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Emerging Materials 2017

10th International Conference on

Emerging Materials and Nanotechnology

July 27-29, 2017 Vancouver, Canada

Keynote Forum

Day 1

C D Montemagno, Res. Rev. J Mat. Sci. 2017
DOI: 10.4172/2321-6212-C1-001

C D Montemagno

University of Alberta, Canada

Small things offer big promise

The ability to use machines to manipulate matter in a single molecule at a time renders many things become possible which were impossible before. Living systems do this on a regular basis. The core challenge to accessing life function is transforming the labile molecules that exist in a fragile living organism into a stable engineered system that is economically scalable. The most significant difficulties revolve around environmental stability and the inherent structural limitations of these molecules. The solution to these difficulties is in hand. Presented is the generic solution methodology used to solve these limiting challenges to produce a new class of materials and devices. By introducing "metabolism" into engineered devices and materials, solutions to grand societal challenges in Medicine, Environment and Agriculture now appear to be attainable. Furthermore this new technology does not rely on $100's of millions of infrastructures making it globally assessable to developing nations. It offers a global promise of economic opportunity and prosperity. Exemplars of the application of this new technology will be shown. We will elucidate the design, engineering and assembly of a complex closed system that uses a highly modified photosynthetic process to transform carbon waste into valuable drop-in specialty chemicals. Enabled by the synthesis of a new class of printable "inks" that have stabilized active biological molecules as integrated elements of synthesized polymer constructs, we will present a technology that transitions additive manufacturing from 3D space to a four-dimensional, functional space creating a whole new class of materials and devices. The application of this technology to medicine, particularly the treatment of type 1 diabetes, glaucoma and other medical conditions will also be illustrated.

Biography

C D Montemagno is the former and founding Dean of the College of Engineering and Applied Science at the University of Cincinnati. Immediately, he was the Chair of the Department of Bioengineering and Associate Director of the California NanoSystems Institute as well as the Roy & Carol Doumani Professor of Biomedical Engineering at UCLA. Previous to his tenure with UCLA, he served as Associate Professor in the Department of Biological and Environmental Engineering at Cornell University. He earned his BSc in Agricultural and Biological Engineering from Cornell (1980) and MSc in Petroleum and Natural Gas Engineering from Penn State University (1990). After completing his undergraduate studies in 1980, he joined the United States Navy and served for 10 years in several senior management positions as a Civil Engineering Corps Officer. He then joined Argonne National Laboratory where he led laboratory and field investigations developing Bioremediation technology for the treatment of hazardous waste. In 1995, he earned his PhD in Civil Engineering and Geological Sciences from Notre Dame University. Upon obtaining his PhD in Civil Engineering, he began his academic career as an Assistant Professor at Cornell University in the Department of Agricultural and Biological Engineering where he was one of the pioneers in the field of Nanobiotechnology. He has amassed a distinguished scholarly record resulting in a number of patents as well as appointments to numerous editorial boards and governmental committees. He is a Fellow of the American Academy of Nanomedicine, a Fellow of the American Institute for Medical and Biological Engineering, and a Fellow of the NASA Institute of Advance Concepts. He is a recipient of the Feynman Prize for Experimental Work in Nanotechnology. His current research and near term investigations focus on the development of experimental techniques to integrate metabolic functionality into materials through the engineering of biomolecular systems. Recent efforts addressed the creation of advanced systems for water purification and treatment, and the development of materials for the synthesis of high-value chemicals through the harvesting of solar energy.

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Beng S Ong, Res. Rev. J Mat. Sci. 2017
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Progress in semiconductor materials and processes for printed transistors

In recent years, significant advances have been made in organic semiconductor materials and process development for printed electronics. The field-effect mobility of organic thin-film transistors (OTFTs) has progressed from gross performance deficiency over a decade ago to meet electronic application requirements today. This quantum leap in OTFT performance has been propelled by both creative semiconductor design and process innovation. Notwithstanding these achievements, there remain significant technical challenges for transitioning printed transistors from laboratory to marketplace. This presentation discusses the issues and challenges of printed transistors and potential approaches to circumventing these technical difficulties. Particular emphasis will focus on materials design and process strategies directed to promoting and facilitating molecular self-assembly of polymer semiconductors to enhance charge carrier transport efficacy. Through simple solution processes under appropriate conditions, we have been able to drive molecular self-assembly of polymer semiconductors to significantly higher molecular orders, leading to greatly enhanced field-effect mobility and current modulation.

Biography

Beng S Ong is the Director of Research Centre of Excellence for Organic Electronics and Chair Professor of Materials Science at Hong Kong Baptist University. He was formerly a Nanyang Professor at Nanyang Technological University in Singapore, who also held joint appointments as Director at Institute of Materials Research and Engineering and Singapore Institute of Manufacturing Technology. Prior to his relocation to Asia in 2007, he was a Senior Xerox Fellow and 21st-Century Materials Strategist at Xerox Corporation as well as Area Manager at Xerox Research Centre of Canada. Over the years, he had held adjunct professorships at various universities including McMaster University and University of Waterloo in Canada, and Honorary Professorship at Shanghai East China University of Science and Technology. He has published journals extensively in Advanced Materials, Organic Electronics, Nanotechnology, etc. Currently, he has a patent portfolio of 230 US patents and many foreign equivalent patents.

