel type of information storage medium in which messages could be written and erased in a reversible fashion using light. Water soluble co-ordinational cages can serve as a robust drug-delivery system.Furthermore, the encapsulation of external stimuli induced conformational change molecules. This encapsulation is a step towards the construction of molecular machines.

Characteristics of Bismuth-Based Frequency Comb Laser

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Abstract
Frequency comb lasers with multi-gigahertz spacing are important for many practical applications such as optical frequency reference, multi-wavelengthsources, optical signal processing, short pulse generation, and coherent optical waveform syntheses. Good spectral flatness, wide operation bandwidth, high coherence, high efficiency, high stability, low noise, and low cost are usually required for those frequency comb applications.

Several techniques for producing the frequency comb have been proposed and demonstrated in the past. Especially, actively and harmonically mode-locked fiber lasers have become an attractive candidate for the frequency comb generators. The actively and harmonically mode-locked fiber lasers generally feature wide tunable wavelength range, short pulse width, small timing jitter, and high repetition frequency. However, it is difficult to produce a frequency comb with good spectral flatness. Therefore, one of the difficult challenges in the actively and harmonically mode-locked fiber lasers is how to produce a spectrally flat frequency comb. Furthermore, the actively and harmonically mode-locked fiber lasers commonly use silica-based erbium-doped fibers as the intra-cavity gain media. Consequently, the tunable wavelength range of the actively and harmonically mode-locked fiber lasers is limited to the alternative of the conventional wavelength band (C-band) region or the longer wavelength band (L-band) region. The tunable wavelength range is also another important issue for the frequency comb lasers.

In this presentation, we review stable, wavelength-tunable and flat frequency comb generation from a 10-GHz actively and harmonically mode-locked short-cavity fiber laser employing a bismuth-oxide-based nonlinear erbium-doped fiber with a fiber length of 1.5 m and a bandwidth-variable tunable filter with a rectangular filter profile. The output characteristics are as follows. The center wavelength of the laser output can be tuned from 1540 nm to 1620 nm. This wide tunable range of 80 nm almost completely covers both the C-band region and the L-band region.The comb spectrum can be flatly broadened up to 2.0 nm (250 GHz in the frequency domain) with 25 comb lines.The temporal pulse width of the laser output is around 7 ps. This bismuth-based frequency comb laser can maintain stable bit-error-free mode-locking operation throughout the entire tunable wavelength range.

Keywords
Frequency Comb; Mode-locked Lasers; Fiber Lasers; Tunable Lasers; Kerr Effect

Poster Presentation

Selectivity Enhancement of Carbon Nanotube Composite Sensor Response to Organic Vapours by Choice of the Polymer Matrix

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Abstract
Recent literature has widely reported the utilisation of multi-walled carbon nanotubes (MWCNTs) in various sensors. Most of the applications are in the field of organic vapour sensing. Nevertheless, entangled MWCNTs structures suffer from low selectivity although their excellent sensitivity. Namely, nanotubes are a perfect nanomaterial for use as electrically conductive nanofiller, whereas the polymer matrix plays a significant role in the selectivity of sensors. The study presents a new method for measuring and sensing a volatile organic compound by a simple sensor made from a copolymer composite based on elastomeric matrix/MWCNTs.

The selection of three different matrices imparts the selectivity to the sensors when reading simultaneously. Using Multiplex datalogger 34980A, the electrical resistance was measured, and data were used to select the concentration of MWCNTs in polymers to measure vapour effects.

Three nanocomposite materials with comparable resistivity were prepared from elastomeric copolymers with MWCNTs filler. Styrene-isoprene-styrene copolymer, ethylene-octene copolymer, and thermoplastic polyurethane were the elastomeric matrices. Filler dispersions in toluene solutions of the copolymers were prepared by ultrasound homogenisation. The sensors were fabricated by casting thin films on substrates with interdigitated electrodes by the automatic dip coating machine. The nanocomposite films were used as transducers in the sensors to detect ambient organic vapours of different polarities such as ethanol, acetone, toluene and heptane. The changes resulted from penetration of the vapours into the polymer matrix, which subsequently swelled, increased the distances between the carbon nanotubes and disrupted the conducting paths. These actions cause resulting in a significant increase in measured resistivity. The most remarkable change in gas sensor electrical resistance (over 8200 %) was made from the carbon nanotube/ethylene-octene copolymer and was elicited by non-polar heptane. Thus, results indicate that these composites are suitable materials for easy manufacturing of inexpensive deformable vapour sensors, which can be readily adjusted to limited space or an unconventional shape.

Keywords
Nanotechnology; Multi-walled Carbon Nanotubes; Copolymer Nanocomposite; Organic Vapour Sensing

Biography
Rostislav Slobodian is a Ph.D. student at the Tomas Bata University in Zlín at Centre of Polymer Systems. He received M.Sc. and graduated from a study program Chemistry and materials technology - Polymer engineering in Faculty of Technology, TBU Zlín. He holds

the award director of the Polymer Centre, TBU Zlín for a master thesis. He cooperates with the research group: Nanomaterials and Advanced Technologies, specializing in Systems with sensorics properties and their applications, at Centre of Polymer Systems, TBU as a junior researcher. His main interests are properties of nanofillers, namely carbon nanotubes / graphene / superconductive carbon black, polymer composite materials and their use as organic vapor sensors. Their utilization is also flexible and stretchable strain sensors, as well as pressure sensors. His field of activity is also plastic and rubber processing for customer products where he has experience with R.& D., start-up projects and direct cooperation with companies.

Optimization of TiO_2 Nanoparticles Preparation for Testing of Nanotoxicity in Pulmonary A549 Cells

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Abstract

A variety of TiO_2 nanomaterials has been developed, e.g. nanoparticles, nanofibers and nanotubes. Especially, TiO_2 nanoparticles have been used in material science and industry. In general, the physicochemical properties of TiO_2 nanoparticles, for example size, shape, crystallinity form, solubility, aggregation, and nanoparticle–protein interaction, can significantly affect their biological effect. Nowadays, the conditions for testing and evaluating nanoparticles toxicity differ in many parameters. Interestingly, the reports on TiO_2 nanoparticle biological effects have provided different findings on the extent of nanoparticle-induced toxicity in cells. Therefore, further research is important in the study to validate the methods for the prediction, characterization, and behavior of nanoparticles in tested systems (*Lewinski, 2008; Prasad, 2013*).

In vitro studies describing the cellular effects of TiO_2 nanoparticles have been reported most frequently, especially using the pulmonary A549 cell line, because the lungs are one of the most common entry points for nanomaterials into the human body. Characterization of experimental conditions and identification of optimal parameters for biological assessment of TiO_2 nanoparticles was caried out in A549 cells. The use of a specific and sensitive bioanalytical assay for characterization of nanoparticles acting in cells is also the crucial point for proper evaluation of changes in cellular status (*Jayaram, 2019; Thirunavukkarasu, 2021*). Based on a thorough review of the literature, the WST-1 test was used to assess changes in dehydrogenase activity in cells. After treatment of A549 cells with TiO_2 nanoparticles, no significant differences in cellular dehydrogenases activity were found after 24 h. Because glutathione, an essential intracellular antioxidant, can act against increased ROS production, we expected finding of glutathione depletion in TiO_2 nanoparticles treated A549 cells. Indeed, after 24 h, significant glutathione depletion was found. Furthermore, MWCNTs were used as a positive benchmark material for the comparison of findings in TiO_2 nanoparticle-treated A549 cells, i.e., in the evaluation of DNA damage and ROS production in A549 cells.

Acknowledgement

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Keywords

Nanoparticles; Nanotoxicity; A549 Cells; Cell Viability

References

[1] Lewinski N, Colvin V, Drezek R. Cytotoxicity of nanoparticles. Small. Jan 2008; 4(1):26-49.

[2] Prasad RY, Wallace K, Daniel KM, et al. Effect of treatment media on the agglomeration of titanium dioxide nanoparticles: impact on genotoxicity, cellular interaction, and cell cycle. ACS nano. 2013;7(3):1929-1942.

[3] Jayaram DT, Kumar A, Kippner LE, et al. TiO_2 nanoparticles generate superoxide and alter gene expression in human lung cells. RSC advances. 2019;9(43):25039-25047.

[4] Thirunavukkarasu GK, Bacova J, Monfort O, et al. Critical comparison of aerogel TiO_2 and P25 nanopowders: cytotoxic properties, photocatalytic activity and photoinduced antimicrobial/antibiofilm performance. Applied Surface Science. 2021:152145.