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Jas Pal Badyal

Durham University, UK

Scalable functional nanocoatings

The worldwide market for functional surfaces exceeds $100 billion per annum (US Department of Energy). A key driver is the added value that can be imparted to commercial products through the molecular engineering of their surface properties. For example, the cleanliness of optical lenses, the feel of fabrics, the resistance of biomedical devices to bacteria, the speed of computer hard disks, and even the wear of car brake pads is governed by their surface properties. The fabrication of such surfaces requires the incorporation of specific functional groups; for which there exists no shortage of potential methods including: self-assembled monolayers (SAMs), Langmuir-Blodgett films, dip-coating, grafting, chemical vapour deposition, to name just a few. However, such techniques suffer from drawbacks including substrate-specificity (cannot be easily adapted to different materials or geometries) and environmental concerns associated with the utilization of solvents, strong acid/base media, or heat. A range of innovative solutions will be described for the molecular tailoring of solid surfaces. Applications will include: super-repellency, non-fouling, anti-fogging, thermoresponsive, rewritable bioarrays, opto-chiral, antibacterial, electrical barrier, water harvesting, capture and release, oil-water separation, and nano-actuation. This research has led to 41 patent families and the establishment of 3 successful start-up companies: Surface Innovations Ltd., Dow Corning Plasma Ltd., and P2i Ltd. (2015 International Business Award for 'Most Innovative Company in Europe').

Biography

Jas Pal Badyal FRS has completed his BA/MA and PhD degrees from Cambridge University; where he subsequently held King's College and Oppenheimer fellowships. He is the primary author/inventor of 175 peer reviewed journal publications/41 patent families. He has received the Royal Society of Chemistry Harrison Medal; the British Vacuum Council Burch Prize; the International Association of Advanced Materials Medal. In 2016, he was elected as a Fellow of the Royal Society (FRS)-UK and Commonwealth National Academy of Sciences. His research has led to 3 successful start-up companies: Surface Innovations Ltd.; Dow Corning Plasma Ltd.; and P2i Ltd.

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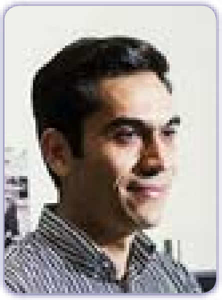

Hamed Sadeghian

Netherlands Organization for Applied Scientific Research, TNO, The Netherlands

Probing the nano-scale with the use of Nano-Opto-Mechatronics Instruments (NOMI)

Understanding the interactions of matter at nano-scale has become the key for the success of several applications. In nanoelectronics or semiconductor industry, it helps for better manufacturing (higher resolution towards sub-10 nm structures, more complex structures) and reliable nanometrology and nano-inspection (for improving the yield of process). One of the NOMI to probe the interactions at nano-scale is scanning probe microscope. The ability to accurately measure critical dimensions in nano-meter scale has made it an important instrument in several industrial applications such as semiconductor, solar and data storage. Single SPM has never been able to compete with other inspection systems in throughput, thus has not fulfilled the industry needs in throughput and cost. Further increase of the speed of the single SPM helps, but it still is far from the required throughput and, therefore, insufficient for high-volume manufacturing. The first part of my talk presents the development of a concept for a multiple miniaturized SPM (MSPM) heads system (parallel SPM), which can inspect and measure many sites in parallel. The very high speed of miniaturized SPM heads allows the user to scan many areas, each with the size of tens of micrometers, in few seconds. Various nanoimagings such as subsurface probe microscopy will also be presented. The second part of my talk is about meta-instrument. Meta-instrument is a type of optical nano-instrument where the core is based on optical metamaterials to go beyond the diffraction limits for high resolution imaging. Advantages of optical techniques compared to SPM is that they provide direct capture imaging which is fast and allow large fields of views to be covered quickly. The development of first generation of meta-instrument will be discussed in detail.

Biography

Hamed Sadeghian has received his PhD (Cum Laude) in 2010 from Delft University of Technology. He has continued his career as a Research Associate and developed several nano-opto-mechanical instruments for nano-scale interaction measurement. He is currently working as a Principal Scientist at TNO. His research program NOMI focuses on development of instruments based on the interaction of electromagnetic or mechanical/quantum waves with matter, with a focus on industrial and societal applications. Examples are the parallel AFM as a sub-nm, high throughput metrology and inspection solution for semiconductor industry and the high resolution optical microscopy with meta-instrument and 3D nano-tomography to resolve invisible nano-structures below the surface. He is the Scientific Leader of the TNO Early Research Program 3D nanomanufacturing. In the last 5 years, he has participated in several EU-funded projects such as E450EDL, E450LMDAP, SeNaTe, Value4Nano, 3DAM and TakeMi5. In 2014, he has received his MBA degree from Leuven Vlerick Business School, Belgium. He was also a co-founder of Jahesh Poulad Co. (2002), which designs, manufactures and installs mechanical and electrical equipment for steel industries. He holds 40 patents, and has (co-) authored more than 60 technical papers and a book. He is a member of the Editorial Advisory Board of *Sensors & Transducers Journal* and a member of the technical committee of SENSORDEVICES conference. In 2012, he has received the “TNO Excellent Researcher” award.