Antibacterial Effect of Polyethylene Terephthalate Grafted with Silver Nanoparticles of Different Shape

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Abstract
Surfaces with immobilized metal nanoparticles have a potential to prevent infection [1,2]. We present a preparation of antibacterial polymer surface by anchoring silver nanoparticles (AgNPs) onto plasma treated polyethylene terephthalate (PET) via biphenyl-4,4'-dithiol (BPD). Since antibacterial properties are closely related to AgNPs' shape, spherical (Ag0) and triangular (Ag3) NPs were employed. AgNPs were characterized by UV-Vis spectroscopy and transmission electron microscopy. Further examination by high resolution transmission electron microscopy disclosed *decahedron* shape of Ag0 and *triangular nanoplates* of Ag3. Average size was 21.0 nm for Ag0 and (20.5 x 5.5) nm for Ag3. Presence of grafted substances on PET was confirmed by X-ray photoelectron spectroscopy and energy dispersive X-ray spectroscopy. Higher amount of Ag was grafted on PET with Ag0. Antibacterial activity was tested against *E. coli and S. epidermidis*., To determine whether any intermediate stage of preparation had an influence on the final antibacterial effect, each preparatory step of the samples was tested. Despite the lesser amount of Ag, PET grafted with Ag3 was more effective against *S. epidermidis* than surface grafted by Ag0. *E. coli* manifested minimal susceptibility to tested substrates, likely due to low Ag concentration on surfaces.

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References
[1] M. Polivkova, T. Hubacek, M. Staszek, V. Svorcik, J. Siegel, Int. J. Mol. Sci. 18 (2017) 419, https://doi.org/10.3390/ijms18020419
[2] Y. N. Slavin, J. Asnis, U. O. Hafeli, H. Bach, J. Nanobiotechnol. 15 (2017) 65. doi: 10.1186/s12951-017-0308-z

Keywords
Polyethylene Terephthalate; Silver Nanoparticles; Antibacterial Effect; Shape Effect

Biography
Hoang Yen Nguyenova was born in the Czech Republic. She obtained her Master's degree in Drug Production at the University of Chemistry and Technology in Prague. She is currently proceeding her Ph.D. studies in Drugs and Biomaterials. Her research interest covers noble metal nanoparticles and their potential application in medicine, polymer materials and polymer composites.

Surface Properties, Antibacterial Effect and Cytotoxicity of Cu layers Sputtered on Plasma Activated Glass

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Abstract
Metal layers have already found use for many applications like gas sensors [1], semiconductors, photocatalysts for carbon dioxide [2] and antimicrobial surfaces [3]. This work is focused on the surface properties of Cu layers sputtered on plasma-activated glass substrate and their biological effects. Etching of the substrate surface in Ar^+ plasma ensured increased adhesion of Cu layer to the surface. Cu layers were also subjected to solid state dewetting process at 300 °C for 1 h. Non-annealed layers showed characteristic surface plasmon resonance band (SPR, 651 nm) in UV-Vis spectra and layers 5 nm and thicker were electrically continuous. Post-deposition annealing of the Cu layers caused both the oxidation of the Cu layers, i.e. higher oxygen content, and the rearrangement of Cu atoms on the substrate surface. Annealed layers showed high sheet electric resistance, no SPR band and higher hydrophobicity. Rearrangement of Cu in the layers and nanoscale structural changes was observed by AFM and SEM. Non-annealed Cu layers exhibited the highest antibacterial activity of all samples against both strains *E. coli and S. epidermidis*. However, the Cu nanostructures also demonstrated high level of cytotoxicity examined against the human dermal fibroblast and liver hepatocellular carcinoma cells.

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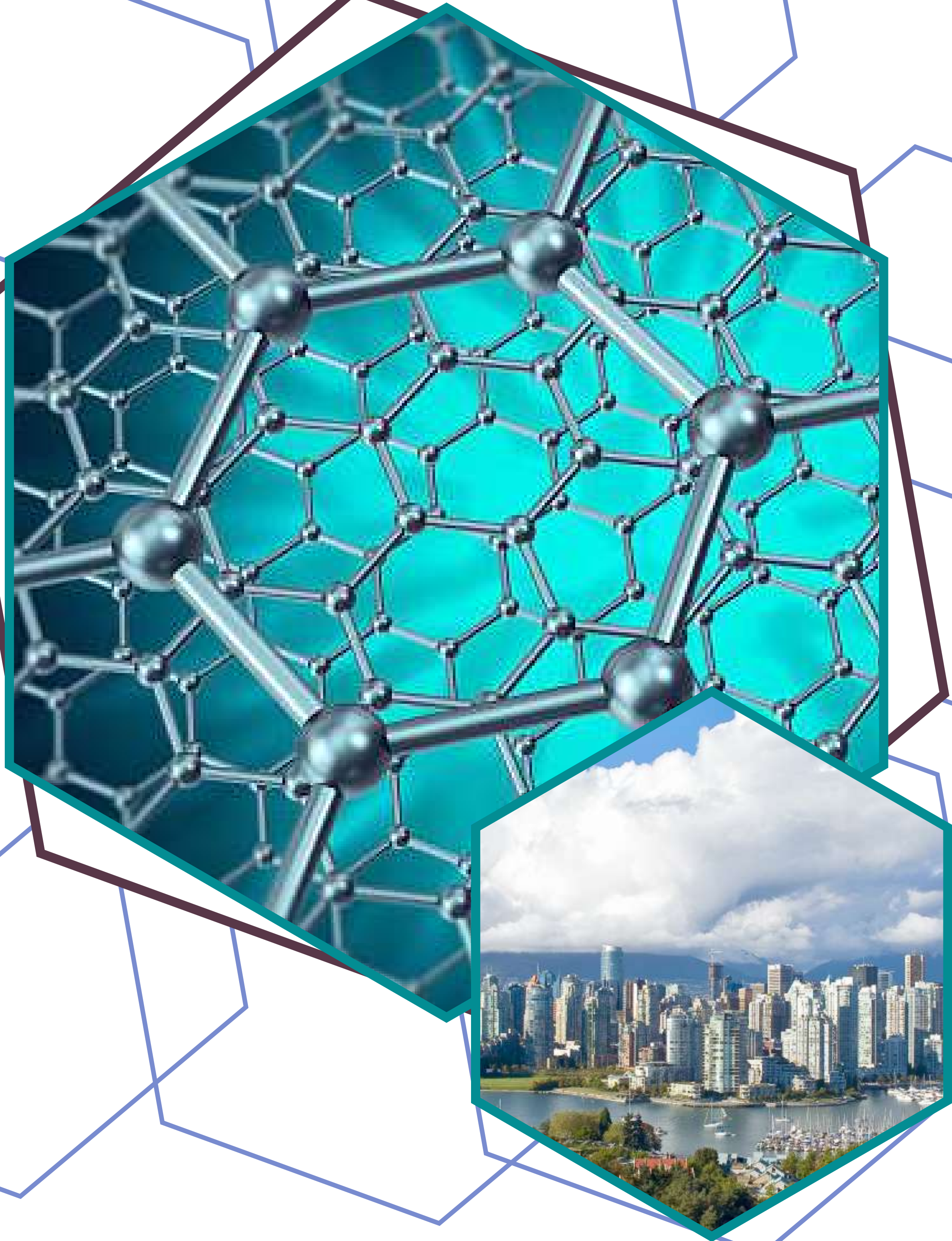
References
[1] A. Tricoli, M. Righettoni, A. Teleki, Angew. Chem. Int. Ed. 2010, 49, 7632–7359.
[2] F. Gonzales-Posada, R. Sellappan, B. Vanpoucke, D. Chakarov, RSC Adv. 2014, 4, 20659-20664.
[3] G. Ren, D. Hu, E. W. C. Cheng, et al., Int. J. Antimicrob. Agents 2009, 33, 587-590.

Keywords
Copper; Annealing; Antibacterial Effect; Cytotoxicity

Biography
Veronika Lacmanova is studying for a Ph.D. in the field of Drugs and biomaterials at UCT Prague. She has been interested in nanomaterial engineering since undergraduate studies, profiling her expertise with techniques for determining surface properties such as UV-Vis spectroscopy, gravimetry, goniometry and other analytical methods. Her work focuses mainly in surface modifications using grafting and cathode sputtering techniques into plasma-activated solid substrates with a variety of applications from biocompatible nanostructured implants to

antibacterial nanomaterials (based on Cu oxides). Her expertise later expanded into biological studies, while solving problematics regarding bio-nano interface between metal nanostructures and various human, bacterial and fungal cells. Her research is currently being fulfilled within the Department of Solid State Engineering in UCT Prague.



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