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Day 2

Jan J Dubowski, Res. Rev. J Mat. Sci. 2017
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Jan J Dubowski
University de Sherbrooke, Canada

Digital etching of III-V semiconductors in aqueous solutions

Etching of semiconducting materials at rates approaching atomic level resolution is of high interest to the advancement of technologies addressing fabrication of low-dimensional devices, tunability of their optoelectronic properties and precise control of device surface structure. The so- called digital etching that takes advantage of a self-limiting reaction has the potential to address some of these challenges. However, conventional applications of this approach proposed almost 30 years ago, require specialized and expensive equipment, which contributed to a relatively slow progress in penetration of digital etching to micro/nanofabrication processing schemes. We have observed that for photoluminescence (PL) emitting materials with negligible dark corrosion, it is possible to carry out PL-monitored photo-corrosion in cycles analogous to those employed in digital etching. The advantage of this approach is that photo-corrosion of materials, such as GaAs/AlGaAs hetero-structures, could be carried in a water environment. This digital photo-corrosion (DIP) process could be carried out in cycles, each approaching sub-monolayer precision. I will discuss fundamentals of DIP and mechanisms responsible for achieving high-resolution etch rates of semiconducting materials. For instance, we have demonstrated a successful dissolution of a 1-nm thick layer of GaAs embedded between $Al_{0.35}Ga_{0.65}As$ barriers in a 28% NH_4OHH_2O, and we claimed that under optimized conditions a further enhanced resolution is feasible. The nm-scale depth resolution achieved with DIP and low-cost of the instrumentation required by this process is of a potential interest to specialized diagnostics, structural analysis of multilayer nanostructures and, e.g., revealing *in-situ* selected interfaces required for the fabrication of advanced nano-architectures. We have explored the sensitivity of DIP to perturbations induced by electrically charged molecules, such as bacteria, immobilized on semiconductor surfaces. Here, I will highlight our recent studies on detection of *Escherichia coli* and *Legionella pneumophila* bacteria immobilized on antibody functionalized GaAs/AlGaAs biochips. I will also discuss the application of this approach for studying antibiotic reactions of bacteria growing on biofunctionalized surfaces of GaAs/AlGaAs biochips.

Biography

Jan J Dubowski received his PhD degree in Semiconductor Physics from the Wroclaw University of Technology, Poland. He is a Canada Research Chair and a full Professor at the Department of Electrical and Computer Engineering of the University de Sherbrooke, Canada. He is a Fellow of SPIE- The International Society for Optics and Photonics (citation: "For innovative methods of investigation of laser- matter interaction"). He has published over 200 research papers, reviews, book chapters and conference proceedings. He is an Associate Editor of the *Journal of Laser Micro/Nanoengineering, Biosensors and Light: Science & Applications.*

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Hao Gong

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Ni-based nanomaterials for high efficiency supercapacitors in energy storage

Nanomaterials have special properties, and have important applications in energy storage and many other devices. For energy storage, supercapacitors have attracted great interest and development. Supercapacitor has found a lot of applications in electric cars and other equipment. Different materials have been proposed and used for supercapacitors. In this presentation, high performance supercapacitors based on nanoscale Ni-based materials, which show very high specific capacitance and energy density are focused. The energy storage performance of such materials and devices are examined and the very high energy storage ability is discussed. Energy storage performance, microstructure, morphology and surface area are found strongly related to Ni and Co oxide structures and morphologies, and the incorporation of some other active materials also enhance performance. 3D core-shell structures contributing to energy storage is presented and discussed. Charged small full supercapacitors prototype will be shown to light up bulb and turn fans for a long time in this presentation.

Biography

Hao Gong is a Full Professor of Materials Science and Engineering at National University of Singapore. He is also the Co-ordinator of the Transmission Electron Microscopy Laboratory at Department of Materials Science and Engineering. His research interests include transparent oxide conductors and semiconductors (n-type and p-type), energy storage materials and devices (mainly supercapacitors), energy harvest materials and devices (mainly solar cells), gas sensors, functional thin film and nano-materials, materials characterization (mainly on transmission electron microscopy and electron diffraction). He received his BS degree in Physics at Yunnan University in 1982. He passed his MS courses in Yunnan University, carried out his MS thesis research work at Glasgow University, UK, and received MS degree of Electron and Ion Physics at Yunnan University in 1987. He then did his PhD at Materials Laboratory at Delft University of Technology, the Netherlands, and obtained PhD degree there in 1992. He joined National University of Singapore in 1992, and is currently Full Professor at Department of Materials Science and Engineering. He has published about 200 refereed papers in major international journals.

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